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Potentials and Problems of Income and Employment Generation Through Small-scale Processing of Coarse Grains, Pulses, Roots and Tubers in Sri Lanka

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Introduction

Early cassava in Asia

Sri Lanka is an agricultural country with 52 percent of its labour force involved in agriculture and 31 percent of the total land area under agricultural crops. Total agricultural production constitutes 20 'percent of the annual Gross Domestic Product, of which three fourths covers food crops and one fourth covers the export-oriented plantation sector.

Agricultural production of Sri Lanka is adapted to suite the bimodal rainfall during the year. In the wet *(Maha)* season, the whole island receives rain. In the dry *(Yala)* season, only the southwestern quarter of the island experiences substantial rainfall. Rice is cultivated in both *Maha* and *Yala* in the wet zone where adequate rainfall is received in both seasons. In the highlands other food crops are grown under rainfed conditions. In the dry zone where heavy rains are experienced only during *Maha,* rice is only cultivated in that season in the lowlands, while other crops such as vegetables, coarse grains and pulses are cultivated in the highlands.

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In the *Yala* season, rice is grown only in well irrigated lowlands while lowland areas with limited water supply and some uplands with irrigation are cultivated to high - valued seasonal cash crops. Some irrigated upland areas with irrigation are cultivated to high - valued seasonal cash crops and to some extent to pulses. The intermediate zone receives rainfall in both seasons but not as much as the wet zone. Depending on water availability, farmers grow paddy and other crops including coarse grains, pulses, roots and tuber crops (CGPRT), in both seasons. Thus CGPRT crop production in Sri Lanka presently receives a lower priority than rice and highland cash crops.

Position of CGPRT Crops in Rural Agriculture

Rice, the staple food of the nation, is the predominant crop in the agricultural sector in terms of total value of production, employment

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and area cultivated (Ranaweera et.al, 1990). At the same time, the importance of roots, tubers, pulses and coarse grains is by no means negligible in terms of the same indicators (Table 1). In addition, these crops have been grown and consumed in Sri Lanka through millennia though their history in lost in antiquity. Studies have revealed that coarse grains and pulses have been an integral part of the dry zone agriculture of Sri Lanka (Abeyratne, 1956), and tropical roots and tubers form an important part of the wet zone farming system because of the low cost risk production process involved and the food security they provide for small farmers (Jayawardena, 1984; Samaratunge, 1987). Some tropical roots and tubers have potential as raw material for industry (Samaratunga, 1987). Potato, a crop introduced in this century, is a popular high profit cash crop.

Table 1. Labour Productivity and Land Utilization of CGPRT Crops in Sri Lanka

Crop Type	GDP (Mn. Rs)	Employment (Man-days)	Number of farm families (Thousand)	Area cultivated
Roots and Tubers	2244	12.09	524.20	40.8
Pulses	362	9.33	193.00	70.9
Coarse grains	155	7.00	81.00	42.2

Source: Diversified Agricultural Research Project Paradeniya.

CGPRT crops constitute 11.3 percent of the annual agricultural GDP (or 2 percent of total GDP), provide (at least partial) employment to 60 percent of farm families and cover 13 percent of the land area cultivated to seasonal crops. The number of CGPRT crops widely grown in Sri Lanka has changed from time to time. Senaviratna and Appadurai (1966) reported 10 types of coarse grains, 7 types of pulses and 7 types or root and tuber crops planted by farmers in Sri Lanka. However, at present only two types of coarse grains, namely maize and kurakkan (finger millet), are important. Five types of pulses i.e., cowpea, greengram, blackgram, soybean and groundnut are also grown in substantial amounts (Table 2): The last two crops were included as pulses rather than oil crops, since in Sri Lanka they are consumed directly. The root and tuber group includes potato, cassava, sweet potato and a mix of tropical yams.

Coarse grains and pulses are found largely in the dry and intermediate zones. These are cultivated under rainfed conditions on the high-lands in the Maha season. Pulses are also grown in the Yala season in the lowlands under irrigation. Roots and tubers are grown in the dry zone as well, though their mainstay is the wet and intermediate zones.

Table 2. Area Cuftivated and Production of CGPRT Crops in Sri Lanka (area in thousand ha and production in metric tons)

	1985		1986		1987		1988		1989	
	Ext	Prod	Ext	Prod	Ext	Prod	Ext	Prod	Ext	Prod
Coarse Grains	48.8	40.34	47.8	47.13	49.7	52.07	61.5	78.43	42.2	40.03
Maize	37.9	33.72	36.4	40.62	39.4	45.23	50.4	70.57	37.1	36.42
Kurakkan	10.9	6.62	11.4	6.51	10.3	6.84	11.1	7.86	5.1	3.61
Pulses	66.7	51.58	73.6	58.96	86.8	81.01	96.4	- 76.13	70.9	52.52
Cowpea	22.7	17.26	22.6	16.81	21.8	17.43	23.9	18.07	**19.9**	14.93
Greengram	21.5	14.4	24.4	17.23	34.8	23.07	33.5	23.1	25.1	19.32
Blackgram	12.2	8.82	10.1	7.76	14.1	12.61	18.2	13.16	10.9	6.53
Soybean	2.4	2.78	6.3	7.33	6.7	10.15	8.3	9.89	4.7	2.91
Groundnut	7.9	8.32	10.2	9.83	9.4	17.75	12.5	11.91	10.3	8.83
Roots and Tubers	58.4	682.79	45.8	701.78	45	555.12	48.4	648.74	40.74	427.63
Potato	8.4	118.23	7.9	108.1	7.1	91.61	6.6	78.17	6.8	93.7
Manioc	35.5	459.98	27.6	503.1	27.8	349.06	31.8	489.25	25.1	276.12
Sweet potato	8.6	65.59	6.3	61.76	6.9	53.1	7.4	62.08	5.7	36.57
Other yams	5.9	38.99	4	28.82	3.2	61.35	2.6	19.24	3.2	21.24
Total	173.9	774.63	167.2	807.87	181.5	688.2	206.3	803.3	153.9	520.18

Source: Department of Agriculture.

