GROWING FOOD AT INSTITUTIONS IN THE LOWLANDS

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Many institutions, such as boarding schools, are growing food crops to become self-sufficient for at least part of their food needs. This article is intended as a guide for such institutions and gives information on suitable crops, land use, crop rotations and fallows. The information comes from a paper presented at the 1976 Waigani Seminar. Copies of the paper, which provide further information, may be obtained from the author.

It costs schools and other institutions a lot of money each year to buy food, so many institutions are growing some of their food themselves. There are a number of things that make institutions different from other farmers and these affect the way they must farm their land. The most important of these is that the same staff and students do not work their farm for very many years compared with village farmers. Sometimes the teachers at schools do not know a lot about growing crops and raising livestock; and at teaching institutions there is a break in farming over the long vacation.

WHICH FOODS TO GROW?

The nutrition section of the Department of Public Health (DPH) has made recommendations for a ration scale for boarding schools and other institutions. The scale gives the daily requirements per person of five sorts of food The DPH recommendation and the approximate daily costs are given in *Table 1*.

Only a few institutions will be completely self-sufficient in food production, so the institutional farmer must firstly decide which sorts of foods to grow. At current prices self-sufficiency should be sought in fruits, vegetables, and high energy foods (coconuts and oil palm) firstly, then staples and finally protein foods. Large price changes might alter this. For example, a large rise in the price of tinned fish might make it more worthwhile to produce grain legumes before staples. (For more figures on this see the Waigani Seminar paper)

Fruits.

Most institutions do not grow much fruit apart from eating bananas and pineapples. A list of suggested fruit and nuts crops is given in Appendix 1. It does not take much work to look after fruit and nut trees and they make just as good decorative and shade trees as unproductive trees that are commonly grown around institutional buildings. Seed of most of the crops in Appendix 1 is available from LAES, Keravat, as it cannot be obtained locally.

Vegetables.

A list of suggested suitable vegetable species is given in Appendix 2. The species are given in an approximate order of usefulness (ease of cultivation and food value). Since many of the introduced

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vegetables, such as cabbage and cucumbers, have more pest and disease problems and are not as nutritious as traditional crops, emphasis should be placed on growing more traditional species. The list includes a number of shrubs and trees which are useful because of low labour requirements. There are other traditional vegetable crops, both wild and cultivated, that can be used. Ferns and tree ferns are an example.

Staples.

It is a good idea not to rely on just one staple but to have two or even three staples. This gives a change in a diet. Also if one crop is damaged or destroyed by insects, disease or drought, there is another one to fall back on. For example sweet potato could be ruined by weevil or drought but cassava would still yield a crop. Sweet potato is the staple crop most commonly grown by institutions. However, cassava and bananas give more food for the work needed to grow them. (See Appendix 3). This suggests that more use should be made of these two crops. Cassava can be stored in the ground and is therefore a more flexible crop than sweet potato. This is an advantage where there is a break in planting over the vacation or in dry periods. Its ability to tolerate poor soil fertility and drought is a further advantage. It can survive without much attention which is an advantage for institutions with long vacations. Except for rats, cassava is free of major pests and diseases in PNG . On the negative side, it is not a popular food and is poorer in protein than most other staples. It must be cooked properly to destroy poisons in tubers. Bananas are not very demanding of labour. They produce all year round and can help fill gaps between other crops. Triploid cultivars used for cooking should be grown.

Corn.

The way it is eaten in PNG gives about the same food value for the work needed to grow it as sweet potato. It can also be picked when it is dry and used to make cornflour. This can replace the imported wheatflour that is often used in institutions. See the 1977 edition of *Liklik Buk* on page 93 and 115 to find out how to do this.

If swamp taro (*Cyrtosperma chamissonis*) is planted in swampy areas, land can be used that would otherwise be wasted. Maturity date is very flexible with swamp taro. Sugar cane planted for snacks while working in the gardens may improve work efficiency and allow other popular foods such as peanuts and pineapples to reach the mess.

The data in Appendix 3 applies to institutional conditions which are different from the village situation. For example, taro gives a more favourable return relative to other staples under village conditions.

