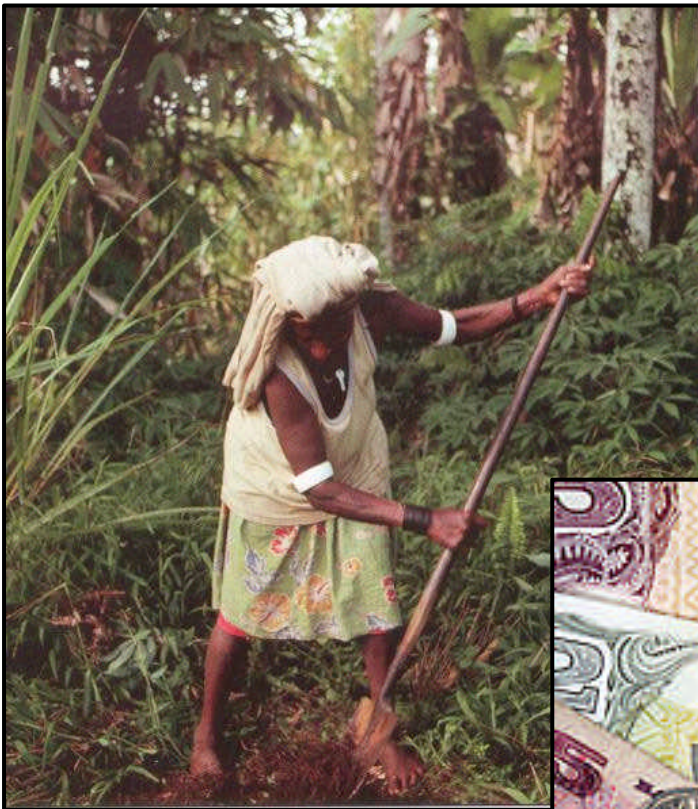


Community Development Strand
Agriculture

Unit 1: Agriculture Resource Science

Module 1.4 Sustainable Agricultural Systems



Lecturer Support Material

Acknowledgements

Materials compiled and edited by Michael Riach.

In consultation with:

Steven Tapi, Lecturer in Agriculture Studies, at St Benedict's Teachers' College, who has contributed much of the material used in writing this module.

Incorporating suggestions from Agriculture Curriculum Development Team:

Jack Hawap	– Balob Teachers College
David Taudiveve	– Gaulim Teachers College
Steven Potek	– Madang Teachers College
Jimmy N'Draras	– Kabaleo Teachers College
Nick Luba	– St Benedict's Teachers College
John Ambelo	– Gaulim Teachers College

Layout and diagrams supported by Nick Lauer.



Primary and Secondary Teacher Education Project

Australian Agency for International Development (AusAID)
GRM International

Papua New Guinea-Australia Development Cooperation Program

Unit outline

Unit	#	Modules
Unit 1 Agriculture Resource Science	1.1	Soil (Core)
	1.2	Crops (Core)
	1.3	Livestock (Core)
	1.4	Sustainable Agricultural Systems (Core)

Icons



Read or research



Write or summarise



Activity or discussion



Suggestion for lecturers

Table of contents

Module 1.4 Sustainable Agricultural Systems	vi
<i>Rationale.....</i>	<i>1</i>
<i>Objectives .....</i>	<i>1</i>
<i>Topics.....</i>	<i>1</i>
<i>Suggested teaching activities .....</i>	<i>1</i>
<i>Suggested assessment activities .....</i>	<i>2</i>
<i>References.....</i>	<i>2</i>
Topic 1: Agricultural Practices in Papua New Guinea.....	3
<i>Objectives .....</i>	<i>3</i>
<i>Resources .....</i>	<i>3</i>
<i>Scope .....</i>	<i>3</i>
Agriculture and its uses.....	3
<i>What is agriculture? .....</i>	<i>4</i>
<i>How farmers used their land .....</i>	<i>5</i>
<i>How is agriculture useful to us?.....</i>	<i>6</i>
The different agricultural systems of Papua New Guinea	7
<i>Shifting cultivation.....</i>	<i>9</i>
<i>Crop rotation.....</i>	<i>9</i>
<i>Mixed cropping.....</i>	<i>9</i>
<i>Sub-soiling.....</i>	<i>9</i>
<i>Mono-cropping .....</i>	<i>9</i>
<i>Raising livestock .....</i>	<i>10</i>
<i>Mixed crop swamp cultivation.....</i>	<i>10</i>
<i>Lowland shifting cultivation .....</i>	<i>10</i>
<i>Plantation.....</i>	<i>10</i>
The development of farming systems.....	10
<i>Farming and ecological zones in Papua New Guinea .....</i>	<i>11</i>
Topic 2: Subsistence Agriculture.....	13
<i>Objectives .....</i>	<i>13</i>
<i>Scope .....</i>	<i>13</i>
<i>Knowledge and skills .....</i>	<i>13</i>
Subsistence agriculture and its benefits to us	13
<i>What is subsistence agriculture?.....</i>	<i>13</i>
<i>Benefits of subsistence agriculture to Papua New Guinea.....</i>	<i>14</i>
Factors affecting subsistence agriculture in Papua New Guinea	17
<i>Case study .....</i>	<i>17</i>
<i>Changes in subsistence farming .....</i>	<i>19</i>
Topic 3: The Life a Shifting Agriculturalist	21
<i>Objectives .....</i>	<i>21</i>
<i>Scope .....</i>	<i>21</i>
<i>The shifting agriculturalist.....</i>	<i>21</i>
<i>Case study .....</i>	<i>22</i>
<i>Techniques used by a shifting agriculturalist.....</i>	<i>25</i>
<i>Labour - the role of men and women.....</i>	<i>25</i>
<i>Case study .....</i>	<i>26</i>
Products of subsistence agriculture	27
<i>Barter exchange- exchanging goods for goods.....</i>	<i>28</i>
<i>Origin of some subsistence crops used in Papua New Guinea.....</i>	<i>29</i>
<i>Legends are part of our people .....</i>	<i>32</i>

Topic 4: Sustainable Agricultural Development in Papua New Guinea...	34
<i>Objectives</i>	34
<i>Scope</i>	34
<i>Knowledge and skills</i>	34
The concept of sustainable agriculture	34
The current problems facing subsistence agriculture	36
<i>The neglect of subsistence farming takes many forms</i>	36
Sustainable ways of subsistence agriculture	38
<i>Improving subsistence gardening</i>	38
The future of subsistence gardening	43
Glossary	45

[Notes]

Module 1.4 Sustainable Agricultural Systems

Rationale

Agriculture Education in Papua New Guinea should teach a farming system, which promotes and plans for generations ahead rather than for the next day or year. The efficiency of such an agricultural system must be measured by its use of energy, raw materials, its minimisation of waste, and its ability to adapt to change. Papua New Guinea needs farming practices that can produce, using methods that above all ensure long-term fertility of the land, crops and animals of the highest quality in nutritional value.

This module should provide student teachers with an insight and understanding of the ways subsistence farmers can best look after the land and optimise rather than maximise food production. By doing this they should encourage agricultural systems in their teaching that promote sustainable agricultural systems. This module is a good lead into the more practical modules, Modules 1.1 Soil and 1.2 Crops.

Objectives

By the end of this module, students will be able to:

- identify the different agricultural practices found in Papua New Guinea particularly in their own area
- identify and describe the different ways and strategies for improving subsistence agriculture
- discuss the different factors that are affecting agriculture in Papua New Guinea
- list and discuss appropriate measures for overcoming these factors
- forecast where Papua New Guinea agricultural practices are leading to and be able to offer appropriate alternatives
- practice examples of improved agricultural techniques.

Topics

1. The Different Agricultural Practices of Papua New Guinea
2. Improving Subsistence farming and gardening
3. The life of a shifting agriculturalist
4. Sustainable agricultural development in Papua New Guinea

Suggested teaching activities

- Lecturer presentation
- Field trips
- Group work
- Video/film

- Seminar presentation
- Visiting speakers/lecturer

Suggested assessment activities

- Worksheets
- Exam questions
- Mini-tests
- Seminar presentations

References

- Cheak Kok Kheong, Hewitt, B., Hsu Yu-Chu, Joseph, K. and Williams, C. (1972). *Modern Agriculture for Tropical Schools*. Kuala Lumpur, Malaysia: Bangunan Loke Yew
- Cox, E. (1980). *Good Gardens for Good Food. Lesson guides for teaching agriculture and nutrition in community schools*.
- Cox, E. and Fitzpatrick, E. (1981). *Good Gardens Good Food Good Development. A handbook of practical agriculture and nutrition for development workers in Papua New Guinea*.
- Environmental and Development Agency Trust (1995). *People's Farming Workbook*
- Ethirveerasingam, N., Kapari, M., Parapi, A. and Ossom, E. (1993). *Agriculture in Melanesia Book 1 and 2*. Longman.
- International Institute of Rural Reconstruction (1992). *The Bio-Intensive Approach to Small-scale Household Food Production*.
- Morrow, R. and Allsop, R. (1993). *Earth User's Guide to Permaculture*. Kangaroo Press.
- National Department of Education (1981). *Learning About Gardening Science Resource Book*. Port Moresby, Papua New Guinea: Curriculum Unit.
- National Department of Education (1999). *Papua New Guinea Primary School Atlas*. Oxford University Press.
- Reijntjes, C., Haverkort, B. and Waters-Bayer, A. (1992). *Farming for the Future. An introduction to Low-External –Input and Sustainable Agriculture*: Macmillan.
- Taylor, P. (1999). *The Agricultural Teachers' Handbook*: VSO Books.
- Trautmann, N. and Krasny, M. (1999). *Composting in the Classroom: Scientific Inquiry for High School Students*. ISBN 0-7872-4433-3.

Topic 1: Agricultural Practices in Papua New Guinea

Objectives

By the end of this topic, students will be able to:

- discuss how agriculture is useful to us
- identify the different agricultural practices used in Papua New Guinea
- discuss and give examples of how some of the practices came to be in a particular area
- identify the different ecological zones of Papua New Guinea and talk about how these zones affect-farming practices.

Resources

- Student Support Material book
- Student garden plots

Scope

This topic helps you to identify with your students the different agricultural practices that are taking place in Papua New Guinea. Particular attention should be placed on agricultural practices in students' own communities. As much as possible, include the local community and invite someone in the community who is engaged in major agricultural activities to assist the course.

Knowledge and Skills

- Upholding and appreciation of local knowledge
- Map reading
- Research and Observation



Introduce the students to the objectives and the skills and knowledge to be examined through the first two sections: Agriculture and Its Uses and Different Agricultural Systems of Papua New Guinea.

Agriculture and its uses

It is important that we know what agriculture is and how helpful it is to us before dealing with the different farming practices used in Papua New Guinea.

What is agriculture?

 Many people have their own practical definition of what agriculture is. Explain that there are different types of agriculture: organic, subsistence, sustainable, traditional to name a few. Ask the students to read the statements about agriculture and match the type of agriculture with a definition. Have them complete 1.4 Activity 1 and allow time to share definitions.

... agriculture is farming systems in which a large part of the final yield is consumed by the producer. This may involve the production of some crops or animals for sale.

... agriculture is systems that encourage healthy soils and crops through practices such as nutrient recycling of organic matter, crop rotations, proper tillage and the avoidance of synthetic fertilisers and pesticides.

... agriculture is the management of resources to satisfy changing human needs, while maintaining or enhancing the quality of the environment and conserving the natural resources.

Types of agriculture:

Organic

Subsistence

Traditional

Sustainable

... agriculture is farming systems which are based on indigenous knowledge and practices, and have evolved over generations.



1.4 Activity 1

There are many different types of agriculture. Read the above definitions and match each definition with a title.

What is your definition of agriculture – based on your experience define agriculture using drawings symbols and key words

Share and discuss your definitions with the class.

How farmers used their land

Before agricultural practices developed in Papua New Guinea people survived by hunting, fishing and gathering. Since the development of agriculture, people have been able to grow and raise animals using various traditional practices. The use of land by farmers to grow crops and raise livestock is called **farming**.



