Integrated Assessment of Trade-Related Policies and Biological Diversity in the Agricultural Sector in Papua New Guinea

A Case Study on Agro-biodiversity of Food Crops: Sweet Potato and Taro

United Nations Environment Programme

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Preface

In July 2005, the United Nations Environment Programme launched an initiative to undertake integrated assessments (IA) of trade-related policies and biodiversity in the agricultural sector with the aim to support the implementation of the Convention on Biological Diversity (CBD). The overall objective of the initiative was to build capacity in national institutions and government departments to assess, design and implement policies that maximize development gains from trade-related policies in the agricultural sector while minimizing the impact on agricultural biodiversity. The initiative was in direct response to the CBD Conference of the Parties Decision VI/5, which called for the assessment of the impacts of trade liberalization on agricultural biological diversity. It specifically aimed to identify the potential impacts of the EU-ACP Economic Partnership Agreements (EPA) concluded between the European Union (EU) and Africa, Caribbean and Pacific (ACP) countries. Six ACP countries participated in the initiative by undertaking national-level assessment projects, including Jamaica, Mauritius, Cameroon, Papua New Guinea, Madagascar and Uganda.

Building on its earlier work on integrated assessment, UNEP began this initiative with the development of a Policy Assessment Manual on Agriculture, Trade and Biodiversity, putting particular emphasis on biodiversity impacts and opportunities. The Manual, which was prepared to assist a wide range of stakeholders, contains materials that explore the linkages between trade policies, the agricultural sector, ecosystem services and biodiversity, and provides a step-by-step approach to conducting an IA that incorporates biodiversity.

The six country studies applied the manual, and by identifying the impacts of trade-related policies in the agricultural sector on biodiversity in a national context aimed to support the further development of effective methodologies.

Throughout this UNEP initiative, focus has been placed on the impacts of trade-related policies in the agricultural sector, national policy responses, and the impacts of those policies on biological diversity. The specific objectives of the country projects were to:

1. Encourage a better understanding of the linkages between trade, development and biodiversity;
2. Build national, institutional and governmental capacities to conduct IA whereby the environmental, social and economic impact of trade-related policies in the agriculture sector are assessed, with particular attention on the protection of biological diversity;
3. Enhance capacity of government policy-makers, decision-makers in the private sector, and civil society, to develop and implement integrated approaches to national policy, which balance trade, development and biodiversity goals;
4. Develop and refine methodologies for assessing agricultural biodiversity and indicators based on specific circumstances within countries, and assessing the contribution of agricultural biodiversity (and its use) to poverty alleviation;
5. Enable ACP countries to integrate the sustainable management of biodiversity and other natural resources in their negotiation and implementation of the EU-ACP EPAs; and
6. Enhance civil society’s engagement in IA and policy-making processes relating to the implementation of both the CBD and the EPAs.
The ACP countries that participated in the initiative received technical and financial support through UNEP to conduct their IAs. Further funding is being provided to assist the countries involved follow up on the results of the studies further develop and implement the policy recommendations that they developed. This step towards implementation provides an opportunity to reinforce the expected outcomes of the IAs, further strengthen capacity, inter-institutional coordination and stakeholder involvement at the national level, to ultimately help ensure that trade liberalization occurs in a way that supports sustainability and strengthens the implementation of the CBD.

Financial support to the initiative was provided by the European Commission and the Swedish International Development Cooperation Agency.
The United Nations Environment Programme

The United Nations Environment Programme (UNEP) is the overall coordinating environmental organization of the United Nations system. Its mission is to provide leadership and encourage partnerships in caring for the environment by inspiring, informing and enabling nations and people to improve their quality of life without compromising that of future generations.

In accordance with its mandate, UNEP works to observe, monitor and assess the state of the global environment, improve the scientific understanding of how environmental change occurs, and in turn, how such change can be managed by action-oriented national policies and international agreements. UNEP’s capacity-building work thus centers on helping countries strengthen environmental management in diverse areas that include freshwater and land resource management, the conservation and sustainable use of biodiversity, marine and coastal ecosystem management, and cleaner industrial production and eco-efficiency, among many others.

UNEP, which is headquartered in Nairobi, Kenya, marked its first 35 years of service in 2007. During this time, in partnership with a global array of collaborating organizations, UNEP has achieved major advances in the development of international environmental policy and law, environmental monitoring and assessment, and the understanding of the science of global change. This work also supports the successful development and implementation of the world’s major environmental conventions.

In parallel, UNEP administers several multilateral environmental agreements (MEAs) including the Vienna Convention’s Montreal Protocol on Substances that Deplete the Ozone Layer, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (SBC), the Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention, PIC) and the Cartagena Protocol on Biosafety to the Convention on Biological Diversity as well as the Stockholm Convention on Persistent Organic Pollutants (POPs).

Division of Technology, Industry and Economics

The mission of the Division of Technology, Industry and Economics (DTIE) is to encourage decision-makers in government, local authorities and industry to develop and adopt policies, strategies and practices that are cleaner and safer, make efficient use of natural resources, ensure environmentally sound management of chemicals, and reduce pollution and risks for humans and the environment. In addition, it seeks to enable implementation of conventions and international agreements and encourage the internalization of environmental costs.

UNEP DTIE’s strategy in carrying out these objectives is to influence decision making through partnerships with other international organizations, governmental authorities, business and industry, and non-governmental organizations; facilitate knowledge management through networks; support implementation of conventions; and work closely with UNEP regional offices. The Division, with its Director and Division Office in Paris, consists of one centre and five branches located in Paris, Geneva and Osaka.
Economics and Trade Branch

The Economics and Trade Branch (ETB) is one of the five branches of DTIE. ETB seeks to support a transition to a green economy by enhancing the capacity of governments, businesses and civil society to integrate environmental considerations in economic, trade, and financial policies and practices. In so doing, ETB focuses its activities on:

1. Stimulating investment in green economic sectors;
2. Promoting integrated policy assessment and design;
3. Strengthening environmental management through subsidy reform;
4. Promoting mutually supportive trade and environment policies; and
5. Enhancing the role of the financial sector in sustainable development.

Over the last decade, ETB has been a leader in the area of economic and trade policy assessment through its projects and activities focused on building national capacities to undertake integrated assessments – a process for analysing the economic, environmental and social effects of current and future policies, examining the linkages between these effects, and formulating policy response packages and measures aimed at promoting sustainable development.

This work has provided countries with the necessary information and analysis to limit and mitigate negative consequences from economic and trade policies and to enhance positive effects. The assessment techniques and tools developed over the years are now being applied to assist countries in transitioning towards a green economy.

For more information on the general programme of the Economics and Trade Branch, please contact:

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Acronyms and abbreviations

ACP  Africa, Caribbean and Pacific countries
CBD  United Nations Convention on Biological Diversity
CCI  Cocoa Coconut Institute
CIC  Coffee Industry Corporation
DAFTI Department of Foreign Affairs, Trade and Immigration
DAL  Department of Agriculture and Livestock
EHP  Eastern Highlands Province
EPA  Economic Partnership Agreement
ETB  Economics and Trade Branch
EU   European Union
FPDA Fresh Produce Development Agency
GDP  Gross domestic product
GIS  Geographic information system
GMO  Genetically modified organism
HCVF High Conservation Valued Forest
HDI  Human Development Index
HPI-1 Human Poverty Index
IA   Integrated assessment
KIK  Coconut Industry Corporation
LSS  Land Settlement Scheme (for oil palm)
MTDS Medium Term Development Strategy
NADP National Agriculture Development Plan
NARI National Agricultural Research Institute
NBPOL New Britain Palm Oil Limited
NGO  Non-governmental organization
OPIC Oil Palm Industry Corporation
OPRA Oil Palm Research Association
PINBio Papua New Guinea Institute of Biodiversity
PNG  Papua New Guinea
PNGBSAP Papua New Guinea Biodiversity Strategic Action Plan
PGRS Plant Genetic Resource Strategy
RSPO Roundtable on Sustainable Palm Oil
TRP  Tariff Reduction Programme
UNDP United Nations Development Programme
UNEP United Nations Environment Programme
VAT  Value-added tax
VOP  Village Oil Palm (scheme)
WNBP West New Britain Province
WTO  World Trade Organization
Executive Summary

The United Nations Environment Programme (UNEP), in collaboration with the Convention on Biological Diversity (CBD), launched a five-year initiative in 2005 to support the implementation of country studies in six Africa, Caribbean and Pacific (ACP) countries, including Papua New Guinea (PNG). The studies aim to build national capacities to understand, examine and assess the environmental, social and economic impacts of trade-related policies in the agriculture sector and emphasize the protection of biological diversity and the promotion of sustainable development. They are intended to increase the understanding of factors that lead to biodiversity loss, and to support the implementation of the CBD.

In PNG, the promotion of food security and poverty alleviation through trade policy reforms, and the effects of trade on agriculture and the conservation of biological diversity, concern a wide range of stakeholders. The aim of this study is to assess the impact of PNG’s trade policies and practices on food-crop biodiversity. The specific trade-related policy examined in the IA is the Tariff Reduction Programme (TRP), which was introduced in 1999. The specific semi-subsistence food crops selected for the study were sweet potato and taro. These two crops were selected because they are among the country’s most important staple crops in terms of food security—the vast majority of the population depend on them for food. In addition to the food crops, two export crops are also examined – coffee and oil palm – because these export crops compete with food crops for land and labour resources. As the production of export crops expands, the resources available for the maintenance of food crops and food-crop diversity is reduced, weakening the resilience of the food crops. Coffee and oil palm were selected because they are the most successful of the agricultural commodities and are increasingly favoured by the government under its export-driven economic recovery strategy. The two crops also make an important contribution to the economic and social development of PNG in terms of income, employment, and foreign exchange earnings.

The TRP was selected as the trade instrument to study in the IA because it is one of the central strategies of PNG’s ‘Export Driven Economic Recovery’ policy, a major pillar of the country’s Medium Term Development Strategy. Specifically, the TRP has reduced tariffs on all agricultural inputs to zero, which lowers costs and could lead to increased agricultural productivity, in particular for export crops, which might occur at the expense of food crops.

In addition to the TRP, the IA examined other factors that might encourage the loss of food-crop diversity. The three key factors that were considered were: (a) the introduction of ‘other’ sweet potato and taro cultivars into the garden; (b) production of rice (an introduced crop) locally; and (c) increased consumption of imported foods, particularly rice and wheat. These were considered significant because PNG’s agricultural system is dynamic, with farmers moving from traditional farming practices to the adoption of innovative farming technology, including new varieties and/or exotic crops. Moreover, income from cash crops is used to buy imported food, while exotic food crops are grown either to supplement the food supply or to sell for cash. The reason for selecting imported food is that the increased consumption of these foods may result in the simultaneous reduction in demand for consumption of staple foods, and a reduced demand for growing and maintaining these crops, leading to neglect and eventual loss. Intuitively, this can be thought of as a natural effect of development. Imported food crops also matter in terms of food security, but they have limitations; their main consumer group is the 10 to 15 per
cent of the population living in major towns. In extreme climatic conditions, imported food cannot support the entire population (as shown in the 1997-1998 nationwide drought).

The approach employed in the IA, to consider the economic, social and environmental impacts of the TRP, relied on both primary and secondary data. A literature review of secondary sources was employed to assess the impacts of export crops on the economy of PNG and on living standards.

The IA employed primary data, collected through surveys, to determine, from an environmental perspective, how export crops had affected food-crop diversity. The survey was carried out in two areas: the Eastern Highlands Province (EHP) (where sweet potato and coffee co-exist), and West New Britain Province (WNBP) (oil palm and taro). A total of 100 smallholder farmers – 50 in each site – were surveyed.

The data were collected using indicators of agro-biodiversity such as land conversion, land use systems (the area of land under export crops versus food crops), income comparisons of food crops versus cash crops, and consumption levels of garden food versus processed food. The survey addressed issues including a comparison of numbers of crop cultivars, income levels, willingness to grow more food crops and more cash crops in the future, and accessibility to road infrastructure. The use of inputs (and their prices) was assessed to explore the impacts of the TRP. Also examined were population densities, accessibility to social services (such as health care), intensity of coffee and/or oil palm activity, and intensity of subsistence farming.

However, difficulties encountered by the survey team prevented the even collection of samples from each site. The survey and the study faced several challenges, which hampered progress. These included the following:

- lack of past records and information on agricultural input costs from the farmers to determine the effect of the tariff; collection of the same information from farmers’ knowledge was subject to farmers’ capacity of recollection and reporting;
- lack of data on land under coffee, sweet potato and taro production in the field survey, which are subject to farmers’ knowledge and may not be representative;
- differences in names of the same crop cultivars due to different languages may have led to counting a particular food crop cultivar more than once;
- the link between food crops and export crops is not direct; and
- difficulties accessing some survey sites resulted in collecting a smaller sample size than originally planned and the sample size was not sufficient to reflect full impacts.

As a result of the research, the IA found indications of lost or missing cultivars of sweet potato and taro in PNG. The status of some cultivars is difficult to trace, and they are classified as either lost or missing. The study found that 274 varieties of traditional sweet potato were lost or missing in the EHP and 422 varieties of taro, deemed to be lost or missing in the taro growing areas of WNBP. The most common reason stated by the farmers for the loss of sweet potato and taro cultivars is their ‘replacement’ by the introduced superior varieties of sweet potato and taro with a shorter maturity period, that taste better, have higher yields, and provide stronger market appeal. For taro, an additional reason was the socio-cultural factor in connection with the destruction of taro cultivars as a form of mourning following the death of a person who was understood to have discovered that cultivar.
No clear causal connection was established between the loss of cultivars and trade. However, the lack of such an extended analysis is partly the result of lack of data, and therefore any links to trade should not be dismissed as there is strong qualitative evidence of a causal relationship. However, this study suggests that discernable benefits of the TRP would be realized by the major plantation companies. The cost of inputs for smallholders has increased, despite the tariff reductions, as a result of other factors such as the introduction of a value-added tax. However, in this case, the TRP may have mitigated what would otherwise have been even greater increases in costs for smallholders. Pending further investigation, the Government of PNG should adopt a balanced approach to its export driven economic recovery strategy so as not to compromise the country’s rich stock of food-crop diversity, which supports 85 per cent of the population. Moreover, the introduction of any new crop varieties should include a clear message that those crops are introduced in addition to the existing stock of food crops, and should not displace them.

In light of difficulties associated with gathering data, the following policy recommendations propose further study to explore more fully the questions that were examined in the study, and to move forward to address some of the additional questions raised by the study itself.

• Further studies should be developed to consider the impacts of trade taking into account a broader range of biodiversity (forest, aquatic, marine, and all food crops).

• A second phase of this IA should be initiated to focus on developing new policies and strengthening existing policies with respect to domestic legislation in the following areas:
  (a) encouraging sustainable farming practices with a focus on revenue and combined farming systems options;
  (b) strengthening the national capacity for robust research, development and maintenance of food-crop cultivars; and
  (c) implementing the current export crop rehabilitation and expansion plan with due consideration to maintaining food crop diversity.

• Legislation should be developed to protect food-crop biodiversity through agricultural and forest certification standards.

• A new study should be undertaken to examine the status of the diversity of all important traditional food crops in order to develop baseline information. In addition, a monitoring system should be established to track changes in diversity, including in relation to developments that include plantation crops.

• The following measures should be put in place because the decline of diversity in taro and sweet potato are not associated only with the expansion of export crops, but also with the introduction of new varieties:
  (a) an awareness-raising effort to focus on the importance of traditional food crops and an action plan that addresses root causes of declining diversity; and
  (b) the introduction of new crop varieties with a clear message that those crops are in addition to existing crops and that they should not replace the existing stock of food crops.

• Environmental impact assessment and strategic environmental assessment for cash crops should be commissioned by the Government of PNG as way to balance the interests of export crops with the food crops.
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1 Introduction

This study is an integrated assessment (IA) of trade-related policies in Papua New Guinea (PNG), with a focus on biological diversity in the agricultural sector, and in particular with respect to the genetic diversity of sweet potato (*Ipomea batatas*) and taro (*Calocassia esculenta*). The IA responds to concerns that trade liberalization and the development of trade-related policies and reforms, may not sufficiently take into account potential effects on the conservation and long-term sustainable use of the full range of agro-biodiversity.

The overall objective of this study is to create the necessary support and capacity in PNG for planning and implementing sustainable national economic development and poverty reduction strategies, while strengthening efforts to conserve biodiversity. A critical area is to enhance capacity to assess, design and implement trade-related policies in the agricultural sector that support these objectives. One vital area of concern is the maintenance of agro-biodiversity in staple food crops and that is why the IA focuses on two key food crops: sweet potato and taro.

