Some suggestions and ideas for improving food crop production in Papua New Guinea

This document is base around a consultancy I did for the United Nations Food and Agriculture Organisation in 1994

The original request was to:
Review the present status of food production within Papua New Guinea.

With the following guidelines:

A discussion of present food production systems in Papua New Guinea including an understanding of the farmer's indigenous knowledge, present status and prospects of crop production and consideration of some socio-anthropological issues and suggested appropriate research and extension strategies. Ways of involving farmers in problem identification, priority setting, national research plans including conservation and utilization of crop germplasm are included.

FAO consultancy report, April '94, Bruce R French

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This report was included in the original consultants report but is here adapted and illustrated and made more widely available as a pdf document in 2006

Some photos of the plants less widely known outside PNG are included at the end.

The importance of subsistence

Since about 1975 some emphasis and recognition has been given to food crops and subsistence systems within Papua New Guinea. The importance of food crops should never be ignored nor down played even if they never enter the cash and market economy. The ANZDEC report suggested the production at present could be of the order of: - Sweet potato 2,079,000 tonnes; Taro 793,000 tonnes and Banana 1,056,000 tonnes. These figures are adapted from the 1963 survey.

Another way of estimating the production of starchy staples within PNG is to assume that the dietary requirements of those who remain alive are being adequately met. With the population of about 4,000,000 who require approximately 2000 cals per day per person (higher for some and lower for children) and based on a starchy staple food which may contain 100 cals per 100 g edible portion the following rough estimate can be made. So a rough estimate is that 4,000,000 x 2000 is the number of grams of staple food produced per day. This is equivalent to 2,920,000 tonnes per year. The value of this to the national economy would be approximately:

K600,000,000	at 20 t per kg
K1,200,000,000	at 40 t per kg
K1,800,000,000	at 60 t per kg
K2,400,000,000	at 80 t per kg
K3,000,000,000	at K1 per kg

These are the sort of figures that, although incomprehensible must never be ignored nor be allowed to be eroded through apathy or default which would allow them to become replaced by food imports.

Bridging the information gulf

Preliminary

Having been in the embarrassing situation where I had to teach the food plants of Papua New Guinea and I didn't have the information I needed, I have over the last 20 years been attempting to collate the information I would have liked to have had. The process is far from complete but some of this is collated in the following volumes. Those "in preparation" are being reviewed prior to publishing. They are available as pdf documents or Filemaker databases.

French, B.R., 1986, Food Plants of PNG. A Compendium (pdf document)
French, B.R., 2006, Food Plants of PNG Database (A runtime database)
French, B.R., 2006, Insect Pests of Food Plants of PNG. A compendium (pdf document and database)

French, B.R., 2006, Diseases of Food Plants of PNG. A Compendium (pdf document and database)
French, B.R., 2006, A brief introduction to important food plants of PNG (pdf document)
French, B.R., 2006, Growing the Most Important Food Plants of PNG (pdf document)

In this report I am suggesting some of the emphases that I consider should be pursued. Rather than repeat all that I have included in the above volumes, I suggest that they be used as baseline reference volumes. They need to be continually updated as more information becomes available. They are available on computer CD disk to enable this to be more easily achieved. A coordinated set of information should be maintained. At present information is scattered and information flow is poor. This information may help people not to go around in circles rediscovering things already known, or spending too much time getting familiar with current knowledge or selectively ignoring situations that we could have been aware of and more informed about. All the information including the drawings in the books mentioned may be freely used without acknowledgement wherever it is useful. If it is wrong or inappropriate ignore it or correct it, rather than waste time endlessly discussing it. More importantly it should be used creatively to attempt to make a genuine sustainable improvement in subsistence food production in Papua New Guinea.

Disclaimer

I have worked in PNG as an agricultural field worker and in teaching in agriculture and have an interest in PNG, its people and their welfare. The food plants of the country have fascinated me, and I am interested in seeing information used for education, planning and production. I am not a research worker, planner, strategist or manager and prefer to leave these more difficult tasks to others. All the views are my carefully considered and informed opinions and no criticism of people or programmes is implied. I have no vested interest in the information I have collated, as it has all been given to me by others and I am happy to return it without any necessary acknowledgement of my involvement. It can be used freely and anonymously.

Information

Most field officers within Papua New Guinea have very little information regarding food plants and food production with which to work. Their self-awareness of this results in a defensive attitude covered by sweeping generalisations and doesn't generate the curiosity and commitment to become highly informed specialists within this area. The growth in information and knowledge of the food plants and production systems of Papua New Guinea could become a lifelong process if a genuine turn around in the information flow could be generated. The field officers have few goals or strategies with which to work.

Often little is undertaken or achieved within the subsistence sector. Some ad hoc introductions or innovations have occurred. These have mostly been to introduce cultivars like Cavendish bananas because a supply of planting material probably existed on a research farm. In a country with one of the world's largest range of banana varieties, this may not be the most informed or thought out procedure. Many people have become deeply concerned about what has not occurred within the subsistence sector regarding food production. The aim should not be to criticise but to assist.

The key to the whole research extension linkage is to ensure an adequate flow of information is occurring in every direction. Good quality attractive posters and displays can do a tremendous amount to increase the knowledge, awareness and interest by all those involved with food production within the country. This is about 90% of the population who are fairly specifically and actively involved in the food production sector and includes health workers, teachers and many other administrators and planners as well as those farmers directly producing food in gardens. The concept of ignoring all the food plants, farming systems, pest and disease problems and all the production and constraint problems until some crisis occurs or an instant and innovative solution is found, is a certain way to ensure that the knowledge and information base within the country remains at an abysmally low level. As well much of the indigenous knowledge and awareness gradually declines. The level of analysis and observation of subsistence food gardening systems in PNG is very low. It is comparable to an astronomer who 20 years after starting their career is still saying "astronomy is basically twinkle twinkle little star." Generalisations about sweet potato farming systems or yam gardens are of this calibre.

Working with mixed cropping situations

Given that the majority of Papua New Guinea food producers work with mixed cropping situations based on 20 - 40 species and with 10 to 40 varieties of the main crops, this is the system that must be worked with. This is reality in a Papua New Guinea garden. The skills required to work with this type of system require careful, cautious observation of the agroecological and sociocultural factors that are involved. If a more or less illiterate farmer has the capacity to work with and maintain such a system, no less skill should be expected of agricultural workers. Papua New Guinea villagers have for generations worked with biological diversity. This system is common throughout the tropical world. It is more ecologically stable than monoculture, and this becomes critically important where the climatic regime allows continuous year round production. It is possible for agricultural workers to develop the capacity to work with this kind of diversity. It is not only not necessary for systems to be continually reduced to the one high yielding variety or the one disease resistant clone, it is positively dangerous to the sustainability of the farming system to allow this to occur. Similarly the only purpose of planting things in rows is to give space for weeds to grow, if people are not using machinery in their gardens. Although it may not be

possible to analyse all the interactions and components of the system as it exists and operates, careful observations, descriptions and innovations must be a regular activity. The systems are already dynamic and regularly changing as farmers informally experiment and adjust. People who are well trained in scientific principles should be able to significantly enhance and facilitate this process in collaboration with the farmer. So instead of simply collecting germplasm collections on research farms and then struggling to maintain them at considerable cost in terms of both time and money, ways need to be developed to enable people to work comfortable and responsibly with a wider more diverse system within the food gardening system. Extensive information at the variety level (= land race; cultivar) needs to be available so that people's requirements and demands can be met and enhanced. This is the level at which most functional decisions are made within subsistence gardens. Unique characteristics of varieties need to be noted and utilised. Non seasonally flowering pitpit or early yielding varieties of bananas have a value separately from their overall yield in specific situations. People maintain diversity for dietary variety and ecological stability.

Because a very large percentage of a local villager's food production system consists of a scattered series of garden plots of varying sizes dispersed over a range of sites within one to two hours walk each way from a village house, and because within these plots the plants are irregularly spaced and mix cropped around a series of tree stumps and other obstacles, the whole methodology of "research" must be reevaluated. As well, the crops are often continuously intercropped with successive plantings and harvesting of different species throughout the life of the garden. Most standard agronomic trials have no methodology or analysis capable of producing any results with any validity to these complex mixed cropping situations. Occasionally a small part of such a system can be analysed eg peanut and corn intercropping, or *Xanthosoma* taro and cocoa intercropping or sweet potato and tree legume alley cropping. But the impact of any intensification within one subsector of the village families' overall subsistence food production remains unanalysed and often not really considered. Increased inputs of labour, time resources or skills into one part of the system may mean, for example, that the edible greens section of the garden does not get planted and the family exists on a protein and vitamin deficient diet. Most research currently being done and that which has been done over the recent years is of this standard agronomic trial type. It may suit marginal producers in the semi commercial sector but so far has produced very few results that could be "extended" to farmers.

If a village farmer must contend with all the food species and cultivars in their area including planting materials and methods as well as all the pest and disease problems and other constraints that impinge on their farming and family welfare, then an extension officer must do the same. The information available to them must be sufficient to allow the extension worker to work intelligently in this context. The extension officer only has to have the information and skills required, while the farmer has to actually do the work as well. It is only from this

broadly informed awareness that an extension officer can meaningfully observe and understand the likely impact and benefits of any innovation and change. Otherwise they won't see either the potential or problems and the farmer will have so little confidence in the extension officer that the farmer will not raise any concerns.

Accessing indigenous knowledge

Considerable skill and information resides in the accumulated wisdom of the farmers of an area. Much of this is in the heads of the farmers and can only be accessed through careful inquiry. Because women spend the largest amount of time in the food gardens, most of the specific observations are made by them. The role of women agricultural research and extension workers is vital in this process. In any area of the country, the knowledge and skills of villagers varies immensely. Only repeated questioning and thoughtful selection of informants can provide useful information. The inquirer has to have sufficient understanding of the situation to ask meaningful questions. And much of the information will not be forthcoming if a large number of visitors go to the garden, as is done in some Rapid Rural Appraisal, and Farming Systems forays. It must be a regular daily activity of the Agricultural officers who live and work in the area. And often only the farmer who has visited some other area and realises there are different ways of doing things will be able to explicitly state what they do or know, even for their own area. Of course, information collected in an office environment is much less reliable than that collected on site in a village garden. Much of this indigenous knowledge is being lost due to young people being in schools but also due to the increased range of options and demands on time which are decreasing the focus on food and gardens. Some knowledge (eg of medicinal plants and edible insects) is being rejected by farmers under the veneer of "sophistication". This information should be recorded but not as a diversion from focussing on food plans and food production. Famine foods such as the large range of edible fungi should also be documented. Over 20 species of fungi are known to be edible and utilised when required in frost prone high altitude areas.

