Production patterns for fruit and nut species in Papua New Guinea and some implications for marketing

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Abstract

The supply of a particular fruit or nut varies over time for a number of reasons, one of which is seasonal or non-seasonal changes in the supply from the plants. This is termed the production pattern. This paper builds on a major study of the production patterns of 180 economic crops in PNG and a subsidiary study that compared the period of plentiful supply of 57 fruit and 5 nut-bearing species in PNG with the patterns in Australia, Indonesia, the Philippines and Thailand.

A brief overview of the production patterns for a number of fruit and nut-bearing species is given. There are three major physical environmental factors that initiate the onset of flowering. These are changes in day length, temperature and moisture. The different influences that these environmental factors have on the flowering of some species is described.

The prospects for exploiting differences in the production patterns for marketing within PNG and to overseas markets is examined. There are some theoretical prospects for exploiting seasonal differences between PNG and both Australian and nearby Northern Hemisphere countries for a number of crops, particularly for durian, langsat, mangosteen, pulasan and rambutan. In practice, the possibilities of exploiting seasonal differences in the producing period between Australia or nearby Northern Hemisphere countries are remote because of significant constraints. There are better prospects for exploiting differences for certain fruit and nut species within PNG.

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Production patterns

This paper gives an overview of the production patterns of fruit and edible nut species grown in PNG. Some of the implications of those patterns for marketing fruit and nuts within PNG and to overseas markets will be summarised.

The supply of a particular species varies over time for one or more of the following reasons:

1. Changes in the rate of planting. This is more true for annual crops than for fruit and nut crops, which are mostly perennial.

2. Changes in the yield per unit area over time. This is responsible for much of the variation for perennial species.

3. Changes in harvesting and marketing behaviour by villagers.

Changes in the production pattern or supply are commonly referred to as the seasonal pattern – someone might say, for example, that it is a good season for sweet potato. The term 'seasonality' is used in this paper in a more technical sense and refers to regular and predictable changes in the supply. Thus, if a particular fruit or nut produces at about the same time each year, we can describe that pattern in terms of the producing season. For example, we can say that the producing season for *marita* pandanus fruit in the main highland valleys is January to April.

However, the observed patterns are more complicated. The period of regular supply for any given species may change from year to year; supply can depend on the variety and it often depends on the physical environment where the crop is grown. The environmental variables day length, temperature and rainfall are particularly influential. Such differences between locations and between years have implications for commercial marketing of fruit and nuts.

Data sources

This paper is based on a major study of the production patterns of 180 economic crops in PNG (Bourke et al. 2004). That study included data on 75 fruit and 25 nut species from various locations in PNG. The main sources of the study were:

1. Weekly or fortnightly surveys of five highlands markets over a three-year period. Four of the markets were in Eastern Highlands Province (Goroka, Kainantu, Aiyura and Ukarumpa) and one was in a remote location in Southern Highlands Province (Hol market on the Nembi Plateau, Nipa District). As well, fortnightly market survey data was available for one year for Wau market in Morobe Province.

2. Purchase records of the Food Marketing Corporation (FMC) for Port Moresby, Lae, Wau, Kainantu, Goroka and Mt Hagen. The Goroka data was for a five-year period and that for the other centres was for a two-year period.

3. Market prices of 15 foods for a 22-year period for Port Moresby, Lae, Rabaul, Madang and Goroka markets. These prices are recorded by PNG Division of Primary Industries staff and used by the National Statistical Office to help compute the Consumer Price Index.

4. Records of experimental plantings of nine fruit and nut species from Keravat, East New Britain Province, pineapple from Keravat and pineapple from Saiho, Oro Province.

5. Records by observers on the producing season of mango for Rabaul, East New Britain Province; Markham Valley, Morobe Province; and Port Moresby over a six-year period.

6. Records by observers on the producing season of *karuka* nut pandanus for Kainantu, Goroka, Wabag, Mendi, Tari and Oksapmin areas over a 6–10 year period.

7. Villagers' statements and literature. Villagers were asked about the producing season for certain crops and their responses were summarised. As well, statements in the literature based on observations by geographers, anthropologists and agriculturalists were compiled.

The quality and quantity of the available data is quite uneven. For some species, such as avocado, mango, mandarin, *marita* pandanus, pineapple, *galip* nut, *karuka* nut and *okari* nut, we have a lot of data. In contrast, there is little data for many lesser-known species, including those confined to experimental plantings at Lowlands Agricultural Experiment Station (LAES) Keravat and some of the minor indigenous species.

