School of Built Environment

Department of Urban and Regional Planning

The role of smallholder farmers in sustaining household food security at Bialla and Hoskins oil palm land settlement schemes, Papua New Guinea

Veronica Gawi Bue

This thesis is presented for the Degree of

Doctor of Philosophy

at

Curtin University

December 2013

Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any other university.

Signature: .....

Date: 28th October, 2014

Acknowledgements

This dissertation would not have been possible without the assistance, guidance and goodwill of many people. My heart is filled with gratitude as I thank them all for their input in one way or another.

First and foremost, my sincere and heartfelt gratitude goes to my supervisors Professor George Curry and Dr. Gina Koczberski. This thesis would not have reached this standard worthy of examination if it were not for their time, guidance, invaluable inputs and encouragements right from the very beginning to the completion of this thesis. I am indebted to both of them.

My heartfelt thanks and appreciation goes to my research assistant, Masan Bernard. I would not have accomplished my fieldwork if it were not for his help and support and for providing security during five months fieldwork at Hoskins and Bialla oil palm project areas.

Many thanks and my heartfelt gratitude also goes to the smallholders at Kapore, Sarakolok, Tiauru, Kabaya and Kavui, for their time and for providing valuable information that formed the basis of this thesis.

There are several people at Hoskins and Bialla oil palm project areas that have contributed towards successful completion of my fieldwork and these people deserve to be mentioned. My thanks goes to these dear people for opening their homes to a stranger they had never met before. They are: Wesley and Yamas Fainame at Kapore subdivision, Simon Takun and family at Tiauru subdivision and Paul Kausa and family at Kabaya subdivision. I thank them for their kindness and friendship which I will forever treasure. Many thanks to the Papua New Guinea Oil Palm Research Association (PNGOPRA) and the Oil Palm Industry Corporation (OPIC) Bialla managements for providing office space during my fieldwork.

Thanks are due to the staff of PNGOPRA namely: Dr. Ian Orrell, Douglas, Emmanuel, Elizabeth, Joe, Joyce, Cathy, Aloiysia, Winston and previous staff: Pauline, Jesse, Pole, Dean and Carol. Also thanks to Steve Oiza (OPIC-Hoskins Project Manager) and his staff at Hoskins project especially, Ben Darius, Frank Bao and Hosea Sule and their Extension Officers, Alex and Benson. Thanks and appreciation is also due to Otto Pukam (OPIC-Bialla Project Manager), Paul Kausa (OPIC-Bialla Field Manager) and their Extension Officers and support staff at Bialla.

There are people who have provided help towards this thesis who also deserve mention. Linda Browning, who proof read and edited the final version of this thesis. James Vuvu (New Britain Palm Oil Limited-NBPOL) produced maps of the study locations. Adella Edwards (James Cook University) kindly assisted with producing a map of palm oil mills PNG for the thesis and Sean Ryan (Curtin University) provided help one way or another when needed.

This study would not have been possible without the support of the Australian Centre for International Agricultural Research (ACIAR) who provided the scholarship of which I am most grateful. Thanks to Curtin University which provided a conducive environment for learning. Thanks are also due to my employer PNG University of Technology who granted me study leave. Within the Agriculture Department, Professor Abdul Halim had been instrumental in me taking up the studies – my heartfelt thanks go to him. Thanks to the Agriculture Departmental staff namely: Dr. Shamsul Akanda for advice and encouragement, Betty Tiko, Ngayamo Antonio and Geraldine Kapipi for promptly attending to my queries and other personal issues upon request.

To my family, your love, support, encouragement and prayers are much appreciated with heartfelt gratitude. To Christine and Linda, thank you for giving me another chance to prove myself. This thesis is dedicated to both of you.

-To God be the Glory-

Abstract

The thesis examines household food security on two oil palm Land Settlement Schemes (LSSs) in West New Britain Province, Papua New Guinea. The thesis draws on Cecilie Benjamin's (1977b) work in the mid-1970s. She warned of future risk of food shortages, mainly on the older LSS subdivisions, as a result of planting all of their 6 ha leasehold block to oil palm without reserving land for food gardening. In the late 1960s and early 1970s when smallholders resettled on the schemes, there was enough land to meet the food gardening needs of these predominantly single household blocks. However, over the years the area of land on-block available for food gardening has contracted as households started planting their 2 ha garden reserve areas to oil palm because of high oil palm prices and high cash demands by multiple families now living on the blocks. Although food gardening had been an integral part of these settlers' lives since their resettlement and has continued to be an important livelihood activity to the present, food security is being undermined because of shortages of garden land. This thesis explores how smallholder households maintain household food security amidst garden land shortages and pressures on other block resources such as oil palm income. This involved the investigation of: (1) smallholder households' daily livelihood activities; (2) various strategies smallholder households were pursuing to address the problem of garden land shortages; and (3) household socio-economic and demographic factors influencing household food security.

Both quantitative and qualitative data collection methods were used including household, garden and dietary recall surveys, case studies, interviews and participant observation. Household surveys collected information on the demographic and socio-economic characteristics of smallholder households which provided the basis for the selection of sub-samples for in-depth study.

Household food intake data were collected in 2010 and 2013 during periods of high and low oil palm prices respectively. During fieldwork in 2010 the price of oil palm was high at K265 per tonne and dropped to K133.37 in January 2013 during the

second round of dietary surveys. Data collected during these two different situations provided insights into the impact of cash income on household daily food consumption during periods of high and low oil palm prices.

Smallholder households were involved in a diverse range of livelihood activities. Spending labour and time in different activities by all family members contributed to family sustenance and wellbeing of all family members. Activities were structured by gender with women involved more in domestic work and food gardening while men spent more labour and time in oil palm work.

Locating gardening land in new locations, intensification of food crop production and involvement in non-oil palm income-earning activities were important livelihood strategies pursued by households to address the problem of garden land shortages. Households were locating gardens in new areas on and off the block. Gardening on oil palm replant sections on the oil palm blocks of others was the most common way to access additional land for food gardening using reciprocal gardening arrangements formed through kinship and social networks. Households were intensifying their food crop production by integrating new soil and crop management practices into their farming systems. These practices included: interplanting a variety of traditional and introduced crops on the same plot of land, rotating crops with legumes (peanut and bean), using pesticides and fertilizers and cultivating crop varieties that mature quickly and are tolerant of pests and less fertile soils. Gardens were cultivated primarily for household consumption with surpluses sold at local food markets. High value crops such as peanut and *Brassica cvs* that gave good returns to labour and were predominantly cultivated by secondary households (households that were not the main households owning the block) throughout all subdivisions.

Households were also involved in non-oil palm income earning activities that supplemented oil palm income. Marketing of food crops and other items, wage employment off-block and broiler production were the three most important activities. Women were more involved in marketing of food crops and other items while men dominated wage employment. Secondary households were mostly involved in non-oil palm income-earning activities which were important for them as they did not share much of the oil palm income.

Household Dietary Diversity (HDD) and Food Consumption (FC) scores revealed that smallholder households had nutritionally adequate diets indicating that the status of household food security was generally good on the LSS. Most households consumed two meals per day with most meal ingredients being from smallholders' own food gardens, though store foods provided an important supplement. Households switched between store and gardens foods depending on the price of oil palm. Relationships were identified between household fortnightly income and daily food expenditure. Store foods such as tinned fish/meat, fresh meat, fish and chicken increased the HDD and FC scores indicating that income is a primary determinant of diet quality for people living on the LSS. Hence, predictions made by earlier researchers of future risks to food shortages have not eventuated because they underestimated the capacity of smallholder households to intensify food production and to employ a diverse range of strategies to increase the supply of land for food gardening.

Table of Contents

List of Figures

List of Tables

List of Boxes

List of Plates

List of Acronyms and Abbreviations

ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
AUD	Australian Dollar
AusAID	Australian Agency for International Development
BMI	Body Mass Index
BFP	Body Fat Per cent
CLUA	Clan Land Usage Agreement
CCHIP	Community Children Hunger Identification Project
CRP	Customary Rights Purchase
DAL	Department of Agriculture and Livestock, PNG
DFID	Department for International Development, UK
DDS	Dietary Diversity Score
DM	Divisional Manager
ENB	East New Britain
EU	European Union
FSM	Federated State of Micronesia
FAO	Food and Agriculture Organisation of the United Nations
FCG	Food Consumption Group
FCS	Food Consumption Score
FVS	Food Variety Score
FFBs	Fresh Fruit Bunches
FICI	Food Import Capability Index
GOs	Government Organisations

GDP	Gross Domestic Product
HDDS	Household Dietary Diversity Score
HFIAS	Household Food Insecurity Access Scale
HOPL	Hargy Oil Palm Limited
IE	Independent Estate
IDA	International Development Assistance
IFAD	International Fund for Agricultural Development
LPC	Land Planning Committee
LSSs	Land Settlement Schemes
LDCs	Least Development Countries
LIFDCs	Low-Income Food Deficit Countries
MDGs	Millennium Development Goals
NNS	National Nutrition Survey
NICs	Net Importing Countries
NBPOL	New Britain Palm Oil Limited
NGOs	Non-government Organisations
OPIC	Oil Palm Industry Corporation
PGK	Papua New Guinea Kina
PICs	Pacific Island Countries
PMV	Public Motor Vehicle
PNG	Papua New Guinea
PNGDB	Papua New Guinea Development Bank
PNGOPRA	PNG Oil Palm Research Association
PSNPs	Productive Safety Net Programs
RCS	Ration Card System

SPSS	Statistical Package for Social Science
SEO	Senior Extension Officer
SP	Social Protection
SLF	Sustainable Livelihood Framework
UK	United Kingdom
USDA	United States Department of Agriculture
USDL	United States Department of Labour
UNOs	United Nations Organisations
USA	United States of America
VOP	Village Oil Palm
WNBP	West New Britain Province
WB	World Bank
WFC	World Food Conference
WFP	World Food Program
WFS	World Food Summit

CHAPTER ONE

INTRODUCTION

Introduction

This thesis examines household food security among oil palm smallholders residing on state agricultural leasehold land on the oil palm Land Settlement Schemes (LSSs) in West New Britain Province (WNBP), Papua New Guinea (PNG). Over the last decade concerns have been raised about the declining access to garden land on the LSSs and the potential impacts on household food security and women's income (Koczberski *et al*. 2001b; Curry *et al*. 2007; Koczberski *et al*. 2012). In the 1970s, Cecile Benjamin (1977a: 70) warned that households on smaller blocks would be facing shortages in gardening land in the future which would have implications on household food security if leasehold blocks were fully planted to oil palm leaving no land for food gardening. Currently, all 6 ha leasehold blocks in the older subdivisions such as Kapore, Sarakolok and Tiauru have been fully planted to oil palm. Hence, this thesis with its focus on examining the status of household food security amidst population and land pressures aims to document how smallholders are adapting to declining access to gardening land to maintain household food security. It also aims to identify the main demographic and socio-economic characteristics of smallholders influencing the status of household food security.

Background setting

Food security is a global issue and a concern in many developing countries including PNG. Since the 1980s, the issue of food security has shifted from the international level in the context of world food supply to a more direct focus at the household and individual levels. This shift in attention is because a country that is self-sufficient in food is not necessarily food secure. Likewise, in a country that is food secure at the national level it does not always mean that at the household level food security is

guaranteed. Furthermore, within the household unit different family members such as pregnant and breast-feeding women and children have different food requirements than others for a healthy life. This means that the household must be able to produce or purchase nutritious food at all times, and on an on-going basis, without experiencing food shortages. If nutritious food is available or can be accessed at all times to meet the dietary needs of all its members, only then can the household be deemed food secure (Food and Agriculture Organisation-FAO, 2010b).

Levels of food security vary between and within countries and even from one locality to another within a country (an example of the latter is PNG. See Chapter 3). Household food insecurity is caused by many factors including poverty, extreme climatic events, natural disasters, increases in the price of basic foods, war and civil unrest and poor governance. These factors can occur independently or collectively causing devastating results on household food security. Factors such as extreme climatic conditions, natural disasters and increases in the price of basic food stuffs most often cause temporary food shortages. In contrast, war and civil unrest that displaces people and can lead to a breakdown in livelihoods can cause long-term or permanent food shortages. Often after a war or civil unrest it can take years to restore livelihoods to their original state. Also, poverty is observed as one of the main causes of food insecurity in developing countries (Chambers, 1983; Conway, 1999; Australian Government-AusAID, 2004). Poverty occurs as a result of households having few or no productive assets to produce food, generate cash income or ability to diversify livelihood activities, especially during unfavourable situations. Poor households drift in and out of food shortages throughout their lifetime. Often, households which are trapped in poverty are not able to emerge from the trap and the cycle continues into the next generation.

Countries that are most food insecure are those which are highly dependent on imported staple foods such as grains to meet their daily food requirements. These are countries labeled by FAO (2008; 2010a) as Net-Importing Countries (NICs) and Low-Income Food Deficit Countries (LIFDCs). Most of these countries are located in Sub-Saharan Africa. The problem of food insecurity is high in these countries because of landlessness due to high population pressures and civil unrest causing unstable livelihoods (United Nations, 2010).

PNG is the largest country in the Pacific and its food security status differs from other Pacific Island Countries (PICs) and many other developing countries. In PNG, the overall level of food security is high. The country has a large resource base for both agricultural production and mineral extraction. One of the key factors that makes PNG more food secure than other developing countries and smaller PICs is that more than 80% of the population live in rural areas (Gwaiseuk, 2001) where they own land communally and largely depend on subsistence food production for their daily dietary intakes. Around 85% of land in PNG is under customary tenure (Filer, 2012). The rural population sustains itself from subsistence food production supplemented with foraging activities and cash income generated from the sale of food and export cash crops (McAlpine *et al*. 1983; Allen *et al*. 1995; Bourke, 2001a). With good access to land and strong subsistence agricultural systems, the bulk of the food consumed in PNG is locally produced. Eighty-three per cent of food energy and 76% of food protein are obtained from local production (see Gibson, 2001; Bourke *et al*. 2009). The balance of food energy and protein is obtained from imported foods such as rice, wheat products, beef, lamb and dairy products. Furthermore, high yielding crop varieties and improved farming practices are being integrated into the subsistence farming systems increasing food crop production, thus enhancing household food security. Likewise, rural people are increasingly involved in the cash economy, and cash is used to purchase food when it is not produced by people themselves and during temporary food shortages.

In PNG, the bulk of imported food caters mostly for the urban population (Gibson, 2001: 47) and acts as a supplement or occasional food substitute for the rural population. The urban poor and those urban dwellers who are highly dependent on imported food for their daily dietary intake are vulnerable to fluctuations in the price of basic food stuffs and the high cost of other services. As a result, urban households may experience reductions in the quality, quantity and the number of daily meals; often sacrificing the education and health of their children, for the provision of food (McGregor *et al*. 2009: 36). On the other hand, price rises for imported food such as rice and wheat products motivate rural farmers to produce more local staples and to supply urban markets. Whilst reaping the economic benefits of this situation, farmers significantly contribute to food security in the urban centres, as people turn to local staples which become more affordable than imported foods during periods of price

inflation. In terms of its trading capacity, PNG has the lowest Food Import Capability Index (FICI)[1] of 0.12 compared with the standard of 0.5 in other PICs, which indicates that it is the least vulnerable country in the South Pacific in terms of food security (McGregor *et al*. 2009). The low FICI reflects that PNG generally has a good balance of trade between its imports and exports compared with trade imbalances observed in other Pacific Island countries (such as Samoa and the Cook Islands) with high FICI indexes, indicating that they import more food than they export.

Though, the status of food security in PNG is generally good, there are pockets of vulnerable locations throughout the country. One of the main causes of household food insecurity is the adverse physical environment and climatic conditions experienced in certain locations in the country. These factors determine the type of farming systems conducted in various climatic zones which have an impact on food availability and the quality of food consumed. For instance, as pointed out by Bourke (2001a), there are certain rural locations in the high altitude areas and small islands and atolls where the climate and the physical environment do not allow cultivation of a wide variety of staple food crops making them susceptible to extreme climatic conditions. Also, in some remote locations, the rough and rugged topography coupled with high rainfall patterns often makes it hard for households to engage in agricultural activities, thus depriving them from cultivating crops of high nutritional value (such as vegetables and legumes) to supplement their diets (Allen, 2009). Another contributing factor is the absence or lack of a range of income earning opportunities in some rural areas thus depriving rural residents of cash income which can be used to purchase food when it is not produced or used to purchase high quality store foods to supplement carbohydrate diets. As a result, these households are vulnerable to food insecurity.

Other locations in PNG that are vulnerable to household food security include urban centres and state sponsored LSSs. Concerns have emerged in recent years regarding the status of household food security in these locations. There is an influx of migrants from rural areas into urban centres seeking economic opportunities or basic government services lacking in rural areas (Koczberski *et al*. 2001a; Numbassa and Koczberski, 2012). These migrants add to the pool of the urban poor. Without a

steady source of income and lacking good access to land for food gardening, they have high dependence on purchased food and, therefore, are highly vulnerable to price increases of basic foods. Most often they miss out on basic utilities and services such as clean water, proper sanitation, health and education (Bryant-Tokalau, 1995). The state sponsored oil palm LSSs at Hoskins and Bialla in WNBP are amongst locations where there are threats to household food security due to high population pressures and scarcity of land for food gardens (Curry *et al*. 2007). It is these LSSs which are the focus of this study.

Overview of LSSs in PNG

The establishment of LSSs in PNG dates back to the colonial administration under the Australian Government. Between the 1950s and the 1970s several LSSs were established throughout the country, both on the coastal mainland and in the islands region (Hulme, 1984). The primary reasons for the establishment of these schemes were to involve rural subsistence farmers in cash cropping as a livelihood activity to improve their living standards and at the same time contribute to national economic development through developing the commercial agricultural sector in PNG (Asian Development Bank-ADB, 1999; Grieve, 1986). Other reasons for establishing LSSs included putting into productive use "unoccupied" arable customary land, increasing the production of animal or food crops to supply the urban population and to create employment opportunities in project areas (Hulme, 1984).

To set up the LSSs, the Australian Administration bought the land from customary land owners and converted the land to state agricultural leases. The land was then leased on 99-year lease agreements to those interested in cultivating cash crops. Establishment of the initial LSSs in the country was mostly under cocoa and coconut. With the cocoa and coconut LSSs, the Administration obtained land near villagers so that smallholders lived and sustained themselves from their customary land and cultivated cash crops on their nearby 2 ha leasehold blocks. In contrast, those schemes that were set up to cater for land-short areas and the commercial cultivation of cash crops involved migration from within or outside the provinces to resettle on leasehold blocks.

Establishment of the LSSs took different forms and varied in their inputs from the government. In-kind inputs included basic infrastructure and services such as roads,

bridges, health services and schools. Financial assistance was allocated through establishment loans that catered for the settlers' needs such as housing materials, water tanks, agricultural inputs and other establishment needs (see Hulme, 1984). Those LSSs that were established purposely to alleviate population pressure and land shortage problems in the country had less financial support from the government than those that were established for the production of export crops, especially those established on a nucleus-estate smallholder model.

Oil Palm LSSs in WNBP

The oil palm LSSs, based on the nucleus-estate smallholder model, was the most successful of all the schemes established by the Administration (Hulme, 1984). One of the main reasons for initiating the oil palm LSSs was to expand commercial agriculture in PNG (Koczberski, 2011). To achieve this customary land tenure was replaced with individualised land tenure.

The oil palm LSSs were established between the late 1960s and 1994 (Grieve, 1986; Koczberski *et al.* 2001b). The success of the oil palm LSSs was due to a number of factors including: high input from the government at the establishment phase in cash and in-kind, international aid assistance that adequately financed the project, proper planning, and linkages amongst smallholders, the milling company and the extension service provider (the Oil Palm Industry Corporation-OPIC)[2]. Assistance in-kind by the government included infrastructure and basic government services and utilities provided at well-established community centres in each subdivision which included:

- primary school and teachers' housing
- health clinic and staff housing
- meeting and marketing hall
- trade stores
- OPIC office and staff housing and
- religious facilities

During the establishment phase, the leasehold blocks were advertised formally and rural villagers applied for blocks, with priority given to applicants from land-short and highly populated areas of the country. The main areas of recruitment included the Gazelle Peninsula of ENB, Chimbu and East Sepik Provinces. A large number of

settlers also come from the provinces of Morobe and West Sepik (Benjamin, 1977a). As a result, there is a representation of diverse ethnic groups living on the LSSs with the majority originating from the provinces of East Sepik, Chimbu and East New Britain who settled at Hoskins (Benjamin, 1977a). Most of the original settlers who arrived at Hoskins in the late 1960s and 1970s are now elderly or deceased. Currently, many of the second and third generation settlers manage the blocks.

When the original migrants settled on the scheme, they were allocated around 6.05 ha of land under a 99-year agricultural lease from the government (Jonas, 1972; Hulme, 1984). At the time, around 4 ha of land towards the front of the blocks facing feeder roads were expected to be planted with oil palm (Figure 1.1). On this 4 ha, about 0.25 ha was used for the homestead area. Fruit trees, coconuts, betelnut and small kitchen gardens were commonly cultivated around the homestead area (Benjamin, 1977a). The remaining 2 ha at the rear of the block were reserved for food gardening. Food gardening was integral to the lives of these smallholders and a substantial proportion of their diets was obtained from their own gardens (Jonas, 1972; Benjamin, 1977a; Hulme, 1984). Also, during the initial stages of the schemes, these gardens provided for their daily dietary needs until the oil palm came into production.

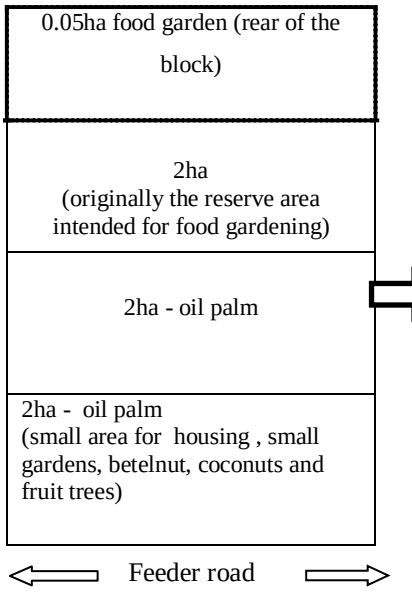


Figure 1.1: Schematic diagram of a leasehold block arrangement.

Plate 1.1: Front of the block facing the feeder road.

Income earned from oil palm was used to purchase store foods to supplement garden foods. Over the years, the rear 2 ha garden reserve area has been gradually planted to oil palm and currently all 6 ha have been fully planted to oil palm in the older subdivisions of Hoskins and Bialla LSSs (OPIC, 2012) (see Chapter 6 for further discussion).

Hoskins project

The Hoskins LSS, established in 1967 is the oldest and the most successful of all the oil palm schemes in the country. The scheme is made up of 9 subdivisions, each comprising 130-320 blocks. Kapore and Tamba subdivisions were the first to be established in 1968 followed by Sarakolok, Buvusi, Galai, Kavui and Kavungara consecutively (Table 1.1). The Siki and Dagi subdivisions were originally cocoa blocks but were redeveloped into oil palm in the 1980s. These blocks are large relative to the LSS blocks of 6 to 6.5 ha hence smallholders at Siki and Dagi still maintain their cocoa and coconut holdings as well as oil palm. By December 2012, 2,368 LSS blocks at Hoskins were planted with oil palm (Orrell, 2012).

Table 1.1: Subdivisions in the Hoskins LSS

LSS Scheme	Year Established
Kapore	1968
Tamba	1968
Sarakolok	1969
Buvusi	1970
Galai 1 and 2	1971
Kavui	1972
Kavungara	1972
Siki	1980s
Dagi	1980s

Source: Benjamin, (1977a: 60).

Bialla project

Following the success of the Hoskins scheme, Bialla LSS was established in 1972, based on the same model. The design of the subdivisions in Bialla LSS is similar to Hoskins apart from the larger block sizes of around 8 to 12 ha redeveloped from cocoa and coconut blocks. The planning of the Bialla LSS took place in two stages. Initially, oil palm LSS blocks were established on redeveloped cocoa and coconut blocks which were on state agricultural leased land. These subdivisions included Sale, Sege, Malasi, Uasilau and Silanga. The redeveloped schemes were mostly

occupied by local landowners. The second stage of development involved the establishment of subdivisions on alienated customary land obtained by the government. Similar to the Hoskins project, the milling company developed the nucleus estate and the government was responsible for the LSS subdivisions. These subdivisions were Tiauru, Wilelo, Lalopo, Barema, Soi and Kabaya. Soi and Kabaya were recently established in 1994 to cater for migrants from the highly populated atolls of WNBP and second and third generation settlers from the Hoskins project. Thus, there is a diverse representation of ethnic groups on the Bialla scheme. The other oil palm LSS in PNG that was established was in Popondetta, Oro Province.

In the 1980s after the LSSs were successfully established, focus was directed to the indigenous landowners to encourage them to develop their land through the cultivation of oil palm under the Village Oil Palm (VOP) scheme. Similarly, financial assistance in loans was given to the VOP growers by the Papua New Guinea Development Bank (PNGDB) to purchase seedlings and production inputs. Hence, in the 1980s, the VOP scheme was initiated in the Bialla project area. VOP schemes continued to increase over the years in Hoskins and Bialla project areas and by December 2012, there were a total of 1,782 VOP[3] and 70 Customary Rights Purchased blocks (CRP)[4] in Bialla and 4,114 VOP and 959 CRP blocks in Hoskins (Orrell, 2012). There is an increase in the purchase of CRP blocks in the Hoskins and Bialla project areas because of the high population pressure on the LSS where second and third generation settlers are looking for ways to source land for oil palm cultivation to sustain their livelihoods.

The oil palm industry

Currently, oil palm is grown in six locations in five provinces of PNG (Figure 1.2) and supports some 200,000 smallholders living on 19,777 smallholder blocks (Orrell, 2012). Oil palm plantings have expanded over the years as has the production of oil palm and the exports of palm oil products (see Koczberski *et al*. 2001b; NBPOL 2008; 2009; 2010/11; 2011). Since the first exports of palm oil in the 1970s, production has climbed over the years and is now by far the largest agricultural export commodity. Currently, it is the leading cash crop in the agricultural sector contributing significantly to the country's export earnings and Gross Domestic Product (GDP) (Talu, 2011). In 2012, palm oil constituted more than half of the total

agricultural tree crop export earnings followed by coffee, cocoa, coconut, rubber and tea (Orrell, 2012) (Figure 1.3).

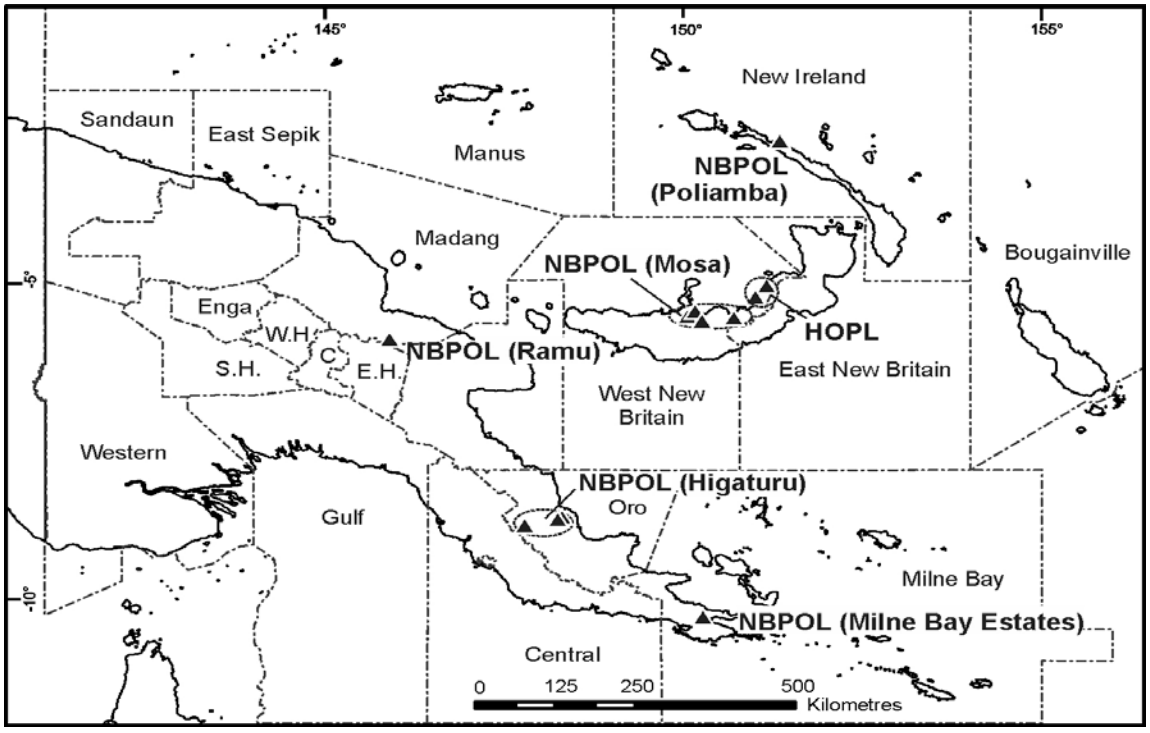


Figure 1.2: Location of palm oil mills in PNG. Adapted from Nelson *et al.* (2013).

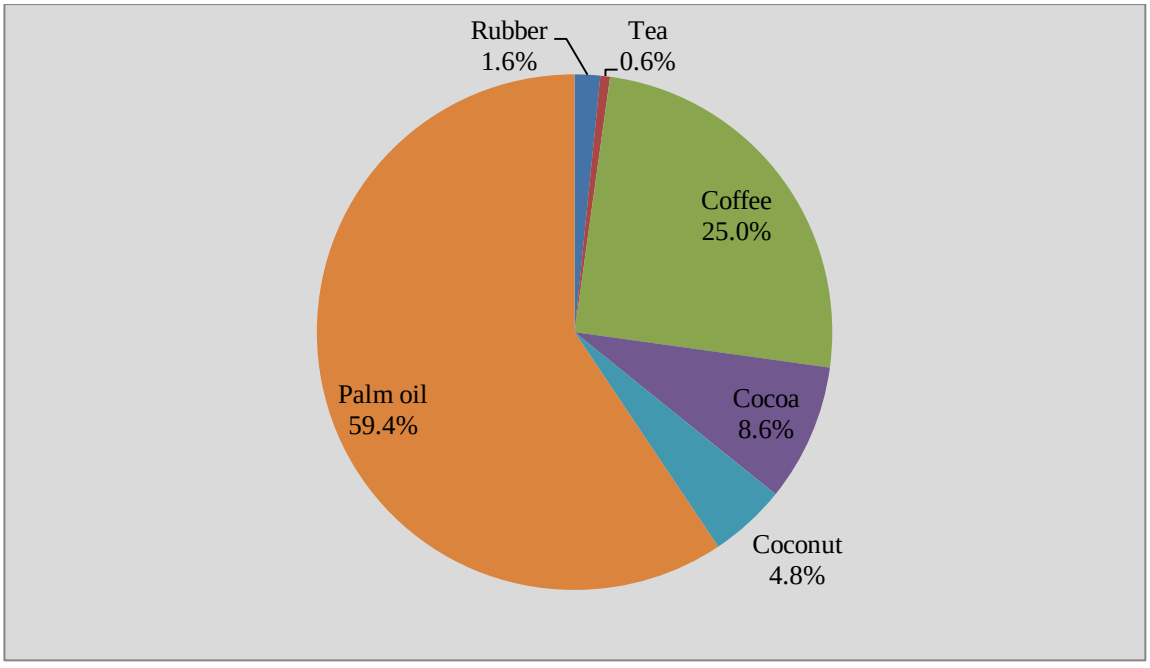


Figure 1.3: Value of PNG agricultural exports in 2012. Source: Orrell, (2012: 4)

Emerging trends

Despite the overall success of the industry, socio-economic problems have arisen on the LSSs over recent years. During the establishment of the LSSs, single families were resettled on the scheme. However, over the years block population has increased and there are now two or more families residing on a block, mainly in the older LSS subdivisions (Koczberski, *et al*. 2001b; Dewhurst, 2007). For example, in the Hoskins LSS (the oldest LSS) population density in 1975 was 7 persons per block (Benjamin, 1977b) which increased to 8.6 persons per block in 1990, after nine years. Population continued to increase and in 2000, there was an average of 13.3 persons per block living in the Hoskins LSS and 11.1 persons in Bialla (Koczberski and Curry, 2005). Fieldwork conducted 10 years later in 2010 indicated that the population density in Hoskins LSS had increased to around 15 persons per block (see Chapter 6). With a larger population, cash demands have also increased which has led to all 6 ha being fully planted to oil palm (OPIC, 2012). This has been at the expense of land for food gardens.

Research questions

This raises the key question of the thesis: how are smallholders maintaining household food security on the older LSSs amidst population pressure and garden land shortages? To answer this, the following related research questions were asked to formulate study objectives for investigation.

1. How do household members allocate their labour and time to oil palm production, food gardening and other livelihood activities for family sustenance?

2. What type of strategies are smallholders pursuing to address the problem of garden land shortages in order to sustain household food security on the older LSSs?

3. How do certain household socio-economic and demographic characteristics of the smallholder households influence the status of household food security and what is the current status of household food security on the LSS?

Study objectives

Based on the research questions, the study objectives were formulated as follows.

1. Document how household members allocate their labour and time to oil palm production, food gardening and other livelihood activities for family sustenance.
2. Identify and describe the types of strategies households are pursuing to address the problem of garden land shortages on the older LSSs.
3. Identify which household demographic and socio-economic characteristics influence the status of household food security and assess the current status of household food security on the LSS.

Each objective is described in more detail below.

Primary households are the centre of most of my investigations. Primary households are made up of the blockholder (typically the original leaseholder, if alive) and his immediate family members. The blockholder is in charge and makes decisions regarding the affairs of the block. Thus, most of the daily livelihood activities recorded revolved around the primary household unit. Other co-resident households on the block are defined as secondary households. These households have less of a share in oil palm income and operate as separate households. The first objective was to examine the involvement of the blockholder and his family members (primary household) in oil palm production and other livelihood activities and to observe where food gardening and non-oil palm income-earning activities fit within their daily suite of livelihood activities. This was explored by documenting how the blockholder and his family spent their time and labour in various livelihood activities including oil palm production, food gardening and non-oil palm income-earning activities. Equal samples of men and women were investigated to observe gender divisions of labour within the household unit.

The second objective was to examine and document the type of strategies smallholders were pursuing to respond to declining access to gardening land. This included examining the gardens cultivated by both primary and secondary households as food was mostly shared amongst households on the block. Benjamin's 1975 gardening study (1977a; 1977b) on the Hoskins LSS was used as the

benchmark to explore how gardening systems had changed over time and how smallholders were adapting to shortages of land for food gardening.

The third objective was to examine the status of household food security on the LSSs by examining the meal composition and consumption frequency of smallholder households by recording the number of meals consumed per day, meal ingredients and meal sources. Meal quality was assessed using the Household Dietary Diversity Score (HDDS) and the Food Consumption Score (FCS) developed by Food and Agriculture Organisation (FAO, 2007) and the World Food Program (WFP, 2008) respectively. Household vulnerability to food insecurity was examined through the FCS. Statistical correlations between demographic and socio-economic characteristics of smallholders and the status of household food security were also explored to identify how certain characteristics of smallholder households were related to household food security.

Significance of the study

In a 2007 report by Curry *et al*. concerns were raised about the declining access to garden lands on the LSSs and the potential impacts on household food security and women's income. The report recommended that further research be initiated to examine smallholder food security and the role of gardens in household incomes. Since Benjamin's studies (1977a and 1977b) on food gardens on the Hoskins LSS, there has been no research on food security on the LSSs, thus this research fills this void.

It is envisaged that findings from this research will contribute to filling in knowledge gaps within the broader context of smallholder livelihoods, land shortages and household food security in PNG and the Pacific. The research has significance for food security issues in other parts of PNG where people have limited access to land such as in urban centres, and at plantation sites and mining locations where large numbers of migrants from elsewhere in PNG settle. Similarly, it has significance for other PICs and developing countries experiencing similar processes of urbanisation and internal migration patterns. The study will also contribute to a theoretical understanding of factors strengthening or undermining food security in general. The thesis also has significance at the policy level. First, it will provide vital information for OPIC to formulate appropriate policies to support smallholder livelihood

strategies that help reduce household vulnerability to food insecurity. Second, as part of an ACIAR project (ASEM/2006/127-Commercial sector/smallholder partnerships for improving incomes in the oil palm and cocoa industries in Papua New Guinea), this research will provide baseline information and help in developing future research strategies on food security amongst oil palm smallholders.

Thesis structure

Chapters 2 and 3 review the literature related to this study. Chapter 2 discusses food security from the global context to the household level. It highlights the main factors causing food insecurity and the impact they have on households, mainly in developing countries. The chapter further points out why some developing countries are more vulnerable to household food insecurity than others. Chapter 3 discusses the status of food security in PNG and the PICs, highlighting why the status of food security in PNG is generally good compared with other PICs.

Chapter 4 outlines the research methods. The chapter begins by reviewing quantitative and qualitative research methods where it highlights the appropriate use of these research approaches. The Chapter then discusses the mixed method approach of data collection used for this research. This is followed by reviews of the different methods used by other researchers to assess the status of household food security. It discusses the FCS and HDDS, to measure household food security and justifies their use in this study.

Chapters 5 to 9 presents research findings. Chapter 5 discusses the different livelihood activities smallholder households were engaged in for family sustenance. The chapter points out the significance of time and labour allocations by different family members to various livelihood activities which contribute to the overall wellbeing of the family.

Most livelihood activities rotate around oil palm production but oil palm is one of many activities. Amidst the various activities, the chapter aims to bring to view food gardening and non-oil palm income-earning activities as part of the suite of livelihood activities. These two activities are important strategies smallholder households have adopted to address pressures on block resources such as garden land shortages to maintain household food security.

Chapters 6 and 7 discuss two gardening strategies smallholder households have adopted to respond to garden land shortages on the older LSSs. Chapter 6 examines intensification of food crop production as one of the strategies smallholder households have adopted to maintain crop yields. The chapter begins by discussing changes in the food gardening systems over time with reference to Benjamin's garden survey in 1975. Though the agricultural system under oil palm production is under pressure as predicted by Benjamin (1977a; 1977b), the chapter argues that smallholders have modified their gardening practices around oil palm production to maintain crop yields, thus contributing to household food security.

Chapter 7 presents discussions on how smallholder households were accessing additional land for food gardening which was not observed in the past. The chapter highlights households' use of oil palm replant sections as an innovative strategy they were employing to gain access to additional garden land, and how they drew on their kinship and social networks to facilitate land access away from the block.

Chapter 8 looks at the third strategy smallholders have adopted to address the problem of garden land shortages and pressures on oil palm income, and that is by engaging in non-oil palm income-earning activities. The chapter discusses primary households' involvement in various income-earning activities and further highlights women's contribution to household food security through their involvement in these activities. A brief overview is also given on the involvement of secondary households in non-oil palm income-earning activities and how these differ from the livelihood strategies of primary households.

Chapter 9 presents findings on the status of household food security on the LSSs. The chapter assesses whether the three strategies adopted by smallholder households were sustaining household food security on the oil palm LSSs. The Chapter begins by highlighting the characteristic profile of the smallholder households which enhances our understanding of 'how' and 'why' smallholders respond to different situations in maintaining household food security on the LSSs. Next, daily diets of the smallholder households are assessed with further discussion of the impact of income on households' daily diets, further pointing out the importance of non-oil palm income, mainly for secondary households. The quantity and the quality of diets using the HDDS and FCS are discussed in relation to food secure and insecure

households further pointing out certain study variables that have an impact on the overall status of household food security on the LSS. Finally, the Chapter concludes that smallholders and block residents are maintaining household food security despite predictions of food shortages by Benjamin (1977a).

Chapter 10 presents the conclusions and recommendations of the study. The chapter summarises the findings of the research and notes the different strategies smallholders pursued to sustain household food security on the LSSs. The Chapter then outlines recommendations based on the findings of the research.

Notes

1. The FICI is an indicator developed and used by FAO to measure a country's vulnerability to food insecurity on the basis of its total food imports against its total exports. Countries with FICI of more than 0.5 are considered vulnerable to food security and those with 1.0 are highly vulnerable. Countries with less than 0.5 are less vulnerable. PNG falls under this latter category and is the least vulnerable (0.12) of the Pacific Island States (McGregor *et al.* 2009).

2. OPIC is a statutory organisation that took over the role of the Department of Agriculture and Livestock (DAL) in 1992 to provide oil palm extension services to smallholders. OPIC acts as a link between the smallholders and other industry stakeholders such as the milling company where issues raised by the smallholders or other stakeholders are addressed. This takes place through the Local Planning Committee (LPC) which consists of representatives from the milling Company, Papua New Guinea Oil Palm Research Association (PNGOPRA), provincial government and smallholders from the oil palm associations representing the six project areas (Koczberski *et al*. 2001b).

3. VOPs are established on customary land under Clan Land Usage Agreements (CLUA) where customary land tenure has been modified to accommodate individual land titling to enhance villagers access to loans for the development of their blocks (Koczberski *et al*. 2001b).

4. CRP –These are oil palm blocks on customary land. The land has been purchased from customary land owners by non-clan members for the cultivation of oil palm. Most of the land transactions are informal to the extent that there is often uncertainty in ownership. This type of transaction to purchase customary blocks is common in the Hoskins project but also occurs in other projects including Bialla and Popondetta (Curry *et al*. 2007; Koczberski *et al*. 2009).

CHAPTER 2

AN OVERVIEW OF GLOBAL FOOD SECURITY

Introduction

This chapter reviews the literature on food security issues at the global scale. The chapter begins by defining the concept of food security. Next the status of food security at the global level is discussed, highlighting the main causes of food insecurity and their impact on households. The Food and Agriculture Organisation's (FAO) reasons for labelling certain countries as food insecure are also discussed.

The concept of food security

The concept of food security was initially introduced at the 1948 United Nation's Declaration of Human Rights convention. Its definition has changed over the years to specifically address the situation of food supply and demand at the international, national and the household level. At the World Food Conference (WFC) held in 1974, the focus on food security was on food supply and the availability of food. Hence, policies were put in place to stabilise the prices of basic foods at the international and national level. The concern for food supply and availability at that time was reflected in the definition of food security as being the "availability at all times of adequate world food supplies of basic foods to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (FAO, 2006b: 1).

In 1983, the FAO modified the definition of food security to include the concept of food access with a direct focus on the household and the individual. Then at the 1996 World Food Summit (WFS) "food utilization" and "stability" were integrated into the definition of food security, thus putting into perspective the health and wellbeing of the individual at all times. The revised definition appropriately reflects the

individual's human right to have access to adequate nutritious food at all times and states that food security is guaranteed when there is "physical, social and economic access to sufficient, safe and nutritious food that meets the dietary needs and food preferences for an active and healthy life for all people at all times" (FAO, 2010a: 11). Conway (1999: 12) elaborates by stating that "a nation is food secure only if each and every one of its inhabitants … has access at all times to food required to lead a healthy and productive life". This means that a country that is self-reliant is not necessarily food secure. Likewise, it is not guaranteed that a country labelled food-secure at a national level has a population that is food secure at the household level.

Based on the FAO's definition, food security is assessed on four main components: food availability; accessibility; utilisation; and, stability (Figure 2.1). For food security to be realised fully, these four components need to be achieved simultaneously. First, households or individuals must be able to produce their own food to meet their daily dietary requirements with the resources they have. Their efforts should be supported by the government through provision of infrastructure and other support services. Second, they must be able to access food through purchases when they are not able to produce food themselves. Therefore, food should be made accessible to consumers regardless of adverse situations such as price volatility. Third, and most importantly, food produced or purchased must be nutritious for a healthy life. Likewise, people should have access to supporting facilities such as health education, nutritional information and other services that contribute to household and individual wellbeing. Fourthly, there must be a continuous daily supply of nutritious food for the household or the individual at all times irrespective of adverse effects on the productive resources or the price of food.

Since the mid-eighties, the concept of household food security has been incorporated into country policies and development goals, largely in developing countries, with a direct focus towards supporting households and small farmers to take part in different livelihood opportunities to enhance food security whilst simultaneously contributing to rural development. Also, allowance was made in various country policies and goals to assist households and small farmers during unfavourable situations so that food security is maintained at all times.

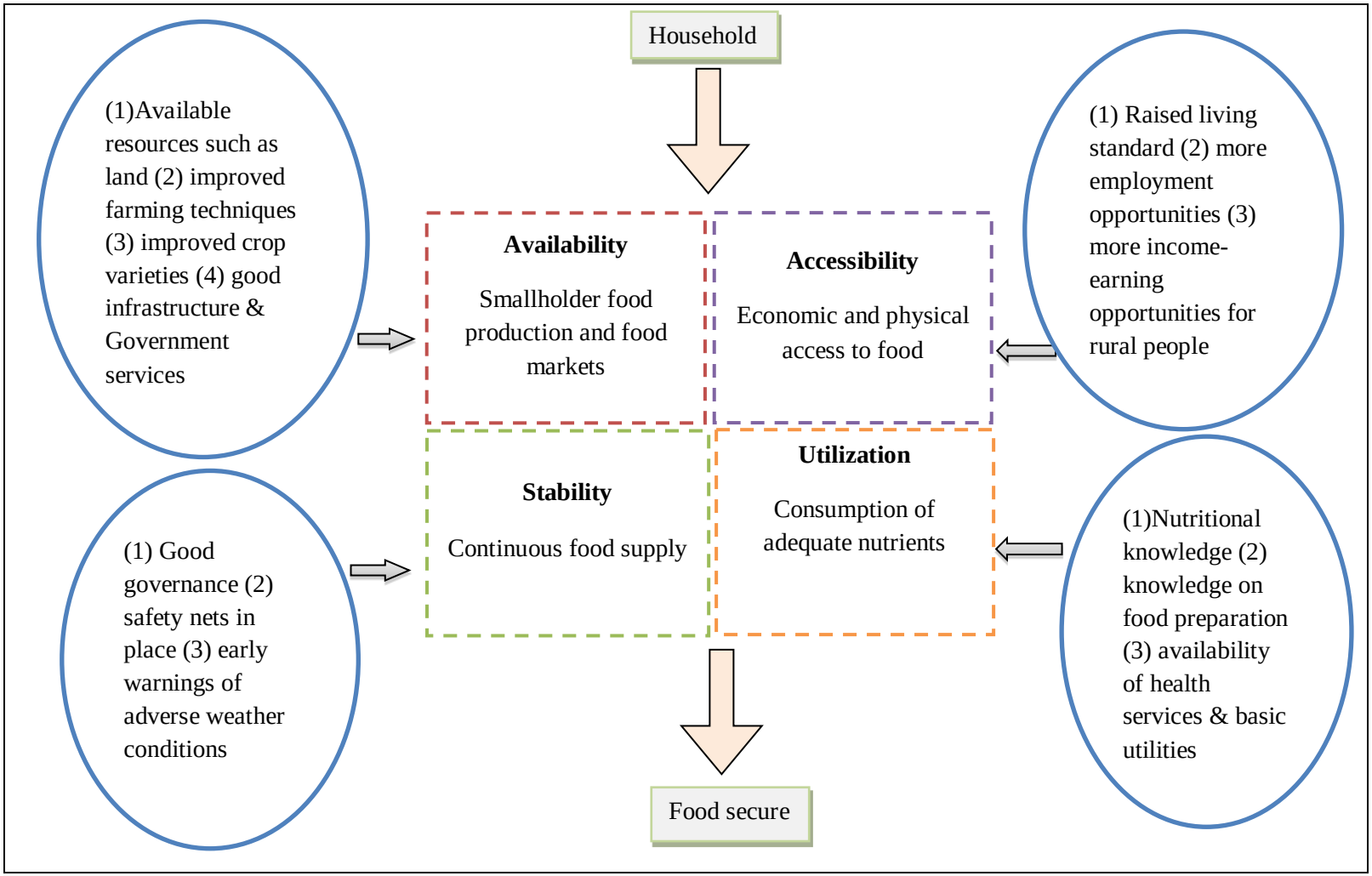


Figure 2.1: Four components of food security. (Source: Nabarro, 2011).

The United Nations Organisations (UNOs) including FAO, World Food Program (WFP) and the International Fund for Agriculture Development (IFAD) are taking a leading role with the support from the World Bank (WB), other UN agencies, Government (GOs) and Non-Government Organisations (NGOs) to address the problem of food insecurity, poverty, hunger and agricultural development, mainly in developing countries. During the WFS in 1996, agreements were made to half hunger worldwide by 2015 (FAO, 1996). The goal was further emphasised in the Millennium Declaration in 2000 (Millennium Development Goals-MDGs) and successive summits thereafter. Taking 1992 as the base year with a global population of 850 million experiencing hunger, the target was made to reduce this by half to 425 million by 2015. Through the contributing efforts of the international community in cash and in kind, much work has been carried out by the UNOs through the twin-track approach of providing temporary support and restoring livelihoods simultaneously. During the 1969-71 base periods the number of undernourished people worldwide was 878 million which decreased gradually over the years until the end of 2007. Since then there has been a steady increase in the number of hungry people which peaked between 2008 and 2009 reaching over 1 billion people due to the global economic crisis. The number of hungry people worldwide has since dropped to 925 million in 2010 (Figure 2.2) which continued to drop to 870 million in 2012. The number of undernourished people worldwide was 870 million of which 852 million live in developing countries (FAO, 2012).

Government strategies to tackle food insecurity include ‘Safety Nets’ or ‘Social Protection’ policies which vary slightly among countries. Common types of safety nets are government subsidies placed on basic food stuffs and agricultural inputs to reduce the price of food. Some examples of safety nets include: the Public Distribution Systems (PDS) of subsidised grains in China and India (Swaminathan, 2003); government subsidies on flour, the staple food in Mongolia (IFAD, 2007); the Ration Card Scheme (RCS) in Pakistan for certain staples, and bans on wheat exports in some countries (IFAD, 2007); the Productive Safety Net Programs (PSNP) in Ethiopia where poor households are assisted in cash or in-kind through public work or direct support (Galligan *et al*. 2008); and Social Protection (SP) programs in parts of Southern Africa where government subsidise basic food stuff and agricultural inputs to improve people’s livelihoods (Devereux, 2006). The goal of safety nets is to

provide vulnerable populations with access to food at affordable prices and simultaneously improve agricultural productivity. The latter is a means to alleviate poverty and promote rural economic growth.

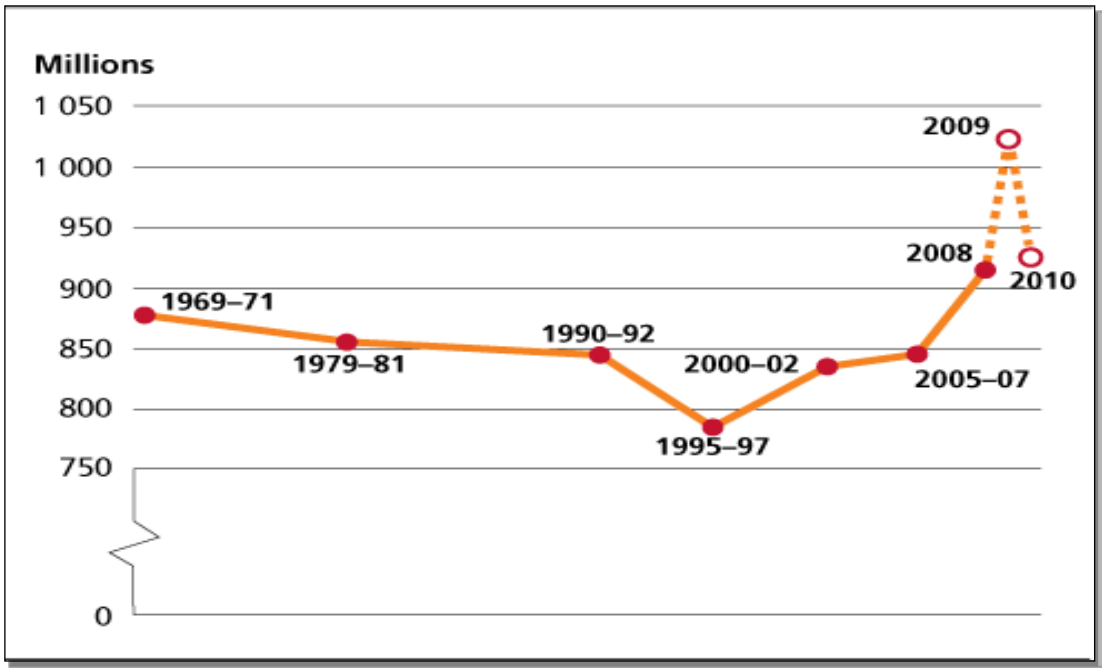


Figure 2.2: The number of hungry people worldwide. Source FAO, 2010a.

