Foi food production

A subsistence food production system based on sago production

The Foi are an ethnic and linguistic group based near Lake Kutubu in the Southern Highlands Province of Papua New Guinea

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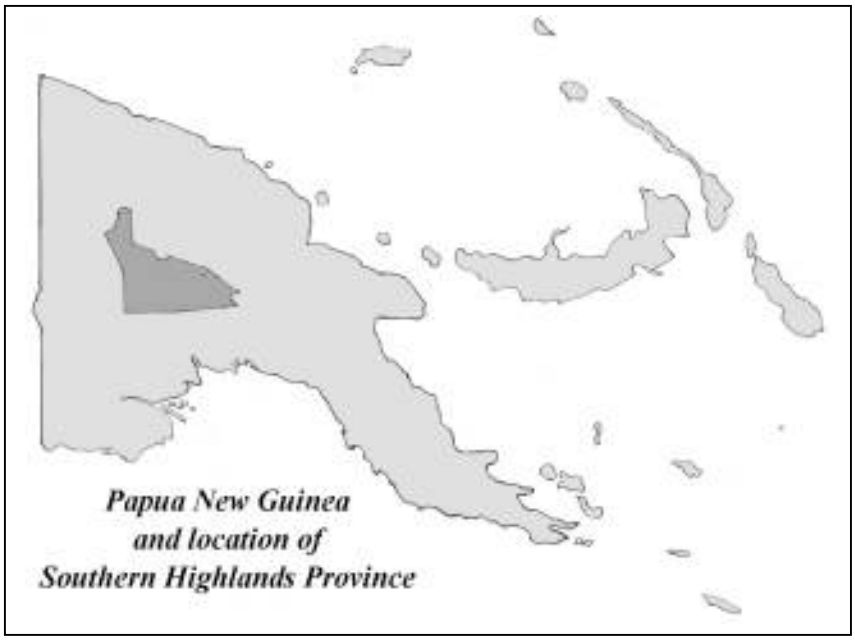
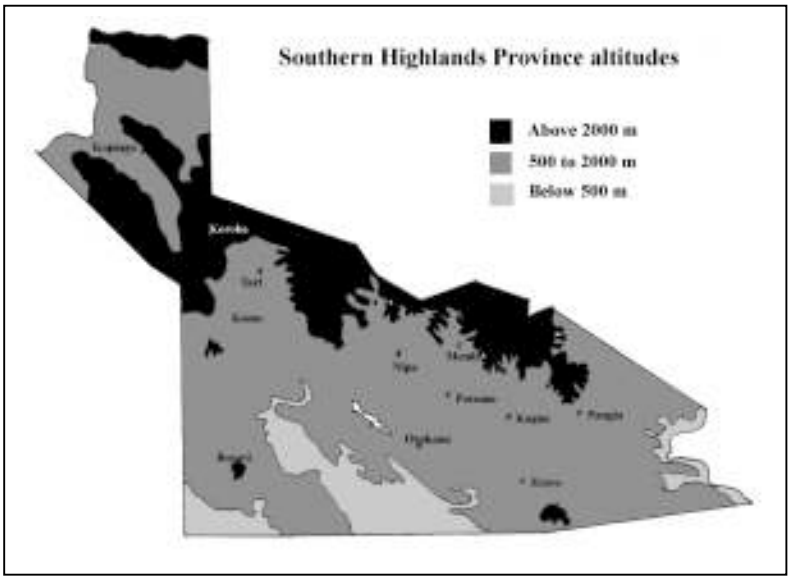
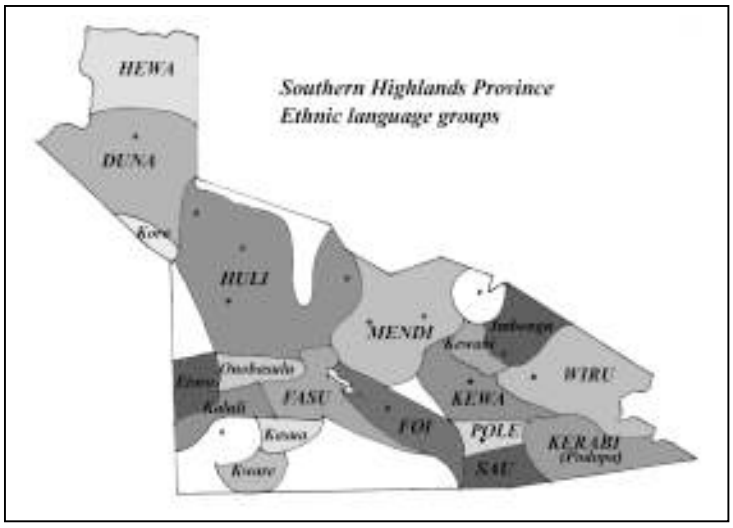


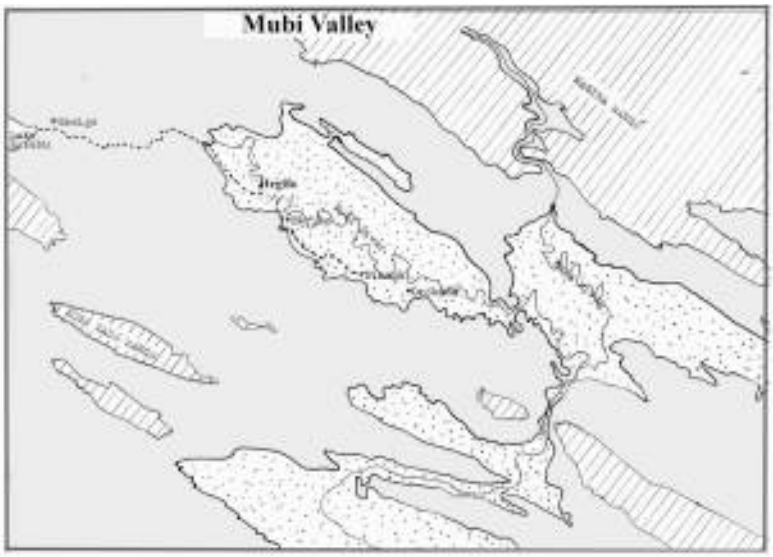
The Southern Highlands Province of Papua New Guinea has an area of 26,600 km^2

The altitudes for the province range from 4370 m on Mt Giluwe to 250 m in some lowland river valleys. The Foi live near Lake Kutubu between 1000 and 1500 m





The Foi are one of 16 main Ethnic and language groups of the Southern Highlands Province



The Mubi River meanders along the Mubi valley with Orokana, Pimaga, Heribo, Hegiso and Gesige Villages before Lake Kutubu.