In order to achieve the overall objective, there are several goals associated with this IA including the following:

- to build national capacity to assess the environmental, social, and economic impacts of the tariff reduction programme, with an emphasis on impacts on biodiversity, including sweet potato and taro varieties;
- to build capacity among trade negotiators and policy makers to encourage sustainable agriculture trade;
- to improve the understanding of the factors that lead to loss of agro-biodiversity;
- to build capacity to develop and implement integrated national responses to the results of this pilot project; and
- to engage civil society in PNG in assessment and policy making, and in sustaining agro-biodiversity.

The IA also aims to provide a better understand of the impacts of trade liberalization on the agricultural sector with respect to changes in the export-crop sector – in this case, coffee and oil palm – and subsequent impacts on the staple food sector – in this case, sweet potato and the taro – and its related genetic diversity.

Chapter 2 presents the background to the agricultural sector in PNG and introduces the IA, which tackles issues related to the structure of the agricultural sector, whether expansion of area under cultivation of cash crops for trade has occurred at the expense of subsistence crops, and what this means for biodiversity. The key trade policy being examined is PNG’s Tariff Reduction Programme (TRP), in the context of the Government’s Medium Term Development Strategy (MTDS), an important component of which is to pursue export-led economic recovery in the country.

In Chapter 3 the IA presents the sectoral and spatial focus of the IA. It introduces the major food crops being analyzed – sweet potato and taro – along with the two most important export crops in PNG – coffee and oil palm. The crops are considered in pairs to trace impacts of changes in export-related agriculture to subsequent impacts on subsistence food crops. Coffee is considered with sweet potato in the Eastern Highlands Province (EHP) and oil palm is paired with taro in the West New Britain Province (WNBP).
Chapter 4 presents the IA methodology that was employed in this study. It begins by developing a conceptual framework that illustrates the complex relationships between export crops, food crops, biodiversity and human well-being. In addition, five scenarios were presented that detailed how the increased production of export crops could arise as a result of liberalization and how this could affect land use, substitution, and ultimately declining crop diversity. To analyze these issues, the IA used a combination of desk research, a field survey and interviews with farmers.

Chapter 5 presents the results of the IA. Through a focus on selected indicators, the IA examined how the export crop sector and the subsistence crop sector were changed as a result of the TRP and related policies. It proved difficult to determine the impact of the TRP on diversity in food crops because the tariff had been introduced prior to the study and there was no baseline data from which to measure the effect of changes. As a result, a qualitative assessment of key indicators was undertaken. Much of the data that were analysed were collected during the field survey.

The IA examined, inter alia, a hypothesis that sweet potato diversity is coming under severe threat of erosion due to a thriving coffee industry. Income from coffee is also used to purchase imported rice and wheat, which are substitutes for sweet potato, thus reducing demand for food crop production and further threatening to narrow the sweet potato genetic base, while exposing the food industry to vulnerability to pests and disease. In areas where coffee is grown intensively, it was observed that there were lower numbers of sweet potato varieties, which implies that export crops compete with subsistence crops and may play a role in declining diversity. The survey did not generate information related to the loss of taro diversity as a result of oil palm cultivation.

Chapter 6 includes some conclusions, noting that the IA found some evidence of a decline in crop diversity, along with an indirect causal relationship to trade policy. Respondents to the survey indicated that the two clear causes of declining genetic diversity were: the introduction of superior varieties, which discouraged the cultivation of a wide range of cultivars, and socio-cultural factors, particularly with respect to taro where a cultivar is destroyed following the death of someone who has claimed to have discovered that cultivar.

In Chapter 7 recommendations are presented. The IA should help contribute to the development of a comprehensive policy for PNG, that considers various aspects of biodiversity, at a time when new policies are being developed and new bilateral and regional trade agreements are being negotiated.

Finally, the technical report included in Annex 1 provides details related to the individuals and organizations that made up the project team and the national steering committee that guided the work. It also presents a summary of the stakeholders involved and the meetings that were held over the course of the project. Further, it provides additional details related to the methodology, including the major challenges that faced the project team, along with specific achievements.
2 Background

PNG is the largest of the Africa, Caribbean and Pacific (ACP) countries in the Pacific region and is also one of the most diverse countries in the world - geographically, biologically, linguistically, and culturally. It has an abundance of natural resources, providing home to roughly five to seven per cent of the world’s biodiversity. Geographically, the country is very mountainous with rolling foothills, coastal lowlands and floodplains. The land area is 459,854 square kilometres ($km^2$), consisting of over 600 islands and over two million $km^2$ of sea. Only about 27 per cent of the landmass is occupied because of the presence of volcanoes, mountains and floodplains. The largest numbers of people live in the fertile highland valleys, an area that has supported agriculture for around 10,000 years. At that time, the staple food crops were sugar cane, taro, edible greens and some species of the Pacific banana. The sweet potato was introduced to PNG roughly 300 years ago and quickly became the most important staple food crop.

PNG gained its independence from Australia in September 1975, and adopted a parliamentary system of government. It has three levels of government: national, provincial and local. Since 1996 a decentralized system of government has been adopted to give people direct access to the government at the local level. There are 20 provinces (including the National Capital District), 89 districts and many local level governments.

2.1 The importance of agriculture and biodiversity

PNG is rich in natural resources, which include rain forests that cover over 70 per cent of the land, a rich marine life, agriculture potential and significant deposits of oil, gas, gold, copper and other minerals. The national economy is largely dependent on the exploitation of these natural resources dominated by the capital-intensive oil, minerals and forestry sectors. Although, there have been fluctuations in gross domestic product (GDP) over the past 10 years, GDP per capita has been growing at a rate of Kina (K)131 per year, with growth rates of around K2,000 and K2,500 in 1996 and 2002, respectively.

Actors in PNG’s economy range from the subsistence level to the market level. In between is the smallholder cash cropping of coffee, cocoa, vanilla, and copra, integrated with food crops. About 75 per cent of the population depends on the subsistence economy. The market sector includes minerals, forestry, fisheries, and oil palm, and is dominated by large foreign investors.

Despite its rich biodiversity and generous resource endowment, the Government of PNG continues to be challenged by the prospect of delivering economic growth and prosperity to its six million people. For a small and open economy facing increasing globalization, it is important that the inherent linkages between biodiversity (and agro-biodiversity), trade and social well-being are recognized as the cornerstones of sustainability. Therefore it is

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1 Over 700 languages are spoken in PNG. Pidgin and Hiri Motu are the most widely used, while English is the official language of business, government and education. The different languages parallel different customs and lifestyles associated with marriage and wedding rituals, land and other titles transfer systems, traditional dispute settlement mechanisms, forms of ceremonial dancing and the associated costumes, tribes and clans, and how they relate to animals, mountains, plants, and even food crops as clan or tribe totems and lore. Sometimes social, economic and political complexities in the country are linked to this diversity. Yet, in general, the country has progressed fairly well as a nation-state in its modern history.

2 A new government is elected every five years, and head of state is Queen Elizabeth II, represented by a Governor General.
imperative that the development of all economic and social development policies reflect environmental and biodiversity dimensions.

Agriculture is the foundation of the rural economy in PNG and is considered to be at the heart of the nation (NADP 2007). The sector produces food for subsistence, provides a basis for employment and income generation for over 85 per cent of the rural population, and contributes between 25 to 38 per cent of total GDP.

Of critical importance in the agricultural sector is the strong pressure on land for the production of staple foods, such as sweet potato, banana, taro and other leafy vegetables for a population that is growing at a rate of 2.7 per cent per year. This presents a significant threat to food-crop diversity, other life supporting ecosystem services, and food security, and magnifies levels of poverty. At the same time, the pursuit of economic growth has attracted domestic and export-oriented cash industries such as coffee, cocoa, oil palm, timber (logging), open pit mining, and fisheries. While these industries have delivered significant benefits to the country, they have also contributed to land shortages for the production of staple crops.

The need to protect biodiversity in general, either directly or indirectly through other ecosystem networks, is absent in the development of most policies and initiatives. This finding is confirmed by the consideration of sectors in isolation where there is a common denominator to protect levels of overall food-crop diversity. There is also a strong hypothesis that competitive food imports (particularly rice and wheat) and the lower cost of agricultural inputs resulting from tariff reductions are influencing food production and threatening agro-biodiversity. Furthermore, the need for imported food is rising due to changing consumer preferences, which tend to be based on income levels.

Most of the conclusions in this study refer to agro-biodiversity and its impact on livelihoods as defined by the CBD as, “a broad term that includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agro-ecosystem: the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem, its structure and processes” (CBD Decision V/5, appendix). Additional specific comments will be made on biodiversity, which includes the diversity of landscapes, ecosystems, communities, populations and genes.

2.2 The integrated assessment

This IA has been undertaken with the cooperation of relevant stakeholders to reflect the importance of the linkages between the economy, agriculture, social well-being and biodiversity. It has contributed to the development of capacity and skill to add innovative dimensions to integrated policies that address the social, economic and environmental priorities in the country.

Food-crop biodiversity is a small, but significant, subset of the biodiversity, ecosystems and livelihoods in PNG, and is the focus of this project. The IA has advanced awareness, secured cooperation, built capacity and skills, assessed gaps and impacts, and developed recommendations to adopt, and strategically implement policies. It has also offered insights to stakeholders for establishing monitoring and evaluation frameworks.
The first step involves reviewing policies in relevant sectors (domestic and trade-oriented) and identifying and assessing important characteristics and issues. From this, a conceptual framework is developed which suggests criteria and indicators for the assessment. On a global scale, international trade agreements and rules to which PNG is committed are assessed, primarily because of the indirect impact of trade on the diversity of domestic staple food crops, which are at the core of this study.

At the impact assessment level the TRP is the trade instrument which forms the reference of analyses of the impact assessment of trade. This is considered relevant given that in the past five to ten years, PNG has undergone significant fiscal and structural changes, including a sequential tariff reduction schedule, privatization, land mobilization, floating the national currency, and the introduction of a user-pay policy and a value-added tax (VAT). This has resulted in the depreciation of the Kina, amendments to provincial and local laws governing the organic sector, among other responses to external and internal shocks. The project uses case studies to explore the impact of the tariff reductions in the TRP, examining sweet potato (with second level impacts on coffee) and taro (with second level impacts on oil palm).

2.3 The stakeholders

The involvement of stakeholders in an agenda that affects them in one way or another is crucial to the success of the undertaking as it confers ownership, partnership, comprehensiveness, transparency, understanding as well as efficient resource mobilization. This project has identified and involved several stakeholders who have contributed substantive and procedural ideas to the project team, with the view to developing an integrated policy package that is practical, comprehensive, forceful, and that will provide a sustainable outcome. The key stakeholders involved, either through their contribution to the research or through the national steering committee, are listed in Table 1. A more thorough description of the range of stakeholders involved in the IA, along with the meetings held and the various challenges faced, is included in a technical report in Annex 1.

<table>
<thead>
<tr>
<th>Department or organization</th>
<th>Major function</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Department of Foreign Affairs and Trade</td>
<td>Responsible for all policies relating to international trade and foreign policies. It is also the lead government agency of this project.</td>
</tr>
<tr>
<td>The Department of Environment and Conservation</td>
<td>Formulates and implements policies related to the environment and the sustainable use of ecosystem services.</td>
</tr>
<tr>
<td>The Department of Agriculture and Livestock</td>
<td>The overarching policy body for national agricultural development.</td>
</tr>
<tr>
<td>Department of Commerce and Industry</td>
<td>Responsible for investment policies, particularly at the domestic level.</td>
</tr>
<tr>
<td>The Department of National Planning and Monitoring</td>
<td>Responsible for national project planning, development and aid coordination as well as monitoring and evaluation of projects.</td>
</tr>
<tr>
<td>The Department of Treasury</td>
<td>Ensures that appropriate fiscal policies are in place consistent with the development agenda of the government as outlined in the MTDS. Also responsible for determining the tariff structure.</td>
</tr>
<tr>
<td>The National Agricultural Research Institute (NARI)</td>
<td>The state funded research institute mandated to conduct applied, adaptive and development oriented research on food crops, emerging food and cash</td>
</tr>
</tbody>
</table>

5
Department of Lands and Physical Planning | Responsible for land policy, management and development.
---|---
Department of Justice and Attorney General | Responsible for law and justice sector of PNG.

**The other national agencies and NGOs**

| National Research Institute (NRI) | Research on policy and social and economic issues pertaining to development in PNG.
| Coffee Industry Corporation (CIC) | Responsible for driving coffee industry through research, extension and development standards.
| Oil Palm Research Association (OPRA) | Research into all aspects of oil palm development.
| Oil Palm Industry Corporation | Responsible for driving oil palm industry through extension and development standards. It also mobilizes and helps smallholder farmers to achieve standards in oil palm production.
| Vudal Agricultural University | The university provides education in agriculture, forestry and fisheries development.
| National Statistics Office | National statistics and data management.
| Papua New Guinea Institute of Biodiversity (PINBio) | A secretariat within the Department of Environment and Conservation that addresses biodiversity issues.
| Rural Industry Council | A rural industry forum.
| The World Wide Fund for Nature | International NGO.
| Conservation Melanesia | NGO.
| Nature Conservancy | NGO.
| United Nations Development Program (UNDP) | UNDP work in Papua New Guinea.
| Office of the Prime Minister’s Department | Office of the National Executive Council.
| Fresh Produce Development Agency (FPDA) | Involved in extension work on fresh produce.

### 2.4 Trade context

At a time of increasing economic interdependence among countries around the world through globalization, PNG has engaged in the international arena by pursuing and exploiting trade liberalization, foreign direct investment and global production chains. From the perspective of wealth creation, these avenues can contribute to the country’s overall goal of national economic development.

Given the strong interrelations between trade, investment and industrialization, in conjunction with pursuing economic growth, PNG has made an effort to liberalize its trade policies since its entry into the World Trade Organization (WTO) in 1997. Despite the absence of a comprehensive trade policy, at the national level PNG liberalized trade barriers in 1999 through the TRP. The TRP resulted in an immediate reduction in tariffs under three tariff rates (intermediate, protective and prohibitive) with the announcement that further reductions would result from a review that would be conducted within the next eight years. The TRP reduced the import tax to zero on all agricultural inputs including machinery, chemicals, and tools. In an effort to encourage the productivity and competitiveness of local industries, the TRP also reduced tariffs on all agricultural imports over the last eight years to the 2006 rate. Only a small number of products are
bound at 40 per cent. The tariff rate on sugar is currently bound at 79 per cent, but will have been reduced to zero by 2020.

At the international level, PNG has been involved in trade negotiations that have resulted in bilateral and regional trade agreements with its traditional trading partners as well as with new partners. These include bilateral agreements with both Fiji and Australia. At the regional level, PNG is a member to the Pacific Island Countries Trade Agreement, the South Pacific Agreement on Regional Trade and Economic Cooperation Agreement, the Melanesian Spearhead Group, and the Asia Pacific Economic Cooperation forum. It is also negotiating an Economic Partnership Agreement (EPA) with the European Union (EU), along with other ACP countries, under the Cotonou Agreement.

PNG’s membership in the WTO obliges it to ensure that all of its trade agreements are compatible with WTO rules. These rules do not take into account other important issues, such as the need to protect its rich biodiversity, including agricultural biodiversity. However, PNG is also a party to multilateral environmental agreements that relate to agricultural biodiversity and conservation, notably the CBD. The CBD obliges PNG to contribute to the protection of world’s biological diversity, including the genetic diversity of food crops. The onus is on PNG to take the appropriate steps at the national level to ensure this protection through the development and implementation of specific policies in order to meet its international commitments, while maintaining a balance, among economic, social and environmental priorities.

At the domestic level, the policy document that captures the overall plan for economic and social development for PNG is the MTDS 2005-2010, which was adopted in 2004. The MTDS guides all development policies including those related to agriculture, trade, the environment and social well-being. It is based on the UN’s Millennium Development Goals and on ten guiding principles.

The TRP is most closely connected to the MTDS principle on “Competitive Advantage and the Global Market” which calls for a focus on “interventions on resources, products, and commodities in which PNG enjoys a competitive advantage in global markets.” This principle implies an acceptance of the opportunities presented by trade liberalization, whereby countries should be encouraged to make efficient use of their resources by specializing in the production of goods and services best suited to their resource base. It also recognizes the need for international competitiveness in exploiting opportunities in the global economy, to overcome the limitations in the domestic market (Schollay 2007).

One of the five major pillars which make up the framework of the MTDS is “Export Driven Economic Recovery”. All efforts to pursue economic growth through increasing exports have been undertaken with very little recognition of the sustainable use of agricultural biodiversity, especially genetic diversity, with respect to sweet potato and taro.