Where are the food insecure and the hungry?

Food security has been a major concern in several developing countries such as those in Africa, South East Asia and to a lesser extent in the Pacific. Food insecurity will continue to intensify due to factors that are continuously disturbing the food system such as population growth, ecological degradation, climate change and rising food prices. The state of food insecurity and hunger has been monitored since the inception of FAO's role in 1969. Hunger is simply defined as not taking in the daily energy requirements needed by the body for a healthy life. Hungry people are undernourished and more prone to diseases and infections.

According to FAO, the bulk of the world's undernourished population is found in developing countries where a high proportion live in rural areas where there are few economic livelihood options to engage in and people depend highly on agriculture for sustenance. Sub-Saharan Africa alone accounts for 26% of the world's undernourished population (Figure 2.3). Although, Asia and the Pacific region accounted for the highest proportion of the hungry population, India and China alone

make up 40%. Also, in this region the number of hungry people decreased because of recent economic growth in countries such as China and India (FAO, 2008).

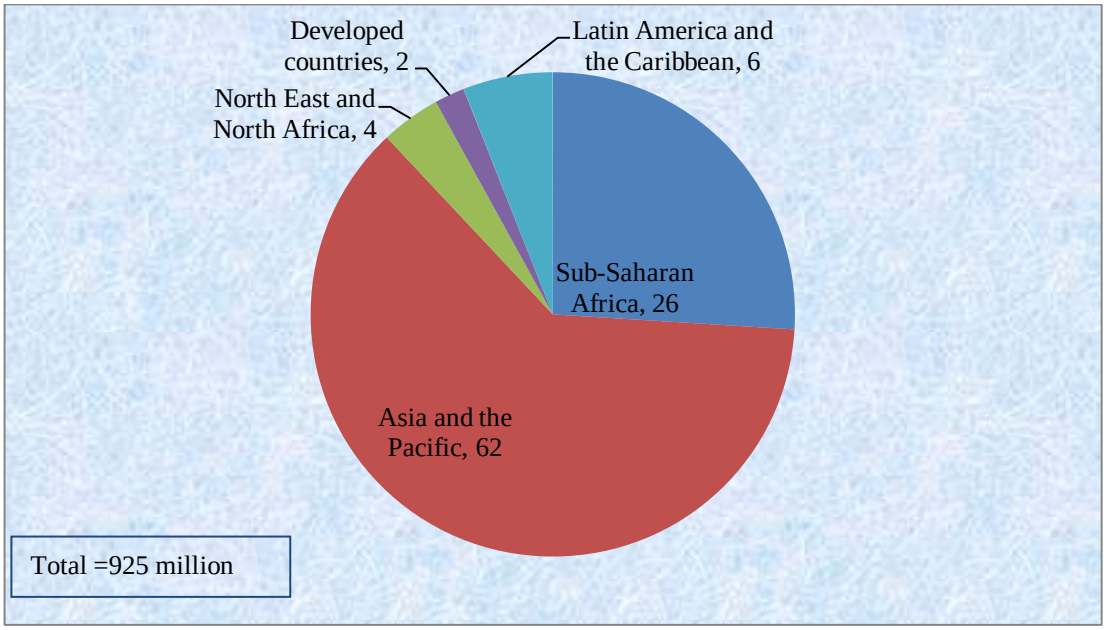


Figure 2.3: Per cent of undernourished people in 2010 by global region. Source: FAO, 2010a.

Seven countries account for two-thirds of the world's undernourished population. These are Bangladesh, China, the Democratic Republic of the Congo, Ethiopia, India, Indonesia and Pakistan (FAO, 2010a). These countries have large populations where the demand for food is high. Likewise, the resource base of these countries is being exhausted with population increase creating poverty gaps between the rich and the poor. Some of these countries such as India, Bangladesh and Indonesia have experienced natural disasters, whilst others such as Somalia, the Democratic Republic of the Congo and Ethiopia are often at war and regular political unrest (FAO, 2008; 2009; 2010a).

As the world population continues to grow, the demand for food is also increasing. It was estimated that if the world population increased from the current population of around 7 billion to the predicted 9.1 billion in 2050, demand for food would rise by 70% (Oxfam, 2011). The populations that will be affected most are those in the Net-Importing Countries (NIC)[1], Low-Income Food Deficit Countries (LIFDCs)[1] and the Least Developed Countries (LDC)[1] (FAO, 2008; 2010a). It is expected that seven out of ten people will be living in those countries by 2050 (Oxfam, 2011). Since the majority of the world's poor in those countries depend on the world food market for

most of their staple food, the number of poor people worldwide will continue to fluctuate with instability in world food prices.

A country's state of hunger and food insecurity is measured by FAO using three types of data which include: production, import and export data; population census data; and, household survey data to determine the number of people who are undernourished or food insecure. Whilst the population and household data are reliable indicators of food insecurity, the import and export data may not be a good measure as emergency food needs often arise at a point in time increasing food imports to exports which gives a false indicator of a country's food situation. For example, food security in PNG is generally good. However, the drought of 1997 resulted in a large increase in imported food stuff mostly rice and flour to cater for victims during and after the drought to allow household food gardens to be brought back into production (McGregor *et al*. 2009). This occurrence misrepresented PNG at that time as one of those countries that are highly depended on imported staples for its population. Another reason why the export and import data are not reliable measures of food insecurity is the fluctuation of prices of different commodities on the world market resulting in trade imbalances. For instance, developing countries that are net importers of cereal may buy cereal at a time when the price of cereal is high while at the same time prices received for their export crops such as coffee and cocoa may have suffered a recent decline in prices resulting in a trade imbalance.

Main factors contributing to food insecurity and hunger

Household food insecurity is caused by many factors. These factors often combine together or operate independently causing devastating results amongst smallholder households. Factors such as extreme climatic conditions, natural disasters and increases in the price of basic food stuff cause temporary food shortages at a point in time after which the situation returns to normal after some time. In contrast, wars and civil unrest that displace people and break down livelihoods most often cause permanent food shortages. Likewise, poverty is the main cause of permanent food insecurity in developing countries, causing households to drift in and out of food shortages throughout their lifetime. These factors are discussed below.

Poverty

Poverty is the main cause of food insecurity in developing countries (Chambers, 1983; Conway, 1999). It is associated with the absence or lack of resources to produce or purchase food. The characteristics of the poor, as pointed out by Conway, are that they have "few or no assets, are unemployed or earn less than a living wage and thus cannot produce or buy the food they need" (1999: 10). According to the United Nations (2010), the number of people living below $1.25 a day has decreased from 1.8 billion in 1990 to 1.4 billion in 2005 resulting in the poverty rate being reduced from 46% to 27% of the world's population. However, the poverty rate will continue to fluctuate with the ongoing instability of world commodity prices. It is estimated that 70% of the world's poor live in rural areas. Of this fraction, South Asia and Sub-Saharan Africa accounts for the highest proportion of people who live in poverty (FAO, 2008).

In these countries poverty is concentrated amongst small farmers and landless families. Moreover, there are few opportunities to expand agricultural enterprises and there is a high level of degradation of natural resources as a result of high population growth. In some developing countries, the chances of the rural poor sustaining themselves are much less than the urban poor due to less economic opportunities available in the rural areas. For example, based on statistical comparisons of the rural and urban populations in Peru, Conway (1999) pointed out that the proportion of malnourished people among the rural poor is much higher than the urban poor. In most cases the urban poor are the rural poor who drifted to the urban centres due to economic and service deprivation in the rural areas, and although poor they generally have access to income-earning opportunities. This pattern of rural to urban migration is widespread in developing countries.

Poor people are highly vulnerable to shocks such as price increases in basic foods, extreme climatic events, pest and disease attacks on livestock and crops, and wars and civil unrests. Poor people's ability to respond to unfavourable situations is most often constrained by few or lack of assets. The detrimental effect of poverty on their livelihoods is often passed on from one generation to the next and for most households it is impossible to rise above the state of poverty. Breaking from the poverty cycle would require extra effort from the household in improving education,

health and securing physical assets with the support of government through provision of basic services, infrastructure and marketing opportunities (Chambers, 1983).

Increases in food prices

Increases in world food prices have been a global concern since the major price hikes in 2008. In 2006 food and fuel prices started to rise gradually and peaked in June 2008, affecting millions of people in developing countries (Figure 2.4). After 2009 a decrease in the price of food and fuel was observed until it rose again towards the end of 2010 reaching another peak in February 2011.

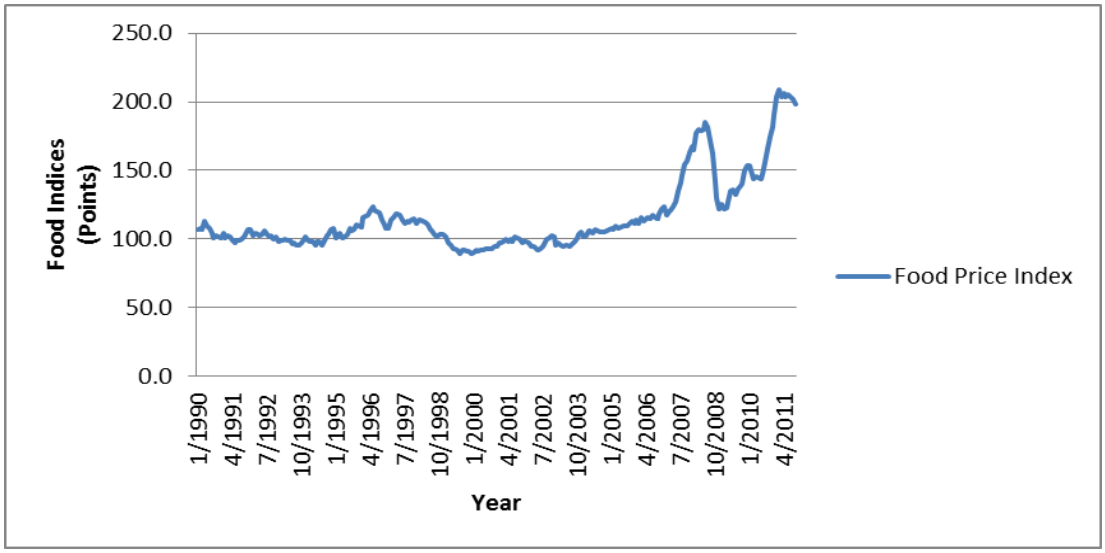


Figure 2.4: FAO monthly food price indices, 1990 to 2011. Source: FAO, 2011.

Fluctuations in world food prices are common and occur due to changes in the supply and demand of commodities. Factors such as natural disasters often affect a certain commodity on the world market causing price instability. It has been observed over the years that most often the rise in price occurs at a point in time followed by price stability for longer periods of time. The world food market price instability from 2008 to 2011 was unusual.

According to the FAO (2009: 13):

> High-price events, like low-price events, are not rare occurrences in agricultural markets, although high prices often tend to be short-lived compared with low prices, which persist for longer periods. What has distinguished this episode was the concurrence of the hike in world prices of not just a few but of nearly all major food and feed commodities and the possibility that the prices may remain high after the effects of short-term shocks dissipate.

Several factors have contributed independently or collectively to the increase in world food prices. These factors include the recent demand for biofuel, increases in world oil prices, population and economic growth (in countries such as China and India resulting in high demand for food), low food stock reserves on the world market, extreme climatic conditions and export bans in some producing countries (FAO, 2009; 2010a). Some countries temporarily refrained from exporting to maintain their national food stocks. For example in 2010, Russia was hit by a prolonged drought which affected its grain production resulting in the government imposing a ban on its grain exports thereby affecting food supply on the world market.

High demand for biofuel and increases in the prices of oil were observed to be the main causes of the recent jump in the world food prices. Demand for biofuel is high in countries such as the United States of America (USA) and those in the European Union (EU) where biofuel has been adopted as an alternative energy source. Not only are the USA and European Union member countries in the frontline for biofuel production, but they are the major producers and exporters of grain. Hence, increased demand for biofuel is often achieved by a reduction in land for food production or other food crops other than feedstock. For example, in 2007, world maize production saw an increase of around 40 million tonnes with a high proportion being produced by the USA (FAO, 2009). Of this figure, around 30 million tonnes were used for biofuel production and the USA utilised the highest proportion of maize due to its increase in biofuel production (FAO, 2009). Of its total domestic use in the same year, 30% of maize was used to produce ethanol apart from feed use, exports and other uses (FAO, 2009). Similarly, 60% of rapeseed oil produced by member states of the EU, representing 25% of the world's production of rapeseed oil, was converted to biodiesel in the same year (2009). This was one of the causes of world price inflation in 2008 through to 2011, combined with extreme climatic conditions that disrupted commodity supplies from other exporting countries such as Australia and Russia where normally these countries could have increased grain production to cover the fall in supply of other producing countries.

Furthermore, the supply at the world market is often disrupted by farmers who tend to follow crops with high demand and high profit. For example, in 2007 the price of

maize was high in the USA because of its high demand for biofuel production (FAO, 2009). The high prices encouraged soybean farmers to opt to plant maize, and maize farmers increased maize production. This trend saw an increased global supply of maize resulting in a drop in the price for maize, whilst the price of soybean was inflated (FAO, 2009). This situation was reversed between 2008 and 2009 when the world prices of maize increased while soybean dropped. Similar practices occur in other major exporting countries where active responses by commercial farmers to shift to producing high profit crops for their economic gain often affect indirectly the majority of the world's population in NICs[2].

Increases in the world price of oil have also increased the viability of biofuel production. The increase in the price of oil saw developing countries being affected most as a result of high production and transport costs. This in turn contributed indirectly to increased prices of basic food stuff. Moreover, developing countries plagued with weak governance often contribute further to the misery of their population by not providing safety nets to subsidies prices of basic foodstuff or agricultural inputs (such as fertiliser) during periods of price inflation. Despite the recent decrease in world prices of basic foodstuffs at the international level, prices of food at the national and household level in net importing countries often remain high due to high import bills pressured by the weak currencies of most developing countries against the US dollar. In addition, due to high import bills, countries are often limited in their capacity to import foodstuff (or certain foodstuff) thus affecting food supply at the world market leading to price instability.

Countries that are self-sufficient in producing most of their staple foods will not be affected much by increases in the price of food, as their population tends to depend more on local staples during periods of high prices. Countries that are affected most by food price increases are the NICs that depend highly on the world market for their food, whose populations have already been placed in a vulnerable situation due to natural or human induced disasters, and have a high number of landless people. Examples include countries in 'protracted crisis' and others such as Egypt and some African countries that depend highly on grain for their staple food. Populations that are affected most are the rural and urban poor and victims of disasters. The last named encounter temporary food shortages. In contrast, poor people face chronic

food shortages and cannot meet their daily caloric requirement and are vulnerable to unfavourable situations that disturb their livelihoods. The most affected countries are those in Sub-Saharan Africa and South Asia where droughts, wars and civil unrests have already placed the majority of the population in a vulnerable situation (Conway, 1999; Devereux and Maxwell, 2001; Staatz *et al*. 2009; FAO, 2010; United Nations, 2010; Oxfam, 2011) and where majority of the population are landless.

As the price of food increases, food will make up the biggest proportion of household expenditure. For example, households in countries such as Kenya, Azerbaijan and Guatemala spend almost 50% of their income on food while households in wealthier countries like the USA spend only 7% (Figure 2.5).

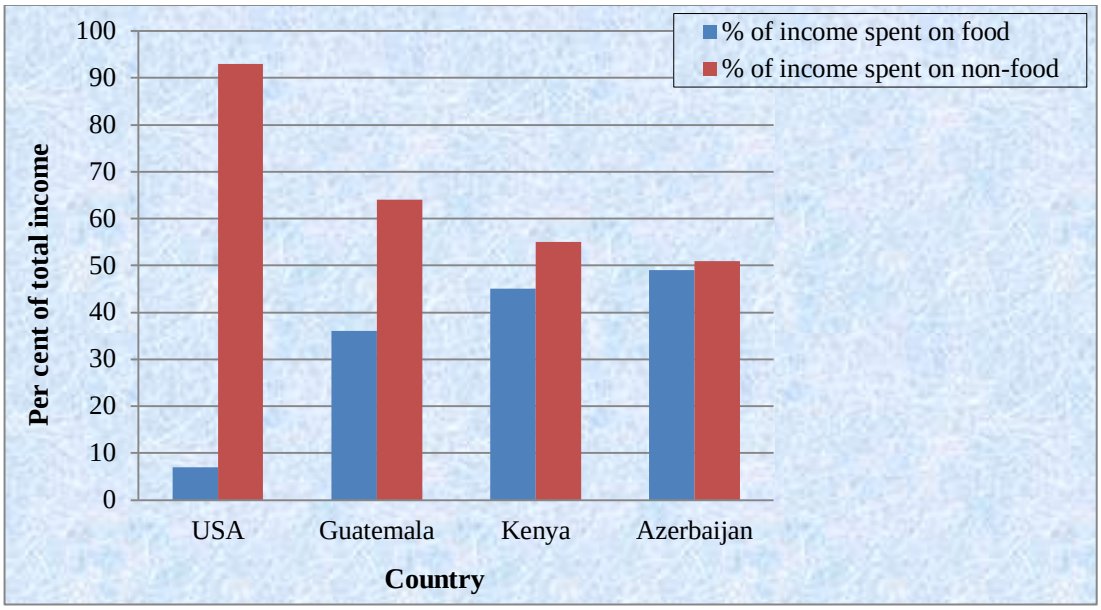


Figure 2.5: Family spending on food during periods of high prices in four countries. Source: WFP, 2011.

People in Pacific Island Countries (PICs) including Tuvalu, Federated States of Micronesia (FSM), Fiji, Samoa, Tonga and Solomon Islands spend around 55% to 70% of the total household income on food (McGregor *et al*. 2009). People in Solomon Islands and Samoa had the highest spending on food of around 70% (McGregor *et al*. 2009). As most of the income earned is spent on food, family budgets for health and education are most likely to be reduced (McGregor *et al*. 2009). For the urban dweller in Port Moresby, PNG, housing and utility bills add to the financial burden faced by families (Box 2.1).

Box 2.1: Example of high cost of living in urban PNG

The high cost of accommodation has left many average and minimum wage income-earners barely 'scraping' through to their next pay packet, with the situation more severe for those with families. In fact for urban PNG, entire families are resorting to renting rooms in houses. An example of this is John and his partner Cheryl who are renting a room in a four-bedroom house with their two small children aged three and two…. The cost of catering for their children's needs coupled with the cost of K300 (USD132.00 where K1=0.44USD) fortnightly rental is a stark reality of the cost of accommodation that has seen dramatic increases in the past three years …. One of the tenants claimed that after paying rental and utility bills, they are left with almost nothing. Post Courier Newspaper, 27th October, 2011.

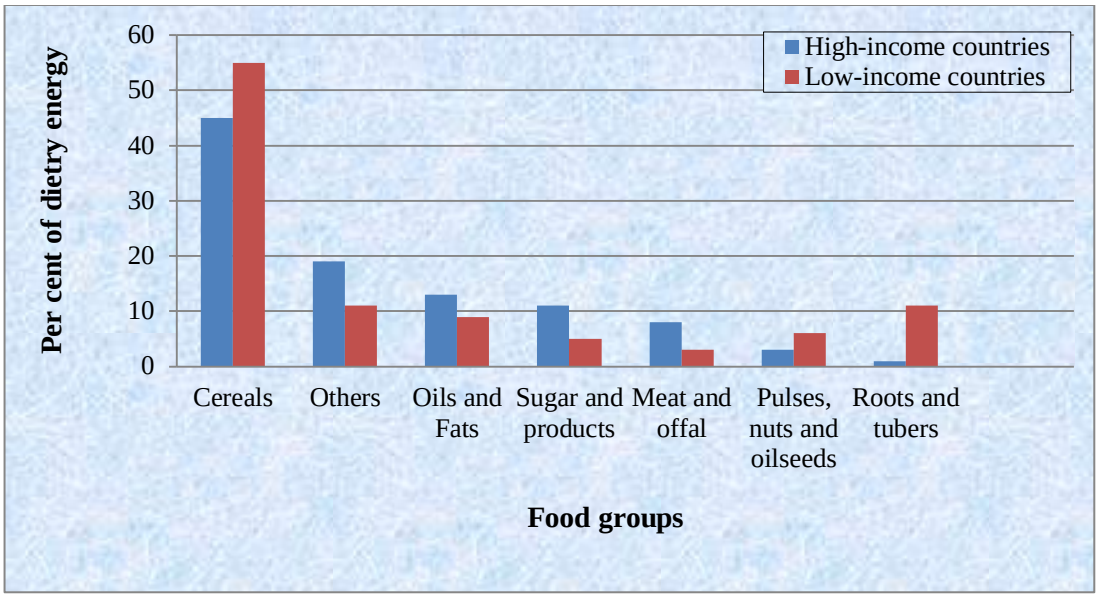


Figure 2.6: Dietary diversity by source of dietary energy in developing and developed nations (Source: FAO, 2008: 29).

Moreover, when under financial pressure there is a tendency for households to reduce the number of meals per day and the quantity and quality of food consumed. A largely carbohydrate diet is most likely to form the daily diet, lacking protein and micro-nutrients despite their importance for a healthy life. According to FAO, children, pregnant women and mothers are the most vulnerable groups where their growth and health will be adversely affected. It was estimated that "156 million children under five in developing countries suffer from protein and energy malnutrition and 90% of all anaemic pre-schoolers and expectant mothers live in developing countries" (FAO, 2008: 11). High deficiency in protein and essential micro-nutrients are common in developing countries and with the pressure on household budgets the problem will continue to escalate (Figure 2.6).

Extreme climatic conditions

Whilst some contributing factors to food insecurity can be contained, the effect of climate change and extreme climatic events cannot be controlled within a short time period and will continue to affect the food system. Extreme climatic events are a major cause of other related problems such as export reduction, decrease in global grain stock reserves and export bans contributing to price instability (see Box 2.2). Most importantly, climatic variations affect a country's food stocks creating food insecurity and livelihood breakdown among the poor, which are not easily restored. It is predicted that by 2050 extreme climate conditions "will have pushed another 24 million children into hunger where almost half of these children will live in sub-Saharan Africa," (FAO, 2010a: 24). Likewise, it is expected that food prices will continue to rise between 70-90 % in the next 20 years and will double as the effects of climate change become more pronounced (Oxfam, 2011).

Box 2.2: Examples of extreme climatic conditions in selected countries in 2010 and 2011

- Pakistan was hit by monsoon flood in 2010 displacing thousands of people and creating food insecurity (WFP, 2011).
- Russia was affected by drought in 2010 resulting in export bans on grains, which were removed in mid-2011 (FAO Media Centre, 2011)
- Australia was affected by rains and flood in 2010 affecting food crop production at the national level and food supply on the world market due to reduced exports.
- Heavy and prolonged rains in Canada and USA in 2010 affected food crop production (Nabarro, 2011).
- The Horn of Africa (Somalia, Djibouti, Ethiopia, Kenya, Sudan, and Uganda) was devastated by drought in 2011, leaving millions of people displaced and hungry (FAO Media Centre, 2011).
- Pakistan was hit by monsoon flood again in September 2011, affecting millions of lives. Those who have not recovered in the previous year's flood were severely affected.

Wars and civil unrest

Wars and civil unrest are becoming more frequent and are causing food insecurity and affecting livelihoods. Millions of people worldwide, mostly in developing countries, are displaced and living in refugee camps because of wars and civil unrest. Some of these conflicts are caused by food shortages and increases in the price of food where people take their grievances to the streets, eventually causing political

instability and strife. Such incidences occurred during the 2008 price hike in some countries in Africa and the Middle East. According to the United Nations (2010), more than 42 million people are currently displaced due to conflicts in their countries. A high proportion of these people live in countries in “protracted crisis”. The FAO has labelled these countries representing the world’s hunger hotspots because of continuous wars and civil unrest combined with natural disasters resulting in prolonged food insecurity. In 2010, 22 countries were in this category and the majority are in Africa (FAO, 2010a). Occurrences of disasters in these countries are mostly human-induced and in some cases are combined with natural calamities. Devastating results are faced by prolonged wars and civil unrest. As a result livelihoods are being destroyed and victims are unable to construct their lives again or often take years to re-establish them again. Therefore, there is a high level of food insecurity in these countries experiencing prolonged civil war: around 116 million people are estimated to be undernourished which account for 37% of the total population of these countries (Figure 2.7), (FAO, 2010a).

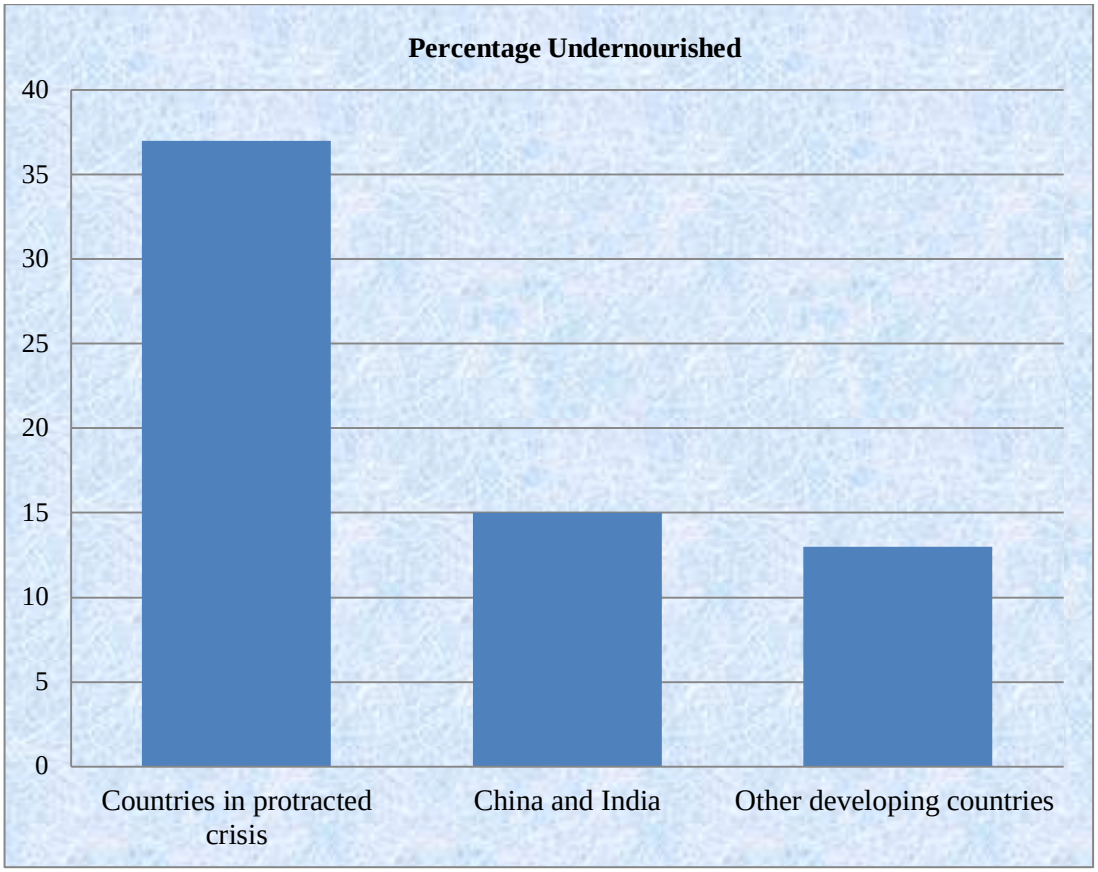


Figure 2.7: Proportion of undernourished people in countries in protracted crises, China, India and in other developing countries. Source: FAO, 2010a.

Wars and civil unrest continue to place threats on household food security (FAO, 2013) and the countries facing this situation include Egypt, Syria, Central African Republic, Democratic Republic of Congo, Somalia, Sudan and countries in West Africa. Even though the number of countries in protracted crisis has decreased from 39 in 2006 (FAO, 2006b: 2) to 22 (FAO, 2010a: 13), the number of human induced disasters has increased dramatically over the years, in addition to natural disasters.

Lack of good governance

Whilst some factors causing food insecurity cannot be manipulated and are beyond a country's capacity, the practice of good governance within a country can facilitate food security and alleviate poverty. Reduction in hunger and poverty are the two most important indicators besides economic growth in countries with good governance (Paarlberg, 2002; Lio and Liu, 2008). Good governance is associated with indicators such as respect for human rights, proper use of public funds, political stability (Roberts *et al*. 2007) and equal distribution of public goods and services (Paarlberg, 2002). In contrast, bad governance can be observed generally as the absence of democratic values (Williams, 2009). Its consequences often contribute to food insecurity situations within a country. For example, unstable political governance in countries such as Somalia has resulted in wars and civil unrest where livelihoods have been destroyed creating continuous food shortages (FAO, 2010a). Likewise, corruption within the governing bodies such as the misappropriation of State funds intended for developmental purposes leads to its population being deprived of certain benefits creating an unstable social environment.

Another distinct indicator of poor governance is the lack of proper distribution of public goods and services to all its population which hinders economic growth and poverty alleviation. In PNG poor people are mostly found in areas where government services are absent or lacking (Gibson and Rozelle, 2002). For example, badly weathered roads and broken bridges hinder poor rural peoples' access to basic services or markets in regional and urban centres where they can participate in economic activities. This is one of the problems faced in PNG where surplus food crops and other foodstuffs obtained from fishing, gardening and hunting in rural areas cannot be brought easily to the urban markets because of the lack of road infrastructure (Manning, 2001). This problem often hinders people from fully

participating in agricultural activities knowing they cannot sell their fresh produce in urban markets. Studies show that providing infrastructure contributes to agricultural productivity and is the key to a country's economic development (Agenor, 2010; Lio and Liu, 2008). Even if government services such as schools and clinics/aid posts are provided in rural areas, the characteristic feature is that they are often run down and not upgraded. Lack of education and health services often have detrimental effects on the population. Uneducated people are more likely to fall into the poverty trap where they are placed in an unfavourable position to sustain themselves.

A common attribute of poor governance, is the unequal participation of women in development activities such as in agriculture, which at the same time undermines household food security as women contribute significantly to household food security. Studies show that men are often given more priority over the distribution of resources than women, despite the positive contribution women make to family wellbeing and household food security (FAO, 2010-2011). Thus, inequity creates variations in levels of food insecurity spatially and socially. FAO uses unequal distribution of resources amongst a country's population as one of its indicators to identify the LDCs.

Conclusion

It is a basic human right that all individuals have physical and economic access to sufficient and nutritious food at all times to meet their daily dietary needs for a healthy life. Since the 1980s, the focus on the status of food security has shifted from the supply of food at the world market to a more directed focus at the household level. To be food secure the four components of food security (food availability, food accessibility, food utilisation and food stability) must be achieved simultaneously. The status of food security varies from one country to another and even between regions and populations within the same country. Poverty, price inflation, increased demand in biofuel, wars and civil conflict, extreme climatic events and bad governance are the main causes of food insecurity in the world today. Chronic or temporary food shortages occur as a result of these factors. Temporary food shortages can be overcome more easily than chronic food shortages where drastic interventions are required to restore livelihoods to adequate standards. The UN organisations and NGOs, such as Oxfam, are in the forefront in addressing food

insecurity situations and simultaneously promoting agricultural development through engaging smallholders in agricultural activities. This chapter has focused on issues of food security at the global scale and identified the main factors contributing to household food insecurity in developing countries. The next chapter will pay specific attention to food security issues in Pacific Island Countries (PICs) and PNG.

Notes

1. LIFDCs are those countries labelled by FAO (2008; 2010a) as net importers of staple food with the net income per person falling below the level used by the World Bank to determine eligibility for International Development Assistance (IDA). LDCs are those countries with the lowest socio-economic and human development indicators. NICs refer to countries that import the bulk of their food staples such as wheat.

2. Making use of this type of opportunity is beneficial for commercial farmers as small farmers in most developing countries do not reap the benefits of high prices because of constraints faced such as production inputs and irregularity in prices offered by financial institutions.

CHAPTER 3

STATUS OF FOOD SECURITY IN PNG AND OTHER PACIFIC ISLAND COUNTRIES

Introduction

This chapter reviews the situation of food security in Pacific Island Countries (PICs) including PNG. It begins by pointing out the contrasting situation in the status of food security between the small island states and the bigger Melanesian countries. The chapter discusses the importance of land access as one of the main factors affecting food security amongst the bigger Melanesian countries. Next the status of food security in PNG is discussed, highlighting why the status of food security in PNG is generally good compared with other PICs. In this section of the chapter, I discuss some of the factors that have enhanced household food security in the country and examine FAO's assessment of the status of food security in the country. I then discuss the diverse physical environments and climatic conditions in PNG to explain the different agricultural systems and subsistence livelihoods practised throughout the country. The chapter shows that the physical environment and climatic conditions are the main causes of household food insecurity in the country.

Status of food security amongst the Pacific Island Countries (PICs)

The degree of vulnerability to food insecurity among the PICs varies generally on the basis of the country's size, its population and the natural resources which dictate the types of agricultural and economic activities. Small PICs tend to have a poor resource base and a high proportion of unproductive land making it difficult to expand agricultural activities (Asian Development Bank, 2011). These countries, such as Samoa and Tonga, generate their main source of income from tourism. Many households also benefit from remittances from relatives working in other countries.

For example, in Tonga, 74% of people surveyed by Rohorua *et al*. (2009: 35) claimed that remittances sent by relatives working overseas contributed to family income and community projects such as church expenses. Although, subsistence farming and fishing supplement imported foods, small island states are highly dependent on imported staples for most of their daily dietary intakes (FAO, 2005). Therefore, they are vulnerable to global recessions and price inflation on imported staples as a result of falling exchange rates and increased prices on the world market (McGregor *et al*. 2009). Small island states in the Pacific are also vulnerable to natural disasters and extreme climatic events. Due to their geographical locations, most of the states are "low-lying, have very limited soil and water resources and face the grim reality of losing large tracts of agricultural land to sea level rise and salinization" (FAO, 2010b: 22-23).

Furthermore, the small island states including Cook Islands, Kiribati, Niue, Samoa, Tonga and Tuvalu have a high to extremely high Food Import Capability Index (FICI) which makes them vulnerable to food insecurity (Table 3.1) (McGregor *et al*. 2009). The FICI is an indicator developed by the FAO to measure a country's vulnerability to food security on the basis of its total food imports against its total exports. The island states with high to extremely high FICI show that they are net

Table 3.1: Food import capability indicators (FICIs) for selected Pacific Island countries, 1990 – 2001.

Country	Year				Average over a decade	Food security vulnerability assessment
	1990-91	1993-95	1996-98	1999-2001		
Cook Islands	1.85	2.36	2.22	0.93	1.84	extremely high
Fiji	0.17	0.18	0.18	0.16	0.17	low
Kiribati	1.73	1.53	1.76	1.22	1.56	extremely high
Niue	1.69	1.44	1.22	0.92	1.32	extremely high
PNG	0.19	0.10	0.11	0.09	0.12	extremely low
Samoa	2.47	4.91	1.42	1.57	2.59	extremely high
SI	0.18	0.11	0.12	0.18	0.15	low
Tonga	0.79	0.89	1.74	0.97	1.10	high
Tuvalu	5.01	6.90	4.97	5.03	5.48	extremely high
Vanuatu	0.50	0.44	0.40	0.49	0.46	moderate

Source: McGregor *et al*. (2009: 32). SI=Solomon Islands.

importers of food with significant trade imbalances. Most often food accounts for the highest proportion of their imports and they are labelled by FAO as Net Importing Countries (NICs).

In contrast, the larger Melanesian Pacific countries such as PNG, Solomon Islands, Fiji and Vanuatu are less vulnerable to food insecurity than the small PICs and atolls. This is because they depend less on imported food for their daily requirements as most of the staple food for family sustenance is produced locally. Only a small proportion of imported food such as rice, wheat, protein and vegetable oil are purchased to supplement the local diet. The large Melanesian countries also benefit from export earnings from agricultural commodity crops and mineral resources. Furthermore, the majority of the population of these bigger island countries live in rural areas where they have access to land for subsistence farming. Vulnerable populations in these countries are the poor urban households who highly depend on purchased food and have limited access to land for gardening, and rural populations who are prevented from participating in economic development activities as a result of their unfavourable environmental conditions and lack of government services (Gibson and Rozelle, 2002; Allen *et al*. 2005). Moreover, in certain rural parts of the country, high population growth is now contributing to land pressures and environmental degradation thereby undermining household food security (McGregor *et al*. 2009).

Based on the FICI, the larger island countries of Vanuatu, Fiji and Solomon Islands were labelled as having moderate to low FICI respectively. PNG has the lowest average FICI value of 0.12 measured against the standard of 0.5 indicating it is the least vulnerable of the PICs to food insecurity (McGregor *et al.* 2009). The lowest FICI indicates generally that PNG has a good balance in trade between its exports and imports. Despite this, PNG is labelled by FAO as one of the Net Importing Countries (NICs). As pointed out by Bourke (2001a) rice and wheat are the main food products imported by the country which contributes to food security by supplementing the local staples.

Reasons why the status of food security in PNG is acceptable

Land use and population density

The food security situation in PNG differs from other developing countries (as outlined in Chapter 2) and some other Pacific island states as the overall level of food security in the country is high. There are several reasons for this. First, more than 80% of the country's population is rural-based and have access to land to construct their livelihoods. Around 85% of land in PNG is under customary tenure (Filer, 2012) where people own land communally[1]. However, out of the total land area of 459,854 km (square) in PNG, only 25.6% is suitable for agricultural activities while the remaining land is considered unsuitable (Allen, 1983; Hartemink, 2003; Allen and Bourke, 2009). Of the suitable land, only 2.4% is used at high and very high intensity, while 23.2% is used at moderate to very low intensity (Allen and Bourke, 2009). High land use intensity is observed in areas with high population pressures, such as the Wahgi valley in Western Highlands Province and the Gazelle Peninsula in East New Britain Province (McAlpine and Freyne, 2001) and those areas engaging in export tree crop production.

Population density varies throughout the country with the highland provinces having the highest densities with similar situations occurring in some small islands and atolls, while most of the lowland provinces have medium to low population densities (Allen and Bourke, 2009). The high population densities in some locations can be explained by two main factors: first, very favourable physical environments with good agricultural land for gardening that can sustain large populations such as in the highlands valleys (Allen, 2001); and second, the migration of people into areas where there are high levels of economic activities such as the oil palm producing areas of West New Britain Province, mining sites and urban and peri-urban centres where people seek income-earning opportunities or basic services that are not available in their home areas.

Most of the provinces in PNG have low population densities where people have enough land to allow extensive shifting cultivation. In those locations shifting cultivation occurs in primary or secondary forest with a cropping period of up to 18 months. The cropping period allows for up to three plantings in the lowlands and five or more in the highlands due to intensification practices associated with sweet potato

(Bourke and Allen, 2009). Since most PNG farming systems have access to sufficient land, more than 70% of the rural population allow their land to fallow for more than 5 years (Bourke and Allen, 2009) sometimes up to 50 years (Allen, 1983: 14) enabling regeneration of secondary forests.

A positive relationship between high population pressure and intensive farming is widespread and is observed in other developing countries where land is scarce. In PNG, high population pressure is one of the reasons for intensive farming. Three other factors include: the environment, cultural factors and the adoption rate of improved farming techniques. First, some locations in the country lack arable land for farming due to unfavourable physical environments causing remaining good agricultural land to be farmed intensively (Allen, 1983; Ohtsuka *et al*. 1995; Allen and Ballard, 2001; Bourke, 2001b). Examples of these locations are populations living in high altitude areas and some small islands and atolls (Allen *et al*. 1995; Bourke, 2001a). In some areas of the country, although land is available, increases in population do not correlate with the cultivation of new areas. This is because people tend to use fallowed gardens and land previously used for other purposes much more intensively (Allen and Bourke, 2009). Furthermore, Allen *et al*. (1995) found that intensive cultivation of sweet potato was associated with altitude, indicating that the crop is cultivated more intensively in the highlands than in the lowlands.

Second, intensive farming is associated with cultural factors. That is, apart from food being produced for dietary sustenance, its production in PNG is closely associated with cultural practices (Brookfield, 2001; Bourke and Allen, 2009). For example, in highlands societies, sweet potato is intensively cultivated for both pig and human consumption. Pigs are important cultural assets linked with social status, wealth and are used in mortuary rituals, bridewealth, compensation and other culturally significant events (Kuchikura, 1999, cited by Umezaki *et al*. 2000). Similar situations occur with the people of Abelam in the East Sepik province who intensively cultivate ceremonial yams (Lea, 1964; Forge, 1965; Scaglion, 1999; Coupaye, 2009). The fourth reason for intensification is that farmers intensify crop production based on market signals and adoption of new and improved crop varieties (Brookfield, 2001).

Subsistence food production

A second reason why food security is generally high in PNG is because the largely rural population is highly dependent on subsistence food production for their daily dietary intakes. This type of farming has sustained rural livelihoods in PNG for millennia. Shifting cultivation or swidden agriculture in PNG dates from when humans began cultivating crops some thousand years ago (Bourke and Allen, 2009). Typically, shifting cultivation in PNG is characterised by clearing a small plot enough to feed the household from virgin forest or fallow land where the debris is burnt and crops are cultivated on soil mixed with ashes from the burnt vegetation. Digging sticks or metal hand tools are commonly used causing minimal disturbance to the soil. Different types of crop require different soil tillage for favourable crop yield. For example, bean and corn seeds generally require very little soil tillage compared with sweet potato and yam which require mounds to remove excess soil moisture, enhance tuber formation and promote high yields.

Generally, the cultivation of crops follows a mixed cropping pattern where different types of crops grow together on the same piece of land. The garden is abandoned and left to fallow when the crop yields start to decline usually after two years and a new site is then cleared and cultivated with seeds and cuttings taken from the old gardens. In the lowlands, banana and cassava are usually the last crops to be found in fallow gardens. Under customary land tenure, where land is owned communally, the tiller takes 'ownership' of the piece of land brought into cultivation and this ceases once the garden reverts to fallow.

Shifting cultivation is a sustainable way of farming because there is minimal overworking and exposure of the top soil to the surface and nutrients are enclosed in the root zone and easily taken up by the crop (Charlton, 1987; Floyd *et al*. 1988; Sillitoe, 1995). Soil moisture is also retained and erosion is reduced on hillside gardens by minimal overworking of the soil. Moreover, burning of vegetation helps provide nutrients directly to the crops through ash which contributes to the organic matter creating a favourable environment for soil organisms and crop growth. Eden (1988) surveyed seven gardens in Western Province of PNG and pointed out that 26 different types of crops were planted with an average of 12.9 different types of crops growing at any one time. This cropping pattern proves to be advantageous as

different crops have different nutrient and moisture requirements and also tap the soil for nutrients at different levels without depleting soil nutrients. Intercropping of leguminous crops also improves the soil fertility through nitrogen fixation. On the whole mixed cropping patterns resemble natural vegetation where soil fertility is maintained enhancing successive cropping cycles. For example, garden surveys conducted by Sillitoe (1995) amongst the Wola people of Southern Highlands Province show that sweet potato was able to be monocropped repeatedly without a fallow on the same piece of land because of previous mixed cropping which contributed to improving the soil fertility. Most importantly the different maturity periods of the different crops ensures food security all year round. The subsistence farming system is also supplemented by the cultivation of export and food crops for cash income and foraging activities including processing of sago, hunting, fishing and gathering of wild edible food (McAlpine *et al*. 1983; Allen *et al*. 1995; Bourke, 2001b).

Local production of staple food crops

A third reason for PNG's high level of food security is that the bulk of the food consumed is produced locally. Bourke *et al.* (2009) noted that in 2006, 83% of food energy and 76% of food protein consumed were derived from locally produced foods including root crops, banana, sago, vegetables, fruits and nuts (see also Gibson, 2001). The balance of 17% and 23% respectively were obtained from imported foods such as rice, wheat products and oil. Sweet potato is the most important staple crop providing two-thirds of the total food energy derived from food produced locally for the bulk of the rural people (Bourke, *et al*. 2009). Studies by Allen *et al*. (1995: 309) of 175 different agricultural systems show that sweet potato is a crop that is grown widely in different farming systems throughout the country. This is because of its agronomic advantages over other staples such as taro (one of the main staples in the lowlands), which was threatened by Taro Beetle and Taro Leaf Blight (TLB). Sweet potato cultivation is being integrated and becoming more important in lowland farming systems (see below). Other important staples are sago, yam, taro and banana. Sago is mainly obtained from the wild and has been domesticated in locations where it is a staple food.

The recent increase in the price of basic food stuffs is one of the main reasons for an increasing dependence on locally produced food in PNG. This was noted after 1997 when the kina was devalued and the price of rice increased causing people to turn back to local staples for their dietary intakes. Generally, in rural areas the high consumption of rice and other imported foods is associated with households generating a high cash income. For example, coffee and oil palm farmers increase their consumption of store foods during periods of high prices (Bourke *et al*. 2009; Koczberski *et al*. 2012). However, as shown in Table 3.2, most imported food in PNG caters for the urban population.

Table 3.2: Proportion of PNG population consuming different types of food (%).

Food	Rural	Urban	Total population
Greens	74	79	75
Sweet Potato	65	34	65
Rice	26	87	35
Banana	34	39	34
Coconut	28	34	29
Biscuit/bread/flour/scone	14	75	23
Taro/Chinese taro	24	10	22
Sago	13	19	14
Tinned meat	6	52	13
Legumes	13	8	12
Tinned fish	9	24	11
Yam	12	5	11
Fresh fish/shell fish	7	28	10
Chicken	4	26	7
Pork/beef/other meat	6	10	7
Cassava	7	4	6
Lamb and mutton	5	14	6
Bush meat	2	1	2

Source: Gibson, (2001: 47)

Over the years, the importation of basic foodstuff has mostly catered for the growing urban population who depend on imported food to meet around half of their caloric intake, while the rural population consumes most of what they produce. Urban populations tend to consume rice, wheat products, tinned fish/meat, chicken, lamb and mutton. Tinned fish/meat, chicken and beef are also produced by industries within the country. Rice and wheat products (manufactured in PNG from imported wheat) make up the bulk of imported food. As indicated by Bourke (2001a),

consumption of rice per year was three times higher in urban centres than in rural areas. Rice imports contribute to food security in the country because PNG is not self-sufficient in rice production (Manning, 2001). Thus, it is appropriate to import certain food crops that a country is not able to produce.

The largest increase in imports of basic foods occurred in 1997 to 1998 during a severe drought when garden food supply was low (Bourke, 2001a; Gibson, 2001; Gwaiseuk, 2001). The imported food catered for the population affected by the drought until subsistence production was restored to adequate production levels.

Adoption of improved crop varieties

Another important factor explaining the high level of food security in PNG is the increase in the introduction of high yielding varieties of food crops into local farming systems. These varieties are short maturing, hardy in nutrient deficit soils and are better able to withstand environmental stress and pests and diseases. These new high yielding varieties are increasingly being moved from one location to another in the country through movement of people and varieties. For example, sweet potato once predominantly cultivated in the high altitude areas and is now cultivated in almost all farming systems in the lowlands due to its agronomic advantages over other staples (Bourke *et al*. 2009). People in other parts of PNG are integrating new types of root crops into their farming systems adding to their staple base. For example, it was observed on Karkar Island, Madang Province, that banana and Chinese taro were becoming important staples which was not the situation earlier under taro based farming systems (Bourke *et al*. 2009). Similarly, as discussed in Chapter 6, oil palm smallholders were intensifying their food crop production to include short-maturing, high-yielding and hardy crops to address the problem of garden land shortages on the older oil palm LSS subdivisions. For example, in the past, cultivation of sweet potato was dominated by the Highlanders (mainly people from Chimbu province) (Benjamin, 1977a), but currently it is cultivated by all ethnic groups because of its favourable agronomic features.

Integration of more than one staple into the farming system promotes food security especially during unfavourable weather conditions. Furthermore, farmers in the high altitude areas are increasingly incorporating introduced vegetables such as broccoli, cauliflower, lettuce, carrots, capsicum, peas, beans, potato and many more new food

crops into their farming systems. These vegetables are of high nutritional value and contribute to the increased quality of the local diets. The crops are grown in the cooler climatic zones in the high altitude areas and are also increasingly being supplied to the lowlands through improved road links and seaports. The different subsistence farming systems practised in the high altitude areas and lowlands contribute positively to a wide variety of food crops being accessed by a large population.

Together with high yielding varieties of food crops, improved land management and cultivation practices over the years have been adopted into subsistence farming systems. This has helped improve food security within the context of a rapidly growing population (Bourke, 2001a). For example, in high rainfall areas, raised beds and mounds are made to improve soil moisture content for optimal crop growth. In the highlands, crop and weed residues (green manure) are incorporated into sweet potato mounds which contribute to the soil organic matter and improve soil quality (Bourke and Allen, 2009). Likewise, certain tree species planted on fallow gardens help to improve soil fertility for the next cropping period. Soil fertility is also maintained by the integration of leguminous crops into the cropping cycles (Bourke and Allen, 2009). Moreover, incorporation of animal manure into the farming systems is becoming more common. Chicken manure is the main type of organic fertilizer used mostly in monocropping of high value food crops grown for sale such as leafy and introduced vegetables.

Involvement of population in cash economy

A final reason why PNG has a high level of food security is that, with the existence of the cash economy, food is also accessible to farming households through purchases when it is not produced within the household. High value crops for cash generation have been incorporated into local farming systems. In many farming systems in PNG, there are no distinct barriers between subsistence and cash agriculture as most farming households are involved in both and are able to switch between the two depending on different situations and circumstances, such as changing market signals. For example, Bourke, (2012) observed that when the price of coffee was low in the Highlands, farmers switched to cultivating sweet potato which was selling at a high price and later switched back to coffee when coffee

prices increased. A similar situation occurs amongst the village oil palm smallholders who engage in alternative income-earning activities and subsistence food gardening to supplement oil palm income during low oil palm prices without abandoning the crop altogether (Koczberski *et al*. 2012).

As a result of the increasing integration of farming households into the cash economy, there has been increased accessibility to store foods such as tinned fish/meat which supplements the daily staples of sago, banana and root crops with protein and oil. Store foods increase the quality of PNG rural diets thereby enhancing food security in the context of food utilisation (see Chapter 9 for further discussion). Access to cash income also helps overcome temporary food shortages, as occurred during the 1997 drought when rural households could use income from cash cropping to purchase store foods. Also, when gardens are not in production, households are able to purchase store or locally produced food for their dietary intakes.

Factors contributing to food security threats in the country

In PNG, concerns relating to food insecurity are found in certain locations in the country. The physical environment and climatic conditions are the main determinants of threats to household food security in PNG. It is important to gain insights into these factors so as to have an understanding of the different agricultural systems contributing to the varying food security situations in the country and why threats arise in certain locations.