Explain the different farming systems shown in these photographs.

Discuss with a peer how the land is used in each example.

 Ask the students to draw or collect pictures of farming activities. Discuss and give examples of the types of agricultural activities taking place in Papua New Guinea and their local areas. Have the students provide their own examples.

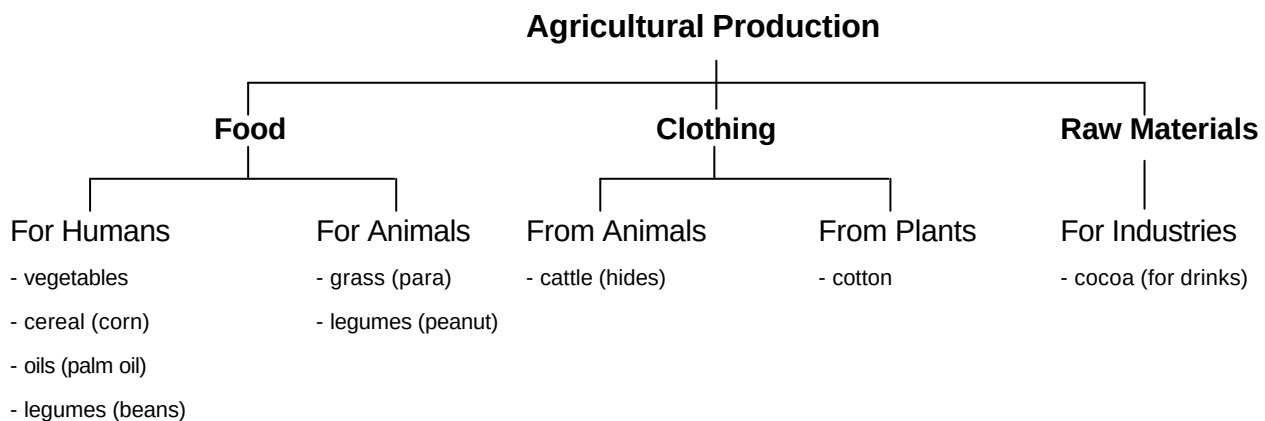
1.4 Activity 2

Draw or collect pictures of farming activities which are taking place in Papua New Guinea and particularly in your local area. Try to get a broad range of farming activities which give a broad picture of farming in this country. Include different livestock, cropping systems, agro-forestry, and cash cropping as well as traditional subsistence farming.

This resource should become a teaching resource in your teaching portfolio.

How is agriculture useful to us?

Farmers use the land to grow crops and raise livestock so that the surplus can be sold to town dwellers like us so that we can have food, materials for making shelter and clothing, animals and materials for sports and entertainment. Certain plants are either grown or looked after for a special use in a community. For example, some ginger species are grown for ceremonial purposes in some parts of Papua New Guinea and others are grown or looked after for medicinal purposes.



 1.4 Activity 3

- *Make a list of how agriculture is useful to you.*
  - *Name two by-products of cocoa, coconut, coffee and citrus.*
  - *Name three plants that are used locally for medicine, house building, clothing and decoration.*
  - *List at least three plants that are used for special ceremonial purposes and three plants for medicinal purposes.*
-

Agriculture is the science and art of cultivating the soil to grow crops and raise livestock to produce goods and to distribute and market those plant and animal products for the good of the community while making a profit for the farmer.

The different agricultural systems of Papua New Guinea

Over most of Papua New Guinea, agriculture has supported relatively low population densities. Our use of agricultural land has, in many parts of the country, produced a pattern of cultivation, which is a result of trial and error based on environmental limitations. Rare or unique techniques have been developed here, for example:

- no-burn forest clearing
  - deep holing for yams
  - grid-iron tillage, and
  - flood-fallowing practiced in Enga.
-

 1.4 Activity 4

Identify and describe the different agricultural practices found in Papua New Guinea.

In this investigation, you should include:

- *The types of farming systems used by the local people in the different regions*
- *The development of these farming systems*

Refer to 'Papua New Guinea Primary School Atlas'. Oxford University Press and NDOE (1999), p42 'Food Production'.

Research has shown that Papua New Guinea's agricultural systems are at least 30 000 years old. This proves that not all agricultural farming innovations are imported. It is also a fact that different communities within Papua New Guinea have had different needs, and they have combined fishing, foraging, hunting and cultivation in very different proportions.

To assist them meet their daily food needs, communities have developed farming systems.



Ask the students to name some of the common farming systems practiced in Papua New Guinea. Write these on the board and allow small group discussion of personal experience with these systems.

A farming system is a way farmers use to cultivate the soil and grow crops in relation to all the factors that exist within the boundary of the farm or garden. For example: people, livestock, crops, wildlife, trees, and all social, economic and ecological interactions between them and with the environment. It is the method of how a farmer organises his/her gardening pattern and the growing of crops and raising livestock.

The two broad cultivating systems are:

1. Subsistence agriculture
2. Commercial agriculture



1.4 Activity 5

Name five crops that are grown under each of these two systems.

People use different ways of planting or growing food crops and looking after animals. These different ways of farming can be termed as *different farming systems*. Some of these farming systems are:

- mixed cropping
- shifting cultivation
- plantation
- raising livestock
- mono-cropping.



Discuss the different features of:

- ? Mixed cropping
- ? Shifting cultivation
- ? Plantation cropping

? Raising livestock

? Mono-cropping

If possible, visit some of these farming systems operating in your area and make a questionnaire for students to fill-in during the visit.

List some of the disadvantages and advantages of each of the farming systems.

Shifting cultivation

This is a system of farming where the production of crop is alternated with periods of fallow. First, a garden site is selected, and then the land is cleared. The cleared bush is left to dry (leaves and bush wood to dry). Then the dried leaves and wood is burnt (usually towards the end of the dry seasons). The land is then planted with food crops until the soil is exhausted. The land is fallowed and allowed to revert to bush.



List tens reasons why this form of farming must change

Crop rotation

Crop rotation is; the planting of different types of crops in different plots; or in the same plot in rotation; or following a definite sequence.

Mixed cropping

This involves the planting of different types of crops on the same field/land in the same cropping season.

Sub-soiling

In the Waghi Valley, the soil is marked out in square or rectangle blocks and the soil from the perimeter ditches of these blocks is thrown onto the plots. The crops are then planted.

Mono-cropping

Mono-cropping is the planting of crops on the same piece of land

with same type of crop year after year or season after season.



A mono-crop of kamaere

What are the advantages and some disadvantages of mono-cropping?

Raising livestock

Domestic animals are kept for many reasons; feasts, bride price, exchange, parties, own consumption or for commercial sale. Pigs play a vital role for gardens during the fallow period.

Mixed crop swamp cultivation

An extremely complex system of swamp cultivation has been developed in Artific Island in West Irian and the Vuvulu Island for growing swamp taro.



Lowland shifting cultivation

In non-swampy lowlands of Papua New Guinea, a system of shifting cultivation with long fallow is practiced for growing food crops for own consumption and for trade.

Plantation

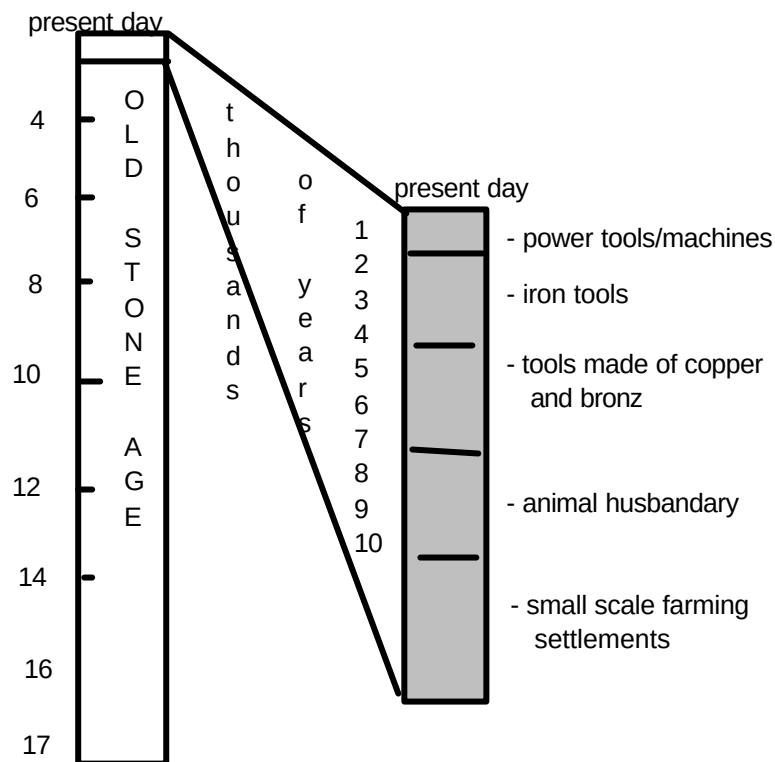
Intensive cultivation of specific crops over a wide range of land using a lot of labour and machines. Mainly export crops are grown here. Plantations can be mono-crop plantations. Eg: pine forests, teak, coffee and tea plantations.

Describe the likely methods of cultivation and crops grown in this intensive farming scene.

The development of farming systems

For many thousands of years, people subsisted by hunting, fishing and gathering. To do this they had to move from place to place. For shelter, they lived in caves and temporary huts. For clothing, they used leaves and animal skins.

This nomadic lifestyle of hunting and gathering stopped for many Papua New Guineans who chose to grow domesticated food crops and animals in a settled environment. This settling in one place brought many changes to the survival activities of that group of people. Now in order to find food, clothing and shelter, men and women were forced to grow specific crops and raise animals to meet their needs. The ways of providing food changed from hunting and gathering always to growing food on a piece of land around where they settled. This was the start of farming systems. Men and women also started to develop tools to assist them to cultivate the land for crop planting.



The development of agricultural production in Papua New Guinea began much earlier than in Europe, perhaps, 30,000 – 40 000 years ago. It may have developed here independently and the people may have domesticated food plants much longer than people of the Fertile Crescent.

1.4 Activity 6

Write a short story on how farming started in your village. Describe the types of tools used for gardening by your ancestors.

Farming and ecological zones in Papua New Guinea

 Refer to the map of ecological zones in Papua New Guinea. Discuss how these zones influence the type of agriculture practiced and land use patterns.

Ecology means the relations of plants and animals to their surroundings. The ecological zones are the different environmental areas where certain plants and animals live in relations to their surroundings.

Ecological zones play a vital role in determining the types of farming systems practiced by farmers in Papua New Guinea. The five ecological zones of Papua New Guinea are:-

SWAMP LOWLANDS In this zone area, the system is based largely on gathering sago and other wild foods. They are only a few cultivated gardens. People practice slash and burn or shifting cultivation methods. In some areas, highly intensive system of mix swamp cultivation has been developed.	FOREST LOWLANDS The scattered populations who live here used a system of shifting cultivation with long bush fallows. They make gardens by cutting the undergrowth, felling the smaller trees and pollarding the large trees. They dry and burn the vegetation debris and plant crops in ashes and soil. Forest regeneration is encouraged following garden cultivation.
GRASSLAND AND SAVANNA In drier grasslands and savannas, the same system is practiced as in forest and swamp lowlands but tillage (cultivation techniques that involves turning and breaking up of the soil) is commonly practiced.	MID ALTITUDE The people who live here have limited agricultural opportunities because of steep slopes and high rainfall. They cultivate small gardens in the forest using shifting cultivation techniques and gather sago and foods from lower elevation.
HIGHLANDS The highlands society throughout the zone has the most distinctive set of agricultural techniques. Various types of tillage methods are used for sweet potatoes cultivation and high human and pig population are supported by semi-permanent cultivation. For example, the Enga style of making kaukau mounts.	ATOLS Here the soil is coral and sand and only plants like paw paw, coconut, taro breadfruit and pandanus can grow. If the island has a high rainfall, then banana and European vegetables can be grown but compost is used a lot in the garden.