PNG has in place a draft of a trade policy framework, which was developed with the assistance from the United Nations Conference for Trade and Development, following a request from the Government of PNG. The draft attempts to bring together trade-related issues, including policy areas that are outside the jurisdiction of the Department of Foreign Affairs and Trade. It seeks to encourage the growth and diversification of exports and will support the Government’s program of economic reform through building

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3 PNG also has other agreements with Australia, such as the Australia-PNG Trade and Commerce Relations Agreement.
and strengthening capacity for trade and trade-related policy design and implementation. The policy is also designed to promote export-led development and enhance the pace of regional and global integration.

At the same time, the draft policy takes into account the development objectives contained in the MTDS and the liberalization in the global economy. However, the draft has not benefited from widespread consultations; information and data were sourced only from two major cities (Lae and Port Moresby). Therefore, work remains to collect and collate data from other parts of the country before finalizing the trade policy.

It was anticipated that a comprehensive trade policy would be developed within a few months of the release of the draft in 2006, but this did not occur. It is difficult to predict when a comprehensive trade policy regime will be finalized, but given the existence of the draft, there is a strong expectation that such a policy will be established within the next two to three years. All that is required is to address the major factors behind the delay including better resource mobilization, strengthening capacity, and securing cooperative partnerships with stakeholders. Addressing these issues would improve the likelihood of the development and implementation of a comprehensive trade policy.

Despite the absence of a comprehensive trade policy, the Government of PNG has successfully implemented several trade-related instruments and strategies. In 1986 a review of tariff policy was undertaken (the Bogan Report), followed by a review by the World Bank in 1996, which resulted in the TRP in 1999. Additional reviews were undertaken in 2003 and in 2006.

In 2003, through the TRP, PNG further reduced its tariff rates in a bid to address the issues of efficiency and productivity. This was in response to the findings of the 1997 White Paper on TRP (GoPNG 2003), which indicated that the previous tariff system had resulted in relatively high nominal rates of protection for some domestic companies, but had made several other companies less competitive by taxing their inputs and raw materials. Therefore, effective protection had been undermined by tariffs on inputs. In this regard, some industries (including agriculture) were said to have been ‘negatively protected’. In 2007, PNG reviewed and reduced tariffs schedules again in conjunction with the negotiation of the EPA with the EU.

Given current developments (both internally and externally), the need for PNG to have in place a comprehensive trade policy is of vital importance. Following the conclusion of the EPA negotiations, it is anticipated that PNG will enter into additional bilateral and regional trade agreements. A comprehensive trade policy should be in place within the next five years.

2.5 Overview of relevant national policies

The first environmental policy in PNG was established in 1976 and was not revised for almost 30 years. It included the following five key principles: (1) that development be economical, social and ecological; (2) that non-renewable resources be used ‘wisely’; (3) that the ability of the environment to produce renewable resources was recognized; (4) that wildlife and their habitats be protected and wisely managed; and (5) that planning be applied to human settlements and urbanization. Since then, PNG has developed several policies and strategies that relate directly to the conservation and sustainable use of biodiversity, bio-safety, genetically modified organisms (GMOs) and other issues relevant to agricultural biodiversity. Some of these are outlined briefly below.
**Papua New Guinea Biodiversity Strategic Action Plan (PNGBSAP).** The PNGBSAP aims to streamline major national policies that focus on biodiversity conservation. The PNGBSAP provides a coherent and consistent framework for the implementation of these policies so that PNG’s international environmental commitments are implemented by all government agencies. The main objectives are to support the Government’s development of the PNGBSAP; to support the Government’s development and establishment of the Papua New Guinea Protected Areas Initiative; and to support the Government’s development of a national bio-safety framework (GoPNG 2005).

**Plant Genetic Resource Strategy (PGRS) for Papua New Guinea, NARI, 2005.** The NARI, custodian of the nation’s food-crop biodiversity, developed PNG’s PGRS in 2005. Its guiding principles are as follows:

- to recognize ‘the diversity in plant genetic resources of crop plants as important in improving PNG’s agricultural productivity and sustainability’;
- to recognize that the major threat to genetic diversity is ‘genetic erosion’ which can be caused by land development (such as plantations and mining), natural disasters (such as earthquakes, volcanic eruptions, droughts and frosts), exotic pests, and increased commercialization and the resulting behavioural and cultural changes;
- the biodiversity of genetic resources is best conserved both *in situ* and *ex situ*; and,
- national policies and legislation provide the foundations for the successful implementation of programmes for conservation, management and sustainable use of plant genetic resources.

The general objectives of the PGRS reflect the rationale behind the UN Food and Agriculture Organization’s Global Plan of Action on the conservation and sustainable use of plant genetic resources and take into account the objectives of the CBD. The PGRS aims to conserve PNG’s rich diversity, to maintain, manage and sustainably use these valuable resources, to fairly and equitably share the benefits arising from the use of genetic resources, and to enhance technical and scientific cooperation nationally, regionally and internationally (including through the exchange of information) to support germplasm conservation, documentation, and use.

An emphasis on the conservation of plant genetic resources in PNG began in the mid-1970s when the country joined the South Asian Regional Programme on Plant Genetic Resources under the auspices of the International Plant Genetic Resource Institute. Under the program several field collections of taro, sweet potato, banana, aibika, yam and cassava were established at Bubia (Morobe), Kerevat (East New Britain Province), Laloki (Central Province) and Aiyura (Eastern Highlands Province). A total of over 500 accessions of bananas, 500 accessions of yams, 142 accessions of aibika, 87 accessions of cassava and over 900 accessions of taro were collected. However, since the establishment of these germplasm collections, no formal conservation and management strategy has been developed and no funding has been forthcoming to support this activity. Therefore, the collections have been maintained on an *ad hoc* basis, resulting in the loss of much of the original germplasm that had been collected. There are also accessions of introduced banana in the collections at Laloki, Kerevat and Aiyura, Africa yam (*Dioscorea rotundata*) at Bubia, sweet potato at Aiyura and Kerevat, and taro at Bubia and the PNG University of Technology.

**Draft Biosafety and Biotechnology Policy 2005.** PNG’s Biosafety and Biotechnology Policy has four main objectives. Two of these are: to ensure safe handling, use and
management of GMOs for the safety of human health and biodiversity protection and to regulate the trade in GMOs that may have harmful effects on health, the environment and biodiversity. There have been two positive outcomes of this policy. The first is a draft policy adopted by the stakeholders for presentation to the government for approval, and the second is that the Government has now ratified the Cartagena Protocol on Biosafety.

**National Agriculture Development Plan (NADP) 2007.** The NADP is the most robust and aggressive policy that has been implemented in this sector in PNG, designed to revitalize its agricultural sector. The NADP aims to promote the sustainable and productive development of agriculture through well-defined national priorities and programmes, improved coordination, and cross-sectoral coherence. Its vision is to achieve economic growth for farming communities, innovative skills and service delivery, improved partnerships, improved farming practices, and strengthened institutional capacities, all in response to national goals. Priority attention is given to the development of food crops and horticulture, including sweet potato, taro, and industrial crop development (such as coffee and oil palm). In the medium term, the NADP has an annual budget of K100 million (about US$33 million) to revive the agricultural industry. The largest share of this is directed to the rehabilitation of cash tree crops. Tree-crop rehabilitation is linked to export policies and is relevant for the IA because the expansion and rehabilitation of tree-crop plantations will have direct impacts on biodiversity (GoPNG 2007).

**National Population Policy 2000-2010.** The National Population Policy 2000-2010 is a comprehensive document that includes details on issues related to the population in PNG and suggests strategies to overcome challenges. It includes 12 policy goals and several strategies. Notably, it calls on government agencies, NGOs and other partners to integrate issues related to population into planning for development. The aim is to achieve a population growth rate of no more than 2.1 per cent by 2010 and below 2 per cent by 2020. The population policy expressly identifies sustainable development as the key principle for development planning.

**National Forest Policy 1990.** The National Forest Policy 1990 is aimed at streamlining and strengthening access to forest resources and their use. The policy includes strategies on management, the industry, research, training, education, organization, and administration related to forests. The policy expressly promotes the conservation of forests.

**Draft Eco-forestry Policy 2003.** The Draft Eco-forestry Policy 2003 aims to complement the National Forest Policy by strengthening the management and protection of the country’s forest resources through the regulation of eco-forest activities. The key features are: national forest and biodiversity inventories; small- and medium-sized sawmills; biodiversity conservation; support for ecotourism; non-timber forest products, agro-forestry, woodlots and community tree nurseries. It is relevant for protected areas because the Government of PNG is committed to biodiversity conservation and protection. It represents an attempt to create a cohesive framework for the implementation of commitments under the Forest Principles, the CBD, and the Tropical Timber Agreement.

**Draft Carbon Trade Policy.** In 2005, the Government agreed to explore opportunities for the country’s development under the Kyoto Protocol, but this was not actively pursued. However, the Papua New Guinea Institute of Biodiversity (PINBio) has promoted research and development projects related to the Kyoto Protocol. The draft Carbon Trade
Policy was formulated in July 2005 and was presented to the Government for endorsement. Although a report shows that the draft has been approved and was to be made public by the end of 2005, its current status is unclear. The Carbon Trade Policy is consistent with the Government’s ‘export driven economic growth’ policy and an integral part of its goals related to food-crop biodiversity and biodiversity in general.

Decentralization (Organic Law and Provincial and Local Level Governments). In 1995 the provincial government system was reformed to allow for greater accessibility by the people to the government and for efficient delivery of government goods and services to the people. It includes a provision that has a significant impact on the sustainable use and management of biological diversity. Section 98 covers benefit sharing from the development of natural resources. However, to date policies have been ineffective and disconnected and raise questions about how any new trade policy will translate into tangible development gains, particularly in the context of agricultural biodiversity.

3 Sectoral and spatial focus

This IA focuses on the effects of the TRP on the export cash crop sector, the semi-subistence crop sectors and how this, in turn, impacts agro-biodiversity related to the sweet potato and taro. Attention has been paid to how the structure of the agricultural sector, and in particular the export crop and subsistence crop sectors, have changed since the introduction of the TRP. The changes related to the export crops of coffee and oil palm, and to the subsistence crops of sweet potato and taro, are examined as indicators of overall change.

The analysis revolved around the issue of whether expansion of area under cultivation of cash crops has occurred at the expense of subsistence crops. The type of land on which cash crops expand has important implications for agriculture, food crop biodiversity, the environment, and different types of biodiversity. For oil palm, the Government’s guidelines have directed that farmers use two hectares of land for garden (subsistence crops) and four hectares for oil palm, but this is now changing. Some farmers have changed the proportions of their planting as result of changes in cash incomes and their own preferences. Changes are also due to access to different markets and improvements in infrastructure.

Other factors that influence agricultural land use include the effect of exotic food crops (such as locally grown rice and wheat), and the effect of imported foods (particularly rice and wheat). The connection between rice and wheat and food crop biodiversity is that they attract consumers away from staple foods and towards imported food, particularly when income levels rise, when the price of imported food is competitive, and when the imported food can substitute for the stable food.

These structural shifts are the basis for exploring the relationship between changes in agricultural production and land use, and biodiversity. The volume and value of export crops and imported food substitutes are important for the analysis of impacts of tariffs on food-crop biodiversity.

3.1 Sectoral focus

Agriculture in PNG can be divided into two sectors: the export commodity sector and the food crop (semi-subistence) sector. The export sector consists primarily of coffee, oil palm, copra, cocoa, rubber and tea. This project focuses on food crops, which have no
direct link to trade. However, food crops are linked indirectly to trade because food crops and export crops compete for land and other resources. Improving terms of trade are expected to encourage the production of export crops, taking up more forest and garden land at the expense of food crop diversity and other biodiversity. The project has assessed the impacts of trade on the food crop sector, based on the assumption that overall increases in exports will result in increases in exports in the food crop sector. For the purposes of the IA, the food crop sector is being employed as a case study.

In terms of oil palm and taro production, the IA focuses on WNBP because production is well established, and taro is a predominant food for the local population. The area of village land available for food production is shrinking due to increases in family size, yet income from oil palm cannot sustain the expanding families. This could have some impact on the loss of genetic diversity of taro, which is largely grown and consumed by the indigenous population of WNBP.

### 3.2 Food crop sector

#### 3.2.1 Sweet potato

The food crop semi-subsistence sector consists primarily of garden crops ranging from sweet potato, banana, taro, yam, and a wide range of leafy vegetables, to a limited stock of introduced grain crops, among several others. It is important to realize that food crops are an alternative to the missing ‘social security’ systems that are found in some other countries. Although the intensity of the staple diet may vary from region to region, nationally sweet potato is the most dominant staple food crop.

**Map 1: Potential areas for production of sweet potato in PNG**

Spatially, while sweet potato can potentially be grown in the lower regions of the country, it is predominantly grown in the highland regions (Eastern Highlands, Western Highlands, Southern Highlands, Enga, and Simbu Provinces) where 40 per cent of the
country’s six million people live (see Map 1). Coffee is the predominant cash crop in these areas (see Map 3). This means that all coffee growers are also sweet potato growers, implying competition for land between coffee and sweet potato production. This relationship introduces a hypothesis that sweet potato diversity is coming under severe threat of erosion in the face of a thriving coffee industry. It has also been established that income from coffee is used to purchase imported rice and wheat, which are substitutes for sweet potato, thereby reducing demand for food crop production and increasing the risk that the genetic base of the sweet potato will shrink, making the food crop sector vulnerable to pests and disease.

Apart from being a major source of household food, sweet potato is also fast becoming a commercial crop in its own right, creating a chain of vibrant local markets as well regional markets in Lae and Port Moresby, and supporting over 85 per cent of the population. This indicates that a specific set of consumer-preferred sweet potato varieties could be dominating the food gardens in the highlands, potentially diminishing diversity. High preferences are due to better market access and this threat could be compounded if the sweet potato market is fully developed in the future.

3.2.2 Taro

Taro is an important food crop in PNG in terms of history and culture, genetic diversity, food security, climate and geographic suitability, and in terms of its contribution to the economy. For decades, taro has been the third most important indigenous staple food product in PNG, after sweet potato and banana. It is estimated that 436,000 tonnes of taro are produced annually on an area covering 77,000 hectares (Ghodake et al. 1993; Sar et al. 1997). Taro is an ancient crop in PNG, and there is archaeological evidence of wetland taro cultivation as far back as 9,000 years ago in the Kuk/Baisu area of the Western Highlands Province. Although the crop is believed to have originated in the Indo-Malay region, PNG now has the world’s largest genetic diversity of taro (Ghodake et al. 1993). At present, taro is grown in all the lowland areas of PNG, and it performs best in these lowland locations. However, taro cultivation also occurs in the highlands including the Star Mountain area of the Western and Simbu Provinces with altitudes of 2,400 and 2,700 metres, respectively (see Map 2).
3.3 Export sector

Coffee and oil palm were selected for the IA because they are the two dominant export crops. In one case study, the IA pairs coffee and sweet potato production and in the second, it pairs oil palm and taro production, because of their respective geographic coexistence, the former in the highlands and the latter in the lowlands.

3.3.1 Coffee

Coffee was introduced to southern PNG in the early 1890s and to the north in the early 1930s. Smallholder coffee farming began in the 1950s in the Asaro valleys of the eastern highlands. Coffee has been planted in the coastal provinces since 1900 (NGHCE 2008).

Until recently, coffee had been the major agricultural export crop with an average export volume of 60 000 tonnes contributing around K350 million annually to the economy. The industry is the major cash income earner for 2.5 million people (almost half the total population) and it has the capacity to double its export volumes to reach 120 000 tonnes per year (CIC 2008). The industry therefore has the potential to further improve the standards of living for rural Papua New Guineans.

Coffee is grown predominantly in the highland regions but is also a significant cash crop in some coastal regions (see Map 3). Approximately 95 per cent of the coffee produced in PNG is Arabica, which is grown in all of the highland provinces with altitudes between 1 000 and 2 000 metres. The remaining five per cent is Robusta coffee, which is grown in the lowlands of Northern Sepik, Morobe, Madang and other coastal provinces. The Western Highlands Province produces 44 per cent of the total crop, Eastern Highlands 31 per cent, Simbu 10 per cent, Morobe seven per cent, East Sepik three per

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4 CIC (2008) and the researchers’ calculations.
cent, Enga three per cent, Madang one per cent and Southern Highlands one per cent (NGHCE 2008). The coffee growing areas are indicated on Map 3.

Since the introduction of the TRP and as a strategy behind the Government’s export-driven policy, a regulatory body, the CIC, has been established. The CIC coordinates the industry to improve supply conditions through instruments such as cooperative societies, issuing licences to processors, exporters, and roasters, encouraging organic coffee certification and fair trade, organizing transportation, and administering quality control. This strategy is making coffee a competitive industry and as a result the coffee industry is undergoing both intensification in production and extensification.