The village people do not have the abstracting skills nor the communication facilities to record or convey this information other than by personal verbal contact. As well, the village people are not paid by the government to promulgate this information. Agricultural officers are. Many appropriate innovations applicable to the local farming system are already being tried or utilised by the more competent gardeners within an area. eg there are already Tolai banana growers who have reduced banana scab moth damage to a manageable level through variety selection and cultural control methods. But this information is far from universally known. Scab moth remains a significant problem which is finally probably solvable by biological control methods but interim use of available knowledge should not be ignored. Within a region this can become a part of on farm demonstrations and be more widely disseminated.

The task of the field agricultural officer and especially from their support system the national agricultural service (NARI and DAL/DPI) is to form a link between this information and the world's scientific and information network in a two way exchange of information and experimentation.

An understanding of fundamental principles is often helpful. For example an understanding of the requirement of sweet potato for an aerated root environment at specific times for tuber initiation is often more widely applicable than any specific mounding or ridging trial done at one restricted location. The correlations between nitrogen balance and foliar and tuber production for sweet potato is also helpful in assessing a range of field situations. Many obvious problems can be faced and solved working with sound scientific principles. In the high rainfall areas of Southern Bougainville where people have swapped from taro to sweet potato and do not mound, the required information can be supplied and the local people allowed to determine for themselves the options and risks. They could then choose either general mounding, drainage, or whatever was necessary to adequately cater for this contingency when it spasmodically occurs. The more direct observation, deduction and innovation based on a good sound understanding of scientific principles can regularly be used. The understanding of integrated biological systems utilised by environmentalists, biologists and ecologists is often far more applicable to subsistence than the formal research strategies of agronomists. This does not mean nothing can be known, understood nor done. Specific intervention strategies beyond the present skill or understanding of farmers needs to be the ongoing role of research.

Identifying disease constraints

Considerable areas of expertise are beyond the observational capacity of village producers but are, or can be, within the capacity of more highly trained and widely experienced agricultural workers. For example, most village farmers are broadly unaware of disease microorganisms and plant pathosystems because they have never had the opportunities to observe their presence through a microscope nor have their spread and impact within the gardening system adequately explained. So diseases such as taro blight and taro viruses have dessimated whole gardening systems (eg Siwai, Manus etc) and have put at risk whole cultural patterns and traditions. Research and breeding to address these taro diseases is currently being undertaken, but presently available information on reducing the impact of these diseases is not being disseminated or utilised by those responsible. (An FAO training video for taro blight from W. Samoa is available and appropriate here.) All yam cultures in PNG are surrounded by traditions of myth and magic and folk lore about menstruating women because neither village farmers nor field officers are sufficiently aware of anthracnose nor *Botryodiplodia* induced silvering of yam leaves. These diseases consequently don't get recognised as research priorities because no reports or concerns are raised by yam growers or field workers. The information flow fails.

Farmers have every right to know about disease organisms and how they spread so that they can have a more informed involvement in their crop production. A disease control strategy normally requires additional effort to that of the normal crop production. If farmers are made aware that their marita, for example, does not just "stink nating" but has a bacterial soft rot, then when an appropriate technology becomes available its relevance is more likely to be appreciated and its adoption more rapid. Until the farmer actually acknowledges that fruit rotting is not just a normal occurrence and is something which could have a solution, few complaints will ever be registered and no research done and nothing will be available to "extend". The same awareness applies to specific nutrient deficiency.

Utilising insect pest information

In relation to insect pests, the information flow is far better but still totally inadequate. Villagers, even from pre school age, can identify and name not only large numbers of insects including pest species, but the more observant producers can recognise and name various parts of the life cycle and often make significant suggestions for cultural control. eg cutworm control with seedlings. The cost of diagnostic services for insect specimens is a real restriction for PNG scientists, but even for the insects already known the capacity to recognise these at field level by agricultural officers is very low. Until field officers become trained to be aware of more common insect pests they rarely observe or record damage or attempt remedial action. The attractively produced posters for cocoa and coconut pests being produced by CCRI need to be produced for the major insect pests of food plants, especially for the more commonly consumed indigenous foods and not just for the introduced vegetables grown for the market sector. Good quality visually attractive drawings and posters are urgently needed. These could be supplemented by OHP transparencies and other teaching aids for educational institutions. These can precede any definitive control strategies and be a part of the general education and awareness strategy. For the organisational and management people within DAL/DPI this becomes an important part of the promotion and consciousness raising that is essential for adequate national financial recognition and funding.

Some of the biological control programmes which are being developed for insect pests are useful but if the parasite/ predator becomes succesfully established, no additional "extension" may be required. Such situations may need no specific action or intervention by the farmer once a satisfactory introduction is done in an area except to see the spraying or other strategies are not detrimental to the biological balance.

Establishing the parameters of the system

Food crop production in Papua New Guinea is based on about 500 species of food plants constrained by about 230 disease organisms and approximately 600 insect pests. For the major root crops, bananas, and sago, these occur in a large

number of land races. (5,000 for sweet potato, 400 to 500 for yams [mainly *D. alata* and *esculenta*], 300 to 400 for taro, 400 to 500 for bananas, 30 or so for sago). Most of these crops are continually producing viable seed and increasing the diversity. Papua New Guinea is a significant centre of diversity for probably 17 food species. At a national level, not all these are of equal importance. Possibly 120 plants species are worthy of significant national attention. About 30 to 40 food plant species are vital to the survival and well being of the population. * See attached list at the end. It may not be possible to do significant research on many of these, due to staff numbers and support facilities, but even so their existence must be recognised and prioritised so that available information is collated and utilised and made accessible to all. For example, *Oenanthe javanica* a "kumu" that is common and being more widely disseminated throughout the country is grown throughout SE Asia and has field advice in publications on vegetable growing in Kwangtung Province, China and in Vietnam. This information is not in English, the crop is not recognised as a food crop so will not be recorded as such in international information systems and the type of information (gardeners handbooks) do not always get included in scientific information systems. But at a national level the capacity to be informed of the diverse crops and aware of them and potentially useful information is vital.

More widely than this, an awareness needs to be maintained of the far more extensive range of authentically tropical/ equatorial food plants that may have a usefulness with the PNG farming system. Some cautious introductions from the approximately 4,000 tropical food plant species may usefully fill specific roles or niches within the countries food production and farming systems. The aim should be to enhance the sustainability of the system through increasing the range of crop options especially for marginal environments or where specific deficiencies exist.

The risks and constraints from the ongoing and changing situation in the disease and pest subsystems need to be constantly assessed and constructive action taken. Other constraining pests such as rats, flying foxes, possums, snails etc need to be considered. Rat damage in food gardens is a matter of national concern.

Localising information and making it accessible

Fortunately, at the district, village and garden level the number of species involved is much less and the situation much simpler. So rather than overwhelm people with excess and inapplicable information which can be overwhelming and counterproductive, a process needs to be set up nationally to supply attractive, well written and presented information both for the extension staff but also for the farmers, school teachers, health workers and all those who are vitally and integrally involved with subsistence. Information therefore needs to be regionalised but anyone anywhere should not be denied access to information. Far too much information is currently locked in files in headquarters and research stations, or remains inaccessible in the heads of the more experienced agricultural officers. Regionalised information needs to be supplied preferably on an

agroecological basis and within a linguistic framework preferably with local language names. Current technology - computers, modems, faxes, colour printers, CD rom foto disks, videos etc make all this quite achievable and not inconceivably expensive. Instead of waiting until some definitive information comes from an exhaustive study of a particular crop or issue, much interim information can be quickly supplied and equally efficiently replaced when superceded, with todays technology. Those who are seen to be using these facilities and supplying information (eg CCRI, Food Producing Company, etc) are gaining far greater support and recognition including financial. Access to worldwide information services is currently not possible at regional, provincial, district or village level and only with great difficulty at national level. Therefore this must become a national (NARI &/or DAL information services) function. Over 1,000 agricultural journals contain information relevant to PNG but the information is widely dispersed and much of the information has to be selectively screened before it can be applied to existing systems. Nevertheless, those involved with food production in PNG from village level up are not stupid and should be given the privilege of having access to available information rather than simply being supplied with a prepackaged formulation, which may not suit their situation nor work in their context. Planning and information must involve people at all levels, including the farmer, and especially women. For this process to be as constructive as possible, information is essential. Ignorance is an expensive option.

Recognising dietary preference and cultural richness

Food in a Papua New Guinea culture (as in any culture) has to achieve far more than meet certain minimal dietary and nutrient requirements. It must fulfil a large range of social and cultural functions. Because the mode of production in Papua New Guinea is still primarily subsistence, where people predominantly eat what they grow, the diverse social, cultural and nutritional aspects of food must be fulfilled in general from within the gardening system. To simply measure the yield per unit area of one variety of one staple food plant and consider that this is helping subsistence production is an insult to the whole social and cultural structure of Papua New Guinea society.

Utilising varietal diversity for cultural and agronomic goals.

