

THE DEVELOPMENT OF FARMING SYSTEMS AND THE NEED FOR FARM PLANNING IN THE NEW GUINEA HIGHLANDS

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ABSTRACT

Cash agriculture is becoming more diversified in the New Guinea highlands. In addition to cattle grazing and the coffee, tea and pyrethrum industries there are opportunities for other forms of agriculture, particularly in the form of annual crops which may be used as food for man and livestock.

The desirability of raising living standards, discussed elsewhere in detail, is assumed. A brief assessment is made of the effects of cash agriculture on the subsistence economy and the emergence of farming systems in the Highlands. However, the development of more viable farming systems depends on a number of factors and after discussion of these, suggestions are made to assist this trend.

INTRODUCTION

THE development of farming systems in under developed countries is an obvious way of helping to solve economic pressures amongst people changing over from a subsistence to a cash economy.

Subsistence agriculture in Papua and New Guinea is in fact a system of land rotation (Barrau, 1958; Newton, 1960). The length of the rotation depends on how much land the individual has available. In many low-land areas of Papua and New Guinea it is a long enough period for the bush to regenerate to high secondary forest. However, rarely if ever in Papua and New Guinea would the rotation be long enough to allow regeneration of a climax forest. Alternatively, the rotation may be over a short period (less than ten years) so that trees may have little time to establish and the land remains permanently under grass, particularly if burning is practised. This is the usual pattern in the New Guinea highlands.

Within this system of land rotation, according to custom and locality, various systems of subsistence cropping may be carried out during the continuous cropping of one area. The Orokaiva people of Inonda take off only one crop (Crocombe et al., 1963) but the Chim-

bu people of the New Guinea highlands use at least three different rotations, often combined with mixed cropping (Barrie, 1956).

In this discussion of developing farming systems for the New Guinea highlands, it is taken for granted that the system of bush fallow rotation, though admirable for the conditions under which it is still being practised, is inadequate to meet the modern developments of cash cropping and increasing population. Gourou (1958) says that if the standard of living of tropical peoples is to be raised, then the system of shifting cultivation (or bush fallow rotation)* must be abolished because it is incompatible with a high standard of living.

The question becomes one of finding more efficient ways of using the land available so that the range of agricultural produce can be diversified and produced in excess to promote cash incomes. This article is mainly concerned with conditions in the New Guinea highlands where cash agriculture is becoming more diversified. Development is proceeding

* Many authors distinguish between the two. Generally the former is carried out over very large areas often under no particular system. The latter adheres to a definite time interval between when a garden is cropped, rested and cropped again.

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in such a way that in addition to cattle grazing and the coffee, tea and pyrethrum industries there are opportunities for other forms of agriculture, particularly in the form of annual crops which may be used as food for man and livestock.

THE EFFECTS OF CASH AGRICULTURE ON THE SUBSISTENCE ECONOMY

The immediate effects of cash cropping and animal husbandry on subsistence agriculture in the New Guinea highlands have been as follows:-

(a) A tendency towards a more sedentary agriculture. Coffee gardens for example, induce people to remain at the one village site. The fallow period between subsistence crops has been shortened, with the result that the land immediately around the village is used most of all.

(b) With increasing cash income, mainly from coffee and the sale of fresh vegetables and meat, some food is now being purchased, as well as cooking utensils, clothing and building materials. Subsistence garden areas have been reduced compared to former times. This is the first real step toward a cash or partly cash economy because it stems from the realisation that it takes less effort to support a family by growing a cash crop with a relatively high return and then purchase food, than trying to grow all the family's food needs, which involves a very high labour input.

(c) A process has been set in motion whereby increased wealth within the community means that higher economic goals have been set and improved methods of agricultural production can be applied which before may have been too costly to people with little or no cash income. An example of this is in the Goroka Valley where returns from coffee production are being invested in livestock (McKillop, 1966). Indeed, in the Goroka Valley some individual farmers now have the means to invest in the hiring of tractors or the purchase of rotary hoes, etc.

(d) The introduction of grazing animals has meant that some fallow areas have been utilised whereas before they were lying idle as part of the traditional bush fallow rota-

tion. About 75 per cent. of the Goroka Valley, for example, is at present unused grass land (McKillop, 1966).