Physical environment

PNG is a country characterised by immense topographical diversity (Allen, 1983; McAlpine *et al*. 1983). The three main topographical features found throughout the country are the plains and valleys, low mountains and hills, and high mountains. Large chains of mountain ranges separate the highlands from the lowlands, creating the setting for high altitude and lowland areas. The vegetation cover varies from the lowlands to the highlands and is mostly influenced by altitude, climate and human influence (Allen, 1983). For example, in the lowlands at sea level, inundated areas covered by swamps and mangroves are mostly found near the coastline, whilst further inland grass, shrubs and small trees make up the vegetation cover. Low-lying land and flood plains are also found further inland where large river systems are

located such as the Sepik and the Fly Rivers. Some of the low lying valleys are not suitable for productive activities as they are flooded regularly, such as the Fly Basin in Western Province which occupies a large land mass (Allen, 1983). Rainforests are found at a range of altitudes such as the premontane and montane areas, though some differences in the vegetation cover occur with altitude. In the high altitude areas alpine forest, shrubs and grasses dominate the vegetation (Allen, 1983; Gurnah, 1992). Mountainous areas contain vast tropical rainforests which cover around 70% of the land mass of PNG (Allen and Bourke, 2009; Allen, 1983). These forests are dense and not suitable for human habitation and agriculture because they are too wet, rugged, and/or have poor soils. Those forests near human habitation are mostly used as a resource base for housing materials, crafts, hunting and the gathering of bush foods. The natural vegetation in certain areas of the country has been modified by shifting cultivation where large areas of grassland and secondary forest have replaced virgin forests (see Allen, 1983).

Climate

PNG has a tropical climate marked by wet and dry periods, with little seasonal variation experienced except in rainfall patterns. Rainfall and temperatures are the main determinants of land usage and, importantly, crop growth. The mean annual temperature is generally constant throughout the year where it ranges from 23º to 32°C in the lowlands and 11º to 25°C in high altitude areas (Allen, 1983; McAlpine *et al*. 1983). Altitude is the determining factor to variations in the temperatures where coastal areas at sea level experience high temperatures compared with the highlands where the temperatures are relatively low.

Rainfall distribution varies throughout the country and is caused by the north-west and south-east monsoonal winds. Most locations receive high rainfall between 2000-4000 mm annually (McAlpine *et al.* 1983). However, there are some dry areas in the lowlands such as Port Moresby, the Markham valley and the Sepik Plain with a marked seasonal rainfall distribution (McAlpine *et al*. 1983; Allen, 1983). McAlpine *et al*. (1983) categorised the provinces into their climatic and agro-ecological zones with respect to their altitudinal locations (Table 3.3). Even within the same province, variations in climate occur. For example, in the Markham valley in Morobe Province, a unimodal rainfall pattern (Gurnah, 1992) is experienced where there is a marked

dry season lasting five to six months followed by a long wet season. In Lae, in the same province, more rain is received between May and September. The climatic conditions determine the type of agricultural activities performed in different areas. Similarly, within the same zonal boundaries variations in rainfall distributions are distinct (see McAlpine *et al*. 1983: 150-164 for detail variations). For example, in the lowlands four distinct types of climate are found: very dry areas with marked seasonality, such as Port Moresby; very wet areas with rainfall distributed evenly throughout the year; and, two climatic zones between these two extremes experiencing both wet and dry seasons throughout the year, such as Madang and Rabaul. It seems that the bulk of agricultural activities occur in the intermediate climatic zones where the environment is conducive for cultivation of a wide variety of food and cash crops.

Types of subsistence agricultural systems

Variations in the climatic and physical environment have largely given rise to different agricultural systems and types of livelihoods in PNG. Allen *et al*. (1995: 302) used six main features to document in detail the different agricultural systems. These were: the type of fallow vegetation on land being cleared for cultivation; length of fallow period; cropping period; staple crops; soil fertility maintenance practice; and garden and crop organisation. They noted that the environment was the main determining factor of the different types of agricultural systems practised. Based on climatic zones categorised by McAlpine *et al*. (1983) (Table 3.3), three main types of agricultural systems were summarised. These are the dry lowlands, wet lowlands and the high altitude farming systems. The dry lowlands farming systems experience average annual rainfall between 1000 and 2000 mm annually with marked seasonal rainfall patterns. Examples of these areas include Port Moresby, Markham Valley in Morobe Province, the Sepik Plains in the East Sepik Province and the southern half of Western Province. The distinctive vegetation cover in these areas is savannah and grassland. Yam, sago and the triploid *Kalapua* banana are the main staples in these areas. Sweet potato and cassava are becoming important staples in the dry lowlands.

Table 3.3: Agro-climatic characteristics of the different ecological zones in PNG.

*Zones	*Representative location (s)	*Climate		*Vegetation	**Farming status	*Staple crop (s)
		Mean annual rainfall (mm)	Mean annual temperature (ºC)			
Dry lowlands (0-500m asl) i) Dry subhumid	Port Moresby	1000-1500	23-32	Savannah, grassland	Most types of farming occur. Intensive farming and densely populated in areas such as Maprik and Wosera. Intensive farming near Rabaul and Madang.	Sago- inundated plains and along the Sepik River. Taro, yam, sweet potato and cassava – coconut, cocoa, Robusta coffee, rubber - elevated locations. Taro – Lae
ii) Subhumid	Daru	1500-2000	23-32	Savannah, dry evergreen forest		
iii) Humid	Ambunti (ESP), Rabaul, Madang	2000-3500	23-30	Lowland hill and alluvium forest		
iv) Perhumid	Lae, Kikori (Gulf)	> 3500	23-30	Lowland hill and alluvium forest		
Wet lowlands -Pre-montane (500-1400m asl) i) Subhumid	Bulolo (Morobe)	1500-2000	18-29	Grassland	Farming is restricted because of steep rugged terrain and the extreme climatic conditions. Mostly low population, except in a few locations	Sweet potato.
ii) Humid	Lumi (WSP), Garaina (Morobe), Panguna	2000-3500	18-29	Hill forest		
iii) Perhumid	Lake Kutubu (SHP)	> 3500	18-29	Hill forest		
Highlands - Lower-montane (1400-3000m asl) i) Subhumid	Goroka	1500-2000	13-25	Grassland	Intensive farming and densely populated	Sweet potato – Arabica coffee
ii) Humid	Mt Hagen	2000-3500	13-25	Lower montane forest		
Upper-montane (> 3000m asl) i) Humid	Mt Wilhelm	-	4-11	Upper montane forest and grassland	No farming	-

Source: *McAlpine *et al.* (1983); **Gurnah, (1992).

Sago is an important food among villages located along the banks of the Sepik River who only have access to land for gardening during the dry season when water levels are lower. Silt and organic matter from the floods add to the soil organic content making it favourable for seasonal crops such as yam, sweet potato and watermelon. In such locations, trading and selling of sago and fish are important for accessing banana, root staples and other food items (Bourke, 2001a).

The wet lowlands farming systems experience average annual rainfall of between 2000 and 4000 mm (McAlpine *et al*. 1983). In these locations rainfall is distributed all year round and the vegetation cover is characterised by hilly terrain and forests. Most of these locations in the country are found in wet lowland farming systems such as near Lae, Madang and Rabaul. Here the climate is conducive to a wide variety of staples such as taro, sweet potato, banana, Chinese taro, cassava and a wide variety of vegetables and fruits.

Most of the population in the dry and wet lowlands farming systems live in coastal and riverine locations and/or have access to fish and marine products and a variety of game from the wild. Most importantly, they have access to sago from the wild (found in swampy areas) which serves as a staple crop or as a co-staple with other root crops. It is an important food crop that is able to withstand droughts and relieves temporary food shortages during extreme climatic events such as the 1997 drought (Bourke, 2001a). Within the lowland systems, villagers are also involved in the cultivation of a variety of export tree crops such as oil palm, Robusta coffee, cocoa, copra and other minor cash and food crops.

However, there are some locations such as some small islands and atolls with unfavourable climate or soil conditions that do not permit cultivation of cash crops and a wide variety of staples. These locations are vulnerable to food insecurity because they are prone to extreme climatic conditions and natural disasters, have low household levels of cash income and depend on a very narrow range of staple crops. Furthermore, small islands and atolls are highly vulnerable to sea level rise often affecting agricultural land through salinisation (Asian Development Bank, 2011).

The high altitude farming system is found in the mountainous areas, mountain fringes and the highlands provinces. Vegetation cover found in these areas varies from grassland and savannah to hilly and montane forests depending on the altitude. Sweet potato is the staple crop supplemented with a wide variety of introduced vegetables and potato. Sweet potato was initially introduced into the highlands and then later spread to other parts of the lowlands where it is becoming a staple crop. Throughout the highlands, different varieties of sweet potato are cultivated including both local and improved varieties which are tolerant to pests, diseases and frost (Bourke, 2001a). Within this system Arabica coffee is the main export tree crop that provides cash income for the smallholders. Increasingly, sweet potato and introduced vegetables are becoming good sources of cash income. However, poor infrastructure and deteriorating roads in some mountainous areas and mountain fringes often constrain smallholder coffee production. Also, in mountain fringes, frost sometimes occurs causing damage to crops: typically the climate is not conducive to as wide a range of staple and cash crops compared with the lowlands (Bourke, 2001a). Thus these fringe highlands areas are more prone to periods of food insecurity than many lowland locations.

Locations facing threats to food security in the country

As discussed, threats to food insecurity in the country are associated mainly with environmental factors. Temporal food shortages mainly occur as a result of natural disasters and extreme climatic conditions, whilst insufficient cash income may contribute to continual food and nutritional insecurity.

As pointed out by Bourke, (2001a), these vulnerable locations are found in three main areas which include:

High altitude areas and small islands and atolls

The highlands provinces, mountainous areas and small islands and atolls that do not have a wide range of staple crops are vulnerable to household food insecurity. These areas have unfavourable physical environments and climatic conditions that do not permit cultivation of a wide range of staple crops leaving them vulnerable to food insecurity during extreme climatic conditions. In these areas people do not have access to hardy staples like cassava, triploid banana and a wide variety of wild foods

which can be used as 'fall back' foods as occurs in many lowland areas when food shortages occur.

Remote rural areas

Remote rural areas located inland or in environments with high rainfall and steep topography are also prone to food insecurity. These rural locations are disadvantaged in two main ways. First, these areas do not permit the cultivation of a wide range of crops and vegetables of high nutritional value thereby compromising the health of the rural population. Two National Nutritional Surveys (NNS) conducted in the country in 1947 and 1982-1983 indicate that low consumption of protein was one of the main causes of children malnutrition in these areas. The environment was identified as an important contributor to child malnutrition in these two studies (Mueller *et al*. 2001; Allen *et al*. 2005). The 1947 study[2] was conducted in Busama, Kaiapit and Patep No. 2 in Morobe Province, Kavitaria in Milne Bay Province and Koravaki in Gulf Province. These locations relied on taro, banana, sweet potato and taro, yam and sago farming systems respectively. The study found that food produced by families was adequate but lacked protein and trace elements required for adequate child growth. The United Nations (2010) pointed out that lack of quality food in rural areas in developing countries is one of the main causes of underweight children. Another nutritional study conducted in 1999 in PNG noted a positive relationship between provinces that participated in cash cropping and the weight and height of children (Bourke *et al*. 2009; Allen, 2009). Mueller *et al*. (2001) reported that locations where people participated in tree cash cropping had better child growth than locations without export tree crops. These results indicated the importance of cash to access imported protein food stuff to supplement the high carbohydrate diets of rural villagers.

The second reason why households in remote areas are prone to food insecurity is because in these locations transport and communication infrastructure and government services are inadequate or absent resulting in very few opportunities for people to participate in income-earning activities (Gibson and Rozelle, 2003). Without cash income rural people in these areas are not able to purchase food to sustain them when their gardens are not in production and during extreme climatic events such as frost. Furthermore, rural populations often lack access to health and

educational facilities which contribute to high illiteracy rates and health problems. (Allen *et al*. 2005; Allen, 2009).

Areas prone to land degradation

The other locations Bourke (2001a) identified as likely to experience food insecurity are those that are prone to land degradation. Continuous farming due to high population pressure is becoming a threat to land degradation in certain locations especially in the highlands provinces, various lowland areas and some small islands in Bougainville and Milne Bay Provinces. Furthermore, low-lying islands and atolls are susceptible to sea level rise that can affect food gardens and cause damage to agricultural land (Asian Development Bank, 2011).

Urban areas and oil palm LSSs

Two other areas where household food security is under threat, and which have been neglected in studies, are urban areas and state-sponsored Land Settlement Schemes (LSSs). In PNG, rural people often migrate from islands to mainland or from the mountains to the lowlands or vice versa for gardening and subsistence hunting and gathering as a result of unfavourable conditions in their home villages. During the colonial administration, migration was organised between provinces to supply labour mainly for the plantations (Koczberski *et al*. 2001a; Keig, 2001). Later, work permits were granted to people to work in the towns and urban centres. Since the 1960s, rural-urban migration has increased greatly. Initially, rural to urban migration was perceived by the administrators as temporary, but over time, informal migrant settlements have become a permanent feature of all towns and cities in PNG, with many informal settlements now hosting third and fourth generation urban migrants. Most of the earlier informal settlements in towns and cities were created to cater for employed people who did not have accommodation or were not able to afford formal rents. Initially, most settlers gained permission to live on customary land through informal agreements with the landowners sealed through payment of cash and/or in-kind or through cultural links (Chand and Yala 2012; Numbasa and Koczberski, 2012). Over the years other relatives migrated to live with the initial settlers adding to the pool of urban settlers. New informal settlements are being created and increasing rapidly throughout the urban areas (Storey, 2010). In PNG, the rate of urban population growth and the national growth rate are about the same. Thus,

despite many efforts by the Government to deal with the situation, it is evident that the urban population is increasing every year through natural increase and rural to urban migration (Koczberski *et al*. 2001a; Goddard, 2001; Keig, 2001; Jones, 2012).

Increased rural-urban migration occurs primarily due to differences in the socio-economic situations between urban and rural locations (Connell, 1987; Curry and Koczberski, 1999) or the desire to explore new places (Umezaki and Ohtsuka, 2003). These migrants most often add to the pool of poor urban dwellers. Without a regular source of income and limited access to land for gardening, the urban poor are highly vulnerable to increases in the price of basic foods as they rely heavily on imported food. For example, in a study of several informal settlements in Wewak, ESP, many migrants living in informal settlements on customary land, did not have access to land for gardening because most of the settlements were established on water logged land (Numbasa and Koczberski, 2012). In some settlements in more favourable locations, almost all the land was taken up by housing with no land available for food gardening.

The oil palm LSSs in WNB and Oro provinces are other areas which can be considered vulnerable to food insecurity. The livelihoods of smallholder settlers are centred on fixed areas of leasehold land for cash cropping and gardening. As pointed out in Chapter 1, initially, single families were settled on the LSSs where they were allocated an agricultural leasehold block of around 6.05 hectares. Smallholders were expected to cultivate 4 hectares of oil palm with the remaining land reserved for household food gardens. However, over the years the situation on the older schemes has changed in ways that were not envisaged by the government at their inception. Second and third generation settlers are now living on the older LSS subdivisions, all of whom are dependent on oil palm income and the resources of a 6 ha block. There are rising pressures from increased population, decreased soil fertility due to continuous gardening and shortening fallow periods and garden land scarcity (Koczberski *et al*. 2012).

Conclusion

Population growth in PNG has generally kept pace with food production (Allen and Bourke, 2009). Since most people own land communally under customary land tenure, household food security is guaranteed for the majority of the population. Subsistence agriculture has played a vital role in sustaining rural livelihoods and household food security throughout the country. Over the years improved land management and cultivation practices, and improved crop varieties have been adopted and incorporated into smallholders' farming systems which have helped to improve food security within the context of a rapidly growing population (Bourke, 2001a).

The different agricultural systems contribute to the availability of a wide range of food crops in PNG, such as corn, peanuts, sweet potato, taro and new cultivars of banana. Also introduced crops such as *Brassica* var., broccoli, cauliflower, peas, beans and carrot which are grown in high altitude areas can be accessed by people in the lowlands through local and urban markets throughout the country. Also, hunting, fishing and gathering of bush food supplements the staple crops produced. Sago is one of the most important crops obtained this way and sustains millions of people throughout the country. It is an important source of food and substitutes as a buffer food during extreme climatic conditions. For villages in the coastal and riverine areas, fish and other marine products are dietary supplements. Large populations are found in coastal areas and along rivers and waterways such as the Sepik River where fish and other goods are traded or sold for cash income. Inland settlements with access to the forest and grassland hunt for wild animals and birds.

Although the outlook of household food security in PNG is good, there are pockets of vulnerable locations in the country such as the small islands and high altitude areas caused largely by the diverse physical environments that determine the type of agricultural and income-earning activities that are possible. Other areas under threat over recent years are urban and rural centres attracting a high influx of migrants where access to land for livelihoods and food gardening is limited and insecure. The state-sponsored oil palm LSSs in WNBP are locations where households are vulnerable to food insecurity due to population and land pressures. The next chapter discusses research methods used in the study to examine the status of household food

security and the strategies smallholder households have pursued to address pressures on the block.

Notes

1. Customary land tenure refers to land that is communally owned by those who belong to the same tribe or clan. Therefore, land is accessible to all members of the clan to make household gardens. Usually ownership of gardens occurs after bringing virgin land into production. Under this tenure outsiders are restricted from conducting activities on the land, only upon the consensus agreement from the members.

2. The 1947 NNS was conducted in selected locations with different farming systems. These areas and the most important foods there were:
   Busama (Lae, Morobe province) – taro
   Kaiapit (Markham valley, Morobe province) – banana
   Patep No. 2 (Wampit valley, Morobe province) – taro and sweet potato
   Kavitaria (Trobriand islands, Milne Bay province) – yam
   Koravaki (Purari River delta, Gulf province) – sago.

CHAPTER 4

STUDY SITES AND METHODOLOGY

Introduction

The Chapter starts by reviewing quantitative and qualitative research methods and justifying the choice of a mixed method approach as being the most appropriate for the study. This is followed with a justification for the selection of study sites, households and sample size. The final part of the chapter describes the methods employed to collect quantitative and qualitative data, and it describes the variables that were used to assess the status of household food security on the LSSs.

Methodological approach

Quantitative and qualitative research methods

Much has been written on the advantages and disadvantages of quantitative and qualitative research approaches. The two broad approaches have differences between them as well as similarities (Bouma and Ling, 2004). Some of the key differences identified by various authors are summarised in Table 4.1.

Researchers from different disciplinary backgrounds recommend approaches based on their own disciplinary experiences and training. However, it is not the question of which is the best approach when choosing the research method because it depends on what the researcher wants to find out (Silverman, 2000; Bouma and Ling, 2004), the resources available to carry out the research (Chadwick *et al*. 1984), and the intended use of the data. For example, quantitative research is most appropriate when collecting factual and descriptive information which can be transformed into numerical data for statistical analysis to 'describe' certain situations and identify trends in behaviour, attitudes or opinions. In contrast, qualitative research is used when seeking to 'understand' behaviour such as 'why' and 'how' people respond to

certain situations. The two approaches have their own standards of validation and assessing reliability. Bouma and Ling (2004) stressed that:

> … the difference between quantitative and qualitative research is not one of better or worse but rather one of appropriateness to the question. … Neither is one easier than the other, nor is one approach more creative than the other (165-187).

Table 4.1: Differences between quantitative and qualitative research.

Quantitative research	Qualitative research
Extensive research (Harre, 1979, cited in Cloke *et al.* 2004)	Intensive research (Harre, 1979, cited in Cloke *et al.* 2004)
Deals with numerical data (counts and measures) (Berg, 2004)	Deals with meanings and concepts (Berg, 2004)
Answers questions such as 'how many' and 'what proportion' (Bouma and Ling, 2004)	Answers questions such as 'why' and 'how' (Bouma and Ling, 2004)
Questioning involved (Cloke *et al*. 2004)	Interviewing and interaction involved (Cloke *et al*. 2004)
Representative of a population Usually large sample (Cloke *et al*. 2004)	Not representative of a population Usually small sample or case study (Cloke *et al*. 2004)
Data collected on events occurred in the past. (Chadwick, Bahr and Albrecht, 1984)	"Study of things in their natural setting" (Denzin and Lincoln, 1998) Researcher identifies with the subjects under study for better understanding (Chadwick, Bahr and Albrecht, 1984)
"…data reports reality" (Silverman, 2000)	"…findings can be influenced by the researcher's values" (Silverman, 2000)

Moreover, researchers have observed the value of using both quantitative and qualitative research methods which complement each other for the collection of quality data. Bouma and Ling (2004: 165-187) point out that, "often the best and most innovative research uses both qualitative and quantitative research approaches". For example, Bouma, in his study of the life of Muslims in Australia, collected quantitative socio-demographic data of the population under study from the Australian Population and Housing census data, and qualitative data from in-depth interviews with Muslim Australians (Bouma, 1994, cited in Bouma and Ling, 2004). Cloke *et al*. (2004), also recognized the importance of collecting both quantitative and qualitative data which he did through questionnaires and personal observations. Similarly, Whitehead (2002) in her studies tracking livelihood change over a period of time in north-east Ghana used both qualitative and quantitative approaches for

data collection. She used earlier data collected from quantitative surveys to identify trends and patterns, and qualitative data from interviews with farming families to understand their behaviour in order to explain the patterns and trends identified in her quantitative data. Other researchers include Chimhowu and Hulme (2006) who used questionnaires and semi-structured and life history interviews within the sustainable livelihoods framework to identify constraints on livelihood activities in spontaneous and state sponsored LSSs in Zimbabwe. Although quantitative data helped to identify patterns, links and trends and provide statistical descriptions of the situation, underlying issues were explained through qualitative methods such as open-ended questionnaires, interviews, informal interviews and participant observation.

Importantly, "qualitative research facilitates quantitative research" and vice-versa (Bryman, 2004). For example, having a better understanding of a case through in-depth study contributes to framing appropriate questions for quantitative data collection; likewise from quantitative data, a case can be selected for in-depth study to collect qualitative information. In my study, quantitative data collected from household surveys initially provided important information for selecting specific populations and cases with desired characteristics for in-depth study to further assess household food security situations.

Assessing food security

Over the years numerous studies have been conducted to address the central theme of food security and poverty alleviation. Many of these studies have attempted to measure the status of household food security. The range of techniques used to assess food security has included in-depth qualitative techniques and household surveys using quantitative methods to sophisticated mathematical models, depending on research goals and the type of analysis to be used. Many of these studies were done in the field of health and nutrition for the purpose of gaining information on communities and selected populations for policy implications or health intervention programs. Other food security studies concentrated on poverty alleviation, while in disaster prone areas, intervention programs were conducted to identify target populations so that assistance can be provided accordingly. Other studies have been undertaken to identify populations and communities susceptible to certain threats for the purpose of sending out early warnings.

Instruments used to measure household food security

Sustainable Livelihood Framework (SLF)

Recently, some food security studies have used the sustainable livelihood approach to assess household food security (e.g. Lovendal *et al*. 2004; Chimhowu and Hulme, 2006). The livelihood framework (DFID, 1999), shows different components within the whole system that are important in contributing to favourable livelihood outcomes (Figure 4.1).

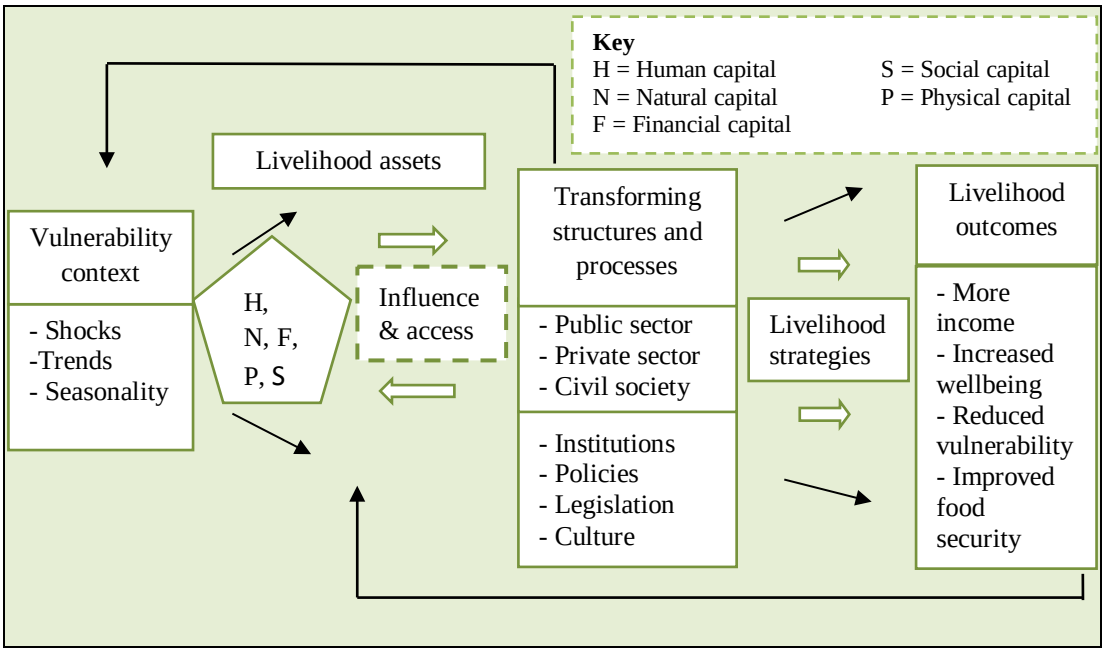


Figure 4.1: Sustainable Livelihood Framework. Source: DFID (1999: 1).

The absence of a component within the system will influence the type of livelihood strategies that are developed (Bebbington, 1999). Furthermore, although households may be equipped with the necessary assets and resources, the absence of good governance that ensures proper policies and institutional support to the population will constrain the achievement of favourable livelihood outcomes and may even push households into vulnerable situations such as increases in the price of goods and services. In some rural areas, the absence or lack of basic government services hinders households' ability to diversify livelihood activities, such as in some remote rural areas of PNG (Gibson and Rozelle, 2003; McGregor *et al*. 2009; Allen, 2009) or on LSSs in some parts of Zimbabwe and North West Province of South Africa (Chimhowu, 2002; Francis, 2002; Chimhowu and Hulme, 2006). Therefore, the use of the SLF to assess household food security captures all the attributes that contribute to sustainable outcomes. It is used most often in livelihood profiling to identify

vulnerable populations (Lovendal *et al*. 2004). Thus, the framework helps to identify constraints faced within the system so that specific issues, such as food insecurity, can be addressed to achieve sustainable livelihoods as depicted in Figure 4.1.

Radimer/Cornell Questionnaire and Household Food Security Module

Another technique to measure household food security is the 12-item 'Radimer/Cornell Questionnaire' (Radimer, 2002). This instrument was developed to assess household food security in the United States (US). The questionnaire captures perception and anxiety of the respondents regarding the food security status of the household. Another instrument used in the US is the 'Household Food Security Module' which is an 18-item (18-questions) instrument, used by the United States Department of Agriculture (USDA, 2005) and was developed based on the Radimer/Cornell and the Community Children Hunger Identification Project (CCHIP) instruments (Radimer, 2002). The 18-item instrument measures the status of household food security and the severity of food insecure households.

These instruments have their limitations. For instance, they capture the status of household food security over the past 12 months which may not reflect the present situation (Bickel *et al*. 2000). Furthermore, the instruments are suitable for developed or industrialised countries where most food consumed is purchased. Therefore, to use this instrument effectively in developing countries where food is mainly home-produced, these instruments have been modified based on pre-knowledge of the locality under study in order to suit the cultural context of the localities (e.g. Knueppel *et al*. 2009; Thorne-Lyman *et al*. 2010). For example, to measure household food insecurity in a selected location in Tehran, Shoae *et al*. (2007) modified the Radimer/Cornell questionnaire through pre-interviews conducted among women where certain 'phrases' and 'terms' of the instrument were changed and additional questions were added to clarify the original questions. Questions were also framed by researchers in the local language for better delivery. Apart from these two main instruments, there are others developed to suit the organization or the researcher's own objective/s. Some examples includes the Household Food Insecurity Access Scale (HFIAS) which was used to measure household food insecurity by exploring relationships amongst certain household socio-economic characteristics (Knueppel *et al.* 2009) and Value-at-risk (VaR) analysis used to assess

vulnerability to household food security using certain thresholds with the use of the questionnaire (Scaramozzino, 2006).

Household Dietary Diversity Score (HDDS) and Food Consumption Score (FCS)

The HDDS and FCS are the key measures used by the Food and Agriculture Organisation (FAO, 2007) and World Food Program (WFP, 2008) respectively to assess the state of household food security. The HDDS measures the count of food groups consumed by a household over a reference period, usually 24 hours. Respondents are asked to recall the number of food groups consumed out of 12 standard food groups whilst the FCS measures the different foods consumed over a seven-day period and scores are assigned to food consumed based on the indicated weight on each food group the food comes under (see for example, Appendices 1 and 2). These instruments have been validated as proxies for household food security (Kennedy *et al*. 2010). For example, use of these instruments has shown positive relationships between household food security and other variables such as micronutrient availability in the different food groups (Ruel, 2003; Torheim *et al*. 2004; Savy *et al*. 2005; Kennedy *et al*. 2007; Vandevijvere *et al*. 2010); socio-economic status of the household (Hoddinott and Yohannes, 2002; Torheim *et al*. 2004; Amaza *et al*. 2008; Knueppel *et al*. 2009; Ayinde et *al*. 2010; Sarker and Itohara, 2010); food expenditure (Thorne-Lyman *et al*. 2010) and household food security. In my study, the HDDS and FCS were used to measure the status of household food security, and were augmented with other quantitative and qualitative findings.

Studies undertaken to measure the state of nutritional and household food security using Household Food Security Module, Radimer/Cornell Questionnaire, HDDS, FCS and SLF are summarised in Table 4.2.

Table 4.2: Some earlier studies to assess the status of household food security in various countries.

Author and location of study	Instrument used and purpose	Method used
Beaumier and Ford (2010) Inuit, Canada	Mixed methods	Semi-structured questionnaire, focus group and key informant interviews
Shoae *et al*. (2007) Tehran, Iran	Modified Radimer/Cornell questionnaire. Test validity of instrument to measure household food insecurity	Self-administered questionnaire
Steyn *et al*. (2006) South Africa	DDS and Food Variety Score (FVS): Test validity of the scores to measure nutrient adequacy in children	24-hour food recall and food frequency questionnaire
Kennedy *et al*. (2007) Philippines	DDS: Test validity of the score to measure adequate micronutrient intake of 24-71 month old non-breast-feeding children	24-hour food recall
Vandevijvere *et al*. (2010) Belgium	Dietary Diversity: Assess relationship between food group diversity and dietary quality	24-hour food recall
Savy *et al*. (2005) Burkina Faso	Dietary Diversity and anthropometric measurement: Compare validity of DDS for 1-day and 3-days and explored relationships with household socioeconomic characteristics and nutritional status of women	three-day food recall = DDS -Anthropometric measurements [Body Mass Index (BMI) and Body Fat Per cent (BFP)]
Torheim *et al*. (2004) Mali	Dietary Diversity: Examine association between dietary diversity and nutrient adequacy	seven-day food frequency questionnaire
Rafiei *et al*. (2009) Iran	US Food Security Module: Test validity of the instrument to measure household food security	18-item questionnaire
Hoddinott and Yohannes (2002) Bangladesh, Egypt, Ghana, India, Kenya, Malawi, Mali, Mexico, Mozambique, Philippines	Dietary Diversity Score: Provides information on household food security	24-hour and seven-days food recall
Thorne-Lyman *et al*. (2010) Bangladesh	Dietary Diversity Score: Assess association between DDS and food expenditures	Questionnaire on socioeconomic characteristics, seven-day food recall and seven-day household food expenditure
Hamelin, Habicht and Beaudry (1999) USA	Open-ended questions, Questionnaire and Radimer/Cornell Questionnaire: Assess implications of household food insecurity	Open-ended questions to collect qualitative information Questionnaire on socio-demographic information Radimer/Cornell Questionnaire to assess status of food insecurity
Lovendal *et al*. (2004) Benin, Guatemala, Vietnam, Nepal and Afghanistan	Sustainable Livelihood Approach: used to measure food security	Qualitative and Quantitative technique used (secondary data, focus group discussions, in-depth structured interviews)
Scoones (1998) Bangladesh, Ethiopia, Mali and Zimbabwe	Sustainable Livelihood Framework (SLF)	Both quantitative and qualitative techniques used

Mixed method approach

From a review of the literature and based on the objectives of the thesis, a mixed method approach using both quantitative and qualitative tools was selected as the most appropriate approach for my data collection. These methods, discussed in detail below, included:

i. Household demographic and socio-economic surveys.
ii. In-depth household case studies which included household 24-hour dietary recall, daily labour allocation recall for main activities done, household garden surveys and collection of life stories,
iii. Participant observation and,
iv. Informal interviews with smallholders and key informants.

The reasons for selecting these methods were twofold. Firstly, quantitative data from the household survey provided demographic and socio-economic information on smallholder households that provided the basis to identify different groups of farmers and their attitudes and approaches towards household food security on the LSSs. Furthermore, changes and patterns in the livelihoods of smallholders over time were identified by comparing quantitative data I collected with previous smallholder studies on the LSSs. Also, quantitative data were required for statistical analysis to explore associations between selected characteristics of smallholder households and the status of household food security (see Chapter 9). Secondly, qualitative data collected through the various methods enabled me to better understand the trends and patterns in the behaviour and attitudes of farmers and brought to light underlying issues which could not be identified through quantitative data.

Study site location

This study was carried out at Hoskins and Bialla oil palm project areas in West New Britain Province, PNG, during two fieldwork periods: 2010–July to October and 2013-January (Figures 3.1 and 3.2) (see Chapter 1 for study background). The oil palm LSS subdivisions selected were Kapore and Sarakolok in the Hoskins oil palm project area and Tiauru and Kabaya in the Bialla project area. Kapore, Sarakolok and Tiauru subdivisions were chosen because they were the oldest of the LSS subdivisions in WNBP and have experienced high population growth rates (Koczberski *et al*. 2001b).

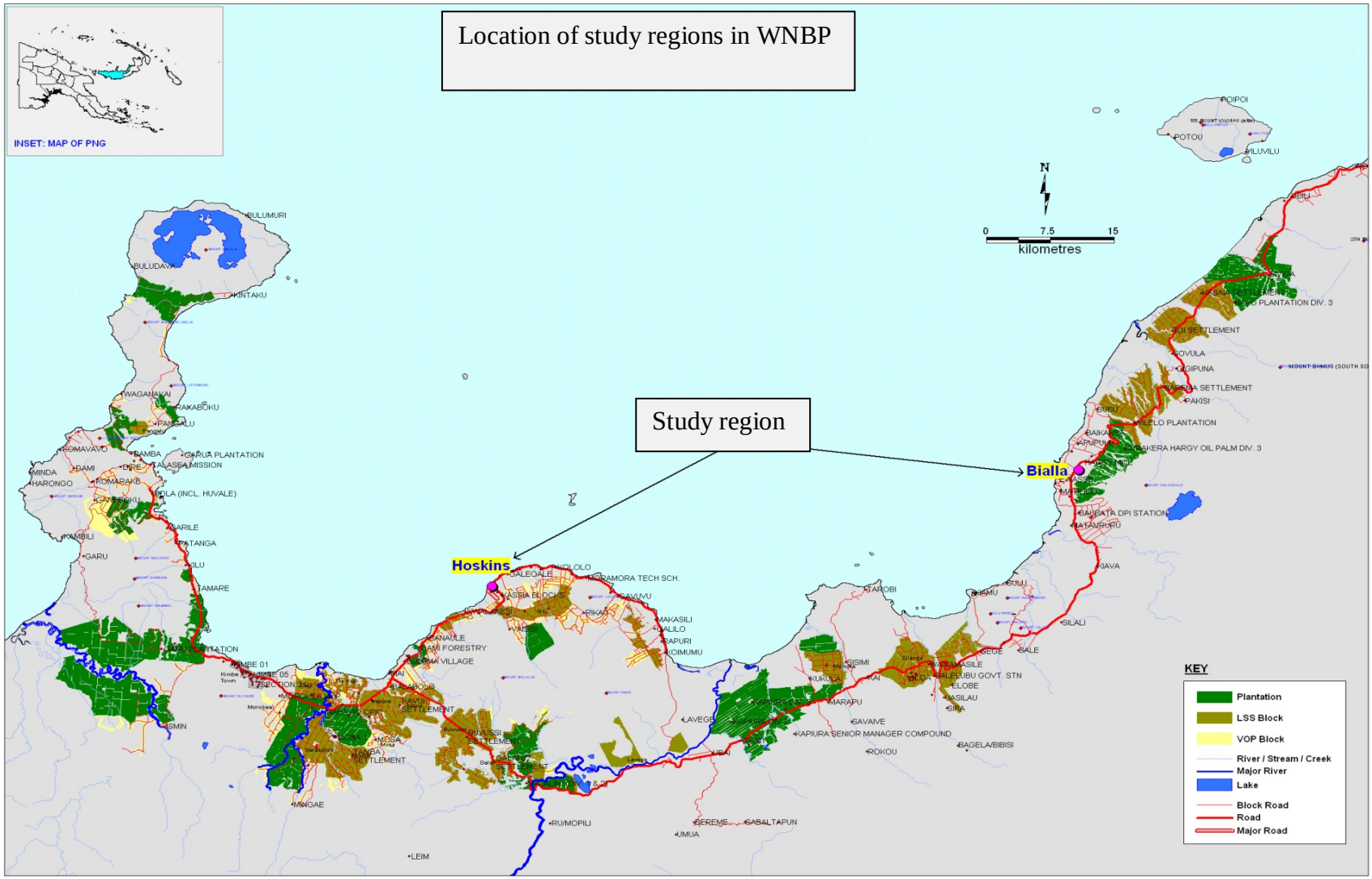


Figure 4.2: Location of study regions in WNBP (Source: NBPOL. Amended by J. Vuvu in 2010).

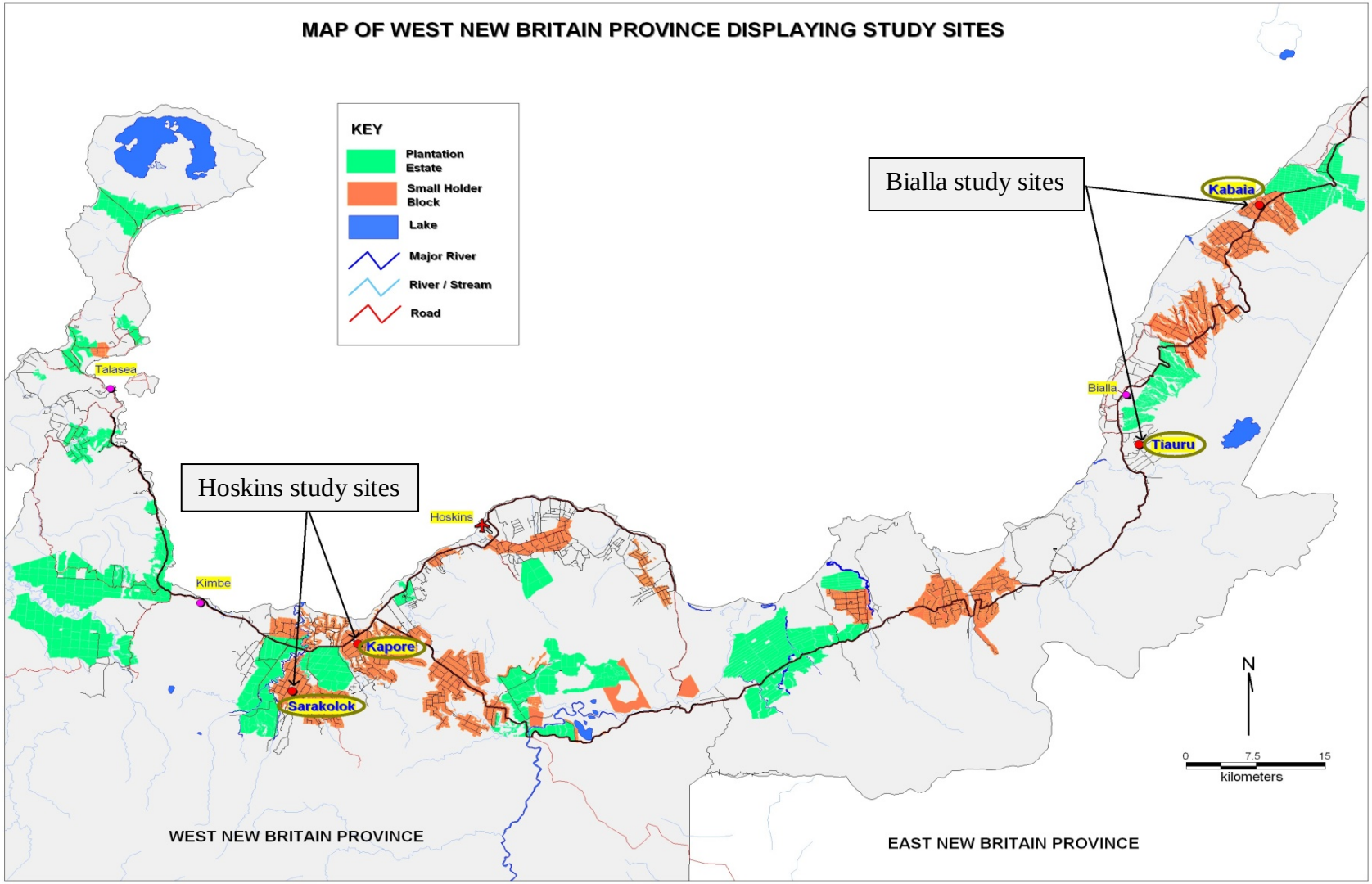


Figure 4.3: Location of study sites at Hoskins and Bialla (Source NBPOL. Amended by J. Vuvu in 2010).

Likewise, as mentioned in Chapter 1, the 2 ha reserve land at the rear of the blocks for gardening has been steadily planted to oil palm due to high cash demands by extended family members, possibly undermining household food security, especially during periods of low oil palm prices (Koczberski *et al*. 2001b; Dewhurst, 2007). Kabaya subdivision, established in 1994, was the most recent subdivision and settlers there were observed not to be experiencing pressures on block resources to the same extent as the older subdivisions. Thus, Kabaya, where population pressures were less, was selected to provide a contrast to the older, more densely populated subdivisions.

Selection of study population

The study population covered all LSS subdivisions in both Hoskins and Bialla. Purposive sampling was used to select Kapore and Sarakolok subdivisions from the total of eight subdivisions at Hoskins; Tiauru and Kabaya subdivisions were chosen from the total of ten subdivisions at Bialla (see Appendix 3). According to Hay (2005), this type of sampling is used in studies that are "purpose-driven". Moreover, this method is used when the researcher has some pre-knowledge of the study population and the subjects to be studied.

Selection of sample for household demographic and socio-economic questionnaire surveys

Clustered random sampling was used to select 60 smallholder blocks each at Hoskins and Bialla oil palm project areas, to participate in a household demographic and socio-economic questionnaire survey. Considering the time constraints in walking long distances between the 6 ha smallholder blocks, cluster sampling was a more appropriate method to use than complete random sampling of the settler population. OPIC area maps of the four selected subdivisions were used as guides to select randomly five clusters where each cluster was made up of four to ten oil palm blocks giving a total of 30 blocks in each subdivision of Kapore, Sarakolok, Tiauru and Kabaya, totalling 120 blocks (Figure 4.4, selection of sample at Kapore). Selection of the clusters was done in a way to ensure a good representation in the sample.

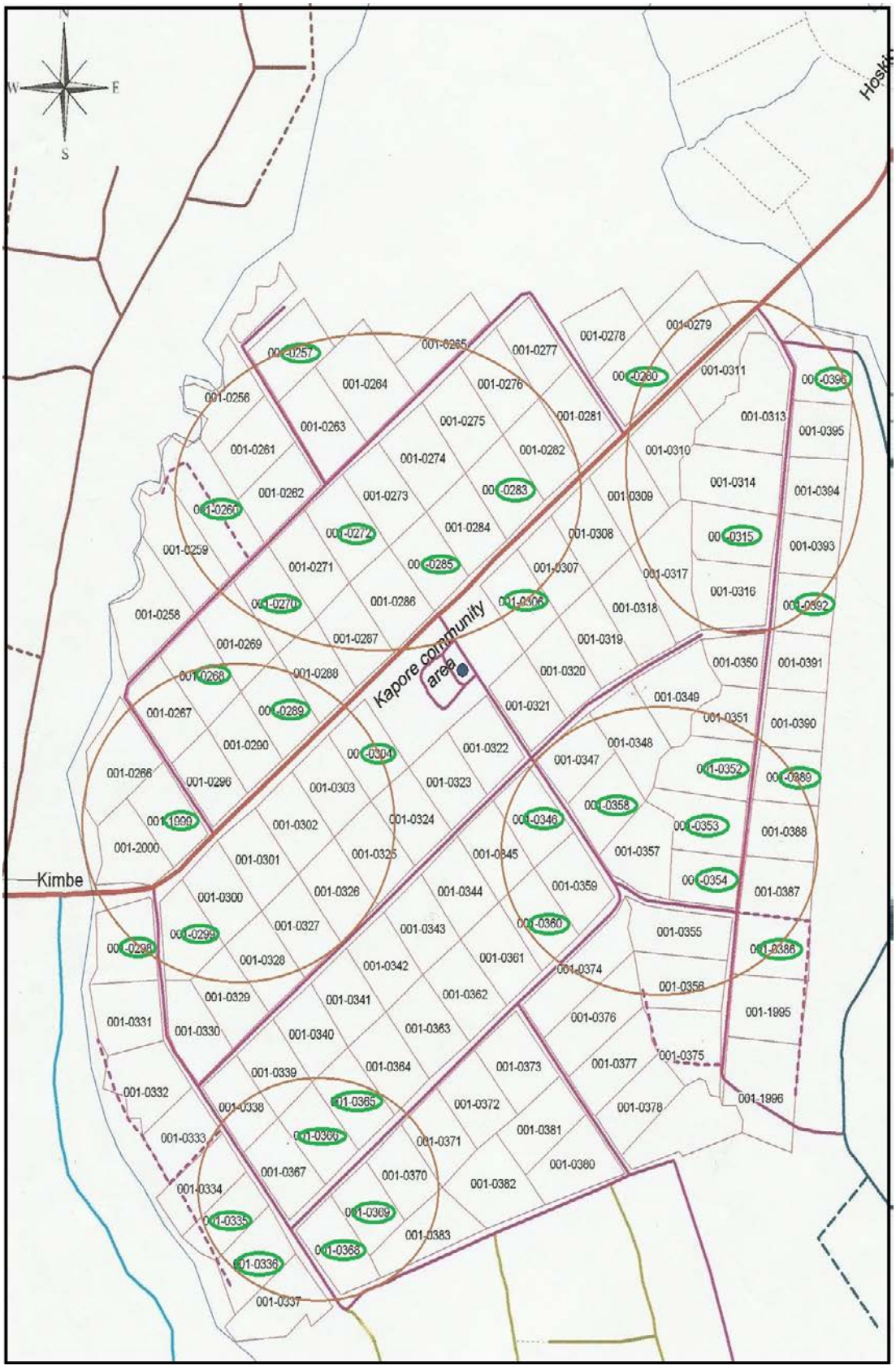


Figure 4.4: Schematic diagram of cluster sampling at Kapore subdivision (Source: adapted from OPIC, 2010).

This method proved to be more convenient where interviews were conducted within the same clusters and in situations where the selected respondents were not available, the next neighbouring block within the same cluster was interviewed, instead of following a randomly selected reserve list. The sampling method ensured a smooth transition of data collection from one cluster to another. Furthermore, being a female researcher, security was a consideration whilst selecting the sample clusters. The selected locations were deemed safe by the OPIC officers before fieldwork began.

The household demographic and socio-economic survey involved the blockholder households or the primary households. As noted in Chapter 1, there are two types of households on LSS blocks: primary and secondary households. The blockholder is usually a male[1] and/or the son of the original leaseholder. Blockholders manage the block and are responsible for distributing oil palm income. Secondary households are co-resident households on the block, and are made up of the blockholder's other siblings and their families and/or relatives from the extended family living together on the same block, and operating as separate household units. Secondary households have fewer claims on the oil palm income than the primary household.

Selection of sample for in-depth household study

The household demographic and socio-economic survey provided the source for the selection of a subsample of household case studies for in-depth study. For the in-depth household studies, a total of 18 blocks were selected at Hoskins and 24 blocks in Bialla. At Hoskins, only Kapore was included. At Bialla equal subsamples of 12 blocks each were selected at Tiauru and Kabaya. To select this subsample, the purpose of the household case studies was explained to respondents and their consent was sought to participate if they were identified as potential participants in the in-depth survey. The respondents' agreement regarding their availability for interview at scheduled times was important for efficient follow-up and data collection and this was obtained during the first day of interviews. Because I was residing at Kapore during data collection, Sarakolok subdivision was excluded from the household case study subsample due to time constraints as the in-depth study required a lot of time doing daily follow-up visits to collect data for the 24-hour dietary recall and household labour allocation. Thus, it would have been difficult making daily trips between the two subdivisions.

Blocks with different attributes were selected as representative of other blocks to investigate the research objectives and to fully understand the underlying issues pertaining to the role of smallholder households in maintaining household food security. Six key block attributes listed in Table 4.3 were used to select households (see Appendix 4 for sample distribution). Purposive stratified sampling (Hay, 2005) was used to select the subsample of 42 blocks with the six characteristic features.

Table 4.3: Categories used for selecting the sub-sample for household case studies.

Categories	Attributes	Sample size
Family type	i. Single household blocks ii. Multiple household blocks	8 8
Block type	i. Blocks fully planted to oil palm ii. Blocks with *wasblock** or with areas of immature palms allowing intercropping with food crops – use single space in tables	8 8
Block location	i. Blocks bordering state reserve land or buffer zones ii. Blocks not bordering state reserve land or buffer zones	5
Total		42

*See Chapter 7, Note 1 for definition.

Study variables and their measurements

A variable "takes on two or more values" (Nachmias and Nachmias, 1976) which can change in response to certain factors. The dependent variable changes as a result of the independent variable(s). Independent and dependent variables take on different forms depending on the research objective. For example, fortnightly income taken as an independent variable in one study such as an examination of consumption patterns may be taken as dependent variable in another study examining access to land for cash cropping.

Dependent variables and their measurements

The status of household food security was the dependent variable and was measured by:

1) number of meals per day
2) meal source, and
3) meal ingredients

The wife of the blockholder was asked for the number of meals she prepared per day for her household the previous day, what each meal consisted of and the source of each meal ingredient.

1. Number of meals per day.

The number of meals per day was measured by the actual number of main meals consumed per day per household.

2. Meal source.

Meal source was measured by a count of the number of main food sources consumed by the household over a period of seven days. There were four main meal sources observed in all the subdivisions which included: own garden, purchased from store, purchased from local food markets, and other (given by relatives or friends). These categories were used to group meal sources. Within the concept of food security information, meal source helps assess the availability and accessibility of food. That is, the variable assesses the capacity of smallholders to produce food themselves or access food through their purchasing power when they are not able to produce their own food.

3. Meal ingredients.

Two different types of measurements were used to measure meal ingredients. These were the Household Dietary Diversity Score (HDDS) and the Food Consumption Score (FCS). These two measurements are proxies for assessing food quality as they measure the frequency of consumption of different meal ingredients representing different food groups over a period of time. The HDDS measures diversity of meal ingredients in a 24 hour period. It is mostly used to assess the economic status of the household (Hatloy *et al*. 2000; Hoddinott and Yohannes, 2002) where it assesses the ability of the households to purchase food (Swindale and Bilinsky, 2006; FAO, 2007). That is, a food secure household is able to purchase a wide range of food stuff apart from the daily staples. For instance, households which are able to purchase condiments (such as food spices and flavouring, sugar, tea and coffee), confectionaries or fast foods indicate that they have the purchasing power to access not only staple foods but other non-staple foods based on their food preferences. FCS assesses the quality of the diets over a seven day period revealing the dietary patterns

of the households. Thus, the two different measurements were used to investigate and confirm the status of household food security on the LSSs.