**Map 3: Production potential Arabica coffee growing areas in PNG**

![Map of PNG coffee growing areas](image)


### 3.3.2 Oil palm

Oil Palm is grown in five areas in PNG: Hoskins and Bialla (WNBP), Popondetta (Oro Province), Alotau (Milne Bay Province) and Poliamba (New Ireland Province) and has the potential to grow in most other lowland regions (see Map 4). All project areas operate on a nucleus estate-smallholder model whereby smallholders supply oil palm fruit to mills operated by the nucleus estate company. In WNBP smallholder production is located on Land Settlement Schemes (LSS) (state-leased land) and on VOP schemes. VOP schemes were introduced after the LSS schemes and were established to encourage more involvement in the industry by local villagers. Presently, there are over 100,000 hectares of oil palm in PNG, of which 43,000 hectares are smallholder plantings.

The Hoskins and Bialla oil palm schemes in WNBP were established in 1968 and 1972, respectively. Both are based on a nucleus-estate model whereby land settlement subdivisions are located near private estate plantations. The estate companies service smallholders by supplying planting materials, extension services, and transport to carry smallholder fruit to the company mills for processing.
The labour force recruited to the LSSs from other provinces are allocated individual leasehold blocks of 6 to 6.5 hectares, of which four hectares are planted with oil palm and two hectares are reserved for food production (Hulme 1984). Due to overpopulation in the highlands, resettlement programs were offered by the Government, which supplied blocks of land to workers to live on and to cultivate. As the industry expanded, villagers surrounding the nucleus estates were encouraged to plant two hectare plots of oil palm as part of the VOP scheme. This study focuses on the VOP schemes and not on the LSS.

Map 4: Production potential for oil palm growing areas in PNG


3.4 Spatial focus

3.4.1 Eastern Highlands Province

The EHP, marked red on the left in Map 5, was selected as an area of focus primarily because of its vulnerability to soil erosion and high loss of nutrients due to hilly terrain and unstable geological formations. Unlike other highland provinces, the EHP has a very high population density and arable land for the development of large coffee plantations and food crops is limited. This may have a negative impact on the genetic diversity of sweet potatoes, which is the staple food crop in the EHP. EHP is also considered representative given its climate and altitude, which are similar to other highland regions. Coffee was first introduced into the EHP during the Second World War and the province now has the largest number of large coffee plantations in the country, and about 200 000 smallholder coffee growers. According to the 2000 Census, the EHP covers a land area of 11 200 km² and has a population of 432 972.
3.4.2 West New Britain Province

The WNBP, marked red on Map 5, was selected as a focus region for this IA because it is an area where data can be easily collected. The VOP scheme was the focus of the survey, mainly to establish the status of taro diversity from the indigenous people of WNBP, rather than from the migrants. Land available for food production is increasingly subject to strong pressure due to increases in family size and increasing pressure on income from oil palm to sustain expanding families. The settlers who were recruited to grow oil palm are now diversifying their incomes through other activities. This could have a negative impact on genetic varieties of taro, which is a crop that is largely grown and consumed in WNBP.

3.5 Ecosystem values of Papua New Guinea

3.5.1 Biodiversity values

PNG is home to over six per cent of the world’s biodiversity and contains some of the world’s most biologically diverse communities (Shearman et al. 2008). The humid tropical and subtropical forests in the lowlands have been ranked among the world’s ten most ecologically distinctive forest regions (Bryant et al. 1997; Olsen and Dinerstein 1998; Brooks et al. 2006; Shearman et al. 2008). The mangrove forests are recognized as the most extensive and species-rich in the world; the tropical savannah woodlands are considered globally important because of their many endemic species; and its riverine ecosystems are recognized for their high levels of fish endemism and other distinctive species that depend on the surrounding forests.

The country has a rich faunal biodiversity and high degree of endemism. It has at least 191 species of mammals (of which over 80 per cent are endemic), 750 bird species (over half are endemic), 300 species of reptiles, 197 species of amphibians, 3 000 species of fish and an estimated 200 000 to 400 000 species of insects, most of which have yet to be described and classified (Sekhran and Miller 1994).
Although the status of many vertebrate species is currently unknown, some species are extremely rare and have very limited bio-geographical distinctions. The International Union of Conservation of Nature's list of most threatened animals in PNG includes 38 species of mammals, 26 species of invertebrates, 22 species of birds, and eight species of reptiles (IUCN 2006).

3.5.2 Forest values

Forests play a key role in the ecology and economy of PNG and are significant from a global environment perspective. PNG is heavily forested and dense tropical rainforests are dominant and integral parts of its nature and landscape. The forests also provide important services such as watershed protection, water filtration, coastal and reef protection, preservation of fish stocks, soil stability and fertility, aesthetic landscape benefits, and carbon sequestration. Indeed, the forests are the foundation to the country’s economy, society and ecology, and are the source of its wealth of biological diversity.

The forests have also sustained the human population for at least 40 000 years (Shearman et al. 2008). They provide food (plants, animals and fungi), commercial timber, and building materials for a large proportion of the population. In recent decades, demand for timber products from abroad has led to increased logging and exports, to the extent that a large proportion of some forest types and some regions have already been fully exploited (Bird et al. 2007).

Non-timber products provided by the forests include plants for food, medicine, ropes, building materials, stimulants, body decoration and adornment, art, utensils and canoes (Powell 1982). Some of the plants of value to Papua New Guineans are shown in Table 2. Hunting also sustains the livelihood of rural people. A recent study suggests that between 4.14 and 7.9 million vertebrate animals, comprising 10.95 to 20.90 million kilograms of biomass, are consumed each year across the country. This would amount to retail replacement value (in town, ignoring transport costs to rural areas) of approximately K75 million annually (US$26 million), for either tinned fish or lamb flaps, the cheapest source of meat (Shearman et al. 2008). Tempering ecosystems through agricultural and other development projects, especially for exports, can negatively affect this rich biodiversity.

Other commercially valuable non-timber products include resins, gums, meat for food, oils, sandalwood, and rattan. Forest-related commercial opportunities exists for butterfly farming, insect farming, orchid production, floriculture, crocodile hunting and deer, fish and cassowary farming, as well as handicrafts, ecotourism, and adventure tourism (Chatterton et al. 2000). The forests of PNG also hold an as yet unassessed value in terms of their biodiversity, gene pools, potential education services and pharmaceutical uses (Shearman et al. 2008). Some of the plants and their uses in PNG are shown in Table 2.
Table 2: Number of plants and their uses in Papua New Guinea

<table>
<thead>
<tr>
<th>Use</th>
<th>Number of plants</th>
<th>Category of ecosystem service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>229</td>
<td>Provisioning</td>
</tr>
<tr>
<td>Ash salt</td>
<td>17</td>
<td>Provisioning</td>
</tr>
<tr>
<td>Medicines</td>
<td>252</td>
<td>Provisioning</td>
</tr>
<tr>
<td>Narcotics, stimulants, intoxicants</td>
<td>10</td>
<td>Provisioning</td>
</tr>
<tr>
<td>House and shelter</td>
<td>100</td>
<td>Provisioning</td>
</tr>
<tr>
<td>Canoes and rafts</td>
<td>43</td>
<td>Provisioning</td>
</tr>
<tr>
<td>Tools and weapons</td>
<td>73</td>
<td>Provisioning</td>
</tr>
<tr>
<td>Hunting and fishing</td>
<td>44</td>
<td>Provisioning</td>
</tr>
<tr>
<td>String and bark cloth</td>
<td>31</td>
<td>Provisioning</td>
</tr>
<tr>
<td>Ropes used in housing and fencing</td>
<td>31</td>
<td>Provisioning</td>
</tr>
<tr>
<td>Personal ornaments</td>
<td>75</td>
<td>Cultural</td>
</tr>
<tr>
<td>Ritual magic</td>
<td>78</td>
<td>Cultural</td>
</tr>
<tr>
<td>Art</td>
<td>50</td>
<td>Cultural</td>
</tr>
<tr>
<td>Food preparation</td>
<td>30</td>
<td>Provisioning</td>
</tr>
</tbody>
</table>


4 Integrated assessment: methodology

The IA methodology involved several steps. First, stakeholder awareness and capacity building was developed through a workshop. In addition to introducing the process of IA, the workshop also helped identify important trade, development, and biodiversity issues with their associated indicators and criteria, and initial conceptual development. Second, a National Steering Committee (NSC) was established to provide policy and other guidance. Following this, a review was undertaken of relevant national policies, and the conceptual framework and indicators were refined. Desk research identified relevant secondary data (such as trade figures, and national data on economic and social indicators) and a field survey was developed and implemented, which provided further data for analysis.

Although the focus of the IA was to assess the impact of the TRP on the diversity of food crops, it was difficult to determine this because the tariff was already introduced before the study began and there was no baseline data from which to measure the effect of any changes. As a result, a qualitative assessment was undertaken of ‘secondary’ variables that were identified as important indicators. Specifically, these included the current state of taro and sweet potato diversity, income and food generated from these crops, the proportion of imported food (mainly rice) consumed, and the area of land under coffee, oil palm, sweet potato and taro cultivation.

4.1 Conceptual framework

A conceptual framework was developed that shows the relationship between export crops, food crops, biodiversity and human well-being (see Figure 1). It has been adapted from the Millennium Ecosystem Assessment (2005), modified to apply to the specific context in PNG in terms of trade policies and the links between the export crop and food crop sectors and biodiversity. Issues related to economic growth, population pressure, and food security are addressed through policies relating to trade, import substitution, and export-driven growth. Impacts are felt as a result of changes to the ecosystem landscape through the conversion of land and forest, and through agricultural intensification. These changes affect not only the environment and biodiversity, but also human well-being, which will be affected if the quality of the ecosystem services is compromised.
Several linkages have been identified. Trade liberalization leads to improved prices and markets for palm oil and coffee products, which enhance choices for export crop production. In addition, lower prices for imported agricultural inputs lead to intensification in export crop production, further affecting the extent of garden land (in addition to other existing pressures), thereby putting downward pressure on the genetic base of food crops. The export sector also attracts the labour force away from the food crop sector, reducing capacity for in situ conservation as the younger generation moves into modern economic sectors. Moreover, competitive prices for imported substitutes of staple foods encourage consumers to purchase the imported food, thus reducing demand for staple food production. In the wider biodiversity context, cultural, aesthetic and spiritual values, including those of existence and option, can deteriorate if the integrity of ecosystem services is not protected.

The conceptual framework also shows that conservation efforts can, to some extent, offset the degradation of biodiversity and declining ecosystem quality. Food crop biodiversity can be developed and protected through in situ conservation on the farm or in sanctuaries, along with ex situ conservation.

**Figure 1: Conceptual framework**

![Conceptual Framework Diagram](image)

Source: Professor Alan Quartermain (personal communication).

For the purposes of this IA, the conceptual framework was developed further to highlight the relationship between export crops and food crops and imported food versus staple food, to determine how the TRP and other trade instruments might indirectly affect food-crop biodiversity (see Figure 2). Trade can affect food-crop biodiversity in two main ways. The first is through the increased production of export crops and the second is through liberalizing imports of competing food products.

The increased production of export crops can occur in several ways. These are presented below as possible scenarios, which are illustrated in Figure 2.

- **Scenario 1:** production of export crops can be increased without converting any new land. This means that increased production would occur through improved farming practices, such as increasing the use of fertilizers (available at a lower price as a result of reduced tariffs). In this scenario there may a limited impact on
food genetic diversity, and the intensification means that no additional land may need to be put under agricultural production.

- Scenario 2: increased production of export crop can be achieved through conversion of land. This additional land could either be existing subsistence garden land and/or forest land. If additional production occurs on current subsistence land, the food garden may then be redeveloped by converting forest land. Both of these options will reduce arable land available to farmers for food crops, limiting their choice of food-crop cultivars.

**Figure 2: Relationship between export crops, food crops and imported food versus staple food**

![Figure 2: Relationship between export crops, food crops and imported food versus staple food](image)

*Explanation for the arrows:*

- **→** little, possible or potential impact,
- **→** little impact,
- **→** big impact,
- double-headed or connecting arrows = means impacting on each other.
The increased competition from imported substitute foods can affect food crop biodiversity under three different scenarios, which represent Scenarios 3, 4 and 5.

Scenario 3: local production of rice and wheat may result in declining crop diversity and could have negative impacts on income. The effect would be similar to that in Scenario 2 as the cultivation of rice and wheat would take land out of subsistence farming or convert forest land. This link is illustrated in Figure 2.

Scenario 4: certain varieties of staple foods preferred in the market would take land away from subsistence gardens and/or encourage the conversion of forest lands as in Scenario 3.

Scenario 5: imported foods attract consumers of staple foods leading to reduced demand for certain food crop production and to the neglect and eventual loss of some varieties. This would have a direct impact on the genetic base of food crops, although land use would not necessarily be affected.

The connection between export crops and food crops also affects other biodiversity, including the general ecosystem. This impact is shown using the circle representing the overall ecosystem, with biodiversity as a subset (the green rectangle). Food-crop biodiversity (represented by the red spot inside the rectangle) is a subset of biodiversity, but is nevertheless very important to PNG and is highlighted in this IA.

4.2 Data, data collection and tools

The types of data identified for the IA were both qualitative and quantitative and were obtained from both primary and secondary sources through field surveys and desk research. The quantitative data includes trade volumes and values for coffee, palm oil, rice, and wheat (flour) (the two main substitutes for the sweet potato and taro). The data for agricultural inputs (mainly fertilizers and pesticides) were obtained through a field survey of farmers. The data for agricultural land-use patterns were analysed using both qualitative and quantitative methods. For other social and economic indicators, secondary data were used. Most of the data on consumption came from the field survey.

4.3 Indicators

From the conceptual framework, a set of economic, social, and environmental indicators was identified. The indicators were selected based on their relevance, reliability, sensitivity, affordability and ease of measurement. These indicators are listed below.

Economic indicators:

• export share of GDP;
• production of coffee and oil palm;
• export revenue from agriculture including coffee and palm oil;
• tariff information;
• employment share of agriculture in total employment;
• income from local crops versus commodity crops.
Social indicators:
  • access to social services (education, health, banking, communications);
  • population dynamics;
  • Human Development Index (HDI).

Environmental indicators (including agricultural biodiversity):
  • overall PNG land-use map and the main drivers of change for forest cover;
  • land area under coffee and oil palm industries;
  • land area under semi-subsistence crops (including sweet potato and taro);
  • inventory of sweet potato and taro varieties;
  • potential growing areas of taro and sweet potato using Geographic Information System (GIS) mapping;
  • rate of use of agricultural chemicals and machinery;
  • price changes of agriculture inputs (that impact agricultural development).

4.4 The field survey

A stratified random sampling method was adopted in the IA for the field survey. The strata identified were: population density, accessibility to road (market), accessibility to other social services (such as health care), income level, intensity of coffee and oil palm activity, and intensity of subsistence farming. These strata had been used in the PNG Rural Development Handbook (Hanson et al. 2001). Additional information was provided by the GIS Unit of NARI. The questionnaire that was employed in the field survey has been reproduced in Annex 2.

Although the original sample size was to be proportional to population size of each site or district, transportation difficulties and time constraints made this approach prohibitive and so random sampling (in terms of proportion) was adopted, according to the strata. Similar challenges prevented the collection data from the planned sample size of 100 to 150 farmers from each of the production system areas (200 to 300 in total). For the IA, 50 farmers were interviewed for each case study – coffee and sweet potato systems in the EHP, and oil palm and taro systems in WNBP (see Table 3).

Table 3: Number of farmers surveyed in Eastern Highlands and West New Britain Provinces

<table>
<thead>
<tr>
<th>Province/district</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eastern Highlands</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daolo</td>
<td>11</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Goroka</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Ungai Bena</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Lufa</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Okapa</td>
<td>13</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Henganofi</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Kainantu</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Obura-Wonenara</td>
<td>5</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>50</td>
<td>29</td>
<td>21</td>
</tr>
</tbody>
</table>

| **West New Britain** |       |      |        |
| Hoskins            | 30    | 7    | 23     |
| Bialla             | 3     | 1    | 2      |
| Talasea            | 17    | 6    | 11     |
| **Total**          | 50    | 29   | 21     |

<table>
<thead>
<tr>
<th>Province/district</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
<td>43</td>
<td>57</td>
</tr>
</tbody>
</table>
Despite the absence of systematic data for advanced econometric analysis, the data collected in the field survey were sufficient to draw generic statistical summaries of the existing situation.

5 Results of the integrated assessment

5.1 Economic impacts

PNG’s economy depends primarily on the mining and oil industries, followed by agriculture and forestry. This is shown in the export revenue figures for 1990 to 2004 in Table 4. Because the mining and oil industries depend on non-renewable resources, over time, the contribution of these industries to export revenues is likely to decline. In the future, it is likely that the current share of agriculture to export revenues (17.9 per cent) will rise, along with sectors that depend upon renewable resources, such as forestry and fisheries.