(e) A joint effect of cash cropping and animal grazing has been the movement towards the changing of traditional forms of land tenure. The old system appears satisfactory for the subsistence agriculture it supports, but those people who are engaging in more intensive crop/animal production involving capital investment are pressing for a more secure tenure of their land, often on an individual basis. This process in lowland areas has been accelerated by the example of the Administration, which purchases land from the people and then subdivides into small-holdings. One would expect the same catalytic effect in the Highlands, particularly in areas close by Administration land resettlement schemes.

THE EMERGENCE OF FARMING SYSTEMS

In the Western Highlands District, settlement of land under Administration control is being carried out at Nondugl, Kindeng West and Kondepina. The farm size is usually eight to ten acres. Tea is being established as a first avenue of income and this is based, as with cocoa, rubber and coconuts in land settlement areas in the Papua and New Guinea lowlands, on the concept of family labour units.* It is thought that the area of tea which the average family could handle (that is a family with one and a half labour units available each working day of the year) would be two or three acres, including labour for subsistence requirements.

One model farm is being developed in the Western Highlands and one at Aiyura in the Eastern Highlands. It is hoped that settlers will use many of the ideas being demonstrated. Around the boundary of the farms trees of a local species of *Casuarina* have been planted in a single line at close spacing. These are rapid growers and will be thinned as they grow and used as a source of fire-

* Department of Agriculture Stock and Fisheries Circulars Nos. 2, 7 and 9 of 1963. These are standard plans and budgets which may be modified to suit local conditions.

wood and building materials because of the often chronic shortage of firewood in grassland areas. *Casuarina* is planted in bush fallow rotation systems in the Highlands for subsequent use as firewood and terracing of steep hillside gardens (Barrie, 1956). The farms are being planted with three acres of tea (one acre in each of the first three years). An area of about one acre is allowed for home site, tea nursery, a few citrus trees and minor subsistence crops such as maize, taro, sugar cane, bananas and pineapples, leaving about four acres available for other activities. It is considered that by introducing cattle into the land resettlement schemes this remaining land could be used at little extra labour cost to the farmer. This would be preferable to growing sweet potato haphazardly for subsistence. Rather should sweet potato be included in a rotation, with the possibility of building up a regular supply to plantations and to local markets. In addition

to cattle, a substantial cash income may be possible for more advanced settlers growing fresh vegetables supplying coastal markets.

Apart from the land settlement schemes there has been little evidence of the emergence of farming systems in the Western Highlands. The development of the coffee and pyrethrum industries by indigenous farmers in this area is as yet in its infancy.

There is no doubt that farming systems are beginning to develop in the Goroka Valley of the Eastern Highlands. These are small scale systems using a combination of subsistence/pigs (with all pig food being grown on the farm) or subsistence/cattle. Coffee may or may not be included in either system. The standard of livestock management is variable and is sometimes quite high, especially in the case of the pigs.



Plate I.—A small intensive pig project in the Goroka Valley. (Photo R. F. McKillop).



Plate II.—A mixed crop garden of corn (*Zea mays*) and sweet potato (*Ipomoea batatas*) to be used for sale and for pig feed. (Photo A. J. Kimber).

Pig projects in the Goroka Valley are being developed along intensive lines, that is with a minimum of grazing, mainly because of the internal parasite problems involved if improved breeds of pigs are grazed (Plate I). Houses are of bush material and/or sawn timber, usually with a roof of corrugated iron. All projects have cement floors and provision for a water supply (usually from a race) to facilitate daily cleaning. The economics of the projects, particularly in regard to labour, are uncertain. The usual practice is to feed the pigs with sweet potato tubers and leaves growing close by, occasionally supplemented with greens (Plate II). Some individuals are beginning to plant soybeans in an effort to raise the protein level of the ration. The pig projects are not farms, demarked on the

ground as such, largely because of the indigenous land tenure system. However the various activities reflecting the working of a farming system are present.