(a) Calculation of HDDS

Calculation of the HDDS was done using household 24-hour dietary recall survey. There are 12 standard food groups and each food group corresponds with different meal ingredients (Appendix 2) (see FAO, 2007 for details). A score of 0 or 1 is given for each food group that corresponds with the meal ingredients consumed. A score of 0 is given to a food group not consumed and a score of 1 is given to a food group that was consumed. Scores for each household were summed to obtain the HDDS. The scores ranged from 0-12, where '0' indicates that no meal ingredient representing the 12 food groups were consumed and '12' indicates that food items from all 12 food groups were consumed during the 24-hour period. Hence, a high score would mean that a household has consumed food from different food groups which means that they are consuming essential nutrients vital for a healthy life. As mentioned above, HDDS have been tested and validated as a good measurement for nutritional security. High scores would also mean that households have a better financial standing which enables them to purchase a variety of foods.

However, discrepancies may exist with this measurement because it is a one-off recall and may not fully represent the dietary pattern of the household over a longer period (for example, it might miss seasonal food shortages). Consumption of high protein foods may increase during special occasions such as festive seasons and cultural celebrations and decrease during the beginning of school years when parents sacrifice such foods to meet school fees. This scenario can be identified with the study site. One of the ways to avoid such discrepancies is to avoid collecting data during those times. Also the FCS can be used to validate HDDS as it collects data on meal ingredients over a seven day period.

(b) Calculation of FCS

The FCS was calculated using 24 hour dietary recall surveys over seven consecutive days. Different food ingredients consumed by the main household over the seven-day period were marked under respective food groups (Appendix 1) (see WFP, 2008 for details). The total number of days in a week each food group was consumed was also noted. The value may range from 0 to 7, where 0 indicates that the food item was not

consumed during the seven-day period and seven indicates that the food item was consumed every day for seven days. The total number of days each ingredient was consumed during the seven-day period was multiplied by the allocated weighting for the respective food group the meal ingredient was from which produced weighted scores for each food group. The weighted scores per group were then summed to obtain the FCS. Because the FCS measures the quality of the diets consumed by smallholder households over a longer period of time (7 days), dietary patterns can be identified. A high FCS means that a household is consuming quality food, and is therefore more food secure than a household with a low FCS.

Selection of the FCS thresholds

To assess the status of food security, households were placed into three Food Consumption Groups (FCGs) based on their FCS. These FCGs were 'at risk', 'borderline' and 'acceptable (WFP, 2008). A low FCG indicates poor quality diets; 'borderline' indicates that households are potentially at risk of falling below the borderline category and an 'acceptable FCG shows a healthy diet. Thresholds for the FCGs are determined by the FCS and pre-knowledge of the consumption patterns in the locality under study (Swindale and Bilinsky, 2006). Usually the first cut-off mark (first threshold) is calculated based on the staple foods consumed in the locality. In my study, the first threshold for the low FCG (at risk households) was identified by daily diets over a seven-day period which were composed of root staples, rice or banana, greens (and other vegetables) cooked in coconut milk (oil). Thus, the first cut-off score was calculated by summing up the product of the average number of days of consuming each food group over the seven-day period by their respective weightings (see Chapter 9, Table 9.5 for the average number of days of consumption of each food groups):

= (Staples x weighting) + (vegetables x weighting) + (coconut milk-oil x weighting)

= (7x2) + (6x1) + (3x0.5)

= 21.5 (First FCS threshold)

The second cut-off score for the FCG of 'borderline' was obtained with the expectation that the typical daily diet of the household was composed of the foods listed above, and was often supplemented with tinned fish or meat. Based on the average frequency of consumption of tinned fish/meat over the seven days, Table 9.7

shows that the average number of days of consuming tinned fish/meat was four and fresh meat, fish or chicken was two.

= (Staples x weighting) + (vegetables x weighting) + (coconut milk [oil] x weighting) + (tinned fish/meat x weighting) + (fresh meat/fish/chicken x weighting)

= (7x2) + (6x1) + (3x0.5) + (4x2) + (2x4)

= 37.5 (Second FCS threshold)

The FCS thresholds provided the basis for the Food Consumption Groups (FCGs) which are:

1. 0 – 21.5 At risk
2. 22 – 37.5 Borderline
3. Above 37.5 Acceptable

Independent variables and their measurements

The independent variables in this study to assess household food security included:

(a) Blockholder's (BH) age
(b) BH's education level
(c) BH's family size
(d) Number of secondary families
e) Block population
f) Blockholders' fortnightly net income
g) BH's daily food expenditure
h) Garden size (gardens belonging to all block members).

These variables were considered likely to have an impact on the status of household food security under certain vulnerable situations such as fluctuations in oil palm prices and when garden land is short for food crop production (Figure 4.5).

<u>Measurement of independent variables</u>

The measurement of independent variables is presented in Table 4.4.

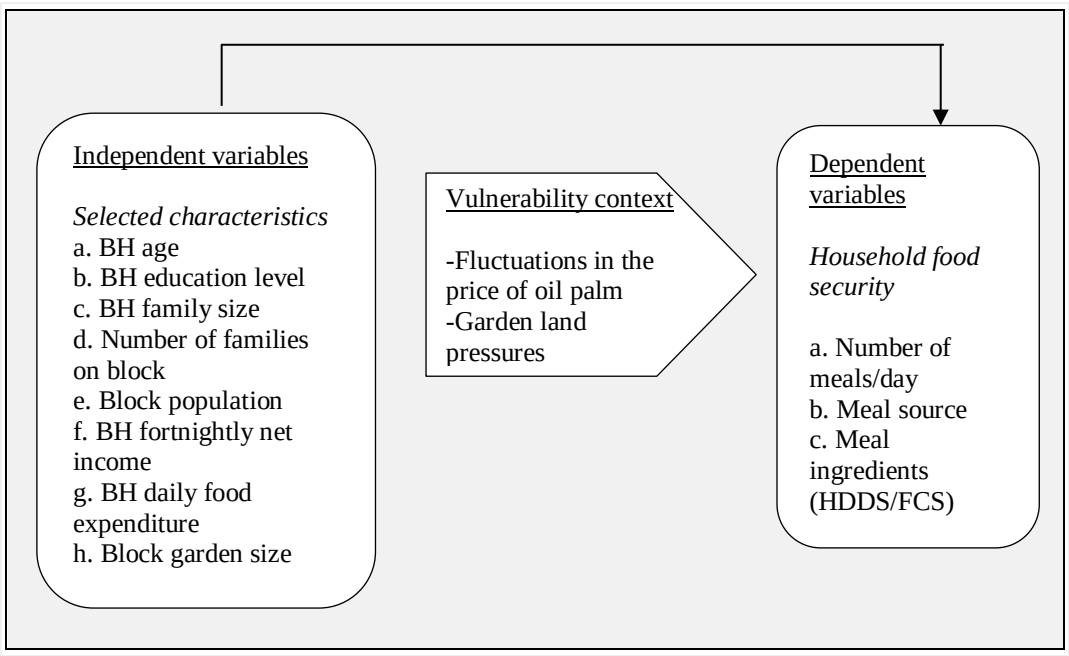


Figure 4.5: Conceptual framework for understanding vulnerability of households to food insecurity.

Table 4.4: Independent variables and their measurements.

Variable	Measurement
Age	Age of blockholder (BH) in years.
Educational level	BH's number of years of formal schooling.
BH's family size	Number of members of primary households residing on block.
Secondary families	Number of secondary households living on the block.
Block population	Total population resident on the block.
Household fortnightly net income	Total fortnightly net income earned by the BH and his family members.
Primary household's daily food expenditure	Daily expenditure on food by the BH and his family.
Garden size	Total garden area both on and off the block belonging to primary and secondary households.

Data collection

A schematic outline of the data collection methods that were employed during fieldwork is presented in Figure 4.6.

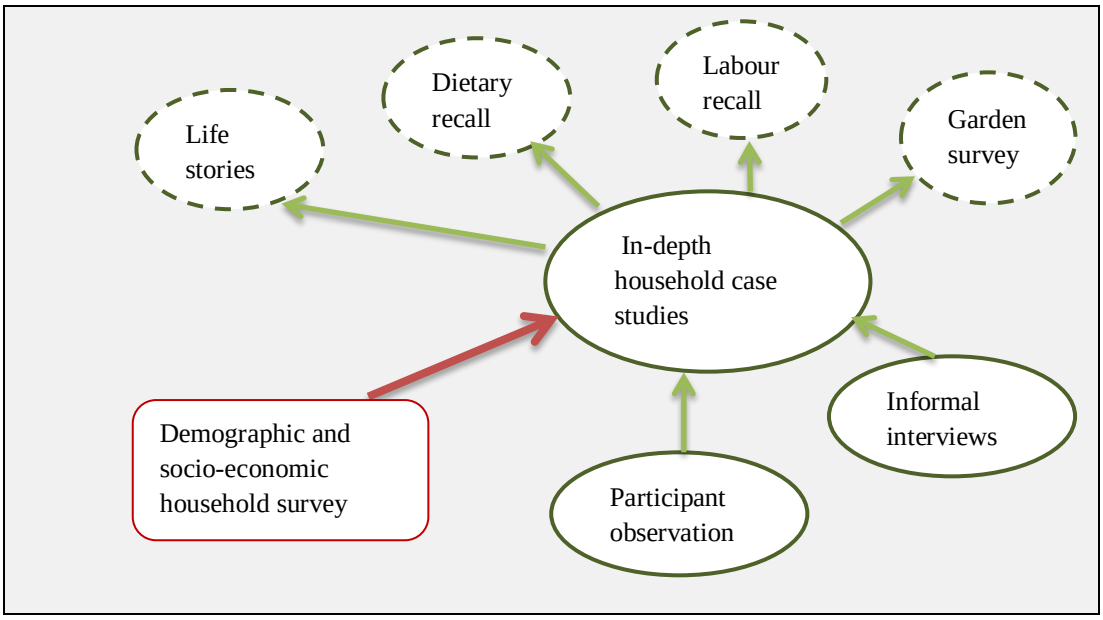


Figure 4.6: Schematic representation of data collection methods.

Demographic and socio-economic survey

The demographic and socio-economic survey sought information on the demographic and socio-economic characteristics of smallholders (see section on 'independent variables and their measurements). It also collected data on household labour activities for each family member above the age of eleven during the previous 24 hour period of the survey. A 24-hour dietary recall question was included which sought information on meal characteristics (see, section on dependent variables and their measurements).

In-depth household case studies

Based on qualitative and quantitative techniques, the in-depth household case studies sought information on: (i) household labour allocations; (ii) household daily food intakes; (iii) gardens and gardening practices; and, (iv) life stories.

Household labour allocation and dietary food intake survey

An interview schedule was used to collect data on labour allocation from the blockholder and members of his family living in the same household. It was anticipated that the daily activities of the blockholder and his family were important influences on household food security. Surveys were conducted with the blockholder and his family members of 12 years[2] of age and above. A daily labour recall interview was conducted over six consecutive days during 2010. Respondents were visited daily (at the end of each day) and asked to recall their activities on the

previous day. Three days were during fortnight pay week[3] and another three days during non-pay week. The activities of individual family members were recorded beside their names on prepared data sheets.

Household food intake data were collected in 2010 and 2013. In 2010 the dietary survey took place at the same time as the labour recall interviews. At the time of fieldwork in 2010 the price of oil palm was high at K265 per tonne. In January 2013 when the second round of dietary surveys was conducted oil palm prices had dropped to K133.37. Data collected during these two different situations provided insights into the impact of cash income on household daily food consumption during periods of high and low oil palm prices.

Dietary recall data were collected on a daily basis in order to avoid inaccuracy of recalling. Data were collected daily for six[4] days: for three days straight after pay day and three days just before pay day. Selection of the days took into account the fact that household income and food stocks would likely be high for three days immediately after the fortnightly pay-day. Likewise, cash resources would have been low or food stock in storage depleted in the three days just before the fortnightly pay-day. Data collected in these two periods provided insights into patterns of food consumption during fortnightly pay-weeks and non-pay weeks. Each survey collected information from the wife about the number of meals she prepared the previous day, the ingredients of each meal and the corresponding sources of each ingredient.

Household garden surveys

All the gardens owned by both primary and secondary households were surveyed. It was observed that sharing of garden foods for consumption amongst families on the same block was a common practice so the gardens of secondary households were also surveyed. The garden surveys included new, established and old gardens. Gardens that were in fallow were not surveyed and were only noted.

Gardens surveys were conducted in the company of the blockholder, his spouse and/or a member of the family who was familiar with the ownership of gardens and other information that was required. On the interview schedule, names of all the garden owners were listed along with their relationship to the blockholder (apart

from the blockholder's garden). For each garden surveyed, information was sought on:

- Garden location and 'owner' of the land.
- Land tenure status: leasehold block, state or customary land.
- Gardening arrangements: block management, reciprocal arrangements or other.
- Area of garden under cultivation.
- Dominant crop(s) grown: crop (s) dominating about half or more of the garden area.
- Purpose of the garden: household consumption, sale, or for consumption and sale.
- Stage of cultivation: first, second, third or fourth planting cycle.
- Gardening practices, improved practices such as the use of fertilizer, pesticides, legume rotation, poly-cropping, other.

Life stories

Individual cases of interest were identified during household case studies. Consent was sought from them to relate the livelihood strategies they pursued for family sustenance. Household interviews were audio-recorded and hand written notes were also taken. Their stories helped me to understand how secondary households and those in adverse situations pursued livelihood activities for family sustenance and survival on the LSS.

Participant observation

Participant observation is an important qualitative method where qualitative data are collected by living with the subject(s) or participating in the activities under study. According to Nachmias and Nachmias (1976), participant observation can be in the form of "complete participation" or "participant-as-observer" where the former refers to the researcher being "wholly concealed" while in the latter, the purpose and motives of the researcher are known. Complete participation is an ideal tool in situations where the researcher needs to access information from subject(s) under cover and that by making known to them their motives would lead to cover-up of the information or respondents altering their behaviour. With this tool the researcher often takes risks and there are also ethical issues involved in not informing

participants of the true role of the researcher. The ‘participant-as-observer’ is a recommended tool where the researcher participates, observes and collects information without being restricted and under suspicion as the former, as long as the subject(s) is/are aware of the research purpose. Likewise, ethical principles have to be followed when dealing with people, which I followed regarding the privacy of the subject(s).

Participant-as-observer formed part of my case studies to collect further qualitative information (Box 4.1). By living with a smallholder family, I was able to observe and participate in activities to gain a better understanding of the livelihood activities of smallholder farmers (Plate 4.1). Primary data were kept in a journal, which noted observations and what people said and did. Data were recorded by note taking, photography and audio-recording conversations.

Plate 4.1: The smallholder family who accommodated me and my research assistant at Kapore LSS.

Box 4.1: Becoming a participant observer

For the first three days of fieldwork, my research assistant and I secured rooms at the OPIC guest house at Nahavio. Living on a tight budget it was not where I intended to stay for more than a few days. Furthermore, I had planned to conduct an ethnographic study and therefore my goal was to live with a smallholder family so as to understand better their livelihoods. I made plans to live for six weeks with a smallholder family at Kapore LSS and then three weeks each with other smallholder families at Tiauru and Kabaya LSS. However, I had no idea about where to live or which family to live with. Arranging a suitable family to live with through the assistance of OPIC was another option, but this would mean more time spent in the guest house which I was trying to minimise. With faith holding on that something would fall into place, my assistant learnt of my predicament and arranged for us to reside with a lovely family from East New Britain Province, whom he knew. We moved in with the family on their LSS block at Kapore subdivision on the fourth day of our first week in Hoskins and remained there until mid-August. While living with this family, they arranged for us to live with another smallholder family at Tiauru subdivision on the Bialla LSS, which was the next location where we planned to conduct surveys. After our work was completed at Tiauru we spent our final three weeks of data collection with a lovely family at Kabaya. Fieldwork followed on smoothly as we moved from one family to another at the three different locations living with three different families during the three month fieldwork period.

Living on an LSS block was advantageous for me and my research assistant because we participated in routine activities mostly in the mornings and evenings, as most of the time during the day was spent collecting data. Domestic chores such as preparing meals, dish-washing, cleaning the living area and fetching water from the river were the activities that we normally partook in. Though we were told not to carry out these tasks, we insisted and as days went by, I sensed a bond of friendship with the host families which helped me to feel at home and contributed to a good frame of mind so that I could concentrate on data collection.

There is no reticulated water supply in any of the sub-divisions, so twice daily I would walk to the nearby river to bathe. I always looked forward to evening baths as it was refreshing after the day's work under the hot tropical sun and most importantly, meeting women and chatting with them. I had the chance of listening to their conversations about their day's work or other issues in the community which provided me with very important information. Upon arriving home after bathing, I made sure the notes were written in my daily journal which I kept during fieldwork.

Getting acquainted with other people in the community through friendly conversations or through common and generous acts was important. For example, my research assistant chewed betelnut[5] and he always carried a handful in his bag which he shared with people he met enhancing conversations. I learnt that having a common past-time such as betelnut chewing created ease during interviews, and additional information was often obtained through further conversations. Similarly, during interviews I took along packets of candies that were given to small children to keep them quiet while I interviewed their parents. It was an expensive exercise for the three months, but it was worth it because at the end of the day data were collected, friendships were created and most of the time we arrived home at the end of a day with bags of garden food given by the respondents. The purpose of residing on the blocks with the smallholders was to observe livelihood activities and develop a better understanding of the household and external factors affecting food security. Becoming a participant-observer, it placed me in a better position to understand a lot of the underlying issues related to food security and farmers' responses to this situation.

Being a female researcher security issues were of a high priority hence, a male research assistant was recruited who was living and working with me throughout the duration of my fieldwork. The assistant was a person I trusted, having worked with him previously. Visiting blocks together gave provided security and contributed positively to effective data collection.

Informal interviews

Certain information that could not be obtained through quantitative methods with the study population was obtained through informal interviews with key informants. Cloke *et al*. (2004), identified key informants as people who have lived or worked in an area for a long period of time and are familiar with the situations under study. Key informants in this study included OPIC officers, PNG Oil Palm Research Association (PNGOPRA) researchers, and my hosts at Kapore, Tiauru and Kabaya. Apart from information gathered from key informants, many informal interviews were held with smallholders during the household and in-depth surveys. These visits to the blocks provided many opportunities to engage in casual conversation which helped develop a good understanding of smallholders' situations. Likewise, casual conversations with smallholders at public places such as food markets and bus stops provided valuable information on the livelihoods of these farmers. Furthermore, living on the block also placed me on common ground with these smallholders, and this helped me in my data collection.

Field work experience

Having a focused work plan initially proved to be vital in guiding the course of my fieldwork. However, planning on paper does not always work out in practice, as minor changes are expected to be made to plans as fieldwork takes its course. Initial preparations were made at the research sites before field data collection began on the 29th of June, 2010. The PNGOPRA office at Dami research station provided a work space to me where necessary paperwork such as editing, printing and photocopying of survey forms were done and where important communications were made with the OPIC officers and my supervisors in Perth. Likewise, getting acquainted and working with the PNGOPRA officers provided invaluable support throughout the course of my fieldwork.

To map out my fieldwork plans, a meeting was held with officers from PNGOPRA socio-economic section where I was attached to and plans for my field work were discussed. Suggestions made were incorporated into my plans before meeting with the OPIC officers to further discuss the work plan, as effective data collection would depend upon their assistance. A meeting was held with the OPIC officers who consisted of the Project Manager (Hoskins), Divisional Managers (DM) and Senior Extension Officers (SEOs). My fieldwork plans and the selected LSS block samples were presented to the officers who were satisfied with my plan and assured me that the sample locations were safe to conduct fieldwork. Transport arrangements were made with the respective DMs for drop-offs and pick-ups during data collection. PNGOPRA provided transport when OPIC was not able to because of other commitments. Based on the sample list, awareness of the interview dates was made by the respective SEOs of the two subdivisions (Kapore and Sarakolok) where the household surveys were to be conducted. Prior to data collection three households at Kapore were arranged by the SEO for pretesting of the interview schedule. Minor editing such as reframing of questions was done before the final version was printed and copies were made for field data collection to begin.

Deciding on the number of days allocated to data collection was important. It was observed that Monday was the busiest day of the week where activities that had not been completed over the weekend were done including tasks such as banking, shopping and gardening to replenish food stocks consumed over the weekend. Hence, data collection was conducted for four days per week which started on Tuesdays through to Fridays. Mondays were allocated to doing my paperwork at the PNGOPRA office, such as typing field notes and other necessary work which included downloading field photos, charging my laptop, camera and recorder (no electricity on the block).

Because I was residing at Kapore, field data collection at Kapore and Sarakolok began each morning with a five minute walk to Kapore sub-divisional office where my assistant and I were picked up by the SEO or the DM, and dropped off at scheduled sections where interviews were conducted. Once the required number of blocks was completed, the SEO or the DM was informed by mobile phone and we were picked up and dropped off at the block where we were residing. At the end of

the day completed survey forms were checked to ensure all questions had been completed and that there were no missing data. Probing questions asked and additional information written on the interview schedule were transferred to the journal.

For the labour allocation and dietary recall surveys, all the smallholder blocks selected were within an hour's walk of where I lived. Interviews were conducted only in the mornings and afternoons as during the day respondents were engaged in their own activities. Labour and food intake recall data were collected on a daily basis to minimise problems with memory recall. Considering the difficulty in visiting 18 blocks daily, which were located within the vicinity of my residence, it was decided that those respondents who were able to competently read and write were to be given the interview schedules to fill out at the end of each day for six days. On the second day of contact five respondents with Grade Ten level of education voluntarily offered to help out. Thorough instructions were given to them about how to fill in the forms and completed forms were checked during the week to ensure data were collected and recorded properly.

Data collection in Bialla followed the same approach where plans were discussed with the OPIC officers, transport was arranged and awareness conducted before field data collection was carried out. However, in Bialla, fieldwork was closely done with the OPIC officers as I was allocated a work space at the OPIC office which made it easier to communicate with the responsible officers and follow-up with the arrangements of transport to and from the field sites.

Data collection at Tiauru began each day when my assistant and I were picked up by OPIC staff from where we were residing and dropped off at scheduled sections. Once the interviews were completed, my assistant and I were picked up and dropped off at the block. Data collection followed the same course as Hoskins where household case studies were conducted after the household survey. However, sample blocks at Tiauru were dispersed compared with Kapore and it was difficult tracking long distances. As at Hoskins, being a female researcher meant security had to be considered, so two research assistants were recruited to help collect the food intake and labour recall data. Both assistants had a Grade Ten level of education and were

observed to be competent during trial interviews they conducted while I observed. Garden surveys were conducted at appropriate times during the in-depth interviews.

After fieldwork was completed at Tiauru, I relocated to Kabaya subdivision where I was accommodated by another family. Data collection followed the same approach as at the other sites and was completed by mid-October 2010. After the fieldwork was completed a few days were spent at the OPIC office in Bialla and PNGOPRA office in Hoskins to collect other relevant information. During this time, interview schedules were checked, labelled and packed to be taken back to Curtin University.

Data analysis

Quantitative data obtained from household surveys and case studies were collated, coded, entered on Excel and analysed using Excel Pivot Tables and Statistical Package for Social Science (SPSS). Tabular method and graphs were used to describe the data. Pearson's correlation coefficient test using the (SPSS) was used to explore statistical relationships amongst study variables. Qualitative data were kept in the daily journal and all journal entries, interview transcripts and audio-recorded interviews were typed. Themes emerging from the interviews were identified and collated under specific topics.

Notes

1. Almost all the blockholders on the oil palm LSSs were male. I came across a few female blockholders at Kabaya who were mostly children of original settlers in the older Hoskins LSS subdivisions of Buvusi, Galai and Kapore. It was noted that, regardless of women's title as blockholders, male spouses were responsible for the block and they took a leading role in making decisions regarding the affairs of the block.

2. People 12 years old and above were considered adults and were included in labour allocation surveys. This is because in the context of PNG village societies, children as young as 12 years old are already engaged in physical work. The household and garden survey took into account the population density hence all individuals regardless of age were counted as one (1) person.

3. Smallholders get paid on a fortnightly basis. Different subdivisions have their own harvesting schedules and also get paid at different times. Harvesting of Fresh Fruit Bunches (FFB) takes place on non-pay weeks where fruits are picked up by the processing company staff who weigh the fruit and mostly process the pay of the smallholders into their bank accounts. Smallholders then get paid on fortnight paydays by withdrawing money from their bank accounts.

4. A seven-day dietary recall was conducted – three days before fortnight paydays and three days after paydays. The seventh day recall data was collected either on pay week or non-pay week. Data for the seven day period were used to calculate the FCS.

5. Betelnut is ingrained in PNG's culture where it is shared and chewed at cultural and social occasions as a token of friendship and a goodwill gesture. Currently, betelnut chewing is part of everyday life and is chewed individually or with others when socialising by the majority of the population. The nut is a mild stimulant that reduces stress and soothes the nerves and is chewed with lime and mustard seed to form a red substance in the mouth.

CHAPTER 5

SMALLHOLDER LIVELIHOOD ACTIVITIES

Introduction

This chapter draws on the information gathered from the in-depth household studies of 42 smallholder families to paint a picture of the everyday lives of smallholders to understand where food gardening and non-oil palm income-earning activities fit into their wider suite of livelihood activities. Diverse livelihood activities are pursued for family sustenance and wellbeing not only by poor households, but amongst all classes of people in both rural and urban centres and in developing and developed countries alike (Ellis, 1998). However, livelihood diversification is more pronounced amongst smallholder households in developing countries. Achieving favourable livelihood outcomes depends on the household's motive for diversification, its assets, the availability of natural resources and the support services from the government, private sector and community organisations.

A livelihood is simply a set of activities a household is able to conduct depending on its resources for the purpose of sustaining household members. As defined by the Department for International Development (DFID) in the United Kingdom (UK) "a livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living" (1999: 1). The household is the key social unit made up of members with closely related ties who live, work together and/or make decisions regarding different livelihood activities for the wellbeing of all its members (Ellis, 1998). It is shown that smallholder households on the LSS were involved in a range of livelihood activities that contributed one way or another to the overall wellbeing of all household members.

The chapter presents the findings on the various livelihood activities pursued by smallholders and their immediate family members on the oil palm LSSs. The chapter reveals and confirms earlier research findings (e.g. Koczberski *et al*. 2001b; Curry and Koczberski, 2005; Curry *et al*. 2007) that oil palm production is but one of the many livelihood activities smallholder households were engaged in for family sustenance and household food security.

In my study, emphasis was placed on the blockholder household or the primary household as the main decision-making unit where most of the livelihood activities occur (see Chapter 4 for the definition of primary and secondary households). Involvement in non-oil palm livelihood activities draws people's time away from oil palm activities. Time is finite, so time spent in one activity means less time is available for other activities. Therefore, allocation of labour and time to different livelihood activities by various family members is important, as multiple activities can be completed simultaneously contributing to the overall wellbeing of all household members.

Household livelihood activities

Data on household livelihood activities were collected over a period of six days from the blockholder and his family members who were 12 years[1] or older (see Chapter 4 for details). A total of 23[2] main activities were conducted by blockholders and their family members (primary households) during the data collection phase. These activities were placed in collapsed categories as depicted in Table 5.1.

Domestic activities, resting at home, food gardening, oil palm work, and visiting and socialising were the five main activities that blockholders and their families allocated most of their labour and time. Similar observations were reported by Koczberski *et al*. (2001b: 51) among settlers at Kavui, Gaungo and Popondetta. They noted that the five main activities that smallholders spent most of their time in were food gardening, oil palm work, resting at home, food preparation and other domestic tasks, and visiting and socialising. Furthermore, Table 5.1 shows that household members spent less time (listed in ascending order) fishing and hunting, gambling and drinking alcohol. Child care, illness and seeking medical attention and wage employment were other activities recorded (Table 5.1).

The allocation of labour amongst different livelihood activities is structured by gender. Studies undertaken in PNG (e.g. Strathern, 1982; Sexton, 1986; Yamauchi *et al*. 2001; Sillitoe, 2006) and other countries (Roshchin, 2003; United States Department of Labour, 2005; Aliaga, 2006; McGinnity and Russell, 2008; Lindsay, 2008) show that, generally, men are involved in activities that require physical strength while women mostly engaged in light activities. For instance, in oil palm work, men were responsible for the physically demanding tasks of pruning, harvesting and carting oil palm bunches (FFB) to roadside pick-up locations while women spent their labour and time collecting oil palm fruit (loose fruit) dislodged from the main bunch. In gardening, men do the laborious work of land clearing and ploughing while women plant crops and tend the garden. In PNG, domestic work and childcare are perceived to be women's work and these responsibilities lie heavily on women (Bue and Halim, 2005; Sillitoe, 2006).

Table 5.1: Proportions of time spent in different activities by the blockholder and his family members at Kapore, Tiauru and Kabaya LSSs (n=124 blockholder households).

Activities	Per cent of time spent by both men and women	Activity Ranking
Domestic activities	26.5	1
Rest at home	19.1	2
Food gardening	11.0	3
Oil palm work	10.8	4
Visit town & shopping	5.7	5
Community & church activities	4.9	6
Visiting & socialising	4.8	7
Selling goods (garden, store, betelnut)	3.5	8
Other income-earning activities	2.9	9
Collecting material/building house	2.3	10
School	2.1	11
Wage employment	2.0	12
Illness & seeking medical attention	1.5	13
Child care	1.2	14
Gambling & drinking alcohol	1.1	15
Fishing & hunting	0.6	16

Given that oil palm is the main source of income, it was expected that a household's involvement in various livelihood activities might be influenced by pay weeks and

non-pay weeks. However, Table 5.2 shows that there was not much difference in the time allocated to the main activities of domestic tasks, resting at home, oil palm work and food gardening during pay week and non-pay week periods. Smallholders did however visit town more often during pay weeks and socialised more often during non-pay weeks (Table 5.2). These activities are discussed below.

Table 5.2: Activity ranking for the top five activities for blockholders and their family members during pay weeks and non-pay weeks (n=152)

Activity (pay week)	(%)	Activity (non-pay week)	(%)
Domestic activities	19.6	Rest at home	20.8
Rest at home	18.2	Domestic activities	19.6
Food gardening	11.2	Oil palm work	12.2
Oil palm work	10.4	Food gardening	10.0
Visiting town	4.9	Visiting & socialising	4.8

Domestic activities

Table 5.1 shows that blockholders and their family members spent the highest proportion of their time on domestic work compared with other livelihood activities. Although not shown in Table 5.1, the bulk of their time in 'domestic work' was spent in: i) preparing meals (63%); ii) cleaning kitchen utensils (14%); iii) laundry (13%); and iv) cleaning the homestead area (10%). Women spent 42% of their time in domestic work compared with only 8% of men's time. This finding confirms other studies that have found women spend more time in domestic work than men (e.g. Yamauchi and Ohtsuka 2002; Roshchin, 2003; United States Department of Labour, 2005; Aliaga, 2006; McGinnity and Russell, 2008; Lindsay, 2008).

Other domestic tasks such as collecting water and bathing in the river took much time and drew people away from their LSS blocks. People used the rivers and creeks daily for bathing and other needs, and at Sarakolok, Kapore and Kabaya subdivisions certain water catchment areas were reserved for cooking and drinking (Plates 5.2, 5.3 and 5.4). Men spent more time than women bathing in the river, perhaps because they had more free time than women. Although not shown in Figure 5.1, people bathed in the river more frequently at Tiauru subdivision than at Kapore and Kabaya. From my observations while living at Tiauru, when it did not rain for almost a month, block residents relied heavily on the river for most of their water needs. Without basic utilities such as water supply on the LSSs, people spend a lot of time

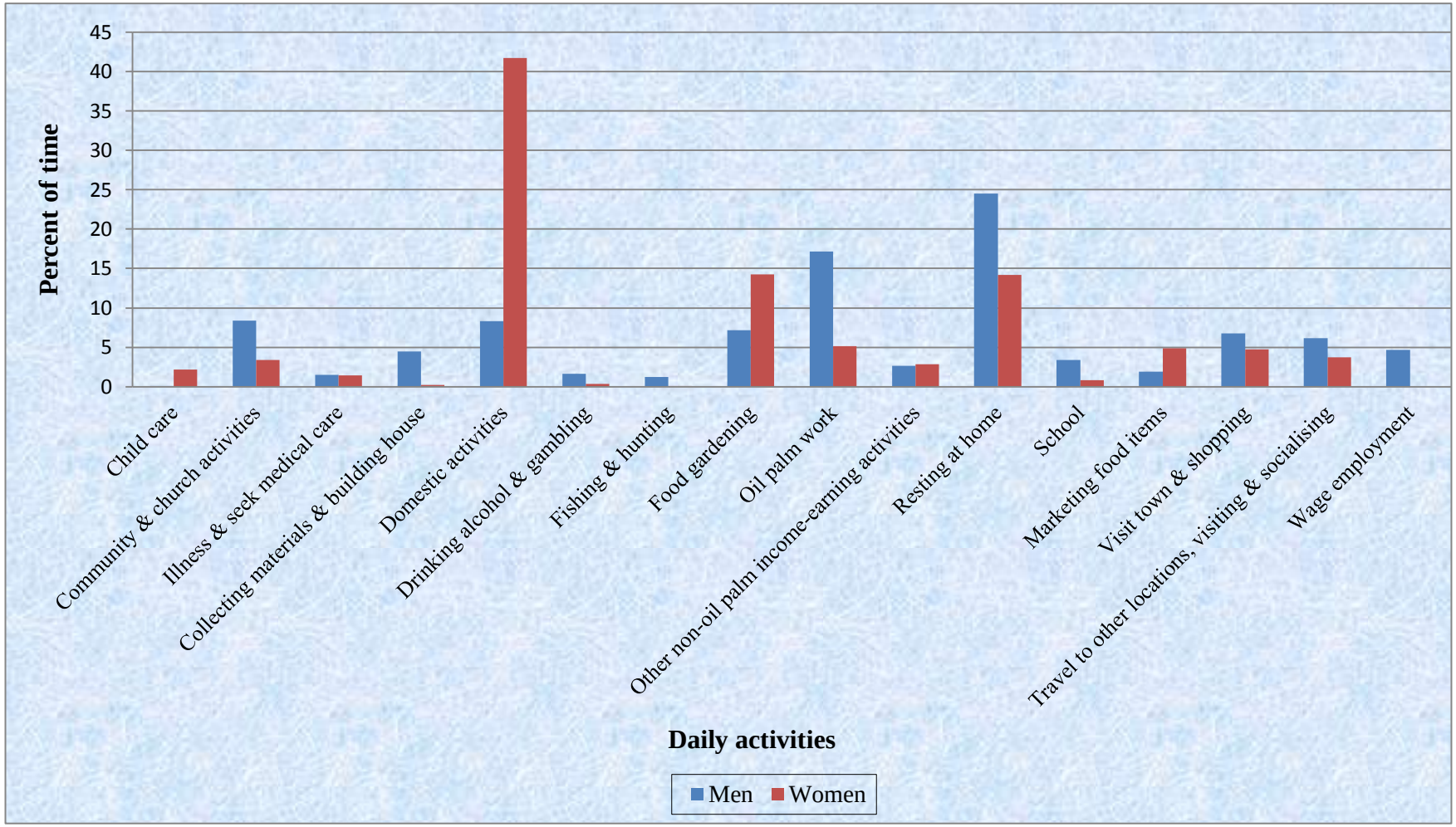


Figure 5.1: The proportions of time that men and women allocated to different activities at Kapore, Tiauru and Kabaya (n=124; 62 men and 62 women).

Plate 5.1: A blockholder at Kapore standing near his well.

Plate 5.2: Women doing various chores at Tiauru River. Insert: Collection of drinking and cooking water from underground spring at Kabaya LSS.

Plate 5.3: Dagi River at Sarakolok LSS. Insert: One of the locations at Sarakolok where drinking and cooking water is collected.

Plate 5.4: Creek at Kapore LSS. Insert: A women fetching drinking water from an underground spring at Kapore. The spring runs down to meet the creek.

sourcing water. Water tanks provided to smallholders during the initial establishment of the LSSs were in disrepair on most smallholder blocks at the time of fieldwork. Most blocks without water tanks collected rain water in 200 litre drums. This water is reserved for drinking and cooking while the rivers and creeks were used for other water needs. Some blockholders without water tanks have dug wells on their blocks (Plate 5.1).

Resting at home

The second most common activity was resting at the house. The blockholder and his family members spent almost one-fifth of their time resting at home (Table 5.1). Resting does not necessarily mean that members were inactive. People will often rest after carrying out heavy laborious tasks (such as oil palm harvesting and gardening activities). Men spent much more time resting than women (Figure 5.1) which accords with other time and labour allocation surveys (e.g. Aliaga and Winqvist, 2003; Bue and Halim, 2005). While collecting data, weather conditions were also taken into consideration as people tended to refrain from engaging in outdoor activities and rest at home during rainy conditions. However, this is not apparent in my data from the LSSs blocks because the weather was fine throughout the data collection period. It was noted that men were involved more in heavy oil palm work on the LSSs, which may be one of the reasons why they spent more time resting than women.

Food gardening

Food gardening was a daily activity for smallholders. Block residents spent more labour time in food gardening than in oil palm, and were actively engaged in food gardening in both pay and non-pay weeks. Gardening was an especially important activity for women on the LSSs. Women spent twice as much time in garden work than men (Figure 5.1). Koczberski *et al*. (2001b) also showed that women spent more time and labour on food gardening than men. They also noted that when oil palm prices were low in 2000, women at Kavui subdivision allocated almost three times as much of their labour and time to food gardening than oil palm, while men spent more time in oil palm work than food gardening. Even though oil palm prices were much higher in 2010, women continued to spend more time in food gardening than their male counterparts (Table 5.3).

Table 5.3: Proportions of time allocated to food gardening and oil palm work by the blockholders and their spouses over a six-day period at Kapore subdivision in 2010 (n=18 male blockholders & 18 spouses).

Activity	Gardening (%)	Oil palm (%)
Male blockholder	35	65
Spouse	76	24

Women 'owned' and managed twice the area of food gardens as men which may be one of the reasons they spent more time in food gardening (Table 5.4). Also, with their male counterparts, they jointly cultivated 52% of the land planted with food crops. When cultivating gardens with their male counterparts, most gardening tasks such as planting, weeding and harvesting were undertaken solely by women and not shared by their male counterparts. This indicates that food gardening was a central component of women's lives which contributed significantly to daily diets (discussed further in Chapter 7). The additional time women spent on gardening activities may also reflect the longer distances women need to walk to gardens. Gardens are increasingly being established off-block (see Chapter 7).

Table 5.4: Garden ownership at Kapore, Tiauru and Kabaya (n=42 blocks)

Garden owner	Per cent of total garden area
Male	16
Female	32
Both male & female	52
Total	100

Furthermore, women have extended their livelihood options to include production of high value food crops such as peanuts and introduced vegetables that sell for a higher price than traditional food crops and provide better returns on their labour (e.g. Box 8.1). It is possible that some women are now spending more time than in the past on gardening activities to earn supplementary income due to the pressures on the oil palm income from a larger resident population. Income earned from food crops is an important source of income for women. Previous studies (Koczberski *et al*. 2001b; Dewhurst 2007; Ryan 2009) have shown that income earned by women from sale of food crops supplements income from oil palm. It is also important because women have a stronger claim on this income than the oil palm income earned from FFB.

My data show that more time is spent in food gardening at Tiauru (15%) and Kabaya (14%) than at Kapore (7%). One reason for this may be due to the greater availability

of land for food gardening at Tiauru and Kabaya compared with Kapore which is currently facing garden land shortages. Although Tiauru subdivision is one of the oldest LSS to be established in Bialla, it is surrounded by large areas of unused state[3] and customary land where smallholders and their families often gain access to additional land for food gardening. Another likely reason for less time being spent in gardening at Kapore than Tiauru (the two older subdivisions) may be due to the higher consumption of store foods at Kapore than Tiauru (see Chapter 9). The next chapter discusses household gardening in more detail.

Oil palm and non-oil palm income-earning activities

Oil palm production is the fourth most important activity after food gardening. Somewhat more time is spent in oil palm work during non-pay weeks than pay weeks (Table 5.2). This is because smallholders harvest FFB during non-pay weeks. During this time all ripe FFB is harvested for scheduled pickups which may take up to three days depending on the size of the block, the amount of ripe fruit to be harvested and the available labour. As mentioned earlier, during harvesting of FFB other tasks such as pruning and stacking of pruned fronds are also done at the same time for crop and block management. Block cleaning such as grass cutting is mostly done during pay weeks when people are not harvesting. For well-maintained and fully harvested blocks, oil palm work can be quite laborious where long hours are spent in harvesting and maintaining the block.

Women also help to harvest FFB but mainly from short palms which are much easier to harvest than tall palms (Plates 5.6 and 5.7). Collection of loose fruit dislodged from harvested fruit bunches is mostly done by women (Plate 5.5). Women take ownership of the income earned from the sale of loose fruit. Koczberski (2007) reported that since women started earning their own income from the sale of loose fruit, many changes have taken place within the household unit. Apart from women's status being raised, household living standards have improved because of women's increased capacity to purchase household items such as mattresses, kitchen utensils and other household goods. Most importantly, they were also able to purchase store foods such as tinned fish and meat, rice, flour, oil and other store goods at their convenience when the need arose, thus contributing to household food security (Koczberski, 2007). This is discussed further in Chapter 8.

Plate 5.5: Spouse of a blockholder and her grandchildren collecting loose fruit which will be packed into a net for pick-up by the milling company truck.

Plate 5.6: Woman harvesting a 10-year old palm.

Plate 5.7: Man harvesting a tall 18-20 year old palm.

Visiting and socialising

Visiting and socialising are important activities. Men spent slightly more time visiting and socialising than women (Figure 5.1). Visiting and socialising occurred more frequently during non-pay weeks than in pay weeks (Table 5.2). One of the reasons for visiting at this time may be due to the supply of labour for oil palm harvesting. Harvesting of oil palm takes place during non-pay weeks which suggests that the reciprocal supply of labour was more likely to occur amongst relatives during this time (see Box 5.1). At other times, visiting most often took place with reciprocated gifts of food rather than labour to families, friends or neighbours which occurred regularly. Visiting extended family members was the most common form of socialising. Second and third generation family members lived in various locations: on their original leasehold blocks; on another LSS block; or on a purchased Customary Rights Purchased (CRP) block within the Hoskins and Bialla oil palm project areas.

Family ties amongst settlers in WNB were being expanded through marriage. Inter-marriage was common among the children of original settlers, which creates and extends marital relationships across the different ethnic groups (Box 5.1).Where family relationships are absent, church, friend and neighbour relationships fill the void. Visiting and socialising helps strengthen social networks which in turn provide peace and harmony within the community and access to labour. Most importantly, reciprocal gardening arrangements (mostly on replant sections of the block) are sought through these networks which help maintain household food security by providing off-block access to land (see Chapter 7). Likewise, members of the various social networks provide for each other (in cash or in food) when the need arises or as goodwill gestures, further strengthening these networks and contributing to household food and income security. For example, gifts of food and cash are often given to a family where there has been a death to assist them perform traditional mortuary practices.

Visiting town and shopping

Most of the banking and shopping for food is done on pay weeks (Table 5.2). Going to town on paydays was a major social event that gave people the opportunity to indulge in the consumption of what were considered luxury foods such as fast food,

ice-cream, soft drinks and snacks. During this time blockholders often take their family members to town to compensate them for their work on the block. Apart from banking and shopping on pay days, men, especially blockholders, visited town more often on other business than other family members (Figure 5.1).

Box 5.1: Examples of family relationships and living arrangements

Case 1: Peter is a second generation male from Chimbu Province. His wife Maria is a second generation settler also from Chimbu. Peter and Maria's parents are living on their own blocks at Buvussi subdivision. Initially, when Peter and Maria married, he and his family were living with his parents at Buvussi until Peter bought his own LSS block at Kapore where they now reside. Peter, Maria and their four children visit their respective families at Buvussi frequently. Reciprocated labour is often provided during the harvesting period between Peter's family and families living on his parent's block.

Case 2: Otto is a second generation male from Manus Province. His wife Anna is a second generation settler from East New Britain Province (ENBP). Both Otto and Anna together with their children are now living together with Otto's parents on their block at Kapore. Anna frequently visits her parents who also live at Kapore. Similarly, her parents regularly visit and bring food to their daughter's block.

Case 3: John is a third generation settler from East Sepik Province who lives at Kapore with his wife Julie. His parents are living on their own block at Kapore. Julie is a third generation female from ENBP. They are now residing with her wife's parents on their block at Kapore. John also visits his family frequently and often provides labour on his father's block.

Community and church activities

Both men and women were involved in church activities. In the LSS subdivisions, a wide range of Christian denominations were present. Most men and women associate with people from their own churches participating in various church activities which draw on their time. On the other hand, social networks were strengthened through socialising and working together in such activities. Men were mostly involved in community activities such as attending court cases which was also noted by Koczberski *et al*. (2001b).

Other activities

Childcare, looking after the sick and seeking medical help for the sick were largely women's responsibilities. Kapore, Tiauru and Kabaya subdivisions do not have health clinics, and hence women often spent time seeking medical care for their young children in town and elsewhere. The daily routine of the household was often disturbed when women had to divert their time to seeking healthcare for young children. For example, a study done in Malawi (Kerr, 2005) showed that one of the reasons for households facing temporary food shortages was because women spent considerable time looking after sick family members and/or relatives and were not able to spend sufficient time in food gardening which resulted in low yields. Generally, this may not be the case on the LSSs because of a regular fortnightly income earned from oil palm. However, when healthcare facilities were not available locally, women's workloads increased considerably.

Plate 5.8: Group of women and children vendors at small food market at Kavui LSS. The two groups of women (indicated by red arrows) are mostly from secondary households.

Other activities that can draw on people's time include: accompanying young children to and from schools, gambling and house-building. Gambling accounts for a lot of time that people spend in idleness. It was observed that secondary households

were likely to be involved in this activity and highlanders seem to spend more time gambling than other ethnic groups (Plate 5.8). Due to economic pressures on the block, some secondary households may resort to gambling as a means to generate extra income, though there is no evidence to suggest that gambling improves their income status.

Conclusion

Most smallholders were engaged in a range of livelihood activities that revolved around the production of oil palm. Cultivation of oil palm is just one activity amongst other livelihood activities that drew on people's time and labour. Women spent most of their time engaged in domestic activities and food gardening. Other tasks included water collection and childcare. Apart from resting, men spent most of their time in oil palm work and food gardening. Other activities that often drew on men's time included visiting town, socialising, community activities and building houses. Engaging in various productive activities at the same time by different family members contributes to the overall wellbeing of the household members.

Food gardening is an important livelihood activity that both men and women were engaged in. The large amount of labour and time spent in food gardening indicates that households still depend on subsistence food production for their dietary needs, despite a regular fortnightly income earned from oil palm. Households' involvement in food gardening also indicates its importance to household food and income security. This shows that, despite garden land shortages in the older subdivisions, smallholders still maintain food gardens. With no opportunity to fallow gardens, households have intensively cultivated their garden plots to maintain good crop yields. The next chapter looks at the intensification of food production as one of the strategies smallholder households have adopted to address the problem of garden land shortages, mainly on the older LSSs.

Notes

1. For the labour allocation study, population ages 12 years and older were considered as adults and were included in the survey. See Chapter 4, note 2, for further explanation.

2. Blockholders and their families were involved in more than 23 different livelihood activities.

3. Tiauru subdivision is surrounded by unused state land (buffer zones). Most of this land is hilly with steep slopes not suitable for planting oil palm. This land is accessed by block residents for food gardening (see Chapter 7 for more discussion).

CHAPTER 6

INTENSIFICATION OF FOOD CROP PRODUCTION

Introduction

In the introduction to the thesis it was highlighted that the rear 2 ha garden reserve area on LSS blocks has been gradually planted to oil palm, and currently on the older subdivisions of Hoskins and Bialla all 6 ha have been fully planted to oil palm. In this and the following two chapters, one of the key questions of the thesis is addressed: what type of strategies are smallholders pursuing to address the problem of garden land shortages in order to sustain household food security mainly on the older LSSs? These chapters highlight how smallholders have responded to land pressures to maintain household food security and the overall wellbeing of smallholder households on the LSSs.

The chapters draw on Cecile Benjamin's study in the 1970s (1977a: 1977b). She warned of low food production occurring in the future which would have implications on household food security mainly on the smaller blocks. Benjamin (1977a: 1977b) warned that this would happen as a result of blockholders fully planting their leasehold blocks to oil palm without reserving sufficient land for food gardening. However, 35 years since Benjamin's predictions, smallholders were still maintaining household food gardens and crop yields despite 6 ha being fully planted to oil palm (Chapter 5). My study has demonstrated how households are able to sustain food production amidst garden land scarcity on the older LSS subdivisions. This is achieved through (1) intensification of food crop production, (2) gardening in new locations, and (3) diversifying incomes. Intensification of food crop production is discussed in this chapter and gardening in new locations in Chapter 7. The two chapters argue that smallholders have modified their food production system to accommodate the commercial cultivation of oil palm. The system that has

evolved serves to maintain household food and income security for both blockholder households and secondary co-resident families living on the blocks in the older subdivisions. Moreover, smallholder households continue to supply garden food for sale to the urban populations of Kimbe and Bialla.

The first part of this chapter provides a background to food gardening on the LSSs. The gardening systems are discussed and the importance of food gardening over the years is highlighted. The second part of the chapter examines changes through time in the available land for gardening and shows how smallholders have intensified their food crop production to maintain crop yields.

Background setting and importance of food crop production

When the oil palm LSSs were established, smallholders were taken from a background of subsistence farming and foraging to resettle on agricultural leasehold land for the commercial cultivation of oil palm. By removing people from predominantly subsistence economies and resettling them on the LSSs, it was expected that their lives would be transformed from subsistence farmers to commercial producers of oil palm (Koczberski *et al*. 2012). However, despite their lives being focused on the commercial cultivation of oil palm, subsistence food production for their dietary needs and cash income has remained an integral part of their lives.

The importance of food gardening was first noted amongst the pioneer settlers in the 1970s, when Benjamin (1977a) showed that the primary purpose of food gardening was to meet household's daily dietary needs and to generate an income to supplement income earned from oil palm. Studies conducted by Benjamin (1977b) on the gardening practices of the settlers at Hoskins LSS during the initial settlement stages revealed that people from Chimbu Province cultivated large gardens of peanuts and sweet potato to sell at local markets. Thus, during the initial settlement of families, smallholders were relying on garden food to generate cash income to meet family needs. Some 25 years later, studies continue to indicate the importance of food gardening and its significance in daily diets (e.g. Koczberski *et al*. 2001b; Dewhurst, 2007). Koczberski *et al*. (2001b) also pointed out the importance of food gardening for women as a source of supplementary income. The study also showed that by maintaining food gardens, households were able to fall

back on them during periods of low oil palm prices. Likewise, recent studies by Dewhurst (2007) and Ryan (2009) also indicated the importance of food gardening for household consumption and as an income source for women. My own findings from household surveys conducted in 2010 at Kapore, Sarakolok, Tiauru and Kabaya show that virtually all smallholder households were cultivating food gardens to provide for their daily dietary needs. Settlers on only one block did not cultivate food gardens. This was because the block was managed by a caretaker who was a single male person and who did not see the need to cultivate food gardens.

Furthermore, the importance of food gardens as a source of household income has been revealed in local food market surveys conducted by Benjamin (1985), Koczberski *et al*. (2001b) and Ryan (2009). These studies showed that women from the LSSs were the main sellers of garden food at Kimbe town market and in many of the small markets within the vicinity of Kimbe. Thus production of food crops by settlers makes an important contribution to food security amongst the rapidly growing urban population of Kimbe and also contributes to the food security of surrounding villagers who are not able to meet all their household food needs from their own production.