Table 4: Sectoral contributions to PNG's export revenue, 1990-2004

<table>
<thead>
<tr>
<th>Year</th>
<th>Mining and oil</th>
<th>Agriculture</th>
<th>Forestry</th>
<th>Marine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>72.1</td>
<td>19.5</td>
<td>7.6</td>
<td>0.8</td>
</tr>
<tr>
<td>1995</td>
<td>71.6</td>
<td>14.8</td>
<td>13.2</td>
<td>0.4</td>
</tr>
<tr>
<td>2000</td>
<td>77.4</td>
<td>16.6</td>
<td>5.4</td>
<td>0.6</td>
</tr>
<tr>
<td>2004</td>
<td>73.3</td>
<td>20.8</td>
<td>5.3</td>
<td>0.7</td>
</tr>
<tr>
<td>15-year average</td>
<td>73.6</td>
<td>17.9</td>
<td>7.9</td>
<td>0.6</td>
</tr>
</tbody>
</table>


5.1.1 Agricultural export crops

Agriculture has been the major driver of PNG’s economy in terms of employment, income, infrastructure development, and, most importantly, foreign exchange earnings. The major commodities in the agricultural sector are oil palm, coffee, cocoa, copra, tea and rubber. Figures 3 and 4 indicate that oil palm and coffee are the two largest export earners, followed by cocoa. Agriculture’s share of GDP was around 30 per cent in 1975. This share has declined gradually to around 25 per cent in 2001. Over time, agricultural trade has been affected positively by currency devaluations and negatively by drought (AusAID 2003).

Coffee was the main driver of economic development prior to 1975, when PNG gained its independence. Prior to 1975 other agricultural export crops and extractive industries (logging, minerals and petroleum) had not yet been developed. Coffee remained the leading agricultural export crop until 2002 when it was overtaken by oil palm. However, in both 2007 and 2008 coffee made a resurgence with export earnings reaching nearly the levels of oil palm. Cocoa and copra also have contributed significantly to the economy and cocoa earnings have been rising for the past five years. Investments in the agricultural sector have attracted supporting infrastructure, such as roads, bridges, wharfs, schools and health-care facilities. Without its export crops PNG would not have reached the level of development that it enjoys today.

5 See also Annex 3, Figures A3-1 and A3-2.
5.1.1.1 Coffee

Coffee is the largest industry in the agricultural sector, although in terms of export earnings, it gave way its long-standing lead to oil palm about five years ago. In 2002, export earnings from coffee represented 4.7 per cent of total exports. Approximately 270 000 families depend on coffee as a source of income and well over one million people derive a direct benefit from the industry. About 80 per cent of the country’s coffee is grown by smallholders on plots of land averaging around 0.5 hectares. The remaining 20 per cent is grown on plantations which range from 20 to 100 hectares up to around 5 000 hectares (NGHCE 2008). The main export destinations for coffee are Germany (42 per cent), the United States (19 per cent), Australia (17 per cent), and Japan (9 per cent) (CIC 2008).

The price of coffee has been increasing steadily since 1990, which is an important trend that can be correlated with declining sweet potato diversity. However, Figure 5 indicates that volumes of trade have not increased with price since 1990. It is assumed that this is

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6 This represents between 120 000 and 135 000 hectares, although this figure differs slightly from the survey findings.
due to the decline in the value of the Kina. Another explanation is the high level of labour migration out of the coffee industry, particularly after 1997 when the drought induced by El Niño affected several food crops. The food supply shortage, particularly with respect to the sweet potato in the Highlands, might have triggered the out-migration.\footnote{Secondary data on migration is not available but this is open for further study.} There is a correlation between the decline in agricultural employment in the Highlands Region (beginning in 1997) and the increase in agricultural employment in the Islands Region (see Figure 6). Figure 7 shows that both the price and volume of palm oil have been increasing since 1990.

**Figure 5: Export price and volume of PNG coffee, 1990-2007**

![Export price and volume of PNG coffee, 1990-2007](source: calculation from data from the Bank of Papua New Guinea (2008)).

**Figure 6: Comparing employment index from the highlands and the islands regions**

![Comparing employment index from the highlands and the islands regions](source: calculation from data from the Bank of Papua New Guinea (2008)).

**Figure 7: Export price and volume of palm oil for PNG, 1990-2007**

![Export price and volume of palm oil for PNG, 1990-2007](source: calculation from data from the Bank of Papua New Guinea (2008)).

5.1.1.2 Oil palm

In recent years, the benefits to PNG of oil palm production have been significant. It is PNG’s most successful industry, providing direct employment for over 20 000 people and indirect employment for over 150 000. In 2000, there were over 14 500 smallholders growing oil palm. Oil palm accounts for 35 per cent of total agricultural exports making it the largest agricultural commodity. It is anticipated that there will be sustained growth...
in the sector for the next 15 years. The rural population has a crucial role to play in increasing productivity levels and increasing value added (Somare 2003).

The New Britain Palm Oil Limited (NBPOL) is the largest oil palm company in WNBP. It recorded a profit in 2007 of US$225 million, which was up from US$133.7 million in 2006 (the rise was attributed to higher market prices). The total smallholder payout for 2006 was US$18.3 million (K56 million); this rose to US$36.7 million (K108 million) in 2007. The NBPOL is the largest private employer in PNG providing over 7,700 jobs in WNBP. Of these, approximately 80 percent of the employees are plantation workers and 99 percent of these are nationals (NBPOL 2008). Most of the people employed at NBPOL are from outside WNBP.

5.1.2 Agricultural food crops

5.1.2.1 Sweet potato

Production for food. The IA survey examined the composition and level of food consumed at home to determine influences that might be linked to the decline of sweet potato biodiversity. In particular, the consumption levels of sweet potato and rice were studied.

The field survey revealed that much of the sweet potato produced is consumed at home. One-third of the farmers in the Eastern Highlands consume over 70 percent of what they produce, meaning that less than 30 percent of the production is sold for cash. District-by-district, about one-third of the farmers in Daulo, Ungai-Bena, and Kainantu consume half of their sweet potatoes, while 80 percent of the farmers in Obura-Wonenara consume half of what they produce. On the other hand, over 40 percent of the farmers in Lufa, Okapa and Henganofi consume over 70 percent of what they produce at home.8 Farmers located along the major roads consume less of what they produce at home compared to those farmers located further from roads and markets.

The following lessons can be drawn from these observations:

• it was thought that populations living in close proximity to the road infrastructure consume more rice and less food produced at home but the survey results showed that a significant number of these people still consume much of their own sweet potato production; and
• much of the sweet potato produced for home consumption is in the less accessible districts of the province.

Source of income. On average, a farmer earns about K300 (approximately US$100) per year. Figure 8 provides a district-by-district comparison, which shows that the average for Kainantu and Obura-Wonenara is higher than for Daulo, Lufa and Henganofi. Ungai-Bena and Okapa have the lowest income levels from sweet potato, ranging from K140 to K210. The total annual income for the 50 farmers is K15,130 (about US$5,000).

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8 See Annex 3, Figure A3-3.
5.1.2.2 Taro

Taro is consumed by almost 22 per cent of the population in PNG. In rural areas it is consumed by around 24 percent of the population, and in urban areas, by roughly 10 per cent. The importance of taro as a food choice is also reflected in the fact that it uses a 5.3 per cent share of the household expenditure compared, for example, to 3.93 per cent of household expenditure which goes towards purchasing rice (Bourke 2000).

The genetic diversity of taro in PNG has been the major factor that has allowed it to survive the onslaught of pests and disease, such as the taro leaf blight, which has virtually eliminated Samoa’s taro industry (Onwuome 1999).

Taro is classified as a ‘normal good’ from the perspective of its income elasticity, which stands at .75, indicating that assuming other factors remain constant, as income levels rise, more taro will be consumed (Gibson, in Bourke 2000). This might explain the rapid uptake of market preferred varieties in WNBP. However, taro is competing for land against oil palm.

5.2 Social impacts

5.2.1 Human Development Index

The HDI for PNG for the year 2006 was 0.516, and it ranked 147 out of 179 countries. This represented an increase from 0.513 in 2003. A HDI of one represents the optimum standard of living. Within the HDI, PNG is ranked 146 for life expectancy at birth, 125 for adult literacy and 136 for GDP per capita (UNEP 2008). With a value of 40.1 per cent in the Human Poverty Index (HPI-1) PNG ranks 116 among the 135 developing countries for which the index has been calculated. Within the HPI-1, PNG ranks 89 for probability of not surviving beyond age 40, 104 for adult literacy rate, 122 for population without access to improved water sources, and 118 with respect to underweight children (% age 0-5) (UNDP 2008).

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9 The HPI-1 measures severe deprivation in health by the proportion of people who are not expected to survive the age of 40. Education is measured by the adult illiteracy rate, and a decent standard of living is measured by the unweighted average of people without access to an improved water source and the proportion of children under age 5 who are underweight for their age (UNDP 2008).
5.2.2 Access to services

A large proportion of Papua New Guineans do not have full access to major services, such as health care, education, banking, shopping centres and markets. Although communications have improved dramatically in the last three to five years, (as a result of mobile telephone technology), much of the rural population is still not connected to national and international networks. The rural population’s access to services has been measured in terms of number of hours or days taken to secure different levels of service points using five main indicators: (i) very poor, (ii) poor, (iii) moderate, (iv) good and (v) very good (Hanson et al. 2001). Figure 9 shows that out of a total rural population of 4 300 000 in 2000, access to services was classified as “very poor” for four per cent, “poor” for 13 per cent, “moderate” for 37 per cent, “good” for 38 percent and “very good” for eight per cent.

Figure 9: Access to services by the rural population, 2000

![Access to services by the rural population, 2000](image)

Source: Hanson et al. (2001).

5.2.3 Population

Between 1972 and 2002 the country’s population more than doubled, from roughly 2.7 million to 5.6 million. Population densities in PNG vary greatly with altitude. The highest rural population densities occur in the highlands region at elevations between 1 200 metres and 2 500 metres (Shearman et al. 2008). An increasing population has led to increased demand for food and consequently for land under food production. This has been observed to lead to the shortening of fallow periods, which results in clearance of primary forests and in some cases to the unintended conversion of secondary forest into grasslands (Allen 1985).

5.3 Environmental impacts

5.3.1 Changes in forest cover, 1972-2002

In PNG, only three per cent of land is owned by the state, while 97 per cent is customarily owned by the indigenous Papua New Guinean population, inherited down through generations. Therefore, land-use planning is carried out primarily by village populations, without input from the Government. Figure 10 indicates that in 1972 there were roughly 38 million hectares of intact forest, including rainforest, swamp forest,
mangrove forest and dry evergreen forest. This represented 82 per cent of the country’s total land area of 46.2 million hectares.

**Figure 10: Forest cover in PNG, 1972**

![Forest Cover of PNG in 1972](image)

Source: Sherman et al. (2008).

Figure 11 indicates that in 2002, 25.3 million hectares of intact rainforest remained in PNG. In the same year, 2.9 million hectares of secondary forest was degraded through logging, while the other types of forest were relatively unchanged during that period.

**Figure 11: Land cover of PNG, 2002**

![Land Cover of PNG 2002](image)

Source: Sherman et al. (2008).

Between 1972 and 2002, a total of 15 per cent of diverse rainforest was cleared, 8.8 per cent was degraded through secondary forestry (such as through the removal of trees from a recovering forest), and 23.8 per cent (7.9 million hectares) was either degraded or destroyed by human activities. This amounts to the degradation or deforestation of nearly a quarter of the county’s living forest resources (Shearman et al. 2008).

Figure 12 shows that the main drivers of change in forest cover are: logging, subsistence agriculture, forest fires, plantations, and the development and operation of mines.
Figure 12: Major drivers of forest cover change in PNG, 1972 to 2002 (%)

Source: Shearman et al. (2008).

5.3.2 Land use for agriculture

There is very little data available with respect to current agricultural land use, but it is possible to estimate land-use areas for oil palm and coffee.

*Oil palm.* At present, oil palm cultivation in WNBP represents less than one per cent of PNG’s total land area and 1.4 per cent of the province’s total area. The land under oil palm increased at the average rate of 2.7 per cent per year between 2006 and 2008. If this trend continues, by 2050 just over 103 000 hectares (or four per cent of the WNBP’s 25 000 km² of land) would be under oil palm cultivation (see Figure 13).

Figure 13: Projected rate of percentage of land in WNBP converted to oil palm

Source: projections based on information generated from the field survey (2008).

It has been reported that the NBPOL has put in place environmental management practices. These include a ‘zero burning’ policy, use of integrated pest management, non broad-acre aerial spraying, reduced use of pesticides, the adoption of High Conservation Valued Forest (HCVF) processes, and the use of milling by-products as compost in nurseries. It has also been reported that the, “management of domestic waste and landfills are much better than the earlier system of ignoring the issue” (NBPOL 2008). The
company claims that these measures mean that, "the costs to the environment and to the company have been reduced" (NBPOL 2008).

In 2004, the NBPOL became one of the first palm oil companies to achieve ISO 14001 certification (an environmental standard), and become the second company in the world to achieve Roundtable on Sustainable Palm Oil (RSPO) certification. The RSPO has eight principles. Principle 5 addresses the environment and biodiversity (including HCVF) and Principle 7 refers to new developments (taking into account HCVF and the land dependence of communities). The company also has a bold plan to include all of its smallholders in the RSPO certification by the end of 2009 (NBPOL 2008).

**Coffee.** Land use patterns are an important criterion for understanding the status of biodiversity. The two major forms of land use in the Eastern Highlands are subsistence agriculture and coffee production (see Map 6). According to the field survey, there has been an increase in land area under coffee production, although the rate of growth has dropped in recent years.

Of the 50 farmers surveyed, 56 per cent had a coffee garden of less than one hectare, 32 per cent had one to two hectares, and six per cent grew coffee on two to five hectares, which added up to roughly 45.5 hectares (see Figure 14). Of the farmers surveyed, 78 per cent extended their gardens after the first plantings by an additional 29 hectares, which brought the total to 74.5 hectares in 2008. This represented an increase of 64 per cent over the past 30 years, which is an estimated annual increase of two per cent.

On average a smallholder cultivates roughly 1.5 hectares of coffee. Across the 270 000 small farmers (CIC data) this represents roughly 400 000 hectares. The CIC estimates that the average farmer has 0.5 hectares of coffee production (CIC 2008). Since 2001, the rate of production (tonnage) has been higher for smallholders than for plantations. Figure 15 shows that the gap between these two systems of production has closed over time.

**Figure 14: Land area under first coffee gardens**

![Figure 14: Land area under first coffee gardens](source: data analysed from the results of the field survey (2008)).
Figure 15: Comparing coffee production from smallholders and plantations

Source: redrawn and modified from Quirke et al. (2007).

The country’s land use suitability for agriculture is classified into three categories: very high, very high to high, and high to moderate. For the tree crops, proportions of the total land area for each category are 1.7 per cent, 3.3 per cent, and 11 per cent, respectively (see Table 5). Cumulatively, this amounts to over 90 000 km$^2$ where, compared to the field survey estimates, coffee represents about 4.4 per cent of the total suitable land area for the tree crops and 0.9 per cent of the country’s total land area. This estimate does not include plantation coffee.

Map 6: Coffee (Arabica) growing areas in the Eastern Highlands Province

Source: data analysed from the results of the field survey (2008).

Table 5: Land suitability for tree crops, arable agriculture, pasture and irrigated rice

<table>
<thead>
<tr>
<th>Land use</th>
<th>Very high</th>
<th>Very high to high</th>
<th>Very high to moderate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>km$^2$</td>
<td>%</td>
<td>km$^2$</td>
</tr>
<tr>
<td>Tree crops</td>
<td>7 790</td>
<td>1.7</td>
<td>15 460</td>
</tr>
<tr>
<td>Arable</td>
<td>4 960</td>
<td>1.1</td>
<td>21 890</td>
</tr>
<tr>
<td>Pasture</td>
<td>14 710</td>
<td>3.1</td>
<td>29 710</td>
</tr>
<tr>
<td>Rice</td>
<td>18 890</td>
<td>2.5</td>
<td>37 980</td>
</tr>
</tbody>
</table>

Source: GoPNG (2000).

The prospect of further increasing coffee gardens in the future seems less popular, possibly due to increasing pressures on land (see Figure 16). The farmers with lower
prospects for expansion are those from Daulo, Henganofi, and Kainantu, where coffee production is also highly intensive and population densities are high. While those in the less populated areas of Okapa and Ungai Bena, where coffee production is less intensive and where access to roads is classified as ‘fair’, have better prospects. Intensive coffee production is associated with higher levels of income from coffee. Daulo, Ungai Bena and Kainantu have higher levels of income compared to incomes in Okapa, Lufa, and Obura Woneara (see Figure 17).