There are now 352 head of cattle in 38 projects in the Goroka Valley (Plate III). Each project has a night paddock of at least five acres. In many recent projects this area is 20 to 30 acres and in one case 100 acres. The fenced area on cattle projects is in excess of 500 acres and is increasing at the rate of 20 to 25 acres each week (McKillop, 1966). For cattle McKillop states that fencing and livestock should be under individual ownership, which is not always the case, and that the fenced area could form the nucleus of a future family farm.



Plate III.—Cattle on a typical project in the Goroka area. Pasture of a stand of *Setaria sphacelata* (Photo A. J. Kimber).

All pig and cattle projects in the Goroka Valley are sound attempts at good husbandry practices, but they are largely feeling their way, not only because of the transition involved for the indigenous farmer himself, but also because of the lack of critical information on the associated crop and pasture production. Basically, for the cattle projects, there is need for information on how best to establish an improved pasture on these small-holdings, which are quite hilly and without machinery. For the pig projects, in view of the relatively high standard of management adopted, there is need for work to be carried out on suitable crops that can be utilised for pig feed. In time one might visualize specialised feed producers supplying pig farmers.

This would be one way of overcoming the present high costs and would seem to be even essential if individual farmers are to expand.

In view of the high cost of purchase of eggs, there is considerable scope for poultry as a sideline for some farming systems, if not for specialised production. Importing feed to the Highlands makes the profit margin in poultry farming small, even in competent hands, so the answer appears to be in feeding locally grown material. It would be possible, for instance, to incorporate a small intensive poultry house on a settler's block and grow the feed for the poultry in rotation. The problem of finding balanced cheap rations has been solved (Ross and Springhall, 1965) and it remains to find out how to grow the required feedstuffs intensively.

FACTORS ASSOCIATED WITH THE DEVELOPMENT OF FARMING SYSTEMS

Land Tenure

Numerous examples have been given in the literature of indigenous land tenure in Papua New Guinea (Barrie, 1956; Crocombe, 1964; Crocombe and Hogbin, 1963; Jackson, 1965; New Guinea Nutrition Survey Report, 1947; Rimoldi, 1966; van Rijswijk, 1966). The usual unit of land ownership is communal. The community may be in the form of a tribe, a village, a family or some other social group. Individuals have various rights to land, such as cultivation, hunting and harvesting certain trees etc., by virtue of their membership of the community. Inheritance patterns vary and may be patrilineal, matrilineal or bi-lineal. Although inheritance of land is often on an individual basis, the sale or transfer of what may be called economic areas of land usually becomes an affair of the community. This is especially so in many parts of the Highlands where fragmentation of land ownership is a problem in developing farming systems.

Taking the country as a whole, Papua and New Guinea is in the fortunate position that the introduction of cash cropping, combined with the prevailing subsistence agricultural pattern, has not created any serious land shortages for food production. There are certain areas where shortage of land is evident, as for example in the Gazelle Peninsula, the Chimbu district and some areas of the Sepik district. Generally the New Guinea highlands are more densely populated than other areas, an example being the Chimbu district, the most populous of all, where the density is about 60 per square mile (population census, 1966). The density on arable land would be much greater than this and so Montgomery (1960) concludes that in the Upper Chimbu Census Division cash cropping should not be allowed to supplant subsistence agriculture because of the interference which would occur with the food needs of the people. Accordingly, he says, the economic potential of the Upper Chimbu is poor.

However, since 1960, when these observations were made, there have been various developments in Administration settlement in Papua and New Guinea and some Chimbu people will in future be migrating to other areas where leasehold land for cash cropping has become available, especially in the West New Britain district. This is not likely to have a substantial effect on the population pressure, though it will help, together with movement to employment opportunities in towns, industrial developments and possibly permanent employment on large plantations instead of the present recruitment system. Apart from migration there is the example of Kenya where statements were made in 1946/47 of how every African area there was grossly overpopulated, but later thoughts on the subject are much more optimistic because of the development of land resettlement and farm plans allowing for a much more efficient use of available land (Brown, 1957).