Food crops cultivated for home consumption and for sale at local markets

Based on household food garden surveys conducted during fieldwork in 2010 (see Chapter 4), smallholder households were cultivating a wide variety of food crops (Table 6.1 and Figure 6.1). Food gardens were being cultivated primarily to cater for household dietary needs and once food needs were met, surpluses were sold at local markets. Household cultivated gardens for three main reasons: for home consumption only, marketing only and mixed home consumption and marketing. The main staple crops cultivated for household consumption included sweet potato (*Ipomoea batatas*), Chinese taro (*Xanthosoma sagittifolium*), and different varieties of banana (*Musa cvs*) (Figure 6.1). Taro (*Colocasia esculenta*), yams (*Dioscorea esculenta*) and cassava (*Manihot esculenta*) occasionally supplemented the main staples (further discussions in this chapter). Green leafy vegetables such as aibika (*Abelmoshus manihot*), aupa (*Amaranthus cvs*), pumpkin tops (*Cucurbita moschata*) and karakap (*Solanum americanum*) were cultivated predominantly for household consumption. Other commonly grown vegetables included corn (*Zea mays*), snake

bean (*Vigna unguiculata*), tomato (*Lycopersicon esculentum*), spring onion (*Allium sepa*) and ginger (*Zingiber officinale*).

Table 6.1: Typical crops cultivated in smallholders' gardens.

Staple crops	Local and introduced vegetables		Fruits, nuts & stimulants
Sweet potato (*Ipomoea batatas*) Chinese taro (*Xanthosoma sagittifolium*) Banana (*Musa cvs*) Taro (*Colocasia esculenta*) Cassava (*Manihot esculenta*) Yam (*Dioscorea esculenta & D. alata*) Sugar cane (*Saccharum officinarum*)	Bean (*Vigna unguiculata*) Water cress (*Rorippa Nasturtium-aquaticum*) Choko (*Sechium edule*) Aibika (*Abelmoshus manihot*) Pumpkin (*Cucurbita moschata*) Aupa (*Amaranthus spp*) Karakap (*Solanum americanum*) Tomato (*Lycopersicon esculentum*) Corn (*Zea mays*) Pitpit (*Saccharum edule*) Ginger (*Zingiber officinale*)	Spring onion (*Allium cepa*) Eggplant (*Solanum melongena*) Capsicum (*Capsicum annuum*) Pak choi (*Brassica rapa*) Chinese cabbage (*Brassica rapa*) Cabbage head (*Brassica oleracea*) Lettuce (*Lactuca sativa*) Bok choi (*Brassica rapa)*	Pineapple (*Ananas comosus*) Pawpaw (*Carica papaya*) Ripe banana (*Musa cvs*) Watermelon (*Citrullus lanatus*) Cucumber (*Cucumis sativus*) Peanut (*Arachis hypogaea*) Coconut (*Cocos nucifera*) Variety of fruit from trees Tobacco (*Nicotiana tabacum*)

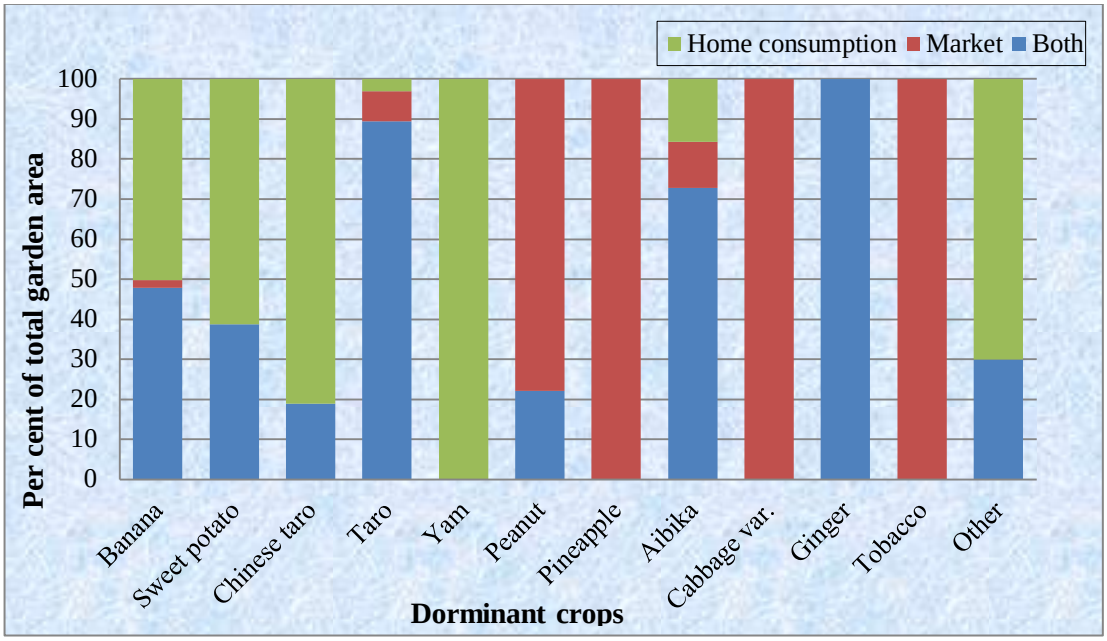


Figure 6.1: Proportions of total garden area allocated to dominant crops cultivated for home consumption only, market only and for both home consumption & local markets at Kapore, Tiauru and Kabaya (n=239 gardens). (Other = cassava and bean).

Introduced vegetables cultivated mainly for sale included Chinese cabbage (*Brassica rapa*), pak choi (*Brassica rapa*), bok choi (*Brassica rapa*), cabbage head (*Brassica oleracea*), lettuce (*Lactuca sativa*), capsicum (*Capsicum annuum*), spring onion (*Allium cepa*), tomato (*Lycopersicon esculentum*) and eggplant (*Solanum*

melongena). Lowland varieties of cabbage head were also cultivated for sale (see, for example, Plate 6.2). Pakchoi (*Brassica rapa*) and Chinese cabbage (*Brassica rapa*) usually dominated gardens where produce was intended for sale at local markets (Figure 6.2).

Cucumber (*Cucumis sativus cv*. group Slicing Cucumber) and green leafy vegetables such as aibika (*Abelmoshus manihot*), aupa (*Amaranthus spp*) and pumpkin (*Cucurbita moschata*) tips were commonly cultivated for sale and are also a good source of income. Plate 6.1, for example, shows a Chimbu woman selling aupa (*Amaranthus spp*), watercress (*Rorippa nasturtium aquaticum*) and aibika (*Abelmoshus manihot*) for 50 toea per bundle at Nahavio roadside market (PGK1=0.42AUD). She is also selling capsicums (*Capsicum annuum*) for 20 toea heap.

Plate 6.1: Woman selling leafy vegetables at Nahavio roadside market (2013).

Taro (*Colocasia esculenta*) and varieties of banana (*Musa cvs*) such as *kiaukiau* fetch a good price at local markets. Fruits including pineapple (*Ananas comosus*), pawpaw (*Carica papaya*) and ripe banana (*Musa cvs*) are grown mainly for sale and also command high prices. Company employees are frequent customers who purchase

fruits at roadside markets in front of smallholder blocks. Peanut (*Arachis hypogaea*) is a very good source of income. Garden surveys conducted at Kapore, Tiauru and Kabaya show that peanut (*Arachis hypogaea*) is extensively cultivated throughout these subdivisions for sale, especially on multiple household blocks, mainly by secondary families (see Chapter 8 for further discussion). Peanuts (*Arachis hypogaea*) occupied 41% of the total garden area allocated to crops for 'market only', followed by cabbage varieties (21%) and pineapple (19%) (Figure 6.2) (see Plates 6.2 and 6.3). There is more pineapple grown at Kapore (by people from Chimbu) than other subdivisions. Tobacco (*Nicotiana tabacum*) is cultivated mostly for sale locally and is typically intercropped with food crops or occasionally cultivated as a monocrop.

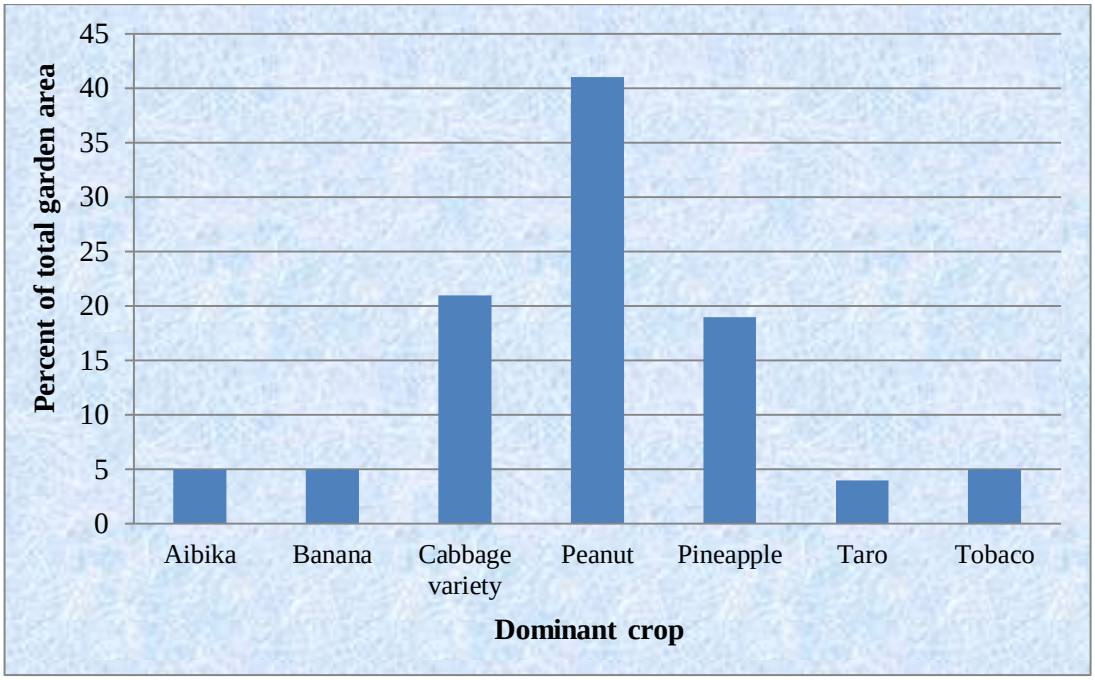


Figure 6.2: Proportion of total garden area allocated to dominant crops cultivated solely for local marketing at Kapore, Tiauru and Kabaya (per cent) (n=239 gardens).

Plate 6.2: Cabbage head grown for sale on oil palm replant section, Kapore (2010).

Plate 6.3: Peanuts grown for sale on oil palm replant section, Kapore (2010).

Furthermore, most of the gardens cultivated by both primary and secondary families at Kabaya, Tiauru and Kapore were for 'household consumption only' and 'mixed household consumption and local market' (Figure 6.3). Usually when food is harvested from mixed gardens, crops that meet market standards are sold while crops of lower quality (e.g. pest damaged) are kept for household consumption. Within these categories, both cooked and uncooked food were also given away to relatives, friends and neighbours, further strengthening kinship and social networks amongst households.

Furthermore, in all subdivisions secondary households cultivated more 'market only' gardens than primary households (Figure 6.3). For many secondary households, surpluses were also being sold for cash income from mixed gardens. As mentioned in Chapter 5, the claims of secondary families on the oil palm income were weaker than those of primary households. Therefore, secondary households were more dependent on non-oil palm income sources than primary households and one of the ways to earn income was by cultivating high value crops for sale. High value crops not only generate income but also can provide food for the household if those crops do not meet market standards. Figure 6.3 also shows that secondary households at Kapore were more involved in cultivating 'market only gardens' than secondary families at Tiauru and Kabaya. A likely reason for the high involvement by Kapore households in 'market only gardens' was the easy availability and accessibility to well-established markets and business houses in the provincial capital of Kimbe (see Chapter 8, Boxes 8.1 and 8.2 for examples). This contrasts with households at Tiauru and Kabaya where access to large urban markets was more limited. Also, Kapore producers have access to a large growing urban population within the township of Kimbe that depends on local food markets for their daily dietary needs.

These findings regarding the gardening strategies of secondary households reinforce the findings from earlier studies (Koczberski *et al*. 2001b; Ryan, 2009) that reported secondary families, especially women, being involved in other income-earning activities such as the cultivation of high value crops for sale. In contrast, Kabaya secondary families had the smallest proportion of garden area allocated to the cultivation of 'market only' crops. This was expected because of the low population

pressure on the subdivision which may have placed less pressure on the oil palm income. Also, as mentioned earlier, secondary families may not have been motivated to grow high value crops for sale because there were no established markets within easy access and the number of potential consumers that depend on food crops was much lower in this area than in the township of Kimbe and Bialla.

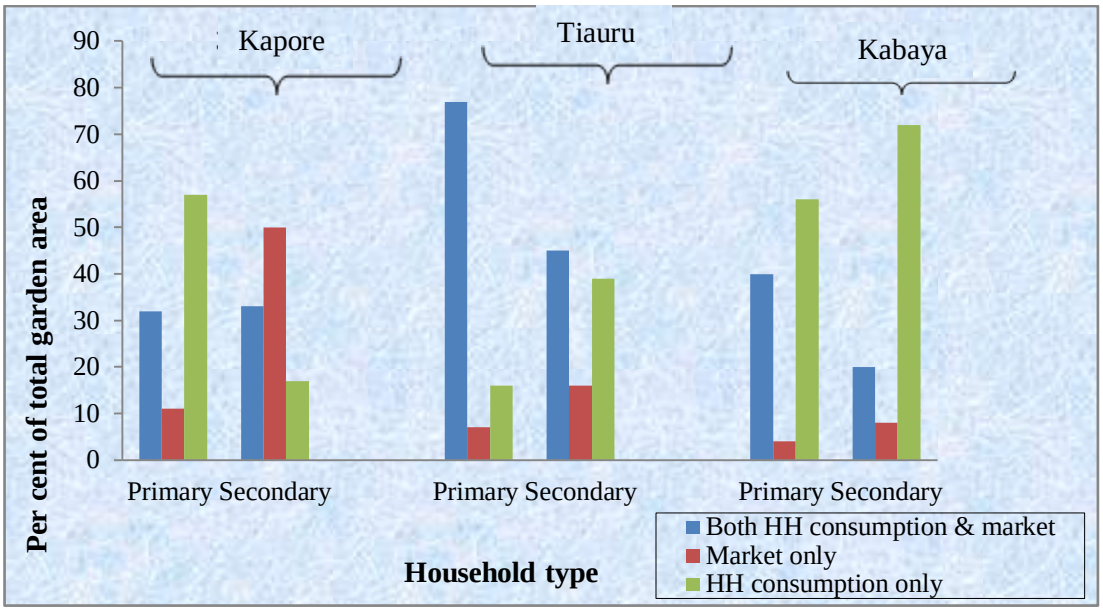


Figure 6.3: Proportion of gardens cultivated by primary and co-resident households for home consumption, market only and both household consumption and market at Kapore, Tiauru and Kabaya (n=239 gardens). HH=household.

Preference of food crops by ethnicity

Settlers from different ethnic groups have preferences for their own staple crops. Many brought seeds and cuttings from their home villages when they initially settled on the LSSs (Benjamin, 1977b) and they have maintained these cultivars over the years. Crops brought from home such as yams (*Dioscoria esculenta*) from the Sepik and different varieties of sweet potato (*Ipomoea batatas*) from the highlands added to the diversity of crops cultivated on the schemes. As mentioned above, banana, sweet potato and Chinese taro were the main crops cultivated across all ethnic groups in 2010. Although all ethnic groups cultivated banana, sweet potato and taro, banana is predominantly cultivated by smallholders from East and West New Britain Province (ENB and WNBP), sweet potato by highlanders and taro by the people from Morobe and Sepik Provinces (Figure 6.4). However, ethnic differences in garden food consumption are not as marked as described by Benjamin in the 1970s (Benjamin, 1977a; 1977b). This is because smallholder food

preferences in the multi-cultural environment of the LSSs have broadened and also because they have modified their gardening practices in response to garden land shortages. Finally, peanut is cultivated extensively by all ethnic groups (Figure 6.4) compared with the past when smallholders from Chimbu Province dominated its cultivation (Benjamin, 1977a; 1977b).

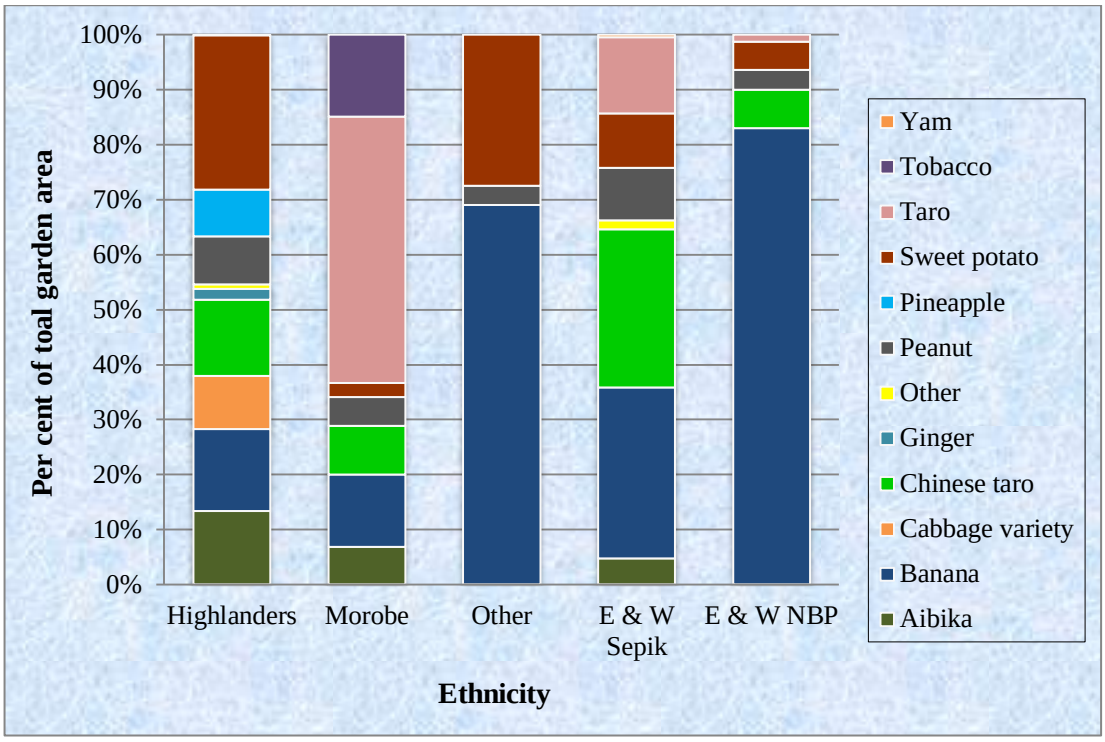


Figure 6.4: Proportion of total land allocated to dominant food crops by different ethnic groups in all subdivisions in 2010 (n=239 gardens). (Other provinces =Manus, Gulf, Oro); (Other crops = cassava, tobacco and bean).

Changes in land area available for food gardening

This section draws on Benjamin's work in the 1970s to assess changes in gardening practices and the availability of land for gardens over time. In 1975, Benjamin conducted a large garden survey in the Hoskins oil palm project which included the subdivisions of Kapore, Tamba, Sarakolok, Buvussi and Galai. Gardening practices of smallholders were identified including their cropping practices, planting cycle, area allocated to gardening of different crops and preference for certain crops by different ethnic groups. I conducted similar garden surveys in 2010 at Kapore, Tiauru and Kabaya.

Garden data collected at Kapore subdivision in 2010 are presented in Table 6.2 alongside Benjamin's 1975 data to track changes in gardening practices over time. Benjamin's study in 1975 (1977b) revealed that smallholder blocks at Kapore,

Tamba, Sarakolok and Buvusi subdivisions had large reserve areas of approximately 2.83 ha for food gardening (see Figure 1.1 in Chapter 1). At that time garden land was more than enough to meet the gardening needs of residents with an average population of 7.24 persons per block. Benjamin (1977b) noted that the average area gardened per block annually at Kapore was 0.402 ha which was more than sufficient to allow a 6 to 9 year fallow on the bigger blocks and 4 to 6 years at subdivisions with 2 ha reserve (Table 6.2). For the bigger blocks, this allowed seven crop rotations before the blockholder returned to the original plot and five crop rotations for the smaller blocks (Benjamin, 1977a; 1977b). Gardens were cultivated for 12 to 18 months and then left to fallow.

Table 6.2: Changes in available land for food gardening from 1975 to 2010 at Kapore subdivision.

Year	1975[a]	2010[b]
Size of leasehold block	6.07	6.61
Persons per block	7.24	14.72
Area of leasehold block planted to oil palm (ha)	3.24	6.00
Garden land available on block per year (i.e. land not planted to oil palm) (ha)	2.83	0.61
Mean garden area cropped per head (ha)	0.058	0.04
Required cultivated garden area per block to meet needs of resident population (ha)	0.4	0.6
Fallow period	6-9 years	Assumes permanent cultivation
Intercropping of immature oil palm with food crops	Non-existent	35% of the total area of food gardens now planted in replant areas

[a]Data for 1975 are drawn from Benjamin (1977b). Her study surveyed 140 gardens at Kapore, Tamba, Sarakolok, Buvussi, Galai, Kavui and Kavugara subdivisions. [b]Data for 2010 are drawn from garden surveys on 118 gardens at Kapore subdivision by author.

However, data collected during fieldwork at Kapore in 2010 show that average block population at Kapore has increased from 7.24 persons per block in 1975 to almost 15 (14.72) (Table 6.2). At the same time, the land available for gardens contracted as smallholders planted the reserve garden area (available at the time of Benjamin's

study of gardens) to oil palm. Conversion of garden reserves to oil palm occurred because of high cash demands from the larger resident population on the blocks. Very high oil palm prices in 2008 and 2009 also encouraged the trend to fully plant blocks to oil palm (Koczberski *et al*. 2012). All blocks at Kapore and Tiauru have planted all 6 ha to oil palm (OPIC, 2012). With 6 ha under oil palm, garden land per block contracted to an average of 0.61 ha[1] (Table 6.2). By 2010 the total garden area required to meet the needs of a block at Kapore increased to 0.5964 ha[2], yet the mean garden area cropped per person had decreased to 0.0405 ha[3] from 0.058 ha in 1975 (Table 6.2).

Because of the reduced area of land available for food gardening in 2010, there was no opportunity to fallow gardens. Smallholders have shifted to more permanent cultivation and were making food gardens on smaller portions of land (see Chapter 7). Given that most smallholders were experiencing shortages of garden land on the block, it is important to understand how they responded to such shortages. One of the major strategies smallholders employed was to intensify food production to maintain or increase crop yields.

Intensification of food crop production

Intensification of food crop production is widely practiced throughout PNG. To intensify crop production means to raise the conventional farming practices by incorporating improved ways of farming in order to gain a greater output from the same gardening land. As discussed in Chapter 3, intensification of food crop production in PNG, as reported by Allen *et al*. (1995), Brookfield (2001), and Bourke (2001b) is also associated with other factors besides population pressure. In certain locations such as the oil palm LSSs and peri-urban settlements, population pressure is becoming a driving force to intensifying of food crop production. People have integrated soil management practices and good crop varieties that are high yielding and hardy to pests and diseases into their farming systems in order to obtain a good output from their land (Bourke, 2001b).

Because of garden land scarcity on the LSS, intensification of food crop production has occurred. This is evidenced by three main trends: 1) improved soil and crop management practices: 2) intercropping of immature oil palm with food crops; and, 3) changes in the types of crops and varieties planted to increase crop production.

Improved soil and crop management practices

Mixed or poly-cropping on the same piece of land was common in all surveyed gardens. Similar trends were observed in the cropping patterns amongst different ethnic groups in the 1970s and in 2010. For example, garden surveys conducted in 2010 showed that residents from the Highlands provinces intercropped sweet potato with corn and snake bean, while corn was mostly interplanted with peanuts (see Plate 6.4). People from Sepik provinces mostly cultivated a diversity of crops on the same piece of land. For instance, taro, Chinese taro, banana and tobacco were intercropped with yam (*D. esculenta*). As discussed in Chapter 3, studies (e.g. Eden, 1988; Sillitoe, 1995) have shown that the cultivation of a range of crops on the same plot helps maintain soil fertility. This is because different crops have different nutrient and moisture requirements which they tap at different soil levels without depleting too many nutrients in the soil. Leguminous crops like peanut interplanted with other food crops also improve soil fertility through nitrogen fixation. As noted in Chapter 3, Sillitoe (1995) reported that among the Wola people of Southern Highlands Province (SHP), sweet potato was successively monocropped with good yields following a previous cycle of poly-cropping.

Plate 6.4: Mixed cropping of peanut, corn, cucumber and sugarcane.

Garden surveys found that crop rotation was practised in all gardening locations. Peanut was rotated with a range of other crops such as sweet potato. Benjamin also noted in her surveys that peanut was typically rotated with sweet potato before the land was fallowed (1977a: 59). Fieldwork in 2010 showed that peanut was sometimes cultivated continuously on the same plot of land for up to three cropping cycles before other crops were planted. This usually occurred on replant sections where soils were relatively fertile (see below for further discussion).

Despite successive monocropping of peanuts, yields were maintained because of the ability of peanut to fix nitrogen and make it available for crop uptake. In addition, the high content of organic matter from decayed old palms and traces of fertilizer in oil palm replant sections facilitates adequate yields until the oil palm canopy closes after two years. Snake bean is another common leguminous crop found in smallholders' gardens and is planted mostly as a boundary crop. Interviews with smallholders indicated that they were aware of the importance of rotating leguminous crops with other food crops to maintain soil fertility and crop yields. With no opportunity to fallow gardens to enhance soil fertility, mixed cropping and crop rotation helped to maintain soil fertility which allowed for more cropping cycles on the same piece of land.

Koczberski *et al*. (2012) also noted that on some LSS blocks, fertilizers intended for oil palm were sometimes used in food gardens, a practice that was not observed during Benjamin's study (1977b). Smallholders tend to use fertilizer on high-value crops cultivated intended for sale such as cabbage.

Crop management strategies

Some smallholder households on the older subdivisions of Kapore, Sarakolok and Tiauru were using pesticides (Karate) in their food gardens, a practice not observed by Benjamin (1977a). Smallholders on the older subdivisions complained that pest infestation was becoming a problem, which most likely may have arisen as a result of short fallow periods. Insect pests were affecting food crops and it was noted that their attacks were not restricted to *aibika* and other green vegetables which was the case previously, but also to crops such as banana (see plates 6.5 and 6.6). Certain varieties of banana which are hardy such as *kalapua* and *tukuru* can withstand pest attacks better than others such as *kiaukiau*.

Plate 6.5: Stage of banana fruit formation where insecticide should be applied to prevent pest attack.

Plate 6.6: *Kiaukiau* banana affected by scab moth.

Table 6.3: Proportions of different types of gardens using pesticides at Kapore, Tiauru and Kabaya (n=239 gardens cultivated by 42 blockholder households).

Dominant crop in garden	No. of gardens	Applied pesticide (%)	Rank
Cabbage var (Brassica cvs)	7	100	1
Aibika (*Abelmoschus manihot*)	21	81	2
Taro (*Colocasia esculenta*)	13	61	3
Other: Snake Bean (*Vigna unguiculata* cv. group *Sesquipedalis*); Ginger (*Zingiber officinale*); Tobacco (*Nicotiana tabacum*)	8	50	4
Banana (*Musa* cvs)	43	23	5
Chinese taro (*Xanthosoma sagittifolium*)	36	19	6
Peanut (*Arachis hypogaea*)	42	14	7
Sweet potato (*Ipomoea batatas*)	65	8	8
Pineapple (*Ananas comosus*)	4	0	9
All	239	27	-

Twenty-seven per cent of smallholders were using pesticides on the three older sub-divisions at Hoskins and Bialla (Table 6.3). Its use was high in gardens where monocrops were cultivated for sale such as cabbage varieties, *aibika*, other vegetables and tobacco. Pesticide use was low in gardens cultivated with sweet potato, peanut and Chinese taro and was absent in pineapple gardens (Table 6.3). Taro (*Colocassia esculenta*) can be damaged by taro beetle which bores into the

corm and spoils it. However, not many smallholders complained of pests attacking taro.

Intercropping of food crops with immature oil palm

Another relatively new strategy smallholder households have adopted to intensify food production is through intercropping of food crops with immature oil palm. At Kapore and Tiauru, 34% and 37% of the total garden area respectively was cultivated on replant sections of smallholders' own block or in the replant section belonging to another grower.

Residents in the older schemes started gaining access to additional land for gardens on the replanted sections of their blocks from the 1990s when the first plantings of oil palm began to be replaced (Curry *et al*. 2007) (see Chapter 7). A 2 ha oil palm planting is ideally replanted every 22 years (some smallholders leave their palms for 2-3 years longer). At 22 years the oil palm is poisoned and the tall palms are left to rot (Plate 6.7). These replanted sections are available for gardening for a period of up to two years until the oil palm canopy closes (Plate 6.7). Thus, within the 22-year rotational replant cycle, smallholder households have 2 ha available for gardening for 6 years of the cycle (2 ha x 3 phases), which gives them an additional 0.54 hectares of garden land per year (Note 1). The large number of gardens on replant sections indicates that a lot more replanting was going on at Kapore and Tiauru during fieldwork in 2010.

Interviews with smallholders and extension officers revealed that, while a few smallholders were using the replant sections of their own leasehold blocks as long as 20 years ago when the first round of oil palm replanting took place, their main gardening area remained the two-hectare 'reserve land' on their blocks. Presently, the replant section provides the only substantial area for food gardening on a smallholder block and is used considerably more intensively than in the past.

By gardening on replant sections which were fertile, smallholders were able to cultivate food crops intensively. For example, in the replant section gardens were generally cultivated continuously on the same plot of land for up to four cropping cycles (approximately 2 to 3 years) before the land was given over to oil palm (see Figure 7.2). As discussed further in Chapter 7, the number of garden cropping cycles

on replant sections was greater than that found on gardens cultivated away from block (e.g. on State or on customary land). The types of food crops interplanted with oil palm were usually high value crops such as monocrops of peanuts and cabbage varieties and poly-crops of taro, yam, green leafy vegetables and other crops. Further discussion on the replant sections is provided in Chapter 7.

Changes in the types of crops and varieties planted to increase crop production

Smallholders were maintaining food production through preferencing crop varieties that could withstand unfavourable soil conditions or which matured quickly. For example, comparisons made between Benjamin's 1975 study (Benjamin, 1977b) and fieldwork data collected at Kapore subdivision in 2010 indicate that the area planted to different crops per block has changed (Table 6.4). In the past, an average of 18% of all gardens was planted with yam (*D. alata*) and *mami* (*D. esculenta*) and people from Sepik and Morobe provinces dominated its cultivation (Benjamin, 1975a). By 2010 yam was almost absent (Figure 6.3). Yam varieties were not being cultivated as often as people desired. Smallholders attributed this to low soil fertility. They explained that yams were usually cultivated as the first crops or one of the first crops in new gardens after fallowing.

Taro (*Colocassia esculenta*) is also another crop that requires fertile soil to yield well, and its cultivation in smallholder gardens has declined since the mid-seventies (Table 6.4). Benjamin (1977a; 1977b) speculated that taro would become less important because of declining soil fertility when shortages of garden land occurred. However, smallholders have maintained taro production by planting it as one of the first crops on replant sections (see Chapter 7 on discussions on soil fertility on replant sections) where it is typically intercropped with other food crops such as cucumber, watermelon, corn and short-maturing banana such as *kiaukiau* (Plate 6.7).

Table 6.4: Proportions of total garden area per block planted to different types of food crops in 1975 and in 2010 at Hoskins LSSs.

Crop	1975 Average area per block (%)	2010 Average area per block (%)
Sweet potato (*Ipomoea batatas*)	33	18
Peanuts (*Arachis hypogaea*)	15	9
Chinese taro (*Xanthosoma sagittifolium*)	23	19
Taro (*Colocasia esculenta*)	16	8
Yams (*Dioscorea* spp)	13	Insignificant
Cassava (*Manihot esculenta*)	Insignificant plantings	Planted as boundary crop
Bananas (*Musa* cvs)	No figure* (insignificant plantings)	46
Totals	100	100

[a]Data for 1975 are drawn from Benjamin's (1977b) garden survey at Kapore LSS.
[b]Data for 2010 are drawn from garden surveys at Kapore by the author.

Plate 6.7: Taro grown as one of the first crops on a replant section, Tiauru.

In contrast to yam and taro cultivation, which have declined since the 1970s, areas cultivated with banana have increased significantly through time (Table 6.4). In the 1970s Benjamin reported that the crop was grown mostly by Tolai settlers from ENBP, mainly around the homestead area. Overall, banana was an insignificant crop in 1975 on the Hoskins LSS. Now, banana is cultivated by all ethnic groups and is the dominant staple followed by Chinese taro and sweet potato. It is likely that one of

the reasons for banana becoming a more important food crop is because varieties such as *kiaukiau* mature quickly and others such as *kalapua* and *tukuru* are hardy and can cope with infertile soils and are resistant to pest attacks. Thus smallholders are shifting to high yielding and quick maturing crops that can tolerate unfavourable conditions. These findings confirm Benjamin's predictions (1977a: 70) that cultivation of short-maturing crops such as Chinese taro, sweet potato, and *Musa cvs* that can tolerate less fertile soils would become more prominent on the LSS as a result of shorter fallow periods.

Similarly, in Benjamin's study, cassava – a crop that can tolerate infertile soil conditions – was not noted in garden surveys indicating it was a minor crop (C. Benjamin, pers. comm., 18 May 2012). By 2010 cassava was commonly planted as a garden boundary crop and was cultivated by all ethnic groups (Table 6.4). Cassava can tolerate poor soils, mature within a short period of time and produces good yields. It is an important crop mainly in dry lowland areas in the country and is increasingly becoming important in other wet lowland areas as well (Bourke, 2001b). People from Sepik who had sago as part of their traditional diet process cassava into flour which they use as a sago substitute.

Sweet potato, which was a staple crop for people from Chimbu Province in the early 1970s (Benjamin, 1975a), is now widely grown by all ethnic groups throughout the LSS (Figure 6.3). Rapidly maturing varieties of sweet potato have also been incorporated into smallholders' farming systems (Appendix 5 lists different varieties of staple food crops grown on the LSSs). Certain varieties such as *wan mun kaukau* and *tri mun kaukau* mature in less than four months (compared with up to six months for other varieties). Sweet potato does not require highly fertile soils unlike yam and taro. Also, sweet potato is less prone to pest attack than taro and banana. Increased cultivation of sweet potato on the LSSs follows wider trends in PNG whereby sweet potato has increased in importance in daily diets (Bourke, 2001b; Bourke and Allen, 2009). Likewise, the shift from more traditional crops like yams and taro to crops such as cassava, sweet potato and Chinese taro are also trends observed in other parts of PNG where land pressures or declining soil fertility is occurring (see Bourke, 2001b for examples observed in the country).

Conclusion

Benjamin (1977a) warned that future food production on LSS blocks would be constrained by low soil fertility as a result of reduced fallow periods and that food shortages may occur on smaller blocks. However, smallholder households still maintain food gardens both for household consumption and to generate cash income. Smallholder households were actively addressing this problem by intensifying food production when faced with garden land shortages, particularly in the older subdivisions.

Households were cultivating crops that tolerated poor soils and matured quickly. Apart from the benefits of mixed cropping, they have also integrated improved gardening practices into their farming systems including the use of leguminous crop rotation, fertilizer and pesticide which were not observed in the past. Smallholder households were also integrating introduced vegetables such as *Brassica cvs* into their farming systems using improved gardening practices. This contributed to a wide selection of food crops cultivated on the LSSs. These crops were made available to LSS households and the wider population of Kimbe through sales at local markets thus contributing to household food security both on the LSS and amongst the wider population including the urban population of Kimbe.

Although certain crops such as yam and taro which require highly fertile soils were not cultivated as much as in the past, smallholders still cultivated these crops when situations were conducive, such as on oil palm replant sections when they become available. This is because replant sections resembles garden land cleared from fallows; that is, fertile soil enriched with significant amounts of organic matter (rotting palms) and few weeds to contend with (seed bank of weeds eliminated by 20+ years of shading by oil palm canopy). In areas not planted to oil palm on the block, fallow periods were short or absent. Households have modified their agricultural practices to accommodate oil palm by treating it almost as a forest fallow stage.

Intensification of food crop production was an important strategy smallholders adopted to address the problem of garden land shortages in order to sustain household food security on the older LSSs subdivisions. These adaptations reflect, to a certain extent, a feature of PNG agricultural systems whereby rural Papua New

Guineans have successfully intensified production and introduced innovations over a very long period in response to changing environmental, economic and social circumstances (Allen *et al*. 1995; Bourke, 2001b; Brookfield, 2001).

The next chapter considers how households on the older subdivisions are accessing land for food gardening despite 6 ha of the block being fully planted to oil palm. The chapter will also discuss how oil palm farming systems have incorporated strategies for accessing additional land for food gardening through various social networks.

Notes

1. Calculated on basis that there are 2 ha of replant available for 6 years in 22 year period (6 years/22 years = 0.2727 X 2 ha = 0.54 ha per year +0.07 ha (the 0.07 ha is part of the 6.07 ha block referred to in Benjamin's study) = 0.61 ha garden land available per year.

2. Calculation of required garden area per block. Total garden area at Kapore was 10.73 hectares surveyed amongst 18 smallholder blocks (10.73/18 = 0.5964 ha per block).

3. Calculation of mean garden area cropped per head. Total garden area was 10.73 ha and total block population sample at Kapore was 265 persons = 10.73567/265 = 0.0405 ha.

CHAPTER 7

ACCESSING GARDENING LAND IN NEW LOCATIONS

Introduction

In chapter 6 I argued that one response by smallholders to garden land shortages was the intensification of gardening practices. This chapter continues to investigate the strategies smallholders have pursued to address the problem of garden land shortages in order to sustain household food security. In particular the chapter examines the strategies that smallholder households employed on the older LSS subdivisions of Kapore and Tiauru to access land for food gardening in new locations to overcome on-block land shortages.

The first part of the chapter discusses households' access to these new gardening locations. Households were making use of previously unused land on their LSS blocks, as well as gardening off-block. These garden locations were not recorded by Benjamin (1977a) in the 1970s because at the time of her study, virtually all gardening occurred in the rear 2 ha of the block reserved for food gardening. The second part of the chapter explores the important role of social networks in enabling smallholders to access additional land for gardening in off-block locations, including blocks belonging to other people. The chapter shows that although there were shortages of garden land on the older LSSs blocks, households were using social networks to access land for food gardening to maintain household food security. They did this relatively successfully.

Gardening in new locations

Garden surveys conducted at Kapore, Tiauru and Kabaya showed that over one-third of smallholder gardens were not located on their own block, and smallholders were accessing land nearby belonging to relatives, customary landowners or the

State (Table 7.1). While almost two-thirds of gardens were still being cultivated on smallholders' own blocks, most of these gardens were located in areas previously unused for gardens. The new gardening locations smallholders were using to cultivate gardens included:

(i) *wasblock*
(ii) converted land
(iii) replant sections
(iv) state buffer zone
(v) state land
(vi) customary land

By expanding the area of land available for gardening, smallholders were striving to ensure food security was maintained. Each is discussed below.

Table 7.1: Proportions of different types of garden area per block at different gardening locations at Kapore and Tiauru (n=167 gardens).

Gardening locations	Average garden area per block				Total garden area (ha) for all households	Total per cent/rank for all households	
	Kapore		Tiauru				
	ha	%	ha	%			
Own *wasblock*	0.18	31	0.06	14	4.01	25.56	62%
Own replant	0.16	26	0.09	22	3.93	25.04	
Converted land	0.09	15	0.005	1	1.72	10.96	
Other replant	0.05	8	0.06	15	1.52	9.69	38%
Buffer zone (state land)	0.08	13	-	-	1.37	8.73	
State land	0.04	7	0.04	9	1.21	7.71	
Customary land	-	-	0.08	20	1.01	6.44	
Other *wasblock*	-		0.08	19	0.92	5.86	
Average garden area/block	0.6	100	0.41	100	15.69	100	

On own block=62%, Off-block=38%.

Gardening on-block

Wasblock

Initially *wasblock* was referred to the original 2 ha garden reserve area at the rear of the block. Since the 2 ha garden reserves have been fully planted to oil palm, blockholders started referring to small portions of land at the back of the LSS block that remains after planting 6 ha of oil palm as *wasblock*. Although smallholders on the older subdivisions of Kapore and Tiauru had planted 6 ha of oil palm, most of the blocks had small portions of '*wasblock*' remaining at the rear of the block. The

size of the remaining *wasblock* varied depending on the subdivision and the location of the block relative to the edge of the subdivision. Kapore, and other older subdivisions including Tamba, Sarakolok, Buvusi and Galai in the Hoskins project area, had larger original reserves of 2.83 ha than Kavui and Kavugara (Benjamin, 1977a). Therefore, when these original reserves were recently converted to oil palm, small portions of land remained which were used for food gardening. Thus at Kapore almost one-third of food gardens were located in the small *wasblock* section of the block compared with only 14% at Tiauru (Table 7.1). Also, blocks located on the edge of the LSS subdivisions effectively were larger than those blocks located in the middle of the subdivision. This was because the block owners had appropriated illegally part of the buffer zone bordering their blocks to extend their land area.

Kabaya is a relatively new subdivision established in 1994 and is the only subdivision where some blocks had retained their original reserve land intended for food gardening. OPIC data (2012) indicate that only 50% of blocks at Kabaya have planted their full 6 ha to oil palm. As mentioned in Chapter 4, population pressures are less at Kabaya because of recent settlement and blocks are largely occupied by first generation settlers. Of the 12 smallholder blocks selected for this study, only 5 had planted 6 ha of oil palm. All the gardening at Kabaya was done on original reserves. Three-quarters of block residents cultivated food gardens on these reserves on their own blocks and one-quarter on other blocks if their reserves had been fully planted to oil palm (Table 7.2; Box 7.1).

Table 7.2. Proportions of garden area at different gardening locations at Kabaya (12 blocks and 72 gardens).

Gardening locations	Total garden area (ha)	Per cent
Own original reserve	4.14	73.53
Other original reserve	1.49	26.47
Grand total	5.63	100

Converted land

Recently, block residents have begun gardening land on their blocks that was unsuitable for oil palm and/or was not previously cultivated for food gardens. This land included hilly and steeply sloping land and land immediately around the house (homestead land). In addition, some smallholders experiencing more severe land pressures were converting small areas of land planted to oil palm to food gardens.

The latter was an interesting strategy. Instead of replanting a full 2 ha phase of senile oil palm which was the common practice, smallholders retained a small portion of the 2 ha phase to be used as garden land. Although, not shown in Table 7.1, 7% of 'converted land' at Kapore was land that would have been replanted with oil palm and instead had been utilised for food gardens. A further 4% of garden at Kapore land was located on hilly and sloping land.

Land allocated to small kitchen gardens around the homestead area accounted for another 4% of the total area of converted land on blocks at Kapore. Benjamin (1977a) reported that smallholders were also making gardens at roadsides surrounding their blocks. Most of the blocks surveyed did not plant gardens at this location anymore. However, few blocks that made gardens on roadside land complained of theft from passers-by. Gardens near the house were mainly cultivated with greens and vegetables such as *aibika* (*Abelmoschus manihot*), pumpkin (*Cucurbita moschata*) and beans (*Vigna unguiculata*). In total, 15% of on-block land, not previously used for gardening at Kapore had been converted to food gardening (Table 7.1). Blocks located in the middle of the LSS subdivisions and which shared a boundary with other blocks were more likely to have gardens located on 'converted land' than blocks located on the boundaries of the subdivisions where they could access State or buffer zone land bordering their blocks.

Replant Sections

As outlined in Chapter 6, the most common gardening strategy was the intercropping of immature oil palm with food crops (Table 7.1). Although a conventional bush fallowing system was absent in smallholders' gardening practices in the older subdivisions (as predicted by Benjamin, 1977a), a modified fallowing process has evolved with oil palm representing the fallow vegetation. That is, land is kept in tree (oil palm) fallow for 22 years while palms are in production. Oil palm is not a fallow in the way that a secondary forest fallow of mixed species allows the rejuvenation of soil nutrition. For example, as mentioned in Chapter 6, the harvesting of oil palm fruit removes nutrients. However, the regular application of fertilizer throughout the 22 years of production and the decaying organic matter of senile poisoned[1] palms at the end of the oil palm cycle, add nutrients to the soil, as does the fertilizer applied to the young oil palm seedlings. Also, the 22 year 'fallow'

eliminates weed seeds like a secondary forest fallow, so weeds are not a major problem during the two to three-year gardening period.

Smallholders can intercrop immature oil palm with food crops for a period of up to three years. When the oil palm canopy closes after two to three years, the garden goes into a 'fallow' of oil palm. Smallholders then wait for the next 2 ha section of oil palm on their leasehold block to become available for intercropping when the palms reach the end of their productive life. Thus the food gardening-oil palm cultivation system of smallholders which incorporates the 2 ha rotational planting of oil palm is similar to shifting cultivation practices found widely in PNG. The garden cultivation periods of up to three years on the replant section exceed that of gardens cultivated from primary and secondary forests in the early 1970s which Benjamin pointed out to be between 12 to 18 months (Figure 7.2). The presence of traces of fertilizers together with the decomposed matter of the old palms enables the garden to be cultivated until the canopy closes.

Furthermore, smallholders have expanded the area of available gardening land for their gardening needs by drawing on customary practices of reciprocal access to land during the replanting stage. This means that through reciprocal exchange relationships, settlers were able to plant gardens on replant sections belonging to other growers (Box 7.1 and 7.2). Allocation of plots of land by blockholders to *wantoks*[2], neighbours and friends living on other blocks created mutual obligations that ensured future access to the replant sections on the blocks of others. Reciprocal gardening arrangements were the most common way to access land for gardening off-block. Another reason for allocating plots of land in replant sections to others was to keep the replant section clear until oil palm seedlings were replanted. This approach was particularly common on the less populated blocks where block residents were not utilising the whole 2 ha replant area with food gardens. Blocks with multiple households made more use of the available gardening land on their block, but typically allocated plots of land to *relatives* and *wantoks* from other blocks if they had land left over after meeting their own gardening needs.

The male head of the block and his spouse take control of the decisions regarding gardening on their replant sections and allocate gardening land at their discretion, although mindful of their obligations to other growers and of their own future needs

to access land for food gardening. Immediate family members and secondary families are given priority over neighbours, friends and relatives living off-block.

Box 7.1: An example of reciprocal gardening arrangements at Kapore

Marcus and Helen are from ENBP. They live with their two unmarried adult sons on their block at Kapore. Their block shares a common boundary with Paul from ENBP (not related) and Petrus from Chimbu. Reciprocal gardening arrangements have been in place amongst these three blocks for several years. Petrus is the youngest of four married brothers and sisters who live together on the same block with no access to land for gardening. At the time of fieldwork he was highly dependent on food produced on his neighbour's replant section. Sometimes Petrus and his wife share harvested crops with Marcus and Helen. Marcus and Helen also share food with Petrus' family when they have food surplus to their own requirements.

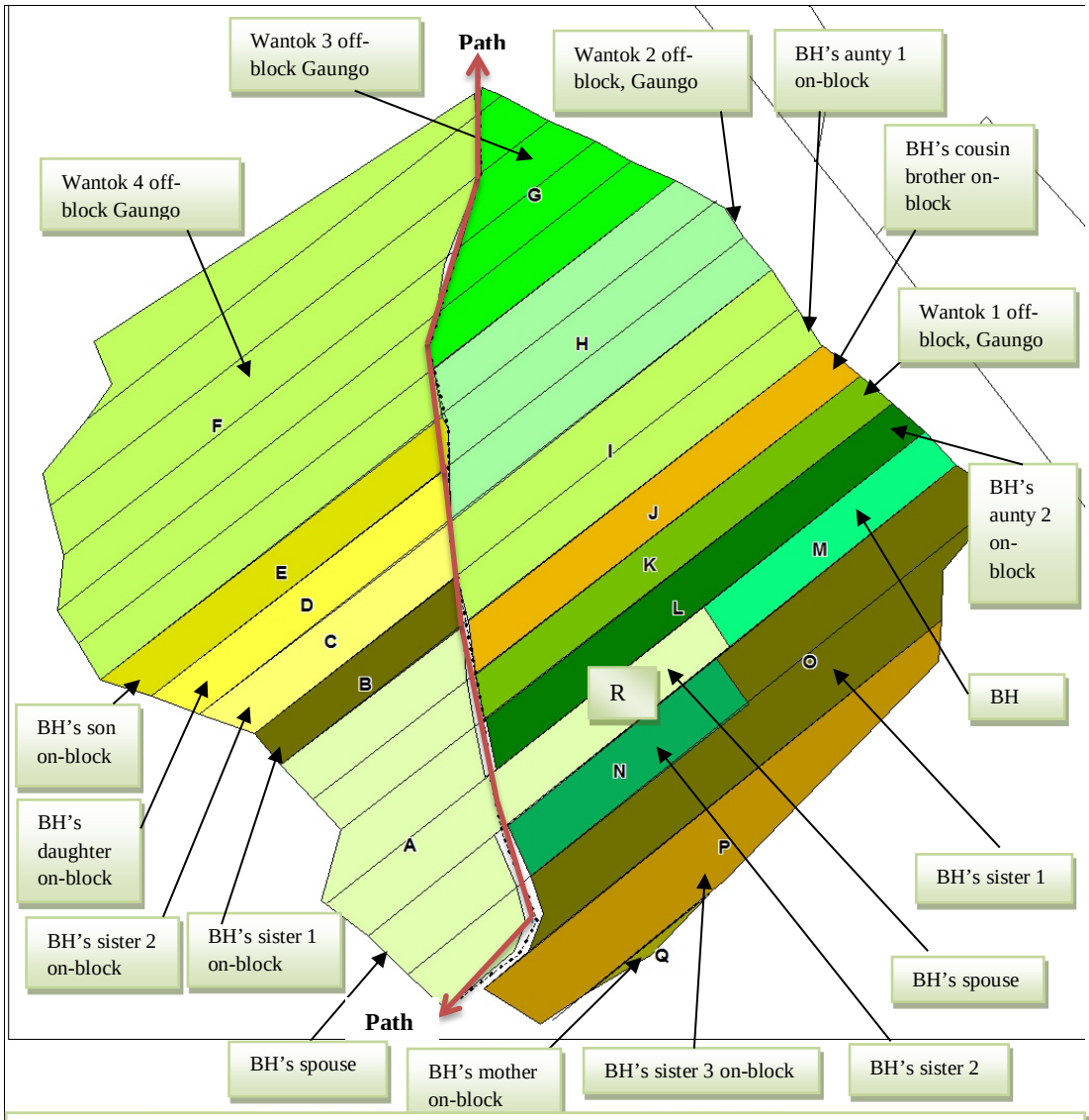
The other neighbour, Paul, lives with his wife and six young children with his married brother and his family on their family block. There is also reciprocal gardening arrangements between Marcus and Helen and Paul and his wife. Reciprocal gardening arrangements created friendships amongst neighbours. For instance, Helen sometimes shared cooked food with Paul's family. This often relieved Paul's wife from the burden of preparing large meals to feed her six children.

Box 7.2: Another example of reciprocal gardening arrangements at Kapore

Plate 7.1 shows women from Maprik, East Sepik Province sowing peanut seeds on their neighbour's 2 ha replant section at Kapore. These women also planted gardens of aibika and sweet potato. Their neighbour is from East New Britain Province and is employed by NBPOL. Their neighbour has accommodation provided by the Company and lives with his family at the company's compound at Mosa. To maintain the replant section of his block, he invited his two neighbours sharing boundaries with his block to cultivate crops. His neighbours were grateful for the additional gardening land and women especially were reaping the benefits of cultivating peanuts and *aibika* for sale. The owner of the block had no immediate need for garden land but, by allocating land to his neighbours, he was investing in future reciprocal gardening arrangements with his neighbours when he decides to live permanently on the block.

Plate 7.1: Women from Sepik planting peanut on oil palm replant section.