**Figure 16: Additional land to be brought under coffee production in 5 years from 2008**

![Image of Figure 16 showing land distribution](image_url)

Source: data analysed from the results of the field survey (2008).

**Figure 17: Levels of income made from coffee by farmers in the survey**

![Image of Figure 17 showing income distribution](image_url)

Source: data analysed from the results of the field survey (2008).

The CIC intends to assist and facilitate the restructuring and reorienting of the PNG production system and crop profile. Its strategy is based on the production of sustainable coffee demanded by a high-value, niche segment of the market. The PNG production sectors will be assisted to reorganize production and processing systems to produce specialty, organic, fair-trade, shade-grown, Oxfam, and bird-friendly coffees (CIC 2008).

**Sweet potato.** The estimated production of sweet potato in 2000 was 2,871,850 tonnes. The mean yield for the highlands and lowlands is 14 tonnes per hectare and therefore the estimated area in 2000 was 205,132 hectares. Allowing for an estimated rate of population growth of 2.7 per cent per year over nine years, the estimated figure for 2009 is 260,716 hectares.
**Taro.** The estimated production of taro in 2000 was 229,088 tonnes. The mean yield for the lowlands is eight tonnes per hectare, which represented roughly 28,636 hectares in 2000. Allowing for population growth rate of 2.7 per cent per year, the total area for taro would be 36,395 hectares in 2009.

5.3.3 Use of agriculture inputs in coffee production

The cost of farm inputs for smallholders has moved in the opposite direction of the TRP in recent years. While current data was not available, some statistics regarding inputs used in PNG, compared to the Oceania region and the world, exist (see Table 6). The field study also attempted to obtain current information on the price and use of inputs. A general increase in cost has been experienced by farmers, which suggests that other influences on price, such as a weakening of the national currency against major currencies and the VAT must have cancelled out the effect of the tariff reduction. The most commonly used inputs are herbicides (Gramoxon and Round-Up) with limited application of fertilizers.10 The highest use of herbicides have been recorded for Daulo, Ungai Bena and Okapa, while only Daulo and Ungai Bena farmers tend to use fertilizers (see Figure 18). No use of tractors has been recorded since all the respondents are smallholders without access to significant capital. According to these farmers, the price increases were most pronounced between 2006 and 2008, about eight to ten years after the introduction of the TRP (see Figure 19). This finding echoes the 2003 Tariff Review (the Review) finding that, “manufacturers generally feel little has improved since the TRP began, and the costs have risen substantially,” particularly those incurred by, “law and order, physical infrastructure, shipping, utilities, public sector performance and macroeconomic management” (GoPNG 2003).

**Table 6: Comparison of agricultural inputs in PNG (various periods)**

<table>
<thead>
<tr>
<th>Agricultural inputs</th>
<th>PNG</th>
<th>Oceania</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual fertilizer use 1999 (thousand tonnes)</td>
<td>9</td>
<td>2998</td>
<td>141,360</td>
</tr>
<tr>
<td>Pesticides use 1994-1996 kg/ha cropped</td>
<td>14</td>
<td>57</td>
<td>95</td>
</tr>
<tr>
<td>Number of tractors 1997 kg/ha cropped</td>
<td>1,160</td>
<td>401,025</td>
<td>26,334,690</td>
</tr>
<tr>
<td>Agricultural workers as a percentage of the total labour force</td>
<td>79.2</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>% of GDP by agriculture, 2000</td>
<td>25.9</td>
<td>3.6</td>
<td>5.0</td>
</tr>
</tbody>
</table>


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10 Other inputs include knapsacks, pulping machines, bags, canvases and slashing knives.
5.3.4 Land under sweet potato production

For the farmers taking part in the field survey, the total land area under sweet potato production was almost 22 hectares, or about one-third of the total land under coffee production for the same farmers. Of this, 18 per cent of the farmers cultivate up to 0.25 hectares, 44 per cent cultivate between 0.25 and 0.5 hectares, and 37 percent between 0.51 and one hectare (see Figure 20). On average, three crops are planted per season, which means that 66 hectares of land are committed to sweet potato per year.

Production volume for sweet potato increased between 2003 and 2008. Almost half of the farmers responded that they had been increasing their sweet potato production, while 26 per cent said production had been constant, 18 per cent indicated that it had fluctuated, and 10 per cent responded that production had decreased (see Figure 21).
On the national scale some six million hectares are used in the rotational gardening cycle (for sweet potato plus other crops). The practice of bush fallow cultivation leads to very complex patterns of garden and vegetation re-growth. Typically, between five and 15 years of fallow will elapse before the re-growth is cleared for further food production. But this cycle is getting shorter, raising the risk of soil erosion.

Of the country’s total land area, approximately 470 000 km² or about 58 per cent is subjected to strong or severe erosion. A further 18 per cent is permanently inundated or regularly flooded. Up to 200 000 hectares are cleared annually for traditional agriculture. Between 1975 and 1996, nearly eight per cent of the forested areas were logged, with a further three per cent subjected to other forms of clearing, resulting in permanent conversion of the forested areas to other land uses (GoPNG 2000).
5.3.5 Sweet potato diversity

PNG is a major centre of sweet potato genetic diversity. Although current baseline data for the sweet potato is sketchy, it is estimated that there are 5 000 cultivars in the country. (Bourke 1985 in Benediktsson 2002). The current national germplasm collection of sweet potato in the highland regions (maintained by NARI) is not representative of all the highland provinces. Table 7 shows that the collection comes mainly from the EHP.

The highlands program currently maintains the national collection with several smaller working collections. The Polycross collection consists of new varieties (F1 generation) that were produced from the Polycross project in 2006. The commercial varieties working collection is also made up of new varieties, which evolved from farmers’ fields and are now used as common commercial varieties. The main germplasm collection and the small working collection include some very old varieties, such as Konime, Munduena, Apo, and Kekori. Ten of the old accessions are also still in the collection, while seven accessions have been lost.\footnote{Their existence in farmers’ fields is currently unknown and further study is warranted to determine whether they still exist.}

Table 7: Sweet potato collection at Aiyura (only from the EHP)

<table>
<thead>
<tr>
<th>Type of collection</th>
<th>Total number of accessions</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>National collection</td>
<td>996</td>
<td>Base collection</td>
</tr>
<tr>
<td>PRAP working collection</td>
<td>146</td>
<td>Has some lowland varieties</td>
</tr>
<tr>
<td>Commercial varieties working collection</td>
<td>10</td>
<td>Recent collection</td>
</tr>
<tr>
<td>Drought working collection</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Polycross collection</td>
<td>376</td>
<td>Hybrids</td>
</tr>
</tbody>
</table>

Source: Apa, personal communication (2008).

In the Eastern Highlands Province 274 varieties of sweet potato cultivars have been found to be ‘missing’. This figure represents about 53 per cent of the original local stock and three quarters of what is currently maintained in farmers’ fields. Of the total 414 varieties that are still maintained, 60 per cent are of ‘local’ origin while 40 per cent are native stock ‘introduced’ from elsewhere in the country (see Figure 22). Twenty-eight per cent of the farmers responded to the survey that some of the missing varieties are maintained by neighbouring communities and could be recovered. Twenty per cent of the farmers were uncertain about the survival status of the missing varieties while over half claimed that the missing varieties were not traceable and should be considered ‘lost’.
Most of the farmers with fewer sweet potato varieties were from the Asaro Valley (Daulo), Ungai Bena, Henganoifi and Kainantu. These districts are located along the major road infrastructure where coffee production is also very significant and with a high intensity of sweet potato gardens (Henson et al. 2001). The reverse is true for farmers in outer districts, such as Okapa (see Figure 23). Furthermore, an inverse correlation was found to exist between sweet potato diversity and agriculture pressure.

According to the farmers surveyed, the main reason for the ‘loss’ of sweet potato varieties is the competition by ‘superior’ varieties that taste better, offer higher yields, have a shorter growing period, are less susceptible to disease and are preferred in the market (see Figure 24). Market preference is the most influential factor in growing decisions, as sweet potato is fast becoming a cash crop. In addition to home consumption and use as feed for livestock, the high and growing urban markets such as Goroka, Lae and Port Moresby encourage greater sweet potato production. This triggers stronger pressure on land and labour to maintain an extensive base of sweet potato and other crops and results in the abandonment of varieties that are not preferred in the market.
Figure 24: Reasons for loss of sweet potato varieties

![Bar chart showing reasons for loss of sweet potato varieties]

Source: data analysed from the results of the field survey (2008).

5.3.6 Rice

Rice consumption is prevalent in many parts of EHP but it is not a staple food. In the province, the annual per capita consumption of rice is 23 kilograms (see Figure 25). An average-sized household (seven family members), consumes around 3.5 kilograms of rice per week; an individual consumes roughly 0.4 kilograms per week.\(^\text{12}\)

Figure 25: Annual per capita consumption of rice in the EHP

![Bar chart showing annual per capita consumption of rice]

Source: data analysed from the results of the field survey (2008).

Since 2000 there has been a general increase in the price of rice. Respondents were asked whether they had changed their consumption of rice over the five years from 2003 to

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\(^{12}\) Populations in the districts of Ungai-Bena and Obura-Wonenara consume above average amounts of rice per week. The next highest consumers are in Daulo, followed Henganofi, Okapa and Kainantu, where consumption is roughly the same. People in Lufa consume the least amount of rice per week. Except for Ungai-Bena and Lufa, the consumption in other districts appear to be inconsistent with the expected results, raising further questions (see Annex 3, Figure A3-4).
2008, and if they had, why. Thirty-eight percent of the farmers surveyed indicated that their consumption patterns of rice did not change very much. The remaining 28 per cent responded that their consumption had increased, 22 per cent said that their consumption had fluctuated, and 18 per cent responded that their consumption had decreased (see Figure 26). Of those that said their consumption had increased, the two main reasons cited were food security (64 per cent) and an increase in income level (36 per cent). During the same period the price of rice had generally gone up and so it could not be established that any change in consumption patterns was caused by the tariff reduction.

Figure 26: District-by-district trend in rice consumption in the EHP, 2004-2008

On the other hand, the main reason cited for those that had decreased their rice consumption was related to price. The majority (56 per cent) said that the main reason they had decreased their rice consumption was due the increase in the price of rice, while 22 per cent indicated that they decreased their rice consumption because the prices of other food items, such as sweet potato and other garden foods, had improved relative to the price of rice.

When the farmers were asked how they would respond if the price of rice were to rise by 10 per cent, 70 per cent said that they would decrease their consumption by more than 10 per cent, while 20 per cent said that they would reduce consumption by less than 10 per cent. Six per cent responded that they would continue to consume the same amount of rice and four per cent said that they would stop eating rice (see Figure 27).

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13 Provincial data is available in Annex 3, Figure A3-5.
14 See Annex 3, Figure A3-6.
15 A further 22 per cent gave random reasons (Annex 3, Figure A3-7).
When asked how a rise in the price of rice would affect sweet potato consumption, 40 per cent of those surveyed responded that if the price of rice rose by 10 per cent, they would increase their consumption of sweet potato by more than 10 per cent. Thirty-four per cent said that they would increase their consumption of sweet potato, but by less than 10 per cent, and the remaining 18 per cent said that they would consume the same amount of sweet potato (see Figure 28).

When asked how a rise in their income would affect their consumption of rice, 46 per cent responded that they would increase their consumption of rice by less than 10 per cent if their income rose by 10 per cent. A further 10 per cent of respondents indicated that they would increase their consumption of rice by over 10 per cent. Thirty-two per cent of those surveyed said that they would not change their consumption of rice. Six per cent responded that they would decrease their consumption by less than 10 per cent and
six per cent said they would decrease their consumption by over 10 per cent\textsuperscript{16} (see Figure 29).

**Figure 29: Consumer response to a 10% increase in price of rice:**

*Consumption of rice*

![Consumer response to a 10% increase in price of rice](image)

Source: data analysed from the results of the field survey (2008).

The following lessons can be derived from these findings:

- rice has a high price elasticity (consumers are very responsive when the price changes), which indicates that rice is not a staple food, nor is it the only choice for food although this may be different for urban consumers where, for convenience or because of limited choice (and the competitive price of sweet potato), they may not respond very much to price changes;

- rice and sweet potato have high price cross elasticity, meaning that when the price of one changes, a consumer will switch to the other, which confirms that they are substitute goods;

- rice is neither a normal good, nor an inferior good, but lies somewhere in between, which is a finding that is quite different from some sources that classify rice as an ‘inferior good’ (Gibson 2001) although the limited sample size could account for these differences.

### 5.3.7 Taro diversity

According to the field survey, 422 taro varieties have either been lost or are ‘missing’ in WNBP. The survey revealed that at the time of this IA, 968 taro varieties were still maintained by farmers, of which 729 were of local origin and 239 had been introduced (see Figure 30). The lost or ‘missing’ cultivars represent roughly 60 per cent of the original local stock and over 40 per cent of the total stock that is currently maintained. Due to language complications and data limitations these findings have yet to be confirmed.

\textsuperscript{16} District-by-district comparisons for Figures 27 to 29 can be seen in Annex 3, Figures A3-8 to A3-10.
As with the sweet potato, the important reasons reported for the loss of traditional taro varieties are the introduction of superior varieties that taste better, have higher yields and are generally preferred in the market. Twelve percent of the respondents said the most important reason for loss of diversity was the introduction of new and superior varieties. Another 12 per cent said in addition to the introduction of new varieties the shortage of land for gardening was another reason for loss of diversity. Therefore, roughly 24 per cent of respondents said the main reason for the abandonment of taro varieties was the introduction of new taro varieties. Additionally, and in contrast to sweet potato farmers, a significant proportion (30 per cent) of taro farmers responded that one main reason for the loss of taro diversity is social-cultural factors (see Figure 31). A common indicator is that when a local person with a strong cultural connection with a taro variety dies, people feel culturally compelled to destroy the taro variety in question as part of mourning. Nevertheless, these farmers grow the ‘superior’ varieties of taro for food and income.

An example of a cultural connection with a taro variety is that the deceased may be the one that had discovered the variety. The extreme case is that the taro variety can be abandoned to extinction. It is also important to note that this kind of practice cannot be expected in every culture in PNG.
Over the past five years, 50 per cent of the farmers surveyed had increased taro production, while 20 per cent had decreased their taro cultivation. Thirty per cent of the farmers responded that they had neither increased nor decreased cultivation. Furthermore, 68 per cent of the farmers want to increase production, while 32 per cent indicated that they were unwilling to increase taro production in the future\(^\text{18}\) (see Figure 32).

**Figure 32: Changes in taro garden area in WNBP, 2003-2008**

![Figure 32: Changes in taro garden area in WNBP, 2003-2008](image)

Source: data analysed from the results of the field survey (2008).

In terms of spatial distribution, the largest number of traditional varieties and introduced taro varieties are concentrated in the Hoskins area, followed by the Talasea and Biala districts. Several of the traditional taro varieties that have been lost are from Talasea followed by the Hoskins area. However, this distribution may not be representative given the uneven sampling distribution, particularly given that only three farmers were surveyed in the Biala district due to logistical complications.

In an effort to determine the impact of rice as the substitute for taro, several indicators were assessed. In terms of consumption patterns, 48 percent of the farmers responded that their rice consumption had increased, while 16 per cent said it had decreased. The remaining 36 per cent said that their consumption patterns had been constant over the last five years (see Figure 33). The majority of people surveyed (54 per cent) consume between two and three kilograms of rice per week, 22 per cent consume between three and five kilograms per week and the remaining eight per cent consume over five kilograms of rice per week (see Figure 34). Rice has a high price elasticity, which means that if the price of rice increases by one unit, consumers will reduce their consumption disproportionately. Figure 35 indicates that 70 per cent of the farmers in WNBP would cut their consumption by over 10 per cent in response to a 10 per cent rise in the price of rice.

\(^{18}\) While the survey did not intend to find the reasons (its main purpose was to determine the importance of taro as a staple food and the land availability) a response to such a question may provide an indirect indication about land availability for food crop gardening against vis a vis oil palm.
The survey did not generate information related to the loss of taro diversity to oil palm production. However, much of the land area now under oil palm cultivation is not taken into consideration by the farmers. In addition, given the current government’s efforts to
promote oil palm production in several provinces where taro and other major crops (such as bananas) are grown, further study is required to assess the impacts of this policy.

