# Planning for village-based agriculture

Land use in Papua New Guinea is almost the antithesis of that familiar to Australians. Instead of farms practising broad-acre highly mechanised agriculture, undertaken with an eye to high yields and profits, our nearest neighbours are mostly involved in subsistence gardening.

Shifting cultivation forms the main basis of food production. In the lowlands, the villagers cut a garden of one-quarter to one hectare from the forest and use it for a year or two before they move on. The rotation period is 10–15 years. In the fertile highlands, the system is more intensive, and gardens may be used for 5 years or more before a new site is selected.

Root crops provide the staple food. In the highlands it's sweet potato, while yam and taro are the main food items nearer the coast. A small range of other starchy food crops — cassava, banana, and sago — and pigs and chickens contribute to the diet.

In addition, many individual small landholders produce coconuts, cocoa, and coffee for cash sale. Crops produced this way now account for about 60% of the country's agricultural export income. At the local level, the revenue from cash cropping is used to add variety to the diet (rice, bread, tinned fish, and beverages), and to pay for schooling and perhaps for vehicles.

Capital-intensive agriculture on large holdings exists, but it contributes less to the total economy.

So for most people in Papua New Guinea, money comes from cash crops produced within the same system that provides them with subsistence crops. More than 80% of the people rely on subsistence food systems, either completely or for a very substantial part of the daily diet. Their first priority is achieving a reliable food supply; dietary variety is of secondary importance, and they get by without the machinery, energy supplies, and fertiliser that we take for granted.

### Rain, rain, rain

Growing food in Papua New Guinea is a matter of coming to terms with rain. Unlike drought-prone Australia, this country experiences the opposite problem: too much water. Most parts register annual rainfall figures measured in metres, with the wettest receiving more than 8 m a year.

Faced with this deluge, the people tend to avoid low-lying country and the flooding, waterlogging, and malaria to which it is prone. Land between 1200 and 2800 m, which occupies 17% of the total area,

In a rural village.

supports nearly half the rural population. Only about one-eighth of the population inhabits riverine environments, yet one-third of Papua New Guinea falls into this category.

In the well-drained highlands, villagers have developed their unique horticultural practices, producing food year after year on slopes of more than 30 degrees. Mechanised agriculture would be impossible on such slopes, but these people have turned the terrain to their advantage. They have learnt to avoid both waterlogging of their root crops and erosion of their soil.

### A new approach

All may appear well, except that Papua New Guinea's population, presently a sparse 3 million, is growing at a rapid 2·3% per year. Recognising that subsistence agriculture and small-scale cash cropping make up the most important and productive sector of the national economy, the government faces a crucial question in planning its development. How far can village-based agriculture be expanded or intensified?

Such a move is necessary to accommodate a larger population and its rising social and economic expectations. Many parts of Papua New Guinea, perhaps 80% of the total area, remain virtually unused. Can these areas be made productive, or are there good reasons why so far they have been avoided?

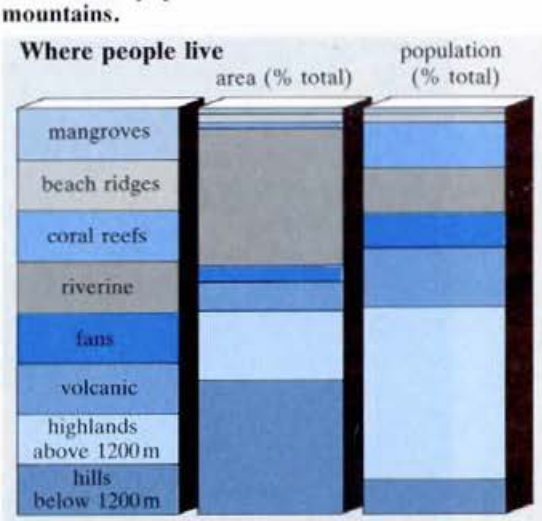
A factor inhibiting the settlement of new areas is the village-based nature of the society. Villages have an average population of about 200. Despite rapid population growth, the creation of villages away from settled areas is unusual. A comparison of aerial photographs taken between 1955 and 1975, during which time the population doubled, showed that no expansion of the area used had occurred, except that associated with new roads and urban spread.

Indeed, the area occupied appeared to have contracted, indicating that land use had intensified. For subsistence gardening, this means that more of the countryside near villages had been put under cultivation or the cycle of garden rotation had been shortened. How far can these processes be pushed before erosion of marginally suitable land occurs or fertility of the more suitable land falls?