1.4 Activity 7

Locate the five ecological zones of Papua New Guinea and mark them on a map. Also, locate the corresponding provincial areas and look for overlap.

Discuss how farming is influenced by an ecological zone.

Research one ecological zone and include at least one picture or drawing to illustrate the type of farming system operating.

Topic 2: Subsistence Agriculture

Objectives

By the end of this topic students should be able to:

- describe what subsistence agriculture is,
- discuss its benefits for Papua New Guinea
- discuss the current problems facing subsistence agriculture.

Scope

Subsistence farming is Papua New Guinea's largest employer and its most diversified industry. This labour intensive and cash input free farming system was and in some ways still is ideally suited to Papua New Guinea. However, there are many problems facing subsistence agriculture today. Neglect, migration, land-pressures and adverse government policies all contribute to the difficulties now facing traditional farming.

Knowledge and skills

- Upholding and appreciation of local knowledge
- Comparing and classifying
- Research and observation

 Introduce the objectives and the skills and knowledge to be developed through the three main areas of this topic:

Subsistence Agriculture and Its Benefits to Papua New Guinea.

Factors that are affecting subsistence agriculture.

Subsistence agriculture and its benefits to us

 Ask the students to make drawings to illustrate what they think subsistence agriculture means. Students should share drawings and try to interpret each others messages. Have the students read on and complete the activities.

What is subsistence agriculture?

Subsistence agriculture is a way of life - a way people go about satisfying their everyday needs and wants. Subsistence is one method of finding food, clothing and shelter. Subsistence agriculture is farming systems in which a larger part of the final yield is consumed by the producer. Most subsistence systems involve production of some crops or animals for sale.

Subsistence agriculture is not the same as shifting agriculture but could include the practice. Shifting agriculture is a system of agriculture where people select a site, clear the bush and burn the debris to make a garden; but after a year or two they will leave this garden and move to a new piece of land (site) and make a new garden. The garden site is shifted rather than crops and the old site is left so that grass and trees can grow and rejuvenate the soil.

This is called *bush fallow* or grass fallow. Fallow is known as the period of time the piece of land is left uncultivated until the site is used again. Fallow period is traditional between five to twenty years. However, with increased population pressure fallow times are getting shorter.



Example of cultivated and fallow fields, Mt Hagen, Western Highlands.

What are the reasons for fallow periods becoming shorter?

Benefits of subsistence agriculture to Papua New Guinea

i To many people subsistence agriculture is linked to poverty and inefficiency. Discuss this notion and together list benefits to Papua New Guinea. Note with the students that subsistence farmers do not pay tax directly to the government. Discuss the disadvantages to the country.



What subsistence activities are happening here?

Employment opportunities

Subsistence agriculture is Papua New Guinea's largest employer. More than eighty percent are employed in subsistence agriculture more than in all other industries throughout the country. It is also the country's most diversified industry. Subsistence farmers are engaged in gardening, forestry, hunting, tool production, house construction, cloth making, dye stuffs manufacture, the

production of cosmetics, traditional medicine, ornament making and the production of ritual materials.

1.4 Activity 8

Write a job description/duty statement for a subsistence farmer. Include hours, pay, work conditions as well as duties.

Display your work for others to read.



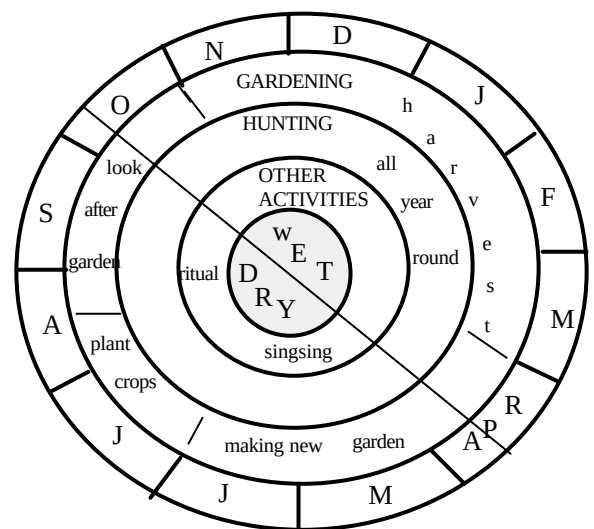
Social activities

Much of the social, festive and daily living activities revolve around subsistence agriculture events. This can be highlighted in the traditional village calendar.

List the skills likely to be possessed by this subsistence farmer.

A typical traditional calendar showing the importance of subsistence activities

In a rural village in the Sepik Plains, peoples' lives depend on the subsistence activities that take place all the year round. The central subsistence activities are based on the garden. The type and size of the garden depends on the land, social obligations, dependents, markets, exchanges and planting materials. The benefits of subsistence gardening go to improving the livelihood of the village people.



1.4 Activity 9

Using the above traditional calendar, design a garden that fits this calendar model. Include subsistence activities and try to be as specific as you can. If it helps, use examples from your area.

Traditional knowledge

In one form or another subsistence agriculture is practiced throughout Papua New Guinea. It supports good dietary traditions, cultural diversity, good traditional knowledge and experiences of making gardens. It is marked by diversity in plant species, varieties, yield and site habitat. It results from an evolutionary process spanning many generations.

Land utilisation

The system is adjustable to the geography of the area that would not otherwise suit other farming systems. When properly practiced, as was in the past, subsistence agriculture provided for almost all the dietary needs of the village people.

Cash and energy inputs

It makes light demands on farmers in terms of energy and cash input. The main cash inputs are buying bush knives, axes, hoes, spades and files. It is not subject to inflationary pressure. It uses biological energy inputs.

Food supply

It can supply a constant harvest of fresh food. It can also supply good planting materials. It readily meets family obligations on food requirements, exchange and trade.



List the business skills of these subsistence farmers.

Pest and diseases

It discourages plant specific pests and diseases. It also discourages a build up of one type of pest and disease.



1.4 Activity 10

Plan the meals for three days based on the crops likely to be produced in subsistence gardens from your area. Include a balance of nutritious plants and protein.

Identify two traditional techniques used to control pests and diseases in subsistence gardens. (Refer to Module 1.1 Crops for more on organic pest control)

Factors affecting subsistence agriculture in Papua New Guinea

i Introduce this section with a discussion on the merits of the cash economy and the demands now placed on subsistence farmers. Examine the economic pressures faced by men and women – are they the same?

Make a list of some of the factors facing subsistence agriculture.

Subsistence agriculture has become a way of life and an essential part of Papua New Guinea culture. Until fairly recently, cash was not very important to most Papua New Guinean subsistence farmers. So farming was carried out entirely to satisfy the needs of the family.

Today things are changing rapidly and changes are taking place in the areas of subsistence sectors in Papua New Guinea.

i Invite a guest speaker to talk to the students about the current factors that are affecting the subsistence agriculture sector in their area.

Read the following Case study which is about the Sepik family of Tanguli and Jikimban. Stop and discuss the activity questions.

Case study

This case study is about the Sepik family of Tanguli and Jikimban who have lived as subsistence farmers for many years. However their way of life is slowly changing.

Traditional subsistence agricultural methods used by Tanguli and Jikimban have varied considerably in scope and form but generally are sufficient to meet their daily demands. The hunting and gathering of food was and is solely on their natural environs (nearness or closeness). The regular tilling of the soil, incorporating with bush fallow was and still is undertaken by them because of restricted land availability or by longer periods for maturity of certain crops. In some instances, when they are faced with regular recurring stress periods, bartering became an accepted way of their lives.

What would these reoccurring stress periods be?

Tanguli and Jikimban have a son who is twenty-one years old and two daughters, both under fifteen years old. Tanguli has two brothers who are married with four older children each old enough to do gardening tasks. Tanguli's land is scattered all over the entire village area. He has about half a hectare in part and another half a hectare in another part. Put all of them together, he owns about half the entire clan land of Numangua Village of the Torembi area. His way of

making gardens was the same as his forefathers until 1974. Major events took place that have now changed the way Tanguli and Jikimban make their food gardens.

In 1972, he was recruited to work in Kimbe to establish the oil palm blocks. He was away for two years and when he returned home he brought some varieties of banana, taro "true", and other edible greens which do not grow in Numangua Village. He also brought with him the idea of growing cash crops and the first thing he did was to visit the DPI office in Wewak. He then went home and cleared three hectares of land for planting coffee. Because he had this drive for growing cash crops, he did little in the food gardens.

What would be the effect of bringing in the new types of vegetables like taro true and banana?

The food crops he brought from Kimbe were given to his wife for planting. He just told her what to do and how to grow them. Normally they used to have three gardens; one for yams only, the other for short-term crops and greens and the last one for long term crops such as banana and pitpit. Now, only his wife makes one garden to grow all these crops while he spends his time in his coffee garden.

Is this a positive change? How could he have managed this change differently?

His son does little to help them both. He claims that working in the garden is hard work and does not earn him any money. He says also that gardening is not the only way of finding food and that he has education that will enable him to get a paid job. He has since left for Wewak.

What advice could be given to this boy that might make a difference?

His brothers are also putting pressure on him to sell part of his land to a logging company. His refusal to sell the land has stopped his brothers from receiving royalties. This has created tension among the brothers.

What realistic alternatives could be put-up as options to logging?

Clan obligations have forced him to give four hectares of land to his extended uncle because he has six boys who are over twenty years old.

Mondays of each week are community workdays and no one is allowed to do gardening activities. Wednesdays is for schoolwork in a nearby community school. This has lessened the time in working in food gardens. Overall, the family has a hard time getting enough to eat in a week.

Source: S.Tapi (2000). 'Personal research from his village'



1.4 Activity 11

Turn this case study into a teaching resource suitable for Grade 6-8 students. Think of ways it could be part of a thematic plan. For example: in Social Science, you could examine the effects of cash crops on traditional food gardens.

Changes in subsistence farming

 Discuss the following changes in subsistence farming with students and ask them for examples of the three areas of change:

Changes in farming systems, the non-agricultural sector and changes in crops grown. Refer to the Case study

Have the students read on and answer 1.4 Activity 12.

Changes in farming systems

The following are some of the significant changes now affecting farming systems in subsistence agriculture.

- Intensity of cropping (relationship between cropping and fallow periods).
- Male and female labour inputs have shifted in the time spent in gardening. More grassland areas are done by females while males do less work in this area.
- Soil fertility maintenance techniques are declining with the use of chemical fertilisers and other agricultural chemicals.
- Cultural techniques of soil erosion and control have since been changed in some parts of the country; that is the making of beds to collect the run-off residues on the side of the hills.
- The growing of cash crops has changed the ways in which people now make their food gardens and the time they spend on these gardens.

Non-agricultural changes

- No tribal fights in most areas of the country. This means that people can now make gardens further away from their villages.
- Introduction of steel tools like axes, spades, forks and grass knives have made the tasks of gardening easier. These tools have made it possible for people to clear large areas of land.
- Movement of people nearer to roads, highways and urban centres have put pressure on some areas for gardening purposes due to increase population in that area. Population increase in a given area means less land available for gardening.
- People's attitude towards gardening - some people don't want to "dirty" their hands and so do not want to work in the gardens as they use to do. Gardening is hard work and some trade store goods offer easier alternatives.
- Cash has become a substitute for growing food - more people are now looking for formal employment and less people work on food gardens.

Changes in crops grown

- The introduction of new types of crops have changed the way of gardening as gardeners adapt and learn new ways of plant propagation, cropping systems, harvesting and processing.

- Expanding existing food crops to other areas of Papua New Guinea has also changed some peoples' way of gardening. (See above Case study.)
- New cultivars of existing crops have been introduced and widely spread in Papua New Guinea.
- New accepted staple food crops mature faster and are easier to grow and people have gone for these crops rather than the old staple crops.

Some examples of factors that are affecting subsistence agriculture in Papua New Guinea

In the Baiyer River area, Western Highlands

It has been reckoned that in this area food gardens will probably end up mainly on the cliff and hillsides where the topsoil is not so thick and rich and from which production is low in both quality and quantity.

