Future potential of crops other than sweetpotato in the Papua New Guinea highlands

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Introduction

Agriculture sustains more than 85% of the population of Papua New Guinea (PNG) and is the mainstay of the rural people. Although characterised by low input and hence low productivity (Gwaiseuk 2001), the overall contribution of the food crop sector to the economy is estimated at 1.3 billion PNG kina (K) with a non-market component valued at K750 million (Gibson 2001a).The non-market component is generally consumed at home or the site of production. Although it looks substantial in value, the agriculture sector's overall contribution to GDP (at 1%) lags behind the population growth rate of 2.3% (Gwaiseuk 2001), presenting serious implications for policymakers, researchers and other stakeholders directly involved in the agriculture sector.

Nevertheless, for the next 30 years, a growing population will demand improved standards of living that will place great pressure on PNG's land resources (Bourke 1990). The population of PNG was 2.0 million in 1966, 3.9 million in 1990 and is conservatively predicted to reach 6.9 million by 2015 and 8.0 million by 2020 (Allen et al. 1995). The country's economy will be unable to provide waged employment for other than a very small proportion of this expanding population. In 1990 approximately 9.3% of the population of PNG aged between 15 and 64 years were in waged employment. Although a mining boom will provide 3–4% growth in waged employment (mainly in construction and utilities), it is estimated that labour force growth will exceed waged employment growth by 40,000 persons per year for the foreseeable future (Allen 1995).

PNG is an agricultural country and it is likely that its increasing population will continue to rely heavily on agriculture in the foreseeable future. More land will be brought into production, and it is in the dense population areas where population pressure on land is becoming a problem. Despite the reporting of critical shortages of land in the highlands, no systematic treatment has been undertaken to relate land use to population density. However, recent data from the PNG Agricultural Land Use Survey suggest that several areas could face similar land-use problems (Sem 1996).

In the highlands, agricultural productivity per land area has generally been high. However, most highlanders have depended heavily on sweetpotato cultivation for centuries, and their cultivatable lands have already been exploited and the fallow periods extremely reduced. This has eventually led to permanent cultivation in many locations (Ohtsuka 1996). As Wood (1984) suggested, soil erosion became manifest in the central highlands as early as the 1950s. Consequently, it will be difficult for highlands farmers to maintain their present agricultural productivity unless the agricultural system is modified.

Agriculture in the economy

Agricultural growth in the highlands is seen to be a catalyst for broad-based economic growth and development in the region. It links to the non-farming economy and generates considerable employment, income and growth in the rest of the economy. Agricultural growth and development is pursued in the highlands for the following reasons:

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- to alleviate poverty through employment creation and income generation in rural areas
- to meet growing food needs (driven by population growth and urbanisation)
- to simulate overall economic growth, given that agriculture is the most viable lead sector for growth and development
- to conserve natural resources through sustainable farming practices.

Over one-third of PNG's population is concentrated in the highlands region, which is only 13.5% of the total land area. Although the average density for the 10 highlands regions is 22 persons/km^2, it is reported that in some fertile highlands valleys densities exceed 200 persons km^2 (Allen 1984), and it is in these areas that reports of population pressure on land have been most frequent. The farm size under subsistence cultivation was estimated to be between 0.08 and 0.24 ha per capita, with an average of 0.12 ha in the highlands (McAlpine 1967, 1970). No reliable information is available as to whether these statistics are still applicable in 2008, but local knowledge suggests that farm sizes for individual households have not changed.

Coffee is the main cash crop, with some cash income generated by the sale of food crops, spices and livestock. Sweetpotato dominates food production in the highlands. Other staple foods include banana, taro, cassava and yam. A wide range of traditional and introduced fruits and vegetables is also grown. There are generally two types of gardens—house gardens are small and intensively cultivated around the edge of settlements, whereas main gardens are often further away from the settlement. The combination of crops found in any garden is associated with the length of the preceding fallow period. New gardens display a greater variety of food types, indicative of higher fertility. As gardens age and fallows shorten, soil fertility declines and there is a progression to sweetpotato-dominant gardens.