Editorial

Soybean Yield

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It is not unusual to find that a gap exists between the soybean yields achieved at experimental fields in research stations and those actually realized in farmer's fields. For instance, the highest reported yield at experimental plot trials in Indonesia is 3.0 tons/ha, while the national yield average is approximately 1.1 tons/ha. Conventional wisdom tells us that this gap can be reduced, if not completely eliminated, through the transfer of technologies to farmers.

In an article in this edition, the preliminary findings of the Soybean Yield Gap Analysis Project (Phase II) are presented. The project addresses the issues relating to technology transfer. Apart from the salient features of the study it reports, interesting results have also emerged of socio-economic aspects. It has been found that in most of the monitoring sites, the recommended technological packages, tuned with agro-ecological conditions of the specific places, have proved to be sufficiently remunerative to be adopted by farmers. They bring not only higher yields but also higher returns to farmers than those given but traditional practices. At the same time, it is revealed that the improved and profitable practice is not easily adapted by the farmers because of the high risk involved. Soybean farming is capital and labour intensive and a crop failure often occurs due to the susceptibility of soybean to soil moisture levels thus becomes a major consideration of resource-poor small farmers.

It is often asserted that a failure of technology transfer does not rest on a deficient transfer process but on the conditions faced by small farmers. Purchase of inputs such as seeds, fertilizers, pesticides, implements and farm equipment may be restricted due to lack of credit or simply money. Irrigation may not be timely, which makes crop production more vulnerable to the vagaries of weather. A poor distribution system causes bottlenecks in supply as well as sales.

Research on the development of an improved system for technology transfer requires that as much attention be paid to socio-economic aspects or constraints as is currently given to technology generation and its dissemination.

Table 3. Population and Labour Force Statistics for Sri Lanka

Sector	Population		Labour force		Unemployment	
	000'	%	000'	% of Total Pop.	000	% of Total Pop.
Urban	3642.2	25.5	1018.1	6.0	242.6	1.4
Rural	12222.7	72.2	3677.8	21.7	780.2	4.6
Estate	1064.2	6.3	431.8	2.5	0	0
Total	16917.7	100	5127.7	30.2	1022.8	6.0

Source: Adopted from Population Census of Sri Lanka, 1981, Department of Census and Statistics, Colombo.

Table 4. Distribution of Work Force in the Rural Sector by Type of Employment

Activity	% of Total Population	As % of the Activity Group Total		
		Employers	Self-employed	Unpaid Family worker
Seasonal agricultural activity	34.0	0.7	39.2	60.0
Agricultural activity	24.0	0.8	50.0	41.0
Non-agricultural activity	7.0	67.0	33.0	0.0

Source: Survey of Household Economic Activities - 1984/1985.

Rural Labour Situation

The present population of Sri Lanka is 17 million of which 36 percent are economically active (Table 3). This includes both labour force and the unemployed. Of this active. population, 52 percent belongs to the rural agricultural sector where CGPRT crops are grown. Table 3 also shows that the rural sector constitutes 4.6 percent of the total unemployed population. This is one target group for new activities such as the processing of CGPRT crops.

Of the total rural population of Sri Lanka, 34, 24 and 7 percent are employed in the rural sector in seasonal agricultural activities, other agricultural activities and non-agricultural activities, respectively (Table 4). The total of these three exceeds the previously stated levels of percentage of rural labour force because some individuals are involved in more than one activity. In the seasonal agricultural activities group, only 0.7 percent are pure non-working employers while 39 percent are self-employed farmers. The largest group of 60 percent are unpaid family members. This group is another target for introducing processing of CGPRT crops. Some CGPRT crops such as cassava are non-seasonal. Hence it is also important to note that the 41 percent of unpaid family workers in the "other agricultural activities" category, can also benefit from CGPRT crop processing activities, if adopted as small-scale industries.

Table 5 provides further support for this argument since both self-employed farmers and unpaid family workers average only 15 days work or less, per month. This clearly shows a surplus labour situation in rural agriculture, especially during off-peak labour demand periods. Improved processing facilities for crops can certainly absorb a part of this labour and provide the peasantry with additional income.

Table 5. Averge Number of Working Days per Month of Rural Agricultural Labour Force

Activity Group	Per Month		
	Employers	Self-employed	Unpaid Family Workers
Seasonal agricultural activities -	13	12	9
Other agricultural activities	16	15	13
Non-agricultural activities	21'	30	

Source: Survey of Household Economic Activities – 1984/1985

Role of CGPRT Crop Processing in Rural Employment and Income Generation

At present, there is no widespread processing of CGPRT crops at the farm level except for the initial processing activities such as threshing, winnowing, drying and cleaning. However, even this basic processing makes up for more than 15. percent of total labour used for production (Table 6) in the majority of the crops.

Table 6. Labour Requirements for Cultivating and Processing Different Crops (per Acre)

Crop	Total Labour M Days/acre	Processing M Days/acre	% of Total Labour
Maize	64.84	13.14	**20.26**
Kurakkan	56.52	7.48	**14.25**
Cowpea	50.66	2.21	**4.36**
Greengram	82.56	6.00	**7.27**
Blackgram	84.36	3.92	**4.64**
Soyabean	74.7	8.38	**11.22**
Gingelly	34.04	5.54	**16.27**
Groundnut	85.63	17.00	**19.85**

Source: Cost of Cultivation of Agricultural Crops
Various Issues - Department of Agriculture, Peradeniya, Sri Lanka

Such basic processing accounts for similar portions of expenditure on labour over total production costs (Table 7). However in the cases of cowpea, greengram and blackgram, of which current farm processing is limited to extracting seeds from pods and manual winnowing, these percentages are as low as 5. According to the national hectarage under these crops, a substantial number of labour days is spent every year on basic farm processing operations (Table 8). The total value of this wage bill amounts to 0.6 percent of the rural agricultural production of Sri Lanka.