Protein crops.

Although it is more profitable to concentrate on other groups of

crops before protein crops, it is a good idea to grow some protein food both for diversity in the diet and because the legumes fit into rotations with other crops. Institutions can also have an educational role in promoting the use of protein crops as a means of improving subsistence farmers' diets. Unfortunately all suitable species are propagated by seed which reduces their usefulness in institutions. Seed viability is a problem in some legumes. Peanuts, cowpea and soybean are probably the most suitable species (See Appendix 4). Grain legumes need to be cooked thoroughly to get the most protein out of them.

LAND USE AND ROTATIONS

The following land uses should be considered for institutions:

1. Main gardens. These will be devoted to staples, vegetables, grain legumes and fallows. Reasonably large areas of flat or moderately sloping land are required if the ground is to be mechanically cultivated.

2. Blocks of perennial crops such as coconuts, bananas, oil palm, pineapples, fruit and nut trees, tulip and kagua. These can be planted in land not suitable for cultivation such as in gullies, or on steep hills.

3. Additional vegetable gardens, preferably near the mess. These can be fertilized with ash from cooking fires and compost made from mess scraps.

4. Fruit trees and other perennials around school buildings.

5. Wet areas that can be used for water tolerant plants such as kangkong, swamp taro and watercress.

6. Fences on which climbers such as yardlong bean, winged bean, choko, granadilla and yams can be trailed.

7. Areas from which wild products can be gathered, for example, sago, sago grubs, bush greens and fish.

Mixed cropping.

This is a widespread practice in village gardens and more use could be made of mixed cropping in institutional gardens. Weed control is often better in mixed stands; the combined yields of mixtures are sometimes greater than pure stands of the individual crops; there tends to be greater yield stability; and there may be less pest and disease problems.

Mechanization reduces the possibilities for mixed cropping, but it is still possible with the level of mechanization found. Generally traditional combinations should be followed as these have been proven over time. Some possible combinations are:

Corn with sweet potato or peanuts

Chinese taro *(Xanthosoma)* under coconuts or bananas

Pineapples under bananas, pawpaw, coconuts, pigeon pea or cassava

Corn and rice grown together.

Long term crops that are mix-cropped in village gardens but cannot be mixed with faster maturing crops where mechanization is used can nevertheless be used on hedges and boundaries. Examples are cassava, sugar cane, pitpit, aibika, diploid bananas and winged bean.

Crop rotations. This section applies mostly to main gardens (Land Use 1).

The long forest fallow traditionally used in the lowlands is a very good system giving high yields for work needed. Unfortunately mechanical cultivation is not possible with a long forest fallow.

Where no mechanical cultivation is used, the long forest or bush fallow can be used. But for most institutions, there is not enough labour and mechanical cultivation is needed. So either a grass, a creeping or planted shrub fallow must be used. Two possible rotational systems are suggested below:

System 1.

This is suitable for institutions with limited land resources and which are prepared to use fertilizer on food crops. It lends itself to mechanical soil cultivation and ridging. The rotations followed will depend upon the soil fertility. An example of such a rotation is as follows:

The available land is split into four blocks. Each year two of the blocks are cropped and two are under fallow. Three sweet potato crops and one crop of vegetables and grain legumes are grown every year. A plan is given in Appendix 5 and the operations for one block in Appendix 6. After the second fallow (stage 12), the cycle commences at stage 7 and continues. On poorer soils two, rather than three, sweet potato crops per four year cycle may be taken to maintain long term fertility.

System 2.

This allows more mechanization than using a long forest fallow but not as much as system 1. It does not require fertilizer to maintain yields, but more land is required. After land is opened up from forest it is alternatively cropped and fallowed, say every second year. Another area is cropped and fallowed in alternate years. After a number of crops, yields will have declined and another area is opened up and the process is repeated. The first area goes back to a fallow, perhaps under forest. To help the forest become established again, strips of forest should be left uncleared next to each block. These will provide seeds for the regrowth. When all available land has been used, the original area is opened up again for gardening. Mechanical cultivation cannot be used for the first year's gardens, but should be possible after that.