Sago is planted throughout this basin

Dr James Weiner in bush house with family holding a Marita pandanus fruit

Community road maintenance by Foi women and children Mubi Valley

Baibu village on a drier ridge in the Foi area

General re-growth vegetation near Mubi Valley in the Foi area

A men's longhouse surrounded by family homes at Hegiso village in the Foi area

Girl holding cooked seeded breadfruit

Foi man taking home *Bambusa forbesii* shoots

Community life in Hegiso area in 1980's
My sincere apologies to the village people whose names I have not recorded

Foi (Hegiso area) Food production System

The following is a preliminary attempt to describe the Foi food production system. It ignores non-plant foods including fish, birds, marsupials and only briefly considers edible insects and the impact of pigs. Because it is based on only 5 days of investigations (9^{th} -14^{th} Oct '80) it must be considered a very preliminary description and many factors need checking and quantifying. No attempt is made to look at soils, climate, health, etc. To have been able to achieve this much in 5 days is mainly a reflection of the high level of rapport, communication, cooperation and understanding that James Weiner, the Anthropologist at Hegiso, has achieved within that society.

The report will be a start at a systems model of the Foi food production system. Therefore the production units at cultivar and species level will be described, the other resources and constraints and the spatial distribution of the garden components will be first described to give the systems structure. This is mainly a listing of facts. Then consideration will be given to the systems behaviour that involves concepts and ideas. This is essential to understand how Foi integrate their units of production into a workable system. Although these units of production are fundamental, it is a holistic understanding of the system that would enable an improved systems management.

SPECIES

The species of food plants utilized by the Foi are listed in Tables 1 & 2. Those cultivated are in table 1 and those mainly harvested from the wild in table 2.

There are a number of wild edible plants that I could not readily or confidently identify. They should be collected and sent for identification when possible. As well, the Hegiso people have land at Aimo and it is anticipated that a considerably larger number of wild edible foods would be observed by a trek into this area. Only wild foods actually observed were recorded and no attempt was made to solicit information on other wild food plants. Other mushrooms are known to be used.

(Foi pronunciation has a glottal stop indicated by a comma ‘ and nasal sounds indicated by a stroke through the letter(s).)

Hole for collecting Campnospermum oil

Sago palm and suckers

Table 1 Species of food plants cultivated by the Foi.
(Listed in approximate order of importance/frequency of occurrence)

Scientific name	Foi name	English/Tok Pisin name
Metroxylon sagu Rottb	kui	Saksak, sago
Setaria palmifolia(Keonig)Stapf	wasia	Highlands pitpit
Rungia klossii S Moore	sona	Highlands kumu
Xanthosoma sagittifolium(L)Schott	yafane	Chinese taro, singapo
Sechium edule (Jacquin) Swartz	sogasai	Choko, sioko
Artocarpus altilis (Parkinson)Fosb.	Ugi	Vreadfruit, kapiak
Pandanus conoideus Lamarck	abare	Red pandanus, marita
Musa sp. (A &/or B genome)	ga	Banana (plantain)
Gnetum gnemon L.	haginamu	Tu lip
Abelmoschus manihot	ga'ana	Aibika
Saccharum officinarum L	magi	Sugarcane, suga
Saccharum edule Hasskarl	gebia	Coastal pitpit
Colocasia esculenta Schott	ega	Taro, taro tru
Psophocarpus tetragonolobus(L)DC	dugaro	Winged bean, asbin
Dioscorea alata L	hamanu	Greater yam,yam tru
Bambusa forbesii Holttum	koya	Cane shoots as pitpit
Nastus elatus Holttum	konya	Bamboo shoots
Ipomoea batatas (L) Paret	agira	Sweet potato, kaukau
Amaranthus caudatus L	gombo	Amaranth, aupa
Zingiber officinale Rosc	da'asibi	Ginger, kawaware
Manihot esculenta Crantz	ira agira	Cassava, tapiok
Cucurbita moschata Duch ez Poir	Pamkin	Pumpkin
Cucumis sativus L	anumu	Cucumber
Oenanthe javanica DC	songura	Water dropwort
Carica papaya L	popo	Pawpaw, papaya, popo
Arachis hypogea L	pinat	Peanut, pinat
Capsicum frutescens L	sili	Chili, sili
Dicliptera papuana Warb	garubaio	Highlands green/kumu
Zea mays L.	kon	Maize, corn, kon
Rorippa nasturtium-aquaticum	karese	Watercress
Citrus limon (L) Burm f	siforo	Lemon
Citrus reticulata Blanco		Mandarin
Dioscorea esculenta(Lour.)Burkill	gina	Lesser yam, mami
Musa maclayi F Muell		Fei banana
Lagenaria siceria(Molina)Standley	baru'u	Bottle gourd
Ananas comosus (L) Merr.		Pineapple
Cocos nucifera L		Coconut
Mangifera indica L		Mango
Dioscorea pentaphylla L		Five leaflet yam
Eugenia malaccensis L		Malay apple, laulau

Table 2 Food plants harvested from the wild
(All identifications are tentative)

Scientific name	Foi name	Comments
Ficus sp.	hohaia	Edible leaf of tree
Ficus copiosa	haiya	Edible leaf of tree
Ficus pungens	gofe	Edible leaf of tree
Rubus sp.	tinigini	Wild raspberry fruit
Castanopsis acuminatissima	bai	Wild chestnut seeds
Trichosanthes pulleana	saru	Wild cucurbit seeds
Trichosanthes pulleana	ifame	Wild cucurbit seeds
Setaria palmifolia	medore	Wild highlands pitpit
Amaranthus sp	gombo	Self sown amaranth
Physalis sp.	sikaru	Cape gooseberry
Dioscorea bulbifera	kongo	Wild potato yam
Dioscorea alata	kebere	Wild greater yam
Dioscorea pentaphylla		Wild five leaflet yam
Dioscorea sp	gina	Wild yam tuber
	Gini	Small palm shoot
Begonia sp	baitanu	Stems eaten
Alpinia sp.	hinanu magenane	Juice of stems
Amomum sp	hinanu kusabu	Fruits cooked and seeds eaten
Terminalia sp	yumu	Okari nut
Spondias cytherea	kinaio/ginayu	Wild fruit eaten
	Gisinobo	Leaflets of shrub eaten raw
	Amamuiri	Seeds of fruit eaten
Horsfieldia sp.	banamo	Skin of fruit eaten
	meko	Grass shoots
	korefe	Red fruit of vine eaten
	irabai'I	Leaves of large tree
	basiaro	Long vine, leaf eaten
	yaribibi	Creeper. Fruit eaten.
Cyrtosperma sp.	gesa kira ira	Red berries on stalks.
Mushroom	kina katera	Bracket fungi on log
Ferns:		
Diplazium sp. ?	buru	
Cyathea sp.	ba amo	
*Cyathea sp.*bare	Tree fern	
Cyclosorus sp.	tenga	
	Kafane	
Diplazium esculentum	kotabara	Aquatic fern
Stenochlaena palustris	tunane sai	Climbing swamp fern