### Jungle treks

The need to specify the limits to growth of traditional agriculture motivated the Papua New Guinea government to start, in 1981, a collaborative research project between its Department of Primary Industry and the CSIRO Division of Water and Land Resources. The leader of the research team at the Division is Mr John McAlpine, once a patrol officer in Papua New Guinea, who joined CSIRO when it first began research there more than 30 years ago. Mr David Freyne, head of the Land Utilization

**Most of the population live in the mountains.**



**A helicopter makes land surveys easier. Here it's investigating the Musa River region of the Northern Province.**

Section in the Department, is responsible for co-ordinating the Papua New Guinea end.

From 1953, when large areas of Papua New Guinea were still unknown to its administrators, let alone to science, CSIRO conducted detailed surveys of soils, vegetation, land forms, land use, and climate. Geomorphologists, botanists, plant ecologists, and foresters from the then Division of Land Research made their way into some of the remotest river valleys and most rugged highlands in the world. They undertook months-long treks on foot, guided mostly by aerial photographs and local knowledge. Up to 100 Papua New Guinea assistants were hired for each expedition, to carry in the scientific equipment, camping gear, and food, and to bring out rock fragments, soil samples, and botanical specimens.

Helicopter support became available in 1964, making life easier. The surveys,

**The areas surveyed in detail by CSIRO from 1952 to 1972 covered nearly half the country. Soils, land form, and vegetation were the main concerns. More general information for the rest of the country was obtained later from aerial photographs.**

funded by the Australian administration in Papua New Guinea, ended in 1972, not long before the country's independence in 1975. The cost of the surveys was approximately $14 million (in 1980 dollars).

These surveys, covering more than half the country, gave Papua New Guinea a huge body of resources information. It is doubtful that any other developing country possesses such a complete set of information on its natural resources. Indeed, no equivalent can yet be said to exist for Australia.

However, the highly valuable resource data cover dozens of reports, a number of books, and many maps. The information needed to be integrated and interpreted in terms of subsistence agriculture, and made more readily accessible to inquirers and planners.

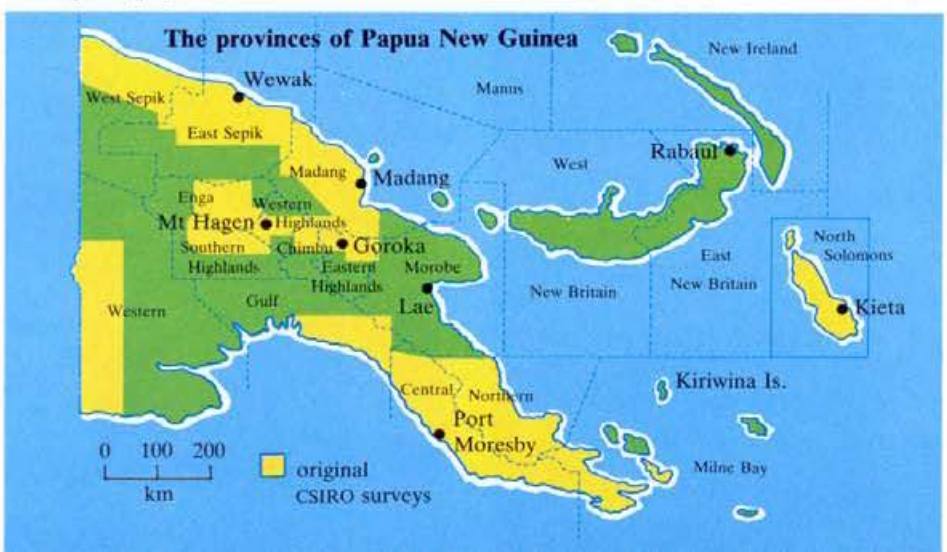
Answering these needs was the aim of the 5-year research contract, due to finish this year, between the Papua New Guinea Department of Primary Industry and the Division. Support for the project also came from the Australian Centre for International Agricultural Research and the World Bank.