A Papua New Guinea dietary system is made up of diversity and variety. For nutritional/dietary/ social and cultural reasons alone, the variety and diversity of food production must be enriched and enhanced. Within bananas, yams, taros, sugarcane, sweet potato, and sago production systems, significant cultural emphasis is given at the variety (land race) level. Many of these are important in ceremony and exchange. Food preparation and presentation is one of the central features of practically all societies and is not a PNG cultural anomaly that should be ignored or superceded. So germplasm collections maintained on research stations can be an expensive and often scarcely used resource. Much of the vital information is lost in the process of collection. Within, for example, the banana crop, there are cutivars important for baby food, for quickly cooked snacks in village gardens, for giving to elderly relatives with poor teeth, for use in ceremonial exchanges, for using in main meals as the starchy staple and also for specific uses such as in soups etc. Some are even eaten sweet and raw for desserts. These criteria are rarely sufficiently recorded or utilised in any germplasm collections or trials. More basic agronomic data, especially yield per area, instead of even yield per day, are what dominate measurements. And even this is not linked with or related to its social function. A banana suitable for baby food may not have a "high" yield but this must be in comparison with other baby food cultivars, not a high starch content, dry cooking cultivar. The cultural relevance of many of these cultivars is overlooked. An early maturing variety for quick yield, or one which gives out of season production often gets overlooked. As well the role of many of these quick yielding short duration but low yielding (/ area) cultivars as a part of the gardening system is poorly recognised. Often as temporary shade, boundary markers and protection, they serve an important function in the gardening system. The use of some diploid bananas as temporary shade while establishing cocoa is at least appreciated in the Gazelle Peninsula. Both the farmer (especially women) and agronomists and extension workers must be involved in planning any trials from the beginning and not simply at the conclusion in some nominal "taste" test.

NARI, or National DAL, has an important function in ensuring this information is collated, recorded and disseminated, not just accumulated within research system filing cabinets or lost in annual reports. It often has immediate relevance in other areas of the country and must be appropriately and attractively presented for the use of those for whom it was done. A non seasonal cultivar of coastal pitpit is worth distributing as is, even before its potential is more fully utilised through some future hypothetical breeding programme or after it may or may not have survived any agronomic screening activity. Pitpit in coconut milk is one of the very few indigenous food plants or food dishes offered in restaurants and the use of a non seasonal variety would enhance this process of acceptance. Such a resource would be of more value than say some highly technical daylength-control production system which is presumably possible for out of season pitpit production to ensure regular supply. Coastal pitpit is a highly nutritious food.

The indigenous knowledge of a crop is often directly proportional to:

1. the time duration that the crop has been grown in an area;
2. the amount of genetic diversity that exists and has been maintained;
and 3. the relative importance of the crop within the farming system.

Traditional yam growers, banana growers or sago growers have far more accumulated wisdom and experience of their particular crop than gardeners using these crops in a secondary role in other areas. Field agricultural officers and NARI / national DAL have to ensure that optimum dissemination of this information is achieved. At present, throughout the country, this has only ever occurred on an extremely ad hoc basis. Both language and infrastructure have restricted this transfer. Few national publications have ever shown any great desire to attractively promote currently available information on local foods. Indigenous knowledge is good within some areas of understanding yet significant areas of information are not understood by village producers and sometimes these are openly acknowledged. Sago growers at Kutubu report an occurrence in some sago cultivars of a gravelly texture within the sago on certain occasions. The cause or condition is not understood but it makes the food unacceptable, except for cultivating sago grubs.

Optimising distribution of crops within the country

Much of the varietal diversity and even species distribution of food plants is very uneven around the country even within appropriate agroecological zones. Because village gardeners are such inherent collectors of new varieties and crop variations to enhance their cultural and dietary range, there is normally no difficulty in getting a local gardener to grow and "trial" a new selection. Many of the better and more observant farmers are highly skilled at working out whether this new addition has a useful ongoing role in their gardening and cultural system. If the plant is particularly unsuited it is often naturally eliminated through not surviving to reproduce. Normally better gardeners can rank the yield and productive efficiency of their varieties within their environment and gardening

system, so it is not necessary to pre-screen these selections through agronomic trials on research farms. More precise information from systematic trials is always a great advantage but this should not preclude less researched and more tentative introductions to potentially useful areas. Farmers have the capacity to adopt or reject innovations whether they are the result of formal trials or tentative suggestions. To be statistically valid, agronomy trials of replicated plots based on one variety are often done, but then have minimal application in a diverse mixed cropping system.

It is not the origin of the crop that is important but whether it is the best suited crop for its location and production system

eg 1. The frost resistant values of the Brassica family should be utilised in the high altitude frost susceptible zones above about 2200 metres, but their nutritional inferiority to say Blackberried nightshade which also grows well there, should be stressed. In areas where nutrition is marginal, cabbages should be avoided except as a frost resistant emergency food. In these crisis situations it is possibly better to have stomachs filled with cabbage to allay hunger pangs than to have them empty.

2. The growth rate potential of European potatoes over sweet potato above about 2200 metres altitude should also be exploited by an appropriate introduction or promotion of a range of thick skinned, coloured skinned varieties of potatoes planted in a mixed garden arrangement to avoid bacterial rot spreading between adjacent plants and to avoid the poisonous greening and to provide a product more suited to baking in the ashes. Several of these varieties already occur within the country and some assistance with their dissemination <u>within subsistence</u> should be provided. Both kinds of cultivars (thin skinned white cultivars and thick skinned coloured ones) and both methods of production (for subsistence and market) are valid but require different recommendations and strategies. Attention should not only be given to those being marketed.

3. Corn which has become well established in the country continually inbreeds in small scattered subsistence plots. It should have seed produced in plots of over 200 plants to prevent inbreeding occurring. The infrastructure and agri-servicing facilities within Papua New Guinea would make it unwise to use hybrid corn except for select producers in specific situations where significant inputs can occur, and the infrastructure allows effective regular seed distribution. Open pollinated corn seed is not a research station function but may be popular and appropriate for district level field stations. The diseases present in Papua New Guinea would make continuous selection within the country more appropriate than introductions from elsewhere.

Critically assessing and utilizing nutritive value

Nutritional value is something not easily assessed by a villager. While village people are well aware of the energy content of the foods and varieties they use, it is not as easily discernible which plants provide the best protein content or balance nor the best vitamin and mineral sources. In lowland mainland PNG where 90% of the population are claimed to be anaemic or low in iron in their diet, the food plants suited to this environmental zone which have significant levels of iron need to be identified, grown and promoted. This is a NARI or national DAL information function. Appropriate information, if not available, needs to be ascertained. In no culture do people automatically adopt a "healthy" diet and because protein/ vitamin and mineral nutrition is subtle and longer term in its effects, active promotion must be consistently done in this regard. Although some of this is outside the domain of agriculture, it remains a function of agriculture to identify appropriate plants for the various agroecological zones. Promotions which are "eye catching" need to be developed for indigenous vegetables (or at least for the majority that are nutritionally greatly superior) to counter the serious erosion in status in competition with the introduced vegetables that are being actively promoted and adopted. Only 3 or 4 of these introduced vegetables (eg spinach, silver beet, Indian spinach) have food value in any way comparable to many indigenous plants and some like cabbage are a nutritional disaster. (Unless roughage in the diet is a problem.)

Attention should be given to the nutritional value of the plants and their stability of production in the existing production systems. For example blackberried nightshade has been shown to give a more reliable and higher more nutritive yield under existing conditions in tropical subsistence gardens than the related and more highly promoted plant, tomatoes. For the majority of people it is also more acceptible in their diet. In lowland coastal areas of the mainland where iron deficiency and anaemia are a recognised nutritional problem, the choice between the two related species in crucial. If a fraction of the effort given to tomatoes within PNG over the years had been devoted to blackberried nightshade the nutritional status of the country would be considerably better. And if some of the effort given to diamond backed moth of Brassicas had been given to taro beetle control, or sugarcane borers the country would have more useful food. Because Papua New Guinea remains a subsistence based economy where the main form of malnutrition is still under-nutrition rather than over-consumption, a strong emphasis must be placed on food value and this needs to be done on a regional basis. Selling food from a rural area with significant infant mortality and low child birthweights to a coastal town where there is the possibility of imports may not be a responsible decision nor have any correlation with development. Money has an attraction to everyone and it may not be spent rationally and must not be the dominant criterion of what is feasible or recommended. A dead child or a seriously grieving mother is not an efficient production unit on which to base projected financial gains from a proposal nor on which to plan the development of a country. In some situations cash cropping has enhanced nutrition whilst in other areas it has at least initially been to the detriment of nutrition.

Many times the dietary superiority of indigenous, established, environmentally suited, plants has been highlighted. But this information fails to be conveyed to village people because everything "Western" has an appeal including introduced vegetables. (I have no inherent objection to food plants of any origin but they should not be introduced without the advantages they contain being adequately recognised and emphasised. Any normal mother would fill their hungry child's stomach with a cheaper nutritionally poorer bulky food to allay their hunger pains and presume in the process that it would meet their dietary requirements. This may not be the case. Protein and vitamin deficiencies are not immediately obvious.

Adequately naming plants nationally

No research attention, nor promotion through extension, nor by nutrition workers is ever likely to occur or be achieved productively for plants which do not have a nationally recognised name. This can extend from names being used inconsistently (eg yam tru and mami in Madang district), to plants either introduced or indigenous, having no nationally recognised common name. This applies especially to the many "kumus" which are absolutely crucial in the dietary balance and protein supply, especially for infants with limited stomach capacity. Many indigenous fruits and nuts and some root crops (eg *Ipomoea tuba*) do not have adequate names. As well, it is hard to convey accurate information on indigenous food plants and their value when the link between local, national and scientific names is tenuous. This means information transfer does not occur and often the food value or other virtues is not well understood nor established. There is a need for a national group to discerningly select and promote national names for plants without a commonly accepted name. This has occurred in countries like Indonesia and been carried out with great success. A naming committee with appropriate authority needs to be constituted. NARI or national DAL should presumably give a lead in this area.

At a field level, especially with women, there is also considerable advantage in using local language names for food plants. A national register of local plant names needs to be established. This could be a computerised data base formulated presumably in association with the Summer Institute of Linguistics or other group with detailed information on languages of the country. Despite the 700 or so languages, a national data base of food plant names in Tok Ples would be a reasonably easily achievable exercise which would ensure communication, discussion and recognition of the immensely valuable resource the country has in its food plants. (I could already provide this for the 17 languages of the Southern Highlands Province.) From a NARI or national DAL perspective, especially in the farming systems and research work, this could help provide information on crop distribution throughout the country. It would also ensure that field officers became aware of the crops and their proper identification, including scientific name. It would also ensure field officers visited food gardens and would give villagers a simple but real involvement in a national program. Many disease and pest records

have been wrongly assigned and many recorded occurrences of plants have been incorrect. A national data base would help reduce this confusion. Several important insect pests also have local names and could be included.