Comments on foods utilized

Xanthosoma taro and *Colocasia* taro leaves are only fed to pigs.
Breadfruit male flowers, young leaves and flesh between the seeds of fruit not eaten.
Wing bean pods are rarely eaten but seeds, leaves and tubers are used.
Sweet potato leaves are not eaten.
Cassava leaves are not eaten but seeds are eaten.
Pumpkin fruit and leaves are eaten
Peanut leaves are not eaten.
Chili leaves are only eaten by a very few people. (As an adjunct to chili production).

Mulberry leaves are not eaten but the fruit are. (Leaves are used for silkworms).
Only some selections of *Begonia sp.* stems are eaten and their use overlaps with medicinal uses.
Watercress was not considered highly palatable and is not widely used.
The *Terminalia sp* was not considered good quality either due to the species or selection available.
Basella rubra was grown and enjoyed by at least one family.
The choko tuber had been tried and was disliked therefore it was not used.
"Tu lip" seeds are mostly eaten by children. As seeds explode if just roasted, the tip is first removed. (In other areas, seeds are often squashed, then fried.)
Coconut - a few palms occur and bear an occasional nut.
Mango- a few trees occur at Hegiso (and Pimaga) and bear some fruit. The high and continuous rainfall would be detrimental to prolific flower production or good fruit production in the Kutubu area.
Malay apple- these grow wild and are also planted. They are grown from cuttings of mature wood with the leaves remaining on cuttings. Fruiting is seasonal.
Both smooth and spiny leaved types of pineapple occur. This is significant if artificial stimulation of fruit production is considered.
Citrus leaves are used as a tea substitute.

Plants related to/or edible and NOT used

Coix lachryma-jobi	korokana	Job's tears
Commelina diffusa		Wandering Jew
Alocasia macrorrhiza	ira I	
Musa sp.	mega	Wild seeded bananas
Caryota rumphiana	kawari	Shoots and sago not used

Additional notes on foods harvested from the wild

gisinobo - a small bush with no flowers or fruits known. The leaflets are eaten raw.
amamuiri - a large tree with alternate leaves and fruits borne in the axils. The seeds of the fruit are eaten. Fruiting is seasonal about Aug/Sep/Oct.
banamo (kibu) - the fruit is about 15 cm across and orange. The flesh of the fruit is eaten. It is seasonal about March/April. A similar plant has a hard fruit that is not eaten.
kinaio(ginayu) - a large tree (40m high) with opposite leaves and oval yellow fruit 5-8 cm across and the fruit has an irregular surface. The fruit is eaten after it falls. The fruiting season is near the end of the year. The seeds of fruit with superior taste are planted. It will not grow from cuttings. The leaves are alternate with leaflets pinnate and weakly toothed. The leaves are eaten. Considerable variation is said to exist between seedling trees. I think this tree is *Spondias cytherea* Sonn. (Syn *Spondias dulcis* Forst.) If so, it would be worth trying propagation by cuttings using mature wood cuttings with the terminal leaflets retained and dipping the cuttings in rooting hormones.
korefe - a vine with 3 leaflets. Fruiting is seasonal about mid year. The red fruit about 10 cm across is eaten. The leaves are not eaten. From names in Petr , this is possibly a *Cissus sp.*
yaribibi - a creeper. The fruit is about 3 cm across and borne in clusters. It bears early in the year and the fruit is eaten raw.
hinanu kusabu - hinanu is the Foi term for a Zingiberaceae. This species an *Amomum sp.* has tightly clumped fruit borne near the ground. The fruit are green but turn yellow when ripe. The fruit is cooked and the seeds eaten.
tinigini - a red raspberry with long brown thorny vine and simple leaves dark green on the upper surface and pale brown on the lower surface. The fruit is eaten. It is seasonal.
gesa kira ira - an Araceae (taro family) with horizontal leaf blade which has very long lobes (25cm) and the petiole joined to the edge of the leaf blade. It does not have a distinct marginal vein. The petiole has small blunt thorns along its length. The lily type flowers develop red berry like fruits that are cooked and eaten.
ifame and saru are probably both *Trichsanthes spp.* probably *Trichsanthes pulleana.*

gina - a yam with round leaves like a potato yam, but no bulbils. The vine has thorns at the base and an irregular shaped tuber. The vine winds around the support in a left handed direction.

tunane sai - sai is the Foi word for leaf. The tunane plant is a vine type of climber that attaches to trees. If Petr's identification of a Davalliaceae applies, it is a fern but I couldn't locate any spores.

CULTIVARS

Sago is the staple food. No attempt was made to estimate intake, but J.Weiner's rough estimate was that it constituted 75% of the intake.

34 cultivars of sago were recorded. These are listed in tables 4 & 5 with some general characteristics listed. It would be a priority job to more precisely specify trends and distinctive aspects of these cultivars. Two cultivars are considered in Foi mythology to be autochthonous. These are Kagia and Aburu. As Kagia is the only cultivar that grows readily from seed, it can spread and grow more easily. All other cultivars are planted from suckers. Twelve cultivars occur commonly around the banks of the Mubi River in the Hegiso area. Another 22 cultivars are known to, grown by and utilized by the Hegiso people in other areas where they have sago.