Table 7. Total Labour Cost for Cultivating and Processing Different Crops (per Acre)

Crop	Total Labour Cost Rs/acre	Processing Cost Rs/acre	Processing Cost % of Total Labour Costs
Maize	2410.1	486.18	20.17
Kurakkan	*2043.89*	204.56	10.00
Cowpea	2041.16	90.66	4.44
Greengram	3633.74	181.43	4.99
Blackgram	3240.04	114.8	3.54
Soyabean	3057.33	135.24	4.42
Gingelly	1371.41	221.6	16.16
Groundnut	3795.59	717.15	18.89

Source: Cost of Cultivation of Agricultural Crops
Various Issues - Department of Agriculture, Peradeniya, Sri Lanka

Table 8. Total Annual Labour Use and Wage Bill of CGPRT Crops Production

Crop	Area Cultivated Acre	Total Labour Use in Processing ('000 man-days)	Total Wage Bill for Processing (million Rupees)
Maize	91760	1206	44.61
Kurakkan	12523	94	2.54
Cowpea	49111	109	4.45
Greengram	62098	373	11.11
Blackgram	26856	106	3.09
Soyabean	11515	96	1.56
Gingelly	43341	240	9.06
Groundnut	25552	434	18.33
Total	322756	2658	95.29

All CGPRT crops listed above do not bear a potential for being processed any further at the farm or village level. Hence, only a few selected cases are discussed here due to their potential for adding to rural employment and income through further processing.

These are:

a. Dehulling and splitting of pulses
b. Extracting soy milk and preparation of food items for sale
c. Producing starch, tapioca pearls and dried chips out of cassava

Dehulling and Splitting of Pulses

At present this is not practised at farms either for commercial purposes or as village level small-scale industries. In fact farmers use traditional soaking and manual grinding or pounding to dehull and split pulses for home consumption. These crops are usually sold as whole grains which are dehulled and split at large - scale grain mills, at a cost of Rs. 1.50 per kg of split product (Hulangamuwa, 1990). These machines have a recovery rate of 75 percent, as against the rate of 52 percent under traditional methods.

There are plans to develop low-cost machinery with comparable efficiency but utilizing more labour, for use at the individual farm level or at small-scale rural industries. Thus, the Rs. 1.50 per kg which now accrues to large millers can be paid to rural inhabitants. This would induce sale of value added products at the village level, reducing the marketing margin flowing into the hands of intermediaries based in towns and cities.

Based on the above logic, two types of small machines have been developed for pulse dehulling and splitting. One is a small manually operated or motor driven machine with an average processing capacity of 65 kg/hour. The other machine is medium sized and is suitable for village level mills operated as private enterprises, or for farmer co-operatives. This has a processing capacity of 125 kg/hour and a recovery percentage of 72 percent, which is very close to the 75 percent recovery rate of large-scale machines. However, these motor driven machines require a higher initial capital, a higher operating cost on imported fuel and a lower level of labour. Hence, it is advisable to popularize the manual farm level machines where labour is abundant and to utilize the motor where labour is scarce.

A hectare of pulse crops generally yields around 1000 kg with good management under Sri Lankan conditions. With a hand operated dehuller, this can be processed in 2 to 3 man-days. Along with the labour for the necessary soaking and drying, a hectare of pulses needs about 5 days of labour for dehulling and splitting. This shows that splitting can be done in a short period and the farmers do not need to face any undue delay in selling due to this additional operation. (However, a hectare of pigeonpea, which is a crop being newly promoted, needs about twice as much labour as it has a harder seed coat).

If the total production of cowpea, greengram, blackgram and soybean is processed with this machine, about 2,220,000 man-days of rural labour can be employed per year. At the current wage rate of Rs. 50.00 per man-day this adds Rs. 11 million per year to the value of rural products which also accrues to rural labour. This is a 3.4 percent increase over the present farmgate value of pulse produced per year.

Producing Soy-based Products

A similar computation is preferred for the production of soy-based products, but could not be made for lack of data-particularly at the village level. However, the income and employment generation potential could be higher than that of pulses since soy products are high priced and processing needs more labour. Nevertheless, products such as tofu and tempe can fetch higher prices only when they are more widely accepted in Sri Lanka. Therefore, as a prerequisite to establishing village level processing, soy products should be intensively popularized.

Cassava Chip and Starch Production

Cassava is the most widely grown CGPRT crop in Sri Lanka and it can be expected that processing of cassava has a large potential for

generating employment and income. Likewise, cassava has been identified as a potential base for manufacturing industrial starch, glucose, adhesives and paints. Furthermore, dried chips and pellets of cassava for animal feed and tapioca pearls (as a substitute for sago) for confectionery, are two other promising potential uses (Jayawardena, 1984). Small-scale plants were producing these commodities before they were adversely affected by higher quality substitutes imported after 1977. The textile industry, which was the major purchaser of starch, presently relies mainly on imports for its requirements. The inability of local producers to maintain the quality and price of cassava starch at competitive levels with imported starch appears to be the major cause of this situation. Animal feed producers too have given up the use of cassava chips in the face of similar competition from less expensive maize. In this context farmers find it more convenient to sell their cassava for direct consumption.

Unfortunately, reliable data on the income and employment generation capacity of this industry are not available. Tapioca pearl production plants especially, need a high capital outlay which the average villagers cannot afford. However, comprehensive bank credit schemes supported them previously. Thus, if cassava starch and chip production are to be reintroduced, some degree of protection and capital funding will have to be provided.

Conclusion

It can be stated that a clear potential exists for generating employment and income in the rural sector by promoting small-scale processing of CGPRT crops. To achieve this potential, the following should be considered by planners and policy makers:

- Technology on low cost processing should be developed and passed on to extension for introduction to the rural sector.
- New products that are developed should be popularized among the consumers in order to create a substantial demand and thereby a price attractive to producers.
- Processing requires machinery and equipment which need capital funds, a scarce resource to average villagers. Credit with acceptable terms should be provided.
- Products may face severe competition from cheaper imported substitutes. Some kind of protection for these products may have to be considered.

Maintaining Sustainable Agriculture in Papua New Guinea: The Dynamics of Farming Systems*

R.D. Ghodake[1], B. Isaacson[2] and W. Hadfield[3] July 1989

The views expressed in this paper do not necessarily reflect those of the Department of Agriculture and Livestock.

Introduction

Modern inputs, technologies and changes to farming systems have been adopted in developing countries to meet increasing demands for food and cash. As a result, many countries are now experiencing problems of soil degradation, pests and diseases, environmental pollution, and social and economic stress. The environmental base in many countries has become fragile and is deteriorating rapidly as population pressure is increasingly taxing the limited resources.