An example using six blocks is given in Appendices 7 and 8.

Areas required. The calculations for garden areas required are as follows:

For an institution of 250 persons seeking to grow enough sweet potato to provide 1 kg to each person every day of the week for 45 weeks a year, the amount of sweet potato needed per year is:

250 persons x 1 kg/person/day x 7 days/week x 45 weeks/year
= 78 750 kg/year.

If the crops yield 14 000 kg/ha, the area of sweet potato per year is:

78 750 kg/year ÷ 14 000 kg/ha
= 5.625 ha/year.

If two crops are taken from a block each year, each block would need to be 2.8125 ha in area. If land is cropped for 1 year in 6, as in system 2 above, then 2.8125 ha x 6 = 17 ha of land is required to maintain the system.

Role of animals.

In general it is considered that animals do not have a major role in institutional farming although a cattle project as a separate project is a possibility if land and money are available. However, land and capital requirements are very high and it is better to put resources into food crop farming because of the large internal food demand, and a cheap alternative protein source (tinned fish).

Pig and poultry units require large areas of cropping to keep them going or capital outlay to purchase food and are not generally suitable for most institutions. A small pig unit to use mess scraps and garden waste would be a useful project. A fattening project where pigs are brought in at the beginning of the year is more suitable than a breeding project unless mess scraps are produced all year. A typical mess could support about 10 pigs so the contribution to the diet would be small. Small goat or duck projects may be possible in many institutions.

Table 1. Cost of recommended daily food requirements per head per day

Type of food	Daily requirements	Approximate cost. Toea per kilogram	Cost per head per day (toea)
Starchy foods:			
Staple (root crops, sago or bananas)*	2.5 kg	6.5 (e.g. sweet potato)	16
(Rice)	(600 g)	35	(21)
(Wheatmeal)	(600 g)	17	(10)
High energy food	30 g	95 (e.g. dripping)	3
Protein food	150 g	55 (e.g. tinned fish)	8
Vegetables	100 g	17 (e.g. aibika, pumpkin tips)	2
Fruits	200 g	20 (e.g. pineapple, pawpaw)	4
		Total cost (using staples)	33

* Rice or wheatmeal can be substituted for staples.

Appendix 1. Some suggested suitable fruit and nut crops

Crop	Scientific Name	Notes
Pineapples	*Ananas comosus*	Grow well under shady conditions (labour requirements lower and yield not greatly reduced). Somewhat seasonal.
Eating bananas	*Musa* spp.	Use ABB or AAB triploid cultivars. Not seasonal.
Pawpaw	*Carica papaya*	Not seasonal.
Coconuts	*Cocos nucifera*	Very little maintenance if arable crops planted under them. Not seasonal.
Galip	*Cannarium indicum*	Edible nuts produced. Seasonal.
Talis (Java almond)	*Terminalia catappa*	Edible nuts produced. Seasonal.
Okari	*Terminalia okari*	Edible nuts produced. Seasonal.
Aila (Tahitian chestnut)	*Inocarpus edulis*	A leguminous nut tree. Seasonal.
Pandanus	*Pandanus* sp.	Two edible varieties: marita (seasonal) and karuka (not seasonal.
Pau	*Barringtonia* sp.	Seasonal.
Taun	*Pometia tomentosa*	Seasonal.
Guava	*Psidium guajava*	A popular fruit. Not seasonal.
Avocado	*Persea americana*	A rich food, not popular. Seasonal.
Pomelo, lemon lime	*Citrus* spp.	Not seasonal.
Orange, grapefruit mandarin	*Citrus* spp.	
Soursop	*Annona muricata*	A popular fruit. Not seasonal.
Five corner	*Averrhoa carambola*	Use sweet varieties. Not seasonal.
Rambutan	*Nephelium lappaceum*	Seasonal.
Langsat	*Lansium domesticum*	Bears heavily. A succulent fruit. Seasonal.
Mangosteen	*Garcinia mangostana*	Seasonal.
Lau lau (Malay apple)	*Eugenia malaccensis*	Seasonal.