Table 4 Sago cultivars along the Mubi River
(In approximate order of frequency)

Name	Thorns	Leaves	Bark/fibr	Ht/Diam.	Sago clr	Maturity	Suckers	Imp
Honamo				fat	white	slow		best
Yora			tough	tall, fat	yellow	early	many	second
Bisu	long			narrow	brown	early	many	
Karu'u	short		tough		red			
Sau	short	v thin, long		fat	white			
Nei	none				white			
Miare					red			
Kagia	long		v tough		red			poor
Yugi	long	long	v tough		yellow/red			
Huubi				fat	white			
Wabari					red			
Sesa'abo	few			v tall	white			

Table 5 Other sago cultivars utilized by the Hegiso Foi

Aburi	short or medium thorns; grubs
Fana	
Kwe'eraro	hard bark, red, good taste
Hebo	
Igiba	red or white, thorns
Gage	like Kagia
Ibutau	
To	like Kagia
Bare	medium thorns
Kenege	very large, tall, seasonal thorns

Fana'iu	
So	smooth leaves
Gininimu	
Wasego	
Enemano	
Farabo	
Ikina	
Yamo	
Hai	
Sgewi	no thorns; "like coconut"
Gosega	
Koofe	like Karu'u; little sago; short midribs

All sago is owned. The unit of ownership is a plant (kui) consisting of a clump of palms and suckers (sometimes 10-20). Normally the clumps are grouped into a sago grove (kuikara) owned by the same man. Most married men have several groves in different localities that have either been inherited or planted by them. For distribution among children it is easier to allocate groves rather than plants. The number of plants and groves is by no means evenly distributed amongst men, families or clans. Often someone may be given permission to harvest an individual palm, but he is not given ownership of that plant or any other automatic access to that grove. Although the primary food product from palms is the sago starch, all palms are partially used for sago grubs, pig forage and less commonly the terminal shoots. The use of this heart "cabbage" of the palm, has been discouraged by the Dokta Boi.

***Setaria* pitpit (wasia)**

Cultivars

ibatu'u	- red leaf sheath - introduced from Tari
senagi	- green leaf sheath – traditional

Probably because sago and *Setaria* pitpit comprise 2 of the main traditional non-seasonal foods of the Foi, they are considered "food" by the Foi and are used in translating general terms for food in the Foi translation of the Bible.

***Rungia* green (sona)**

Cultivars - tuba - long leafed

sa'ara	- yellow mid vein in the leaf
iburi	- large leaf, green/yellow mid vein
namika'u	- dry leaf and variegated

Although *Rungia* has previously been recorded as the main green utilized by the Foi, it has now undoubtedly been replaced by Choko tips.

***Xanthosoma* taro (yafane)**

Only one cultivar of this taro was introduced, with the European settlement at Lake Kutubu, probably about 1938-1940. It has been readily adopted and largely replaced *Colocasia* taro. The cultivar grown has green petioles.

Choko (Sogasai)

The Foi are pragmatic and say their main reason for adopting choko tips as their main green since European contact is that it is more easily grown and therefore more readily available.

Rungia is still considered to be better tasting. Only the green-fruited cultivar of choko was cultivated or known.

Breadfruit (ugi)

Cultivars	Fruit	Fruit size	Fruit no.	Seed size	Seed taste	Maturity
Namiyu	white	large		large		
Baro'ore	soft skin	large	many	large	sweetest	
Yiyebu	borne at angle					
Afafa	soft skin	long				
Abeto'o						ripens quickly
Kiuyamare	white	long & large		large		
Fagiramu'u	white					
Kogohae	round	small				

Only seeded cultivars of breadfruit occur in the area. (on nutritional grounds they are preferable to seedless). No noticeable variations. in either tree vigour or time to production of first fruits, had been observed by our informants. Identification of cultivars was based predominantly on fruit characteristics and they said it was not easy to identify a cultivar based on observing a seedling tree only. An intelligent guess could often be made because of the proximity of the seedling to a mature tree of known cultivar. Vegetative propagation (which is normally by root cuttings elsewhere) was not used to maintain or select improved trees. Production from seedlings was considered to be fairly uniform to type.

Marita pandanus (abare)

Cultivar	Fruit colour	Fruit shape	Comments
Wasa'a	Red	Long	
Sarawi	Black but red when ripe		
Weyu	Yellow		
Mo'a	Yellow	Long & flat	
Haga	Black but red when ripe	Large	Large "pits".
Faro	Yellow with red markings		
Eraro			
Tamiao			Grown at Pimaga
Usi			Doesn't come up well
Koya'a	Half yellow		
Fa'u	Black to lighter	Short	
Sona'ai	Black but red when ripe	Long	Small "pits"
Warayo	Black but red when ripe	Long	Small "pits"-similar
Korofe	Black but red when ripe	Long	Small "pits"
Yo'ora			
Mumani			

Identification of marita pandanus cultivars depends on a number of characteristics of the tree. These include aspects of the roots, leaf colour and size, amount of branching, bark characteristics and the relative occurrence (or resistance) to a couple of the fungal diseases on the leaves. (But not the leaf spot).

Banana (ga)

Cultivars	Fruit characteristics
Bohabo	Long yellow sweet fruit
Nami ka'a	Short "like ribs"
Dobe	Very long fruit
Ugi	Round "like breadfruit"
Hoha'are	Short with white petioles
Doro	Short fruit
Urebi	Short, green, cooked in ashes.
Me'o	Large
Amamuga	Sweet
Bununubo	Red sweet
Mahagi	Short, sweet, small
Mara	Green to yellow
Bebibubu	Like "urebi"
Kanima	White, short
Weria'o	Very long
Di'u	"rare"
Tayo	Like Mara
Ginigi	Like bununubo

Other triploid (probably AAA genome) Cavendish type bananas for eating as sweet ripe fruit had been introduced since European contact but they have not been given cultivar names. They were simply called "sweet banana". They were eaten. No attempt was made to key out cultivars. Many were obviously diploid although evidence of B genome components were present in some cultivars. A cultivar claimed to be the same as "Java" in the Gazelle, was called "Kerema" due to its immediate source. A fei banana had been introduced from Bosavi and the fruit were used by its owner.

Gnetum gnemon Tu lip tree (Haginamu)

Cultivars	Notes
Gibi	red young leaf
Mai	small long leaves, branch yellow
Siaro	small whitish leaves
Kumu	large flat green leaves

Seeds of these tu lip trees are self-sown and seedlings transplanted. Soil fertility has more significant influence on tree size etc than variations due to cultivars. The two small leaved cultivars are considered a nuisance to harvest but otherwise few distinctions are made between cultivars regarding taste.