For example, for avocado, there is longitudinal data from:

- locations in the seasonally dry lowlands (Port Moresby area)
- a seasonally dry intermediate altitude location (Wau)
- certain seasonally dry highlands areas (Kainantu and Goroka)
- one non-seasonal highlands location (Mt Hagen).

The datasets for avocado are: surveys of three markets in Kainantu area (3 years); a survey of Goroka market (3 years); FMC purchases, Goroka (5 years); FMC purchases, Port Moresby, Wau, Lae, Kainantu and Mt Hagen (2 years); and general statements in the literature. Despite the fact that there are some differences between the patterns in these datasets and that the start and duration of the main producing period for avocado varies from year to year, we can be confident in conclusions based on these data. In contrast, where the only observations are from experimental plantings at LAES Keravat or single published statements about minor indigenous species, conclusions about the overall production pattern are tentative.

For most of PNG, seasonal differences in day length and temperature are small to negligible. Rainfall seasonality varies from negligible to marked. Hence, the start and finish of the producing season for most crops is not well defined. Even for crops that have a markedly seasonal producing pattern, it is important to note that there is usually some variation in the pattern between years.

A subsidiary study by Camarotto and Bourke (1994) compared the period of most plentiful supply of 57 fruit and 5 nut species in the PNG highlands, PNG lowlands, tropical Australia (Northern Territory and north Queensland), sub-tropical Australia (New South Wales), Indonesia, the Philippines and Thailand. Thus, the data came from three nations in the Southern Hemisphere (PNG, Australia and Indonesia) and two in the Northern Hemisphere (the Philippines and Thailand).

That study examined the potential for exporting fruit and nuts from PNG to nearby nations when the supply is plentiful in PNG and scarce in the nearby countries. The markets considered were the Southern Hemisphere ones of Australia and New Zealand; and the Northern Hemisphere markets of Singapore and Hong Kong, which are normally supplied from nearby Northern Hemisphere countries. The study examined the seasonal production pattern only and did not consider other important factors including demand, quality and competition from other markets.

Production patterns of fruit and nuts

Of the fruit trees described in Bourke et al. (2004), about two-thirds (44) fruit seasonally in PNG and the remainder fruit non-seasonally. Of the 21 species where the information does not indicate a seasonal pattern, 12 are restricted to experimental plantings in a weakly seasonal environment at Keravat and it is possible that they may bear seasonally in other environments.

Five highlands species do not bear seasonally. These are cape gooseberry (*Physalis peruviana*), elder (*Sambucus nigra*), naranjilla (*Solanum quitoense*), highland yellow passionfruit (*suga prut*) (*Passiflora ligularis*) and black raspberry (*Rubus lasiocarpus*). Other non-seasonal fruit species are *Parartocarpus venenosa* on New Britain Island, rukam (*Flacourtia rukam*) in Milne Bay Province, and soursop (*Annona muricata*) and pomelo (*Citrus maxima*) in the lowlands.

For a number of fruit species, the pattern varies between environments. Pawpaw (*Carica papaya*), guava (*Psidium guajava*) and carambola (*Averrhoa carambola*) are non-seasonal in the lowlands, but produce seasonally in the highlands. It seems that the supply of lime (*Citrus aurantifolia*) is weakly seasonal in seasonally dry locations from the lowlands to the highlands, but production is not seasonal where rainfall is uniform throughout the year.

Most species that produce an edible nut bear seasonally (13 species). Pao nut (*Barringtonia procera*) bears in an intermittent, but non-seasonal manner. Breadfruit (*Artocarpus altilis*), Polynesian chestnut (*Inocarpus fagifer*) and *karuka* nut (*Pandanus julianettii*) bear seasonally in some environments, but not in others. *Karuka* bears in a more-or-less regular manner in the seasonally dry Eastern Highlands Province, but in a more irregular manner in Enga and Southern Highlands provinces and in the Oksapmin area of Sandaun Province, where the rainfall pattern is non-seasonal (see Figure 91 in Bourke et al. 2004:154).

Environmental influences on flowering and fruiting

Three major physical environmental factors instigate the onset of flowering. These are changes in photoperiod (day length), temperature and moisture (Rathcke and Lacey 1985:190). It is possible to make some suggestions as to the influence of these environmental factors on the production patterns where we have long-term data from a range of environments in PNG.