Latitudinal differences in solar energy, temperature, rainfall and soil nutrients are some of the ecological constraints on agricultural systems (Bayliss-Smith and Feachem 1977). Often, a farmer is unable to directly control the constraints of solar radiation, temperature and rainfall but is able to adapt to changes brought about by these constraints. PNG farmers have been able to adapt to seasonal and annual climate fluctuations and socioeconomic conditions so that agriculture has remained the mainstay of rural societies (Bourke 1983). Some of these responses and mitigating factors have resulted in the development of elaborate farming techniques. These include mounding, terracing, mulching, ditching, draining and irrigation systems that are now considered to have developed independently of the major agricultural areas of the world. Some writers ascribe development of such techniques to the introduction of new crops, population growth and increased demands for social production (Brookfield 1972), plus a combination of all these factors. This technological change/innovation is a result of the agricultural intensification that is now evident in PNG.

It was only after the most recent droughts in 1997 that people in the region realised the fragility of the farming systems and, more importantly, the fact that food insecurity in both its transitory and chronic forms poses a real threat.

Any attempt to develop sustainable agriculture must be based on eradicating poverty and stemming urban drift. Production systems should serve the needs of small-scale farmers. This requires the knowledge and use of traditional indigenous technology as well as scientific research, especially into the biological processes that govern agricultural production. This approach would entail the development and adoption of diversified farming systems that make the most efficient possible use of external inputs, while having a minimal negative impact on the environment.

People in the highlands have been finding innovative solutions to these problems. One solution has been to intensify subsistence production by reducing the length of fallow periods and increasing cropping periods, and this has been occurring over the past 60 years or so. If left unchecked, this sort of intensification will eventually result in declining soil fertility. However, declining soil fertility and reduced garden areas have been offset by the adoption of new, high-yielding crops (both species and cultivars). More recently, farmers in the highlands have demonstrated their ability to adopt new technology by accepting large-scale farming, improved farming practices, mechanisation, irrigation and the use of fertilisers and pesticides. Semi-commercial and commercial farms of varying sizes on communal and private land have emerged as a result of favourable market prices for produce.

Food and nutrition and sustainability issues

The highlands diet is rich in carbohydrates but poor in protein, fats and vitamins. Protein deficiency is identified as a major problem despite adequate resources of high-energy, starchy foods such as taro, yam, sweetpotato and sago (Norgan et al. 1979). Children are particularly susceptible to protein deficiency because growth and development require daily intakes of protein. As a result, during colonial days legislation was made that stipulated the compulsory vitamin enrichment of imported foods like rice (Mills 2002). Many PNG children are malnourished according to the Food and Agriculture Organization of the United Nations standards, and malnutrition remains a basic cause of poor health for rural people. The vulnerable groups of people are children, pregnant and postpartum mothers, sick adults and the elderly (Benjamin et al. 2001). Malnourished children in the schooling age group, who are vulnerable to preventable diseases due to low resistance to infections, can miss their education, eventually resulting in illiteracy, poverty and low productivity among rural people. Attempts to supplement the local diets are well documented; for instance, in 1936 (Densley and Cairns unpublished) the labourers at Aiyura were fed wheat meal and soy meal rations.

At present almost 35% of the population, representing about 2.1 million people in PNG, are undernourished. Based on a household survey conducted in 1996 (Gibson 2001b), it was estimated that about 50% of the children in the rural areas showed stunted growth. This survey revealed that, while per capita daily calorie availability was very similar in both the rural and urban areas, there was significant disparity in per capita protein availability, with a difference of 31% between the rural and urban populations. As a result, rural children were more prone to malnutrition (Muntwiler and Shelton 2001). Generally, the malnutrition rate in PNG is on an 'upward trend', suggesting that more of the population (especially children) are being affected. When trends in the last 5 years are compared, the increases in malnutrition have been very nominal, in the range 0.1–0.3% between 2001 and 2004; however, during 2004–05 there was a dramatic increase by 2.6%, which depicts the possibility that malnutrition could worsen in the future.

Availability of protein in the diet seems to be a major contributing factor to malnutrition in PNG. In another study it was noted that socioeconomic factors such as more possessions (an indication of more disposable income) correlated positively with child health (Mueller 2001). However, the fact still remains that a large majority of the people are income disadvantaged, and the traditional source of protein from wild game is now critically in short supply.

What is crop diversification?