Tu-lip

Choko tips

Sugarcane (magi)

Cultivars	Skin colour	Skin texture	width	Internodes	length	Preference
abayu	red	soft	fat	short	longest	first
sona'ae	white	hard but strips	medium	long	long	second
suibo	striped	hard but strips		long	long	third
habora	white	soft			long	
ka'amu	red	soft			long	
hefa	yellow/orange	strong				
kogame	yellow/orange	strong				
sabe	red leaf					
ao	red to white	soft			second longest	
oro	yellow/white	strong				

No observable difference, in amount of sugarcane borer damage between cultivars, had been observed by informants.

Saccharum pitpit (gebia)

Cultivars	Comments
Boge	most preferred because of taste & second to mature
Kaenasu	tallest cane and fattest
Karage	earliest to mature but not high ranking for taste
Tindi	
Sabi	
Karuagamage	
Eraro	last to mature
Gai	yellow stalk and tall
Fayaro	
Ureri	

All cultivars in the Foi area are seasonal. (Occasional daylength neutral cultivars are known in other areas of PNG.)

Winged bean (Dugaro)

Cultivars	Comments
Sabia	
Eraro	
Iragoai	Like sabia but poorer
Giri	Red bean inside
Berega	Short pod and rounder in cross section
Wararo	

All cultivars apparently suffer considerably from false rust (*Synchytrium psophocarpi*) especially on the pods, and also by pod borer. No distinct differences had been noticed between cultivars for these characteristics. Tuber formation was only moderate in all cultivars.

***Colocasia* taro (ega)**

Only one cultivar with a dark blue petiole was observed and it was not widely grown. No attempt was made to solicit information on other cultivars. Foi tradition maintains that taro was a dominant crop before sago. *Colocasia* taro has been largely replaced by *Xanthosoma* taro. The reason given being the relative amounts of damage by taro beetle. Ease of cultivation has probably been a significant factor. A feral *Colocasia* taro similar in appearance to the cultigen was not used except for pigs, probably due to its oxalate content.

Bamboos

A large number of species and/or cultivars were maintained for cooking, carrying water, and *Campnospermum* tree oil etc but only one cultigen was traditionally eaten. Another cultigen with edible shoots had recently been introduced, from the Wage River.

Sweet potato (agira)

The cultivar hai'i was considered to be the traditional cultivar. Introduced cultivars such as "wanmun", were grown by a few people.

***Oenanthe* kumu (songura)**

One cultivar was considered to be suitable for dry garden sites and another for moist sites.

***Amaranth* (gombo)**

Of the cultivated species two cultivars were recognised:

Waria	red colouring on the leaf
nami ka'u	pale coloured leaf

Five leaflet yam

Cultivar	**Comments**
ko'omeano	very long tuber
sisu'u	very large round tuber
kabiu	medium sized tuber

Cassava

Cultivar	**Comments**
Ma	red petiole and wide leaflets
?	orange petiole and wide leaflets
gemia	orange petiole and distorted leaflets and yellow flesh

Production techniques

Williams in his monograph on the Foi of the Kutubu area spoke disparagingly of their gardening ability. The level of technology and management put into cultivation of food plants on the production side is, in comparison with other areas of PNG, simple.

But the technology and competence displayed in harvesting and processing of food, particularly sago, is of a very high level. The technological competence of the Foi can also be seen in their canoes, fish traps, men's houses, harvesting of *Campnospermum* tree oil, tool production and other facets of their society. Therefore the simplicity of their food production strategy is probably not incompetence but deliberate choice. The distinctive features of their production techniques are probably ease and simplicity; a fairly discriminating ecological understanding and a high level of management of the overall production system, rather than the individual components.

Sago production

Sago is planted from suckers. A sucker from a selected cultivar is removed by severing it from the parent plant with an axe. But before this is done, the root from which the sucker is growing is checked to see that it has reached an advanced stage of maturity and is well lignified. It is also checked to see that fresh roots are being produced from the base of the sucker. A suitable sucker probably has fronds 3-4m long and is about 1.5 years old. The sucker is then simply carried to a suitable new site and planted in a hole about 30cm x 30 cm x 30cm. Any undesirable vegetation in the near vicinity is removed. The plant then receives practically no further attention until a palm is harvested in 14-20 years time.

Several informants estimated that approximately 50% of transplanted suckers died. The suggested reasons were either choice of an immature sucker or climatic variability, especially drought. (Because of a general lack of awareness of disease organisms by PNG farmers, these should not be ruled out.) If a seedling palm, as opposed to a sucker, was available for transplanting, it was considered to be equally suitable. Apart from walking time and site clearing, if needed, the work involved in planting a sago took about 10 minutes.

The type of site chosen was just marginally too damp for gardening of annual vegetables, but not permanently inundated. Sago palm and *Campnospermum* oil trees inhabit the same ecological niche.

Maturity of the palm and readiness for harvesting was normally determined from the accumulated experience of that particular palm plus the size - especially height, of the palm. If there was genuine doubt about the palm, and this occurred particularly when a shortage of palms encouraged early harvesting, then a test hole was cut in the trunk. This needs to be resealed to stop sago grubs.

Normally there is a division of labour with sago palm harvesting. Men normally fell the palms and remove the bark. Women pound, wash and sieve the sago. But many woman do fell palms and remove the bark. Men only pound and wash sago, under extreme circumstances. As well, if the husband is not available, it does not seem difficult to find a man to fell palms and remove the bark. Thus male absenteeism is probably not a significant constraint for this aspect of food production.

A mature palm is felled. Providing flowering has not proceeded to the stage of actual seed set, the palm is still considered useable.

A hole about 20cm x 20 cm is cut into the trunk of the palm at the top near the base of the existing fronds to allow sago beetles access to this portion of the palm. Some fronds may be removed for building materials or for construction of the sago washing apparatus. Then a portion of the trunk is opened up for pounding for sago. The fibrous sheath bases are stripped off. A ring

is cut in the bark around the trunk dividing off a 45-60 cm length of trunk. This is split open at the top and the strips of bark on either side peeled back, against sticks, which have been pushed under the trunk. This produces a well-sprung seat on which the woman sits to pound the pith. At Hegiso, the sago pounding adzes still have traditional stone heads. The pith of the palm is reduced to shreds by pairing away thin layers of the fibrous pith with the adze head. If fibrous lengths of the material flake off, these are chopped up with either an axe or a bush knife. Each woman has her own sago pounding songs that are sung during this operation.