Agricultural development in Papua New Guinea (PNG) is at an early stage and marginal changes in farming systems, which incorporate modern ideas and techniques, are a recent phenomenon. Traditional subsistence farming systems based on extensive and shifting cultivation are generally intact and efficient. These systems are dynamic and capable of adapting quite rapidly. Recently, PNG has been experiencing a period of accelerated cultural, economic, and social change that is having significant effects on agriculture, particularly in the smallholder subsistence sector. Population pressure is beginning to cause land shortages and degradation in localized areas.

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*Revised version of the paper presented at the Farming Systems Research and Extension Symposium, at the Center. for Continuing Education, University of Arkansas, Fayetteville, U.S.A., 9-12 October 1988.

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The growing desire for cash and consumer goods is diverting land and labour, previously used for subsistence food gardens, into production of export tree crops such as coffee, thereby threatening food security. Although there have not, in general, been significant changes in traditional farming systems which may be regarded as destabilizing and causing agro-ecological damage, the future direction and possible consequences need to be anticipated.

The challenge for Papua New Guinea is to maintain sustainability and modify existing farming systems in light of inevitable changes. The need is to have means by which the farming systems can be appropriately and positively modified over time in order to maintain sustainability. The national Department of Agriculture and Livestock has reorganized its research activities and has fully adopted a programme of farming systems research (FSR) to meet this challenge, by focusing its research on the needs of smallholder semi-subsistence producers.

Agriculture In PNG's Economy

Papua New Guinea has a land area of approximately 462,800 sq. kms. There are roughly 700 tribal groups speaking different languages. The population exceeds 3.5 million, about 40% of which live in the highlands with the rest in the lowlands and islands.

The agricultural sector remains the most important economic sector in the country, accounting for about 40% of GDP and about a third of total exports. It provides livelihood to approximately 85% of the country's population. The sector is largely dependent on smallholders who account for virtually all subsistence production and about 65% of all agricultural exports (Shaw 1985).

Subsistence agriculture is marked by diversity in plant species, varieties, yield, micro-climate, and habitat. It is adjustable to steep, rocky or marginal lands. The main cash inputs are tools such as bush knives, axes, and spades. Subsistence agriculture is not subject to inflationary pressure. The economy is, thus, underpinned by a labour intensive, cash input-free, inflation-proof system of agriculture.

Coffee is an important cash crop with production heavily dominated by smallholders. Estates account for about 30% of coffee production. In 1988, oil palm, cocoa, and coconut were ranked second, third, and fourth, respectively, in export value. Fruits and vegetables have been growing in importance in recent years. Government policies promote the replacement of imported fruits and vegetables with domestic production through a mixture of tariffs and import quotas/bans. Efforts to further diversity income earning opportunities for smallholders currently focus on the introduction of minor crops such as cardamom and chillies.

Government strategy places a high priority on the development of farming system for sustaining subsistence production. This reflects concern over the rapidly growing population and consequent increases in the demand for food, a declining agricultural resource base, and increases in the cost of food imports. There is also a growing concern over apparent malnutrition in some rural areas.

Cropping Systems

Traditional staple foods include sweet potato, taro, yams, banana, and sago. Sweet potato is the main crop in the cooler highlands areas. In its cultivation, all the garden's topsoil is usually broken up. Taro is a characteristic staple food crop in the lowlands rainforest areas of moderate fertility, and in its cultivation the surface soil is left virtually undisturbed. The plant is left to mature with little weeding. Yams are typically found -on better drained soils of high mineral fertility such as new volcanic soils and also richer soils derived from coral limestones. The soil is worked deep in preparation for planting, and the area around the yam vine is kept loose to facilitate the tuber growth.

Bananas have become an important crop in areas with a pronounced dry season. Triploid bananas will continue producing for several years following other crops. Sago has become an important staple in the swampy lowlands. It is often harvested in other lowland areas only during times of food shortages. Cassava is salt-tolerant and has grown in importance as a subsidiary crop.

Increasing emphasis is being placed on cash crops by the farmers in their pursuit of a cash income. These crops are often interplanted with some of the traditional food crops. These compete with subsistence crops for farmers' limited resources. Introduced vegetables are increasingly being raised by smallholders, both for consumption and for sale to the growing urban markets.

Cultivation Practices

Small plots are burned, cleared, sometimes fenced, and planted with a wide range of cultivars. Mixed and inters copping are common features of subsistence gardening. New gardens are usually planted with taro, banana, sugarcane, pitpit, beans, and other rapidly maturing crops

including leafy vegetables. Older gardens are usually dominated by sweet potato or crops adopted to conditions of increasingly poor soils. Gardens under extensive systems are generally cultivated for one to two years, then abandoned to fallow. Gardens under intensive systems can be cropped for several years, often exceeding the length of fallow.

Livestock System

Traditional livestock are limited to pigs and, to a growing extent, chickens. These, however, are not consumed regularly in rural areas and make little contribution to a family's nutritional well-being. Pigs play an important role in traditional farming systems and utilize considerable food and effort from farmers. In some highland areas up to 50% of sweet potatoes raised are fed to pigs. They serve numerous purposes such as traditional exchange gifts, compensation payment, bride price, storage of food, and as a sign of wealth. Pigs are highly valued and are considered complementary to subsistence agriculture by eating waste and low quality food, excess production, and as insurance against food shortages. Pigs are generally raised extensively and often roam village compounds, sometimes causing considerable damage to food gardens and soils. Recent indications suggest that pigs are losing their status as they increasingly compete for food and with cash crops.

Land Tenure

Approximately 97% of land in PNG is customarily owned by tribal groups or clans. There may or may not be a single authority within the group who controls the land use. Individual land rights are generally quite specific. A person may have rights to garden land which cannot be abrogated by the group. Rights to the use of land may be inherited either through the mother or the father. A family may cultivate the wife's land, husband's land or some combination thereof.

Dynamics of Farming Systems

Subsistence farming systems in Papua New Guinea are dynamic and capable of adapting quite rapidly to both external and internal stimuli. These systems have adopted new crops, animals, and production methods, tried them, modified them, and accepted or rejected them, usually with good reason. At the same time, some previously existing crops, cultivars or production methods, have been modified or dropped from the production system. Some specific examples of the dynamics of farming systems in PNG follow.