At present over 97 per cent. of the land in Papua and New Guinea is held under indigenous tenure. Not all of this is arable, but it represents the greatest potential for agricultural development in the country. Land consolidation is therefore important in the development of farming systems. Apart from the purchase of land by the Administration for subsequent subdivision and leasing as smallholder blocks, there is now opportunity for the consolidation of indigenous land into economic areas of secure tenure (Land Tenure Conversion Ordinance, 1963) (Plate IV). Perhaps the most encouraging sign is that in certain areas of Papua and New Guinea, such as the Northern district around Popondetta and Kokoda, land tenure conversion to individual blocks has become highly desired by the people. However, advantages such as these, when they occur in the Highlands, need to be followed up by new farming techniques, otherwise there will be a tendency towards continuous cropping and subsequent rapid depletion of nutrients and loss of viable soil structure. These problems are even more pressing in the Lowlands where the clearing and burning of forest results in rapid leaching of nutrients and yields are likely to decline after the first one



Plate IV.—An indigenous market garden, near Goroka, on land owned by a single individual.
(Photo A. J. Kimber).

or two crops (*Department of Agriculture, Stock and Fisheries, Annual Reports, 1956-64*). Conversion of land to individual title is not encouraged in heavily populated areas because consolidation into what would be sub-economic areas would be valueless and would therefore create an unfavourable impression from a landowner's point of view.

It is not known if a system of land tenure based on individual title will overcome all or most of the impediments placed on agricultural development by traditional tenure systems. However, in the author's experience in the Northern and West New Britain districts, it does at least provide an initial stimulus to cash cropping on an individual basis. The advantages and disadvantages have been summarised by Brown (1957).

Size of Holding.

This will depend on the type of farming programme envisaged. In lowland areas, on Administration settlement schemes, the acreage of land that a man and his family can handle is reasonably well established for such crops as cocoa, rubber and copra.* Size of holding is designed according to the crop plus an extra quite substantial area of land, to allow for future development and subsistence. A similar situation exists for the Administration tea settlement schemes in the Highlands.

* *Department of Agriculture, Stock and Fisheries Circulars Nos. 2, 7 and 9 of 1963*. These are standard plans and budget which may be modified to suit local conditions.

In land tenure conversion schemes size of holdings can be fairly well controlled, but it can vary according to the number of people who have an interest in the particular area to be subdivided. Individual titles would not be granted on sub-economic areas, but because of the extending range of commercial agriculture in the Highlands information is now needed on yields of the various crops under local conditions so that realistic plans and budgets can be prepared and minimum economic areas determined.

Machinery.

Up to the present time the increasing income of most indigenous farmers has been from expansion of areas planted to perennial tree crops. There is a need for diversification, particularly as tree crops are a long term investment and alternative quick return cash crops mean that farmers can withstand price fluctuations in the former more easily. In this connection the use of machinery is particularly relevant. Whitehead (1962) describes various applications of Japanese machines which are often unique in design and Phillipson (1962) and Boshoff (1961) advocate the use of walking type tractors on farms. Boshoff reports that in trials conducted in Buganda prior to 1958, the conclusion was that because of their unreliability, the effort required to operate them, the limited range of accessory implements and the lack of skill of the operators, these machines would not be suitable for use by African peasant farmers. However, subsequent trials led to the conclusion that two types of walking tractors tested would be satisfactory, but certain conditions would have to be fulfilled before they could be economically employed. These included the following:

(a) On the smaller farms the machines would have to be occupied in alternative productive work such as weed control in coffee, water pumping, coffee hulling and transport, thus making up for the restriction in farm size. Alternatively, contract work could be undertaken.

(b) A technique would have to be developed for the training of farmers so that machines would be sufficiently and efficiently utilised and maintained.

This type of tractor may provide an attractive alternative to the use of tractor drawn machinery to many farmers in the New Guinea highlands, particularly at their present stage of development where operations may not be sufficiently large scale to require the use of a large tractor and where labour is often unreliable. They would also be more practicable on hillside farms and could be used for a variety of purposes similar to those mentioned.

An alternative to the ownership of machinery by individual farmers would be to use contract tractor operation. This would ensure perhaps a more efficient use of machinery.

Credit and Labour.