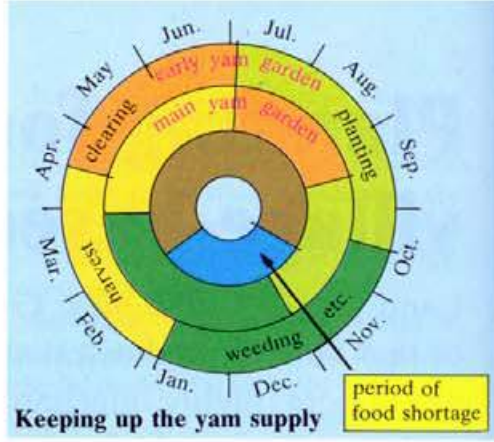
## Appropriate assessments

The initial land-resource surveys culminated in assessments of the suitability of areas for large-scale agricultural development. They provided suitability ratings for four types of use — arable crops, tree crops, improved pastures, and wetland rice — based on ratings for factors such as slope, drainage, flooding, and salinity.

While large-scale agriculture, producing export crops, may become a more important part of Papua New Guinea's economy than it is now, most food production will remain village-based, as will a significant proportion of cash-crop production. Village-based cash-crop production will provide the main local contribution to economic development.

With broad-acre farming in mind, the United Nations Food and Agricultural Organisation reported in 1980 in its 'Land




**Keeping up the yam supply**

**By growing two crops of yams, the people of Kiriwina Island minimise the period of food shortage.**

Resources for Populations of the Future' that, for the production of sweet potato, slopes of 0–5 degrees are optimal and 5–12 degrees marginal. On that basis, the northern and central region of the Chimbu Province would be classed as mostly unsuitable for production of this staple crop. Yet the area contains 95% of the Province's rural population. Conversely, the southern region, which contains only 5% of the population, is judged to be highly suitable.

In fact, 70% of the Chimbu Province's population live on slopes in excess of 30 degrees. For the Chimbu, slope is a positive asset, partly because forest can be cleared for garden preparation more easily than on flat land, but mostly because of the good drainage it provides. They have learnt to grow sweet potato very well on the sides of mountains, and signs of erosion are remarkably infrequent.

So in assessing the potential of subsistence horticulture in Papua New Guinea, we require a different approach, and different assessment techniques. We must not only investigate the distribution of natural resources, but also match these to the farming systems used, and to the local population density and growth.

The collaborative research program therefore set itself the following goals:

- ▷ to assess the potential for village-based subsistence agriculture and smallholder cash cropping over the whole of the country
- ▷ to describe the full range of current farming systems and estimate the intensity of land use under current practices
- ▷ to map Papua New Guinea into distinct land units for the planning of agricultural development
- ▷ to calculate the maximum population that each area could support under the present farming systems, and to determine where land degradation may occur

## Microcomputer system

The researchers assembled the vast array of relevant existing data in a computer-based information system that can be run on relatively cheap and simple microcomputers. They call the system PNGRIS — the Papua New Guinea Resources Information System — and the diagram on this page illustrates the way it's structured and linked up with the wider facets of the research program.

All the information in PNGRIS is stored by locality. The country is divided into about 4600 areas, each essentially with uniform characteristics, called 'resource mapping units'. Aerial photographs had to be used in carving up the countryside because only half of it had been surveyed on foot when the initial work was terminated. Fortunately, the scientists have found that these photographs can provide very detailed information on many aspects of the land, even how intensively it is cultivated.

Although individual gardens are rarely apparent in the photographs, a succession of abandoned gardens leaves behind a sequence of vegetation changes that can be identified. Researchers can therefore draw up a map of land use intensity by plotting the amounts of different types of vegetation.

Other valuable information, supplementary to that obtained from the aerial photographs and the original surveys, came from three major sources. Firstly, topographic survey maps became available from the National Mapping Bureau of Papua New Guinea. Then geological maps of the country were published by Australia's Bureau of Mineral Resources and Papua New Guinea's Geological Survey Office. Finally, the 1980 national census provided population numbers and the first complete maps of the names and locations of the country's 10 000 villages; it also gave an account of the extent of agricultural activities in each village.

**To evaluate land for subsistence agriculture, the scientists take the computer data base and merge it with information on crops and their needs and knowledge of local farming techniques.**

**A village garden in the western highlands.**

All this information has been keyed into PNGRIS under the three main headings of natural resources, population, and land use — and a variety of sub-headings.

The PNGRIS system stores more than a million items of data, and is set up for rapid correction, updating, and possible expansion. It can run on most 8-bit or 16-bit microcomputers, and is designed to be readily used by the Papua New Guinea Department of Primary Industry. Other Departments, such as Statistics, Transport, and Health, may also take it on.

## Matching plants to environment

The data in PNGRIS provide a good picture of the country's terrain and present land use. But, to identify the constraints on future food production and population growth, it will be necessary to calculate the development potential — for traditional agriculture — of each resource-mapping unit.