1. Sweet potato and cassava are replacing taro as taro leaf blight moves across the islands and lowlands. Recent introduction to cropping systems include pumpkin, *Xanthosoma* (taro), groundnut, tomato, onion, cabagge, irish potato, papaw, cassava, carrot, broccoli, cauliflower, chickens, and goats.

2. Customary land is still being allocated and re-allocated within landowning groups according to the changing needs of its members and the customary laws which have developed over long periods of time. These laws show themselves to be continually evolving and flexible, and have avoided the creation of a rural landless or dispossessed class.

3. Mulch mounding technique is extensively used in high altitude (above 1400 m) areas of two highland provinces. In some areas *Casuarina oligodon,* widely planted around houses, in fallow fields and cropped lands, is used for nitrogen fixation, coffee shade, firewood, and construction.

4. In high altitude areas, farmers are adapting to frost by strategically locating their gardens and by planting more frost resistant temperate crops.

5. A dense population of humans and pigs is managed by balancing intensive and extensive land use according to prevailing circumstances. As population density increases, the proportion of intensively cultivated land using tillage and mulching increases and pig numbers may drop.

6. The majority of the population now face choices which include subsistence production-consumption, as well as cash earning opportunities. But unlike farmers in many other developing countries, smallholders in PNG are not locked into a monocrop or an entirely market-oriented cropping system. As a result, their choices are more diverse, and in times of low prices they make the rational choice of increasing the proportion of their limited resources into subsistence production. A highly elastic supply curve for smallholder agriculture produce has been demonstrated for coffee, coconut, and cocoa, giving evidence of such choice (Livingstone 1977).

7. The recent Land Use Project (Wohlt and Goie 1986) concluded that subsistence agriculture in one potential stress area of the country was "alive". The traditional system - based on sweet potato and including a number of subsidiary crops raised in conjunction with an intensive fallow utilizing Casuarina - was still basically intact after absorbing a number of new crops, including coffee.

In general, the root crops raised and the shifting cultivation systems are efficient for subsistence production in Papua New Guinea. Shifting cultivation is an efficient method of restoring soil fertility through forest or grassland regeneration, plant material breakdown, and reclearing. This complex system exploits the environment and its interdependencies in a sophisticated way, but is only efficient and sustainable provided person/land ratios are low, and the climate and soils suitable.

In spite of all the dynamism and adaptability of PNG agriculture, there have been indications of location specific stress and of general trends indicating rising pressures due to rapidly increasing population and changing economic and socio-cultural conditions. Some such trends are:

Population Pressure

The official growth rate of population in PNG is 2.3% per year. However, evidence suggests the actual rate may be as much as 2.8 per cent (Goodman et al. 1985), indicating a possible doubling of population in 25 years. This will place considerable strain on evironmental resources.

Population pressure in some areas is increasing as people move from less accessible and more rugged areas to areas with road access, fertile land, cash cropping potential, and proximity to urban centres. Some parts of the country are already densely populated. This has initiated trends of shortened fallow periods, many plantings per cultivation, declining soil fertility, and land degradation (Ghodake and Watinga 1987). Population density in some areas is as high as 400 people per sq. km.

Cash Cropping

Smallholders are increasingly putting more and more land and other resources into cash crops, with a tendency for the best sites to be devoted to cash crops. This exacerbates the pressure on land, as food production is relegated to less fertile, shallow, and steep soils. To some extent cash cropping has been discouraging men's contribution to food production, thus increasing women's workload in subsistence agriculture. Cash cropping also has been influencing the intra-household cash control in favour of men.

Modernization

Although gardening and subsistence production systems have for the most part remained relatively stable, they have been recently influenced by changes in new work attitudes, ways of living, cash crops, modern facilities, communication systems, changing consumption patterns, educational systems, government policies, new techniques of production, and perhaps most importantly, the attitude of youth toward rural life.

Migration

Migration from one rural area to another and from rural areas to urban areas in search of job opportunities is increasing. The absentee rate in some areas is as high as one third (Wohlt and Goie 1986). This migration may help reduce pressure on land where population density is high, and migrated people often bring back money, ideas, and gifts which may or may not improve food consumption, nutrition, and the quality of life. However it is generally the young and strong who leave the village, thus increasing the work load for those remaining. This may lead to output declines as the labour input is reduced. In some areas malnutrition and poverty among women and children are exacerbated by the high rate of migration among men (Joughin and Thistleton 1987, and Harvey and Heywood 1983).

Government Policy

Little emphasis has been placed by the government on improving marketing and transport facilities oriented toward traditional food staples, as has occurred for export crops and introduced vegetables. As a result, the effective demand for traditional staples in the domestic market itself is declining. This discourages farmers from improving the productivity of traditional staples and from allocating scarce resources including management, to subsistence agriculture.

The government's strong Kina (currency) policy has biased development away from agriculture, in general, and away from small-scale agriculture, in particular. This may reduce export earnings, and discourage consumption of local agricultural produce, since imports will be cheaper. The prices of staple foods favour imported rice in all the main urban markets. The real prices of some traditional staples have risen over the years, while the real price of rice has declined (Joughin and Kelly 1986).

Land Shortages and Soil Fertility

As population densities increase and cultivable land becomes scarcer, the cognatic descent system becomes less flexible and changes to one with a greater agnatic bias. This reduces the number of locations people can choose to establish gardens, making it more difficult for them to move from degraded areas to more favourable environments.

In PNG, all sections of society show a strong bias toward expenditure on current consumption versus saving and investment for the future. Since land has supported them reasonably well for centuries with virtually no investment, the people may be undervaluing the need to continually improve this basic resource. Current tenure systems do not provide farmers with incentive to improve or maintain the productivity of the land through investment.

In a few parts of PNG virtually all arable land is cropped. More and more arable land is being cropped as population increases and people concentrate into smaller areas. Changes in the amount of forest vegetation serves as an indication of the stability of agriculture in different environments. In some areas an annual forest loss of about one percent per year is reported (Wood 1985). The ratio of grass fallow land to forest land has been increasing in some areas, indicating increasing instability and degradation.