6 Conclusions

The IA has found some evidence of a decline in crop diversity. Although it has not quantified the relationship between trade policy and genetic diversity, it has found some qualitative evidence of a causal relationship. Policy makers should take into account issues related to biodiversity and food-crop diversity when negotiating trade agreements. This is particularly relevant given developments related to New Zealand, Australia and other smaller Pacific island countries, which are all potential export markets for agricultural products from PNG. Negotiations with respect to trade in food commodities should be pursued, while safeguarding the diversity of food-crop cultivars that are not traded, but which are important for food security in PNG. The effect of new trading arrangements on land use and overall biodiversity should be considered.

This project began with the analysis of PNG’s various sectoral policies and in particular the MTDS’s Export-Driven Economic Growth Strategy. This strategy directly affects biodiversity, as PNG mainly exports raw materials, including agricultural commodities. The study examined food crops as the biodiversity component, and export crops as the policy strategy that influenced the biological diversity. It focussed on sweet potato versus coffee and taro versus oil palm.

The particular instrument of trade policy assessed was the 1999 TRP. However, the lack of data on agricultural input prices before and after the TRP made the assessment difficult. Therefore, the project team assessed various dimensions of the TRP and trade, such as conversion of arable land to export crops, levels of consumption of imported food (particularly rice), competition from introduced varieties of the same food crops, the impact of income on consumption of local food versus imported food, and the levels of use of agricultural inputs. These factors were discussed in the scenarios that were presented with the conceptual framework. Shortcomings in data were addressed by direct field surveys involving farmers. The project team also assessed the impact of trade by considering the intensity of export crop production versus the diversity of food crop maintained (for coffee and sweet potato this approach worked well). Because no central agency exists where these sorts of data can be collected, direct interviews with farmers were carried out to generate solid anecdotal evidence.

Due to the absence of sufficient data, it was difficult to link the loss of genetic diversity, through tariff reductions, to trade. Nevertheless, two key findings emerged from the interviews with the farmers. They indicated that a decline in genetic diversity was due to the introduction of superior varieties of the same crops and to socio-cultural factors such as the destruction of taro varieties following a death, where someone has claimed to have discovered the taro cultivar. With respect to coffee and sweet potato, the IA observed that in areas where coffee is grown more intensively, there appears to be lower number of sweet potato varieties. The opposite is also true, implying that export crops contribute to some extent to a decline of food-crop diversity.

This IA has demonstrated the importance of export crops to the socio-economic well-being in PNG and so growth should be pursued, while at the same time safeguarding biodiversity and food-crop diversity. PNG must strive to achieve a balanced result between agricultural export promotion and biodiversity preservation.
• Up to 2002, there was 38 million hectares of intact forest in PNG representing 82 per cent of the country’s total land area of 46.2 million hectares.
• The country’s population has more than doubled between 1972 and 2002, from approximately 2.7 million to 5.6 million, increasing the demand for food and saleable produce from gardens.
• The main drivers of the decline in forest cover are logging, subsistence farming, forest fires, plantations, and mining.
• The IA found that 274 varieties of sweet potato are either lost or ‘missing’. The missing cultivars of sweet potato in the Eastern Highlands Province represent about 53 per cent of the original local stock and 75 per cent of the total stock maintained currently. Some farmers believed that missing varieties were recoverable from other areas, while others disagreed.
• The IA found that 422 varieties of taro are either lost or ‘missing’. The missing cultivars of taro in West New Britain Province represent about 60 per cent of the original local stock, and over 40 per cent of the total stock maintained currently.
• There has been a high rate of land converted to coffee production in the past 30 years, but this has declined in the last 10 years due to reduced prospects for expansion in the Eastern Highlands Province. The main reasons for future expansion are higher coffee prices, good market networks and excess land for planting coffee.
• The cost of farm inputs for smallholders has increased in recent years despite tariff reductions. This, along with unfavourable exchange rates and the introduction of a VAT have negated the effect of the tariff reduction. However, had the TRP not been introduced, input costs would be much higher. The most commonly used inputs are herbicides, with limited application of fertilizers.
• Apart from external factors such as transportation costs, volatility in commodity prices, and lack of local input markets, and in conjunction with the Government’s “Green Revolution” policy, any discernible benefits of the TRP are thought to have been realized by the major plantations.
• The area under oil palm in West New Britain Province is currently less than one per cent of the country’s total land area, and 1.4 per cent of the province’s total area.
• Consumers of rice in rural PNG are very responsive to changes in the price of rice. This means that rice is not a staple food, nor is it the only choice for food. Rice and sweet potato and rice and taro are pairs of substitute goods, meaning that the higher the price of rice is, the more is grown locally. This may represent a threat to local food production, as it may increase the risk of neglect. Having more income does not necessarily mean more rice will be consumed.

While the scale and causes of missing varieties of sweet potato and taro is not indicative, an expected loss of taro and sweet potato diversity is foreseen. These, and other food crops, are very important to Papua New Guineans and sustained the population before the introduction of cash crops for export. Because of their informal market arrangements, their transaction values are not reflected in the national accounts but if their value were to be captured it would undoubtedly outweigh the total value of all agricultural and non-agricultural exports from PNG. Food-crop diversity is to Papua New Guineans, what a portfolio of investment and savings is to an industrialized society; it is what insurance is to a modern economy. Food crops provide more than simply food security, they are part of the country’s identity.
However, there is no doubt that export crops have encouraged economic development in PNG. Coffee has been the principal driver of economic development and, more recently, oil palm. To a large extent, growth in agricultural commodities is due to the MTDS, and the ‘export-driven economic recovery’ strategy. The introduction of the TRP (zero tariff for agricultural inputs), the Green Revolution, legislation on commodity extension and regulatory bodies, such as the CIC, Oil Palm Industry Corporation, Coconut Industry Corporation (KIK), Cocoa Board, Rubber Board, and, in 2007 the overarching National Agricultural Development Plan (with an emphasis on export crop rehabilitation), means that the area of land dedicated to export crops will increase. It is vital that this not occur at the expense of food crop production. Appropriate assistance measures for food crop producers should be put in place along with the development of the export crop sector and extractive industries, such as forestry and mining. Such an integrated approach would ensure balanced outcomes that support sustainable development. A strategy must also be in place to ensure that while receiving introduced varieties of food crops, the farmers should take care not to discard the traditional cultivars.

The IA found consistent indications of lost or missing cultivars of sweet potato and taro in PNG. The IA suggests that the main cause of these losses is their displacement by introduced varieties of the same crop types. For taro, an additional cause is the social factor. While no causal link to trade has been established due to lack of data, there is a consensus that trade does play a role that is worthy of further investigation. Pending this, the Government should adopt a balanced approach when promoting its export-driven strategy so as not to compromise its ability to preserve the nation’s rich stock of food-crop diversity, which supports the livelihood of much of population.

7 Recommendations

- Further studies should be developed to consider the impacts of trade and should take into account a broader range of biodiversity (forest, aquatic, marine, and all food crops).

- A second phase of this study should be initiated to focus on developing new policies and strengthening existing policies with respect to domestic legislation in the following areas:
  
  Ø Strongly encourage sustainable farming practices with the focus on revenue and combined farming system options. Since income security is as important as food security, a combined farming approach is highly recommended. This can be approached through (a) intercropping and (b) land set-aside policies. In intercropping, cash crops must be grown together with garden foods in well defined proportions and based on agronomically sound recommendations. In this case, the area dedicated to garden food should include traditional cultivars as well as market preferred varieties in roughly equal proportions. For communities that only grow staple food crops (because they have limited options for cash crops) land should be set aside for growing traditional food-crop cultivars and/or practicing intra-cropping. Organizations that can enforce this are NARI, FPDA, the Department of Agriculture and Livestock (DAL), and the main cash crop commodity bodies, such as the CIC, the Cocoa Coconut Institute (CCI), the KIK, the Oil Palm Research Association (OPRA), OPIC, the National Rubber Board and, where applicable, the National Forest Authority.
➢ Strengthening the national capacity for robust research, development and maintenance of food-crop cultivars including, but not limited to, equipment in DNA finger printing to fully catalogue the food crop germplasm, strengthening the current food-crop germplasm collection and maintenance, and identifying and establishing ‘sanctuaries’ for maintaining food crops as an alternative or variant to cataloguing.

➢ The current export crop rehabilitation and expansion plan (NADP) should be implemented with due consideration to maintaining food-crop diversity (that is, to promote a balance between export crops and food crops). Specifically, a sustainable practice is recommended where companies comply with existing standards (such RSPO, Forest Standards Certifications, and HCVF). There should be a focus on livelihood practices including food crop production generally and dependence on gardens (thereby embracing crop diversity). Land-use planning should be clearly developed through the relevant government agencies (such as NARI, the CCI, the Coffee Research Institute, OPIC, the CIC, OPRA, FPDA, DAL, and Lands and Physical Planning).

• Legislation should be developed to protect food-crop biodiversity through agricultural and forest certification standards.

• A new study should be undertaken to examine the status of the diversity of all important traditional food crops in order to develop baseline information. In addition, a monitoring system should be established to track changes in diversity, including in relation to developments that include plantation crops.

• Awareness-raising efforts should focus on the importance of traditional food crops and an action plan should be developed that addresses root causes of declining agro-diversity.

• The introduction of new crop varieties should occur with a clear message that those crops are in addition to existing crops and they should not replace the existing stock of food crops.

• Environmental impact assessments and strategic environmental assessments should be commissioned by the Government for cash crops as way to balance the interests of export crops with the food crops.
References


NARI. 2008. *NARI GIS unit, Personal communication*.


Annex 1: Technical report of the integrated assessment study for Papua New Guinea

Main stakeholders and responsibilities

The Department of Foreign Affairs, Trade and Immigration (DAFTI) was the lead government agency for this project. DAFTI is responsible for formulating PNG’s foreign policy, which governs the country’s relations with other countries, and it is also responsible for PNG’s trade policy. It is DAFTI’s role to examine different aspects of trade policy and intervene where necessary, both internally and externally, to protect the interests of PNG. Internally, the department, in consultation with all relevant stakeholders, determines the levels of tariffs on imports while externally it negotiates and signs trade agreements to improve market access at the bilateral, regional and multilateral levels, with existing or new trading partners.

The National Agriculture Research Institute (NARI) is a statutory organization that is mandated to conduct basic and applied research in agriculture, particularly in sectors other than traditional export crops. At the corporate level, NARI deals with policies impacting on agriculture as well as the science of agriculture, agricultural technology development, and the use of natural resources. NARI has been entrusted by the Government of PNG (under the NARI Act of 1996, Section 4 (e)) to maintain and conserve the diversity of genetic resources for food and agriculture, act as custodian for these resources, and promote their effective utilization. Over the years, the genetic diversity of the major staple food crops, fruit and nut species and traditional vegetables have been collected from farmers and market places and conserved in institutional gene-banks. These genetic resources are characterized and evaluated for their agronomic potential and other qualities or entered into breeding programmes. Eventually, superior cultivars are selected, multiplied and distributed to farmers for productive use. However, due to lack of capacity, some of these collections are being lost. Therefore, more emphasis is now being placed on in situ conservation, which requires government attention.

Apart from the two lead agencies (DAFTI and NARI) other departments and line agencies whose responsibilities influence food-crop biodiversity and agricultural trade, have also been engaged in the IA. They include:

- The Department of Environment and Conservation. Under its Conservation division it has four branches; the Biodiversity branch deals mainly with inventories of species; the Law Enforcement and Licensing branch deals with biosafety and biotechnology; the Parks and Wildlife branch looks after Reserves, Wildlife Management Areas and National Parks; and the fourth branch is responsible for the PINBio. Expertise from this Department is necessary to understand the legal and technical issues associated with biodiversity in PNG.

- The Department of National Planning and Monitoring plays a role in formulating PNG’s overarching development strategy, the MTDS, which provides the framework for prioritizing government expenditures from the annual budget. The current MTDS, which charts the development path for 2005 to 2010, defines export driven economic growth as one of its five pillars. The strategy is designed to empower Papua New Guineans, particularly those in rural areas, to mobilize their resources to improve their living standards.
• The Department of Agriculture and Livestock (DAL) is responsible for issues relating to the agricultural sector, including the formulation of the nation’s Agriculture Policy. DAL oversees the operations of the organizations it establishes to address issues relating to agriculture (such as industry development, production, research and development or marketing).

• The National Research Institute (NRI) is a statutory body responsible for conducting research in economics and social sciences. Engaging the NRI in the IA was useful for understanding the broader socio-economic issues in the country that are influencing agriculture and trade or being influenced by agriculture and trade.

Other relevant public, private and international organizations engaged in the IA were: PINBio, the Department of Lands, the Rural Industry Council, the World Wide Fund for Nature, the Nature Conservancy, Conservation Melanesia, the Vudal University, the CIC, the Oil Palm Industry Corporation, the OPRA, the Department of Prime Minister’s Office, the Department of the Attorney General, the United Nations Development Program, the Fresh Produce Development Agency, the Department of Treasury, the Department of Commerce and Industry, and the National Statistics Office. All these stakeholders were introduced to the project initially through the launching and the capacity building workshop, and thereafter were involved in research and information exchanges either through bilateral visits or through the NSC and the country review meetings.

**Project coordination and implementation team**

The project was coordinated by NARI’s Professor Udai Pal (initially by Dr. Birte Komolong) and the research was undertaken by the following core research team:

- Mr. Clifton Gwabu (Agricultural and resource economist and the project research team leader);
- Ms. Veronica Mangi (Scientist, environmental chemistry; alternate research team leader);
- Ms. Magdalene Moi-he (Assistant Director for the Trade Development Branch of the Trade Division; assistance to the project in trade negotiations); and
- Mrs. Rosa Kambuou (Principal Scientist, Plant Genetic Resources, NARI).

**Composition of the National Steering Committee**

A NSC was established prior to the launching of the project. NSC members where identified by the core research team with input from the Director General of NARI. Members of the NSC were the following:

- Dr Ragunath Ghodake, Director General (NARI)
- Dr. Ian Orrell (OPRA)
- Dr. Gae Gowae (Department of Environment and Conservation)
- Mr. Clement Kote (Treasury Department, fiscal branch)
- Mr. Andrew Yamanea (Director General, National Agriculture Quarantine and Inspection Authority)
- Ms. Gwen Maru (United Nations Development Programme)
- Mr. Brown Bai (Chairman, Rural Industries Council)
- Mr. Ricky Mitio (Chief Executive Officer, CIC)
• Mr. Alois Tabareng (Director, Trade Division, DFAT&I)
• Mr Anton Kulit (Secretary Department of Commerce and Industry/now Mr. Gabriel Pepson, Secretary Department of Foreign Affairs, Immigration and Trade)
• Mr Alan Aku (Director Policy Division DAL/now replaced by Dr. Oti Jigo)
• Ms. Monica Lopyui (Monitoring Division Department of National Planning and Monitoring)
• Dr Alan Quartermain (Head of the Agriculture Department, University of Vudal)
• Mr. John Ganopa (Conversation Melanesia)
• Mrs. Maria Linibi (Farmer Representative).

Some members of the NSC were represented by alternates within the same organization, at the meetings.

**Launch**

The project launch was overseen by Mr. Anton Kulit (Secretary of the then Department of Trade and Industry) at the Lamana Hotel in Port Moresby on 17 April 2007. The Secretary delivered a keynote address on the importance of both trade and biodiversity. Dignitaries who attended the launch included NARI’s Chairman, Dr. John Kola, representatives from UNDP, Mr. Ian Orrel, Chairman of the OPRA. Several individuals from the public sector, private sector, statutory organizations, research institutions, civil sector and non-state actors also attended.

**Capacity Building Workshop**

Following the launch, a Capacity Building Workshop was held on 18 and 19 April 2007 at the Lamana Hotel in Port Moresby. The main objective of the workshop was to train the stakeholders in the processes of incorporating biodiversity into IAs of trade policy in the agricultural sector.

The evaluation showed that the workshop was constructive, although several people commented that it was too short. Participants would have preferred more time to go through the processes thoroughly because they appreciated that the tools presented were vital for application to similar IAs. The workshop also facilitated exchange of sources of relevant information, the establishment of contacts, relationship building, and provided the project implementation team with a useful launching pad. Overall, the participants understood the objectives of the project and how each stakeholder could contribute effectively to the IA.

The different presentations by the then Department of Trade and Industry, the Department of Environment and Conservation and NARI all emphasized the need for a policy to protect biodiversity in the agricultural sector. At the close of the workshop, participants were able to identify most of the criteria and indicators and draft an outline of a conceptual framework.