Figure 7.1 shows a replant section belonging to a blockholder, Ben from Chimbu at Kapore subdivision who shared the block with four co-resident (secondary) families. Ben allocated gardening rows (approximately 0.13 ha each) to 15 people, including both primary and secondary households living on the block as well as *wantoks* living off-block on Customary Rights Purchase (CRP)[3] blocks at Gaungo. Although reciprocal gardening arrangements are unlikely to occur with Ben's *wantoks* living on CRP blocks, because of the lack of excess land for gardening on CRP blocks, gifts of food to Ben's family were common. Twelve per cent of the replant section was cultivated with food crops by the primary household, while 42% was cultivated by secondary households (42%) and 46% by *wantoks* living off-block. The large area of the replant section allocated to secondary households was to give them the opportunity to generate income through food crop production. As mentioned earlier in the thesis, secondary households have limited access to the oil palm income on the block. Similarly, *wantoks* on CRP blocks, typically only have 2 ha of oil palm.



Key (Area in hectares. Total area of replant section is approximately 2 ha)

A (0.22) - Aibika, eggplant, capsicum, peanut, pakchoi
B (0.03) - Snakebean/sale
C (0.05) - Peanut harvested/sale
D (0.05) - Peanut harvested/sale

E (0.06) - Peanut/sale

F (0.44) - Peanut/sale
G (0.10) - Peanut/sale

H (0.16) - Aibika, peanut/sale
I (0.14) - Mixed cropping- peanut, bean, cucumber

J (0.08) – Peanut, bean/sale
K (0.07) - Peanut/sale
L (0.08) - Peanut/sale
M (0.05) – Pakchoi, Chinese cabbage/sale
N (0.05) - Spring onion, Chinese cabbage, peanut/sale
O 0.16) - Peanut/sale
P (0.11) - Aibika, corn. Pakchoi/sale
Q (0.003) – Aibika/sale
R (0.05) – Pakchoi/sale

BH = Blockholder

Figure 7.1: An example of a replanted section at Kapore being allocated to different gardeners.

On Ben's replant section, secondary households cultivated only high value crops for sale such as peanut and a variety of local and introduced vegetables. Peanuts are a good source of income. Of the total 26 productive gardens shown in Figure 7.1, peanuts were grown in 13 gardens predominantly as monocrops. The other 13 gardens were mixed cropping of vegetables and monocrops of Chinese cabbage, pakchoi or *aibika*. In a few cases, peanuts were intercropped with other crops such as corn or bean. Of the four dominant high value crops cultivated on the replant section (Figure 7.1), peanut ranked the highest in terms of area planted (42%) followed by Pakchoi (13%), aibika (13%) and bean (10%).

Some smallholders were aware of the nutritional benefits to the soil of planting peanuts. One smallholder interviewed pointed out that he allowed secondary households to plant only peanuts; no other food crops were allowed to be planted in the replant section. This was because he believed that peanuts would add nutrients to the soil. Sometimes blockholders placed restrictions on the types of crops to be cultivated on replant sections. For instance, Ben forbade the cultivation of banana, taro and other food crops that had the potential to grow large and compete with oil palm seedlings for space, light and nutrients.

As outlined in Chapter 6, replant sections have at least four cropping cycles (approximately 2 to 3 years). Prolonged gardening of up to three years also occurred on some *wasblocks*. On customary and State land most garden cycles were for less than two years. These improved practices allowed the cultivator to plant up to four crops on the same piece of land. Moreover, in all gardening locations, most of the gardens surveyed (83%) were in their second cropping cycle whilst only 17% of the gardens were cultivated with third and fourth crops (Figure 7.2).

Furthermore, as mentioned in Chapter 6, improved gardening practices were closely associated with the cultivation of high value crops which were mostly cultivated on-block. This may indicate that residents were disinterested in investing labour and improved soil management practices in off-block gardens where theft of food is common and tenure security is poor. It is most likely that residents abandoned their gardens after two cropping cycles, unless improved soil management practices were used.

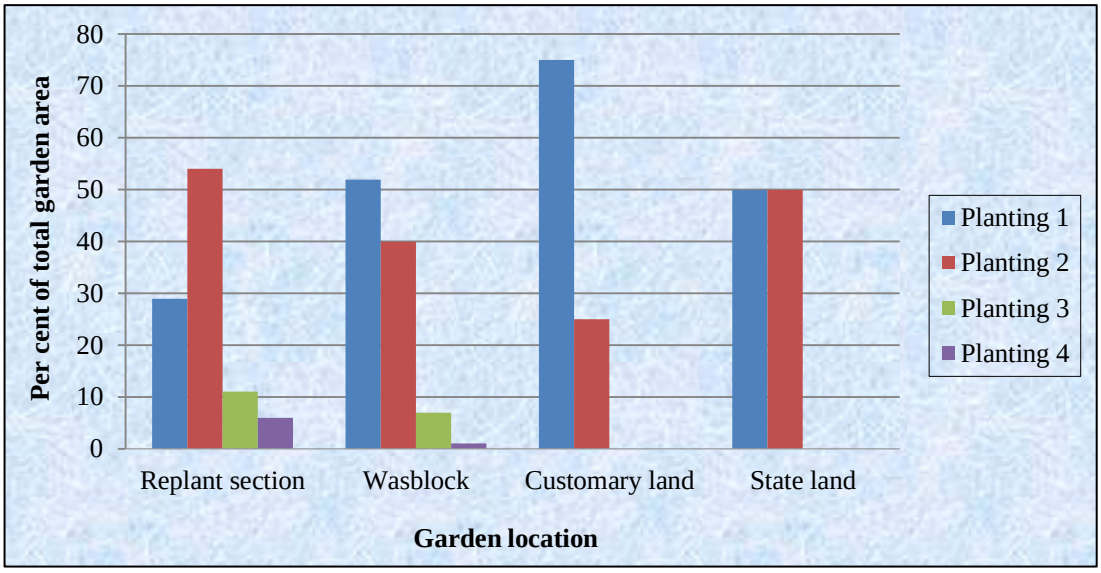


Figure 7.2: Cropping cycle at various gardening locations at Kapore and Tiauru.

Gardening off-block

When gardening land is unavailable on-block, residents seek land off-block. At Kapore and Tiauru, most of the gardens cultivated off-block were on buffer zones and State land (Table 7.1). Gardening on the backblock reserves of other blocks was not common. Usually, this small portion of the block is specifically reserved for the blockholder and his immediate family. However, in certain circumstances, a portion may be allocated to a very close relative such as a brother or sister living on or off-block. For example, there was a case that was noted where a family at Kapore were doing their gardening on a relative's *wasblock* at Kavui.

State land

Although technically illegal, most blocks at Kapore, and Tiauru adjoining State land used the State land for gardening. For example, blocks bordering (and those within 500 m) the unused Department of Agriculture and Livestock (DAL) State land at Kapore regularly used this land for gardening. Leaseholders whose blocks adjoin State land often became 'gatekeepers' of the State land and controlled access for gardening. They monitored the gardening activities carried out on the land by relatives and other settlers. For example, in their role as 'gatekeepers' leaseholders typically allocated plots of land on their own block to relatives for gardening while they themselves did most of their gardening on State land. They may have done this to prevent others from asserting claims over the State land through gardening it, while they themselves were staking their 'ownership' rights to this land through

cultivation. Almost 8% of gardens at Kapore and Tiauru were cultivated on State land although land tenure is insecure (Table 7.1).

Buffer zones

Blocks located on the edge of the LSSs have access to adjoining land classified as buffer zone land (part of the LSS leasehold State agricultural leasehold land) where, like State land, it is illegal to cultivate food gardens. Buffer zones are reserved areas created along creek lines and river beds as a measure to protect wildlife and the environment. Gardening is prohibited in these areas as is hunting and cutting timber. However, 9% of gardens were located on buffer zones. Gardens located along river banks are exposed to the risk of flooding, and riverbank erosion can be a problem.

Customary land

When other avenues to access land adjoining the block, or in the replant section of other LSS blocks were constrained, blockholders sought to garden nearby customary land. Growers used friendship/social networks to access customary land with the relationship sealed through exchanges of small gifts of food or occasionally cash as goodwill gestures. However, tenure was insecure and garden owners were restricted to establishing gardens within clearly demarcated areas. Also, settlers were not able to use the land in any way they wished. For example, restrictions were often imposed on the types of crops smallholders were permitted to plant. Generally, they were not permitted to cultivate perennial plants that gave gardening rights for more than one year, and some landowners would not allow the cultivation of high value food crops which could be sold at local markets. This is because perennial crops gave long-term use rights to the land, thereby potentially undermining the use rights of customary landowners, while high value cash crops would require higher levels of 'compensation for the customary landowners to legitimate such land uses by 'outsiders'.

Cultivation of food gardens off-block on State land, buffer zone land and on customary land often experienced a high risk of theft which smallholders managed in various ways. Smallholders often planted crops that were less prone to theft. For instance, crops that could be easily harvested and consumed immediately (therefore, more prone to theft) such as cucumber, watermelon, peanut and corn tended to be cultivated on-block, while banana, sweet potato and Chinese taro were more likely to

be cultivated off-block. Another strategy garden owners used to deter theft was to visit their off-block gardens more frequently when crops were near ready for harvesting thereby making their presence known to potential thieves. However, the drawback was that off-block gardens meant that much time was spent visiting these gardens.

Conclusion

This chapter has shown that another strategy that households pursued to address garden land shortages was to expand the area of available gardening land through cultivating gardens in new locations both on and off the block. This was more pronounced on the older subdivisions than the recently-established LSSs such as Kabaya subdivision where population pressures were less. Common locations for gardening in the older subdivisions were the replant sections and small portions of land at the rear of the block (*wasblock*) that remain after 6 ha have been fully planted to oil palm. Likewise, certain portions of land on-block unsuitable for oil palm, such as hilly or steeply sloping land have recently been converted to garden land. When land was not available on-block, residents sought land off-block. Even though gardening off-block had risks such as theft of food crops, garden owners devised ways to address such problems by selecting crops that were less prone to theft and by developing other strategies to discourage theft.

Importantly, since replanting of oil palm began in the 1990s (Curry *et al*. 2007), smallholders were able to expand their garden land holdings to include land on replant sections on or off their blocks. Replant sections resemble land cut from a bush fallow; smallholders were able to make up to four plantings before the oil palm canopy closed. Although a conventional agricultural system had been squeezed out (no rotational bush fallow on the block), smallholders have adapted to a modified system based around the commercial cultivation of oil palm. This system continues to sustain household food security on the LSSs and the wider population of Kimbe as did the agricultural system practised 35 years ago (Benjamin, 1977a).

Finally, as noted above, the sourcing of garden land was not confined within subdivisions but also, in a few cases, across subdivisions. Social networks and family and ethnic ties enabled smallholder households to gain access to gardening land through a range of reciprocal informal arrangements. It is a sound strategy to

foster these social networks and reciprocal obligations regarding land access. These networks greatly expanded access to gardening land by making land available continually through reciprocal exchange relations. If smallholders were dependent solely on land on their own blocks for gardening, it may not have been possible for them to fully plant their blocks to oil palm.

The next chapter will examine the involvement of smallholder households in non-oil palm income-earning activities as the third strategy households have adopted to address the problem of garden land shortages in order to sustain household food security on the LSSs.

Notes

1. When smallholders wish to replant their 2 ha senile palms, OPIC manages contract teams to destroy the old palms by injecting them with glyphosate. The chemical kills the palms which then dry out and decompose into the soil.

2. *Wantoks* refer to people who come from the same ethnic background and who speak the same language.

3. Gaungo VOP is located some 5 to 10 minutes' drive from Kapore. Most people walk along bush tracks (short cuts) between Gaungo and Kapore which takes 20 to 30 minutes. Gaungo settlements are Customary Rights Purchased (CRP) blocks 'purchased' from landowners by migrants such as the children of the original settlers and employees working in Kimbe (Koczberski *et al*. 2012). The 2 ha blocks accommodated the housing area, food gardens and oil palm plots.

CHAPTER 8

INCOME DIVERSIFICATION

Introduction

This chapter examines households' involvement in non-oil palm income-earning activities as another strategy that smallholder households have adopted to address the problem of garden land shortages to maintain household food security. By diversifying their livelihood strategies, smallholders are able to improve their capacity to purchase food thereby adding to food security. The chapter also provides an overview of the involvement of co-resident, secondary households in non-oil palm income-earning activities. These additional non-oil palm income-earning activities are especially important income sources for secondary households who have a weaker claim on oil palm income than primary households.

Studies have shown that income diversification is important in many rural areas in developing countries because one income-earning activity alone is often insufficient or too risky to sustain farming households, especially during unfavourable economic situations (Orr and Mwale, 2001; Ferreira and Lanjouw, 2001; Smith *et al*. 2001; Abdulai and CroleRees, 2001; Whitehead, 2002; Francis, 2002; Chimhowu, 2002; Rigg, 2006; Orr *et al*. 2009; Rigg and Salamanca, 2009; Owusu *et al*. 2011; Thuo, 2011). Studies have also widely reported on the importance of non-farm income for household food security and improved livelihoods amongst rural households. For example, several studies have reported improved overall status of rural households in African countries as a result of a household's involvement in non-farm activities (Barrett *et al*. 2001; Owusu *et al*. 2011). These studies reveal that households in high income categories have a wide choice of high quality foods to choose from compared with households in low income categories. Iram and Butt (2004) based on the National Household Surveys pointed out that income is the main determinant of

household food security amongst households in Pakistan. Similarly, Ruben and Berg (2001), in their study amongst rural farm households in Honduras reported that household food security is positively correlated with non-farm income. This study also indicated that income earned from non-farm activities helped farmers to purchase farm inputs to improve yields which also contributed to household food security. Barrett *et al*. (2001) reported improved overall status of rural households in African countries as a result of household's involvement in non-farm activities. These studies reveal that households in high income level categories have a wide choice to select from a variety of high quality foods compared with households in low income categories.

Furthermore, opportunities for income diversification were greatest amongst households that have good access to resources, such as land, finance, wide social networks, credit and government infrastructure and services (Abdulai and CroleRees, 2001; Smith *et al*. 2001; Chimhowu, 2002; Winters *et al*. 2009). To diversify income involves weighing up options and making decisions depending on the household's resources and the ability to become involved in income-earning activities apart from oil palm. Decisions made within the household unit are made voluntarily or involuntarily due to two contrasting situational factors. Barrett *et al*. (2001: 315-316) referred to these as "pull" and "push" factors. Pull factors are economic opportunities that households voluntarily engage in to earn income to improve their living standards or accumulate assets to enhance household security. In contrast, push factors are those where the households are in unfavourable circumstances which involuntarily compel them to diversify to sustain the family (Ellis, 1998).

On the LSSs, smallholder households were involved in a range of non-oil palm income-earning activities as a result of both pull and push factors. For those households on the recently-established LSS subdivisions, adopting other income-earning activities was not only about sustaining household food security but also about accumulating financial assets for long-term sustainable livelihoods. This may not be the case amongst most households in the older subdivisions where they are being pushed into diversifying their livelihood options as a result of population pressure, scarcity of resources and increased prices of store foods (such as rice[1])

which are threatening household food security. These households were involved in other income-earning activities to sustain household food and income security.

Involvement of smallholder households in non-oil palm income-earning activities

Time and labour allocation surveys conducted at Kapore, Tiauru and Kabaya showed that 81% of primary households were involved in non-oil palm income-earning activities. Out of the 18 households surveyed at Kapore, people on 17 blocks were involved in on-block non-oil palm income-earning activities while one blockholder was involved in cocoa production off-block. This blockholder has a cocoa block managed by his wife (and three young children) in Rabaul, ENBP. It was unclear how much of this off-block cocoa income was re-invested in oil palm block, but it was highly likely that the cocoa income was supporting his wife and family. Households were involved in a range of non-oil palm income-earning activities which included:

(i) Local marketing of food and other items
(ii) Broiler production
(iii) Trade store
(iv) Wage employment
(v) Other small businesses

Figure 8.1 shows the participation rates of smallholder households in these non-oil palm income-earning activities. Each of the activities is discussed below.

Marketing of food and other items

Marketing of food and other items was the most important non-oil palm income-earning activity for smallholders on the LSSs in terms of frequency and participation rates. Related studies done on the Hoskins LSSs in WNB (Koczberski *et al*. 2001b; Dewhurst, 2007; Ryan, 2009) also reported similar findings. More than half (55%) of smallholder households were involved in this activity (Figure 8.1). Items commonly marketed included food crops, cooked food, store goods[2] such as phone cards (phone credits for mobile phones) cigarettes, candies, snacks and betelnut, betel pepper and kerosene. Women dominated marketing of food crops, cooked food and processed goods such as biscuits, candies, cigarettes and other store goods at roadside markets (Figure 8.2) (for example, see Plate 8.2).

Figure 8.1: Proportions of households involved in non-oil palm income-earning activities between July and October, 2010 at Kapore, Tiauru and Kabaya subdivisions (n=42 households). ('Other' includes: petrol & kerosene sales, PMV business, other cash crop).

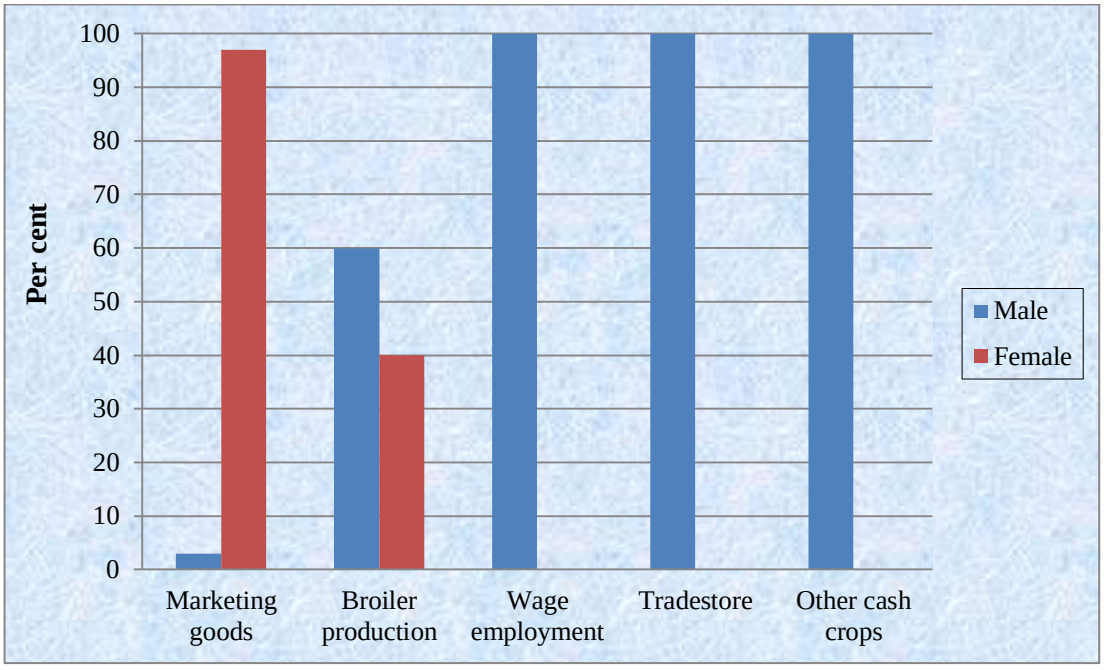


Figure 8.2: The share of non-oil palm income-earning activities by gender for primary households between July and October, 2010 at Kapore, Tiauru and Kabaya subdivisions (n=42 households).

As mentioned in Chapter 6, women earned a good income from marketing of high value garden food crops such as peanut and introduced vegetables (e.g. cabbage head and varieties of Chinese cabbages) (for example, Plate 8.1). Local leafy vegetables such as *aibika*, *aupa* and water cress also generated a good return at local markets.

Koczberski *et al*. (2001b) reported that income earned by women in marketing goods supplements oil palm income which contributed significantly to household food security. Studies done in other parts of PNG and other developing countries have also shown that women's income is associated with the overall wellbeing of the family and household food security. For instance, Fresh Produce Development Corporation (FPDC, 2000) revealed from surveys in parts of Eastern Highlands and Central Province of PNG that women spend 75% of their income on family welfare while men spend 25% of their income on family welfare and bulk of their income is spent on self-pleasure. Research showing women's income benefiting the family unit, is also observed in other developing countries including Ghana (Gladwin *et al*. 2001; Boakye-Achampong *et al*. 2012). FAO also reported studies across many developing countries that revealed increases in women's income was more strongly associated with improvements in children's health and nutritional status than increases in men's income (FAO, 2010-2011: 43).

Betelnut is another crop that fetches a good income in terms of returns to labour. Betelnut is typically sold for between 20 and 40 toea (PGK1=AUD0.44) each depending on the supply at local markets. The price of a single betelnut was the same as for a bundle of green leafy vegetables. Though male household members also sell betelnut and betel pepper, female household members dominated its sale at roadside and local markets throughout the LSSs (Figure 8.3). It was common practice for those selling betelnut to also sell cigarettes and rolled tobacco. At Kapore subdivision, betelnut was harvested from the block or bought from sellers at Kimbe market and resold at a profit on LSS subdivision markets (Plate 8.2). It is possible that the trend towards the increase participation in local marketing of betelnut is due to land shortages and that smallholder households are engaging more in income-earning activities that do not require much land and provide a good return on labour. Furthermore, the betelnut business on the LSSs is similar to the trade elsewhere in PNG (see Allen *et al*. 2009 and Sharp, 2012) where it is viewed as a profitable business.

Plate 8.1: Women from Chimbu waiting at Kapore bus-stop with their produce they intend to sell at Kimbe town local food market (displaying lettuces).

Plate 8.2: Betel stands around the homestead area at Sarakolok subdivision. Insert: Spouse of original blockholder sorting out her betelnut to sell at the local market.

Plate 8.3: Women (mostly from secondary households) marketing betelnut, cigarettes and other store goods in front of their block at Sarakolok subdivision.

Off-block employment

Wage employment was the second most important non-oil palm activity after local marketing in which smallholder households were involved. Whilst there are relatively few opportunities for paid employment in WNB, 19% of primary households had a family member in full-time wage employment, off-block (Figure 8.1). Similar findings were also reported by Ryan *et al*. (2013: 19) who reported that 19% of primary households generated income from wage employment, off-block. It needs to be pointed out that a few blockholders were also employed off-block. Although not shown in Figure 8.2, from a survey of 120 households, 10% of blockholders were employed off-block. When blockholders take on off-block work, they rely on male relatives to take over the oil palm work. For most blockholders, income earned from off-block employment was secondary to income generated from oil palm. For example, one informant in my study worked as a public servant with the WNB provincial government and earned a fortnightly income of K1070.00 which he claimed was less than the fortnightly oil palm income generated on his block. Field data show that those engaged in off-block wage employment were men (Figure 8.2). They were employed in a range of skilled and unskilled jobs such as primary

school teachers and drivers. Most were employed by New Britain Palm Oil Limited (NBPOL). Studies in other developing countries have shown that men have more opportunity to diversify income-earning activities through formal sector employment than women. Typically women are involved more in the informal economies through activities such as crop and small animal production, selling cooked food, store goods, second hand clothes, crafts and other cottage industries (Smith *et al*. 2001; Koczberski *et al*. 2001b; Umezaki and Ohtsuka, 2003; Dewhurst, 2007; Ryan, 2009). Households with off-block employment were more advantaged than other households, especially during periods of low oil palm prices or when there was insufficient land for household food production. Studies done in other developing countries show that wage employment off-block is correlated significantly with improved level of household income and food security (Ruben and Berg, 2001; Iram and Butt, 2004; Owusu *et al*. 2011).

Furthermore, a correlation analysis (Appendix 9) showed that blockholders' educational levels were positively associated with secondary income-earning activities on the LSSs, especially waged employment. This indicates that households with educated members were more advantaged over those with less educated members, which confirms findings in other developing countries that revealed education level is highly correlated with non-farm wage employment (Abdulai and CroleRees, 2001; Tschirley and Benfica, 2001; Ferreira and Lanjouw, 2001).

Broiler production

Ten per cent of smallholder households were engaged in broiler production (Figure 8.1). Broilers were a profitable business and could raise relatively large amounts of cash quickly. Income can be generated within a period of 3 to 4 months when live birds are ready to be sold. For example, in 2012, start-up production costs were K820 (box of 50 chicks at K200, 6 stock feed bags at K100 per bag, and K20 transport cost) while the price of a live bird was K50 at Bialla and between K40 and K50 at Hoskins. The sale of 50 chickens can generate an income of K2000 to K2500, with a net profit of K1180 to K1680 (S. Simon, pers. comm., 17th October, 2012). Most households involved in other small business activities were also involved in poultry production. For example, most of the households which operated trade stores or were involved in petrol or kerosene sales had also diversified into broiler production. This

suggests that as households became successful in one income-earning activity, they diversified into other types of activities. More males than females were involved in broiler production (Figure 8.2).

As pointed out by Koczberski *et al*. (2001b), birds sold on credit and excessive delays in payments inhibited producers from continuously carrying out their poultry business. These businesses failed when outstanding credit levels became too high to allow restocking. Despite the disadvantage of delayed payment, selling birds on credit helped minimise feeding costs as birds were sold more quickly. Importantly, allocating food in the form of live birds to customers when they are not able to pay immediately helped maintain good diets.

Trade stores and other small businesses

Ten per cent of smallholder households were running trade store business. Store owners could earn a reasonable income by selling basic goods such as rice, flour, noodles, tinned fish and meat, biscuits and other essential household items. Stores that had electrical generators sold additional goods such as fresh meat, chicken, soft drinks and beer. Trade stores were operated mostly by primary households. Initiating a trade store business requires a reasonable amount of capital as well as a strong and lockable building to store goods. Thus, primary households with greater access to the oil palm income were in a better position to establish small businesses than secondary households.

Whilst block residents did most of their shopping in the townships of Kimbe and Bialla, small trade stores on the LSS subdivisions provided convenient services to those who were not able to pick up groceries in town or when household stocks ran out. Store owners also provided credit on store goods to LSS residents when they were not able to pay immediately, also alleviating temporary food needs. By extending credit to customers, trade store owners often faced delayed payments from creditors which sometimes adversely affected their business operations. Curry (1999) reported similar situation amongst trade store owners in the Wosera area in East Sepik Province.

Six per cent of smallholder households were involved in other income-earning activities such as selling of petrol and kerosene, Public Motor Vehicle (PMV)

businesses and cultivating other cash crops such as cocoa (Figure 8.1). Selling of kerosene is a profitable income-earning activity as there is no electricity supply in the LSS subdivisions. Kerosene is usually sold in an empty beer bottle (375 ml) for K1.00 (USD 0.42) per bottle. Only one household in my sample had a PMV business. From communication with informants, I was told that a few households in the older subdivisions of Kapore and Sarakolok had previously operated a PMV but these businesses had collapsed because of mismanagement. Cultivation of other cash crops was another strategy adopted by a few primary households. This strategy was common amongst blocks situated on the edge of LSSs where they was additional land bordering the block. For example, two of the blocks that I visited at Kapore had planted cocoa on land at the rear of their blocks and on bordering buffer zones bordering their blocks. These two blocks had relatively large cocoa plots of 60 to 100 cocoa trees. Both of these smallholder blocks had cocoa fermentaries and were able to produce dry cocoa beans. Koczberski *et al*. (2001b) noted that one of the main reasons why smallholder households were cultivating alternative cash crops was because they could fall back on these cash crops when oil palm prices were low. Other cash crops households were cultivating included tobacco and vanilla. Tobacco gave reasonable returns to labour when sold at local markets.

Involvement of secondary households in other income earning activities

Secondary households were also involved in a variety of non-oil palm income-earning activities. Income earned from non-oil palm income sources was very important for secondary households because they did not receive a large share of the oil palm income. For secondary households which did not receive any oil palm income, the income earned from other sources was essential to sustain their families. The number of non-oil palm income-earning activities on a block increased with the number of secondary households. Marketing of food and other items dominated income-earning activities (Figure 8.3). Also, women from secondary households dominated sale of betelnut, betel pepper and store goods (see for example, Plate 8.2).

Wage employment was the second most important income activity and involved one-third of secondary households (Figure 8.3). Similarly, Ryan *et al*. (2013: 19) reported that one-third of secondary households were engaged in wage employment off-block. Secondary households were more involved in wage employment than members of

primary households. Other income-earning activities secondary households were involved in included money lending and providing hired labour (mainly for oil palm harvesting) which accounted for 10% of their income-generating activities. The latter was noted only amongst secondary households. A few secondary households were involved in broiler production (5%) and trade store businesses (4%) which was a lot less than the involvement of primary households in these activities (see discussion above).

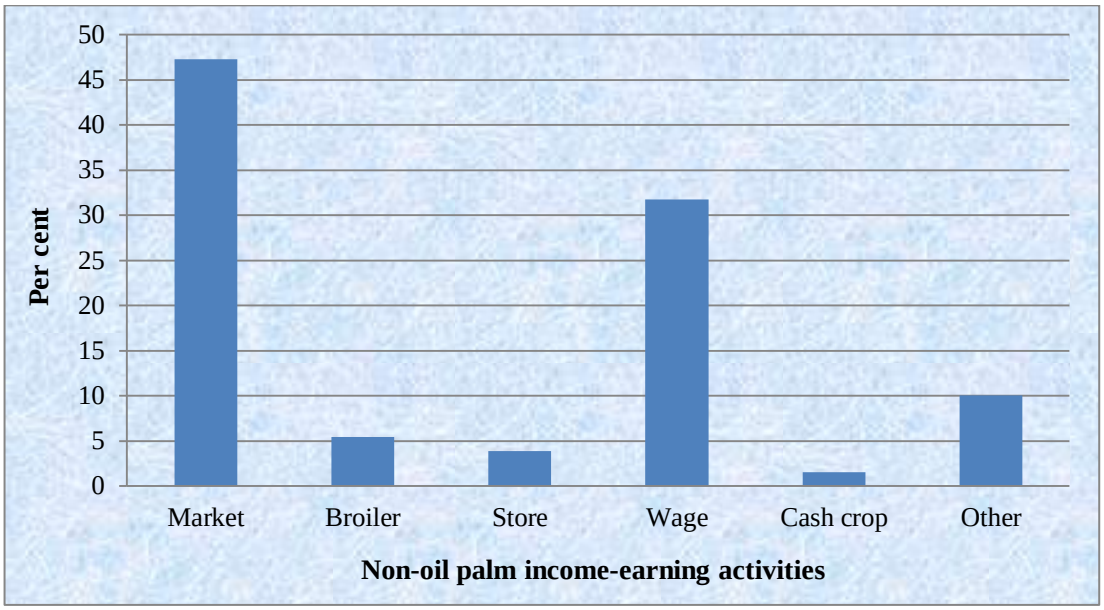


Figure 8.3: Proportions of different types of non-oil palm income-earning activities that secondary households engaged in between July and October, 2010 at Kapore, Tiauru and Kabaya subdivisions (n=42 households).

Boxes 8.1, 8.2 and 8.3 show examples of livelihood options pursued by secondary households. Box 8.1 shows livelihood diversification being pursued by the sister of the blockholder who may also receive financial assistance from her blockholder brother to meet financial obligations such as school fees or other needs. This may not be the case with friends or more distantly related family members who then become highly dependent on other income sources. In situations where there is insufficient land to diversify into food crop production for local markets, secondary households have become involved in other income-earning activities (Box 8.3).

Box 8.1: An example which illustrates that food gardening is an important income source

Mary is a single mother living with her brother who is the current blockholder at Kapore LSS. Mary's mother (spouse of the original leaseholder) and Mary's two other married but separated sisters, were also living with their children on the same block. Her brother and his immediate family take control of income generated from oil palm. Mary and her sisters have diversified their livelihood options from staple food crops for household consumption to include high value food crops such as peanut, snake bean, bokchoi and *aibika*. On the replant section of the block allocated to Mary, she cultivated these high value food crops which she sold at Kimbe town food market. She has generated almost K1000 (PGK1=0.43AUD) from selling these crops within a month. This income supported her and her young son, and she was able to pay her son's school fees at primary level and provide for his other needs. From her savings, she has also purchased a sewing machine to sew clothes for sale. At the time of my visit to their block (August, 2010), she had been sewing primary school uniform skirts and other items to sell at Bialla market. When she has sewn enough skirts to sell, she planned to travel to Bialla. She had hoped to make around K1000 from her sales.

Box 8.2: A secondary household which accesses land for gardening off-block

Lucy and her husband from a secondary household live on the block of their *wantok* at Kapore. They totally depend on food crop production for their family sustenance. It was fortunate for them that their *wantok's* block was located on the edge of the LSS where there was additional land at the back of the block available for food gardening. Their *wantok* allocated a small portion of this land which was just enough to build a small house (bush material) and make gardens. Because the block was located on the edge of the LSS, adjoining the Department of Primary Industry (DPI) State land, they also had access to State land (although illegal) to make gardens. Because they had access to additional land for gardening, they have diversified into the cultivation of high value crops such as peanut, snake beans, pakchoi, bokchoi, lettuce and tomato. They purchased pesticides and inorganic fertilizers to produce these crops to market standard because these crops were their main sources of income. They sell their crops at Kimbe town food market and sometimes at the tourist resort, Liamo Beach Resort. They have generated almost K1000 in selling these vegetables from one cropping cycle alone. Both Lucy and her husband mentioned that income from these high value food crops was an important source of income for their family.

Box 8.3: An example of non-agricultural income-earning activities on a block

Nancy and her husband live with her husband's brother who owns the block at Sarakolok. Her husband's other siblings and their families were also living on the same block. Nancy and her husband were engaged in poultry production as their main source of income. Most of their time was spent in this activity where it was an on-going project for them. Two batches of birds were being reared at the same time. When one batch of birds was going into the maturity stage, a new batch of chicks was being ordered, thus enabling continuous production. Nancy and her husband earn a high income from this activity and therefore they were not dependent on oil palm income. Nancy's husband had also diversified into selling mobile phone prepaid cards. He sold K3 and K5 Digicel phone cards for K3.50 and K6 respectively earning a return of 17% and 20% on K3 and K5 prepaid cards.

Conclusion

Oil palm is the main income-earning activity for all primary households on the LSSs. However, with pressures on oil palm income and garden land, smallholder households have diversified their livelihoods to include non-oil palm income-earning activities as a means to supplement oil palm income for family sustenance and to maintain household food security. A high proportion of male members from primary households were involved in wage employment, tradestores, and broiler production. Households with educated members were more advantaged than others as they were more likely to contribute a regular fortnightly income to the household to supplement oil palm income.

For secondary households, income earned from non-oil palm sources is the main source of income. Secondary households were mostly involved in marketing of food crops and other items, mainly processed and manufactured goods. They were more involved in wage employment than primary households, engaging in both skilled and unskilled jobs. Women dominated marketing of food and other items. Thus income was very important for them and contributed significantly to household food security (Koczberski *et al*. 2001b).

This chapter has shown that households on the older oil palm LSSs were not passive acceptors of the stresses arising from population growth; rather, they actively responded to garden land shortages and pressures in oil palm income by diversifying

their livelihood options to include non-oil palm income-earning activities as one of their main strategies to maintain household food and income security. Indeed as is shown in the next chapter, access to a regular income source allowed households to supplement garden foods with store foods such as tinned fish/meat and rice which added significantly to the quality of daily household diets.

Notes

1. Rice is becoming an important staple for most households in the urban centres. Data from this study revealed that rice is an important staple supplementing banana and root crops on the LSSs. The price of rice in PNG had continued to increase over the years since the devaluation of PNG Kina against US dollar in 1997 (McGregor and Bourke, 2009).

2. Store goods refer to any processed goods including food or other items commonly sold at roadside markets or at the homestead area. Examples of store goods include: biscuits (snax and others), noodles, stock cubes, mobile phone top-up cards, cigarettes, rice (pre-packed in 500 grams), tinned fish, etc. Trade store is categorised on its own and has a wider variety of goods sold than roadside markets. More people are engaged in selling store goods at markets than operating trade stores.

CHAPTER 9

STATUS OF HOUSEHOLD FOOD SECURITY ON THE LSS

Introduction

The previous three chapters examined the three main strategies smallholder households adopted to address garden land shortages and to maintain household food security. These chapters showed that smallholder households have continued to maintain food gardens despite garden land shortages, and they have become involved in various non-oil palm income-earning activities for family sustenance. However, the question remains: were smallholder households able to maintain nutritionally adequate diets by pursuing these different strategies?

This chapter aims to answer this question by assessing the status of household food security on the LSSs. The status of household food security was explored by: (i) examining selected demographic and socio-economic characteristics of smallholder households; and, (ii) assessing their meal characteristics. The first part of the chapter discusses the selected demographic and socio-economic characteristics of smallholder households (see Chapter 4 for the measurement of these characteristics). These variables and the categorisation of smallholder households were based on their personal and family characteristics. These attributes were considered to be important determinants of how individuals or households behave and respond to moral, environmental and economic situations. Having an understanding of these different attributes can help provide insights as to 'how' and 'why' smallholders respond in different ways to different situations to maintain household food security on the LSSs.

The second part of the chapter assesses the status of household food security on the LSSs by examining the meal characteristics of the households which included: (i) the

number of meals consumed per day; (ii) meal sources; and (iii) meal ingredients. Next, the chapter considers household dietary patterns (meal frequency and quality) during periods of low and high oil palm prices and during oil palm pay and non-pay weeks. The final section discusses the statistical relationships between the selected characteristics of smallholder households (independent variables) and the status of household food security using the Food Consumption Score (FCS) (dependent variable).

Selected characteristics of sample households

A household survey was conducted from June to October, 2010 among 120 primary households from 30 blocks each at Kapore, Sarakolok, Tiauru and Kabaya. Blockholders were selected as representatives of the households as they had leading roles in decision-making regarding family and block affairs. It was assumed that their personal characteristics and the socio-economic status of their households would influence how they dealt with the affairs of the family and the block, and their management decisions regarding food security. The selected characteristics of blockholder households included:

	Independent variables		**Dependent variables**
i	Blockholder's (BH's) age	ix	Number of meals per day
ii	BH's educational level	x	Meal source
iii	BH's family size	xi	Household Dietary Diversity Score (HDDS)
iv	Number of secondary families	xii	FCS
v	Block population		
vi	Block garden size		
vii	BH's fortnightly net income		
viii	BH's household daily food expenditure		

Studies have confirmed significant relationships between the demographic and socio-economic characteristics of smallholder households and the state of household food security. For example, Amaza *et al*. (2008) reported that large household size, low education level, small farm size and the type of farm enterprise are correlated with household food insecurity in Borno, Nigeria. Ayinde *at al*. (2010) also reported

associations between household income and farm size with caloric intake amongst smallholder households in Ogun state, Nigeria. Iram and Butt (2004) revealed that income is an important determinant of household food security amongst households in Pakistan. Similar findings were also reported in Bangladesh by Sarker and Itohara (2010) who further pointed out that the education level of the household head besides household income and farm size were positively correlated with household food security. Torheim *et al*. (2004) and Knueppel *et al*. (2009) also confirmed that the socio-economic status of the household is associated with the status of household food security in Mali and Tanzania respectively.

In this study the selected personal and household characteristics of the blockholder were taken as independent variables to explore relationships with the status of household food security as the dependent variable (Chapter 4 provides further details). Descriptive statistics including frequency, mean, standard deviation and percentages were used to describe the survey data. Unless specified, all categories were based on the average and frequency distribution of each variable, where approximate numbers were placed in each group following the pattern of the normal distribution curve. Summary profiles of the smallholders' characteristics are presented in Table 9.1.

Independent variables

Blockholders' Age

The mean age of blockholders at 46 years was close to Yala's average age for Hoskins of 45 years (2008: 47). Based on their age distribution and the mean age, blockholders were classified into three age categories: 18-40 years; 41-60 years; and, over 60 years with the largest category being aged 41 to 60 years (Table 9.1). In total 82% were between the ages of 18 to 60 years. Most of the growers were the children of the original leaseholders or the second generation managing the blocks. The over 60s were largely the original leaseholders who were entering old age. These original leaseholders still retained some control over the block; however, most of them were highly dependent on their adult children to make decisions regarding the affairs of the block and the daily sustenance of the household. It could be said that generally the younger generation of blockholders were more innovative than their parents.

Table 9.1: Characteristics profile of blockholder households in 2010 (n=120).

Characteristics	Observed range	Measuring Unit	Categories	Frequency	(%)	Mean	SD
BH's age	18-74	Years	18 to 40	41	34	46	12.7
			41 – 60	58	48		
			Above 60	21	18		
BH's education level	0-13	Grade (s)	Illiterate (0)	24	20	5.6	3.7
			Primary (1-8)	69	58		
			Secondary (9-12)	24	20		
			Tertiary (Above 12)	3	2		
BH family size	1-19	Number of members	Small (Up to 5)	32	26	7.1	3.1
			Medium (6 – 9)	68	57		
			Large (Above 9)	20	17		
Number of secondary families	1-13	Number of family on block	Single (1)	25	21	2.5	1.5
			Medium (2-3)	77	64		
			Large (Above 3)	18	15		
Block population	3 - 66	Number of residents on block	Low (Up to 7)	32	27	12.5	7.8
			Medium (8– 15)	58	48		
			High (> 15)	30	25		
BH household fortnightly net income	100 - 6460	Kina	Up to 500	16	13	1289	800
			501 – 1000	27	22		
			1001 - 1500	38	32		
			1501 - 2000	27	23		
			Above 2000	12	10		
BH daily food expenditure	0 -75	Kina	0.00	29	24	15.5	17
			0.60 – 13	40	33		
			13.01 – 30	31	26		
			Above 30	20	17		
Block garden size (N=42)	0.04 - 2.22	Hectares	Up to 0.25	14	33	0.51	0.46
			0.26 - 0.60	16	38		
			Above 0.60	12	29		
No of meals per day	1 - 3	Number of meals	1	7	6	2.1	0.4
			2	95	79		
			3	18	15		
HDDS (meal ingredients)	2 - 6	Scores (food groups)	Up to 3	37	31	4.1	1.2
			4	32	27		
			Above 4	51	42		
FCS (N=42)	24.5 - 51.5 Possible (0-66.5)	Scores	Up to 21.5	0	0	37.1	5.9
			22 – 37.5	27	64		
			Above 37.5	15	36		

When faced with problems of garden land shortages and income pressures on the LSSs, which were not a problem when their parents were young, the second generation growers were able to venture into new livelihood options and adopt new strategies to respond to pressures on block resources. A number of studies (e.g. Hossain *et al*. 2002; Islam *et al*. 2002) have shown that innovative people are risk-takers who try out new concepts and quickly adopt new and improved farming methods.

Blockholders' education levels

The mean number of years of schooling of 5.6 years is the same as that observed by Yala (2008: 47) and slightly less than 6.9 years noted by Ryan *et al*. (2013). Blockholders were categorised into four educational categories: illiterate (no schooling), primary (Grade 1-8); secondary (Grade 9-12) and tertiary (more than 12 years education). Over half of blockholders have primary education only, with only one fifth having completed grades 9 to 12 (Table 9.1). Very few went beyond 12 years of schooling, while one fifth had no formal education (Table 9.1). Of the 80% who had been to school, 31% had completed Grade 6 and only 16% had completed Grade 10. As reported by Ryan *et al*. (2013), there is a high dropout rate from schools on the LSSs due to several factors such as difficulties paying school fees for all children when there are several children in the family.

Furthermore, correlation analyses (Appendix 7) show that there is a highly significant inverse relationship at 99% probability between the educational level of smallholders and their age. That is, the second generation of blockholders are better educated than their parents, the original leaseholders. Kapia-Mendano (2012) and Ryan *et al*. (2013) reported similar findings amongst LSS settlers. This has implications for household food security as educated people tend to respond better to unfavourable situations and have more options to diversify livelihood activities than people with low education levels. This was noted on the LSS whereby better educated members of both primary and secondary households were able to engage in wage employment off-block thus contributing to household income and food security. Furthermore, nutritional studies done in selected locations in PNG show positive relationships between education level and good nutrition. For example, in a study to examine the nutritional status of children in the highlands fringes of PNG,

King and Mascie-Taylor (2002) revealed that the education level of mothers had a positive relationship with high Z-scores (proxy to good nutritional status). Similarly, Ulijaszek (2003) reported that education level of adults in the Purari delta (Gulf Province) was positively related to body size and fatness. Education develops the capabilities of an individual to respond to their situations favourably. Likewise, educated people are better equipped with knowledge and skills to utilize household assets and resources effectively. For example, studies have shown that educated farmers are quicker to adopt new and improved farming techniques than non-educated farmers or those with low education levels (Ali *et al*. 1986; Hossain *et al*. 2002). Kapia-Mendano (2012) confirmed that educated famers at Hoskins LSS responded more quickly to extension messages than uneducated farmers. This suggests that educated smallholders manage their blocks better (e.g. good block upkeep, fertilizer application and timely replanting) than less educated farmers and were reaping the income benefits of high oil palm yields.

Family size

Blockholders' average family size of 7 is close to Yala's (2008: 47) mean of 6 members. Based on the family size distribution and the average family size, appropriate categories were made which were 'small family (up to 5 members)', 'medium family (6 to 9 members)' and 'large family (more than 9 members)'. Almost three-quarters of smallholder blocks have medium to large families of 6 or more family members. Appendix 11 shows that there is significant positive relationship (at 99% level of probability) between blockholders' family size and the number of families on block. Similar relationships occur between the blockholders' family size and the block population. This is expected, of course, because as family size and the number of families on the block increases, block population also increases. Though there are pressures on block resources such as garden land and oil palm income (Koczberski *et al*. 2001b; Koczberski and Curry, 2003), household members mainly from highly populated blocks were involved in other income-earning activities. For example, almost one-fifth of members from primary households were involved in wage employment (see Chapter 8). Households with more than one regular income source are advantaged over those with only one income source as income generated contributes significantly to household food security and provides a buffer against low oil palm prices (discussed in Chapter 8).

Number of secondary families

The average number of families living on the same leasehold block including the blockholder's family was three (Table 9.1). Appropriate categories were made which were 'single family', '2 to 3 families' and 'more than 3 families'. Most smallholder blocks have 2 to 3 secondary families and four-fifths of blocks had more than one family residing on the same block (Table 9.2). Blocks in the older subdivisions of Kapore, Sarakolok and Tiauru tend to have more resident families and larger populations than recent subdivisions like Kabaya. The results confirm other findings (e.g. Koczberski *et al*. 2001b; Koczberski and Curry, 2003; Curry *et al*. 2007; Yala, 2008; Curry *et al*. 2012) that multiple families are residing on the blocks in the older subdivisions. In 2000, Koczberski *et al*. (2001b: 77) found that the mean number of secondary families residing on the same block at Kapore and Sarakolok subdivisions was 2.5 and 1.8 respectively. My 2010 data from Kapore and Sarakolok showed that the number of secondary households per block had increased to 2.9 and 3.1 respectively from 2000 to 2010. An example is depicted in Figure 9.1, which shows three generations living on a block at Kapore subdivision.

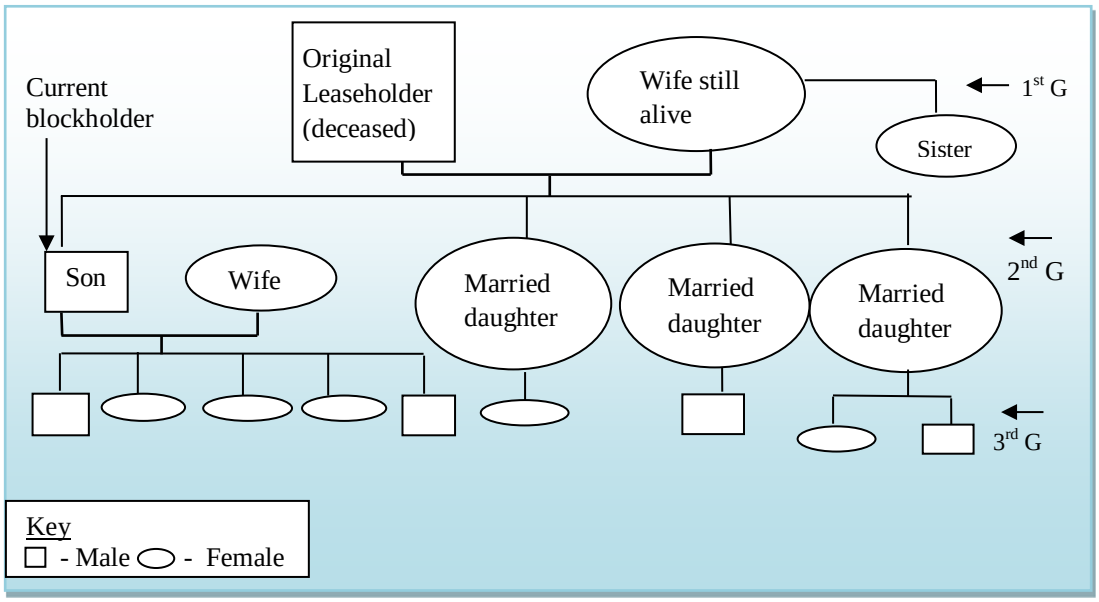


Figure 9.1: Schematic representation of three generations of families residing on one block at Kapore subdivision. (G=generation)

Some of the secondary households residing on LSS blocks are relatives and friends in formal employment who lack accommodation in the township of Kimbe or within its vicinity. In some cases the wives of male relatives or friends live on-block while the husband works in another province. For example, two women living on two

different blocks had husbands working in mining outside the province who visited the block during leave. It was quite common for blocks to have husbands in secondary households working away. These secondary families had their own houses or lived with other households on the blocks. In such cases, it is more about secondary families securing accommodation on block than attaching themselves to primary households and/or resources on the block. As mentioned in Chapter 8, secondary families have adopted various livelihood strategies to sustain themselves and many of them were involved in wage employment off-block. Most of the blocks with single households were located at Kabaya subdivision, one of the more recent subdivisions to be established. One-third of blocks at Kabaya were single family blocks (Table 9.2). This suggests that population pressure is not yet a major issue at Kabaya and other recently-established LSS subdivisions.

Table 9.2: Cross tabulations of the numbers of families living on block at different subdivisions (n=120).

Subdivision	Year established	Per cent of families on the same leasehold block			Total
		Single family	2 to 3 families	More than 3 families	
Kapore	1968	17 (5)	60 (18)	23 (7)	30
Sarakolok	1969	17 (5)	56 (17)	27 (8)	30
Tiauru	1972	17 (5)	76 (23)	7 (2)	30
Kabaya	1994	34 (10)	63 (19)	3 (1)	30
Total		21 (25)	64 (77)	15 (18)	120

Note: Figures in brackets shows the actual numbers of blocks.

Multiple families residing on the same block do not always live in harmony with each other and there are often disputes amongst them. Most of these disputes are related to the sharing of harvesting schedules and the distribution of oil palm income which often results in irregular harvesting and a lack of block upkeep. Disputes can lead to lower FFB production which can reduce the total income for the block (see Koczberski *et al*. 2001b).

Block population

The average population per block was 13. Based on the mean and the population distribution, approximate categories were made as ‘small population (up to 7 residents)’, ‘medium population (8 to 15 residents)’ and ‘large population (more than 15 residents)’. Nearly half of blocks had a medium population (Table 9.1). Although not presented in Table 9.1, the maximum block population was 18 at Kabaya; 35 at

Kapore; 36 in Tiauru; and, the largest block population of 66 was recorded at Sarakolok. Table 9.3 shows that most of the blocks at Sarakolok, Tiauru and Kabaya have medium size populations while more than half of the blocks at Kapore had large populations.

Table 9.3: Cross tabulations of block populations at different subdivisions (n=120).

Subdivision	Per cent of block population			Total
	Small population	Medium population	Large population	
Kapore	16 (5)	27 (8)	57 (17)	30
Sarakolok	23 (7)	47 (14)	30 (9)	30
Tiauru	30 (9)	63 (19)	7 (2)	30
Kabaya	36 (11)	57 (17)	7 (2)	30
Total	27 (32)	48 (58)	25 (30)	120

Note: Figures in brackets shows the actual numbers of blocks.