Biological Constraints

In the past, biological yield reducers such as pests, diseases, and weeds were not very important because of their virtual absence, long fallows, scattering of gardens, large genetic diversity of each crop, possible genetic resistance, and admixture of different crop types within a garden. With farming systems changing in the direction of shorter fallows, shorter rotations, denser plantings, introduced crops, monoculture, and fewer varieties and crops in a system, there is loss of genetic diversity, which is likely to increase the incidence of insect pests and diseases. Some indications are the recent outbreak of coffee leaf rust, a locust outbreak, a black rot disease on sweet potato, significant damages due to taro beetle, sweet potato weevil, taro leaf blight, sigatoka disease of banana, banana leaf roller etc.

Stress Areas

Periodic food shortages occur in some parts of the country, and are becoming more frequent. they occur as a result of frost, drought, and heavy rains. Some areas appear to be more prone than others, and some, with poor communications have food shortages, either absolute or seasonal. There are mid-altitude and lowland areas which commonly suffer from regular food shortages.

Research Reorganization

The national Department of Agriculture and Livestock has recently reorganized its Agriculture Research Division by fully adopting a programme of farming systems research to generate relevant technology options which will help maintain the sustainability of agriculture in PNG. Two main farming systems research teams have been established, one for the highlands and another for the lowlands. Their focus is on subsistence and semi-subsistence farmers and their related activities, with particular emphasis on food crop production and livestock integration. Because of the importance of coffee, cocoa, and coconut in the smallholder agriculture, two additional FSR teams have been established. One is coffee-based and the other is cocoa- and coconut-based. These teams will address problems relevant to cash-food crop integrated farming systems. Another lowlands research station serves as a centre for germplasm agronomy, variety trials, biological control, and post harvest work.

An agroforestry research programme is being set up in conjunction with the coffee based FSR team. The programme is expected to be one of applied research with focus on ecological issues covering aspects of biomass productivity, soil fertility, and response to pest attacks (Ewel 1988). The ultimate aim is to generate knowledge and agroforestry components such as alley cropping, crop rotation, planted fellows etc. to assure the future of smallholder farming systems.

National and Regional Linkages

A major objective of FSR is, to create linkages between research, farmers, extension, policy makers, and others concerned with agricultural development, through which information about farmers conditions and needs can be channeled; and through which new technology can be developed and adapted before eventually. being transferred to farmers (IARC 1987).

In Papua New Guinea the extension responsibilities have been decentralized to 19 provincial governments. This separates, both administratively and physically, the extension service from research which is a national function. This has made the information flow between research and extension difficult. The FSR programme is designed to strengthen the linkage by involving

extension agents in FSR activities from the early planning stages. Rapid appraisals have proved to be a good forum for initiating this co-operative involvement.

Research Strategy

The highlands FSR team has adopted a resource base oriented strategy with research parameters set by the resource-base which determines the direction of research. This strategy focuses on marginal resource situations. Commodity choice is not predetermined. The problem thus is to find a production system which can best use the available resource-base (Ghodake 1988). The lowlands team has been concentrating on taro and banana - the two dominant lowland crops - in their effort to solve problems of general agricultural improvement. The cash crop - based FSR teams have adopted a commodity strategy with focus on the integration of the target cash crops with food crops, and with the overall aim of designing technologies which will bring improvements in productivity and stability of smallholder farming systems.

The usual stages of FSR are: pre-diagnostic, descriptive/diagnostic, design of novel practices, testing, recommendation, and monitoring and evaluation. This sequence may not always be followed and stages may overlap depending on the information available from past research and farmer circumstances. Training of national scientists in FSR concepts and practice is an important facet of the programme. The major activities performed are base-data and information collection and analysis, surveys, station-based studies, and on-farm studies.

Rapid rural appraisals have been emphasized for diagnostic and design work. These, have proven effective to gain an understanding of farmers problems and circumstances in target areas, and for determining research priorities. These surveys are considered highly essential as first-hand field orientation for expatriate researchers, for training of national researchers, and for development of effective multidisciplinary spirit between researchers, extension, and policy makers. Perhaps most importantly, these RRAs assure a farmer-orientation and a common understanding of farming systems and problems among all participants, right from the early stage of the research programme. These RRAs help identify farmer constraints, prioritize them, and decide on research options.

Priority has been given to those technologies which have a high probability of success, low labour and capital requirements, and high sustainability (Isaacson and King 1987). Consideration is also accorded to compatibility with changing aspects of lifer cash cropping, consumption patterns, the desire for cash, socio-cultural changes, and rising population pressures.

Identified Constraints

The major constraints identified by the FSR programme in PNG are low and rapidly declining soil fertility with high population pressure (short fallow periods); seasonal and absolute food shortages (possibly causing malnutrition) due to distinct and prolonged drought or flood; lack of effective demand for vegetables, black rot and dieback diseases of sweet potato, and inadequate input supply; and a host of constraints like banana leaf roller, taro leaf blight, taro beetle, sigatoka disease of banana, poor planting density, land shortage and poor soil fertility.

Research Priority

If we assume that a greater number of plantings per cultivation cycle means good soil fertility and a lower number means lower fertility, and further assume that long fallows indicate low population pressure, and short fallows high population pressure, then we have four typical situations as presented in Table 1.

Table 1 There, garden cycles are short as yields drop quickly and short fallows are necessary

	Low soil fertility Few plantings	High soil fertility Many plantings
High population pressure and short fallow	Few highlands and lowlands areas Watch out in short run	Many highlands areas Potential source of problem (1)*
Low population pressure and long fallow	Many lowlands areas Problems anticipated with population increase	Few highlands and lowlands areas Many highlands in short run (3)

*Numbers in parentheses are rankings.

Areas are ranked from (1) to (4), with (1) having the greatest stress and (4) the least. The areas in the lower right quadrant (rank 4) are not likely to be a cause for alarm. While the areas in the lower left quadrant (rank 3) ire typical of a

few peripheral areas and gardens that need to be cycled more quickly, but because of low population pressure long fallows maximize garden recovery. Problems would occur with population growth or in-migration in such areas.

The areas in the upper right quadrant (rank 2) are likely to have potential problems. It is characteristic of those areas to have populations concentrated on better soils. The areas in the upper left quadrant (rank 1) are the ones to watch. There, garden cycles are short as yields drop quickly and short fallows are necessary.