In the Chimbu area

It has been reported that more and more Kikin people are putting much of their time and efforts into coffee production because they realise its importance, they seek to put less emphasis on growing other food crops for family consumption.

In the Nembi Plateau

It has been found that men were reluctant to clear new gardens, although yields from old and over-worked gardens were extremely low, and women were working themselves into a state of near exhaustion seven days a week in order to feed their families and pigs. Men were however, prepared to work for payment in cash, on government projects to maintain roads.

In a family unit

'Women certainly appreciate the relief from daily chores of harvesting and preparing garden food. My wife no longer feels committed to go to the garden everyday to bring food for the children, our pigs and us. When there is money she buys what we need.' (S. Tapi, 2000)



1.4 Activity 12

Think of your own area and try to share stories, which also tell of the changes happening to subsistence farming.

Work in groups to draw a poster on one of the most influencing factors that are affecting subsistence gardening in Papua New Guinea or their area.

Topic 3: The Life a Shifting Agriculturalist

Objectives

By the end of this topic students should be able to:

- list some factors that affect the work and lifestyle of a shifting agriculturalist
- identify the different techniques used in shifting cultivation in Papua New Guinea
- describe the role of men and women in gardening activities
- identify different subsistence gardening products.

Scope

This topic will examine in some details the features of subsistence agriculture. It will build on from the last topic that dealt with the history and the development of farming systems. It should be emphasised that many features of subsistence agriculture are common to all areas of Papua New Guinea but there may be features particular to some areas which are absent in others. Your discussions should give the students a general definition of the types of life style a typical subsistence farmer lives through. You should also discuss the type of crops produced and where these crops came from and how you can store some of these crops for later use. Use your local knowledge as much as possible.

Knowledge and Skills

- Upholding and appreciation of local knowledge
- Comparing and classifying
- Research and Observation



Introduce the objectives, skills and knowledge and the two main areas of study:

? Life of a shifting agriculturalist

? Subsistence crops grown in Papua New Guinea

The shifting agriculturalist

Subsistence agriculture has become a way of life for a shifting agriculturalist. The activities of a typical shifting agriculturalist vary little from place to place and from ecological zone to ecological zone. Use your own local examples when studying the lifestyle of a shifting agriculturalist.

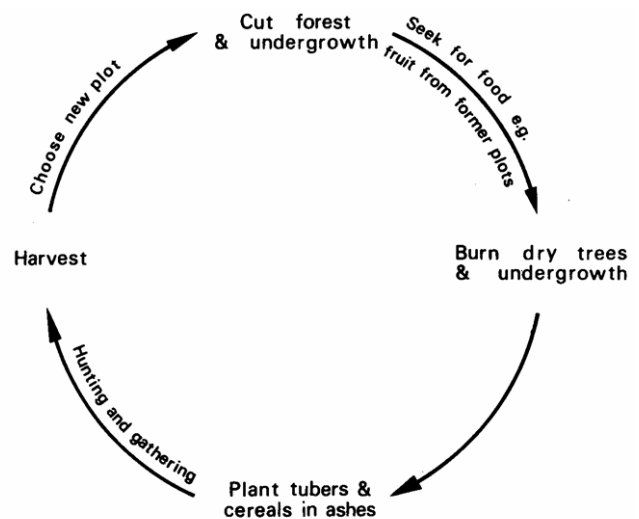
Case study

i Have the students construct a seasonal calendar based on the activities in this case study. As they read, ask them to note all farming related activities.

This case study continues to explore the lives of Tanguli and Jikimban from Numangua Village, East Sepik Province

Tanguli begins seriously to think about making a new garden towards the end of July and the beginning of August, at the start of the dry season, when the yam leaves and vines have begun to curl and turn brown. The yam harvest and the making of the new garden proceed concurrently. Yet, Tanguli and Jikimban have selected the site some months earlier. The most convenient site for the new garden is one adjacent to the old garden; distance for transplanting is at a minimum, a section of old fence will enclose the new garden and the old garden shelter

maybe used for another year.



Cycle of work done by a shifting agriculturalist

Jikimban has to make a decision with her husband on site selection because she will carry the produce from the garden to the village and planting materials from the old garden site to new site. Both also remember well the sites of past gardens and the kinds of harvest they yielded.

Day by day, Tanguli and Jikimban, and their close relatives clear away the under bush and weeds. With clearing well forward, older and unmarried male relatives start looping the big trees, while fathers clean off the cut branches and stake them against uncut trees. In time, these staked branches will be needed as supports for yams and mami vines and for building fences. After looping comes felling, work for Tanguli and older boys and men. The large trunks are left where they fall, most of them effectively dividing the site into plots which will be marked out to the members of the households and for special crops like yams and pitpit. Smaller trunks maybe used for the same purpose or rolled across or down the slope to make a base for the garden fences. Trunks are cleaned, the larger branches being stripped and laid aside as fencing materials. Sapling and younger trees are left standing to provide shade and to be the central supports of pyramids of yam stakes. The site cleared, the next task is to burn off the dried litter of sticks, weeds and leaves. It is normally done in two stages:-

First, at about noon on a hot sunny day, a torch is put to it, then a day or so later, depending on the yam harvest, the site is cleaned by firing small piles and ashes and raking them all over the ground; a long and painful task usually done by Jikimban and her daughters.

As cleaning is completed so Tanguli marks out plots to the names of members of his household and starts to plant yams called 'mami'. Then Tanguli, Jikimban and their children thrust shoots of taro into the ground here and there, banana suckers are transplanted, greens planted in their selected areas of the plots and other early maturing crops are also planted. In the old garden, meanwhile, the weeds have been allowed to grow undisturbed. There is still much to be done. Bananas are fruiting and transplanting of suckers continues through November to March of next year. Pitpit canes start to yield their edible flower buds which are cut back by Jikimban and transplanted as their harvest is gathered. Old garden fences are broken down by Tanguli and Jikimban for use as firewood throughout the following year. December to February are the months of scarcity of food supply. Tubers are in short supply, the Sepik River is flooded, and many gardens are sometimes under water. This is the time Jikimban goes to the market to barter for fish with sago.

By February, however, all the crops planted in the new garden are growing. The garden fence is near completion and the shelter, as a rough windbreak in October, has been transformed into a house, small, but large enough for the family to live in and hold the 'mami' harvest in June and July. Jikimban and her daughter are busy weeding. Tanguli sleeps in the garden occasionally to chase wild pigs away or kill them for meat. In March, wild fruits and nuts like 'taun' and 'galip' are collected by Tanguli, Jikimban and the children; for selling, for barter and for eating.

From April until June, taro and 'mami' are being dug up. These are the months that Tanguli does little in the garden. He spends most of his time hunting and fishing while Jikimban and her daughter continue with the seemingly endless task of weeding and clearing the garden. Then as kaukau ripens, to be followed on by taro true, banana and yams, Tanguli is kept busy. Apart from the work itself, as each crop comes to maturity in its turn there are exchange obligations, feast, and dances to organise and attend. The problems involved in these activities keep Tanguli occupied until the time comes when, with these same matters in mind, he begins to think about the size and site of his new garden.

Source: S.Tapi (2000). 'Personal research from his village'.

 1.4 Activity 12

From the information given, construct a seasonal food calendar to show what this family grows and eats throughout the year.

Traditional calendar

The shifting agriculturalist work is not governed by time. Rather, she follows the climatic pattern of the area. Apart from making gardens, she has other jobs and activities like gardening, fishing, hunting, feasting and community work programme. Her subsistence activities include:

- selecting the site using criteria like yield, distance from old garden site and custom and exchange obligations

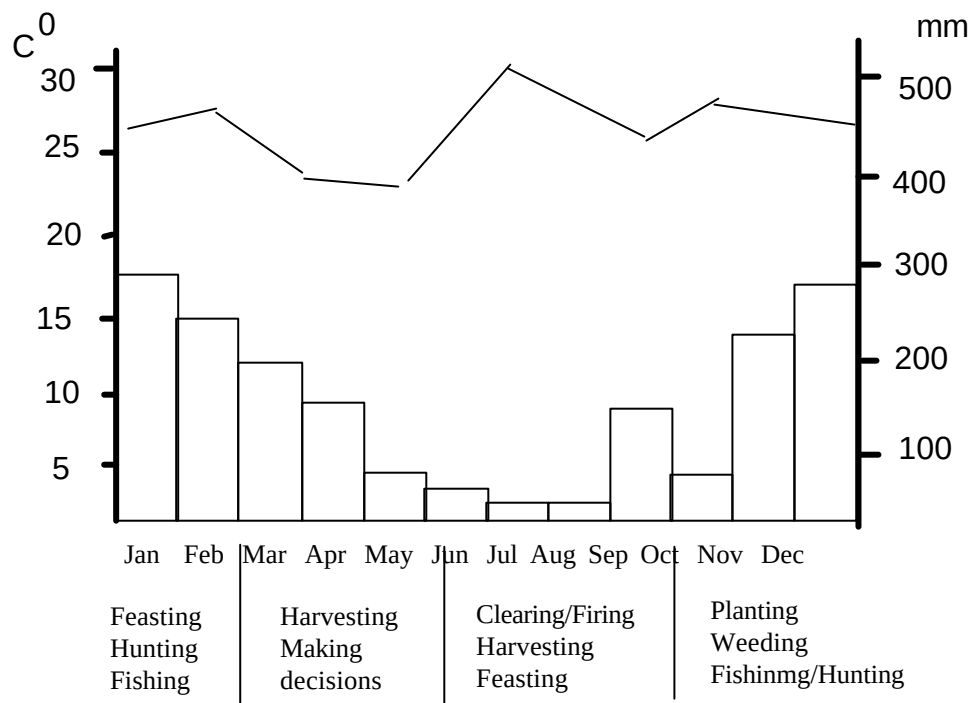
- clearing and preparing the land
- transporting planting materials and planting of these materials, and
- garden maintenance, harvesting and storage.

The weather

There are many factors that affect gardening activities. One of the factors that affects all gardening activities is the weather. The graph below shows the effect of weather on gardening in the Torembi area of the East Sepik Province.

Certain subsistence activities are carried out at certain times of the year when the climate is ideal.

Subsistence activities in relation to weather



1.4 Activity 13

From the graph SUBSISTENCE ACTIVITIES IN RELATION TO WEATHER, deduce when the following activities would be carried out:

1. *Burning debris, planting and harvesting*
2. *Fishing, hunting and trading*
3. *Feasting ceremonies and religious and traditional rituals.*

Techniques used by a shifting agriculturalist

The techniques used in the traditional subsistence agriculture vary from place to place. Some societies have simple techniques of just clearing the land, burning the debris and planting the crops while other societies have more complex techniques. They use different tillage methods and complex rotation techniques. These farmers use techniques that have been tried out in their area and so to change some of these techniques requires careful thought.

The most common techniques used by a shifting agriculturalist are:

- moving garden site year after year
- growing of different crops on the same garden (mixed cropping)
- growing of special crops on a different garden (yam garden)
- burning of cleared bush and undergrowth
- less soil tillage and making drains and mounds
- growing of perennial crops in the old garden
- using cuttings and suckers as planting materials, with less emphasis on seeds
- planting magical plants for good harvest
- use of rituals in time of planting, maintenance and harvesting.

Labour - the role of men and women



Make general lists of men and women's roles in Papua New Guinea society. Explain that division of labour occurred for very good reasons, name a few. As they read have them record other possible reasons why division of labour occurred in traditional agriculture.

In Papua New Guinea, 'men and women' leading a subsistence life, often do separate tasks. The men generally do the hunting and the heaviest clearing and cultivation, the women the lighter but no less arduous tasks. The sex role may be firmly differentiated, with one sex never intruding onto the other's role, or can be quiet casual, more a matter of convenience and to be broken when convenience dictates.

Group work is common for heavy clearing, while ownership of and the day-to-day work in a garden is by far most commonly individual or small family. Beside the group clearing work, an individual may do some of the work in the gardens of various relatives. Group or individual work in person's garden is generally repaid reciprocally. In societies, a further subdivision of work exists, with specialist production and trading.