Blockholders' household fortnightly net income

The average fortnightly income of primary households was K1289 (Table 9.1). Five fortnightly income categories were made: 'up to K500'; 'K501 to K1000'; 'K1001 to K1500'; 'K1501 to K2000'; and 'more than K2000'. The income range was large as indicated by the high standard deviation. One-third of smallholder households earned a net income of between K1001 and K1500 while just over a fifth of households earned between K501 and K1000 and nearly a quarter of households earned between K1501 to K2000. Few households were in the extreme categories earning less than K500 or above K2000. Although not presented in Table 9.1, the bulk of income was from oil palm while the main secondary income sources (see also Chapter 8) in descending order of importance were: marketing of food and other items; wage employment; broiler production; trade store and other activities (such as petrol sales, kerosene sales, transport services (Public Motor Vehicle – PMV and other cash crops). The highest fortnightly income of K6460 was generated by a smallholder who owned and operated a PMV business.

Households' fortnightly income had a positive relationship with the educational level of blockholders (Appendix 11). Blockholders with high educational levels were earning higher fortnightly incomes than those with lower educational levels. Smallholders with tertiary education were more likely to be engaged in wage employment than those without tertiary qualifications, which is similar to findings

elsewhere that show more years of schooling and work experience are positively correlated with income level, mainly obtained through wage employment (e.g. Abdulai and CroleRees, 2001; Tschirley and Benfica, 2001; Ferreira and Lanjouw, 2001; Owusu, 2009). Ryan *et al*. (2013: 13) found that education levels of blockholders on the oil palm LSSs at Hoskins, Bialla and Popondetta was positively correlated with the education levels of their sons. Hence, it is likely that households with educated blockholders would have educated children who are employed off-block.

Moreover, there is a positive relationship between fortnightly income of blockholder households and block population. This suggests that primary households having medium to large family sizes, as indicated in Table 9.1, may have members engaging in various non-oil palm income-earning activities that contributed to household income.

Daily food expenditure

The average daily spending of the household on food was K16 (Table 9.1). As indicated by the large standard deviation, there is a wide variation in the amount of money spent daily on food. Based on the distribution of the daily food expenses and the approximate fitting of each case following the normal distribution pattern, four categories were created. These were 'K0', 'up to K13', 'K13.01 to K30' and 'more than K30'. One-third of households spent up to K13 on food daily, whether bought from the store or from local food markets. Importantly, around a quarter of households did not purchase any food on a daily basis. These households obtained their meal ingredients from their food gardens.

On the LSSs the level of spending on food depends mainly on factors such as income levels, pay or non-pay days (or week), garden food supply and family size. As would be expected, a positive relationship exists between daily food expenditure and fortnightly income (Appendix 7). However, most meal ingredients come from smallholders' own food gardens. As mentioned in Chapter 5, nearly all households have food gardens. Furthermore, it needs to be also mentioned that most households purchase store foods in bulk such as rice, flour, cooking oil, noodles and tinned fish and meat on paydays to sustain them through to the next fortnightly payday. Usually store foods are supplementary to the foods produced by smallholders themselves and

consist of garden foods not produced by the household or when their own garden supplies are low, and fresh chicken, meat or fish.

Garden size

Garden area data were from garden surveys of the 42 smallholder blocks surveyed as part of the in-depth household survey (see Chapter 4). The total area of food gardens per block includes gardens located on and off-block belonging to both blockholder households and all secondary families living on the same block (see Chapter 4 for further details). The average total garden area per block was 0.51 ha. Food gardens were categorised into three categories: 'up to 0.25 ha'; 0.26 to 0.6 ha'; and 'more than 0.6 ha'. The largest category of garden area was the 0.26 to 0.6 ha. One-third of blocks had less than or equal to 0.25 ha, while almost one-third of blocks had more than 0.6 ha (Table 9.1). The latter category was mostly those blocks that had access to replant sections and/or state land adjoining the LSSs. As mentioned in Chapter 7, though garden land was becoming scarce on the older LSSs, households were still cultivating small kitchen gardens around the homestead area and maintaining off-block gardens to meet their daily dietary needs.

Dependent Variables

Number of meals per day

The number of meals consumed daily by smallholder households ranged from 1 to 3 with a mean of 2.1. Smallholder households were categorised into three categories based on the number of meals they consumed per day (Table 9.1). The large majority of families consumed two meals per day. Typically, two main meals were consumed by all family members at breakfast and in the evening. During these times large meals were usually consumed. During the middle of the day family members often ate a light meal of purchased food or food prepared where they were working such as the food garden. Although the number of meals consumed daily did not always reflect the quality of food consumed, consumption of 2 to 3 meals consisting of mainly garden foods (94%) reveals the capacity of households to meet their food requirements from their own food gardens.

Within the context of the four main concepts by which food security is assessed (availability, accessibility, utilization and stability), it can be concluded that food

availability on the older LSS subdivisions is not a problem because households were able to produce enough food for their families (discussed later in the next section). This finding is similar to that from many other areas of PNG where the population is able to produce their own food despite rising population and land pressures. However, the problem lies in the ability of households to access quality store and local foods to supplement their high carbohydrate diets (Mueller *et al*. 2001; Hipsley and Clement, 1950 cited in Allen, 2009). The assessment of food quality on the LSSs is discussed later in this chapter.

Furthermore, a correlation analysis shows that there is a positive relationship between the number of meal ingredients obtained from gardens and the number of meals per day (Appendix 12). This implies that households were able to eat more meals per day because they were able to produce a wide selection of food crops which came from their own food gardens.

Meal source

Smallholder households were obtaining their meal ingredients[1] from four main sources (Table 9.4) with the bulk of meal ingredients coming from their own food gardens. Table 9.5 shows that the average of three and two meal ingredients that made up a meal in 2010 and 2013 respectively, came from smallholders' food gardens. Furthermore, a small proportion of fresh food was purchased at local food markets (Table 9.4). Purchased garden foods were mainly food crops not grown in smallholders' own food gardens and included mainly green leafy vegetables such as *aibika* (*Ablemoshus manihot*), pumpkin tips (*Cucurbita moschata*), *aupa* (*Amaranthus tricolor*) and other vegetables and root crops. Very few households obtained food from the sea and surrounding forests.

Table 9.4: Count of meal sources in daily household meals at Kapore, Sarakolok, Kavui, Tiauru and Kabaya subdivisions over 7 and 3-day periods in 2010 and 2013 respectively.

Meal source	2010 (%)	2013 (%)
Own garden	48	57
Store (processed food & fresh meat and chicken)	41	37
Local fresh food market	8	3
Other (bush, sea, relatives and friends)	3	3

2010 data (n=42 households). 2013 data (n=29 households).

Table 9.5: Average number of meal ingredients per meal from different sources at Kapore, Sarakolok, Kavui, Tiauru and Kabaya subdivisions.

Food source	2010	2013
Garden	3	2
Non-garden	3	1

2010 data (n=42 households). 2013 data (n=29 households).

Store meal ingredients were the next most important food source after garden food (Table 9.4). In 2010, for each meal, smallholder households supplemented garden food with an average of three store ingredients. More than half of the households at Kabaya (65%), Kapore (60%) and Tiauru (55%) consumed meals with at least one non-garden ingredient (mainly store food) throughout the seven day period of the dietary survey (Figure 9.2).

The main store ingredients were rice, tinned fish or meat and noodles. Households tended to purchase more store foods when prices of oil palm were high[2] and fall back on garden foods when oil palm prices dropped. A similar dietary recall survey conducted at Kavui subdivision at Hoskins LSS by Koczberski *et al*. (2001b) in 2000 when the price of oil palm was low at K50 per tonne (PGK1=AUD0.66) found that 80% of meals were made up entirely of garden foods. In January 2013, I conducted a similar dietary recall survey to explore the effect of oil palm prices on households' dietary patterns when the price of oil palm dropped from an average of K242.36 (PGK1=0.51) (average taken from price of oil palm from June to December, 2012) in 2012 to K133.37/tonne (PGK1=0.50) (Bank South Pacific). The average number of store ingredients per meal dropped to one in 2013 (Table 9.5). The reduced number of store food ingredients can be attributed to the drop in oil palm prices when people had less money to spend on store foods.

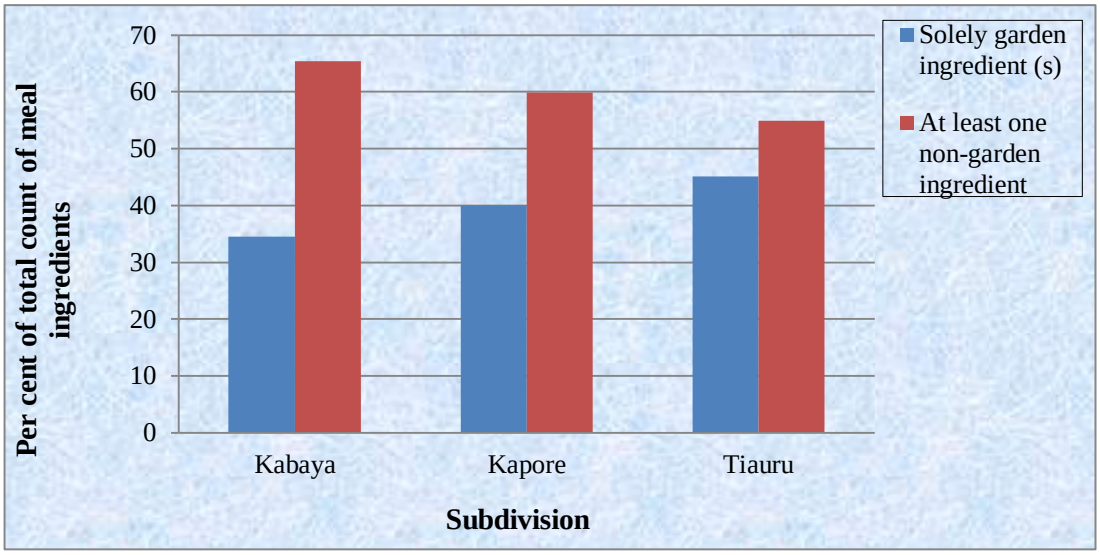


Figure 9.2: Proportion of meals consisting entirely of garden foods and at least one non-garden food consumed by 42 households over a 7-day period in 2010 (n=728 meals).

Households consumed more garden food and less store foods in 2013 compared with 2010 (Figure 9.2). But households' consumption of store food in 2013 was higher (Table 9.4) than in 2000 as expected because even though the price of oil palm in 2013 was less than in 2010, it was still higher in real terms than the price of oil palm in 2000. The evidence therefore suggests that households switch between store and garden foods depending on the price of oil palm. Some support for this argument is from the correlation analysis in Appendix 8 which reveals an inverse relationship between the number of store meal ingredients and garden food ingredients. Thus household food gardens provide a buffer against low oil palm prices.

Data were also collected in 2010 and 2013 to explore whether consumption of store foods was influenced by smallholder oil palm pay and non-pay weeks (Figure 9.3). Data show that in 2010 when oil palm prices were relatively high there was not much difference in the consumption of store food during pay (58%) and non-pay weeks (60%). Consumption of store food was spread throughout the non-pay week and was slightly higher during non-pay week. As discussed earlier, the explanation for this is that households had enough money to spend on store food during both pay and non-pay weeks. This was attributed to high oil palm prices that prevailed in 2010. It was normal practice for smallholders to make bulk purchases of store foods on pay days which would last through to the following pay day. Thus, consumption of store foods was more evenly spread across pay and non-pay weeks, though it was more

concentrated around pay days. Also, when smallholders' income or food stocks ran low in 2010, they could often get store foods or live chickens on credit from trade store owners or broiler farmers respectively, and pay off their credit on fortnight pay days, thus relieving temporary food shortages (see Chapter 5). There was more credit available in 2010 because of the high oil palm prices.

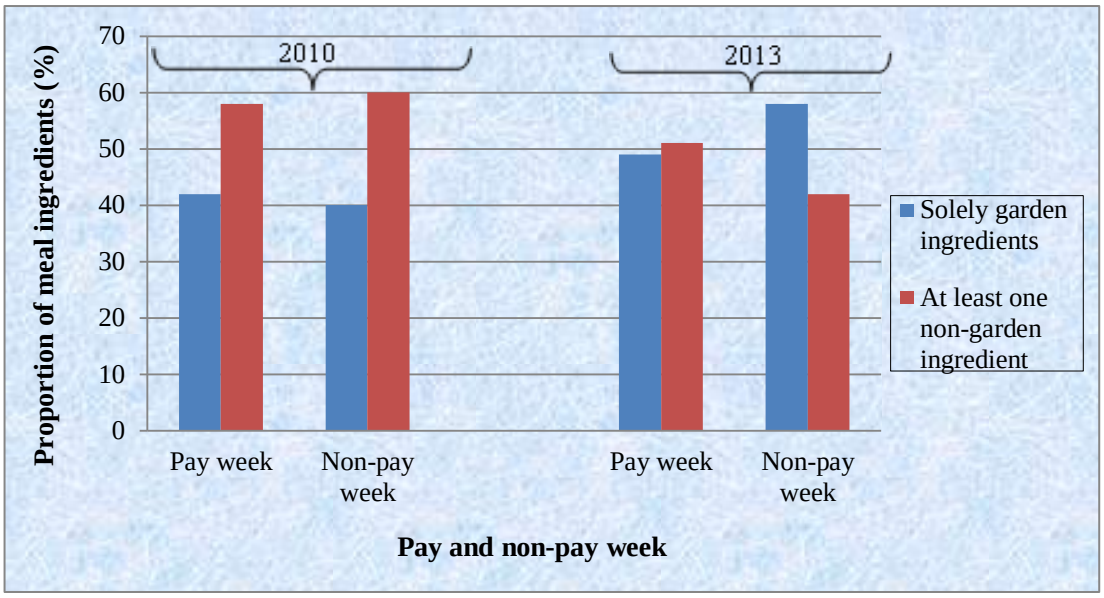


Figure 9.3: Proportion of meals consisting entirely of garden foods and meals that contain at least one non-garden ingredient consumed by 42 households during pay and non-pay week in 2010 and 2013. 2010 data: n=594 meals, 2013 data n=226 meals).

Although in January 2013, a similar dietary recall survey to the one in 2010 showed that consumption of at least one store meal ingredient was quite high during pay days (51%) and low during non-pay days (42%), the count of store food ingredients was lower than in 2010 (average of one compared with three meal ingredients in 2010, (Table 9.5). This was attributed to the lower oil palm prices during data collection in 2013 suggesting that oil palm income plays a significant role in household food security on the LSSs where it influences the type and frequency of food consumed.

Meal ingredients

Table 9.6 list the different meal ingredients consumed by smallholders at Kapore, Tiauru and Kabaya over a 7-day period between August and October in 2010 and Kapore, Kavui and Sarakolok in January 2013. Meal ingredients were grouped into 10 main categories frequently consumed on the LSSs. The top 5 meal ingredients in order of importance in 2010 were vegetables, rice, other store goods, root crops and

coconut products, mainly coconut milk. A similar dietary pattern was observed in the meal ingredients consumed in 2013 where the main ingredients were vegetables, coconut milk, rice, root crops and tinned fish/meat. The main vegetables included green leaves such as *aibika* (*Abelmoshus manihot*), *aupa* (*Amaranthus cvs*), pumpkin tips (*Cucurbita moschata*), *karakap* (*Solanum americanum*) and other vegetables such as snake bean (*Vigna unguiculata*) and tomato (*Lycopersicon esculentum*). Vegetables and rice or/and root crops were mostly supplemented by coconut milk and/or other store foods such as noodles and/or tinned fish or meat.

Table 9.6: Frequency of consumption of meal ingredients consumed over a seven-day period in 2010 and 2013.

Meal ingredients	2010		2013	
	Per cent	Rank	Per cent	Rank
Green leafy vegetables (indigenous & introduced)	22.9	1	21.6	1
Rice	14.2	2	14.5	3
Other store foods (e.g. noodles, oil, flour, bread)	13.5	3	8.9	7
Root crops	11.2	4	13.6	4
Coconut products	11	5	14.6	2
Tinned fish/meat	10.6	6	12.9	5
Banana	9.7	7	10.3	6
Fresh chicken/meat/fish	4.7	8	3.2	8
Sago/cassava sago	2.1	9	-	-
Fruits	0.2	10	0.3	9

Data for 2010 were collected at Kapore, Tiauru and Kabaya (n=42). The 2013 data were collected at Kapore, Kavui and Sarakolok (n=29).

In 2010 and 2013, tinned fish and meat were consumed more often (though, tinned fish was consumed more often than tinned meat) than fresh chicken, fish or meat and their consumption was concentrated on the days immediately following an oil palm payment. As mentioned earlier, the high consumption of rice as well as other store ingredients in 2010 was attributed to the high oil palm prices during the time of data collection (2010 data was collected from July to October). During high oil palm prices, households were able to purchase other store goods such as noodles, bread, buns, butter, peanut paste and other food items which supplemented the main staples. However, in 2013 (during lower oil palm prices) consumption of these types of store foods dropped slightly. It appears households cut down their spending on other store food and concentrated more on staples such as rice and tinned fish/meat instead.

Very little fruit was consumed in 2010 and 2013 (Table 9.6). As discussed in Chapter 6, fruits such as pineapple, pawpaw and ripe banana command high prices and were grown mostly for sale. This may be one reason for their low consumption. Also, because they are relatively expensive, growers may be reluctant to purchase them. It is also possible that households were not aware of the nutritional importance of fruit in their diets.

To obtain a greater understanding of diet quality, meal ingredients were placed into ten nutritional food groups (developed by the World Food Program-WFP, 2008) to assess the frequency of consumption of different quality foods consumed over seven and three-day periods in 2010 and 2013 respectively (see Chapter 3 and Appendix 4 for further details). As discussed later in this chapter, the FCS measures diet quality by assessing the different food groups that make up meal ingredients. Figure 9.4 shows similar results as Table 9.6 and Appendix 7 that vegetables, staples (root crops, banana and rice), tinned fish/meat and oil (coconut milk & cooking oil) were frequently consumed in both 2010 and 2013.

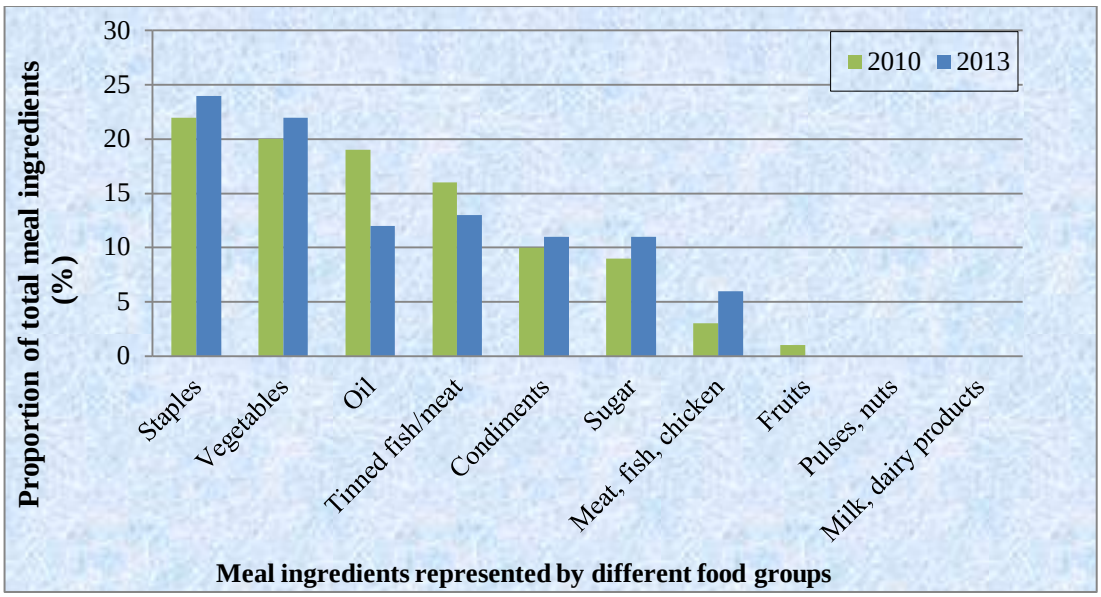


Figure 9.4: Consumption of different food groups consumed over a seven and three-day period in 2010 and 2013 respectively. The 2010 data were from Kapore, Tiauru and Kabaya (n=42 household). The 2013 data were from Kapore, Kavui and Sarakolok (n=29).
Note: Staples are root crops, banana and rice.

Some food groups were consumed daily whilst others were consumed less often, and in a few cases, not at all. In 2010 at least one or more than one staples (rice, banana,

root crops and sago) were part of every meal for every household over the seven days (Table 9.7). Rice is coming to be viewed as a staple item on the LSSs. In the past it was considered to be a prestigious food and consumed on special occasions.

Table 9.7: Consumption frequency of main meal ingredients for seven days in 2010 at Kapore, Tiauru and Kabaya LSS expressed as a percentage (n=42).

Meal ingredient	Households' consumption of meal ingredients over seven days (%)								Average days
	0* Day	1 Day	2 Days	3 Days	4 Days	5 Days	6 Days	7 Days	
Rice	-	0	5	12	19	17	33	14	5
Vegetables	-	0	0	2	2	14	29	52	6
Root crops and sago	-	0	2	7	5	17	33	36	6
Banana	20	27	32	12	5	2	0	2	2
Tinned fish/meat	-	5	14	19	26	26	5	5	4
Coconut and vegetable oil	-	14	19	17	24	14	5	7	3
Fresh meat/fish/ chicken/other	19	25	26	23	5	2	0	0	2

0* = did not consume meal ingredients on any of the seven days.

The frequency of consumption of rice by households in 2010 ranged from two to seven days with an average of five days over a seven day survey period. One-third of households ate rice supplemented with other meal ingredients for six days. Also, daily consumption of vegetables was high with just over half of households (52%) consuming staples supplemented with vegetables daily for seven days. Another 43% of households consumed vegetables for five to six days while 4% had vegetables as part of their meals for three to four days in a week (Table 9.7). In total, 95% of households consumed vegetables daily for five to seven days per week which is generally high. Vegetables are important in the daily servings as they provide vitamins and minerals necessary for good health.

Green leafy vegetables are high in phytochemicals and antioxidants that promote good health and prolong life (Patrick, 2008; Moyo *et al*. 2013). In addition, these chemicals (phytochemicals and anti-oxidants) protect against Non-Communicable Diseases (NCD) such as Type 2 diabetes and heart disease. Likewise, traditional staples such as taro, yam and sweet potato are high in nutrients. As reported by Dignan *et al*. (2004), a meal made up of root staples such as yam, taro and sweet

potato supplemented with green vegetables supplies nutrients such as amino acids[3] which provide building blocks for the body.

Most households (71%) consumed tinned fish for three to five days in a week which is a high level of consumption by rural PNG standards. Also, oil consumption from home-grown coconuts and purchased vegetable oils is high. Just over half of households (55%) use coconut milk for cooking three to five days per week. Fresh chicken, meat or fish was consumed between once and three times per week and mostly on pay days. In contrast, daily consumption of nuts, legumes and fruits (7%) was very low amongst households throughout all subdivisions, and dairy products were not consumed (Figure 9.4). Even in Kabaya, where there is less pressure on oil palm income and gardening land, similar findings were obtained. Low consumption of these food items may be attributed to factors such as lack of nutritional knowledge on the nutritional importance of these foods and their relatively high prices.

Consumption of condiments[4] such as tea was reasonably high. Although this ingredient is not used to assess meal quality, its consumption indicates the household's purchasing ability. If a household purchases such items after buying the main staples, then it may have more disposable income than another household not purchasing these items.

Household Dietary Diversity Score (HDDS)

The HDDS gives the count of the different food groups represented by the meal ingredients consumed in a meal (see, Chapter 4 for further details). It is an alternative measure of food quality and accessibility (Swindale and Bilinsky, 2006; FAO, 2007). Being able to consume more food groups whether purchased or produced by the household itself indicates that households are capable of ensuring a continuous supply of nutritious food for their daily dietary intakes. Thus, the higher the HDDS (or more number of different food groups), the higher the quality of household diets.

The HDDS of smallholders' daily meals ranged from two to six with a mean of 4.1 (Table 9.1). The largest food group category was 'more than 4 food groups', followed by 'up to 3', and then '4' food groups (Table 9.1). Banana, root crops and/or rice supplemented with green leafy vegetables and coconut milk were the daily staples. These staples were typically supplemented with tinned fish/meat and

occasionally with fresh meat, chicken or fish. Based on the dietary diversity tercile (Table 9.8), 42% of households fell in the category of 'high dietary diversity', consuming more than four food groups in a meal.

Correlation analysis (Appendix 7) shows a positive relationship between HDDS and daily food expenditure which implies that the purchase of more store foods such as tinned fish/meat, fresh meat, fish and chicken increases diet quality of diets. In total, 69% of households were labelled as having medium to high dietary diversity thus indicating that the diet quality on the LSS is good.

Table 9.8: Dietary pattern of households by dietary diversity tercile.

Low dietary diversity (31% of HHs)	Medium dietary diversity (27% of HHs)	High dietary diversity (42% of HHs)
Rice and root crops	Rice and root crops	Rice and root crops
Green leafy vegetables	Green leafy vegetables	Green leafy vegetables
Coconut milk (oil)	Coconut milk (oil)	Coconut milk (oil)
	Tinned fish/meat	Tinned fish/meat
		Fresh meat, chicken or fish

HHs=households

Food Consumption Score (FCS)

The FCS is also a measure of food quality and is used as a substitute measure of household food security. The HDDS gives insights into the status of household food security based on a 24-hour period while the FCS measures food quality over a seven-day period. Thus, this measure shows the dietary patterns of smallholder households. The FCS gives the weighted score for each type of ingredient based on the importance of those ingredients to human health. Thus, it is a relatively sensitive measure of diet quality because of the different weights assigned to different food groups (see Chapter 3 for measurement).

The FCSs of smallholder households ranged from 24.5 to 51.5 with a mean of 37.1 (n=42) (Table 9.1). Potential scores ranged from 0 to 66.5 where 0 indicates very low quality and 66.5 indicate a very high quality of food consumed. Based on the first and second cut-off scores of 21.5 and 37.5 respectively, three categories were made which were 'at risk' (up to 21.5), 'borderline' (22 to 37.5) and 'acceptable' (more than 37.5). The largest category was 'borderline' FCS, followed by 'acceptable', category accounting for one third of households (Table 9.1). No households were in

the ‘risk’ FCS category. This indicates that the status of household food security on the LSSs is generally good. However, households in the ‘borderline’ FCS category are potentially at risk of falling below the ‘borderline’ category. This could happen if households were not earning enough income to purchase high quality store and local food to supplement their high carbohydrate diets. Similarly, households could rise above the ‘borderline’ category when they increase their consumption of quality food. This could come about by maintaining a good source of income for purchases of quality store and locally produced food.

The highest score achieved of 51.5 falls one third below the maximum possible score of 66.5 (see Table 9.1) which confirms that smallholder households were maintaining a good level of diets, although households were missing out or not consuming enough of some important food groups such as dairy products, leguminous food crops and nuts. Milk and dairy products such as cheese are not part of the traditional diets of Papua New Guineans. Also, these foods are imported and are relatively expensive, which may be another reason why dairy foods were not purchased more often. For most households these foods were not consumed at all in 2010 and 2013. Also, nutritious local foods such as beans and nuts were not consumed regularly and for some households they were not consumed at all. A likely reason as mentioned earlier may be due to lack of knowledge on the importance of these foods for human nutrition. These findings follow wider trends in developing countries where country-level data from FAO (2008: 29) show that poor households in low-income countries consume staples such as cereals, root and tuber crops but do not balance their diets with high quality foods such as milk, nuts and animal proteins.

The main food ingredients that were weighted most and increased the weighted FCS were tinned fish/meat and fresh chicken and meat. Households with sufficient income were able to purchase these store foods frequently. This indicates that income is the main determinant of food quality. Thus increases in income raise the level of household food security on the LSSs. This study confirms findings from other studies done in PNG. For example, Shack (1988) who investigated the diets of settlers on the Gavien resettlement scheme in the East Sepik Province (ESP) found that as income rose the quality of settler’s diets improved as local staples were supplemented with store foods. Also, when resettling on the scheme, settlers from villages along the

Sepik River (who were hunters and gatherers) were able to cultivate food gardens that further improved their diets.

The National Nutrition Surveys (NNSs) conducted in 1982/83 and 1999 (Mueller and Smith, 1999) pointed out the importance of store foods such as tinned fish/meat and oil for child growth in PNG. Other studies have reported similar findings (Harvey and Heywood, 1983; Heywood, 1983; Zemel, 1989; Grossman, 1991). Mueller and Smith (1999) and Mueller *et al*. (2001) found that the socio-economic status of households was correlated positively with child growth, thus highlighting the importance of the financial status of the household and the significance of cash for purchasing quality foods. Most of these studies reported the impact of cash cropping on diets. Households who were involved in cash cropping had good diets as reflected in the anthropometric measures[5].

Relationships between the independent and dependent variables

Selected characteristics of smallholder households (independent variables) were statistically analysed to explore the status of household food security through the FCS. There were no relationships between the blockholder's age, educational level, family size, number of co-resident families on block, block population, household fortnightly net income, block garden size, and FCS (Table 9.9). However, there was a positive association at 95% level of probability between daily food expenditure and FCS. This means that diet quality increases, and thus the status of household food security, when store foods such as tinned fish/meat and fresh meat, chicken and fish are regularly purchased to supplement garden foods. Also, there is a positive relationship between fortnightly net income and store purchased meal ingredients (Table 9.9) which implies that high income households supplemented their garden staples with store goods more frequently than low income households. This is expected as households earning more income would be in a better position to diversify their diets as well as increase the number of daily meals and the frequency of consumption of quality ingredients.

Table 9. 9: Relationships between the independent and dependent variables (n=42).

Independent variables	Dependent variables					
Selected characteristics of smallholder households	No. of meals/day	Garden ingredients per meal	Store ingredients per meal	Other sources of meal ingredients	HDDS	FCS
Age	-0.134	0.025	-0.214	-0.066	-0.225	-0.084
Educational level	-0.064	-0.026	-0.042	0.185	-0.100	0.104
BH family size	0.082	0.145	-0.208	0.063	-0.019	0.086
Number of families on block	-0.243	**-0.340***	0.005	-0.154	-0.122	-0.088
Block population	-0.242	-0.265	-0.009	-0.088	-0.135	-0.089
Fortnightly net income	-0.159	-0.259	**0.345***	-0.177	0.128	-0.050
Daily food expenditure	**-0.324***	**-0.506****	**0.369***	-0.038	0.113	**0.387***
Block garden size	0.091	0.008	-0.018	0.219	0.114	0.140

**Correlation is significant at the 0.01 level
*Correlation is significant at the 0.05 level

The income-nutrition relationship discussed above, raises an important question: if income is the main determinant of diet quality and if smallholders were still maintaining food gardens (which supplies the bulk of their daily dietary intakes, despite all 6 ha being fully planted to oil palm), does the planting of all six hectares to oil palm add to food security? As noted above, rice could now be considered a staple rather than a prestige food as in earlier days. As discussed earlier, in 2010 when the price of oil palm was high, rice was an ingredient in almost every meal (Table 9.6). In January 2013, when oil palm prices were considerable lower, more than half of the households supplemented their meals with rice (Appendix 7). For an average family of seven, 1.5 kg of rice would be enough for one meal for the family (see Box 9.1). Households consumed two main meals per day, so 3 kg of rice would be required daily to feed an average family which equates to 2 tonnes of rice to feed two average families per year (for a family of five, 2 tonnes of rice would feed three 5-member families per year). The income from 2 ha of oil palm would provide enough income to purchase 2 tonnes of rice. Thus, when families have access to gardening land in the replant section on other blocks, the planting of all 6 ha to oil palm is a viable option that would add significantly to household food security (Box 9. 1).

Box 9.1: Hypothetical annual rice consumption from a 2 ha oil palm section.

FFB production (average): 20 tonnes per ha per year per block
40 tonnes in 2 ha per year
40 tonnes x K200 per tonne (average price in 2010)
= K8000

Bags of rice: K40 per bag of rice (10 kg)
K8000/40
= 200 bags of rice
= 200 bags x 10 kg per bag
= 2000 kg of rice per year

Rice consumption by an average family of 7 (findings from my study):
1.5 kg per meal x 2 main meals per day
= 3 kg per day x 365 days
= 1095 kg per family per year

Number of families to be fed per year:
2000 kg of rice per year/1095 kg per family
= 2 families consisting of 7 members in each family.

Conclusion

Smallholder households on the older LSSs have employed a range of livelihood coping strategies to address the problem of land shortages for food gardening in the older subdivisions. The findings show that the large majority of households consumed two meals per day and the bulk of their meal ingredients came from their own food gardens. Little difference was observed in the consumption of the main meal ingredients of root crops, rice, vegetables, coconut milk, tinned fish/meat and other store foods between households during pay and non-pay weeks. Consumption of green leafy and other vegetables was very high and these were part of almost every meal throughout the seven-day survey period in 2013 and three-day period in 2013. Consumption patterns changed between periods of high and low oil palm prices with households consuming more store foods, especially non-staples such as noodles, buns, bread and butter and condiments, during periods of high oil palm prices; they reduced their intake and range of store foods when oil palm prices fell. Household food gardens provide an important buffer against periods of low oil palm prices.

Most households scored medium to high on Household Dietary Diversity Score (HDDS) and Food Consumption Score (FCS). Thus diet quality on the older LSSs is generally good indicating that most smallholder households were maintaining household food security. Foods that increased the HDDS and FCS were store foods such as tinned fish/meat and fresh meat, fish and chicken. Hence, income is the main determinant of diet quality as it influences dietary patterns and the range of meal ingredients consumed by LSS households. This finding accords with other studies in PNG (e.g. Harvey and Heywood, 1983; Gibson *et al*. 1991; Grossman, 1991; Mueller and Smith, 1999; Mueller *et al*. 2001; Hipsley and Clements, 1950 cited in Allen, 2009) and in other developing countries (FAO, 2008)[6] that show that whilst people are able to produce most of their own foods, local foods usually lack sufficient protein and important vitamins and minerals. Therefore, having the income to purchase store foods of high nutritional value is important for maintaining both food and nutritional security.

Positive correlations were found between: (i) fortnightly income and blockholders' level of education; and (ii) fortnightly income and daily food expenditures further indicating the importance of income for obtaining quality foods and ensuring food security. Local foods which are of good nutritional value such as legumes and nuts are equally important, however, these foods were not consumed frequently by smallholders. Infrequent consumption of these foods in the diets was attributed to a lack of nutritional knowledge of their benefits. Most smallholders were educated up to Grade 6; and one-fifth were illiterate. Therefore, the majority of the households may have lacked knowledge of this issue.

On the whole, the findings show that the three strategies employed by smallholder households, on the older oil palm LSS subdivisions, were effective in maintaining good dietary intake levels and their diets generally met the four concepts of food security: availability, accessibility, utilisation and stability. Importantly, the planting of all 6 ha to oil palm appears to be a viable and significant strategy for enhancing food security given the importance of cash for diet quality. The fact that land is taken out of food production for oil palm to increase food security might seem counter-intuitive. However, the increased cash revenue generated from an additional 2 ha of oil palm more than compensates for lost garden food production. Very importantly,

this strategy enables smallholders to purchase foods from high quality food groups that are largely absent from diets based on garden production.

In the next chapter, I will draw on arguments from each of the chapters to show how smallholder households were maintaining household food security on the older LSSs amidst pressures on block resources such as gardening land and oil palm income.

Notes

1. A variety of meal ingredients from the store and food gardens were consumed on the LSSs. These meal ingredients can be grouped as follows.

(i) *Root crops*	(ii) *Vegetables*		
Sweet potato	*Aibika*	Watercress	Chinese cabbage
Chinese taro	*Aupa*	*Tulip*	Tomato
Taro	Pumpkin tips	Ferns	Capsicum
Cassava	*Karakap*	*Kumu mosong*	Spring onion
Yam	Choko	Bean	

(iii) *Other store food*		(iv) *Fresh Food*	(v) *Sago*
Noodles	Doughnut	Chicken	Sago
Flour	Soft drinks	Meat	Cassava sago
Cooking oil	Butter	Fish	
Bread	Buns	Seafood	
Biscuit	Sugar		
Peanut butter	Tea/coffee		

(vi) Fruits	(viii) *Rice*	(viii) *Banana*	(vii) *Tinned fish/meat*
Pawpaw	Rice	Banana	Tinned fish/meat
Pineapple			

2. During data collection between July and November 2010, the price of oil palm was relatively high and ranged from K250 to K350/tonne with an average price of K300 (PGK1=AUD0.44).

3. Amino acids are organic compounds that act as building blocks for the body, as they make up proteins. All the cells of our body are comprised of proteins, which are essential for the repair, growth and maintenance of the cells. Proteins are chains of amino acids linked together which regulate all body functions (Exceptional Health, 2012).

4. Condiments refer to substances that add flavour to food such as spices and sauces. Condiments and beverages such as tea, coffee, milo, milk and sugar (used in tea) were not taken into consideration when assessing the quality of meals (FAO, 2007).

5. Three anthropometric surveys of women and children on the Hoskins scheme were conducted during the 1970s and 1980, but due to differences in sample size and selection no firm conclusions were able to be made on the nutritional status of the LSS population (Heywood and Hide, 1994).

6. Country level data from food balance sheets show that income is the main determinant of obtaining high quality foods such as milk, fruits, nuts and animal protein.

CHAPTER 10

CONCLUSIONS, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Introduction

PNG is considered to be among the most food secure nations in the Pacific. However, there are increasing pockets of food insecure households such as migrant households residing in urban centres and in rural areas where they have limited or insecure access to land, for example, on the oil palm LSSs and in mining towns. Thus, it is not guaranteed that a country labelled food-secure at a national level has a population that is food secure at the household level.

Over recent years concerns have arisen about the status of household food security on the older LSSs as a result of pressures on block resources such as gardening land and oil palm income as a result of population increase. In the 1960s, when smallholders settled on the LSS to cultivate oil palm, 2 ha of garden reserves were more than enough to meet the gardening needs of these smallholders. However, over the years garden reserves were planted to oil palm and so by 2010, when fieldwork was conducted, all blocks in the older subdivisions of Kapore, Tiauru and Sarakolok had their 2 ha reserves planted to oil palm. Since the area of land available for gardening has contracted, households have shifted to more permanent cultivation by gardening portions of land on or off their blocks not planted to oil palm. By shifting to permanent cultivation, thereby eliminating fallows, households have intensified food crop production.

This thesis has shown how smallholder households have maintained household food security on the older LSS subdivisions amidst pressures on block resources such as gardening land and oil palm income by pursuing various livelihood strategies. The

findings revealed that smallholder households have maintained relatively healthy diets and, overall, the status of household food and nutritional security is generally good. The thesis argues that smallholder households have achieved food and nutritional security through three main livelihood strategies apart from oil palm cultivation to generate cash income: (i) intensification of food production (ii) accessing gardening land in new locations, and (iii) diversifying income to access store foods.

Intensification of food production

The study reported three main strategies smallholders used to intensify garden production. These were: (i) improved soil and crop management practices; (ii) intercropping of immature oil palm with food crops; and, (iii) changes in the types of crops and varieties planted to increase crop production. Another innovative strategy smallholders have adopted was by accessing gardening land in new locations not which was not observed in the past.

The first strategy smallholder households have adopted to intensify food crop production was by integrating three new soil and crop management practices into their farming systems to maintain soil fertility and crop growth. These were mixed or poly-cropping of food crops, crop rotation and use of pesticides. Mixed cropping of food crops was common in almost all food gardens with some exceptions for peanut and cabbage varieties which were monocropped for sale. The study showed that cropping patterns were influenced by ethnic preferences. People from Chimbu intercropped sweet potato with corn and peanut with corn or bean whilst people from Sepik and Morobe cultivated a diversity of crops on the same piece of land. These practices were also observed by Benjamin (1977a). Mixed cropping of different crop species on the same piece of land helps to maintain soil fertility (Eden, 1988; Sillitoe, 1995). This is because different crops tap the soil at different levels for their soil and moisture requirements, often without depleting soil nutrients, and leguminous crops such as peanuts and beans put nitrogen back into the soil.

Crop rotation with a legume was another practice that helped to maintain soil fertility. Sweet potato and peanut were widely grown in all subdivisions and these two crops were mostly rotated. Peanut was intensively cultivated on replant sections

for up to three cropping cycles because of the benefits of peanut to fix nitrogen. Whether or not smallholders knew about the benefits of mixed cropping and crop rotation, by cultivating different species of crops on the same piece of land and/or by rotating crops with legumes, households were able to maintain soil fertility that sustained crop yields.

Intensification of gardening practices was also achieved through the use of pesticides. This was a relatively new practice not observed in the past. Pest infestation on food crops has become a problem and it was attributed to short or absent fallows. To address this problem, smallholders were using pesticides on food crops. Over one quarter of smallholders had used pesticides in their gardens and its use was high in gardens cultivated with monocrops of vegetables for sale such as cabbage varieties, *aibika* and other vegetables. However, pesticide use was not limited to green leafy vegetables only, but was also applied to crops such as taro, banana and Chinese taro indicating the desperate need of smallholders to save their crops from pest attacks to maintain crop yields.

Intercropping immature palms with food crops was another strategy smallholders have adopted to intensify food crop production. This was a relatively new strategy and has been adopted since smallholders started gaining access to oil palm replants in the 1990s. Of the 6 ha smallholder block, oil palm is planted on 2 ha sections of the block on a rotational basis. Once the oil palm reaches its productive life span of 22 years, the 2 ha section of oil palm is poisoned and the oil palm stands are left to decompose. During this time immature palms are planted and intercropped with food crops either on smallholders' own replant sections or on the replant sections on other block through reciprocal gardening arrangements. Replant sections are fertile because of traces of fertilizer in the soil and from fertilizer continuously being applied to oil palm seedlings which were also taken up by food crops. The high organic matter from decomposed palms also provides a conducive environment for plant growth.

By intercropping immature palms with food crops on replant sections, smallholders cultivated food crops for up to four cropping cycles (approximately two to three years) before the oil palm canopy closes and gardens were abandoned and left to oil palm. Gardens cultivated on State or customary land had shorter cropping periods.

Also, cultivating food gardens on oil palm replant sections for two to three years was relatively longer than the 12 to 18 months on land converted from fallow during Benjamin's study (1977a). My findings show that although fallows were short or absent on smallholder blocks because of reduced gardening land, by intercropping immature palms with food crops intensively on the oil palm replant sections, smallholders were maintaining crop yields.

Smallholders have also intensified food crop production by cultivating food crops that can withstand unfavourable soil conditions and pest attacks or which mature quickly. By tracking changes in the gardening systems practiced in 1975, it was noted that a variety of new food crops were cultivated by smallholders. At that time ethnic preferences of staple crops was distinct with people from Chimbu planting more sweet potato, people from the Sepik dominated the cultivation of yams, people from Morobe planting more taro, and bananas being planted by people from East New Britain Province. Cassava was an insignificant crop. During that time gardening land was adequate which allowed effective fallows that sustained traditional staples such as yam and taro which required highly fertile soils.

My findings revealed that by 2010, ethnic preferences of staple food crops were not as marked as in the past. However, there was a trend towards the adoption of crop varieties that were hardy and could withstand less fertile soils and pest attacks. These were crops such as Chinese taro and new varieties of sweet potato, banana and cassava. My findings revealed that the three staple crops including Chinese taro and new varieties of sweet potato and banana were being widely cultivated by all ethnic groups because of their agronomic advantages. For example, sweet potato, Chinese taro, cassava and some varieties of banana such as *kalapua* and *tukuru* are resistant to pests and can cope with poor soils. Also, banana varieties such as *kiaukiau* and *5-minute* are short maturing. Sweet potato was the most important crop cultivated by all ethnic groups and preferred varieties were being cultivated such as *one mun* and *three mun kaukau* which mature in less than four months. Bourke (2001b) reported that throughout PNG new varieties of crops with good agronomic features were replacing old crop varieties and this trend was observed on the LSS. The rising importance of sweet potato as a staple crop throughout the LSSs follows wider trends

in PNG where the crop has become a staple cultivated in almost all farming systems throughout the country (Bourke, 2001b)

The trend towards adopting crops with favourable agronomic features confirmed Benjamin's (1977a) predictions that such crops would become important because of reduced fallow periods. Also, Benjamin suggested that taro and yam would become insignificant because of low soil fertility as a result of reduced fallow periods. However, the study has shown that although taro and yams were not being cultivated as extensively as in the past because of their requirements for high fertile soils, households were still cultivating them as first crops or one of the first crops in oil palm replant sections which are fertile. Although, traditional fallows were absent, oil palm replant sections had some similarities to land converted from secondary forest fallow during which time oil palm was under production for 22 years. Also, during the long fallow seed bank of weeds were eliminated so there were less problem of weeds.

Accessing gardening land in new locations

Besides intensification of food crop production, accessing gardening land in new locations was another innovative strategy pursued by smallholder households to address the problem of garden land shortages, mainly on the older subdivisions. Households were accessing gardening land in various locations on and off the LSS blocks which was not observed in the past. Most of the gardening was done on smallholders' blocks. Although, the 2 ha garden reserves on the older subdivisions were fully planted to oil palm, most households were still gardening on their blocks, but in new locations. These new locations were *wasblock*, 'converted land' (land not available for oil palm) and oil palm replant sections. Some blocks had small portions of land (*wasblock*) that remained at the rear of the block after smallholders fully planted their 6 ha block to oil palm. Blocks located on the edge of the LSS were fortunate to have larger *wasblocks* than those blocks located in the middle of subdivisions. A lot of gardening was done on *wasblocks* followed by replant sections and 'converted land'.

Also, households were converting land not suitable for oil palm such as hilly land into food gardens. This was land which was not previously used for food gardening. An interesting practice noticed was that a few blocks reserved a portion of their oil

palm land for food gardening. Instead of fully planting the replant sections of their oil palm block, a small portion was reserved for food gardening. This strategy was common amongst blocks located away from the edge of a subdivision and did not have easy access to State land adjoining the LSS. Households have sought various ways to access gardening land realising the importance of food gardening for households' daily dietary needs. Kitchen gardens were common and were located around the homestead area.

When gardening land on-block was constrained, households sought land off-block on other replant sections, buffer zones, State land and customary land by drawing on their social and kinship networks. Gaining access to replant sections located on another block was the most common way of accessing gardening land off-block. The LSSs have become more like urban villages where children of blockholders marry into other ethnic groups extending kinship and family ties. Also, members within various social networks supported each other with gifts of food or cash in times of need thus contributing to household food security. Importantly, by drawing on these various social networks households have expanded the available gardening land by accessing land on other replant sections through reciprocal gardening arrangements. Allocation of plots of land by blockholders to *wantoks*, neighbours and friends living on other blocks created mutual obligations that ensured future access rights to the replant sections on the blocks of others. Another reason for allocating plots of land on replant sections to others was to keep the replant section clear of weeds until seedlings were replanted. This practice was more common on blocks with relatively small populations, as blocks with multiple co-resident families often made use of all their available land.

Blocks located on the edge of the LSS and bordering State land and buffer zones were able to access additional land on buffer zones (State land) or other State land although it was illegal to cultivate food gardens. Blockholders gaining illegal access rights to State land often became 'Gatekeepers', monitoring gardening activities and allocating access rights to other smallholders.

Involvement in non-oil palm income-earning activities

Another important strategy households pursued to address the problem of garden land shortages and pressures in oil palm income was by taking up non-oil palm income earning activities. The marketing of food crops and other items, wage employment off-block and broiler production were the three main activities in which households were involved. Women were highly involved in marketing of food crops and other items and much more so than men. By pursuing different sources of income, household were able to increase their purchasing power to buy store foods.

Marketing of processed food and manufactured items and betelnut with betel pepper was common at roadside markets. Selling of betelnut and betel pepper was an important income-earning activity that generated good returns. Both primary and secondary households were involved in this activity and women dominated its sales. The betelnut business on the LSSs follows wider trends in PNG (see, Allen *et al*. 2009 and Sharp, 2012) with betelnut becoming a very profitable business. Because of garden land shortages, households were engaging more in income-earning activities that do not require much land to initiate such as growing betelnut.

Secondary households were involved more in non-oil palm income-earning activities than primary households. Also, more members of secondary households were involved in wage employment than primary households. For most secondary households, income earned from other income sources was very important, especially those households which did not receive a share of the oil palm income. For primary households, involvement in other non-oil palm income-earning activities helped spread the risk from fluctuating oil palm prices.

Status of household food security on the LSS

To determine if the above four strategies adopted by smallholder households were successful in maintaining household food security and nutritionally adequate diets, daily diets were assessed. This study showed that a high proportion of households consumed two main meals per day which were consumed at breakfast and at evening when all family members met together. The bulk of the households' meal ingredients came from their own food gardens followed by store and other sources. In 2010, when oil palm prices were relatively high, households consumed an average of three

store foods and three garden foods in a meal. However, in 2013 when oil palm prices fell, store and garden ingredients decreased to an average of one and two respectively.

The main store food ingredients included rice, tinned fish/meat and noodles and the main garden foods were banana, root crops and green leafy vegetables mostly supplemented with coconut milk. The top five meal ingredients that were consumed over a 7-day period based on their frequency of consumption were vegetables, rice, other store food such as noodles and flour, root crops and coconut milk. However, the consumption of tinned fish/meat and fresh meat, fish and chicken was concentrated around paydays. Also, during the high oil palm prices prevailing in 2010, store foods considered as luxury foods such as noodles, flour, bread and butter were consumed more frequently than in 2013. The findings revealed that the number of meals, type of meal ingredients and frequency of consumption of store and garden foods were largely influenced by income. Thus access to a reasonable income is critical for maintaining food security in the land short LSS subdivisions.

The Household Dietary Diversity Score (HDDS) and Food Consumption Score (FCS) were the two instruments used to measure the status of household food security. These two instruments have been validated as proxies for household food security and have been used widely in other countries. Both of these instruments measured the number of different food groups consumed as represented in different meal ingredients. Therefore, consumption of more food groups meant that more nutritious food was consumed, thus raising the quality of household diets. My findings revealed that most households scored medium to high on HDDS and FCS indicating that the status of household food security on the LSS was good. Foods that increased the HDDS and FCS were store foods such as tinned fish/meat and fresh meat, fish and chicken. The study revealed that income was the main determinant of diet quality as it influenced dietary patterns and the range of meal ingredients consumed by LSS households.

Positive statistical relationships existed between (i) HDDS and daily food expenditures; and (ii) fortnightly income and daily food expenditures further indicating the importance of income for obtaining quality foods and ensuring food security. This finding confirmed other studies done in PNG (e.g. Harvey and

Heywood, 1983; Gibson *et al*. 1991; Grossman, 1991; Mueller and Smith, 1999; Mueller *et al*. 2001; Hipsley and Clements, 1950 cited in Allen, 2009) and in other developing countries (FAO, 2008) that showed that whilst people were able to produce most of their own foods, local foods usually lacked sufficient protein and important vitamins and minerals. Therefore, having the income to purchase store foods of high nutritional value is important for maintaining both food and nutritional security.

In conclusion, the thesis answered the key research question (Chapter 1) by revealing that the three strategies employed by smallholder households, mainly on the older oil palm LSSs, were effective for maintaining good dietary intake levels, and their diets generally met the four pillars of food security: availability, accessibility, utilisation and stability. Importantly, the planting of all 6 ha to oil palm appears to be a viable and significant strategy for enhancing food security given the importance of cash for diet quality. Also, despite all 6 ha have been fully planted to oil palm smallholders households were not missing out on food gardening because they were able to develop new strategies to secure access to land. The use of oil palm replant sections for food gardening is, perhaps, the most significant of these strategies.