The FSR programme should accord priority for areas with rank (1) by conducting location-specific problem-solving research. The potential benefits are likely to be greater in these areas because of higher population and equity considerations. Secondary priorities would be for areas ranked (2) or (3) depending on the relative stress and trends. The programme may not be directed to areas with rank 4.

Research Programme

The highlands team has been conducting location specific adaptive research on mulch mounding, introduced vegetables, planting density, and alley cropping. Diagnostic-cum-adaptive research is being conducted on food supply seasonality in two areas. On-farm socio-economic studies are being done to understand strengths and weaknesses of traditional farming systems. A plan is to do applied work on agroforestry with an aim to generate alley cropping, crop rotation, planted fallow options for land and fertility management. It is also planned to assess yield losses caused by nematodes in farmers' fields. A feasibility study for integrated livestock-food-cash crop farming systems will also be conducted in the high altitude areas. Market surveys, agro-economic, and nutrition surveys are other activities aimed to design prospective technologies.

The lowlands team has station-based and on-farm trial programmes in the Bubia area, covering chemical control of taro beetle, alley cropping and planted fallow for soil fertility, varietal evaluation for taro leaf blight, rapid multiplication technique for taro planting material, and livestock research involving guinea pigs, pigs, and sheep. The team also has planned farmer surveys covering markets, labour inputs, gardens, and consumption, and on-farm research with variety trials on sweet potato, crop rotations with leguminous food crops and planted fallows, taro variety adaptability, and sago harvesting.

Research efforts are required to monitor the environmental effects of long-term cultivation, the agronomic functions of fallow, the effectiveness of traditional cultivation techniques in controlling environmental degradation, and ways of rehabilitating degraded environments. There is also a need for analyzing off-farm influences of farmer decision making. For example, little is known about smallholder response to prices, risk, credit, the influence of seasonal employment opportunities on investment and production decisions.

Accomplishments

The FSR programme has been fully accepted by the PNG Government and represents a major change in research policy from the established disciplinary approach of the past. The Agriculture Research Division of DAL has been completely restructured to achieve the ultimate objective of the programme which is directed to subsistence farmers to maintain sustainability of agriculture.

While the programme is only in its third year, two of the four teams are fully operational, with the other two teams gearing up fast. Institutionalizing the programme has been a major objective of the past few years. With the mechanisms in place it is likely that research recommendations will soon become available. As agricultural research is a long-term process, its impact will not be fully recognized for many years to come.

Conclusion

Agricultural problems and stress exist in some localized areas in Papua New Guinea due to poor resources, poor access, lack of income earning opportunities, and location-specific population pressure. These need to be given priority in research agenda to help assure that those people are able to maintain a sustainable livelihood in the immediate future, which in turn can allow these areas to move towards sustainable development in the long-run.

The major challenge is to maintain the overall sustainability of agriculture in PNG, in view of changing farming environments, systems, and conditions. The already demonstrated dynamism of PNG farming systems needs to be improved and maintained in a state of equalibrium to allow it to generate and continue to generate a sustainable agricultural system and smallholder subsistence sector.

Priorities for Increasing Soybean Production in Indonesia and Thailand: SYGAP Annual Report 1990

Dr. P. Rondot
SYGAP regional coordinator
ESCAP CGPRT Centre - CIRAD/DSA
Bogor, Indonesia (March 1991)

Extensive, adaptive on-farm research, including the monitoring for almost two years of selected farmers, was conducted by agronomists, economists, extension personnel and farmers within the Soybean Yield Gap Analysis Project phase II (SYGAP II). The project sites in Indonesia and Thailand were based in traditional soybean farming areas and areas where soybean had recently been introduced. The preliminary results (presented in the SYGAP annual report) allow us to set out priorities for the development of soybean production in these two countries.

It must be stressed that the objective of the project was not to develop new soybean production technology. Rather, it was to study and improve the process of adoption by farmers, of recommended soybean technology.

The major constraint which prevents farmers from investing in soybean production is the unpredictability of yield caused by its high sensitivity to moisture stress (excess or shortage). In both irrigated and rainfed areas, inappropriate water management results in unpredictable plant growth, weed proliferation, poor plant population and a high sensitivity to pests and disease. If this situation is not remedied, even the use of good quality soybean seed will not counteract these problems.

Stabilization of yield is the basic requirement of farmers (and entrepreneurs) wanting to invest in soybean production. Research for the improvement of soybean yield stability should be given high priority, thereby supporting the diversification of agricultural production. This could be achieved by strengthening research efforts in the following areas:

1. Improvement of Soil Moisture Management.

Appropriate techniques of soil tillage prior to planting (bedding, ridging etc.) are needed to prevent flooding and also to improve the soil's water retention capacity. Because there is much competition at planting time between the activities of the farmers, the research should investigate the possibility of mechanizing soil tillage in order to reduce the cost of production per hectare while improving crop establishment and tolerance to excess or insufficient water.

2. Breeding Programme to increase Drought Resistance and Waterlogging Tolerance.

Existing soybean varieties already have a high yield potential. Sometimes, yields of four tonnes per hectare have been achieved in farmers' fields or in experimental plots, both in Indonesia and Thailand. Future breeding programmes should aim at increasing the tolerance of the existing varieties to water shortage (for rainfed soybean) or waterlogging (for irrigated soybean).

3. Extension of the Project's Research and Development Approach.

The methodology used by the project has already proved successful. Within the project areas in both Countries, farmers have already begun to adopt the recommended technology when it has been adapted to their needs.

4. The Role of the Private Sector in Developing Soybean Production.

The increase in demand for soybean is due to the recent development of the animal and related feed industries. These new agro-industries are mainly in the hands of the private sector, which is already engaged in various forms of soybean production. The role of the private sector in supporting the development of soybean production has to be carefully investigated in order to make optimum use of national resources. It is vital that unfair competition between small and large producers be avoided. This would reduce the limited incomes of most of the farmers who already grow soybean and have a dramatic effect on the traditional soybean processing sector which provides labour opportunities in remote and poor rural areas.

5 **Conditions for Adoption of New Technology**

The last year of the project will be devoted to a thorough analysis of all the information which has been collected during the previous two years. Since the R and D approach has been successful, the project will be able to identify the necessary basic requirements which will enable farmers to adopt new technology in the field.