For species where the start of the producing period is quite regular from year to year, it is most likely that flowering is induced by changes in day length, as this is regular from year to year, whereas changes in temperature and rainfall vary from year to year. Species that have a regular production pattern in PNG include purple passionfruit (*Passiflora edulis* f. *edulis*), *sis* nut (*Pangium edule*) and *marita* pandanus (*Pandanus conoideus*). There is no predictable producing season for breadfruit and Polynesian

chestnut in much of PNG but, for locations south of about latitude 8° S, the producing season is predictable and regular. It is likely that this happens because changes in day length are great enough at this distance from the equator to initiate flowering at about the same time each year.

There is a clear relationship between latitude and the start of the harvesting period for *okari* nut (*Terminalia kaernbachii*) and *galip* nut (*Canarium indicum*). The producing season commences earlier near the equator and progressively later at locations further south of the equator. For *galip* nut, this pattern is more apparent at latitudes south of 6 °S. It is likely that this pattern is caused by differences in day length (see Figure 93 in Bourke et al. 2004:156).

Altitude has the greatest influence on temperature in PNG (McAlpine et al. 1983). Above 500 m, temperature falls at a regular rate of 0.5 °C for every 100 m increase in altitude. Seasonal temperature differences are generally small, with larger seasonal differences at locations further from the equator. These differences are reinforced where most rainfall occurs in the south-east season (May to September), which coincides with the Southern Hemisphere winter.

For many crops, altitude (temperature) has no apparent influence on the start and duration of the production period. This is the case for avocado, mandarin, orange and purple passionfruit. However, there is a relationship between temperature and the start and duration of the fruiting period for *marita* pandanus. Near sea level, production is continuous throughout the year and non-seasonal. The producing period becomes shorter with increasing altitude and is only four months long at 1600–1700 m near the crop's upper altitudinal limit (see Figure 92 in Bourke et al. 2004:155). An experimental study on rough leaf pineapple at Keravat concluded that flowering is initiated by low night-time temperature, and not by other environmental factors (Bourke 1976). That conclusion was supported by non-experimental data compiled by Bourke et al. (2004).

Mean annual rainfall in PNG varies from about 1000 mm (near Port Moresby) to nearly 10,000 mm, with most of the population living in locations where the rainfall is 1800 to 3500 mm per year. Three broad patterns of rainfall distribution can be distinguished. In most of PNG, rainfall distribution is seasonal with the maximum from January to April and the minimum from May to August. Parts of PNG have the reverse pattern, with the highest rainfall from May to August. In the third pattern, there is little rainfall seasonality, that is, all months are wet (McAlpine et al. 1983). Changes in the rainfall seasonality occur over short distances, often with all three patterns occurring in nearby locations. This allows us to examine the impact of rainfall seasonality on the supply of fruit and nuts, knowing that seasonal changes in day length and temperature are negligible.

In general, rainfall seasonality has only a limited effect on the flowering and fruiting behaviour of fruit and nut species. For example, in Milne Bay Province, the producing period for many fruit and nut species is the same in locations that receive more rain in January–April as it is in locations that receive more rain in May–August. For a few annual crops, rainfall seasonality influences the incidence of diseases and insect pests and thus determines the optimum time for planting. This seems to be the situation for a number of cucurbits, including watermelon (*Citrullus lanatus*) and rockmelon (*Cucumis melo*).

Development and maturation of mango (*Mangifera indica*) fruit is dependent on both seasonal temperature and rainfall changes (Cull 1991). In PNG, mango bears during the same period (October–January) in all locations, irrespective of the timing of the rainfall seasonality pattern, although the pattern varies from year to year for any location. Rainfall has an influence in that the highest yields occur in locations with a marked dry season, such as coastal Central Province, the southern part of Western Province, the Rabaraba–Cape Vogel area of Milne Bay Province, the upper Markham Valley, the Sialum area on the Huon Peninsula, the western end of Umboi Island and the eastern part of the north-east Gazelle Peninsula of East New Britain Province. For the three locations where observations are available for a six-year period (Rabaul, Markham Valley and Port Moresby areas), a relationship exists between the period of lower rainfall and the start of the harvesting period. For example, in the Port Moresby area, the harvest period starts 5–6 months after the start of the drier months in any given year (see Figure 90 in Bourke et al. 2004:153).

Some implications for marketing within PNG

Within PNG, differences in the production pattern between locations may present some opportunity to market produce so as to exploit these differences. In general, however, there are only limited opportunities to do so.