Contribution to existing knowledge base

Results from this research confirmed findings from past studies conducted on the oil palm LSSs, other locations in PNG and in other developing countries within the broader context of smallholder livelihoods, land shortages and household food security and contributed to addressing knowledge gaps within these areas. Findings from this study specifically filled in knowledge gap within the context of the oil palm smallholder livelihoods and household food security where changes in smallholders' gardening practices were tracked over time and documented since Benjamin's studies in 1975. Also, this research has provided baseline information for similar studies to be conducted on other LSSs and VOPs. Results from this research have provided benchmark information on food security issues for other parts of PNG where people have limited access to land such as the urban centres, plantation sites, mining locations and other Pacific Island (PI) and developing countries experiencing urbanisation.

Recommendations

From the outcome of this study, three recommendations are made to OPIC to formulate appropriate policies for the industry to support smallholders. These policies are outlined below:

1. Pressures on block resources such as gardening land and oil palm income will continue to rise as block populations continue to grow. Findings from this study revealed that block residents were actively involved in various non-oil palm income-earning activities. Residents are looking for ways to generate income. Therefore, it is important that OPIC supports them by: providing training in small-scale industries where men and women can generate income from such activities as sewing, cooking, broiler production, fixing small engines (such as lawnmower) and, carpentry skills in making small household furniture.

2. Smallholders will continue to depend on food gardens for the bulk of their daily dietary needs despite being involved in the cash economy. As this study has pointed out, despite garden land shortages, households were able to access garden land in new locations. However, without improved farming practices, gardens may not be able to maintain crop yields for long cropping periods. Therefore, extension delivery by OPIC should be widened beyond oil palm to include food crop production. Smallholders should be trained on using improved and sustainable ways of farming to increase productivity over their land.

3. As mentioned in Chapter 9, local foods of high nutritional value were lacking in the diets and it was attributed to lack of knowledge on food nutrition. Therefore, it is recommended that OPIC should arrange for trainings to be conducted on food nutrition and the importance of these foods to different age groups and human health. On the same note, training should be given to women in homestead vegetable farming so that they can expand production of vegetables for home consumption.

Suggestions for future research

1. Due to time constraints, this study focused largely on primary households. The study concluded that primary households were maintaining household food security on the LSS. It may not be the case with secondary households as they do not have the same privileges as the primary households in terms of access to oil palm income and other economic opportunities.

2. It is also suggested that similar studies be conducted in other older LSS such as Popondetta to ascertain if the situation is similar to Hoskins and Bialla. Similar studies should also be conducted on VOP where there are less pressures on gardening land.

3. This study uses the HDDS and FCS as proxies to measure the status of household food security. Although these instruments have been validated in many developing countries as alternative measures to household food security, nutritional studies that use anthropometric measurements and proper measurements of caloric intake to assess the status of household food security should be conducted to confirm the findings of this thesis.

REFERENCES

Abdulai, A. and CroleRees, A. (2001). Determinants of income diversification amongst rural households in Southern Mali. *Food Policy*, **26**(4): 437-452.

Agenor, P. (2010) A theory of infrastructure-led development. *Journal of Economic Dynamics and Control*, **34**(5): 932-950.

Ali, K., Chowdhury, S. A., Kader, M. A. A. and Gani, M. O. (1986). Factors influencing adoption of improved sugarcane production technology among the growers of a sugarcane Mill Zone. *Bangladesh Journal of Extension Education*, **1**(2): 25-31.

Allen, B. (1983). Human geography of Papua New Guinea. *Journal of Human Evolution*, **12**: 3-23.

Allen, B. (2001). Boserup and Brookfield and the association between population density and agricultural intensity in Papua New Guinea. *Asia Pacific Viewpoint*, **42**(2/3): 237-254.

Allen, B. (2009). Agricultural development, policies and governance. In: R. M. Bourke and T. Harwood. (eds). *Food and Agriculture in Papua New Guinea*, pp. 425-488. ANU Press, Canberra.

Allen, B. and Ballard, C. (2001). Beyond intensification? Reconsidering agricultural transformations. *Asia Pacific Viewpoint*, **42***(*2/3): 157-162.

Allen, B. and Bourke, R. M. (2009). People, land and environment. In: R. M. Bourke and T. Harwood (eds). *Food and Agriculture in Papua New Guinea*, pp. 129-192. ANU Press, Canberra.

Allen, B., Bourke, R. M. and Gibson, J. (2005). Poor rural places in Papua New Guinea. *Asia Pacific Viewpoint*, **46**(2): 201-217.

Allen, B. J., Bourke, R. M. and Hide, R. L. (1995). The sustainability of Papua New Guinea agricultural systems: the conceptual background. *Global Environmental Change*, **5**(4): 297-312.

Allen, M., Bourke, R. M. and McGregor, A. (2009). Cash income from agriculture. In: R. M. Bourke and T. Harwood (eds). *Food and Agriculture in Papua New Guinea*, pp. 283-420. ANU Press, Canberra.

Aliaga, C. (2006). How is the time of women and men distributed in Europe? Statistics in Focus. Population and social conditions. *Eurostat*, 4/2006.

Aliaga, C. and Winqvist, K. (2003). How women and men spend their time. Results from 13 European countries. Statistics in Focus. *Eurostat*, Theme 3-12/2003.

Amaza, P. S., Adejobi, A. O. and Fregene, T. (2008). Measurement and determinants of food insecurity in northeast Nigeria: Some empirical policy guidelines. *Journal of Food Agriculture & Environment*, **6**(2): 92-96.

Asian Development Bank (1999) Project Performance Audit Report on the West New Britain Smallholder Development Project (Loan Nos. 874(SF)/785-PNG) in Papua New Guinea.

Asian Development Bank (2011) Food Security and Climate Change in the Pacific. Rethinking the Options. Manila, Philippines.

AusAID. (2004). Food Security Strategy. AusAID Public Affairs Group. Canberra.

Ayinde, A. A., Akerele, D. and Dipeolu, A. O. (2010). Socio-economic determinants of calorie intake among members of farm households in Ogun State, Nigeria. *Journal of Food Agriculture & Environment*, **8**(2): 209-212.

Bank South Pacific. Website: http://www.bsp.com.pg/International/Exchange-Rates/Exchange-Rates.aspx>. Accessed: January, 2013.

Barrett, C. B., Reardon, T. and Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. *Food Policy*, **26**: 315-331.

Beaumier, M. C. and Ford, J. D. (2010). Food insecurity among Inuit women exacerbated by socio-economic stress and climate change. *Canadian Journal of Public Health*, **101**(3): 196-201.

Bebbington, A. (1999) Capitals and capabilities: A framework for analysing peasant viability, rural livelihoods and poverty. *World Development*, **27**(12): 2021-2044.

Benjamin, C. (1977a). A survey of food gardens in the Hoskins oil palm scheme. *Papua New Guinea Agricultural Journal*, **28**(2, 3 & 4): 57-70.

Benjamin, C. (1977b). Implications of further cash cropping on the settlement blocks of the Hoskins Oil Palm Scheme. In: B.A.C. Enyi and T. Vargese (eds). *Agriculture in the Tropics*, pp. 46-53. UPNG, PNG.

Benjamin, C. (1985). Some food market influences of a large-scale small-holder development in the West New Britain area of Papua New Guinea. *Papua New Guinea Journal of Agriculture, Forestry and Fisheries*, **33**(3-4): 133-141.

Berg, L. B. (2004). Qualitative Research Methods for the Social Sciences. 5th Edition. Pearson Education Inc, USA.

Bickel, G., Nord, M., Price, C., Hamilton, W. and Cook, J. (2000). *Guide to Measuring Household Food Security, Revised 2000*. U.S. Department of Agriculture, Food and Nutrition Service, Alexandria. US.

Boakye-Achampong, S., Mensah, J. O., Aidoo, R., and Osei-Agyemang, K. (2012). The role of rural women in the attainment of household food security in Ghana: A case study of women-farmers in Ejura-Sekyeredumasi district. *International Journal of Pure and Applied Sciences and Technology*, **12**(1): 29-38.

Bouma, G., and Ling, R. (2004). *The Research Process*. Fifth edition. Oxford University Press, Victoria. Australia.

Bourke, R. M. (2001a). An Overview of Food Security in PNG. In R.M. Bourke, M.G. Allen and J.G. Salisbury (eds). *Food Security for Papua New Guinea. Proceedings of the Papua New Guinea Food and Nutrition 2000 Conference*. ACIAR Proceedings No. 99, pp. 9-14. Australian Centre for International Agricultural Research, Canberra.

Bourke, R. M. (2001b). Intensification of agricultural systems in Papua New Guinea. *Asia Pacific Viewpoint*, **42**(2-3): 219-235.

Bourke, R. M. and Harwood, T, Eds. (2009). *Food and Agriculture in Papua New Guinea*. ANU Press, Canberra.

Bourke, R. M. and Allen, B. (2009). Village food production systems In: R. M. Bourke and T. Harwood (eds). *Food and Agriculture in Papua New Guinea*, pp. 129-192. ANU Press, Canberra.

Bourke, R. M., Gibson, J., Quartermain, A., Barclay, K., Allen, B. and Kennedy J. (2009). Food production, consumption and imports. In: R. M. Bourke and T. Harwood (eds). *Food and Agriculture in Papua New Guinea*, pp. 129-192. ANU Press, Canberra.

Bourke, R. M. (2012). The role of agriculture in a national economy dominated by gas, petroleum and mineral exports. Paper presented at: PNG Securing a Prosperous Future. Conference 12-13 April, 2012. Geelong Waterfront Campus, Deakin University. Geelong.

Brookfield, H. (2001). Intensification, and alternative approaches to agricultural change. *Asia Pacific Viewpoint*, special issue on Agricultural Transformation and Intensification, **42**(2-3): 181-192.

Bryant-Tokalau, M. (1995). The myth exploded: urban poverty in the Pacific *Environment and Urbanization*, **7**(2): 109-129.

Bryman, A. (2004). *Social Research Methods*. Second edition. Oxford, New York, Oxford University Press.

Bue, V. and Halim, A. (2005). Household time allocation of men and women in a selected village of Papua New Guinea. *Bangladesh Journal of Extension Education*, **17**(1 & 2): 61-67.

Chadwick, B. A., Bahr, H. M. and Albrecht, S. L. (1984). *Social Science Research Methods*, Prentice Hall INC. Eagle Woods Cliffs, New Jersey.

Chambers, R. (1983). *Rural Development. Putting the Last First*. Pearson, Harlow. Essex, England.

Chand, S. and Yala, C. (2012). Institutions for improving access to land for settler-housing: Evidence from Papua New Guinea. *Land Use Policy*, **29**(1): 143-153.

Charlton, C. A. (1987). Problems and prospects for sustainable agricultural systems in the humid tropics. *Applied Geography*, **7**: 153-174.

Chimhowu, A. O. (2002). Extending the grain basket to the margins: spontaneous land resettlement and changing livelihoods in the Hurunggwe District, Zimbabwe. *Journal of Southern African Studies,* **28**(3): 551-573.

Chimhowu, A. and Hulme, D. (2006). Livelihood Dynamics in Planned and Spontaneous Resettlement in Zimbabwe: Converging and Vulnerable. *World Development*, **34**(4): 728-750.

Cloke, P., Cook, I., Crang, P., Goodwin, M., Painter, J. and Philo, C. (2004). *Practicing Human Geography*. Talking to People, Sage Publication Ltd, London.

Connell, J. (1987). Migration, rural development and policy formation in the South Pacific. *Journal of Rural Studies*, **3**(2): 105-121.

Conway, G. (1999). Food for all in the 21st Century. *Social Research*, **66**(1): 8-18.

Coupaye, L. (2009). What's the matter with technology? Long (and short) yams, materialisation and technology in Niyamikum village, Maprick district, Papua New Guinea. *The Australian Journal of Anthropology*, **20**: 93-111.

Curry, G. (1999). Markets, social embeddedness and precapitalist societies: the case of village tradestores in Papua New Guinea. *Geoforum*, **30**: 285-298.

Curry, G., and Koczberski, G. (1999). The risks and uncertainties of migration: an exploration of recent trends amongst Wosera Abelam of Papua New Guinea. *Oceania*, **70**: 130-144.

Curry, G. and Koczberski, G. (2005). Making a living: Land pressures and changing livelihood strategies among oil palm settlers in Papua New Guinea. *Agricultural Systems,* **85**(3): 324-339.

Curry, G. N., Koczberski, G., Omuru, E., Duigu, J., Yala, C. and Imbun, B. (2007). Social Assessment Report for the Smallholder Agriculture Development Project (SADP). Papua New Guinea.

Curry, G. N., Koczberski, G., Lummani, J., Ryan, S. and Bue, V. (2012). Earning a living in PNG: from subsistence to a cash economy. In: M. Robertson (ed). *Schooling for sustainable development. A focus on Australia, New Zealand, and the Oceanic Region*, pp. 159-184. Springer Dordrecht Heidelberg, New York, London.

Denzin, N. K., and Lincoln, Y. S. (1998). *Strategies of Qualitative Inquiry*. California, USA, Sage Publications.

DFID, (1999). *Sustainable Livelihoods Guidance Sheets*. Department for International Development, London.

Devereux, S. (2006). Social protection for enhanced food security in Sub-Saharan Africa. *Working Paper 2006-010 February 2006,* United Nations Development Program (UNDP).

Devereux, S. and Maxwell, S. (eds). (2001). *Food security in Sub-Saharan Africa* University of Sussex. Institute of Development Studies. London : ITDG.

Dewhurst, R. (2007). *Where's the Balance? Oil Palm, Subsistence Production and Gender Relations in Smallholder Households of Papua New Guinea*. Honours Dissertation, University of Nottingham, Nottingham.

Dignan, C., Burlingame, B., Kumar, S. and Aalbersberg, W. (2004). The Pacific Islands Food Composition Tables. 2nd edition. FAO, Rome.

Eden, M. J. (1988). Crop diversity in tropical swidden cultivation: comparative data from Colombia and Papua New Guinea. *Agriculture, Ecosystems and Environment*, **20**: 127-136.

Ellis, F. (1998). Household Strategies and Rural Livelihood Diversification. *Development Studies*, **35**(1): 1-38.

Exceptional Health (2012) http://exceptionalhealth.org/health/what-does-amino-acids-do-for-the-body/. Accessed: June, 2012.

Ferreira, F. and Lanjouw, P. (2001). Rural non-farm activities and poverty in the Brazilian Northeast. *World Development*, **29**(3): 509-528.

Filer, C. (2012). The Commission of Inquiry into Special Agricultural and Business Leases in Papua New Guinea: Fresh Details for the Portrait of a Process of Expropriation. Paper presented at: International Conference on Land Grabbing II. Conference October 17-19, 2012. Cornell University, Ithaca, NY.

Food and Agriculture Organisation of the United Nations (FAO). (1996). World Food Summit: Rome Declaration and Plan of Action. Rome, 13-17 November 1996.

FAO. (2005). Small Island Developing States Agricultural Production and Trade, Preferences and Policy. FAO Commodities and Trade Technical Paper (7). Food and Agriculture Organisations of the United Nations, Rome.

FAO. (2006a). The State of Food Insecurity in the World. Eradicating World Hunger. Taking Stock Ten Years after the World Food Summit. FAO. Rome, Italy.

FAO. (2006b). Food Security. *Policy Brief*. June 2006, Issue 2. FAO. Rome, Italy.

FAO. (2007). Guidelines for measuring household and individual dietary diversity. Prepared by FAO Nutrition and Consumer Protection Division with support from the EC/FAO Food Security Information for Action Program and the Food and Nutrition Technical Assistance (FANTA) Project. Rome, Italy.

FAO. (2008). The state of food insecurity in the world. High Food Prices and Food Security - Threats and Opportunities. FAO. Rome, Italy.

FAO. (2009). The State of Agricultural Commodity Markets. High Food Prices and the Food Crisis - experiences and lessons learned. FAO. Rome, Italy.

FAO. (2010a). The State of Food Insecurity in the World. Addressing Food Insecurity in Protracted Crises. FAO. Rome, Italy.

FAO. (2010b). Pacific Food Security Tool Kit. Building Resilience to Climate Change. Root Crop and Fishery Production. FAO, Rome. Italy.

FAO. (2010-11). The State of Food and Agriculture. Women in agriculture. Closing the gender gap for development. FAO. Rome, Italy.

FAO (2011). Global food price monitor. 8 September 2011. Trade and markets division of FAO, Global Information and Early Warning System (GIEWS). Italy, Rome.

FAO. (2012). The State of Food Insecurity in the World. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. FAO, Rome.

FAO. (2013). FAO Statistical Yearbook 2013. World food and agriculture. FAO, Rome.

FAO Media Centre. FAO Website: <http://www.fao.org/news/newsroom-home/en/>. Accessed: June, 2011.

Forge, J. A. W. (1965). Art and society in the Sepik. Proceedings of the Royal Anthropological Institute of Great Britain & Ireland 23-32.

Floyd, C. N., Lefroy, R. D. B. and D'Souza, E. J. (1988). Soil fertility and sweet potato production on volcanic ash soils in the highlands of Papua New Guinea. *Field Crops Research*, **19**(1): 1-25.

Francis, E. (2002). Rural livelihoods, institutions and vulnerability in North West Province, South Africa. *Southern African Studies*, **28**(3): 531-550.

FPDC. (2000). Evaluation Report on Women Village Based Extension Worker Pilot Program. Fresh Produce Development Corporation, Goroka.

Galligan, D. O., Hoddinott, J., and Taffesse, A. S. (2008). The impact of Ethiopia's productive safety net program and its linkages. IFPRI Discussion Paper 00839. Food Consumption and Nutrition Division and Development Strategy and Governance Division. International Food Policy Research Institute, Washington.

Gibson, J. (2001). Food demand in the rural and urban sectors of PNG. In: Bourke, R. M., Allen, M. G. and Salisbury, J. G. (eds). *Food Security for Papua New Guinea. Proceedings of the Papua New Guinea Food and Nutrition 2000 Conference*. ACIAR Proceedings No. 99: 45-53. Australian Centre for International Agricultural Research, Canberra.

Gibson, J., and Rozelle, S. (2003). Poverty and access to infrastructure in Papua New Guinea. *Working Paper*, University of California.

Gibson, R. S., Heywood, A., Yaman, C., Thompson, L. U., Heywood, P. (1991). Food consumption patterns and trace elements intakes of children from the Wosera, Papua New Guinea. *Ecology of Food and Nutrition*, **25**: 69-77.

Gladwin, C. H., Thomson, A. M., Peterson, J. S., and Anderson, A. S. (2001). Addressing food security in Africa via multiple livelihood strategies of women farmers. *Food Policy*, **26**: 177-207.

Goddard, M. (2001). From rolling thunder to reggae: imagining squatter settlements in Papua New Guinea. *The Contemporary Pacific*, **13**(1): 1-32.

Grieve, R. B. (1986). The Oil Palm Industry of Papua New Guinea. *Australian Geographer*, **17**(1): 72-76.

Grossman, L. S. (1991). Diet, income, and subsistence in an Eastern Highland village, Papua New Guinea. *Ecology of Food and Nutrition*, **26**: 235-253.

Gurnah, A. H. (1992). Agro-Climatic Zones of Papua New Guinea. *Niugini Agrisaiens. Journal of the Department of Agriculture*, **1**(1): 17-21. PNG University of Technology. Lae.

Gwaiseuk, J. R. (2001). The role of agriculture in the PNG economy In: Bourke, R.M., Allen, M.G. and Salisbury, J.G. (eds). *Food Security for Papua New Guinea. Proceedings of the Papua New Guinea Food and Nutrition 2000 Conference*. ACIAR Proceedings No. 99, pp. 30-36. Australian Centre for International Agricultural Research, Canberra.

Hamelin, A. M., Habicht, J. P. and Beaudry, M. (1999). Food insecurity: consequences for the household and broader social implications. *The Journal of Nutrition*, **129**(2): 525s-528s.

Hartemink, A. E. (2003). Sweet potato yields and nutrient dynamics after short-term fallows in the humid lowlands of Papua New Guinea. *Netherlands Journal of Agricultural Science*, **50**: 297-391.

Harvey, P. W., and Heywood, P. F. (1983). Twenty-five Years of Dietary Change in Simbu Province, Papua New Guinea. *Ecology of Food and Nutrition*, **13**: 27-35.

Hatloy, A., Hallund, J., Diarra, M. M. and Oshaug, A. (2000). Food variety, socio-economic status and nutritional status in urban and rural areas in Koutiala (Mali). *Public Health Nutrition*, **3**(1): 57-65.

Hay, L. (2005). *Qualitative Research Method in Human Geography*. Second edition. Melbourne, Oxford University Press.

Heywood, P. F. (1983). Growth and nutrition in Papua New Guinea. *Journal of Human Evolution*, **12**: 133-143.

Heywood, P. F., and Hide, R. L. (1994). Nutritional effects of export-crop production in Papua New Guinea: a review of the evidence. *Food and Nutrition Bulletin*, **14**(3): 233-249

Hoddinott, J. and Yohannes, Y. (2002). Dietary diversity as a food security indicator. FCND Discussion Paper No. 136, International Food Policy Research Institute.

Hossain, M. A., Islam. M. S., and Miah, M. A. M. (2002). Attitude of Island farmers towards adoption of modern agricultural technologies. *Bangladesh Journal of Extension Education*, **14**(1 & 2): 47-51.

Hulme, D. (1984). *Land Settlement Schemes and Rural Development in Papua New Guinea*. Unpublished Ph.D Thesis. James Cook University, North Queensland.

IFAD, (2007). Mongolia: Arhangai Rural Poverty Alleviation Project Completion Evaluation. Report No. 1889-MN. International Fund for Agricultural Development, Rome.

Iram, U. and Butt, M. S. (2004). Determinants of household food security. An empirical analysis for Pakistan. *International Journal of Social Science*, **31**(8): 753-766.

Islam, M. R., Biswas, J. C., and Islam, M. N. (2002). Correlates of selected personal characteristics of FFS farmers with their IPM knowledge. *Bangladesh Journal of Extension Education*, **14**(1 & 2): 107-111.

Jonas, W. J. A. (1972). The Hoskins Oil Palm Scheme. *Australian Geographer*, **12**(I): 57-58.

Jones, P. (2012). Pacific Urbanization and the Rise of Informal Settlements: Trends and Implications from Port Moresby. *Urban Policy and Research*, **30**(2): 145-160.

Kapia-Mendano, S. (2012). *The Effectiveness of Agricultural Extension Services to Oil Palm Smallholders in West New Britain, Papua New Guinea.* Unpublished Masters Thesis, Curtin University, Perth.

Keig, G. (2001). Rural population growth in Papua New Guinea between 1980 and 1990. *Asia Pacific Viewpoint*, **42**(2-3): 255-268.

Kennedy, G. L., Pedro, M. R., Seghieri, C., Nantel, G. and Brouwer, I. (2007). Dietary diversity score is a useful indicator of micronutrient intake in non-breast-feeding Filipino children. *The Journal of Nutrition*, **137**(2): 472-477.

Kennedy, G., Berardo, A., Papavero, C., Horjus, P., Ballard, T., Dop, M., Delbaere, J. and Brouwer, I. D. (2010). Proxy measures of household food consumption for food security assessment and surveillance: comparison of the household dietary diversity and food consumption scores. *Public Health Nutrition*, **13**(12): 2010-2018.

Kerr, R. B. (2005). Food Security in Northern Malawi: Gender, Kinship Relations and Entitlements in Historical Context. *Southern African Studies*, **31**(1): 53-74.

King, S. E., and Mascie-Taylor, C. G. N. (2002). Nutritional status of children from Papua New Guinea: Associations with socioeconomic factors. *American Journal of Human Biology*, **14**(5): 659-668.

Knueppel, D., Demment, M. and Kaiser, L. (2009). Validation of the household food insecurity access scale in rural Tanzania. *Public Health Nutrition*, **13**(3): 360-367.

Koczberski, G. (2007). Loose Fruit Mamas: Creating Incentives for Smallholder Women in Oil Palm Production in Papua New Guinea. *World Development*, **35**(7): 1172-1185.

Koczberski, G. (2011) *Smallholder Households and the Changing Agricultural and Social Landscape of the Oil Palm Land Settlement Schemes, West New Britain, Papua New Guinea*. Unpublished Ph.D. Thesis, School of Geosciences, University of Sydney.

Koczberski, G. and Curry, G. N. (2003). *Sustaining Production and Livelihoods among Oil Palm Smallholders. A Socio-economic Study of the Bialla Smallholder Sector*. Research Unit for the Study of Societies in Change. Curtin University. Perth, Western Australia.

Koczberski, G. and Curry, G. N. (2005). Making a living: Land pressures and changing livelihood strategies among oil palm settlers in Papua New Guinea. *Agricultural Systems*, **85**: 325-339.

Koczberski, G., Curry, G., and Connell, J. (2001a). Full Circle or Spiralling Out of Control? State Violence and the Control of Urbanisation in Papua New Guinea. *Urban Studies*, **38**(11): 2017-2036.

Koczberski, G., Curry, G. N., and Gibson, K. (2001b). *Improving productivity of the smallholder oil palm sector in Papua New Guinea: A socio-economic study of the Hoskins and Popondetta Schemes.* The Australian National University. Canberra ACT. Australia.

Koczberski, G., Curry, G. N. and Bue, V. (2012). Oil palm, food security and adaptation among smallholder households in Papua New Guinea. *Asia Pacific Viewpoint*, **53**(3): 288-299.

Koczberski G., Curry, G. N. and Imbun, B. (2009). Property rights for social inclusion: migrant strategies for securing land and livelihoods in Papua New Guinea. *Asia Pacific Viewpoint*, **50**(1): 29-42.

Lea, D. A. M. (1964). *Abelam Land and Sustenance: Swidden Horticulture in an area of high Population Density, Maprik, New Guinea.* PhD Thesis. Australian National University, Canberra.

Lindsay, C. (2008). Are women spending more time in unpaid domestic work than men in Canada? Matter of Fact No. 9. Statistics Canada-Catalogue no. 89-630-X. Canada.

Lio, M. and Liu, M. C. (2008). Governance and agricultural productivity: A cross-national analysis. *Food Policy*, **33**(6): 504-512.

Lovendal, C. R., Knowles, M. and Horii, N. (2004). Understanding Vulnerability to Food Insecurity. Lessons from Vulnerable Livelihood Profiling. ESA Working Paper No. 04-18. FAO, Rome.

Manning, M. (2001). Food security in PNG. In: Bourke, R. M., Allen, M. G. and Salisbury, J. G. (eds). *Food Security for Papua New Guinea. Proceedings of the Papua New Guinea Food and Nutrition 2000 Conference*. ACIAR Proceedings No. 99, pp. 15-22. Australian Centre for International Agricultural Research, Canberra.

McAlpine, J. R., Keig, G., and Falls, R. (1983). *Climate of Papua New Guinea*.Commonwealth Scientific and Industrial Research Organisation in association with Australian National University Press, Canberra.

McAlpine, J. R., and Freyne, D. F. (2001). Land use change and intensification in Papua New Guinea 1975-1996. *Asia Pacific Viewpoint*, **42**(2/3): 209-218.

McGinnity, F. and Russell, H. (2008). *Gender Inequalities in Time Use. The Distribution of Caring, Housework and Employment Among Women and Men in Ireland*. Brunswick Press. Ireland.

McGregor, A., and Bourke, R. M. (2009). The broader economy. In: R.M. Bourke and T. Harwood (eds). *Food and Agriculture in Papua New Guinea*, pp. 271-281. ANU Press, Canberra.

McGregor, A., Bourke, R. M., Manley, M., Tubuna, S., and Deo, R. (2009). Pacific Island food security: situation, challenges and opportunities. *Pacific Economic Bulletin*, **24**(2): 24-42.

Moyo, M., Amoo, S. O., Ndhlala, A. R., Finnie, J. F. and Staden, J. V. (2013). Phytochemical and antioxidant properties of unconventional leafy vegetables consumed in southern Africa. *Southern African Journal of Botany*, **84**: 65-71.

Mueller, I. and Smith, T. A. (1999). Patterns of child growth in Papua new Guinea and their relation to environmental, dietary and socioeconomic factors - further analysis of the 1982-1983 Papua New Guinea National Nutritional Survey. *PNG Medical Journal*, **42**(3-4): 94-113.

Mueller, I., Vountsou, P., Smith, T. and Allen, B. J. (2001). Subsistence agriculture and child growth in Papua New Guinea. *Ecology of Food and Nutrition*, **40**(4): 367-395.

Nabarro, D. (2011). Addressing Food Price Volatility: Actions and Tools. The role of Committee on World Food Security (CFS) and way forward. Powerpoint presentation 27th May. Rome.

Nachmias, D. and Nachmias, C. (1976). *Research Methods in the Social Science*. Edward Arnold Publishers Ltd, London.

Nelson, P. N., Gabriel, J., Filer, C., Banabas, M., Sayer, J. A., Curry, G. N., Koczberski, G. and Venter, O. (2013). Oil palm and deforestation in Papua New Guinea. *Conservation Letters.* Doi:10.1111/concl.12058.

New Britain Palm Oil Limited-NBPOL. (2008). Annual Report, NBPOL, Kimbe. Papua New Guinea.

NBPOL. (2009). Sustainability Report. NBPOL, Mosa. West New Britain Province. Papua New Guinea.

NBPOL. (2010/11). Sustainability Report. NBPOL, Mosa. West New Britain Province. Papua New Guinea.

NBPOL. (2011). Sustainability Report. NBPOL, Mosa. West New Britain Province. Papua New Guinea.

Numbassa, G. and Koczberski, G. (2012). Migration, informal settlements and non-market land transactions: A case study of Wewak, East Sepik Province, Papua New Guinea. *Australian Geographer*, 43(2): 143-161.

Ohtsuka, R., Inaoka, T., Umezaki, M., Nakada, N. and Abe, T. (1995). Long-term subsistence adaptation to the diversified Papua New Guinea environment: Human ecological assessments and prospects. *Global Environmental Change*, **5**(4): 347-353.

Oil Palm Industry Corporation-OPIC. (2010). Area maps of LSSs subdivision. OPIC, Hoskins.

Oil Palm Industry Corporation-OPIC. (2012). Monthly report-December 2012. OPIC, Bialla.

Orr, A., and Mwale, B. (2001). Adapting to adjustment: smallholder livelihood strategies in Southern Malawi. *World Development*, **29**(8): 1325-1343.

Orr, A., Mwale, B. and Saiti-Chitsinga, D. (2009). Exploring seasonal poverty traps: the 'six-week window' in Southern Malawi. *Journal of Development Studies*, **45**(2): 227-255.

Orrell, I. (2012). Palm Oil Industry Statistics - 2012. Papua New Guinea Palm Oil Council. Kimbe, West New Britain Province. PNG.

Owusu, F. (2009) Livelihoods. In: R. Kitchen and N. Thrift (eds). International Encyclopedia of Human Geography, Vol. 6, pp. 219-224. Elsevier, Oxford.

Owusu, V., Abdulai, A. and Abdul-Rahman, S. (2011). Non-farm work and food security among farm households in Northern Ghana. *Food Policy*, **36** (2011): 108-118.

Oxfam International. (2011). Growing a better future. Food justice in a resource-constrained world. Oxford, UK, Oxford International.

Paarlberg, R. (2002). Governance and food security in an age of globalization. *2020 Brief*. Washington, USA, International Food Policy Research Institute.

Patrick, O. (2008). *Functional diversity of indigenous diets in coastal Papua New Guinea: role in the nutrition transition and noncommunicable disease risk*. PhD Thesis. School of Dietetics and human nutrition, McGill University, Montreal.

Post Courier Newspaper (2011) Exorbitant rentals affect nationals. Post Courier, Thursday 27th October, 2011. Website: http://www.postcourier.com.pg/20110714/thhome.htm. Accessed: 27/10/2011.

Radimer, K. (2002) Measurement of household food security in the USA and other industrialised countries. *Public Health Nutrition* (1368-9800), **5**(6A): 859-864.

Rafiei, M., Nord, M., Sadeghizadeh, A. and Entezari, M. H. (2009). Assessing the internal validity of a household survey-based food security measure adapted for use in Iran. *Nutrition Journal*, **8** (28): 1-11.

Roberts, S. M., Wright, S. and O'Neil, P. (2007). Good governance in the Pacific? Ambivalence and possibility. *Geoforum*, **38**(5): 967-984.

Rigg, J. (2006). Land, farming, livelihoods, and poverty: Rethinking the links in the rural South. *World Development*, **34**(1): 180-202.

Rigg, J. and Salamanca, A. (2009). Managing risk and vulnerability in Asia: A (re) study from Thailand, 1982-83 and 2008. *Asia Pacific Viewpoint*, **50**(3): 255-270.

Rohorua, H., Gibson, J., McKenzie, D. and Martinez, P. G. (2009). How do Pacific island households and communities cope with seasonally absent members? *Pacific Economic Bulletin*, **24**(3): 19-38.

Roshchin, S.Y. (2003). *Gender Equality and Extension of Women Rights in Russia within Millennium Development Goals*. UN Gender Theme Group.

Ruben, R., and Berg, M. (2001). Nonfarm employment and poverty alleviation of rural farm households in Honduras. *World Development*, **28**(3): 549-560.

Ruel, M. T. (2003). Operationalizing dietary diversity: A review of measurement issues and research priorities. *The Journal of Nutrition*, **133**: 3911S-3926S.

Ryan, S. (2009). *Maximising income: livelihood change and risk management for oil palm settlers in Papua New Guinea (A case study through the local markets)*. Unpublished Honours Thesis. School of Social Sciences and Asian Languages, Curtin University, Perth.

Ryan, S., Koczberski, G., and Curry. G. N (2013) Developing a smallholder engagement strategy for OPIC. *Smallholder Education Strategies Report*. RUSSIC. School of Built Environment, Curtin University and PNG Oil Palm Research Association.

Sarker, M. A. and Itohara, Y. (2010). Adoption of organic farming and household food security of the smallholders: A case study from Bangladesh. *Journal of Food Agriculture & Environment*, **8**(1): 86-90.

Savy, M., Martin-Prevel, Y., Sawadogo, P., Kameli, Y. and Delpeuch, F. (2005) Use of variety diversity scores for diet quality measurement: relation with nutritional status of women in a rural area in Burkina Faso. *European Journal of Clinical Nutrition*, **59**: 703-716

Sexton, L. (1986). *Mothers of Money, Daughters of Coffee: The Wok Meri Movement*. Michigan, UMI Research Press.

Scaglion, R. (1999). Yam cycles and timeless time in Melanesia. *Ethnology,* **38**(3) (Summer 1999): 211-225.

Scaramozzino, P. (2006). Measuring vulnerability to food insecurity. ESA Working Paper No. 06-12. FAO, Rome.

Scoones, I. (1998). *Sustainable Rural Livelihoods: A Framework for Analysis*. Working Paper 72, Institute for Development Studies, Brighton.

Shack, K. W. (1988). Effects of agricultural development and resettlement on nutritional status and dietary intakes of mothers and children: A study of three ethnic groups in lowland Papua New Guinea. PhD Thesis. UMI Dissertations Publishing, University of California.

Sharp, T. L. M. (2012). Following buai: the highlands betelnut trade, Papua New Guinea. PhD Thesis. Australian National University.

Shoae, N. Z., Omidvar, N., Ghazi-Tabatabaie, M., Rad, A. H., Fallah, H. and Mehrabi, Y. (2007). Is the adapted Radimer/Cornell questionnaire valid to measure food insecurity of urban households in Tehran, Iran? *Public Health Nutrition*, **10**(8): 855-861.

Sillitoe, P. (1995). Fallow and fertility under subsistence cultivation in Papua New Guinea highlands: II. Soil Fertility. *Singapore Journal of Tropical Geography*, **16**(1): 101-115.

Sillitoe, P. (1998). It's All in the Mound: Fertility Management under Stationary Shifting Cultivation in the Papua New Guinea Highlands. *Mountain Research and Development*, **18**(2): 123-134.

Sillitoe, P. (2006). What labour engenders: women and men, time and work in the New Guinea Highlands. *The Asia Pacific Journal of Anthropology*, **7**(2), 119-151.

Silverman, D. (2000). *Doing Qualitative Research: A Practical Handbook*. London, Sage Publications.

Smith, D. R., Gordon, A., Meadows, K. and Zwick, K. (2001). Livelihood diversification in Uganda: patterns and determinants of change across two rural districts. *Food Policy*, **26**: 421-435.

Staatz, J. M., Boughton, D. H. and Donovan, C. (2009). Food security in developing countries. Staff Paper 2009-03, Department of Agricultural, Food and Resource Economics. Michigan State University.

Steyn, N. P., Nel, J. H., Nantel, G., Kennedy, G. and Labadarios, D. (2006). Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy? *Public Health Nutrition*, **9**(5): 644-650.

Storey, D. (2010). Urban Poverty in Papua New Guinea. The National Research Institute of Papua New Guinea. Discussion Paper No. 109. Port Moresby.

Strathern, A. (1982). The division of labour and processes of social change in Mount Hagen. *American Anthropological Association*, **9**(2): 307-319.

Swaminathan, M. (2003). Strategies towards food security. *Social Scientist*, **31**(9/10): 58-94.

Swindale, A. and Bilinsky, P. (2006). Household Dietary Diversity Score (HDDS) for measurement of household food access: indicator guide. Food and Nutrition Technical Assistance Project (FANTA). Academy for Educational Development. Washington DC.

Talu, P. (2011). Agro sector enjoys good export prices. The National Tuesday July 5, 2011. Website: <http://www.thenational.com.pg/?q=node/20784>. Accessed: 5/7/11.

Thorne-Lyman, A. L., Valpiani, N., Sun, K., Semba, R. D., Klotz, C. L., Kraemer, K., Akhter, N., de Pee, S., Moench-Pfanner, R. and Sari, M. (2010). Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to the financial crisis. *The Journal of Nutrition*, **140**: 182-188.

Thuo, C. M. (2011). The Influence of enterprise diversification on household food security among small-scale sugarcane farmers: A case Study of Muhoroni Division, Nyando District, Kenya. *The Journal of Agricultural Education and Extension*, **17**(3): 223-238.

Torheim, L. E., Ouattara, F., Diarra, M. M., Thiam, F. D., Barikmo, I., Hatloy, A. and Oshaug, A. (2004). Nutrient adequacy and dietary diversity in rural Mali: association and determinants. *European Journal of Clinical Nutrition*, **58**: 594-604.

Tschirley, D. L. and Benfica, R. (2001). Smallholder agriculture, wage labour and rural poverty alleviation in land-abundant areas of Africa: Evidence from Mozambique. *Journal of Modern African Studies*, **39**: 333-358.

Ulijaszek, S. J. (2003). Socio-economic factors associated with physique of adults of the Purari delta of the Gulf Province, Papua New Guinea. *Annals of Human Biology*, **30**(3): 316-328.

Umezaki, M., and Ohtsuka, R. (2003). Adaptive strategies of Highlands-origin migrant settlers in Port Moresby, Papua New Guinea. *Human Ecology*, **31**(1): 3-25.

Umezaki, M., Kuchikura, Y., Yamauchi, T. and Ohtsuka, R. (2000). Impact of population pressure on food production: An analysis of land use change and subsistence pattern in the Tari Basin in Papua New Guinea. *Human Ecology*, **28**, 359-381.

United Nations (2010). The Millennium Development Goals Report. United Nations. New York.

United States Department of Labour (2005). *American Time Use Survey*. US Bureau of Labour Statistics. USA.

United States Department of Agriculture-USDA, (2005). Measuring food security and hunger: Phase one report. Panel to Review U.S Department of Agriculture's Measurement of Food Insecurity and Hunger, National Research Council. USDA. United States.

Vandevijvere, S., De Vriese, S., Huybrechts, I., Moreau, M. and Van Oyen, H. (2010). Overall and within-food group diversity are associated with dietary quality in Belgium. *Public Health Nutrition*, **13**(12): 1965-1973.

Williams, G. (2009). Governance, Good. In: R. Kitchin and N. Thrift (eds). *International Encyclopedia of Human Geography*, pp.606-614. Oxford, Elsevier.

Whitehead, A. (2002). Tracking livelihood change: theoretical, methodological and empirical perspectives from North-East Ghana. *Journal of Southern African Studies*, **28**(3), 575-598.

Winters. P., Davis, B. and Carletto, G. (2009). Assets, activities and rural income generation: evidence from a multicountry analysis. *World Development*, **37**(9): 1435-1452.

WFP. (2008). Food consumption analysis. Calculation and use of the food consumption score in food security analysis. World Food Program of the United Nations. Italy, Rome.

WFP. (2011). Rising food prices. WFP Website: <http://www.wfp.org/stories/rising-food-prices-infographic>. Accessed June, 2011.

Yala, C. (2008). Improving access to finance through land titling: evidence from the Hoskins Smallholder Oil Palm Project. *Pacific Economic Bulletin*, **23**(1): 39-58.

Yamauchi, T., Umezaki, M. and Ohtsuka, R. (2001). Influence of urbanisation on physical activity and dietary changes in Huli-speaking population: a comparative study of village dwellers and migrants in urban settlements. *British Journal of Nutrition*, **85**: 65-73.

Yamauchi, T. and Ohtsuka, R. (2002). Nutritional Adaptation of Women in Contrasting Agricultural Environments in Tari, PNG. *PNG Medical Journal*. Volume **45**, No 1-2: 99-105.

Zemel, B. S. (1989). Dietary change and adolescent growth among the Bundi (Gende-speaking) people of Papua New Guinea. Unpublished PhD. Thesis. University of Pennsylvania.

Appendix 1

Dietary Recall Calculation Sheet 1 (HDDS)

Food Groups used in the calculation of household HDDS.

Food Group No.	Food Group	Examples	Food groups consumed Yes=1, No= 0
1	Cereals	Bread, noodles, biscuit, flour balls or any other foods made from maize, rice, wheat.	
2	Vitamins A rich vegetables & tubers, dark green leafy vegetables & other vegetables	Pumpkin, carrot, orange sweet potato, dark green leafy vegetables, tomato, onion, capsicum, corn, mushroom	
3	White tubers & root	Yam, cassava, white sweet potato, Chinese taro, taro, banana, breadfruit	
4	Vitamin A rich fruits & other fruits	Mango, ripe banana, pineapple	
5	Organ meat (iron rich) & flesh meat	Liver, kidney, heart, beef, pork, lamb, chicken	
6	Eggs		
7	Fish	Fresh or dried, shellfish	
8	Legumes, nuts & seeds	Beans, peanut	
9	Milk & milk products	Milk	
10	Oils & fats	Oil, butter, coconut milk, *marita* pandanas	
11	Sweets	Soft drink, cordial	
12	Spices, condiments & beverages	Coffee, tea, sugar, salt, curry	

Source: FAO, 2007.

Appendix 2

Dietary Recall Calculation Sheet 2 (FCS)

Food Group	Food Items	Food Groups	Weight	D1	D2	D3	D4	D5	D6	D7	Tot # of days
1	Corn, rice, bread, biscuit, pancake, flour balls Cassava, sweet potato, taro, banana, sago, breadfruit	Main staples	2								
2	Beans, peanuts, other nuts	Pulses	3								
3	Vegetables, green leaves	Vegetables	1								
4	Fruits	Fruit	1								
5	Beef, chicken, pork, fish, eggs, seafood	Meat & fish	4								
6	Milk, other dairy product	Milk	4								
7	Sugar and sugar products	Sugar	0.5								
8	Oils, butter, coconut milk, *marita* pandanas	Oil	0.5								
9	Tea, coffee	Condiments	0								
10	Canned fish/meat	Canned fish & meat	2								

Food groups and their weights for the calculation of FCS.

Appendix 3

Distribution of sample size for household and in-depth surveys.

LSS subdivision	Total no. of blocks in household survey	Total no. of blocks in garden survey	Total no. of gardens surveyed	Ethnicity sample in garden survey					Total
				Chimbu	ESP	ENBP	Morobe	Other	
Kapore	30	18	104	8	4	4	-	2	
Sarakolok	30	-	-	-	-		-	-	
Hoskins	60	18	104	8	4	4	-	2	**18**
Tiauru	30	12	48	1	4	-	3	4	
Kabaya	30	12	67	2	3	2	-	5	
Bialla	60	24	121	3	7	2	3	9	**24**
Totals	**120**	**42**	**219**	**11**	**11**	**6**	**3**	**11**	**42**

Appendix 4

Distribution and sample size for in-depth studies (n=42).

Strata	Characteristics	LSS Sub-divisions				
		Hoskins	Bialla			
		Kapore	Tiauru	Kabaya	Total for all sub-divisions	
Family type	i. Multiple family block	3	2	3	8	
	ii. Single family block	3	2	3	8	
Block type	i. Blocks fully planted with mature palms	3	2	3	8	
	ii. Blocks with immature palms or areas without oil palm	3	2	3	8	
		3	2	-	5	
Block location	i. Blocks with no access to State reserve land	3	2	-	5	
	ii. Blocks with access to State reserve land					
Total Sample in LSS Sub-divisions		18	12	12	21	21
Total Sample		42			42	

Appendix 5

Different varieties of staple crops grown on the LSSs.

Varieties of staple crops grown on the LSS	Features
Sweet potato (*Ipomoea batatas*)	
(1) crisis	White skin/yellow flesh
(2) 3 mun	-
(3) 1 mun	-
(4) Wahgi besta	orange flesh
Banana (*Musa cultivars*)	
(1) Yawa	ripe banana
(2) Kiaukiau	cooking
(3) Tukuru (*kalapua*)	cooking
(4) Four wheel banana	cooking
(5) Katkattur	cooking
(6) Mosbi banana	cooking
(7) Semis banana	cooking
(8) Manki banana	Ripe banana
Chinese taro (*Xanthosoma sagittifolium*)	
(1) Red variety	
(2) White variety	
Taro (*Colocasia esculenta*)	
(1) Yellow variety	
(2) Red variety	Ox &Palm
(3) Purple mix variety	
Cassava (*Manihot esculenta*)	
(1) yellow variety	
(2) white variety	
Yam (*Dioscorea varieties)*	
(1) Yam – *D. alata*	greater yam
(2) mami – *D. esculenta*	smaller yam

Note: Women from Kavui subdivision identified the staples during focus group interviews

Appendix 6

Frequency of food consumed daily for a period of 7 consecutive days in 2010. Calculation of FCS (n=42)

Block No	Staples	Beans, peanut	Vegetables	Fruits	Beef, pork, chicken, fish	Milk	Sugar	oil/coconut milk	Tea	Tinned fish/meat	FCS
289	7	0	6	0	1	0	0	1	0	2	28.5
1999	7	0	7	0	2	0	0	2	0	2	34
299	7	0	7	0	1	0	0	1	9	4	33.5
358	7	0	7	0	0	0	0	5	3	4	31.5
272	7	0	6	0	0	0	0	4	9	5	32
304	7	0	7	0	3	0	0	2	5	3	40
306	7	0	6	0	2	0	0	3	6	1	31.5
352	7	0	7	0	5	0	0	5	9	4	51.5
386	7	0	7	0	2	0	0	4	1	2	35
366	7	0	5	0	0	0	0	3	5	3	26.5
354	7	0	3	0	3	0	0	2	1	5	42
315	7	0	5	2	1	0	0	4	6	5	37
263	7	0	5	0	2	0	0	1	3	4	35.5
283	7	0	6	0	3	0	0	3	3	5	43.5
336	7	0	6	0	4	0	0	4	5	3	44
285	7	0	6	0	4	0	0	2	2	3	43
346	7	0	4	0	3	0	0	3	7	3	37.5
257	7	0	7	0	0	0	0	3	5	6	34.5
660	7	1	5	0	2	0	0	1	3	7	44.5
377	7	0	7	0	0	0	0	4	1	4	31
370	7	0	7	1	0	0	0	2	0	5	33
257	7	0	7	0	2	0	0	5	0	2	35.5
342	7	0	7	0	1	0	0	3	5	6	38.5

Appendix 6 continued

235	7	0	7	0	1	0	0	7	2	4	36.5
233	7	0	7	0	2	0	0	5	1	3	37.5
342	7	0	6	0	1	0	0	4	0	4	34
239	7	0	7	0	3	0	0	5	6	4	43.5
361	7	0	7	0	1	0	0	3	2	3	32.5
234	7	0	7	0	0	0	0	4	2	4	31
240	7	0	6	0	2	0	0	6	4	4	39
1868	7	0	6	1	4	0	0	4	4	6	51
1870	7	0	5	0	3	0	0	2	1	5	44
1874	7	0	7	0	1	0	0	2	4	5	36
2010	7	0	7	0	2	0	0	7	1	2	36.5
1932	6	0	6	0	3	0	0	4	6	2	36
1907	7	0	7	0	3	0	0	4	4	5	45
1834	7	0	6	0	4	0	0	1	4	3	42.5
1872	7	0	7	0	1	0	0	6	1	2	32
1896	7	0	7	0	2	0	0	7	1	4	40.5
2003	7	0	7	0	1	0	0	2	1	5	36
2004	7	0	5	0	2	0	0	1	3	5	37.5
1905	7	0	6	0	0	0	0	5	1	1	24.5

Appendix 7

Frequency of consumption of main meal ingredients for 3 days, 2013 (n=29)

Meal ingredient	Frequency of consumption over 3 days (%)				Total %	Average days
	0*	1 Day	2 Days	3 Days		
Rice	-	7	34	59	100	3
Vegetables	-	3	21	76	100	3
Root crops and sago	10	38	31	21	100	2
Banana	-	41	21	38	100	2
Tinned fish/meat	3	21	28	48	100	2
Fresh meat/fish/chicken	66	24	10	-	100	0

0* = did not consume meal ingredients. Data were collected in January 2013.

Appendix 8

Correlations between independent and dependent variables (n=120)

	X1	X2	X3	X4	X5	X6	X7	Y1	Y2
X1	1								
X2	**-.267****	1							
X3	-.077	**.195***	1						
X4	-.171	**.202***	.057	1					
X5	.046	.017	.139	**.259****	1				
X6	-.015	.094	**.189***	**.441****	**.876****	1			
X7	-.015	.121	**.202***	-.136	.066	.048	1		
Y1	-.118	.101	.119	.034	**-.182***	**-.186***	-.064	1	
Y2	-.167	.087	.126	-.046	**-.271****	**-.254****	**.185***	**.441****	1

** Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

Code

Independent variables
X1=Age
X2=Educational level
X3=Fortnightly net income
X4=BH family size
X5=No. of families on block
X6=Block population
X7=Daily food expenditure

Dependent variables
Y1=No. of meals per day
Y2= HDDS

Appendix 9

Correlations between independent and dependent variables (n=42).

	X1	X2	X3	X4	X5	X6	X7	X8	X9	Y1	Y2	Y3	Y4	Y5	Y6
X1	1														
X2	.006	1													
X3	-.077	.302	1												
X4	.095	-.004	.172	1											
X5	.136	.070	**.381***	**.815****	1										
X6	.033	.069	-.038	.090	.187	1									
X7	-.034	.152	-.140	.173	.026	.079	1								
X8	-.084	.003	.189	.290	.218	.257	.068	1							
Y1	-.134	-.064	.082	-.243	-.242	-.159	**-.324***	.091	-.117	1					
Y2	.025	-.026	.145	**-.340***	-.265	-.259	**-.506****	.008	-.042	**.403****	1				
Y3	-.214	-.042	-.208	.005	-.009	**.345***	**.369***	-.018	.014	.150	**-.473****	1			
Y4	-.066	.185	.063	-.154	-.088	-.177	-.038	.219	-.204	.248	-.067	-.046	1		
Y5	-.225	-.100	-.019	-.122	-.135	.128	.113	.114	-.059	**.439****	.075	**.617****	.161	1	
Y6	-.084	.104	.086	-.088	-.089	-.050	**.387***	.140	.017	**.381***	-.140	**.392***	.291	**.475****	1

Code

Independent variables

X1=Age
X2=Educational level
X3=BH family size
X4=No. of families on block
X5=Block population
X6=Fortnightly net income
X7=Daily food expenditure
X8=Block garden size

Dependent variables

Y1=No. of meals per day
Y2=Garden ingredients
Y3=Ingredients bought
Y4=Ingredients from other source
Y5=HDDS
Y6=FCS