Division of labour

An example is given in the case study below on how one society organises its labour.

Case study

A traditional but still firmly asserted division of labour between the sexes among the Torembe people requires that an efficient working group should consist of male and females in partnership. Men cut down trees, loop and make fences, build houses, dig, plant, hunt, trap, fish with spears. Women weed, carry, cook, draw water, clear under bush, fish with nets and look after children. Men help with the cooking of foodstuffs, particularly meat, on public feasting occasions; they make their own gear, equipment, dress and decoration, they work in wood, paint, carve, make cuts in skins, and weave cane waistbands, armbands, anklets and wristlets. Women make skirts, strings, string bags, dogs' tooth necklace, and their decorative accessories and work in cane. Men regard it as degrading to have to do work specifically associated with women. Their role is to think, plan, invent, create, initiate, manage and be ready with a spear. Women's work is generally hard, dull, monotonous and routine; they simply work hard all the time.

Source: S. Tapi (2000). 'Personal research from his village'.

i As a whole class examine the case study and identify all those tasks done by men, women and both sexes. Draw the following table on the board and complete cooperatively.

Type of Work	Men only	Women only	Both Sexes



1.4 Activity 14

Discuss the case study with your peers.

Is your traditional society anything like this? Using the above case study as an example complete the table below on the division of labour in your own area/village. Give reasons as to why certain tasks are done by men only; or women only.

Type of Work	Men only	Women only	Both Sexes

Some reasons for having division of labour

 Ask the students why there is a division of labour, what the advantages for this division are and what effect the move for gender equity will have on subsistence life.

The role of man and woman in gardening and other subsistence activities was and in some places still is very distinctive. For example, the growing and harvesting of yams in the Sepik area was the task of the man and his eldest sons. Women were only to carry the planting tubers to the garden and leave them at a pre-arranged spot. The man then got certain herbs and saying the magic words, he dug the soil, put some dead leaves into the hole and planted the yams. This was done in the very early part of the morning.

Source: S. Tapi (2000). 'Personal research from his village'.

Products of subsistence agriculture

 The products discussed here are only those taken from the subsistence garden. Discuss with the students how these products were used in barter exchange and storage methods. Draw the following chart on the board and together complete it for each province of Papua New Guinea. Allow students to work in mixed regional groups

Area	Cultivated Plants		Plants Not Cultivated	
	In Garden	Not Garden	Regular Use	Occasional
East Sepik Province	taro, yam	pitpit	tulip, mon	mango, taun

Subsistence products harvested can be divided into two groups the **cultivated** products and **uncultivated** products.

1.4 Activity 15

Work in mixed regional groups and try to complete this table. Be prepared to share your results with the whole group.

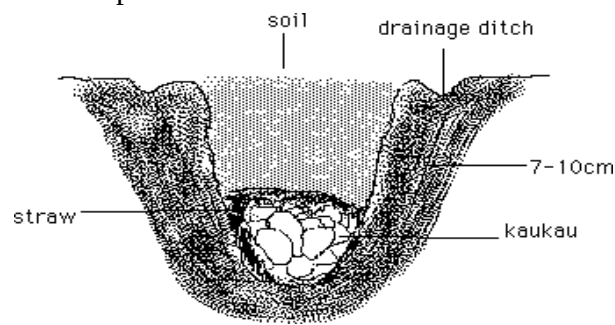
Uses of these products

The uses of these products are similar wherever you go in Papua New Guinea. Most are used as food, some for exchange for other items or for cash, some for feast and bride price and a few for gifts. Not many products are stored for later use. However, some people store vegetables in pits and containers and some of these vegetables can store for a long time and remain very acceptable products.

There are a number of ways of storing subsistence products in the villages. The methods used depend on what you want to store and for how long and for what purpose. For example, kaukau can be stored under the ground for a long time.

One method of storing kaukau or any vegetables.

- Dig a hole 14-20 cm deep, in a shape of a cone
- Put kaukau into the hole
- Put layer of grass 7 cm thick over and around the kaukau
- Cover the grass and kaukau with 7-10 cm of soil
- Soil is then made firm over the grass
- Dig a drain around the pit



i Have the students work in groups to cooperatively discuss the storage methods used for the various traditional crops in their area and complete this table. Share results.

Barter exchange- exchanging goods for goods

The story of barter

Every Thursday of each week, the women from Torembi, Aulimbit, Numangua, Slai and Kosembi villages travel to a market place called, 'Apajagi'. Here, barter exchange and at the same time, cash sales take place. The women from these villages bring, for exchange, the following crops (products); sago, yams, betel nuts and mustard seeds, greens of various kinds, coconuts, sugarcane, paw paw and other edible fruits and nuts while women from Kandje, Korogo, Yanjmangua bring fish and lotus nuts. This market place is also a place for exchanging news and other valuables such as traditional shell money. Men and boys are now also accompanying women to this market.

Source: S. Tapi: Personal research from his village, 2000

i Explain to the students that in many western countries people are showing interest in rediscovering systems of barter or 'green-dollar exchange' that their ancestors used before cash and credit cards became the main currency of exchange. Discuss why this could be happening and have them complete 1.4 Activity 16.

1.4 Activity 16

Explain what barter is and give examples of how you think it operates – use your own area as an example. (Use the glossary to assist)

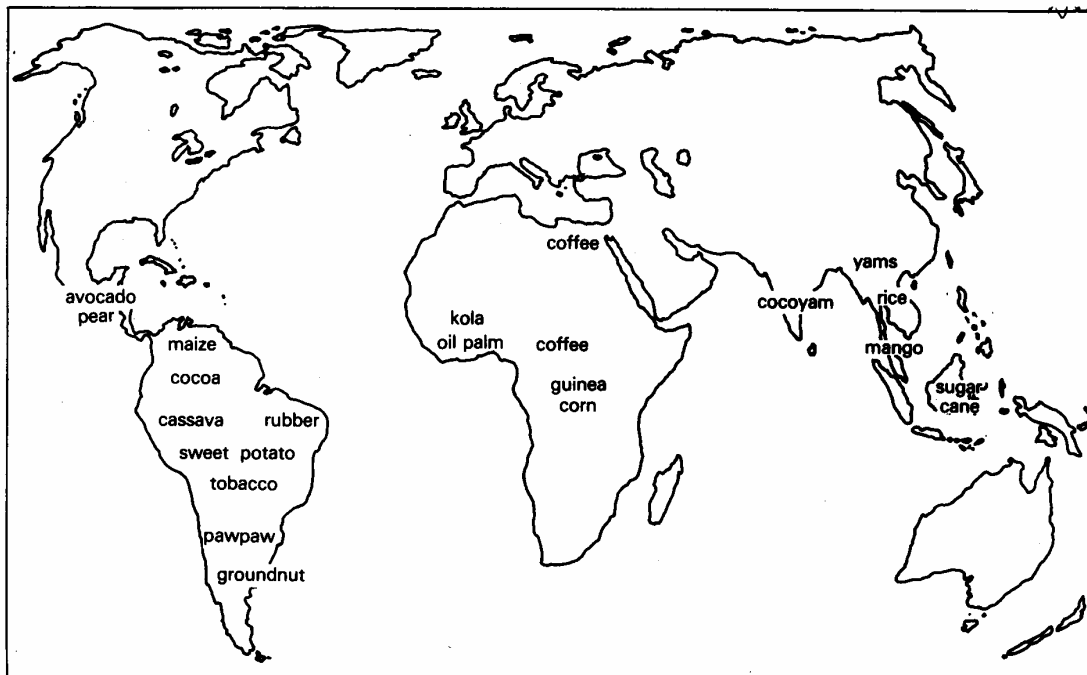
Origin of some subsistence crops used in Papua New Guinea

i Write the headings **Indigenous** and **Non-indigenous** on the board. Allow the students time in small groups to make lists of crops under these headings. Compile a class list and provide additional information about the origin of such introduced crops

Name of crops	Parts of crops used	Storage methods used
e.g. Taro	roots/corms and leaves	in pits; in home made pots

such as: kaukau, peanuts, corn.

Most of the subsistence crops grown in Papua New Guinea were introduced. There are two groupings of crops: Indigenous and Non Indigenous Introduced.



1.4 Activity 17

In your regional groups discuss the Food Place of Origin map and trace the origin of some food crops grown in your area. Then complete the table below.

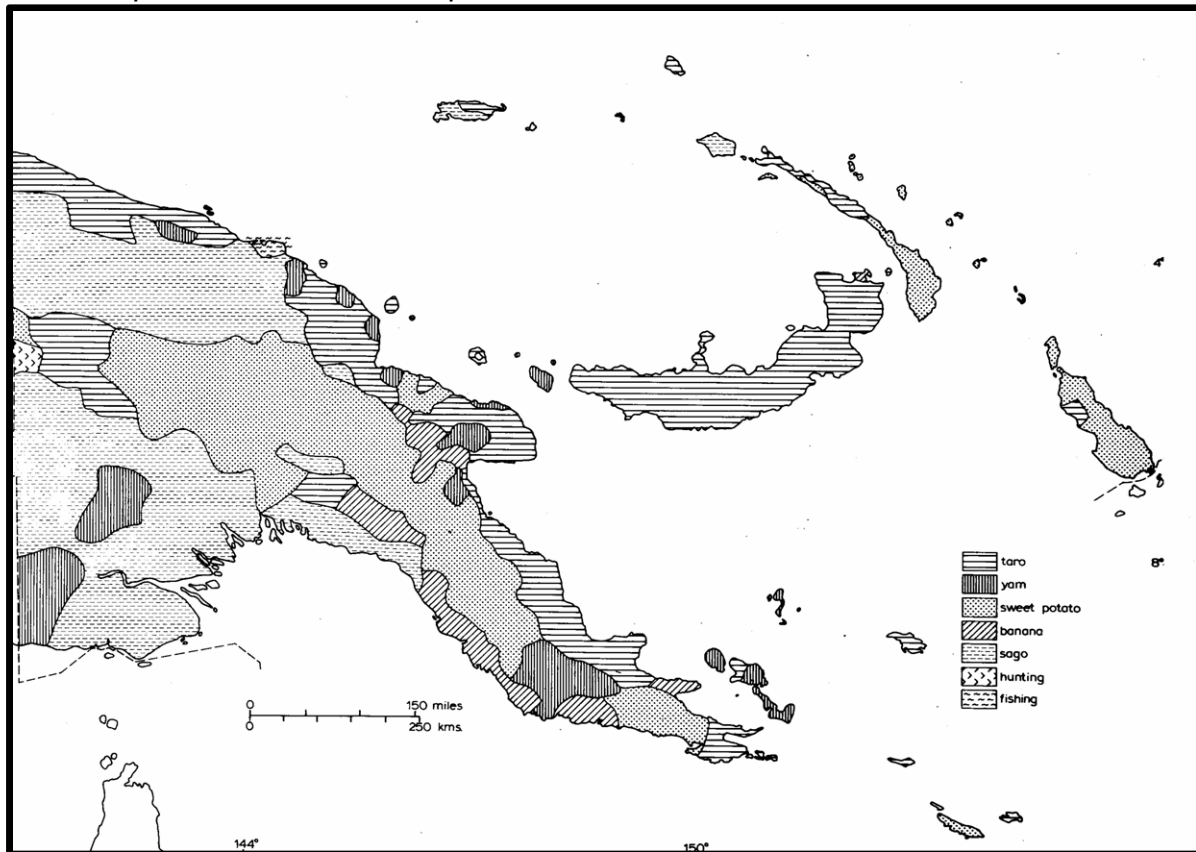
Traditional Food Plants Grown	Place of Origin
e.g. Sugarcane	Indonesia & New Guinea

Name three crops that have the greatest influence on the lives of subsistence farmers in your area. Be prepared to give reasons.

