Future vegetable farming in Papua New Guinea – responding to resource constraints and population in a developing country: a case study

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Introduction

The population of Papua New Guinea (PNG) is growing at approximately 2.1% per year (CIA 2009) increasing the demand for food. Internal migration to peri-urban areas, in particular, the national capital of Port Moresby (PoM), and increased demand from an expanding middle class and expatriate mining and gas industry professionals are compounding food demands. Highland regions e.g. Eastern Highlands Province (EHP) grow a range of temperate (or western) vegetables, but distance from PoM, and poor transport infrastructure and services constrain consistency of supply and quality. Seasonally dry coastal lowlands and cooler highlands (Sogeri Plateau, Goilala District), in Central Province (CP) nearer PoM could increase production and improve supply. In 2008, about 50,000 tonnes of PoM's 141,000 tonne/yr fresh produce came from peri-urban gardens (FPDA 2008) on on rocky, erodible, drought prone and difficult to irrigate sites (Bleeker 1975). Thus, sustainable production is unlikely. Vegetables, e.g. root and leafy crops, broccoli and zucchini are also produced in alluvial flood plains and on the Sogeri Plateau. Retail prices are unstable, and marketing is mostly through informal markets and direct supply to end users or supermarkets. Supply has not met PoM demand (FPDA 2008), so this study was initiated to identify constraints to and opportunities for expanding production to improve vegetable supplies to PoM markets.

Materials and Methods

Field visits to farms and research institutes, interviews of individual or groups of farmers, agricultural RDandE officers, commercial providers in EHP and CP, and market operators and retailers in PoM were undertaken during May and July 2009. The purpose was to determine farm characteristics and practices, land management and recent developments in vegetable production in EHP, and to identify opportunities for

improvement in production and delivery to consumers in PoM. Data were analysed using rapid value chain analysis (Collins and Dunne 2008). Climatic limitations were assessed as in Hackett (1988) for PoM and Goroka (35 and 9 years of data), and from qualitative survey and literature sources. Land resources were assessed by soil profile assessment at key sites and GIS mapping (Doyle, et al. 2010).

Results and Discussion

Biophysical considerations in designing future farming systems

Climatic characteristics and limitations, principally temperature and water supply (Table 1) vary with altitude and topography. Rainfall also increases to the east in CP lowlands improving land use potential, though irrigation and enhanced drainage will be necessary during the dry and wet seasons respectively. High temperature is a major constraint to temperate vegetable production, though spring onions, white radish, bulb onions and shallot are grown near PoM. Soils and landscape are highly variable, and only those currently used or most suitable, and their physical and chemical limitations are included (Table 2). Potential for production in acidic and phosphorus fixing but otherwise physically fertile Red Ferrosols on flatter sites of the highly dissected Sogeri Plateau is moderate to high, but in the Goilala district, soils are poorer and have lower production potential (Hanson, et al., 2001). Alluvial soils in the lowlands have good structure and moderate natural fertility, but both would be expected to both physically and chemically decline once cultivated.

Table 1. Climatic characteristics and main climatic constraints in Central and Eastern Highlands Provinces

Location and altitude	Rainfall (mm)	Wet season	Mean max temp (^{o}C)	Mean min temp (^{o}C)	Main climatic constraints
Port Moresby 44m (Weather station)	899	Dec-Apr (61%)	31.4-32.5	22.4-23.7	High temperature (for C3 plants)* Inundation (Dec-April) Water stress* (May-Nov)
Goroka (EHP) 1587m (Weather station)	1722	Sept-May	25.5-27.5	14.9-16.2	Mild water stress* (June-Aug)
Goilala District (CP) ~1000m (at Tapini AP)	2200 - 3200	~Sept - May	Highly variable, related to altitude		Water stress* (~June-Aug) Low temperature, occasional frost Cloud cover
Sogeri Plateau 500-1000m	2200 - 3500	Few data, expect temperatures to be between Port Moresby and Goroka temperatures, with only minor climatic limitations			

Sources: Hanson et al (2001), PNG National Weather Service (2009), Goilala District (2011)

***** Assessed as in Hackett (1988)

Table2. Soil characteristics and constraints in Eastern Highlands and Central Provinces

District	Principal soils	Physical limitations	Fertility limitations
EHP	Andisol	Slope, erosion risk	Acid infertility, P fixation, low K and B, high C:N ratio, some areas low Zn, Mo, Cu, Mn
CP Lowlands	Alluvial	Inundation Impeded drainage	Fertility decline leading to multiple deficiencies Organic matter loss, structural decline
	Skeletal soils	Slope, erosion risk, low water holding capacity	Multiple deficiencies
Goilala	Ferrosols, Andisols	Slope, erosion risk	Multiple deficiencies, P-fixation
Sogeri	Ferrosols	Slope, erosion risk	Acid infertility, multiple deficiencies, P-fixation

Sources: Birch et al 2009, Hanson et al 2001, Radcliffe and Kanua 1998

Socio-economic considerations in designing future farming systems

Shifting cultivation, where an area is cultivated for several years and then allowed to revert to natural vegetation for an extended period to restore soil fertility, is widely practised. However, as the population and food demands increase, the now shorter and shorter rotations increase the risk of land degradation through erosion and nutrient depletion. Individual farmers or groups of farmers (e.g. cooperatives in the Goroka district (EHP) and Rigo and Goilala (CP)) select crops to maximise returns and meet socio-cultural norms. Limited availability and expense of inputs such as suitable cultivars, fertilisers, agricultural chemicals and portable irrigation infrastructure can compromise production. Transport and marketing infrastructure and market performance (Bonney, et al., these proceedings) combined with size and scale of enterprises, seasonality of production, insecurity of land tenure and land management all limit capacity to improve overall system performance.

What of the future farming systems?

Future farming systems in PNG will be substantially determined by topographic, climatic and soil features and socio-cultural conditions. Land management is likely to range from low-input practices ranging from long bush fallows and burning, to high input techniques such as legume rotations, composting, mounding, drainage, soil retention barriers, mechanised tillage and irrigation. Land tenure, predominantly 'customary' with no individual ownership, may impede development of larger enterprises requiring substantial infrastructure. Aggregation of production from small holdings, group purchase of equipment and inputs, and cooperative arrangements among kinship groups will achieve some benefits of economies of scale through larger scale production and improved marketing. This is already occurring e.g. in EHP (Birch, et al 2009). Challenges in agronomic practices will be enhanced retention of organic matter (Sparrow et al 2011), optimisation of use of local resources and

strategic use of purchased inputs which are likely to remain expensive and not readily available. Nitrogen fertilisers and N from legumes are already being used in higher input production systems, but are not to any extent in the still dominant subsistence farming with shifting cultivation. Adequacy of future production will depend on utilising a range of agro-ecological environments appropriate cultivars of vegetable crops and planned production schedules to ensure continuity of supply and income through the year.

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