In contrast, there are many opportunities for marketing produce within PNG for crops that perform better in certain environments than in others. In PNG, environmental differences are often large, sometimes over short distances. These differences are associated with changes in rainfall patterns and altitude. For example, certain crops that thrive in the Markham and Ramu valleys, such as mango, watermelon, coconut and peanuts, cannot be grown in the highlands, or do not perform as well there. In the north-east lowlands of the Gazelle Peninsula, there are differences in crop performance in seasonally dry locations, such as near Blanche Bay, and locations where rainfall is only weakly seasonal, such as in the Keravat–Vudal area.

It is worth noting that there are large and consistent differences in the supply pattern of betel nut (a narcotic) between certain locations. The most obvious is that the best supply in the Madang area occurs in January–March, and this is the period of poorest supply in the Port Moresby area. This creates a commercial opportunity in that betel nut can be moved from a location where it is abundant and cheap to one where it is scarce and hence expensive.

As noted above, the start of the producing period for both *okari* nut and *galip* nut tends to occur later with increasing distance from the equator. This presents the opportunity for a larger processor to obtain supplies from different locations over a longer period and thus extend the processing season. This is hypothetical at this stage, as there is no commercial processing of these edible nuts in PNG.

The producing period for *marita* pandanus commences later and is shorter with increasing altitude in PNG. This is exploited by villagers who live at lower altitude locations in the highlands, as their *marita* fruit is ready for harvest and can be sold or given as a gift to people who live at higher altitudes. Towards the end of the calendar year, villagers who live at 1200–1500 m commonly carry fruit to markets and to individuals who live at 1600–1800 m. This production pattern could be commercially exploited in the future.

Two other crops have a production pattern that varies from year to year, but also between locations. The first is *karuka* nut, for which the pattern varies considerably both between years and between locations. The producing period tends to be more regular in Eastern Highlands Province, where there is a regular dryer season, than in the western part of the highlands where rainfall is not seasonally distributed. This creates the possibility of moving the highly sought-after *karuka* nuts within the highlands. The other crop is mango. The start and duration of the season varies somewhat from year to year. It tends to commence earlier where the dry period is earlier. Again, this creates the potential to move fruit from locations where fruiting has commenced to those where the production season has not yet started or where the fruit does not grow. The potential to move mango within PNG is limited by the highly perishable nature of the fruit and the poor transport system at many of the locations where it grows well, for example, at the Sialum area on the Huon Peninsula and on western Siassi Island.

Some implications for marketing outside PNG

The study by Camarotto and Bourke (1994), which examined the potential for exporting fruit from PNG to overseas markets during their off-seasons, found a number of differences in the production patterns which could theoretically be exploited by PNG producers. There are clear and consistent differences in the main producing period between the Northern and Southern Hemispheres for some species, including durian (*Durio zibethinus*), rambutan (*Nephelium lappaceum*) and mandarin (*Citrus reticulata*). For other species, such as avocado and watermelon, the production period is somewhat different, but overlaps in the two hemispheres.

Camarotto and Bourke concluded that the best prospects for exporting fruit from PNG so as to exploit seasonal differences are for durian, langsat, mangosteen, pulasan and rambutan to certain Asian markets during the Northern Hemisphere non-production period.

There is theoretical potential for exporting some other fruit species to both Northern Hemisphere (Asian) and Southern Hemisphere (Australian) markets, based on seasonal differences. This is the case for avocado, grapefruit, lime, mandarin, mango, pomelo, raspberry and strawberry. For example, production of avocado occurs throughout the year in Australia, but the supply is light from January to March. The period of poorest supply in Australia coincides with the period of peak production in the PNG lowlands and highlands. The producing season for strawberry in the PNG highlands (June to September) coincides with the off-season in nearby Northern Hemisphere countries, suggesting the possibility of exporting strawberries from PNG to Singapore, for example.

Conclusions

There are differences in the producing patterns for a number of fruit species grown in PNG compared with both Australia and nearby Northern Hemisphere countries. However, there are few realistic possibilities for PNG to export fruit to Australia, New Zealand or South-East Asian markets to exploit different seasonal production patterns. The fruit and nut industries in PNG are poorly developed commercially. Other significant constraints include:

1. The poor quality of much fruit in PNG

2. The highly perishable nature of many fruits

3. Poor communication and transport links within PNG
4. The absence of marketing systems that move high quality fruit within PNG
5. Quarantine restrictions that would prevent fruit being imported from PNG, especially high levels of fruit fly infestation
6. Limited demand for certain species.

A few specialist producers may be able to exploit seasonal differences, but this is not a realistic option in the short to medium term for most PNG producers.

There are better prospects for exploiting differences in production patterns for certain fruit and nut species within PNG.

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