Stent (1962-63) lists four pre-requisites which must be met for any rationalisation of peasant agriculture to be successful. Among them he considers that farmers must have financial assistance available to them. Credit for family farming has been important in the pattern of development of Administration settlement areas in Papua and New Guinea (Cheetham, 1963). Agricultural loans can be obtained from the Papua and New Guinea Development Bank and terms are usually for the development of a minimum economic area, or what is estimated to be such, for one farmer using family labour for the various crops concerned. This has applied mostly to the lowlands settlement areas on Administration leasehold land and so far loans have not been granted for the tea settlement areas of the Highlands.

However, apart from the family labour concept, the Administration is ready to give those who have demonstrated their ability opportunity, in the form of loan monies, to develop their interests beyond that which can be handled by family labour. Despite the fact that many settlers are not suitable as employers of labour, there are indications that the more competent indigenous farmers can both employ labour and use machinery. Examples can be found of settlers on settlement blocks in the Popondetta, Gazelle Peninsula and Cape Hoskins areas employing extra labour in addition to carrying out

the development programme undertaken with their loan monies. Some have been granted extra loans.

In these settlement areas, however, extra labour is often paid for out of private finances or it is employed at no immediate cost to the settler under the terms of indigenous social structures. One can envisage the same pattern occurring in the settlement areas of the New Guinea highlands where labour is more plentiful. It may become useful also in areas of tenure conversion where it is not so important that loans be granted because farmers, though they may be considered "settled" on blocks, particularly if they build their houses on them, cannot be considered as being "resettled" in foreign areas and they will, therefore, already have subsistence gardens and a house. Loans for development can be granted to such individuals, provided they have demonstrated their ability, but any tendency to associate automatic credit with tenure conversion would be detrimental to the aims of the latter.

Before extra loan monies can be granted, however, it is important to the development of farming systems that accurate records of the performance of labour be obtained. Clayton (1960) lists three possible methods of recording labour:

(a) By observing and timing randomly chosen individuals as they work on their normal farm tasks. Although sometimes difficult to assess, this method when spread over an adequate number of individuals can be quite accurate.

(b) By operating a farm plan and system with a controlled labour force. This means data are relevant to the particular plan but can be expensive. It is nevertheless possible to separate different parts of the system, for example a small piggery or a small vegetable growing project and apply the findings elsewhere.

(c) Recording labour spent on stock and crops over a long period, but within the setting of a farm system.

Each of these methods is already being used in the New Guinea highlands. Observations are being made under the conditions of (a) in the Western Highlands where settlers are

at the moment planting tea and subsistence gardens. In regard to (b) records are being kept by staff supervising the demonstration settlement blocks, one in the Western Highlands at Nondugl and one in the Eastern Highlands at Aiyura. Recording has begun along the lines of the third aspect at Aiyura and with certain crops, especially coffee and sweet potato, has been going on for some time. When records are more complete it will be possible to compare the results of the three methods.

The Problem of Fertilizing and Rotations.

As knowledge of the farming potential of the Highlands increases, land can be utilised more intensively, but in the meantime it will be necessary to adopt systems which can be readily applied and improved upon as experience and experiment suggests. Wakefield (1948) points out that it is impossible to improve soil fertility by trying to find ideal crop and crop/grazing rotations without the use of fertilizers. It may be possible to maintain and improve soil structure, use crops less demanding on the soil, add nitrogen through legumes and increase yields after grass fallow but all the time soil reserves are being depleted and must eventually be replaced.

If the emerging farming systems discussed previously in the section '*The Emergence of Farming Systems*' are to become more viable, the question becomes one of deciding whether systems more intensive than bush fallow rotation can be applied under the circumstances. It is necessary to be aware of the basic changes that occur from an agronomic point of view:-

- (a) because the farmer becomes sedentary, lengthy bush fallow is eliminated and the rotation is speeded up,
- (b) a variety of new crops is grown to suit commercial conditions. This does not mean that subsistence crops are eliminated, but rather they become a relatively minor part of the farming system,
- (c) the old concept of allowing time for the release of nutrients from soil minerals to restore the fertility of the soil and for control of disease and insect pests disappears and is replaced by more productive methods.