Women in agriculture

The majority of food production within PNG is done by women. This must be reflected in the overall food production, research and extension strategy. Women must be involved in this at all levels and stages. Developing human resources and appropriate support strategies for women within agriculture must be given the highest priority. If pre-service training of young single women for involvement in professional agriculture has not been successful, then the post marriage recruitment, in service training and flexible employment of appropriately educated women in field and provincial locations should be undertaken. Women farmers throughout the country are being increasingly stressed through land pressure and declining fertility of the soil along with the increasingly greater demands being put on them by an increasing range of expectations. Only female field workers are ever likely to be able to monitor and assess with any reliability and sensitivity the impact of these on their health and lifestyle. Several areas of food production, utilization and labour demands by women farmers will only ever be able to be reliably recorded by female research workers. In several areas where plants are restricted on a gender basis (eg marita, some yams, some bananas where mostly women and children are denied the right to eat them) some appropriate new introductions by women to women may enable this cultural restriction to be bipassed. This may be more effective than direct confrontation.

Addressing nutrient decline

Declining soil fertility and soil erosion are nationally recognised problems. Because the road infrastructure does not allow fertilisers to be used in many places and the cost prohibits it, a range of strategies must be developed to enable people to work as creatively with the situation as possible. Colour photos of key diagnostic deficiency symptoms for a range of food crops (or fallow vegetation) would greatly facilitate advice and suggested strategies. Specific problems such as aluminium toxicity would also need to be included, and particularly susceptible crop plants may be able to be used as indicators. This form of assistance would avoid more expensive soil analysis. Some of the nutrient deficiency symptoms for tropical food crops are being studied at the University of Queensland and elsewhere and assistance could probably be sought from there. Indigenous knowledge by farmers allows them to assess that the ground is "sot long gris" but they cannot more accurately diagnose the deficient nutrient(s). Formal soil analysis is often too expensive (and brings information too late in shifting cultivation situations), but knowledge of patterns throughout the country and of specific crop responses and demands is broadly available. Greater dissemination and utilization of this information, along with deficiency symptoms, enhances the ability of field workers to give interim advice until research is more definitive. If

it is good enough to prepackage molybdenum and boron as trace elements for cauliflower production for Port Moresby, more careful consideration should be given to their role and deficiency in more indigenous crops grown to be consumed in villages. Declining bean and other legume production throughout the country may be associated with high soil acidity and low molybdenum and not simply apathy or disinterest.

Agroecological zones

Farming systems mapping is being done for the whole country by Dr. B Allen and others under an AIDAB funded project. As this information becomes available it will provide a suitable base line for planning on an agroecological basis. Soils, cultivation, drainage, altitudinal and other data are being incorporated. This will greatly facilitate coordination and planning of strategies. It is crucial that this information be effectively utilised, including people trained in the competent use of the computerised data base. A range of generalisations and strategies could be initially formulated by giving thoughtful consideration to the systems described. For example, in areas where people are doing a very rapid garden rotation (eg one crop of 6 months in Western and Southern Highlands Provinces) there is obviously a reason. My prediction is that in the Western Province it is potash deficiency and in some of the Southern Highlands eg near Pangia, it is very acid soils temporarily made productive by fires releasing cations sufficient to ameliorate the aluminium toxicity. Such guestimates could easily be subject to field trials at minimal expense. (A bag of lime and a bag of potash in each place!) Because detailed soil analyses and data are unlikely to become available nationally in the short term it would be worth making some visual observations and intelligent guesses as the basis of preliminary investigations. Intervention strategies may or may not be readily available at an affordable price, but would be worth simple (non randomized nor replicated!) field trials. If the results were not obvious the strategy is unlikely to be adopted by farmers.

Sustainability

Sustainability has several dimensions.

1. Crop resources. Rather than attempt to maintain all the cultivars of all crops in germplasm collections on research stations, a pragmatic decision needs to be made about what genetic resources are at risk. While the current subsistence system which is still practiced by probably 60 to 80 % of the population continues, there is a high level of sustainability of planting resources and biological diversity to provide stability and continuous adaption. Normally a collapse of the system occurs where the diversity has been lost due to whatever reason.

2. Disease and pest pathosystem.

The pest and disease system within subsistence gardens has reached a level of ecological balance for a number of insects and diseases. Only some diseases

and pests significantly stop production, but many could potentially do so if the balance of the system is disturbed. Some insects such as taro beetle are a problem wherever taro is grown, while taro blight is only a seriously limiting constraint under 800 metres altitude and in areas with a continuously wet climate. Other lowland areas may have seasonal fluctuations in intensity. Some insects such as locusts can achieve plague proportions occasionally but divert funds and people resources. Others such as cacao armyworm can invade food gardens in serious numbers spasmodically normally due to extensive areas of monocultured cover crop nearby. The system is seriously disrupted when a new pest (eg Giant African snail initial invasion); or disease introduction (eg taro blight) causes a serious imbalance of the system. Apart from some of the regular occurrences the overall dynamic and stability of the pest and disease system is something that should not be taken for granted. Declining soil fertility often due to restricted rotations can easily lead to a significantly increased amount of sweet potato scab damage for example. Resorting to chemical sprays can quickly induce a state of permanent dependency on chemical control as biological balance is disturbed and horizontal resistance is eroded. Resistance to insecticides quickly develops within tropical systems with continuous sequential production operating. (eg diamond backed moth in Brassicas). The traditional systems of maximum intercropping significantly reduces the pest and disease occurrence. Shifting rotations are particularly important for root knot nematode control in most areas and for weed control in lowland areas, as well as for nutrient restoring functions. The currently existing farming systems are normally not just opportunistic occurrences but have naturally evolved over considerable time. They express the accumulated wisdom and experience of those within the farming systems. Although those involved as farmers may not be able to verbally articulate the advantages, any significant adjustment to the system, especially within subsistence where they do no have access to significant outside resources for disease and pest control and fertility maintenance, should be undertaken only with great caution. Chemical pesticides should be kept out of subsistence in most situations. Sequential harvesting, the consumption of raw greens especially by children within gardens, the continued consumption of edible insects, again often by children and women, the lack of literacy, poor storage facilities and a range of other reasons mean that naturally sustainable strategies for disease and pest management should be understood and continued.

3. Soil nutrient status, erosion control and sustainability. Population pressure on land is increasing due to a range of factors. Roads and other infrastructural improvements could in the short term reduce this land pressure as people congregate near facilities. Changing the food crops to less fertility demanding species is already occurring in many areas. (eg Cassava is being used in place of taro or yam). This is only temporarily avoiding the issue. Often people respond by increasing the crop production area. Normally intensification demands increased management skills so using a greater area is an alternate response for the short term, but as an adjunct the work load of women normally greatly increases as they try to produce the same amount from larger areas. Composting of material

collected from clan land is often recommended and works but it increases labour and ultimately simply concentrates nutrients in the crop layer to the detriment of the overall land. High rainfall, low organic matter status and other factors greatly increase the rate of loss of nutrients. Some indigenous farming systems are attempts to respond to these situations. eg composting in sweet potato mounds near Mt Hagen, cropping under yar trees in Chimbu, felling trees on top of the banana and taro plants near Mt Bosavi and Nomad River, cultivating taro along drainage ditches near Tari etc. But ultimately there is no such thing as "organic gardening" where you get something for nothing. Nutrients lost must be replaced. The nutrients lost from the highland vegetable gardens down the Port Moresby sewers must eventually be replaced. In urban centers, residential sites could consistently become more nutrient rich if formal composting were practiced. This would reduce urban litter and enhance back yard food production. But such strategies have little practical application in extensive subsistence production systems as at present practiced.

Some suggestions for consideration in formulating a national policy and practice for food production.

Utilising indigenous food crops.

Papua New Guinea is a tropical equatorial country. As such there are a significant number of food plants that have never been adequately investigated. The tendency continues to take more familiar species from temperate or subtropical regions and to adapt them to production in regions such as PNG. This may have some validity in higher altitude regions but still creates national dependency in terms of seed supplies. This could become a serious constraint if there were a change in international political situations or if erosion of other crop resources created a permanent dependency. It is doubtful if adapting temperate crops to the tropics is the best policy. It should not be presumed to be the most productive nor successful way to go. It may well continue to be unsound on an agro-ecological basis on into the future. The former President of Peru in an address to FAO emphasised that his country had been reduced to a permanent state of dependence because they had allowed the dietary habits and food production systems of their country to be modified to ones that their country could not now satisfactorily and sustainably produce. Projects such as the Fresh Produce Company which promotes introduced vegetables for urban markets are vigorously run and are a model of innovation and market led and directional work. They have many ancillary benefits of developing marketing structures and management skills. They also provide a legitimate cash income to highland areas. But their focus, the 200,000 well fed people in Port Moresby, must be put into the context of the other 3,800,000 often less well fed, people throughout the country upon whom much primary health care expenditure is invested. Food plants do not achieve value to the country only when they are traded, but are always important to the country for the overall welfare and nutritional well-being of the citizens.

But subsistence food whether traded or not does achieve a recognizable status in the national economy in terms of their import replacement potential.

It is more scientifically sound to start with what is already there and with the production systems that are already in existence and to explore their potential. To date, this has still not been done with Papua New Guinea food production systems although scattered information is available.