Crop	Scientific Name	Notes
Giant lau lau	*Eugenia megacarpa*	Seasonal.
Mango	*Mangifera indica*	Prefers areas with definite dry season. Seasonal.
Bullocks heart	*Annona reticulata*	Popular in certain areas. Not seasonal.
Custard apple	*Annona squamosa*	Prefers areas with definite dry season. Seasonal.
Bukubuk	*Dysoxylum* sp.	Seasonal.
Breadfruit	*Artocarpus altilis*	Fruit, seeds and young leaves edible. Seasonal.
Jak fruit	*Artocarpus integrifolia*	Seasonal.
Granadilla	*Passiflora quadrangularis*	Not seasonal.

Appendix 2. Some suggested suitable vegetable crops.

Crop	Scientific Name	Notes
Aibika	*Abelmoschus manihot*	Insect pests can be serious.
Tulip	*Gnetum gnemon*	A tree. Young leaves and fruit edible.
Pumpkin	*Cucurbita maxima*	Both tips and fruit edible.
Choko	*Sechium edule*	Tips and fruit edible. A climber.
Karakap	*Solanum nigrum*	Self-sown.
Valangur	*Polyscias grandifolia*	Shrub. Young leaves edible.
Kangkong	*Ipomoea aquatica*	Grows in wet areas.
Chinese cabbage	*Brassica* sp.	
Taro	*Colocasia* and *Xanthosoma*	Leaves edible as well as corms/cormels.
Pitpit	*Saccharum edule*	
Kagua	*Ficus* sp.	A tree. Young leaves and fruit edible.
Russian comfrey	*Symphytum asperrimun*	
Cowpea and yardlong bean	*Vigna unguiculata*	Other leguminous bean can be used as green vegetables. Leaves also edible.
Sweet potato	*Ipomoea batatas*	Leaves edible as well as tubers.
Cassava	*Manihot esculenta*	Young leaves edible. Must be cooked for at least 15 minutes to destroy poison.
Aupa	*Amaranthus tricolour*	
Pepenge	*Amaranthus gracilis*	Self-sown.
Salat (water cress)	*Nasturtium indicum*	Grows in wet areas.
Basella (Ceylon spinach)	*Basella rubra*	Staking needed for best results.

Appendix 3. Comparison of various energy crops

Crop	Average yield Kg/ha (1) (2)	% edible portion	Energy value. Calories/ 100 g edible portion (3)	Labour requirements. Man-day/ha/ crop or year (2) (4)	Calories/ ha/crop or year (x 10^6) (2)	Calories/ man-day (x 10^3)
Cassava	22 000	80	146	180	25.7	143
Bananas (5)	10 000	46	94	75	4.3	58
Sweet Potato	14 000	80	117	280	13.1	47
Corn	2 300 (6)	100	270 (6)	140	6.2	44
Yams	12 000	80	105	350	12.6	36
Chinese Taro	8 000	80	104 (7)	220	6.7	30
Rice	2 000 (8)	65	360	220	4.7	21
Sago	6 000 (9)	100	362	1200 ? (10)	21.7	18
Taro tru	3 500	80	104	250	2.9	12

1. Average long term yield for PNG lowlands for institutional conditions. Presumes a high yielding variety and moderate soil fertility.
2. On a per crop basis except for bananas where it is per year.
3. World Health Organization figures.
4. Does not include clearing, soil cultivation (except for necessary ridging/mounding), peeling or hulling. Includes transportation to mess.
5. Triploid cultivars.
6. Fresh corn as eaten in PNG
7. Taken as the same for taro tru.
8. Winnowed paddy. Hulling required before consumption.
9. Waterfree starch.
10. An estimate for processing wild stands.

Appendix 4. Some suggested suitable high protein crops.