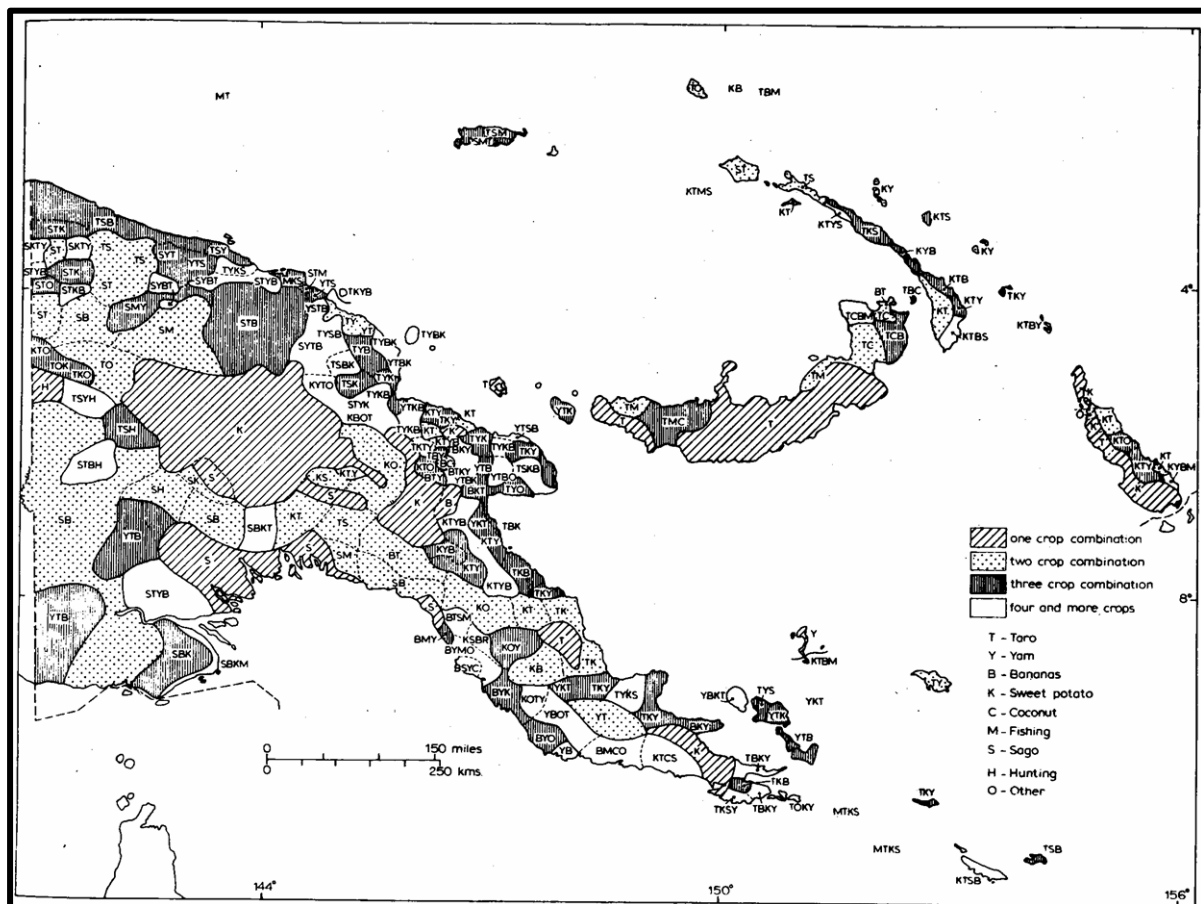


Introduce the following maps and discuss the reasons for the geographical position of crops such as kaukau, sago and taro. Have the students complete 1.4 Activity 18.

Principal food sources of Papua New Guinea



Food crop combinations found in Papua New Guinea





1.4 Activity 18

Look at the map of Principal food sources and answer these questions:

- *Why do you think yams had their source in the islands of Milne Bay?*
- *Can you explain the reasons for Manus having sago and taro as principal foods and not so much yam?*
- *What are the ideal growing requirements for kaukau? Use altitude tolerance in your answer.*

Look at the map of Food crop combinations answer these questions:

- *What are the optimum growing conditions for sago? Why will it not grow in the Highlands?*
- *Most areas have at least two staple crops which they depend on. Find areas which have only one crop and try to explain why.*
- *What are the advantages for having crop combinations of sago, taro and banana? Consider the following factors in your answer: nutritional value, work involved, time to mature.*

Legends are part of our people

Some of the subsistence crops have stories or legends of how they came to be in a certain village or area. Here is an example of local legend from Torembi area in East Sepik.

In Torembi area, people believe that a man named Dambui arrived during a storm and told the people that if they cleared the land and planted edible wild plants, they wouldn't have to move from place to place looking for food. He then stayed with them for one season showing them how to make gardens. He also showed them how to make mounds to plant yams. He gave one crop, the edible pitpit (*Saccharum*) and showed them how to plant it and in what type of garden they should grow this plant. This was the start of settled farming and the introduction of edible pitpit in the Torembi area.

Source: S. Tapi: Personal research from his village, 2000



Why did traditional communities create these legends? Ask the students if they know of similar legends in their area.

The stories and legends about some of these food crops have become part of our daily lives. In some societies, some of these food crops symbolise clan identity. Others believe that their own existence derives from a crop. Others also believe that some of these food crops are

humans and others believe that food crops are made available to use for our own survival and for making peace with others.



1.4 Activity 19

Why did your ancestors make-up legends to explain the origin of important food crops?

Think of a significant legend from your place and practice telling it. Be prepared to share your story with a small group in class.

What is the fate of these traditional legends? Please explain.

Topic 4: Sustainable Agricultural Development in Papua New Guinea

Objectives

By the end of this topic students should be able to:

- discuss the current problems facing subsistence agriculture in Papua New Guinea and discuss and give examples of the forms these problems take
- discuss sustainable ways of subsistence gardening
- predict the future of subsistence gardening.

Scope

This topic examines some ways in which subsistence agriculture may change, or will have to change, if it is to meet the demands of Papua New Guinea's rapidly changing society and growing population. Cash cropping and resource development have changed the attitudes of people towards subsistence gardening. Government help in trying to address land and population problems is covered, as is the influence of introduced crops.

Knowledge and skills

- Upholding and appreciation of local knowledge
- Map reading
- Research and observation
- Predicting
- Researching and collecting data



Introduce the objectives and the skills and knowledge. Revise the concept of 'sustainability'. Ask for definitions and examples of practice. Read the following section with the students providing examples and encouraging questions.

The concept of sustainable agriculture

The word sustainability is often widely used, (Refer to Community Development Unit 1 Module 1.1)

According to a dictionary definition, 'sustainability' refers to 'keeping an effort going continuously, the ability to last out and keep from falling'. In terms of agriculture, 'sustainability' refers to the capacity to remain productive while maintaining the resource base. However many people in Papua New Guinea use a wider definition, insisting agriculture must have the following features if it is sustainable:

Ecologically sound, which means that the quality of natural resources is maintained and the vitality of the entire agro-ecosystem - from humans, crops and animals to soil organisms - is enhanced. This is best ensured when the soil is managed and the health of crops, animals and people is maintained through biological processes (self-regulation). Local resources are used in a way that minimises losses of nutrients, biomass and energy, and avoids pollution. Emphasis is on the use of renewable resources.

Economically viable, which means that farmers can produce enough for self-sufficiency and/or income, and gain sufficient returns to warrant the labour and costs involved. Economic viability is measured not only in terms of direct farm produce (yield) but also in terms of functions such as conserving resources and minimising risks.

Socially just, which means that resources and power are distributed in such a way that the basic needs of all members of society are met and their rights to land use, adequate capital, technical assistance and market opportunities are assured. All people have the opportunity to participate in decision-making, in the field and in the society.

Humane means that all forms of life (plant, animal, human) are respected. The fundamental dignity of all human beings is recognised, and relationships show such basic human values as trust, honesty, self-respect, cooperation and compassion. The cultural and spiritual integrity of the society is preserved and nurtured.

Adaptable means that rural communities are capable of adjusting to the constantly changing conditions for farming: population growth, policies, and market demand.

1.4 Activity 19

What is meant by an agro-ecosystem?

Under each of the headings used above provide practical examples (some are provided to get you started):

- 1. Ecologically sound, e.g. recycling of organic matter through composting.*
- 2. Economically viable, e.g. distributing risks by not relying on one cash crop, drought prone crops.*
- 3. Socially just.*
- 4. Humane, e.g. conservation is practiced, insect pest predators (useful snakes, frogs, preying mantis and birds) are encouraged.*
- 5. Adaptable, e.g. developing intensive home gardens.*

 Introduce the next section by discussing some of the problems and challenges facing subsistence agriculture.

The current problems facing subsistence agriculture

Subsistence agriculture has long been a way of life for many people in Papua New Guinea. The stability of this way of life has been under severe stress for many years.

Despite the fact that over 70 percent of the population rely to some extent on sustainable agriculture, it does not get a top priority in agricultural planning. There are all kinds of training and training institutions and departments geared to “develop” so many aspects of Papua New Guinea’s economy. However, subsistence agriculture, the major industry, the major employer, and the most basic supporter of village life, is practically ignored. There is no institution, department, development funding or association to promote its development. It is forgotten and neglected. (Cox 1980)

The neglect of subsistence farming takes many forms

The labour scenario

Migration of male work force to cities, towns or plantation work creates grave problems for women left behind. These women work long hours in subsistence gardens. At the same time, they are politically and socially disadvantaged. (Newland, 1979) As a result, no development plans for women engaged in subsistence agriculture are included in national planning.

Cash cropping

The grower of perennial crops such as tea, coconut, cocoa and rubber uses prime land and so uses land that is not suitable for gardening for subsistence use. It has also become common practices that food gardens are made further away from the villages and that good land nearer to home has been used for cash cropping. The following story from Numangua Village may be typical.

People are spending more time and money on cash crops such as vegetables for markets, coffee, cocoa, copra and rubber and now vanilla. This often means time away from their subsistence gardens. Cash is used to buy trade store goods and as people become used to buying store foods they are not spending much time working and improving their subsistence gardens. (Cox 1981)



1.4 Activity 20

After reading the story from Numangua village - are the changes occurring necessarily a bad thing? Surely, subsistence gardening as practiced by ancestors is no longer relevant in a cash economy! Discuss in small groups and look for examples from other areas.

Labour inputs

The time spent in subsistence gardening activities is becoming less now by some family members than before. Women spend more time working in subsistence gardens than men and children. Children are busy in schools, men spend most of their time tending cash crops, working in community oriented tasks, and some even move to urban areas looking for jobs. Once again, a story from Numangua Village can be used to illustrate this problem.

Many of their men are leaving the village to find paid jobs in towns. Some of the young people go to school and only women, children and old people are left in the village. They now take on the task of tending the food gardens. Many of their women now do the heavy work like clearing the bush and felling the big trees, which traditionally was done by men. Because of the labour problem, women are now forced to use the same piece of land. This now put pressure on the fertility of that piece of land. This means they work harder and harder to produce less and less food. (Cox 1981)

Source: S. Tapi (2000). 'Personal research from his village'

Development

The government plans for the country also have an impact on the subsistence agriculture system. The resource development of an area has a diverse effect on the style and methods used in subsistence agriculture in a given area. In places where logging is done, subsistence agriculture tends to suffer. If new roads are built in an area, they sometimes go through areas that were good for food gardens.

Changing social relationships in rural communities

In many parts of the country, the food from gardens was exchanged and shared among families and community members. These obligations determined the type and sizes of their gardens. Now people are not practicing these cultures because food crops are now sold for cash. More and more people are depending on cash to buy food from stores and from other subsistence farmers. The following story from Numangua Village explains part of this problem.

Barter exchange does not take place any more at the above village. Cash is now being used to pay for food. Because of this, the methods and style of subsistence gardening practiced before now longer applies here. Chemicals and fertilisers are being used to produce the best crops for sale. With the use of these chemicals and fertilisers, farmers are beginning to experience problems. (Cox 1981)

Source: S. Tapi (2000). 'Personal research from his village'

Other problems of subsistence agriculture

Resource wasteful – too much burning, not enough organic recycling.