Crop diversification within the context of household food production is a risk aversion strategy adopted by farmers to spread the risk of crop failure, to add diversity to their diets and to adapt to the limitations imposed by the environment. Almost all gardens in the highlands grow more than one crop to meet household food and economic requirements. Studies in the Markham Valley demonstrated that, in a more marginalised environment, farmers tended to diversify the number of crops that were grown and the area occupied (Saese et al. 2007). Small (1995) defined crop diversification as 'programs of expanding the number of crops in a region, in the hope of increasing overall productivity and marketability'. Wallis et al. (1989) noted that it was important to have well-developed selection criteria to identify successful new crop industries in any region. Although the idea will not be dealt with extensively in this paper, crop diversification can also involve conventional crops.

This type of activity falls into a number of categories:

- adaptation of the crop to grow in new ecoregions; for example, the Markham Valley is currently underused for peanut production, and the development of new adapted germplasm could have a remarkable impact on productivity in the area
- research and development to identify unique components or constituents that can be extracted from conventional crops, such as the industrial extraction of starch from sweetpotato or cassava for ethanol
- development of cultivars that are adapted to specific production systems, such as varieties that perform well within organic cropping systems
- the use of transformation technologies to develop new types of conventional crops that have the capability of producing high-value products through the still-evolving tools of molecular biology (such as pharmaceutical products).

Development of such products must include a public education component regarding their value, as well as a secure system of production to ensure no risk to conventional production and marketing systems.

Why diversify?

Crop diversification is driven by several motivating factors (Connor 2001), including the following.

Low conventional crop prices

Efficient producers have a clear picture of how conventional crop prices will influence their profitability. When conventional crop prices fall due to overproduction and subsequent oversupply, they look for other alternatives (Thompson 1988). The overall goal of crop diversification is to increase profitability.

Innovation

The rapid inclusion of any new technology has provided a great opportunity for many industries. Producers and processors are always eager to get in on the ‘ground floor’ of a new idea that promises to be lucrative. Due to the increased level of knowledge available through new resources such as the internet, plus international contacts and the interest of some producers, much greater emphasis has been placed on the assessment of new crops. The aim is to establish the potential of species from other parts of the globe, for example oil palm in the lowlands and pyrethrum in the highlands of PNG.

Environmental protection

The inclusion of nitrogen-fixing legumes, tree crops, fibre crops and other bioproduct crops in cropping systems can have advantageous effects. These benefits can be obtained by reducing the requirement for application of inorganic fertilisers, decreasing the need for forest fibre through annually renewable agricultural sources, increasing the potential for minimum tillage in annual cropping systems, and establishing long-term perennial plantations.

Risk reduction

The inclusion of several species in a crop production plan can have the advantage of buffering low prices in a specific crop. Diversification allows a producer to balance low prices in one or two crops against reasonable returns in other commodities.

Biodiversity

An additional advantage to increased numbers of crops is that the enhanced biodiversity can reduce problem insects and diseases, as well as create new opportunities for innovative weed management through extended crop rotation.

Development of new production systems

The advent of herbicides and their availability in PNG has created a new window for crop diversification. Intercropping of annual crops (for both grain and fodder production) with coffee, cocoa, coconut, oil palm, timber and other perennial cropping systems can be considered to maximise yield and quality.

Opportunities for diversification in PNG highlands

PNG has been rated as one of the least developed countries because of poor living standards and poverty, which are manifested through malnutrition and undernourishment, low cash income and purchasing power, highly unbalanced income distribution, high unemployment and underemployment, consistent problems of law and order, high and rising food imports, and overall low rating as per the development index (UNDP 1999; World Bank 2006).

Cereal and grain legumes have emerged strongly since World War II and by now have become prominent in the PNG food basket. They contribute a significant part to national nutrition and calorie requirements, and thereby play a critical role in national food security. PNG has a high and increasing demand for cereal and grains, with annual imports estimated at 303,000 t with a total sale value of K526 million. This gives a per capita consumption of 70 kg/year and contributes about one-fifth of the total national calorie intake (Mills 2002). In addition, the rising trend of imports has obvious and serious implications for the food security and self-reliance of the nation. PNG has equally high but untapped production potential for cereal and grain crops, but concrete efforts in terms of research and development are lacking. This potential should be harnessed not only to reduce the import bill but also, and more importantly, to ensure food security, generate gainful employment, raise incomes and improve income distribution in the country.

Furthermore, there is a worldwide demand for edible oils, especially those with low cholesterol contents such as from corn, soybean, sunflower and peanut (Hymowitz 1990). The arable and fertile valleys of the highlands are highly suitable for the production of feed grains (sorghum and corn) and oilseed crops (soybean, sunflower and peanut). This presents an opportunity for export if these crops are effectively produced as well as processed in PNG.