When enough pith has been shredded to fill the woven bark bag that is available, this portion is taken for washing. Water availability normally determines where the sago is washed. If a river or creek is nearby the shredded pith is carried to it. Otherwise, a water hole is dug near the palm. The sago washing apparatus is constructed by supporting the midrib base portions of two sago palm fronds on a framework. The starch is beaten, washed and sieved out of the fibre. The starch settles out in a sedimentation (winimabu) trough made from the spathe of a limbom palm.

Settled starch is put in a net bag (arera) platted from bark, then carried to the house and hung up. Dirty washing water discolours the starch.

The diameter of the palms observed being processed was between about 45-60 cm. Therefore from 45-60cm lengths of the trunk a volume of about 8300 cubic centimetres of pith was being processed per session. Langlas gave a starch yield of 20-27kg for the Foi. For many families processing was done twice a week (Wed & Sat) and the starch used up between those days. No accurate timing was done, but the time to shred that section of the trunk was probably between 1-1.5 hours. Washing etc may take 1.5-2 hours if the apparatus was already constructed. An average palm trunk probably had sufficient trunk for 6-8 "days" pounding. Thus a trunk may last a family 3-4 weeks. A grub harvest could normally be taken after 2 months.

The base of the sago normally has a more fibrous pith than further up the trunk.

All sago palms can occasionally have a poor taste (giniwa), "as if it had sand or gravel inside". This, according to informants has no apparent cause as they could not correlate it with cultivar, soil type or weather conditions. They said it was more common in very fat and large palms but sometimes only affected portions of the trunk. When trunks like this were found, they were left for sago grubs, but they normally gave a poor grub yield.

An additional significant management technique was observed. The initial spacing of sago plantings was measured to be between 7-10m (but is irregular) between plants. After suckering, suckers can occur at a distance of up to 5m from the base of the parent plant. This can produce overcrowding and poor spacing. This would result in delayed maturity and poor production from palms. To correct this poor spacing, a hole is simply cut in the trunk of some medium sized palms. This allows the entry of sago beetles and their activity kills the palm sucker. Death of the growing point is observed, then after this, the palm is opened up to harvest the grubs for eating. Other young suckers of the same plant, are not killed by this process. Therefore the process controls plant spacing, and adds to the supply of edible grubs.

Production techniques for other crops

Of the other food crops commonly produced, from the production technique point of view, they can probably be considered under the groups:

1. Perennial, mostly seasonal crops;
2. Short term annual crops gardens;
3. Longer lasting type crops in semi permanent sites.

1. Perennial, mostly seasonal crops

These include breadfruit (ugi), marita pandanus (abare), tu-lip tree (haginamu), bamboo, (konya), pawpaw (popo), lemons (siforo), *Saccharum* pitpit (gebia) and probably some *Ficus spp.* and *Castanopsis* nuts (bai).

Both breadfruit and tu-lip are largely self sown by seeds, and seedlings are transplanted. A number of trees are therefore simply owned because seedlings grew on patrilineal land. Where transplanting occurs the distribution tends to be in relation to settlement and communication routes. Therefore these trees are more common near current house sites, optional house sites, and along rivers and tracks. Little management of the trees is exercised apart from transplanting and harvesting.

Where land is owned beside the road, marita pandanus trees are planted there as it permits easy access and minimises weeding. Marita are also sometimes planted in suitable sites near creeks and in depressions close to old garden sites. Marita are mostly planted using suckers growing near the base, but cuttings from branch ends are sometimes used.

The phenology of these seasonal crops is important

Breadfruit (ugi)	Season Sep-Oct
Tulip (haginamu)	Season leaves Oct -?
	Fruit Jan-?
Marita pandanus (abare)	Fruiting Oct - Jan
Saccharum pitpit (gebia)	Feb - Mar
Castanopsis nuts (bai)	?

Time from planting to first harvest was not determined. This lag time would be important both for regular plantings and for any programme to introduce new cultivars to extend the season.

2. Short term annual foods

These include *Setaria* pitpit (wasia), winged bean (dugara), *Rungia* green (sona), aibika (ga'ana), ginger (da'asibi), traditional banana (ga), sugarcane (magi), bamboo cane pitpit (konya), sweet potato (agira),*Colocasia* taro (ega), and sometimes amaranth (gombo), cucumber (anumu) and corn (kon). *Heliconia sp* is often planted nearby for use as wrapping leaves for mumus. (Food cooked in earth ovens)

These plants are grown in a mixed planting bush fallow shifting cultivation system in almost primary rainforest. They are distributed on tracks branching off the main through road. Clearings are made strictly on an annual basis by clearing the undergrowth, cutting only restricted numbers of trees and removal of some logs as firewood. There is limited burning around the bases of the trees that they do not wish to regenerate. Spacing is random and opportunistic. Beans are put in the ashes near stumps which will serve to support a trellis; sweet potato and *Colocasia* taros are dibbled in the areas between the roots where there is sufficient depth of soil. *Setaria* pitpit is spaced between roots and sugarcane stalks are planted in pairs. This paired planting permits easier strapping and it also illustrates the Foi association between pairs of sugarcane stalks and the marriage relationship. After one year, the rainforest re-growth that has already begun, is allowed to reclaim the garden site. Weeding is only rarely and casually done as required. The soil is not dug.

The time of preparation of these annual gardens is not distinctly seasonal and is more a personal preference than a culturally proscribed pattern. Time of preparation and planting can occur throughout the year but is more easily achieved between August and March when the weather is drier.

There is a sexual division of labour. Men cut the trees, clear the larger undergrowth and assist with burning. They plant *Colocasia* taro, *Xanthosoma* taro and bananas. Women heap up smaller debris and burn it around the stumps and plant pitpits, greens etc.

Occasionally a small amount of *Xanthosoma* taro or choko is planted in these gardens but it is not the main location for them. As well, *Amaranthus*, bamboo and cucumber are often planted in a smaller garden close to houses along the river if such a site is available. This is considered a more suitable ecological niche for them.