Each district agricultural officer should be encouraged to do a survey and analysis of what is already the current status of food production within their region. This would, as a fundamental start, necessitate recording the crops and plants utilised for food, in each region. This should not be seen as an end in itself but as an ongoing process provide a framework for planning and a continuous development of area descriptions. Some form of completeness should be attempted for the species used. So garden plants, wild food reserves and fruit and nut crops should be assessed. These should be grouped and ranked in some sort of order. It does not make sense to compare a sweet potato with an edible green nor a seasonally available nut. They must be ranked on a food group basis. These can roughly correlate with the nutritionist categories of energy, protein and health foods. But within a food type some ranking and highlighting of priorities that already exist and potential or constraints that operate, should be considered. Special attention should be given to plants with considerable genetic diversity or which are poorly known and therefore cannot be adequately evaluated. So although some of this information is becoming available on a consistent countrywide basis through the Agricultural systems study, this needs to be worked with on an ongoing basis. This could form a baseline on which seasonal planting and harvesting patterns, pest and disease problems and a range of other factors could be superimposed. The aim should be to analyse the situations, look for constraints, identify possible items for research and attempt innovations through consultation with the farmers. In response to the extension officers providing this local and indigenous knowledge, national DAL or NARI could provide additional attractively presented information available from national and international sources to complement that collected from an area. It is most unlikely that this process would occur on its own but would need a highly motivated facilitator and possibly be linked with crop specialist training programmes within districts proposed under NARI. From this mutual interaction, planning goals and intervention strategies could be continually developed. Only a part of this process has occurred under the Farming Systems programmes so far operating.

Most fruit and nut crops within the country need input into their selection, vegetative propagation, pruning and other production techniques. Any which easily grow from cuttings are already produced that way but those that may require some inputs such as rooting hormone or mist propagation or marcottage have still not had these readily available technologies applied in any appropriate fashion. Any techniques such as these should not be the subject of 10 to 20 year trials to prove the superiority of the strategy, but simply released to village farmers as soon

as available. For example the rooted galip cuttings should be grown in villages not on a research farm. The funds required for labourers to cut the grass on that site for the next 20 years could be diverted to some more useful end. A village person can easily assess whether this new plant gives earlier production, sweeter taste, higher yield etc compared to the plants already in their location. For most subsistence situations the benefits have to be fairly obvious.

Some adaptive technologies can be continually tried, refined and reformed. Many should be made available to farmers even in their tentative and early development stages. This would allow far greater farmer participation and avoid a massive research effort that failed to be adopted and for which the extension officer normally gets the blame.

Status, challenges and prospects of production for specific food crops.

Root and starchy staple crops.

Sweet potato

For this crop, PNG has become a centre of diversity. This is because plants are regularly flowering, producing seed and gardeners are selecting seedlings for observation at least in highland regions. The farmers work with the system as it occurs. Often they do this naturally and sometimes without specifically giving systematic thought. A variety that is not producing well has less planting material available and gets less area devoted to it. The dynamics of the system are constantly changing. As fertility changes and declines, varieties that previously performed well under higher soil fertility become less favoured. The movement of varieties throughout the country is constant. Any attempt to identify the optimum variety for each region is probably not the most productive long term strategy. Ranking of varieties suitable for highland and lowland areas is probably valid as the ranking probably stays consistent within a region, but this can also be done by observant village growers. Sweet potato is the most significant food crop resource in the country and should receive ongoing high level attention and support. All aspects of germplasm diversity, farming system production, disease and pest problems etc should be regularly assessed and improved. And recording of yield figures that are not recorded on a dry matter basis are a waste of time and should simply not be accepted in reports. Recommendations and distribution of selections have been made on total yield and this has led to the lowering of the confidence and respect for sweet potato research. A bulky root crop staple must have a high dry matter content and people will not accept one that does not have this, except for pig food. [People working with a crop such as sweet potato need a fundamental understanding of disease processes. Cultivars selected within the PNG environment have a high level of horizontal (polygenic) resistance to disease such as Elsinoe scab when compared to those such as the Taiwanese cultivars that have been introduced but which have been selected outside this pathosystem. Trials designed to establish the obvious are not the type of applied research needed

for this country.] Given that the PNG sweet potato diversity of about 5000 cultivars has apparently developed over a period of 300 years, the incredibly active diversification and selection process occurring at least in the highlands where plants actively seed and undergo sexual reproduction, should put questions against trying to preserve the totality of this selection in expensive labour and cost demanding germplasm collections. The maintenance of some cultivars may be justified.

Sugarcane. In Australia it is estimated that 10% of the dietary energy requirements of the people are met by sugar. PNG has a low recorded consumption for processed sugar but the universal acceptance of chewing canes throughout the gardening and farming systems of the country make it most likely that sugarcane is the second most important crop for PNG irrespective of the Ramu sugar project. Many significant problems seriously erode the contribution of this crop to the social, cultural and dietary life of the population. The constant erosion of the yield by pests and disease problems that are often understood but ignored within subsistence is a reality. Rats and other pests also cause significant losses. Sugar does not only become important once it is sold and processed and the great value of this crop within the country needs constant attention. The varietal diversity is considerable, and has been the subject of various collecting expeditions but little return benefit has ever come to the country from providing the world with this resource. Much of the data and information collected has been lost in the world's obscure literature system and not returned to PNG in an appropriate form. Ramu sugar is an excellent development. Subsistence sugar for chewing deserves 10 times the input on any rational and economic basis. Chewing cane is a national past-time as well as a significant food supplement.

Taro. The varietal diversity is great. Several hundred cultivars occur and have been collected on research stations but maintaining the collections has been fairly unsuccessful. An active breeding programme is occurring near Lae and the philosophy of doing simple crosses and allowing village growers to propagate and assess their potential is excellent. Any attempt to breed for complete resistance to blight will produce a non sustainable solution. Monogenic resistance is unstable. Taro blight, taro beetles and alomae and bobone virus have drastically affected taro production. With taro research, care should be taken not to rediscover the already known. The environmental conditions for taro blight epidemics are already precisely known. They are not an appropriate proposal for research. Workers in PNG should be using this, and other information to control blight. They should also be publishing attractive colour brochures on the range of taro disease (11 or more) so that people don't keep recording taro blight in the highlands or do Ph D's on the history of taro blight in North Solomons seemingly oblivious of the fact that several taro leaf spots and blights occur in the country.

Colocasia esculenta var. *antiquorum* type taros occur in the Western Province. These have some advantage in distinctly seasonally dry areas because they store better and it is easier to maintain planting material. They should be considered for other seasonally dry areas.

Xanthosoma taro has increased at the expense of *Colocasia* taro. *Xanthosoma* taro has little varietal diversity and, as a relatively recent introduction, it has little accumulated tradition or cultural and social restrictions. It is a significant staple in several areas. Root rots cause some concern.

Amorphophallus campanulatus or elephant foot yam is mainly utilised by Sepik people although I suspect it has been incorrectly recorded as common in the Papuan region where it has probably been confused with Polynesian arrowroot. Elephant foot yam has some values because of its taro like taste and very good storability. (People need to be educated to not dismiss the edible variety because of its similarity to the more widely distributed inedible variety.) The crop is significant in some areas of India.

Alocasia and *Cyrtosperma* taros are significant in some New Britain, New Ireland and North Solomons regions. *Cyrtosperma* taro has an environmental niche worth exploring for swampland areas.

Yams

In seasonally dry areas yams become significant. They exist in six species and for *Dioscorea alata* and *D. esculenta* these have a wide range of varietal diversity. Collections of these have been made and are being maintained on some research stations. More needs to be done with these than either maintain them or work out which gives the highest yield. The significance of the diversity needs to be assessed and ways of utilizing this incorporated into the farming systems of the country. Food in all cultures has far more than a functional role and PNG yam growers should not be denied this universal privilege. The role of yams (and other traditional crops) in cultural and social events should not be ignored or considered unimportant. The significance of damage by rats and other dry and wet storage losses should be assessed and monitored. Many traditional explanations of disease phenomena in yams are disguised by village explanations such as "lightning strike", magic, poisoning or interference by an antagonistic neighbor or menstruating women etc.. Underlying this is the reality that many of the disease and pest problems of yams have not been carefully or systematically recorded, observed or assessed. The disease of yams in PNG needs to be definitively established and accurately recorded against the correct species. "Yams" is totally inadequate as a crop title. Great care needs to be taken in any simple screening of varieties for (horizontal) resistance. Any such program will automatically leave the crop vulnerable to alternate currently minor diseases eg selection for resistance to anthracnose in yams has in other countries left crops vulnerable to virus. A village farmer can already rank varieties for yield and recognizes cultivars susceptible to both anthracnose and virus even if they don't cognitively understand the disease cause or process. Much accumulated wisdom is also maintained in the traditional production systems with their extensive foliar displays and staking systems. The principles underlying these should be taught to agriculture officers so that they can optimise rather than minimise the benefits for improved production. Any assumed "yam improvement programme" needs highly informed, integrated and critical thinking. Social and cultural traditions should not be

arrogantly dismissed or seen as total constraints to change but should be discerningly assessed for the underlying often legitimate concern.

Bananas

PNG probably has one of the world's widest collections of banana germplasm. Various attempts have been made to collect and preserve this but very little attempt has been made to use this richness or the information contained within the Papua New Guinea banana production areas. Papua New Guinea farmers are careful and pragmatic observers of the crops they grow. It is not necessary to pre screen all the varieties before planting material is made available into an area. But of course disease spread and pests such as banana nematode and banana weevil should be reduced or minimised by appropriate heat treatment and paring techniques. (Not necessarily tissue culture for within the country.) Many farmers are quite capable of determining whether a particular variety has a place in their production system. But if they do not have access to it, or are not made aware of some of its virtues they may not have the opportunity to avail themselves of these advantages. Some of the traditional diploid varieties give a small but very early yield. This is useful in certain situations. As well, some diploid varieties have a significant role as temporary shade for the establishment of for example cacao. But this opportunity is denied those who do not live in an area like the Gazelle where this planting material is available. Some of the absolutely huge tetraploid banana varieties that occur in the Gazelle and Finschafen region could be made more widely available. At this stage it is hard to make any worthwhile assessment of their value. Of prime importance are some of the ABB and AAB triploid varieties that have such good sustainable production in areas with declining fertility and disease susceptibility. In many places where residences have become more permanent, cultivars in these groups undoubtedly have a role near houses. They often provide firm, high dry matter fruit of good cooking quality. It appears to me that banana varieties are very unevenly distributed around the country and that an experienced banana producer from some of these areas could make significant recommendations on the values of specific varieties for specific social and cultural situations. Much of this information would not have to be verified by replicated scientific research at least in the first instance as the accumulated wisdom of a good and observant producer from a banana area has high credibility. Some specific problems in bananas still need attention. These include Scab moth in New Britain. Diploid cultivars are undoubtedly at risk from genetic erosion but some attempts have been made to preserve these cultivars both nationally and internationally. The world market for sweet bananas is so competitive and artificially controlled that it is probably not worth considering this as an export avenue. There may be a market for cooking varieties to the Polynesian residents in Australia except that quarantine regulations are likely to be restrictive.