Crop	Scientific Name	Notes
Peanuts	*Arachis hypogaea*	Always popular.
Cowpea	*Vigna unguiculata*	High yielding if insects are not too serious. Yields poor in wet weather.
Soyabean	*Glycine max*	Seed storage is a problem.
Yardlong bean	*Vigna unguiculata*	Staking required.
Pigeon pea	*Cajanus cajan*	Grain yield often low because of insect attack.
Winged bean	*Psophocarpus tetragonolobus*	Labour requirements relatively high.
Mung bean	*Vigna radiata*	

Appendix 5. System 1. Plan of rotations

Year	Block 1	Block 2	Block 3	Block 4
1.	Sweet potato			
	Sweet potato			
2.	Vegetables and legumes	Sweet potato		
	Sweet potato*	Sweet potato		
3.	Fallow	Vegetables and legumes	Sweet potato	
		Sweet potato*	Sweet potato	
4.	Fallow	Fallow	Vegetables and legumes	Sweet potato
			Sweet potato*	Sweet potato
5.	Sweet potato	Fallow	Fallow	Vegetables and legumes
	Sweet potato*			Sweet potato*
6.	Vegetables and legumes	Sweet potato	Fallow	Fallow
	Sweet potato*	Sweet potato*		
7.	Fallow	Vegetables and legumes	Sweet potato	Fallow
		Sweet potato*	Sweet potato*	
8.	Fallow	Fallow	Vegetables and legumes	Sweet potato
			Sweet potato*	Sweet potato*

* Sweet potato crop fertilized

Appendix 6. System 1. Operations in Block 1

Year	Stage	Operations
1	1	Clear and burn forest or grass for gardens.
1	2	Sweet potato crop with corn, etc.
1	3	Sweet potato crop with corn, etc.
2	4	Cowpea, soyabean, pumpkin, aibika, aupa, etc.
2	5	Sweet potato (fertilized) with aibika, cassava, diploid bananas, sugar cane, etc.
3,4	6	Pigeon pea fallow.
5	7	Cut and burn fallow.
5	8	Sweet potato with corn, etc.
5	9	Sweet potato (fertilized) with corn, etc.
6	10	Cowpea, soyabean, pumpkin, aupa, etc.
6	11	Sweet potato (fertilized) with aibika, cassava, diploid bananas.
7,8	12	Pigeon pea fallow.

Appendix 7. The plan of rotations used for System 2

BLOCK	1	2	3	4	5	6
Years cropped	1,3,5	2,4,6	7,9,11	8,10,12	13,15,17	14,16,18
Years under short fallow	2,4	3,5	8,10	9,11	14,16	15,17
Years under long fallow	6-18	7-18; 1	1-6; 12-18	1-7; 13-18	I-12; 18	1-13

Appendix 8. System 2. Operations in Block 1

Year	Stage	Operations
1	1	Clear and burn forest fallow.
1	2	Sweet potato crop with corn, etc.
1	3	Sweet potato-crop with aibika, cassava, diploid bananas, sugar cane, etc.
2	4	Pigeon pea fallow.
3	5	Cut and burn fallow.
3	6	Sweet potato with corn, etc.
3	7	Sweet potato with aibika, cassava, diploid bananas, sugar cane, etc.
4	8	Pigeon pea fallow.
5	9	Cut and burn fallow.
5	10	Sweet potato with corn, etc.
5	11	Sweet potato with aibika, cassava, diploid bananas, sugar cane, etc.
6-18	12	Long forest fallow.

1. An old mango tree gives shade at a high school. Fruit trees provide food and shade, reduce grass cutting and are just as attractive as unproductive trees. But the fruit trees selected must be ones that bear well in that area and are liked for eating (See Appendix 1).

2. Valangur forms a hedge around a Tolai farmer's house. This is a popular leaf vegetable on the Gazelle Peninsula. Traditional vegetables are usually easier to grow, have fewer pest and disease problems.

3. High school girls mound for a sweet potato garden. Sweet potato is the staple food generally grown by institutions. However cassava and triploid bananas give more food for the work needed to grow them. (See Appendix 3).

4. Pineapples, Chinese taro and bananas growing under coconuts. Mixed cropping is a very good system that is widely practised by villagers but not by institutions. Compared with mono-cropping, mixed cropping often gives higher and more stable total yields, and less weed, pest and disease problems.

5. A pigeon pea (Cajanus cajan) fallow. Pigeon pea is a legume shrub. Some system of crop rotations and fallows is required for soil fertility maintenance. Two possible rotational systems using a planted pigeon pea fallow are suggested.