Extensive rather than intensive – relies on plentiful supply of land in a fallow-production cycle.

Is a major cause of deforestation – most deforestation in the world is not caused by big companies but by the slash and burn work of the shifting agriculturalist.

Does not integrate other systems – integrating crop-livestock-fish does generally not happen in subsistence farming.



1.4 Activity 21

What type of problems do you think the Numangua people are going to face with the introduction of chemicals and fertilisers in their gardens?

Sustainable ways of subsistence agriculture



Explain that this section offers suggestions to improve subsistence agriculture. Explain that many of these methods are explained in greater detail in modules 1.1 Soil and 1.2 Crops.

There are many ways we can adapt traditional gardening systems to fit the needs of our changing nation. We should be aware that there are many parts to a subsistence gardening system - cultural and economic as well as agricultural factors are involved.

This study should help you to explore some ideas and techniques for improving and sustaining subsistence food production. These ideas, methods and techniques are discussed here so that you can select from them what best fits your own particular changing condition(s).

Improving subsistence gardening

Many of the ideas outlined below are covered in detail in Modules 1.1 Soil and 1.2 Crops.

There are many easy rules to follow in gardening that can prevent the damage to our soils. They can be followed by farmers who can understand the problems of traditional slash and burn, and who wish to keep their soil fertile and continue gardening in the same place for a longer time. Often these changes can only happen if people first change their attitudes.

Do not burn the ground

Cut the grass, under wood and trees and allow it to dry on the ground. This will protect the soil as mulch until you are ready to plant crops. When grasses and leaves are dry, collect them for mulch and compost.

Crop rotation

Different kinds of crops take different kinds of foods from the soil. Because of this, we should change the place where we plant our crops after each harvest. For example, if we grow a crop of corn, we should plant a crop there that can put plant food back into the soil, e.g. beans.

Three main groups of crops used in a rotation are:

Heavy feeders e.g. corn, lettuce; **Light feeders** e.g. kaukau, taro; **Nutrient givers** (legumes) e.g. wing bean, peanuts, makuna beans.

Intercropping

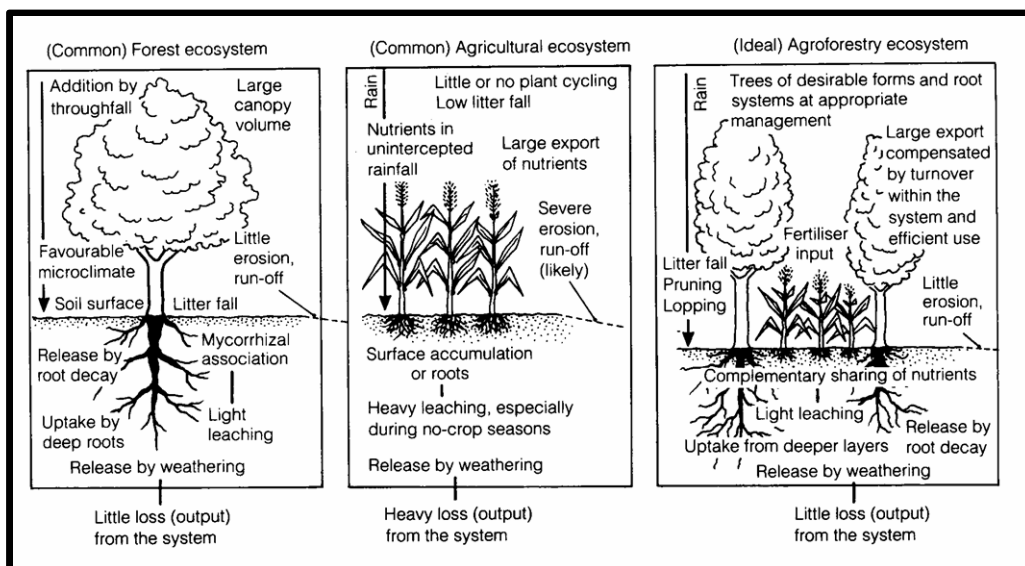
Intercropping means planting of many different kinds of crops in one area at the same time. Another name for it is mixed cropping. This method was first practiced in traditional gardens. There are many advantages to this method of growing crops. Some of them are:

Crops help each other. For example, when corn and bean are grown together, the corn shades the beans from the hot sun. The bean in return put nitrogen in the soil that helps the corn to grow well. This is called **companion planting**.

Pest and disease control. If one type of crop is grown on a piece of land, you make it easy for insects and disease to destroy your crop. Intercropping makes the spread of pest and disease harder.

Planting trees

Traditionally most people lived in the bush, close to many kinds of trees. They provided them with their daily needs of food, clothing and shelter. Now, many people live far away from these trees.



Source:
Farming for the
Future
(1992)

Composting

In nature all living things die and rot. They supply the organic subsistence that the soil needs to feed other plants. This is how nature maintains a balance between life and death. Gardening should follow nature's balance. Leaves, grass, animal manure and plants should be returned to the soil and used again.... NOT THROWN AWAY or burnt. (Refer to module 1.1 Soil for more information on compost systems)

Mulch

Dry grass or other dry materials placed on top of the garden beds, ridges or mounds, protects the soil from drying out and being cooked. Mulch protects the soil from heavy rain, it prevents weeds from coming up too quickly in the garden, it helps the ground to stay cool and wet during the dry season, and it provides plant nutrients to the growing crops.

Selecting of seeds and planting materials

To make sure you have healthy and productive crops you should select your planting materials well. You should encourage people to save the best of their harvest for seeds and store them well. (Refer to Module 1.2 Crops for more on seed saving and processing)

Dig the soil well

When we dig the soil well, we allow air, water and nutrients to go deep into the soil. This digging also makes our soil softer and lets the roots of our crop go down deeper where they can get the food and water they need to grow strong and resist disease.

Improved use of fallow time

The traditional approach has been to allow nature to provide the regrowth. However, as fallow times get shorter due to a variety of pressures, planting desirable fallow crops will improve soil condition quicker.



Discuss ways that farmer could make greater and more productive use of fallow time. Look at the deliberate planting of carefully chosen cover crops.

The following is a table of criteria for selection of plants for improved fallow can be used to assist students complete 1.4 Activity 22

Criteria	Effects
High biomass production	Movement of nutrients from soil into vegetation; suppression of weeds
Deep rooting system	Accessing nutrients not used by or accessible to main crop.
Fast initial growth	Quick soil cover for effective soil protection; suppression of weeds.
More leaf than wood	Easy decomposition of organic matter leading to greater availability of nutrients for main crops; easy to handle during cutting and / or digging into the soil.
Nitrogen fixing	Increase of available nitrogen
Efficient water use	Possibility to grow after main cropping season on low soil moisture or with less rainfall
Non-host for crop related diseases and pests	Decrease in pest and disease occurrence.
No rhizomes	Growth of cover crop needs to be controlled
Useful 'by-products' (e.g. fodder, wood)	Possible integration of animal husbandry and forestry

Conclude by listing with the students the names of suitable plants and discuss their qualities. For example: makuna bean, centro sema, leucaena.

 1.4 Activity 22

Using the fallow period so that main cropping fields where planted in high performing cover crops which reconditioned the soil quickly and efficiently for the farmer could be a great boast to the improvement of subsistence farming. Explain why this could be so.

Think of criteria for the selection of plants to improve fallow, list them in this table and note the favourable effects. Try to find nine criteria.

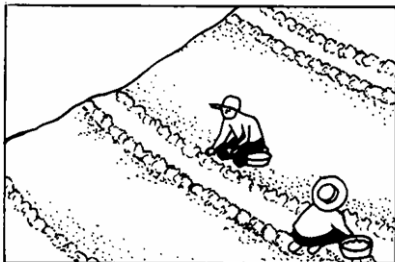
Criteria	Favourable effects
1. High biomass production	Movement of nutrients from soil to plants; less weeds
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	

Contour farming

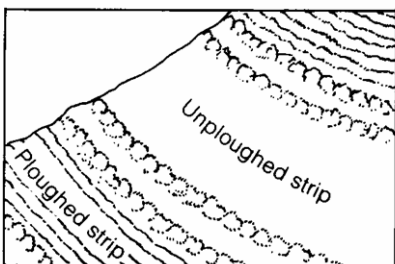
In places like the Highlands (Chimbu, Enga), The Owen Stanley Range and the hills around Port Moresby or any sloping agricultural land subsistence farming can be greatly improved by contour farming. It enables farmers to stabilise and enrich the soil, conserves soil moisture, reduces pests and diseases and reduces the need for expensive inputs, such as chemical fertilisers. Moreover, it replaces an eroded hillside with a terraced, green landscape. Most important of all, the technology can increase the farmer's annual income almost threefold after only 5 years. It involves the following steps:



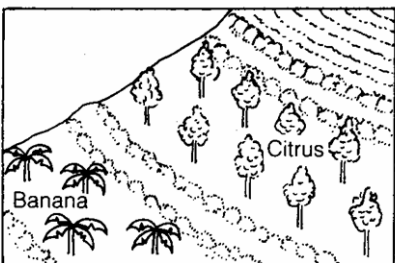
Locating contours



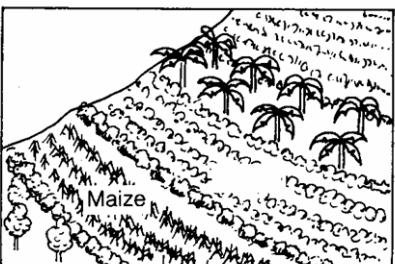
Planting double hedgerows



Cultivating alternate strips



Planting perennial crops



Sowing annuals between perennials

- Locating the contour lines and cultivating the ground along them, 4 - 6 m apart on steep hills and 7 - 10 m apart on more gradual slopes;
- Planting nitrogen-fixing shrubs and trees as double hedgerows in two furrows 50 cm apart along each contour line;
- Cultivating and planting permanent crops (e.g. coffee, cocoa, citrus) in every third or fourth strip;
- Cultivating alternate strips between the hedgerows before they are fully grown (thereafter, every strip is cultivated);
- Planting short- and medium-term crops (e.g. corn, pineapple, European potato, kaukau) between strips of permanent crops as sources of food and regular income;
- Trimming the hedgerows down to 1 m above ground and using the trimmings as organic manure;
- Rotating the non-permanent crops to maintain productivity, fertility and good soil formation;
- Building green terraces by piling stalks, leaves and stones at the base of the hedgerows to capture and enrich the soil.

Source: Adapted from 'Farming for the Future'. An introduction to Low-External-Input and Sustainable Agriculture: Macmillan. (1992)

The future of subsistence gardening

There is not enough food available in the world to adequately feed all the people who live in it. Papua New Guinea cannot be allowed to ignore this notion. Something should now be done to look at ways of improving our food supply systems. Our subsistence gardening system should be reviewed so that the methods used in growing food crops under this system should be further developed. Sustainable ways should be practiced so that our food supply should meet our food demands and at the same time look after our environment.

i Discuss with students what might happen to subsistence farming in ten to twenty years time. Collect of information that suggests changes are and will take place in the subsistence farming sector in Papua New Guinea.

Explain 1.4 Activity 23, which asks the class to answer the following questions from discussions with local people, observing their local environment and by reading from various media documents and literature.