Cassava is becoming popular because of its ease and reliability of production. This is especially in areas where significant dry seasons occur. The young leaves although of very high nutritional value are often overlooked. Care always needs to be taken to see that cassava is adequately cooked. Ways of

incorporating it in mixed cropping situations could be improved. Consideration needs to be also given to the fact that when people are resorting to cassava as a main production staple they are probably approaching the limits of exhausting their soil nutrients and strategies need to be put into place to reestablish the soil and gardening system. Tree legumes may need to be used as a follow-on crop to restore soil fertility levels.

Sago. The unique value of this crop is that it suits environments that would be unsuitable for other crops. The productivity of the system should not be undervalued. The long term sustainable production probably matches or exceeds that of a shifting bush fallow or grass fallow where significant fertiliser inputs are not being made. Over a 20 year period the production from sago is probably at least equivalent to that of a 20 year rotation garden site in another area with its alternating crop and fallow sequence. For those who own land and live in sago areas and for those who have sago as there preferred dietary option it remains an important and vital crop. The production systems vary greatly in different regions. These need to be more closely monitored and critically analyzed. One of the unique problems in sago areas is the protein deficiency of sago as a food. This remains a real problem and strategic thought needs to be given to appropriate crops to complement sago in its agro-ecological environment. In the mid altitude Kutubu production system *Xanthosoma* taro and choko tips have become established as minimal maintenance supplement gardens to sago. But other options need to be actively pursued eg Oenanthe, Talinum, Kangkong, Climbing swamp fern, other aquatic ferns.

Sago processing is a labour intensive task left mainly to women. Improved methods of processing need to be evaluated. Countries with more formal sago production systems such as Malaysia must have made technological progress in this area. Appropriate technological innovations need to be introduced. Simple hand operated scrapers may have no energy efficiency advantage over the present system. Very light weight pounders may have a role or some form of simply motorised system may gain acceptance. There is also considerable scope for the improvement of the cooking methods to enhance and diversify the product as a food. It can be used successfully for omlets etc and a wider range of cooking methods need to be developed.

Considerable varietal diversity occurs but as this is probably not at present at risk it is probably not necessary to collect or attempt to maintain this on research stations. It should be understood and utilised within the existing systems. In some areas sago is so extensive that little energy on the production side is exerted. In other more intensive areas there are some problems with newly planted suckers rotting and other aspects worthy of attention. The time to maturity for palms creates a sequence of social interactions and trades for young marrieds while they wait for their plants to reach maturity. One of the studies done on sago for PNG suggested overcrowding as a constraint. It dismissed thinning as too difficult a task. It is in fact very simple by making a small hole to allow the palm weevil to

gain access. A promotion of this spacing policy may achieve better more productive palms requiring less harvesting energy.

The Sago species in North Solomons Province and some of the off shore islands of New Ireland is a different species with a slightly different ecological habitat and a different growth and production pattern and should be evaluated and its potential considered for other areas. It is sown from seed. One of the advantages of sago is that it is a good emergency store of food in the growing palm, but also in short to medium term storage of processed sago under traditional methods for times of famine. Bougainville sago fronds are excellent house roofing material superior to *Metroxylon sagu.* The Bougainville species demands more energy for processing and therefore tends to be done by men.

Other staples

Ipomoea tuba in the Western Province needs some recognition and assessment. *Ipomoea tuba* a root crop related to sweet potato is widespread in the Transfly area. It is grown in yam gardens and called a variety of yam. It needs some investigation. The disease on the leaves needs recording. It's storability needs investigation. Presumably those involved with sweet potato germplasm collections and breeding strategies could be informed. Any varietal diversity and indigenous knowledge should be collected and made accessible. Its regional distribution and names need documenting.

The high Andes tropical root crops Anu, Ulluco and Oca have been introduced with limited varieties and minimal information. An introduction with greater varietal diversity and some understanding of how they fit in an indigenous production system may facilitate their adoption in high altitude zones where they may have some potential.

Some crops such as swedes and turnips are basically not liked by village people but may be able to be introduced into high altitude zones to fulfil a dual role for both pigs and people as is often done with their production in temperate countries. During times of frost they would still be available as a famine reserve for people but could otherwise be used for pigs within the village pig production system.

Nuts as seasonal storable foods.

Karuka pandanus plays a very significant role in several high altitude areas. Because they are storable and seasonally occur in large quantities, their impact and importance in daily nutrition should be carefully considered. Collecting germplasm may be difficult but also unnecessary. People are notoriously protective of some of their varietal selections and will not trade them, but it is most unlikely that germplasm is being significantly diminished under indigenous farming systems at this point in time. Considerable diversity exists. The potential of this crop in other high altitude zones 1800 to 3100 metres altitude

both within the country and in other tropical equatorial countries could be considered. The problems with borers, possums, etc need to be studied and information from the *Sexava* research on coconuts and oil palm on the coast needs to be adaptively applied to karuka. Karuka heads before the nuts are separated have a spectacular appearance and this could be capitalized on in the exotic tourist and restaurant market both within the country and overseas. With appropriate marketing and information especially about some of the secret karuka languages used by indigenous karuka growers they could be sold, at least in the short term for a high price for the top end of the tourist trade where clients thrive on novelty and experiencing the "exotic" and who can afford to pay for the privilege. Locally, within PNG, karuka nuts may have a market as a food, especially in coastal areas, but their potential as food in the highly competitive nut market in overseas situations is harder to predict.

***Finschia* species** nuts in the Eastern Highlands should have their potential explored given the rapid rise to world fame of the related Macadamia nuts. They may well have export potential but this could also rapidly be exploited by groups involved with exotic fruits and nuts in tropical Australia so may not warrant extensive research effort which could be quickly lost to alternative growers.

***Castanopsis* chestnuts** in the mid altitude highlands zone make a significant contribution in several areas. Some dietary problems that may occur need further investigation, and the role of them in feeding pigs needs further consideration. Some of these trees could presumably be productively planted in denuded and grassland areas in highlands regions. Assistance with this may be useful.

"**Illipe" nuts.** The German annual reports for 1895 said these nuts at Madang had potential which should be explored. I am not sure what progress has been made since then!

Galip nuts. The distribution of these around the country is irregular. In some areas, their production has significantly declined. The reasons for this need to be investigated. Some recent work has been done in the Solomon Islands. Rather than allowing a quality resource to decline by default, these nuts should be exploited by creative marketing and for processing. Current work on vegetative propagation at LAES should be continued. It should have specific aims such as enabling improved cultivar selection, allowing quicker establishment, achieving earlier maturity, and establishing a lower tree more easily harvested. The unusual wood structure of *Canarium* may necessitate extra innovations in propagation. Surveys of varieties, especially in North Solomons should be undertaken. If pathogen free material could be introduced, there are a number of other *Canarium* species in the Asia Pacific region that may be worth considering. The attempts at meristem culture at LAES may be relevant to this.

Okari nuts and other nuts in the same group need to be more extensively studied and understood. They seem to be randomly distributed in coastal regions

and more common in southern regions and Popondetta. Some distributions to villages in other areas could be useful.

Aila nuts appear to be the sort of nuts that have processing potential to make them a more diversified and useful product. eg desiccation and other roles as with walnuts in other countries.

Pao nuts (*Barringtonia spp.*) are far more common on the north coast. This may be environmental but the information is lacking and some simple village plantings in other areas of the country would be the easiest and cheapest way to determine the areas for which they were suited. It may be useful to also introduce other species from the Pacific. (With appropriate quarantine precautions.) As well information on the varietal diversity within species in PNG would be useful. This is probably significant in the Gazelle and near Madang.

Fruit

Studies on seasonality

The distribution of seasonality, biennial bearing, etc of most fruits and nuts throughout PNG in poorly understood. The seasonality, production, and other factors need both preliminary surveys and detailed study. With most fruits and nuts progress on selection and vegetative propagation is needed.

Pawpaws are largely self-propagating in the lowlands and planted in mid altitudes. Adequate production information is available. Given bisexual types are common male trees can be safely reduced or eliminated. Little improvement in production or propagation has been undertaken. Promoting local production rather than marketing may be the simplest strategy and avoid post harvest losses.

Pineapples have adequate information but technology for producing fruit out of season needs to be extended especially in the lowlands where seasonality is greater. Production for local and national markets, including fruit juice and other processing could always be potentially valuable.

Citrus have received significant attention (out of all proportion to their value as a food crop in PNG). The pest and disease problems are an entomologists and plant pathologists picnic, but because they are a well known group of plants it is possible to do endless work with them even if it is not justified. West Indian lime, Pomelo, Lime berry and Clymenia suit the coast. Others may have a role in mid altitudinal "sub tropical" zones where they belong. As an export they probably have little scope in a competitive and demanding international market and as a food for their nutritive value they are significantly eclipsed by for example guava. If there is a local market this may benefit some mid altitudinal places with few income generating opportunities. Research and development should be given lower priority than guava and some other plants.

Clymenia polyandra is the only indigenous citrus in PNG and because of the worldwide importance of citrus and the fact that most people do not know of the existence of this plant, some information about it should be collected and distributed. It should be recognised as a fruit for coral atolls and offshore islands both within Papua New Guinea and internationally. It probably does not have any unique resistance to at least some of the common citrus diseases but this would be worth investigating by someone with citrus interests and speciality outside the country. It does not warrant research from local workers.