CGPRT Centre News and Activities

Centre to Distribute CIP Publications in Indonesia

Publications produced by the International Potato Center in Peru are now available in Indonesia from the CGPRT Centre. A price list is also available from the Publications Section.

The Centre distributes "Grain Legume Breeding for Wetland and for Acid Soil Adaptation"

This book is published by the Central Research Institute for Food Crops. The Centre will distribute it on request to the interested customers in Indonesia only.

Sumarno, Tateng Sutarman, Soegito. CRIFC, Bogor, 1989. 63 p. Free.

New Publications

Sweet Potato in Viet Nam: Production and Markets J.W.T. Bottema, Pham Thanh Binh, Dong Thanh Ha, Mai Thach Hoanh, and H. Kim. 1991. 113 p. ISBN 979-8059-41-7. Price US$ 12.50. US$ 9.00 (developing countries). Rp 11.000.

This publication contains a number of papers dealing with the development of the market for sweet potato in Central and South Viet Nam, and production of sweet potato throughout Viet Nam. A separate section addresses the role of co-operatives in production and marketing of sweet potato. The information was generated in collaboration with a number of Vietnamese research institutes, the Ministry of Agriculture of Viet Nam, the International Potato Center (CIP), and the CGPRT Centre. Throughout the volume, attention is given to the transition from a centrally planned economy to a market oriented one. The data generated include reliable estimations of household and farm income throughout Viet Nam. Among the major findings is evidence indicating that diversification and individualization of agriculture in Viet Nam go hand in hand.

Newly Available Publications from AVRDC, APO and IDRC

The following AVRDC, APO and IDRC publications are available for purchase in Indonesia from the Publications Section of the Centre and its Indonesian's distribution network as well.

1988 Progress Report. AVRDC 1990. 412 p. Rp 25.000.

1989 Progress Report. AVRDC 1990. 350 p. Rp 25.000.

1990 Progress Report. AVRDC 1991. 312 p. Rp 25.000.

Vegetable Research and Development in South Asia. AVRDC 1990. 194 p. Rp 18.000.

Farm-Level Irrigation Water Management. APO 1991. 221 p. Rp 7.500.

Value Added Productivity Measurement and Practical Approach to Management Improvement. APO 1990. 231 p. Rp 15.000.

Quality of Work Life in Japan. APO 1990. 77 p. Rp 7.500.

Agricultural Trade Policy in Asia. APO 1991. 257 p. Rp 7.500.

Agricultural Diversification. APO 1991. 445 p. Rp 10.000.

Utilization of Farm Machinery in Asia. APO 1991. 302 p. Rp 7.500.

Food Processing Industry in Asia and the Pacific. APO 1991. 266 p. Rp 7.500.

Shrubs and Tree Fodders for Farm Animals. Devendra, C., ed. IDRC 1990. 349 p. Rp 36.000.

New Distributor

CGPRT Centre publications are now also available at:

Parry's Book Center Sdn. Bhd.
60, Jalan Negara, Taman Melawati, 53100
Kuala Lumpur
P.O. Box 10960, 50730 Kuala Lumpur
Malaysia

UN/ESCAP CGPRT CENTRE

ESCAP Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific

Regional Statistical Database System

R S D S June 1991

The CGPRT Centre was established in 1981 as a subsidiary body of UN\ESCAP. The objectives of the Centre are to initiate and promote research, training and dissemination of information on socio - economic and related aspects of CGPRT crops in Asia and the Pacific.

In its activities, the Centre aims to serve the needs of institutions and individuals concerned with planning, research, extension and development in relation to CGPRT crop production, marketing and use.

In fact, a rapidly increased need for improved accessibility of information can be observed by many of those involved in research and development of CGPRT crops within the Asian Region. To respond to this need the Centre has compiled an integrated data set of basic time series covering production, prices, trade and use of selected CGPRT crops and macro-economic indicators. The Regional Statistical Database System (RSDS) rearranges and facilitates the accessibility of data on regional, national, provincial and district levels, from a wide range of national and international sources

At present, ten countries are participating in the Regional Statistical Database System (RSDS) project, including Indonesia, Thailand, the Philippines, Viet Nam, Myanmar, Republic of Korea, Bangladesh, Nepal, Sri Lanka and Pakistan.

The RSDS Project at the Centre now has on-line services

The Database Section has developed its own software to store and retrieve CGPRT crop data. RSDS is a versatile and user friendly software now available to users along with the data modules. The database can be expanded by specific users to serve specific purposes.

Software is available on request at nominal costs. Data modules can be acquired in the format of Lotus 1-2-3 Release 2.2 or Database File (.DBF) in 5.25" floppy disks.

For further information, please contact the RSDS UN/ESCAP CGPRT Centre, JL. Merdeka 145, Bogor 16111, Indonesia, or phone (0251) 326290/328399 Ext.20. Fax 62-251-326290. Attn. Prajogo U. Hadi or Maria F. Ferrari, Database Economists.

CGPRT Centre

The Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (CGPRT Centre) was established in 1981 as a subsidiary body of UN/ESCAP.

Objectives

In co-operation with ESCAP member countries, the Centre will initiate and promote research, training and dissemination of information on socio-economic and related aspects of CGPRT crops in Asia and the Pacific. In its activities, the Centre aims to serve the needs of institutions concerned with planning, research, extension and development in relation to CGPRT crop production, marketing and use.

Programmes

In pursuit of its objectives, the Centre has three programmes which are mutually supportive:

1. Research, which entails the preparation and implementation of studies covering production, utilization and trade of CGPRT crops in the countries of Asia and the South Pacific;
2. Training of national research and extension workers;
3. Information and documentation which encompasses the collection, processing and dissemination of relevant information for use by researchers, policy makers, and extension workers.

Palawija News

Contributors are invited to submit concise summaries of significant social research related to CGPRT crops for publication. Submissions should be limited to two to four double-spaced typewritten text. Two figures (graphs or tables) may accompany the article. Include only references cited. All articles are subject to editing to meet space limitations.

Please send all queries relating to articles in *Palawija News* to Head Publications Section, CGPRT Centre, Jalan Merdeka 145, Bogor 16111, Indonesia.

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