In one newly planted garden about half the area was planted. The planted area was about 170 square metres. It contained:

Setaria pitpit (wasia)	169 clumps
Rungia green (sona)	31 clumps
Sugarcane (magi)	10 clumps
Winged bean (dugaro)	4 plants
Colocasia taro (ega)	4 plants
Banana (ga)	3 plants
Aibika (ga'ana)	3 plants
Xanthosoma taro (yafane)	3 plants
Sweet potato (agira)	2 clumps
Choko (sogasai)	2 planted
Ginger (da'asibi)	not yet planted
Bamboo cane shoots (koya)	1 large clump

3. "Permanent" annual crops garden

The main crops grown on higher land on the hill between Hegiso and Lake Kutubu were *Xanthosoma* taro (yafane), choko (sogasai) and pumpkin. There was also some bananas, marita pandanus, sugarcane and *Colocasia* taro. But the general impression was of a more or less permanently maintained jungle of *Xanthosoma* taro, choko and pumpkin. Younger gardens had some *Setaria* pitpit remaining. Some of the older gardens had been on the same site for over 12 years, with harvesting being the main activity. Gardens were not formally replanted but *Xanthosoma* corms were replanted after harvesting. The level of soil fertility was claimed to be the main reason for growing these crops on this site. As both the main crops are significantly shade tolerant they could have been included on the fringes of mixed forest gardens, but this would undoubtedly have involved greater work imputs. *Xanthosoma* taro comprises a significant and regular energy supplement to sago in the diet.

Yafane or *Xanthosoma* taro

PEST AND DISEASE SUBSYSTEM

Components:

Diseases noticed included:

Leaf spot on sago
Leaf spot on marita pandanus
False rust on winged beans
Soft squashy rot in unripe marita fruit
Mycosphaerella leaf spots on bananas
Black cross fungus on bananas
Elsinoe scab in sweet potato
Black leaf mould on marita
Leaf spot on cassava
Sooty mould on mango
Sooty mould on citrus
Sooty mould/tar spot ? on breadfruit
Leaf spot/rust on breadfruit
Leaf spot on five leaflet yam
Diffuse leaf spot on Malay apple

Insect damage noticed included:

Borers in stems of marita pandanus
Borers in sugarcane
Taro beetle damage
Large blue weevil (gayamo) eating leaves of potato yam, tu-lip, *Ficus copiosa* and kotabura aquatic fern
Grasshoppers eating breadfruit leaves
Oribius weevils eating aibika and common bean leaves

Insect and disease mentioned but not observed.

Pod borer in winged bean
Insects (fruit fly ?) in edible mushrooms

Other disorders of unknown etiology:

Wrinkled tips of pandanus leaves
Gravelly texture is sago (giniwa)

Insects that were captured for food but which are also crop pests:

Grasshopper (giraru)
Bug -Hemiptera, Heteroptera - (hiruwari)
Butterfly - larvae - (gikoba konami)
gayamo - blue weevil
yuruwari - Hemiptera - bug
ira hunga - tree grubs -Longicorn beetles

Insects cultivated:

Sago grubs - 3 stages recognised and utilised

- hunga yarao -pupae ?
- hunga giwa - larvae ?
- ibu huupi - nearly adult

(Silk worms for silk food.)

No attempt was made to assess the importance of these pest and disease problems. Nor was the investigation systematic, so no attempt was made to look for nematode damage etc. Some of the diseases have known levels of horizontal resistance available eg *Elsinoe* scab, so are probably manageable. No *Phytophthora* blight was observed in *Colocasia* taro, but it would be of interest to know if it had in any way contributed to the decline of taro. As the leaf spots in sago and marita don't appear to be recorded in Shaw's list of diseases in the country, it would be of interest to identify them for posterity. The leaf spot in marita is conspicuous if not important. Also it is of concern the way the soft rotting condition in marita fruit on the tree was regarded as a fact of life, rather than a condition with a cause that needs to be understood and if possible reduced. The fruit were simply cut and abandoned without any occurrence or complaint being recorded.

SYSTEMS BEHAVIOUR

Two principle factors of the Foi food production system make the management decisions more complex. The first is the seasonality of production of many of the crops and the second is the long lag time between planting and harvest of the perennial crops.

Sago, with a production time of about 14 years, necessitates either accurate predictions 14-15 years in advance, of family requirements by individual men, or some method of adjusting for individual miscalculations. It could be some method of tolerating under supply, of permitting oversupply, or a social system capable of compensating for individual variations.

Sago can become available by 4 different methods:

1. Growth of plants.
2. Reproduction of clumps.
3. Inheritance of groves.
4. Gift of harvestable palms.

From informant descriptions of sago growth, it appears that auto regulation of growth of a clump is maintained. (This is probably through some mechanism such as competition for nutrients, or source/sink relationships for carbohydrate accumulation). A plant with between 10-20 suckers develops one dominant trunk that develops at the expense of others. Therefore it does not normally occur that 2 or 3 trunks of the one palm reach maturity close to each other. As a result, from a clump, sago is acquired basically by growth, not reproduction. A man with a certain number of clumps produces sago at a fairly constant rate.

An increase in sago production can be achieved by an increase in sago clumps, presumably well spaced in an original grove or in a new grove. On a population/society basis the increase in sago production would need to match the population increase to maintain the status quo. ie a 3% population growth rate would require a 3% increase in number of sago clumps. On a population basis, given that sites suitable for sago are available, this would be an easily achievable goal.

But sago clumps and groves are individually owned on patriclan land. Therefore an individual man must match the individual future requirements of himself and his sons by present plantings. He could plant regardless, and if he either had few sons or didn't have children he would ultimately have surplus sago. Under traditional Foi inheritance it is not considered possible to give away clumps as they are a perennial crop growing on individually assigned patriclan land, and this would conflict with land tenure patterns. The alternative is to give people permission to harvest a palm without acquiring ownership of the clump. This in fact occurs.

An old man in Hegiso has the following palms nearly ready to harvest:

Grove 1	
	1 Sau
	10 Karu'u
	2 Honamo
Grove 2	
	2 Yora
	1 Honamo
	9 Karu'u
Grove 3	
	2 Nei
	4 Karu'u
Grove 4	
	4 Karu'u
Grove 5	
	9 Karu'u
Grove 6	
	3 Karu'u
	1 Honamo
	48 palms = 4 years supply

As well he has recently given away 14 palms, although sometimes he has received compensation in money or pigs. (Figures per favour J Weiner).