In the New Guinea highlands generally the large areas of grassland are usually thought to have arisen from frequent cultivation, often combined with the practice of burning for hunting and preparation of food gardens, preventing the regeneration of forest trees. This often leads to the conclusion that the soil fertility cannot be high since deep rooting forest trees have not been present to recover leached minerals from greater depth and the accumulation of organic matter under forest has not taken place. Adherents of this idea would further state that soil fertility and presumably structure under these conditions must be gradually declining. This is supported by the fact that the people do not usually leave their food gardens in the one place for more than three years before moving to a new site.

On the other hand it is commonly acknowledged that grassland areas give a good yield of most crops. Especially is this so with sweet potato in the second and subsequent croppings and it is thought at Aiyura to be due to the first cropping helping to mobilise soil nutrients after the grass fallow. In addition, tentative results of soil exhaustion and crop rotation trials at Aiyura (*Department of Agriculture Stock and Fisheries, Annual Reports, 1956-64*) indicate the possibilities of continuous cropping on some grassland soils. The soil exhaustion and crop rotation trials are sited predominantly on a black to brownish-grey light to heavy loam up to 16 in. deep, with a dark-grey to grey clay-loam sub-soil down to as deep as 38 in. and subject to a periodic water table. Though this soil structurally responds well to cultivation, it would not be regarded as first class. The variety of sweet potato used in these trials was inadvertently changed about 1961, when the higher yielding variety Akaio was substituted for the less productive though popular Gonimi. This however, has not altered the fact that it is possible to continuously cultivate a grassland soil, since current yields in the rotation trial (20,000 lb./acre) compare well with local village plantings and in the exhaustion trials are still economic, though variable (about 16,000 lb./acre).

However, the question may be asked, why do subsistence farmers themselves not cultivate for longer periods? In addition, why do they cultivate steep slopes, unless it is because more favourable areas are quickly depleted? The cultivation of steep slopes, however, is commonly given over to sweet potato because this crop requires better drainage conditions than can usually be found on the flatter valley floors. Further, there are social customs and spiritual beliefs prompting many people to rotate their land. An example of shifting due to insect pests and not soil fertility decline is of the Orokaiva people of Inonda village in the Northern District of Papua (Crocombe and Hogbin, 1963).

Many farming systems in other developing countries are based on the value of crop and grazing rotations as a means of maintaining soil fertility. Such systems are often used because of the impracticability of applying fertilizers under the local conditions of costs and lack of knowledge by farmers. The basic factor in developing farming systems in the New Guinea highlands at the moment is to ensure that productivity does not decline through more intensive land use. This involves aiming at the conservation and improvement of the nutrient and structural status of soils. The use of a grass fallow is practical for farming systems because it is cheap and conservative. Moreover, other experimental work has shown that in many tropical areas soil fertility and hence crop production can be maintained at an adequate level (Jameson and Kerkham, 1969; Kerkham, 1947; Martin and Biggs, 1937; Pereira, Chenery and Mills, 1954) by the inclusion of a grass fallow, with or without grazing. The crop rotation trial at Aiyura supports the contention that fairly conservative systems based on grass and/or legume fallow might reduce depletion of soil reserves to the level where fertilizing may not become critically important for some time. The time factor will depend on soil type and inherent soil fertility and will vary from soil to soil. It seems also in the New Guinea highlands where cattle are incorporated into systems of farming that grazed fallows or ley pastures would improve soil structure after cropping. Generally

speaking, there are good prospects of recommending farming systems for indigenous people who have little or no knowledge of the use of fertilizers. However, the use of fertilizers by more progressive farmers should be encouraged.

The traditional background amongst New Guinea highlanders is one of mixed cropping. This raises the question as to whether this should be continued or replaced by pure stands in rotation. The best possibilities for inter-cropping are where machinery is not used for harvesting and this perhaps is a sound approach for small scale farmers at the moment who are growing their own pig feed and perhaps in the future, poultry feed. Results from Tanganyika (Evans, 1960) indicated that over a wide range of populations inter-cropping maize and sorghum with groundnuts generally leads to greater overall crop production per acre than growing the crops in pure stands. This was found so in two years of different rainfall, one favourable, the other unfavourable, and in two areas where soil fertility was contrasting.