Grain legumes in PNG are usually cultivated predominantly as intercrops or mixed crops with other traditional staple crops, with the exception of peanut which is generally cultivated as a sole crop. Apart from peanut, the majority of grain legumes are consumed primarily as green vegetables rather than directly as grain, or processed into other products like tofu (produced from soybean mainly in Asian countries) or feed products.

Grain legumes constitute an important part of household food consumption in the rural parts of PNG, where protein from meat and wild game are in seasonal supply and often very scarce. Protein availability in the diets of children in the rural areas is about 50% less than that in the urban areas (Muntwiler and Shelton 2001). As a consequence, it is estimated that more than half of the children in rural areas show stunted growth (an indicator for malnutrition) compared to 20% in urban areas (note that these are average figures as there are variations among urban populations which are dictated by the level of income earned by individuals, and differences in rural populations dependent on the staples produced).

Unlike protein from meat, which is quite expensive and not easily accessible to most rural households, the promotion and adoption of new and appropriate varieties of grain legumes in the farming systems will have a far-reaching impact on improving the nutritional status of the rural population in PNG. It is possible that, by doing so, the widespread malnutrition recorded in children in the rural population can be significantly reduced.

The subsistence production and consumption of legumes has increased, with an estimated 12.7% of the rural population now consuming legumes largely as fresh vegetable compared to 7.8% of the population in urban areas (Gibson 2001b). Although data on the volumes and type of grain legumes produced and consumed in the rural areas are not available, general observations reveal that several selections of grain legume are now being cultivated and consumed on a regular, if not daily, basis. Soybean (*Glycine max*), for instance, has a slightly longer history than other beans or peas. It was first reported as a potential crop in the highlands in 1936. Initial trials conducted in 1937 at Aiyura showed some promise, with mean pod yields of 750 lbs (equivalent to 341 kg) (Kimber 1969). Kimber noted that soybean was also grown as a pretreatment crop together with sweetpotato to speed up the decomposition of grass roots prior to the establishment of experimental coffee plots at Aiyura station; and then eventually grown regularly to substitute wheat meal and fats for labour rations on stations. This would be the first record of soybean used in human diets in PNG. After a long absence during World War II, regular consumption was reported in the Baiyer River, Pari, in Chimbu province in 1954. It is quite possible that soybean was transferred by labourers who had initially worked at Aiyura and had been introduced to its cultivation and consumption. Currently, soybean is regularly consumed after boiling and is sold in the markets.

The only exception to increased legume production would be pigeon pea (*Cajanus cajan*), which is not being grown widely as a crop. Farmers consider them to be ‘hedges’ and even ‘ornamentals’ because of their bright yellowish flower (or, in their own words, *mipela ting olsem em flower ya!*). Only a very few individuals use them as food; otherwise, the bulk of the population is not aware of their food uses. In fact, pigeon pea is well adapted and volunteer stands are noted at various sites in the highlands provinces. Unlike other legumes, which are ‘annuals’, pigeon pea is a perennial crop that can grow for up to 5–6 years, providing farmers with multiple harvests. Early reports of its use show that pigeon pea was consumed by students attending the Christ the King high school on Manus Island, and most recently in a few areas in Simbu and Western provinces (Mcqueen 1993).

During 1973–74 legume imports steadily increased and peaked at 700 t in 1975. Thereafter, volumes declined to 500 t and dropped to a record low due to the Bougainville crisis. After the crisis the volume of imports started to increase again. Generally, imports of processed and fresh legumes increased relative to increases in employment rate and income of urban dwellers.

Role of grain legumes in the cropping systems

Most farmers in PNG perceive legumes as soil ameliorators and associate them with increased crop vigour and health in the subsequent crop. The value of legumes in the fixation of atmospheric nitrogen is little known. Apart from this general experience, much of the crop rotation that is practised in the country with the assumption that legumes contribute to residual nitrogen (N) is based on experiences elsewhere. A compounding effect in the PNG highlands is the provision of an adequate N-supply for low N users such as sweetpotato.

Giller (2001) discussed the variation in the level of N contributed as residual N for each type of grain legume. Table 1 summarises the widely cultivated grain legumes in the tropics and the amount of N fixed and actual N taken up by the subsequent crop as residual N. Accordingly, peanut (*Arachis hypogaea*) and the *Vigna* species contribute a significant proportion of residual N compared to other legumes.