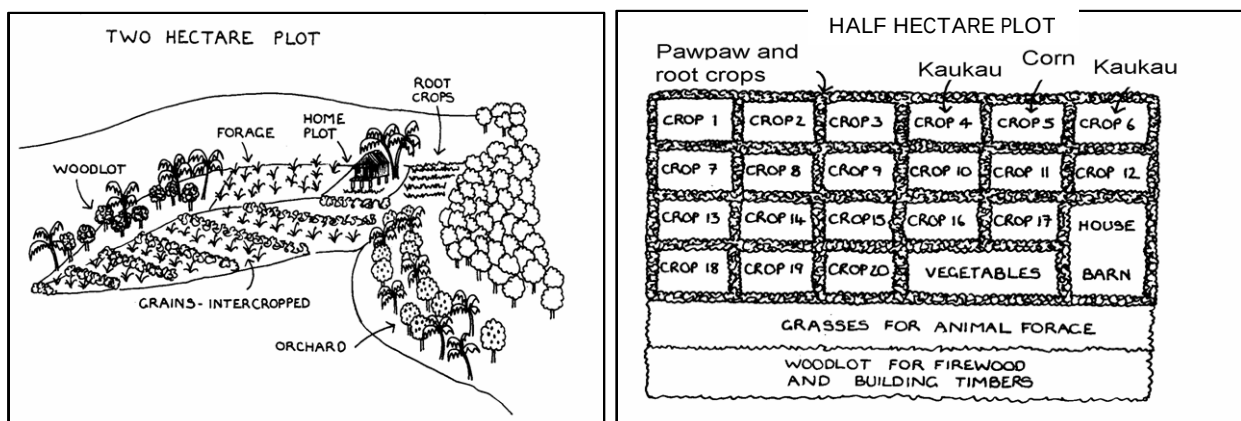
1.4 Activity 23

What sustainable activities are taking place in the subsistence farming sector of the Highlands, Coastal and Islands Regions.

What can be done to further strengthen these sustainable activities?

Can you suggest any new sustainable gardening methods?

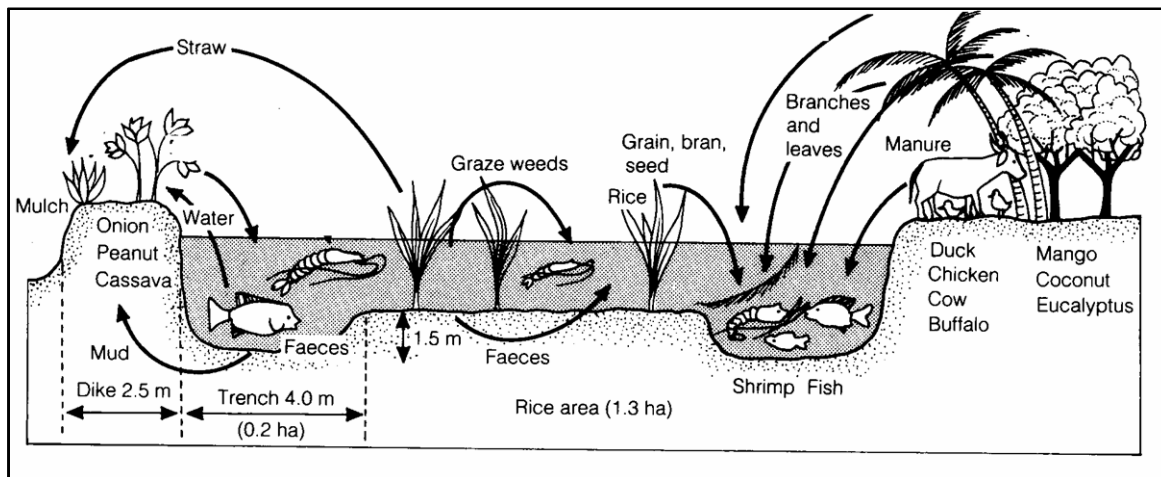
Our long term answer to sustainable agricultural system is education. It is through education that people's attitudes can be changed. People could be encouraged to eat new kinds of food. It could be less expensive to eat vegetable protein rather than animal protein. People could even farm on the same piece of land for years using improved methods like composting, mulching, contour farming and crop and land rotation.



Finally, increased co-operation between subsistence farmers, commercial farmers and developers of natural resources should work together to find new solutions for the future of subsistence farming system and the environment.

The following diagrams illustrate possible sustainable models for the future. Each shows how a family plots of land can be farmed intensively and sustainably without destroying the environment.

The following model is of an integrated crop-livestock-fish farming system in Vietnam. Such systems are sustainable – they make maximum use of on-farm resources, they encourage conservation rather than destruction, they are productive and profitable. Nothing is wasted! Could such a farming system operate in a modified form in Papua New Guinea?



Source: Adapted from 'Farming for the Future. An introduction to Low-External -Input and Sustainable Agriculture': Macmillan. (1992)



Introduce 1.4 Activity 24 by referring back to the section '**The current problems facing subsistence agriculture**'. Explain that any future systems must try to solve these problems and take into account sustainable practices. Tell the students that their plan must be practical and must not dish up old ideas. They are expected to take into account many of the ideas presented in Sustainable ways for subsistence agriculture.



1.4 Activity 24

Think of the future for subsistence agriculture and design a farming system that could work in your area. Use the ideas presented above in the three models for the future and include ideas from the section 'Sustainable ways of subsistence agriculture'.

Present your design-ideas on chart paper. This planning diagram must be self-explanatory and note what resources are needed, how they are used and what outputs are gained. This resource will become a useful teaching and community resource.

Glossary

Acid	Sour soil usually has a pH of 4.0-6.0. Potatoes and peanuts prefer acidic soils.
Agro-ecosystem	An ecological system modified by people to produce food, fibre, fuel and other products desired for human use.
Agro-forestry	The deliberate use of woody perennials (trees, shrubs, palms, bamboo) on the same land-management unit as arable crops, fields and/or animals, often in the same place at the same time.
Alkaline	A substance like ash which is capable of neutralising acidic soils. Usually has a pH range from 7.0-7.5.
Aerated static pile	Composting system that uses a series of perforated pipes as an air distribution system running under the compost pile and connected to a blower. The pile is not turned.
Aeration	Bringing about the contact of the compost with air through turning, or ventilating to allow microbial aerobic metabolism.
Aerobic	Occurring in the presence of oxygen. For successful composting, sufficient oxygen should be provided to keep the system aerobic. This ensures that the composting proceeds rapidly and with minimal odour.
Ambient temperature	Temperature outside the compost pile.
Anaerobic	Occurring in the absence of oxygen. Anaerobic composting proceeds slowly and is odiferous.
Barter	Exchange.
Biodegradability	To trade by exchange of goods or services without using money.
Biomass	The weight of material produced by a living organism or collection of organisms, plant or animal.
Bulking agent	Material, such as wood chips, added to compost primarily to help create good pore structure for airflow. Often provides part of carbon source as well.
Bulk density	The mass of a unit volume of soil, generally expressed in gm/cm^3 . The volume includes both solids and pores. Thus, soils that are light and porous will have low bulk densities, while heavy or compact soils will have high bulk densities.
Bund	A ridge of earth placed in line along the contour of a slope to control water run-off and soil erosion.
Contaminant	Unwanted material. Physical contaminants of compost include glass, plastic, and stones, and chemical contaminants include trace heavy metals and toxic compounds.
Contour	An imaginary line on a field joining all places at the same height above sea level.
Contour farming	Growing crops between contour lines stabilised by; e.g., earth bunds, stone ridges, logs or hedges which conserve both soil and water.

Cover crop	Annual crop sown to create a favourable soil micro-climate, decrease evaporation and protect soil from erosion. Cover crops like 'makuna bean' also produce biomass which can be used for soil fertility management.
Curing	The last stage of composting that occurs after much of the readily metabolised material has been decomposed. Provides for additional stabilization and reduction of pathogens and allows further decomposition of cellulose and lignin.
Decomposition	The breakdown of organic matter through microbial action.
Ecology	The science of the relationship between organisms and their environment.
Erosion	The process of losing soil through wind and rain.
Farm system	All the components within a given farm or garden boundary which interact as a system, including people crops, livestock, other vegetation, wildlife, and the social, economic and ecological interactions between them and with the environment.
Friable	Easily crumbled into small pieces.
Granular	Consisting of small particles or grains.
Green manure	A plant crop (legume) grown specifically to enrich the soil.
Heavy metals, trace metals	Trace elements whose concentrations are regulated because of the potential for toxicity to humans, animals, or plants. Examples include chromium, copper, nickel, cadmium, lead, mercury, and zinc.
Humus	A complex aggregate made during the decomposition of plant and animal residues; mainly derivatives of lignin, proteins, and cellulose combined with inorganic soil parts.
Igneous rocks	Formed by volcanic action.
Inorganic	Substances in which carbon-to-carbon bonds are absent. Mineral matter.
Leachate	Liquid that drains from the mix of fresh organic matter.
Legume	A member of a family (Leguminosae) of trees, shrubs and herbs (e.g. beans and peas), many of which have the ability to live in symbiotic relationship with rhizobia that can fix atmospheric nitrogen.
Lignin	A hard substance embedded in the cellulose of plant cell walls that provides support.
Loam	A rich soil of clay, sand and organic matter.
Macro-organism	Large organisms which live in the soil. E.g. worms and beetles.
Mature compost	The stabilized and sanitized product of composting; it has undergone decomposition and is in the process of stabilization. It is characterized as containing readily available forms of plant nutrients; it is low in phytotoxic acids.

Metabolism	Exchange of matter and energy between an organism and its environment and the transformation of this matter and energy within the organism.
Metamorphic	Rocks changed in structure under pressure or heat.
Microclimate	The temperature, sunlight, humidity and other climatic conditions in a small localised area.
Micro-organism	Tiny organisms that inhabit the soil, e.g. bacteria.
Mineral	An inorganic substance occurring naturally in the earth, e.g. copper, iron, and sulphur.
Moisture content	Weight of water in material divided by weight of solids in material.
Mulch	Substances spread on the ground to protect the roots of plants from extreme temperatures and moisture changes. Mulch may be manure, sawdust, leaves and grass, peat moss and even stones.
Organic	All compounds whose molecules contain carbon with a few exceptions such as carbon dioxide.
Pathogen	An organism including viruses, bacteria, fungi and protozoa capable of producing an infection or disease in a susceptible host.
Permeability	A measure of the rate at which water can percolate through soil.
Pest	Any plant, animal or organism that is in the wrong place at the wrong time. e.g. an Australian in New Zealand.
Pesticide	Any substance for destroying or controlling any pest, includes insecticides, herbicides, fungicides.
Phenol	A caustic, poisonous acidic compound present in coal tar and wood tar; a hydroxyl derivative of aromatic hydrocarbons.
pH	The symbol for the degree of acidity or alkalinity.
Porous	Full of pores (tiny holes) which fluids, air or light may pass.
Productivity	The relationship between the quantity of goods or services produced and the factors used to produce them.
Rhizome	A creeping stem which grows and spreads across the soil. Produces dense and spreading roots. Often difficult to control.
Ridging	Making long, parallel, raised strips of earth, into which seeds are sown. Ridges are usually made at right angles to the slope. They can serve to increase water retention, reduce soil erosion, bury and compost weeds, and create a favourable environment for the seed by concentrating topsoil and raising the root growing-area of the young plants above the water table.
Sedimentary rocks	Material carried by wind or water that deposited on the land and that one-day may become consolidated as rock, e.g. limestone.
Shifting cultivation	A form of agriculture in which soil fertility is maintained by rotating fields rather than crops. A piece of land is cropped until the soil shows signs of exhaustion or is overrun by weeds, when the land is left to regenerate naturally while cultivation is done else where.

Soil ions	The atoms of the soil – electrically attracted.
Soil texture	The feel and appearance of the soil.
Source separation	The practice of separating waste generated within each household or commercial operation into separate fractions such as newspapers, glass etc., and placing them in separate containers for recycling, composting, and disposal.
Stability	The degree to which the composted material can be stored or used without giving rise to nuisances, or can be applied to the soil without causing problems due to incomplete degradation of readily biodegradable materials.
Sub soil	Soil lying immediately under the top soil.
Tilling	Working the soil, e.g. ploughing.
Tome	A section or segment.
Top soil	The thin layer of surface soil up which life on the earth depends.
Toxins	Substances that cause a reduction of viability or functionality in living things.
Traditional agriculture	Farming systems that are based on indigenous knowledge and practices, and have evolved over many generations.
Trace element	A chemical element required in only tiny amounts by living organisms for normal growth.
Windrow system	Composting mixture is placed in elongated piles called windrows. These windrows are aerated naturally through the chimney effect, or by.