In the Eastern Highlands of New Guinea coffee has so far been the means by which people have accumulated some money for investment in other forms of agriculture, at the same time retaining their interest in coffee. The mulching of coffee is one method of utilising material which may otherwise be inefficiently used. Schindler and Fraser (1964) demonstrated the superiority of mulching over clean weeding and cover crops in coffee shaded with *Albizia* sp. They concluded that labour requirements for mulching were very high, but that the yield increases obtained in the third and fourth years more than compensated for the extra cost involved and the advantage could be expected to continue. They recommended that a yearly application of six tons of elephant grass mulch per acre, whether in a single or in two applications, would be sufficient to give a worthwhile return. Alternatively any other material easily obtained would be useful. In this regard the use of maize stover for mulching material is of particular interest, as reported by Mehlick (1966). Under New Guinea highlands conditions maize is of only

minor importance in the subsistence diet, so the grain could perhaps be used as a cash crop for supplying pig or poultry farmers, or alternatively for the farmer's own pigs or poultry. Another consideration would be a sorghum variety capable of producing both grain and mulching material, since this too may be useful as a cash crop supplying feed to pig and poultry projects (McKillop, 1966).

SUMMARY AND CONCLUSIONS

It has been shown that the traditional subsistence economy of the Eastern and Western highlands of New Guinea is being greatly modified and that if the standard of living of the people is to be raised, then this change is desirable. However, if improvements are to continue, consideration must be given to the consolidation of and the granting of individual rights to land as quickly as possible in areas where population pressure is not too great. In overpopulated areas it is probably necessary that there be some evolution of rights within the traditional system and some outward movement of population so that remaining individuals will have rights to economic blocks, before tenure conversion would be desirable. The more widespread use of credit by competent individuals is also desirable.

In the Western Highlands, apart from the relatively new coffee and pyrethrum industries, there are possibilities of developing farming systems in Administration settlement schemes. These include tea as a permanent cash crop, but sufficient land remains on each block for other activities such as cattle grazing. It may be possible for more advanced farmers to get extra income from high return annual cash crops grown in rotation with grazing on grass fallows or ley pastures.

In the Eastern Highlands, returns from the indigenous coffee industry are now being invested in cattle and pig projects. Certain farming systems have been initiated, especially in the Goroka Valley, and these will, under their own momentum and with proper guidance, develop into more definite systems on land consolidated into individual tenures.

The ultimate in farming systems is to have all relevant information available so that accurate budgets may be prepared, either partially or on a whole farm basis. This is necessary so that realistic proposals can be made by farmers to obtain credit. Before this is possible, critical information on certain crops is required and the following are some suggestions:

(a) Selection of crops suitable for the growing of pig and poultry feed, perhaps with the residues of some being used for the mulching of coffee. Possibilities include sweet potato, maize, sorghum, soybeans and groundnuts.

(b) Methods of cultivation. For the small scale producer, mixed cropping may be more productive than growing one stand crops. Selection of varieties needs to be carried out and establishment of optimum planting distance concurrently with fertilizer requirements. There are also possibilities of large scale production of these crops in the not too distant future, perhaps using mechanical preparation, planting and maintenance and using hand labour for harvesting.

(c) Investigations into methods of growing fresh foods such as potatoes, beans, peas, cabbage, strawberries etc.

(d) Investigations into labour and capital inputs relative to yield of all crops.

(e) Investigations into suitable species for ley pasture under Highlands conditions.

It is important that farming systems be allowed to develop with a certain amount of flexibility to allow for variations in climate, markets and preferences of individual farmers. There is a need for some systems to be organised (as for example when indigenous farmers do not understand supply and demand situations) but because of the overall picture in the Highlands of little land shortage there is opportunity to develop these systems as the agricultural knowledge of the people regarding cash cropping becomes greater. Thus simple rotations at first may be best, adopting sound agronomic practices, yet at the same time being able to be fitted in with the capabilities of the people. It would be legitimate to use up some of the soil reserves,

as long as it is done conservatively, until economic conditions are such that they can be replenished with artificial fertilizers.

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