Mangoes are common in the lowlands but restricted in their productivity by anthracnose. In seasonally dry areas, or dry seasons, production is good. Quality is not always as good. Considerable improvement could be made by both varietal introductions and propagation improvements. This propagation should be a private sector function for local nurseries with DAL/DPI providing initial training in budding, grafting or selection of "vegetative" seedlings from seed.

Bukubuk (*Burckella obovata*) This fruit tree is mainly in East New Britain, New Ireland and some of the coastal islands. It is a highly preferred fruit. There does not seem to be a lot of genetic variation obvious although longer and rounder fruited types are known and some regions are known to have good bukubuks eg Feni Islands. This is a fruit that is worth considerable attention and further consideration. It has the sort of texture that could enable it to have export potential but transport is difficult. It has potential as a crop for coral islands here and internationally.

Ton (*Pometia pinnata*) is valued in the Islands. Education and clarification needs to be made regarding the timber varieties and the edible fruit varieties. Information on ton from New Ireland and other regions needs to be collated and some simple vegetative propagation techniques undertaken. Trial plantings of selected kinds in villages in other locations within the country should be undertaken. This is a fruit crop with potential possibly even in export (cf rambutan and litchi).

Marita pandanus is common especially in mid altitude regions. It has some genetic diversity. Its food value is not high but it is popular. Several cultural constraints restrict its use by women.

Mon (*Dracontomelon dao*) probably has little potential as a fruit although I am always happy to be proved wrong in this regard. Nevertheless its use in villages and sale in markets should be recognised and any available information from the Philippines or elsewhere should be made available for PNG.

Golden plum (*Spondias cytherea*) is, I think, a fruit with potential both for edible leaves and fruit and would, I think, respond significantly to selection of better kinds maintained by vegetative propagation.

Corynocarpus cribbianus is an indigenous fruit on Manus which exists in a small number of varieties. The species also occurs in some other Pacific countries and a related species is used in New Zealand, but little information on it is available except from Manus. It needs appropriate recognition. Because it is a very fibrous fruit it may not have great potential for export in my opinion but if olives can be made edible then delivered around the world to appear in Papua New Guinea restaurants, then anything is possible!

Baccaurea papuana is an indigenous species of fruit and mainly occurs along the Gulf region. It is linked to a larger number of related species in Indonesia. Trees have been maintained in the arboretum at Kerevat but little else is known about the value of this fruit tree. It and related species in West Irian justify some consideration but not a major focus at present.

Parartocarpus venenosus is a fruit tree related to breadfruit and occurs in the rainforest on some islands such a New Britain. This species also occurs in the Philippines. It again needs the indigenous knowledge, varietal diversity and other basic information collecting.

Breadfruit both as a nut (seed) food and as a starchy staple is common. Some benefit may be obtained by more widely distributing the seedless smooth skinned kinds to other locations - mainly in the North and West. Some assistance with vegetative root propagation may be a useful extension role. Little seems to have been done on the diversity of the seeded kinds. The value of breadfruit in several countries and problems with disease (Pingalap) may mean Papua New Guinea seed tree selections may have value, but this is unknown. Any breadfruit introductions from the Pacific would need to be with great care because of disease problems.

Litchis, to my knowledge have only ever been introduced to the lowlands such as Lae and Kerevat. This is the wrong environmental zone so they have not produced and have been ignored. They need to be in mid altitudinal zones. A few select trial plantings in this region should precede any significant trial work.

A range of other potentially useful tropical fruits have been introduced but many more remain potentially available.

Some regions place greater emphasis on fruit and nut culture and more detailed studies should be made in these areas. A number of as yet unrecorded fruit and nuts species occur in these places. Several *Syzygium/Eugenia* species probably occur near Balimo and other fruits such as *Myristica holrungii* and others occur in the Gulf. They should be assessed before the area is sold for wood chips!

Beans and legumes

Long bean. This bean seems optimum in lowland areas and should normally be given preference over common bean in this location. Its suitability should be given greater emphasis. **Cowpeas** have in the past been effectively used in nutrition intervention programmes in the Baiyer Valley and this strategy and crop may have wider possibilities.

Winged bean. Considerable attention has been given to this bean worldwide, in recent years. Not a lot of the accumulated information has been actively returned to the village producer. The virtues of this bean should not be lost for subsistence production and within the diet, even if the "Western" world found that its fascination with the plant died when they realised that it was not easily adaptable to mechanised production outside the tropics. In areas where the production and use of this bean is declining within the country, the reasons should be investigated and wherever possible remedial measures taken to ensure that the optimum use is made of its soil nutrient building potential and the importance of its dietary quality is not ignored. The effectiveness of nodulation and the potential occurrence of molybdenum deficiency, along with nematode damage should be monitored. Production systems that enable it to be optimised within the farming system need to be developed. A distinction needs to be made between its potential and use as a root crop in the mid altitude highlands and its role for seed pods, beans and edible leaves and flowers in other areas of the country. Seed selections that have unfortunately been lost from Research Farms should be restored if possible and then more adequately stored where power failures and rat problems are less risk.

Lima and lablab beans. Additional information and attention needs to be paid to these traditional beans of highland areas. Legumes do not feature as highly within PNG as they warrant. Care should be taken with fads on only lightly cooking vegetables. Several tropical vegetables have high cyanide levels, but this is easily removed with adequate cooking.

Pigeon pea has only received very scant attention and probably has a significant role in modified grass fallow production systems in seasonally dry areas.

Peas and broad beans may need more serious consideration in high altitude areas that are subject to frost.

Edible greens. These are the vitamin and protein source for the bulk of the inhabitants of PNG. An emphasis should be placed on these before any significant vitamin supplement strategies or protein enrichment policies are developed. The daily protein and vitamin requirements can be better met for adults and children by a careful and appropriate selection of good qualities greens.

Some protein quality may still not be met. (But sufficient protein levels may not be adequately met by several introduced vegetables.)

Rungia only occurs in the highlands of Papua New Guinea and Irian Jaya so information will have to be developed locally. The related *Dicliptera sp* is more variable in its use and acceptance but should be considered at the same time. A nationally acceptable and recognised name should be developed for Rungia.

Aibika is a uniquely valuable plant grown from Indonesia to the Pacific. It is highly productive, of very high nutritive value, and with very acceptable taste. (In some other countries it is utilised for industrial purposes.) High priority national attention should be given to this plant at all times. It is, for example, very responsive to very low doses of nitrogen foliar spray and techniques like this may enhance its productive efficiency especially in low nitrogen grassland areas. Its growth potential above about 1800 metres altitude makes it less valuable in those regions. Giant African snails have been a problem in coastal areas at certain times. Aibika flowers and seeds regularly and selection could be an on-going process. The varietal diversity is significant and rather than this being collected in a germplasm collection on a research farm it needs to be utilised within the farming systems. Different cultivar selections are needed for mixed cropping situations (narrow leafed kinds) than for use in monoculture situations. And no nutritionist in the country should complain about lack of funds for distributing iron supplements whilst edible greens like aibika are available. The nutritional qualities of aibika need to be promoted regularly and appropriate cooking techniques - frying /steaming emphasised to enable it to gain acceptance in the national cuisine in restaurants as well as in all coastal villages. The diversity within aibika could be easily and economically conserved in seed form as the individual selections appear to be a part of the gene pool easily accessible from the diverse progeny from a few seeds. Pest and disease problems are being studied and need to be the subject of ongoing study. But enhancing growth through appropriate crop nutrition may be a wiser and safer policy than controlling the insect damage through pesticides. Information on many insect pests of aibika is readily available from the literature on cotton. Appropriate control strategies may be able to be adapted from research on cotton (especially biological control) rather than developed for aibika in isolation.

Amaranths have gained some world wide attention but this has mostly been for grain amaranths. The leafy amaranths (Aupa & pepenge in Kuanua) are distributed worldwide as food plants in the tropics and lots of emphasis is given to them in West Africa because of their fast production, suitability to small plots, high food value, and good yields. The species and varietal diversity and distribution within PNG needs to be further understood. They need some consistent and nationally recognised name. They need to be extensively promoted as edible greens of great importance. They should be a daily part of the diet in most areas of the country. (Except in the cooler season in high altitude areas where temperature restricts germination.) In urban areas even where water is in

short supply, amaranths should be being regularly produced in small back yard plots. Small urban plots have the potential to be continually increasing in fertility if effective composting measures are carried out, and amaranth is one of the more productive plants for these sites. Good information is available on this from Nigeria.

Oenanthe is another green needing a nationally recognised name. The use of this part of the scientific name "*Oenanthe*" will be confusing because of poisonous species with the same generic name. As a food, this plant is used in South East Asia including Malaysia, Indonesia, Vietnam and the Kwantung province in China. They have available information on its production but it is written in their national languages. *Oenanthe* is being increasingly introduced to the lowlands and seems to produced well in lowland streams and damp areas. It has specific value in areas that are damp and should be considered more carefully for sago areas where edible greens are in short supply. *Oenanthe* is well suited to these environments, and greens are badly needed there to balance the diet. Before extensive "variety" collections are made, consideration needs to be given as to whether they really are genetically different or simply variations in leaf shape due to temperature etc. Baiyer Valley seems to show significant variation in leaf shape for this species. Some consideration needs to be given to potential risk factors associated with this plant from a dietary point of view. See review of 36 Important Food plants for CSIRO land use study by B.R French. (Being published by DAL).

Waterleaf or *Talinum* is a leafy green not yet widely distributed throughout the country but has significant advantages in terms of being suited to wet sites and having efficient production. *Talinum* was introduced probably by the Japanese during the war but people were not given information on its name, edibility, cooking, value etc. The utilization and acceptance of it therefore varies around the country. It has virtues worth exploring.

Blackberried nightshade is grown as a food plant in most tropical countries. It has nutritional advantages and a special role as one of the earliest available edible greens as well as giving stable production and high yield. An ongoing range of false assumptions and inherent biases limit its useful promotion. It has a range of indigenous names throughout the country and is regularly both grown and harvested from the wild and also sold in markets.