It is possible, therefore, to assert that not all grain legumes contribute net N benefit to the cropping systems. The general suggestion would be to select legumes that have the ability to serve the primary purpose of producing food and, at the same time, contribute N as residual nutrient that would be available for the next crop.

Studies in rice showed that mungbean produced 0.9 t of grain and straw when incorporated, and substituted 60 kg N/ha (De Datta 1989). Garside et al. (undated) recorded a 20–30% increase in each of the first and second ratoon sugarcane crop yields when peanut and soybean were rotated with the sugarcane, and concluded that grain legume rotation with sugarcane sustains crop yields. Although limited data are available in PNG on levels of N contributed by various legumes, Trukai Farms Limited has used peanut in rotation with rice for the last 10 years (1997–2007) in the Markham Valley. Peanut as a major rotation crop has been able to sustain rice crop yields. In similar practices adopted by Ramu Agribusiness Industries, cowpeas have been grown extensively in crop rotation with sugarcane and, recently, peanuts have been trialled (Kuniata, pers. comm. 2008). In the areas of the highlands where peanuts are produced, they are invariably rotated with sweetpotato. Observations have shown that this rotation results in a much healthier sweetpotato crop that is more resistant to pests, and there is reduced weed pressure.

Crop rotations with legumes and other alternative crops such as oilseeds, feed and fodder in the vast fallow lands in the region can help reduce the monocropping of sweetpotato. Environmental sustainability will be greatly enhanced, particularly on sloping and marginal lands (eroded soils), and crop productivity will potentially be increased.

The integration of livestock species and varieties with existing staple crops and new emerging crops will help diversify and increase protein-rich food production (Gama 1995). The integration of livestock in subsistence gardening will assist in transforming the current subsistence-based agrarian society and add to its overall farm productivity on smallholder farms. This will contribute significantly to improved food security and the nutritional status of the people.

Springhall (1969) evaluated several combinations of feedstuffs and reported that soybean meal produced significantly higher weight gains compared to other feed rations. Peanut hay was also trialled but did not produce any significant increase in live weight gain (LWG). Similar trials (two

Table 1. Amount of N fixed and contributions to soil fertility by grain legumes in the tropics grown as sole crops (modified from Giller 2001)

Grain legume	Duration (days)	Grain yield (t/ha)	Stover yield (t/ha)	Amount of N fixed (kg N/ha)	N in Stover (kg N/ha)	Residual effect (kg N/ha)
Arachis hypogaea	90–140	0.3–3.1	1.4–6.7	21–206	52–166	0–97
Cajanus cajan	90–241	0.2–1.4	1.8–13.8	0–166	12–50	0–67
Cicer arietinum	90–241	0.2–1.4	5.9–7.5	0–124	–	–
Glycine max	96–104	0.6–2.9	1.0–10.4	26–188	30–170	0–22
Phaseolus vulgaris	72–114	0.8–3.0	0.1–7.5	2–125	3–38	–
Vigna radiata	70–84	0.7–1.7	1.3–3.9	61–107	30–88	68–94
Vigna unguiculata	69–115	0.2–2.7	0.0–0.84	9–201	20–94	38–205

experiments) conducted by Malyvnicz (1974) showed that cooked soybean fed to pigs with sweet-potato markedly increased live weights of pigs; however, feeding raw soybean inhibited performance. Danbaro et al. (2001) reported that soybean as a protein supplement at 400 g/meal/day significantly improved LWG in pigs.

The untapped potential of grain legumes in the highlands cropping system

Since the introduction of grain legumes some 70 years ago in the PNG highlands, their potential to provide food and, to some extent, address issues in human and animal nutrition, soil fertility decline and income has been underexploited due to lack of promotion of their benefits. This will continue to be the case in the future if attention is not directed towards grain legumes' potential in cropping systems and the role they can play in addressing the widespread food nutrition issues at the household level in the highlands. Early work on grain legumes was driven by the need to provide nutritional balance in human diets. However, at a later time the need to replenish soil fertility degradation through the adoption of appropriate legume species has become very important. This is because the intensity of agricultural production has increased, as evidenced by the replacement of woody species fallow by grass or weed fallow across the highlands region. The change in production levels is driven by an increase in population and the general reluctance to cultivate new and marginal areas. As it stands now, agriculture researchers, policymakers and stakeholders involved in rural food production will have to balance the need for human nutrition with the wide-scale degradation in soil fertility.