**Meetings**

Three types of meetings were held during the IA to contribute to its successful implementation. These were: NSC meetings, Country Review meetings, and International Review meetings.
(i) NSC

The NSC held three meetings. The first meeting was held on 17 April 2008 upon the launching of the project. The agenda included in the first meeting was (1) the confirmation of NSC members and the election of the chairperson and deputy of the NSC and (2) presentation of the terms of reference. The second NSC meeting was held on 7 May 2008 with the main discussion points revolving around a progress report on the status of the project as there had been delays in implementation. Other important issues discussed were refining the TOR for the NSC, defining indicators and criteria, the assessment model, the conceptual framework and data reconciliation. The third meeting was held on 30 October 2008. The agenda focused on the findings of the survey and the recommendations.

(ii) Country review

Two national review meetings were held. The first was held on 17 June 2008 and the second on 9 December 2008. The first meeting discussed the similar agenda items tabled in NSC II. Two international advisors, Petra Meekers (private consultant) and Suresh Raj (UNEP Pacific Branch Office in Fiji) attended the meeting. The meeting helped the team prepare for the second international review meeting in Geneva.

(iii) International review

A series of international review meetings were also held where the project implementation team met with UNEP officers and the international experts to discuss technical, management and research issues related to the IA. One meeting was held in November 2007, a second on 1-3 July 2008 and the third on 18-20 March 2009. The first meeting was attended by Magdalene Moi-he and Veronica Mangi. The second and third meetings were attended by Clifton Gwabu and Magdalene Moi-he. While the first two meetings focused on the progressive status of the project assessment, the third meeting centred on the project findings, recommendations and the prospect for the second phase. All the international review meetings were held in Geneva.

Main achievements

The IA achieved several important goals including the following:

- Capacity building on the challenging and complex social, economic and environmental impacts of trade;
- Formation of the NSC and identification and networking of important stakeholders;
- Successful launch of the project and the hosting of the capacity building workshop, which was well attended by all identified stakeholders and interested others;
- Identification of main issues, the associated criteria and indicators of measurement, and the challenging task of developing the conceptual framework;
- Comprehensive policy analysis and identification of export-driven policy as the main policy of interest in the context of the project;
- The minimum amount of sufficient information secured through the structured survey amidst the challenges of data anomalies, logistical difficulties and cultural barriers;
• The finding that there is a serious loss of food-crop biodiversity already taking place, with some causes were identified;
• Identification of the absence of ‘biodiversity target’ in the Roundtable in Sustainable Palm Oil of NBPOL and a recommendation that one be included by all major agricultural companies;
• Recommendation for new similar assessment projects (impact of trade) on biodiversity as a whole as a result of this IA;
• Recommendation of new similar IA projects (impact of trade) on the entire range of food-crop biodiversity as a result of this project; and
• Recommendation for capacity building for conservation and maintenance of staple food crops as a result of this project.

Main challenges

The main challenges associated with the IA were the following:

• Difficulties connecting economic, social, and environmental (biodiversity) dimensions in the assessment to adequately to reach a common measure for appreciating the interrelationships, to drive the multidimensional nature of the message as effectively as possible.
• Difficulties establishing a clear benchmark for the start of the TRP with respect to how to measure reduced costs, and how to determine whether farmers are better off than they would be had the TRP not been introduced, particularly in the face of intervening factors such as the introduction of a VAT and currency depreciation.
• Difficulties linking loss of food crops to trade as farmers responses varied. The results were not as expected making it difficult to conclude the study satisfactorily without further research.
• Problems with respect to ‘multiple counting’ of a unique food crop cultivar due to different lingua franca of local communities.
• Difficulties establishing a link between food crops and export, which is not direct.
• Challenges ensuring that biodiversity issues are reflected in the trade policy when formulated.
• Achieving an understanding of the implications of trade-related policies on other sectors.
• Sustaining the interest of the some stakeholders and difficulties in accessing information from some agencies.
• Identifying the appropriate policy fora for delivering the main message and the policy recommendations (another stakeholder-wide awareness effort is being planned); and
• A challenge with respect to resources, given that the project implementation team had other responsibilities apart from the IA.
Annex 2: Questionnaire for the field survey

The questionnaire below is for coffee and sweet potato systems. The questionnaire for oil palm and taro systems is similar, but is not appended.

TRADE INTERGRATED ASSESSMENT ON BIODIVERSITY:  ID:  

Date: __________________________

Section A:  Coffee Production (Similar Questionnaire for Oil Palm and Taro)

1. What are the major forms of agricultural activities you engage in?
   Coffee production    Sweet potato production    Green leafy vegetables
   Other food crops grown for sale and home consumption    Other

2. What percentage of your resources (labour, time, money) is spent in each of the activities engaged? (note: should add up to 100%).
   Coffee production _______ Sweet potato production _______ Other food crops
   Grown for sale and home consumption ____________ Other __________

3. When was the first time you established your coffee garden?

4. How big was your first coffee garden?
   Less than 1 ha       between 1- 2 ha       between 2 – 5 ha       between 5-10 ha
   more than 10 ha

5. Have you ever reduced your coffee garden area since the first planting?
   Yes                 No

6. If yes why?
   Poor coffee price    Land shortage
   Poor road condition  No markets    Other attractive cash options

7. Did you plant any new coffee gardens since the first planting?
   Yes                 No

8. If yes were the new coffee trees you planted different varieties from the first one?
   Yes                 No

9. If yes what was the average size of each additional garden planted?
   Less than 1 ha , between 1- 2 ha , between 2 – 5 ha , between 5-10 ha ,
   more than 10 ha

10. Have you been increasing your coffee production over the last 10 years?
    Yes                 No

11. If yes how did you achieve this?
    By increasing the production area (planting new trees)
    By using the existing gardens/plantations through:
    Use of fertilizer

59
Replacing old trees with new high yielding varieties
Improved management practices
Others  (specify) __________________________________________

12. What is the area of your current coffee garden?
   Less than 1 ha , 1- 2 ha , 2 – 5 ha , 5-10 ha , more than 10 ha

13. Do you plan to increase your coffee garden size in the future?
   Yes                                                  No

14. If yes,
   (a) Why would you want to do that?
       Good coffee price   Good marketing network   High coffee demand
       Have surplus land   Increase my production volume   Lower input costs

   (b) How much additional land area would you plan to bring under coffee production?
       Less than 1 ha , 1- 2 ha , 2 – 5 ha , 5-10 ha , more than 10 ha
       On the current land area but using improved technology

   (c) How would you want to achieve that?
       By increasing the production area (planting new trees)
       By using the existing gardens/plantations through:
       Use of fertilizer
       Replacing old trees with new high yielding varieties
       Improve trees (coffee) management practices
       Other (specify)

15. What kinds of inputs do you use in your coffee production?
   Tractors , Coffee pulper , Fertilizers , Insecticides , Weedicides
   Irrigation Equipment      Other

16. Within the last ten years, have the price of any of the inputs changed?
   Yes                                                  No

17. If yes, which input, and was the price increasing, decreasing
   Tractors Increasing   Decreasing
   Coffee Bean Pulper Increasing   Decreasing
   Fertilizers Increasing   Decreasing
   Insecticides Increasing   Decreasing
   Weedicides Increasing   Decreasing
   Irrigation Equipment Increasing   Decreasing
   Other (specify) Increasing   Decreasing

18. How much agricultural chemicals do you use in your coffee garden per year?
   Fertilizers
   Insecticides
   Weedicides
   Others
19. In what year did the price change became very dramatic for each of the input?
   Tractors _______________ Coffee bean pulper, _______________
   Fertilizers _______________ Insecticides _______________
   Weedicides _______________ Irrigation equipment _______________
   Other (specify) _______________ _______________

20. What is the current price per kg of coffee ________?

21. What is the least price you are willing and able to accept for 1 kg of coffee? ____

22. What is your annual income from coffee?
   
   Below K1000  K1000 – K5000  K501 – K10 000
   K10 000 – K20 000  K20 000 – 50 000  Over K50 000

Section C: Crop Biodiversity Related Questions

23. Do you have enough land area for other activities?
   Yes   No

24. If yes what are these other activities?
   Sweet potato garden     Potato garden     Vegetable production
   Citrus production       Other       (specify) ______________________

25. Which activities need more land?
   Sweet potato garden     Potato garden     Vegetable production
   Citrus production       Other       (specify) ______________________

26. What is the main purpose of your production of this food?
   Home food consumption
   Sales
   Special events like bride price
   Others

27. Use the table below to show how many types of kaukau you have.

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<tr>
<th>Name (list)</th>
<th>Introduced/local</th>
<th>Area planted (ha)</th>
<th>Area (% of the total)</th>
<th>Tuber shape</th>
<th>Tuber skin colour</th>
<th>Flesh colour</th>
<th>Leaf shape</th>
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</table>
28. In the last 10 years have there been any ‘traditional’ kaukau varieties that you have in your garden but you do not have them anymore now? Yes           No

29. If yes, how many varieties_______________________

30. If yes, why have they ‘disappeared’?
   - Because the taste was no longer preferable to me
   - Because it (they) had not attracted consumers from the market
   - Because superior variety dominated the market
   - Because not enough land to keep them all
   - Just out of sheer ignorance.

31. Are those varieties still kept by any other people in the neighbourhood? Yes           No

32. If yes, can these varieties be sourced from them when needed? Yes           No

33. Do you know of any ‘wild’ sweet potato? Yes           No

34. If yes, how many types are there? __________________________

35. Within the past five years has your kaukau production (kg) been…
   increasing                   decreasing                    or      constant              ?

36. How much kaukau garden area do you have at any one season?
   Up to 1/4 ha  ¼ - ½ ha  ½ - 1 ha                  1-2 ha
   2-5 ha       5 – 10 ha          over 10ha.

37. What percentage of kaukau you produce is consumed at home?
   Up to 10%                   11 – 20%             21 – 40%            41 -50
   50 -60%                     70 -90%               Over 90%

38. Within the last ten years has the area of your garden been
   increasing ,       decreasing       or       constant       ?

39. If increasing, why?
   - Because there is more demand for kaukau at the market
   - Because my family size has increased
   - Because my income from other sources are unreliable
   - Because food from other sources are unreliable
   - Other reasons  ______________________________________________
40. If the garden area has been decreasing, why?

Because I prefer imported food over kaukau
Because I make enough money from coffee to buy imported food
Because I make enough money from other sources to buy imported food
Because I have lost my kaukau labour force to coffee production
Because I have lost my kaukau labour force to other industries
Other reasons __________________________________________

41. Do you plan to increase your production of kaukau in the future?

Yes                                                   No

42. If yes, why?

Because I prefer kaukau over its substitutes (rice, flour, others)
Because the market attracts better price for kaukau
Because I want to have enough space to keep all my varieties ‘preserved’
Others (specify) __________________________________________

If yes, how much additional area do you want to bring it under kaukau production?
Up to 1/4 ha ¼ - ½ ha ½ - 1 ha 1-2 ha
2-5 ha 5 – 10 ha over 10ha

43. What is the average price of kaukau within the last

12 months?__________;  2 years?__________ ;  5 years? _________.

44. What is the average annual change of kaukau price within the last 5 years (%)?

___________________

45. What is the least price you are willing to offer for 1 kg of your kaukau? _________

46. What is your current actual market price you are selling price of kaukau?_______

47. How much income do you make from your kaukau per year (Kina)?

___________________

Section D: Questions Related to Substitutes of Kaukau

48. How much rice do you and your household (#) __________) consume per week?

1- 2 kg, 2.1 – 3 kg 3.1 – 5 kg 5 – 10kg
10.1 -15 kg 15.1 – 20 kg 20.1 – 20 kg

49. What price are you most willing and able to pay for per unit (______) of rice per week? __________

50. What is the current average price of per unit (________) of rice? __________

51. Over the past 5 years has your consumption of rice…

increasing             decreasing             or             constant ?
52. If increasing why?

The price has become cheaper
I have sufficient money to afford it
I prefer rice more than its substitutes
Other (specify) _______________________________________

53. If decreasing why?

I prefer rice over kaukau
The price of kaukau has improved comparatively
The price of flour became comparatively cheaper
Other (specify) _______________________________________

54. If the price of rice increases by 10% how will you respond?

Increase consumption of rice by more than 10%
Increase consumption of rice by less than 10%
Decrease consumption of rice by more than 10%
Decrease consumption of rice by less than 10%
Still consume the same amount of rice

55. If the price of rice increases by 10% how will you respond in terms of your consumption of kaukau?

Increase consumption of kaukau by more than 10%
Increase consumption of kaukau by less than 10%
Decrease consumption of kaukau by more than 10%
Decrease consumption of kaukau by less than 10%
Still consume the same amount of kaukau

56. If your income increases by 10% how will you respond in terms of rice consumption?

Increase consumption of rice by more than 10%
Increase consumption of rice by less than 10%
Decrease consumption of rice by more than 10%
Decrease consumption of rice by less than 10%
Still consume the same amount of rice

Section E: Demographic Profile

57. Name: _______________________ Surname: ______________________

58. Gender: Male , Female ,

59. Age: 20 -30 , 31 - 40 , 41 -50 , 51 -60 , over 60

60. Marital Status: married , single , widowed , divorced ,

61. Village _______________________ District _______________________
62. Education: Primary  Secondary  Tertiary  Not educated

63. Occupation: Food crop subsistence and Coffee farmer  Other  _____________

64. Total annual net income contributed by you and your household.

<table>
<thead>
<tr>
<th>Less than K1000</th>
<th>K1000 – K2000</th>
<th>K2001 – K5000</th>
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<tr>
<td>K5001 – K1000</td>
<td>K10001 – K2000</td>
<td>K20001 – K30000</td>
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<tr>
<td>K30001 – K50000</td>
<td>Over K50000</td>
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</table>

65. What are the sources of your income stated above? (% must add to 100)

Coffee (%_____), Kaukau (%_____), Vegetables (%_____)  Fruit trees
Poultry (%_____)  Pensions (%_____)  Formal employment (%_____)  Remittance (%_____)  others specify _________________(%_____)  

66. Number of dependents: ________________
Annex 3: Additional figures

Figure A-1: Export prices of major agriculture commodities, 1990-2007

![Graph showing export prices of major agriculture commodities, 1990-2007](Diagram)


Figure A-2: Percentage share of the values of PNG’s major agricultural commodity exports, 1990-2007

![Graph showing percentage share of the values of PNG’s major agricultural commodity exports, 1990-2007](Diagram)


Figure A-3: Proportions of sweet potato consumed at home as stated by farmers

![Pie chart showing proportions of sweet potato consumed at home](Diagram)

Source: data analysed from the results of the field survey (2008).
**Figure A-4: Weekly consumption of rice in EHP as stated by farmers**

![Bar chart showing weekly consumption of rice in EHP]

Source: data analysed from the results of the field survey (2008).

**Figure A-5: Trend in rice consumption for EHP 2004-2008, as stated by farmers**

![Pie chart showing trend in rice consumption]

Source: data analysed from the results of the field survey (2008).
Figure A-6: Reason for increase in consumption of rice from 2004-2008 in EHP as stated by farmers

![Reason for Increasing Rice Consumption (%)](image)

- My income has increased: 36%
- Food Security: 64%

Source: data analysed from the results of the field survey (2008).

Figure A-7: Reason for decrease in consumption of rice from 2004-2008 in EHP as stated by farmers

![Reason for decrease in consumption of rice from 2004-2008 (%)](image)

- Price of sweet potato has improved relative to rice: 22%
- Price of rice has increased: 22%
- Others: 56%

Source: data analysed from the results of the field survey (2008).

Figure A-8: Response of consumers in EHP to a 10% rise in price of sweet potato

![Response of consumers in EHP to a 10% rise in price of sweet potato](image)

- Increase consumption of sweet potato by more than 10%
- Increase consumption of sweet potato by less than 10%
- Still consume the same amount of sweet potato

Source: data analysed from the results of the field survey (2008).
Figure A-9: How the consumers would respond in terms of rice consumption if their income increases by 10% as stated by farmers

Source: data analysed from the results of the field survey (2008).

Figure A-10: How consumers would respond if the price of rice increases by 10% in the future, by district, as stated by farmers

Source: data analysed from the results of the field survey (2008).
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About the UNEP Division of Technology, Industry and Economics

The UNEP Division of Technology, Industry and Economics (DTIE) helps governments, local authorities and decision-makers in business and industry to develop and implement policies and practices focusing on sustainable development.

The Division works to promote:
> sustainable consumption and production,
> the efficient use of renewable energy,
> adequate management of chemicals,
> the integration of environmental costs in development policies.

The Office of the Director, located in Paris, coordinates activities through:
> The International Environmental Technology Centre (IETC, Osaka, Shiga), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.
> Production and Consumption (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.
> Chemicals (Geneva), which catalyzes global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.
> Energy (Paris), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.
> OzonAction (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.
> Economics and Trade (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies.

UNEP DTIE activities focus on raising awareness, improving the transfer of knowledge and information, fostering technological cooperation and partnerships, and implementing international conventions and agreements.

For more information, see www.unep.fr