The other option to planting a surplus is to under plant. One informant, the youngest of several sons, found himself in the situation where he inherited no sago clumps because the older sons were first allocated sufficient clumps to satisfy their requirements. (The inheritance details and allocation method obviously warrant further research by the anthropologist). This man's response to this situation was to rapidly establish his own clumps and groves. Nevertheless, due to the lag time of 10-14 years he still has to find a source of sago food during this time. That Foi society somehow manages their sago groves with a deal of precision is perhaps indicated by the fact that no sago palms in flower could be observed either from the air or from the ground. A sago palm in flower would indicate a palm surplus to requirements. An alternative to letting a palm flower is to fell the palm for sago grubs. No example could be found of a good quality sago palm being deliberately felled for grubs. Conversely, there seems to be little evidence that sago supplies for the population, are regarded by Foi as inadequate, despite individual inequities. Figures of palms harvested, given away and planted are being compiled by J Weiner. At least from a few casually selected inquiries it appears that most men maintain a replanting programme, as well as harvesting.

Individual gifts or exchange of mature palms for harvesting occurs frequently. Often convenience is the main factor. The palm in question may be more accessible or conveniently located near one family residence than another. So a gift or exchange is made and the other person permitted to harvest the palm.

One informant had 17 places (kiukara) with sago planted. Seven of these were at Aimo which is located at a considerable distance. In the last year he had cut 6 palms and planted 3 additional clumps. If it were possible, it would be invaluable to get some type of an estimate of potential sites for sago groves.

Options and constraints

Residence at Hegiso normally is based on 2 houses. One is the village line house consisting of a sleeping space in the men's long house and an adjacent women's house. The other residence is a bush house often located along the river and in proximity to sago groves. A system of locating the bush houses at alternate sites near different sago groves exists, but I didn't understand the pattern. The bush houses are at defined locations, generally readily accessible by road or canoe and should not make a malaria control programme impractical. But the time spent in travelling between sago groves, bush gardens, mountain gardens and service facilities (church, clinic, council work parades etc) was not assessed. Travelling distances (except for hunting and to Aimo) did not appear to be a limiting constraint. The Foi week is defined or programmed by external organisation.

Sunday	- church activities
Monday	- council work day
Tuesday	- business day - chilies, cattle or silk
Wednesday	- sago processing.
Thursday	- school, clinic or mission
Friday	- school, clinic or mission
Saturday	- sago processing

Who has instituted this weekly programme or how it is enforced was very difficult to determine. It appears in reality to be oppressive and undesireable. The programme restricts time available for hunting, foraging, fishing, supplementary gardening and a number of activities that are normally considered important adjuncts in a sago based diet. At least one lady was observed going to start pounding sago at 4 pm on Monday after council work parade. The other non-seasonal staple food supply, is from the taro/choko gardens located in the hills over 1 hours walk away.

Follow up

The following suggestions are things that could be followed up in the Foi area.

1. All information presented in this report would need to be checked as it was collected over a very short period.

2. It would be an advantage to quantify several aspects.
   2.1 Pig population, and impact
   2.2 Sago yields per palm, cultivar, man-hour, area etc
   2.3 Time and labour inputs
   2.4 Travelling distances between gardens, groves etc
   2.5 Approximate production from different components of the food production system, including seasonality
   2..6 Land availability of different types

3. Descriptions and identifications are needed:
   3.1 The wild edible food plants need to be sent to Botanists for identification.
   3.2 Some diseases need identification - especially leaf spots on sago and marita and soft rot in marita fruit.
   3.3 Many cultivars, especially of sago, need more precise objective descriptions.

4. Social systems:
   4.1 Various aspects of tenure and exchange of perennial food crops need to be clarified.
   4.2 The social (and nutritional) impact of having to beg, buy or borrow sago for 10-15 years needs consideration.

5. Non agricultural:
   5.1 Malaria control programme is needed.
   5.2 The usefulness of pulling grass (along a road that has no vehicles) needs to be reconsidered. Several long term weedkillers may be suitable.
   5.3 The rigidly programmed week needs to be reconsidered.
   5.4 The nutritional adequacy of a basically sago/greens diet needs to be assessed.
   5.5 The cooking methods for sago are more restricted than that recorded for other sago areas.

6. Specific points:
   6.1 Normally kangkong is relished and particularly suits sago swamp areas. The varieties present need to be checked. Normally glabrous non-fibrous cultivars are preferred.
   6.2 The bean production needs to be looked at. Additional cultivars of winged bean may be an advantage, particularly for improved tuber production. Peanut production needs to be considered. Other beans especially yard long bean (*Vigna unguiculata ssp. sesquipedalis*) should do well at this altitude and under the bush fallow system practiced but nodulation would need to be checked. This bean has higher levels of resistance &/or tolerance than other *Phaseolus* beans.
   6.3 Mandarins grow satisfactorily and could be extended.
   6.4 Introduction of some triploid B genome bananas may be justified.
   6.5 If cultivars of breadfruit, marita, tu-lip, or coastal pitpit are available which would extend the season, their introduction would be very useful.
   6.6 Fish ponds near sago groves for cultivating fish, kangkong and providing sago washing water may be justified.
   6.7 As *Colocasia* taro leaves were not eaten this may indicate the cultivars present are high in oxalate. (Normally taro leaves are well liked and are very nutritious.) Introductions of other cultivars could be considered.
   6.8 J Weiner estimates that about 500 people mostly young men, are out of the Foi area (ie 10% of the population). The impact of this on food production would most likely be felt in the annual food crops gardens in the rainforest, where initial clearing is a men's job. (Gardens are not normally fenced.) It should not greatly restrict sago harvesting but may limit replanting. It would be an astute move if young men could be encouraged to establish their sago groves before going out to seek cash employment.
   6.9 Technological improvements to sago processing equipment should not be totally ignored. Light-weight sago pounders are distinctly preferred so their development may have a role. Motorised grinder/scrapers, as chainsaw attachments, may find an application if larger amounts of sago for institutions or commercial sago processing for sale as food, was required.
   6.10 Sago pounding is physically demanding and takes time. In very wet weather it must be a more onerous task than merely harvesting a few tubers. Storable food or conveniently located root crop gardens for very wet weather may make a nutritional and lifestyle improvement.

References

Some descriptions of Foi food production are given in:-

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Chopping the tougher pith with an axe

Placing the shredded pith in the washing apparatus

Carrying washing water in a bowl from the spathe of a palm

Washing the starch from the shredded sago pith

Planting a sago sucker in a hole

Stripping the bark off a fallen sago log

Shredding the sago pith

Squeezing the starch from the shredded pith

The sitting platform onto which sago pith is shredded

The top section of the palm used for cultivating sago

The sago-washing frame made from the base of the sago fronds

A small clump of sago palms beside a creek and the road