Fig leaves. Several species of Ficus are used throughout the country. In some areas they become of great significance and in some areas are an important part of the gardening pattern. One problem is that with over 600 species of figs in PNG and no authoritative work on their scientific naming it is hard to accurately identify or name them. Encouragement could be given to some international Botanical authority to do work on this group. Because of their importance to the country in many ways it may be possible to provide incentives through one of the national projects eg forestry, to include some systematics and evaluation as part of

their overall programme and strategy. Sorting out this group of plants may be too large for a Ph.D student but some encouragement should be given to someone to do some work on the genus. Independently of this, the importance of fig leaves and fruit in the national diet and production should not be overlooked.

Kangkong. This name is recognised as such in the world literature and does not need any additional naming. The varieties grown from seed receive more attention in some South East Asian countries and may have roles in some production systems within PNG. The importance of this crop and the variation within it within the country needs recognising and utilizing. Greater use in lowland marginal saline environments needs to be constantly emphasised.

Watercress is well established in highland streams but also occurs in the lowlands. It needs to be more widely distributed and promoted. It suits limestone areas but has advantages because of its low maintenance once established and its lack of competition with garden production.

Valanguar has a somewhat confused status in the country. The exact species utilised is still unclear. The boundaries between varieties that are popular and cultivated and species that grow wild is not clear. Information on this remains mainly in the heads of Tolai people from the Gazelle, who are the main users of this plant both in the Gazelle and in other areas of the country where they have taken it. One of its advantages is as an attractive ornamental and edible hedge.

Tu-lip is an adequately recognised Tok Pisin name throughout the country for *Gnetum.* This plant is grown throughout Asia and the Pacific but more creative use is made of it in the diet and food preparation - especially of the seeds, in Indonesia. It is a highly preferred green and worthy of further study on its intensive production including spacing of trees, their pruning for more optimal management and production, and on the factors which promote seasonal flushes of leaves.

Edible ferns. A range of edible ferns is commonly used throughout the country. They are widely enjoyed but their perceived status compared to "European" vegetables is very low. An expatriate buying or eating them is considered an absolute anomaly. Their nutritional value should be highlighted and their role in tropical nutrition in other countries should be taught to counteract the negative perceptions.

Climbing swamp fern is significant in sago areas and other aquatic type ferns may also have a greater role in these environments. It would be nice to have better names and recognition for the edible fern species.

Several other leaves in the country are known to be edible but are not preferred because their flavour is bland. Simple recommendations for appropriate village level cooking techniques - eg stir frying, and flavour enhancing using either locally available spices or ones which could be bought or cultivated for

home use (eg turmeric, ginger, pepper, mint, spring onions, etc) could greatly increase the use and enjoyment of these plants. Strategies to maximise locally available products could reduce transportation costs, storage and cartage losses, and although not seemingly entering the cash economy could produce an overall improvement in the national welfare. The more that food is productively and efficiently produced within subsistence, the greater freedom people have in how they use their scarce cash resources for other purposes. Development becomes then more than mere substitution and enables genuinely new options to be pursued. Leaves such as taro leaves and especially cassava leaves are still under-utilised as food within PNG. Cassava leaves are one of the most nutritious tropical edible leaves. Where the diet remains based on bulky root crop and other starchy staples the protein balance and intake in adequate amounts is a delicate subject. A food such as cabbage which is bulky and low in food value may be adequate in a "Western" diversified diet with concentrated and processed foods in ample supply but can be treacherous in the diet of a young Papua New Guinea child.

Hedges of edible greens should be promoted around houses especially in urban areas. There appears to be no thought out strategy in relation to these. The species utilised appears to be confined on a cultural or ethnic basis rather than a climatic or environmental basis. This is most likely because the information has not been collated and promoted by those involved with agricultural education. Crops suitable for edible hedges and boundary markers include *Polyscias* (Valanguar in the Gazelle); *Ormocarpum* (Kalava in the Gazelle and also common at Kerema); *Ficus* (Kumu musong) as used near Tari; *Gnetum* - Tu-lip as used near Kutubu. Others could be usefully introduced. These include *Sauropus* that occurs on Solomon Islands and is recognised as useful in this role in several tropical countries.

A number of other edible greens mainly harvested from the wild have not yet been correctly identified. These could become a useful study for University botany students in place of all the studies of mangrove swamps.

List of the 45 most important or commonly used food plants of PNG

STARCHY STAPLES

Sweet potato	*Ipomoea batatas* (L)Lam
Bananas	*Musa sp* (A &/or B genome)
Taro	*Colocasia esculenta* Schott
Lesser yam	*Dioscorea esculenta* (Lour) Burk.
Greater yam	*Dioscorea alata* L.
Chinese taro	*Xanthosoma sagittifolium* (L) Schott
Sago	*Metroxylon sagu* Rottb.
Cassava	*Manihot esculenta* Crantz
Sugarcane	*Saccharum officinarum* L
Potato	*Solanum tuberosum* L

GREENS

Aibika	*Abelmoschus manihot* (L) Medik
Rungia	*Rungia klossii* S.Moore
Oenanthe	*Oenanthe javanica* DC
Amaranth	*Amaranthus tricolor* L
	Amaranthus cruentus L and 4 other species
Tu-lip	*Gnetum gnemon* L
Fig leaves	*Ficus copiosa* Steud.
	Ficus wassa Roxb & several others.
Cabbage	*Brassica oleracea* var. *capitata*
	Brassica chinensis L
Choko	*Sechium edule* (Jacquin) Swartz
Pumpkin	*Cucurbita moschata* Duch ex Poir.
	Cucurbita maxima Duch ex Lam
	Nasturtium schlechteri O.E.Schultz
Watercress	*Nasturtium officinale* R.Br.

Many fern fronds are eaten. The 4 most commonly used are probably:

	Cyathea contaminans (Wall ex Hook) Capel
	Diplazium esculentum Swartz
Kumugras	*Callipteris prolifera* (Lam,)Bory
Climbing swamp fern	*Stenochlaena palustris* (Burm.f.)Bedd.

VEGETABLES

Corn	*Zea mays* L
Spring onion	*Allium cepa* var. *aggregatum* G.Don
Cucumber	*Cucumis sativus* L
Long pipit	*Saccharum edule* Hasskarl
Short pitpit	*Setaria palmifolia* (Koenig) Stapf.

BEANS

Common bean	*Phaseolus vulgaris* L
Snake bean	*Vigna unguiculata* ssp. *sesquipedalis* (L) Verdc.
Winged bean	*Psophocarpus tetragonolobus* (L) DC
Lima bean	*Phaseolus lunatus* L

Lablab bean	*Lablab purpureus* (L) Sweet
Peanuts	*Arachis hypogea* L

NUTS

Karuka	*Pandanus jiulianettii* Martelli
Wild karuka	*Pandanus brosimos* Merrill & Perry
Breadfruit	*Artocarpus communis* J & G Forster
Okari/talis	*Terminalia catappa* L
Okari	*Terminalia kaernbachii* Warb
Coconut	*Cocos nucifera* L
Galip nuts	*Canarium indicum* L
Castanopsis	*Castanopsis acuminatissima* (Bl) A DC

FRUITS

Mango	*Mangifera indica* L
Pawpaw	*Carica papaya* L
Marita	*Pandanus conoideus* Lamarck
Guava	*Psidium guajava* L
Malay apple	*Syzygium malaccensis* L (& *S. aquea* Burm.f.)
Ton (Taun)	*Pometia pinnata* J.R. G. Forster
Watermelon	*Citrullus lanatus* (Thunb)Mansf.
Pineapple	*Ananas comosus* (L) Mead

Ipomoea tuba

Rungia klossii

Stenochlaena palustris

Polyscias fruticosa

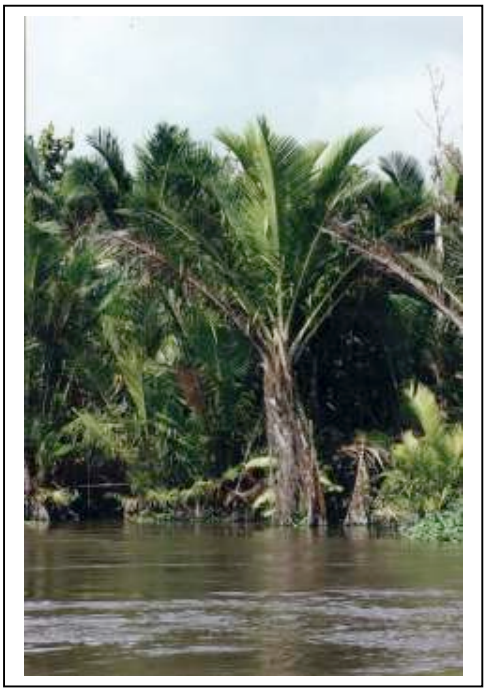
Pandanus juilianettii

Pandanus brosimus

Pandanus antaresensis

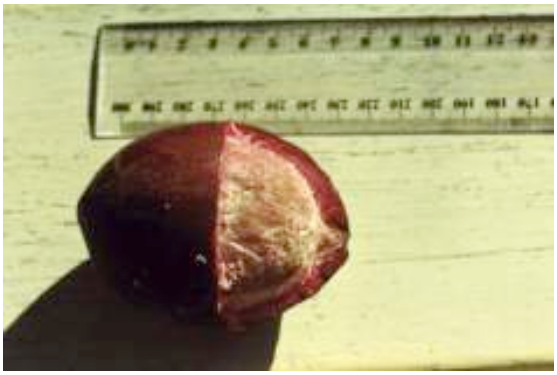
Pandanus conoideus

Pandanus tectorius



Metroxylon sagu

Metroxylon salomonense



Terminalia kaernbachii

Terminalia catappa

Oenanthe javanica

Gnetum gnemon

Talinum triangulare

Ficus copiosa – **market bundle**

Ficus dammaropsis

Ficus pungens

Inocarpus fagifer

Spondias cytherea

Burckella obovata

Pometia pinnata

Finschia chloroxantha

Canarium indicum

Setaria palmifolia

Saccharum edule