However, while the arguments have remained unchanged, there has been a failure to ensure the wide-scale adoption of grain legumes in PNG and, in particular, the highlands since independence. For instance, between 1970 and 1980 several seminars and conferences were organised to assess the prospects of grain legume production together with cereal grains like maize, both in the highlands and the lowlands, to encourage wide-scale production. However, the progress made in mustering sustainable and viable grain legume production since then has failed to materialise. While the reasons for the failure remain unknown, lessons from the short-lived peanut industry in the 1960s, as highlighted by Densley and Cairns (unpublished), can shed some light on possible problems that could have hampered progress. In simple terms the failure of the peanut industry can be attributed to (i) a decline in seed viability because of the farmers' general practice of saving inferior seed materials, (ii) a lack of availability of improved varieties to keep pace with industry's demand, (iii) weed pressure created by continuous cropping and (iv) an outbreak of peanut rust (*Puccinia arachidis*) in 1974. A further factor, not listed by Densley and Cairns (unpublished) is the question of whether PNG farmers actually had a peanut industry in the 1960s.

Similar problems have been reported for soybean, whereby commercial trials in the Markham Valley produced poor yields due to insect pests like the green vegetable bug (*Nezara viridula*) and *Riptoris* sp. (Sumbak 1976). Also, soybean rust had been noted as a potential problem (Kimber 1969) in the lowlands, while suitable and appropriate farm machinery was noted as a constraint for small-scale commercial production in the highlands. The prospects for scaling up to commercial production were not possible due to the high cost of production. The inefficiency in operating large-scale commercial entities and the lack of standards also played their part in making commercial production in PNG undesirable. At present there is a lack of confidence in a potential local grain legume industry given the past experiences, the quality requirements and the huge capital requirements for producing grain legumes for both the food and the animal feed industries. Production on a commercial scale still remains unfeasible at present, but the need for adoption of appropriate grain legumes for household consumption and to counter soil degradation is of priority now.

One of the greatest impediments, not normally documented in the literature, is the effect of socio-economic factors. These have the potential to facilitate a wide-scale adoption or rejection of the crop species and technologies being introduced. PNG farmers, and farmers in general, are very pessimistic, risk averse oriented and generally unwilling to let go of technologies and crop species that have co-evolved with them over the years. These crop species and technologies are ingrained into their customs and cultural beliefs, which makes it very difficult to forgo them in the event of change. Researchers must therefore deal with this barrier in order to introduce what they believe is better than what the farmers have. In the western world, income, profit and wealth are the motivations for adoption of change, and farmers are ultimately covered by social security. In contrast, farmers in PNG will adopt crop diversification as insurance against hunger, which is equivalent in context to social security, and to maintain their social status in society. Of course, the crop or practices adopted must be acceptable within their culture and play an important role as a crop of social significance. Finally, if they are able to earn extra income, then farmers will adopt the technology or the crop.

As more diversified farming activities are attended to, together with daily social chores and commitments, the time and labour available become very limited. Any new crop or technology being introduced into the system must come with a strong socioeconomic justification and definite commercial incentive; otherwise, they end up merely being written up and shelved in libraries. This seems to have been the case for the early grain legumes research conducted in PNG.

Conclusions

'Crop diversification: been there, done it'
Editorial, *Western Producer* newspaper,
Saskatoon, Canada (31 May 2001)

In the PNG highlands there has been measured success in a number of crop diversification innovations. Furthermore, alternative production systems have been examined, such as organic production and aquaculture. Therefore, crop diversification is not a new concept in PNG and can provide a set of choices for PNG highlanders offering increased productivity and profitability. However, the fact is that we still have to develop a national farm policy that ensures the long-term sustainability of our agricultural producers. Many of the potential opportunities within crop diversification are not attractive to many in the current demographic structure of these producers. Crop diversification is only one piece of a much more complex process that will lead to a renewed and optimistic outlook for the agricultural sector in the highlands.

Many hurdles must be overcome to increase crop diversification in PNG. Research funding has been identified as a key to continued success, although the resources needed to make progress are still not adequate. Crop diversification initiatives must compete with established crops for research funding and struggle to find donor money to 'match' public investment. Markets continue to fluctuate as global competition increases.

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