This is the hardest part of the present project, and it calls for matching environmental data with the growth requirements of each tropical crop. Often those growth requirements are hard to define. For example, rainfall normally beyond the tolerance of a certain crop can cease to be a problem if appropriate drainage techniques are employed. 'In Papua New Guinea, you can get just about anything to grow if you take enough care with it', comments Mr McAlpine.

The project team is currently collecting information on crop–environment interrelations (ecophysiology), as well as cataloguing the management practices used in subsistence agriculture. A method of describing crop needs in tabular form, suitable for computer format, has been devised, and it has been applied so far to sweet potato, sago, palm, tannia, winged bean, cassava, potato, coffee, taro, mango, coconut, and bananas.

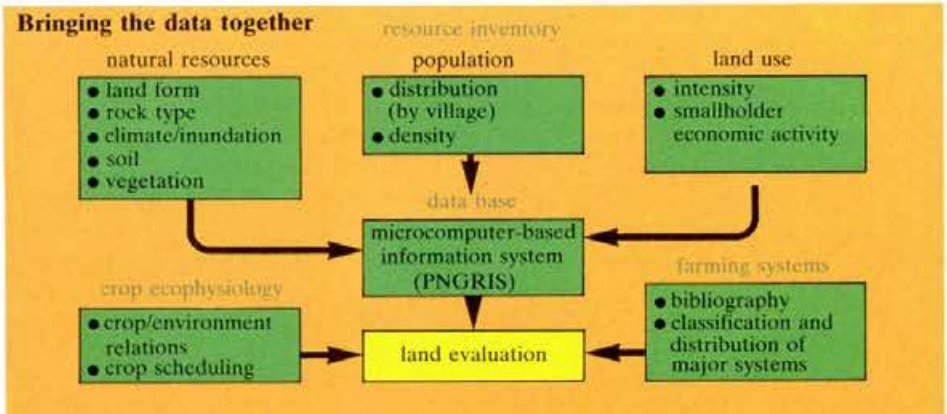
Dr Clive Hackett, who is in charge of this work, is extracting information from published literature and directly from the knowledge of field workers. One of the difficulties he has encountered is the wide range of different cultivars grown in Papua New Guinea; a family in the highlands may plant 10–20 cultivars at one time. He is now adding information on other crop types and hopes also to cover fuel-wood species, soil-stabilising plants, tropical tree fruits, and weeds.

A bibliography of published material describing the farming systems of small landholders throughout the country has been compiled. This too is set out in coded form suitable for computer retrieval.

Results from the 1983 National Nutrition Survey are keyed into the system. The survey, which was framed in terms of PNGRIS' resource-mapping units, gives height and weight data for children in a village representative of each unit. Low weight-for-height figures can be interpreted as indicators of poor nutrition, perhaps due to growing population pressure on food supplies. Preliminary analysis of the figures using PNGRIS has indicated that districts with apparently poor nourishment correspond with lowland areas where the soil is sedimentary and of low fertility. Children who live in localities with rich volcanic soils appear well-nourished.

Ultimately, the plan is to make PNGRIS able to answer questions such as 'which areas in East New Britain with child malnutrition are suitable for growing

**Bringing the data together**



peanuts as a protein supplement?' and to provide information on the sustainable crop-production capability and population-supporting capacity of any area.

The PNGRIS system uses an interactive program so that, when it is in full operation, an operator with little or no expertise with computers could, for example, soon determine the environmental requirements of peanuts. Then the computer would search its files to find those resource-mapping units fulfilling the necessary conditions.

## Further afield

Crops, environments, and farming systems similar to those encountered in Papua New Guinea are found in other parts of Melanesia and the south-western Pacific, so PNGRIS could be applied more widely. Indeed, it appears that the techniques can be applied to the humid equatorial tropics in general.

The Philippines, for example, resembles Papua New Guinea in size, climate, soils, and topography. However, with a population of 57 million, it has a far greater need to ascertain where its limits to growth lie.

Last year the Philippines government, through the Australian Development Assistance Bureau, sent 15 agricultural planners to a training course designed and run by the Papua New Guinea project team in Canberra. A second course was completed this May.

In 1984, a Thai land use planner spent 6 months at the Division adapting the CSIRO techniques to the needs of Thailand. Australian consultants, working on behalf of the Indonesian government, have also acquainted themselves with the scientists' assessment methods.

*Andrew Bell*

## More about the topic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