Gendered differences in crop diversity choices: a case study from Papua New Guinea

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Abstract

Crop choice, including the conservation of traditional crops and the uptake of novel ones, is a central issue in agricultural development. This paper examines differences between male and female farmers' motivations for growing diverse crop portfolios in Papua New Guinea, a highly agro-biodiverse context facing rapid social change. Q methodology, a mixed qualitative-quantitative approach, is used to examine how alignment with different viewpoints related to crop diversity differs across male and female farmers. We show that, of five distinct 'types' of farmers identified with regards to crop diversity choices, all include both men and women, and three of five groups show no significant gender-related differences. However, there are also significant gender differences. A large proportion of women farmers associate with being highly motivated by crop marketing, whereas male farmers are more likely to favor agricultural diversity due to tradition or status motivations. Overall, strict gendering of crops does not appear highly salient. The results confirm earlier work in the region on women's roles in marketing but contrast to those on crop gendering. Altogether, they underline the complexity of gender and identity in agricultural choices. The results also have implications for the targeting and implementation of crop conservation and promotion policies and programs, including those aiming for improved nutrition or agricultural development.

Keywords: Papua New Guinea, Agrobiodiversity, Crop choice, Q methodology, Gender

1. Introduction

The Food and Agriculture Organization (FAO 2011), the Convention on Biological Diversity (UN 1992), and the International Union for Conservation of Nature (Sasvari et al. 2010) identify women as users, managers, and custodians of biodiversity, prioritizing their active involvement in conservation and development policy. In addition, many scholars identify women as key custodians of agricultural biodiversity (agrobiodiversity[1]) (e.g., Howard 2003; Mogina 2002)—though others point out that the evidence on women as 'environmental stewards' is mixed and complex (Doss et al. 2018). At the same time, the focus on women in smallholder agriculture in the Global South has grown considerably in recent years amid interest in supporting women's empowerment within agriculture (e.g., Alkire and Meinzen-Dick 2013) and is reflected in development funders' policies (e.g., Gates 2014; GAC 2017; USAID 2012). Women are also frequently targeted by agricultural development interventions, such as those aiming to improve nutrition by increasing crop diversity (e.g., SPRING 2014; Haselow et al. 2016) or the uptake of particular crops (e.g., Girard et al. 2017). However, gendered[2] motivations for crop choice, and how these may impact development programs, have not been widely examined in the literature (Howard-Borjas 1999; Elias 2015). This is despite evidence of frequent gender divisions in labor, knowledge, norms, and access-related issues that drive agricultural choices (e.g., Quisumbing 1996; Doss et al. 2018).

There are several avenues through which gender may impact crop diversity choices: gendered knowledge of plant usage (Howard 2003); gendered access to resources and technology, leading to differences in productivity (Quisumbing 1996); gendered divisions of labor (Duflo and Udry 2004; Quisumbing 1996; Hamilton 1998); traditional norms about the genders associated with different crops (Carr 2008a; Arndt and Tarp 2000; Gladwin 1992); and gender dynamics in systems for acquiring planting materials (Sachs et al. 1997; Howard 2003; Oakley and Momsen 2007; Zimmerer 2003). Indeed, women typically play diverse roles as farmers, home gardeners, plant gatherers, seed selectors and traders, food processors, and healthcare providers—all of which may influence their motivation for growing diverse crops (Elias 2015). In each of these roles, their identity as women intersects with other identities – e.g., wealth, education, race/ethnicity, and livelihood – which impact crop choices (e.g.,

Carr 2008b). As Doss (2002, p. 1993) notes, "gender patterns are important, but gender is only one of many factors that determine what crops a farmer will grow and sell."

The literature also refers to 'custodian' farmers or 'guardians' of biodiversity (e.g., Sthapit et al. 2015) as well as certain farmer types, such as managerial, stewardship-based, or conservative (Walter 1997). In some cases, women are noted as particularly important preservers of biodiversity (e.g., Tapia 1997 in Escobar, Odame and Theile 2016; Elias 2015; Zimmerer 2014) and priority targets for interventions related to *in situ* conservation (Elias 2015; Zimmerer 2014). In other cases, men are seen as more prepared to take on this role, given women's obligations to carry out 'care work' (Sthapit and Bhurtyal 2015). However, there are considerable gaps in our understanding of why crop diversity might differ across men and women—even though such assumptions are central to development interventions and policies related to crop conservation, food security, and improved nutrition. This paper helps fill those gaps by building on a prior study on the heterogeneity of farmers' crop choices (Nordhagen, Pascual, and Drucker 2017) and applying Q methodology, a mixed qualitative-quantitative approach, to examine how motivations for crop diversity choices differ between male and female farmers.

The paper is based on a case study in Papua New Guinea (PNG). PNG is a fitting country for such a study: rich in agrobiodiversity, it is considered a key area for *in situ* conservation but also faces rapid changes in economics, social values, climate, and demographics that may threaten this diversity, with implications for local culture as well as global crop conservation. Moreover, PNG has a largely patriarchal culture wherein gender pervades many aspects of both agriculture and the economy (Sillitoe 1981; Busse and Sharp 2019). Its agricultural productivity remains below potential in many sectors, and diets tend to be low in diversity, with serious consequences for nutrition and food security (IFPRI 2016; Hurney 2017). Amid these challenges, agricultural extension services have struggled to properly serve the female population (Mikhailovich et al. 2016). Recent work has highlighted how PNG society continues to change rapidly, sometimes overturning the norms and customs documented in prior research (Busse and Sharp 2019; Curry et al. 2019).

This study thus adds to the literature by revisiting past research on gender and crop diversity in Oceania (Howlett 1962; Sillitoe 1981; Brookfield 1991), much of which took place before major socio-economic changes with implications for crop diversity, such as the spread of large-scale marketing (Benediktsson 2001; Curry et al. 2019) and mobile telephony and associated connectedness (Watson 2011). It also broadens understanding of gender and crop diversity more generally: understanding gendered motivations and viewpoints can help policymakers anticipate how programs and initiatives will be received by different types of farmers. Finally, it uses a novel approach, Q methodology, for examining gender differences in viewpoints.

Section 2 provides a brief overview of past research on the topic and context, indicating how gendered differences in crop choices may manifest themselves. Section 3 introduces the field sites, the methodology, and data collection and analysis procedures. Section 4 presents the results, Section 5 discusses these results, and Section 6 concludes.

2. Bakground: Agrobiodiversity, Gender, and Papua New Guinea

2.1. Gender and Crop Choice

Before discussing gender and crop choice in PNG, we briefly discuss the topic more broadly. There are many examples of gendered norms in crop choice. For example, in some West African societies it is traditional for men to grow the main staples and cash crops, whereas women cultivate more minor crops (Wooten 2003 in Mali; Carr 2008a in Ghana). In many cases, norms may not be fully reflected in reality (Doss 2002). Regardless of whether the same crops are grown, men and women sometimes manage different plots and the resulting production streams (Duflo and Udry 2004). It has also been reported that men focus more than women on generating income, as opposed to providing food (Quisumbing 1996; Anderson 2008; Goodrich 2013; Jost et al. 2015).

Gendered crop diversity preferences may be motivated by culinary preferences or preparation needs (e.g., ease of cooking; Goodrich 2013; Howard 2003), particularly among women, who usually have almost complete responsibility for household cooking. Preferences are also determined by labor availability or harvest times, which may have gendered impacts, such as through gendered migration, which has been shown to impact crop diversity

(e.g., Mani 2013). In some cultures, crop diversity may be connected to traditional exchanges and ceremonies—which are often gendered. Finally, gendered aspects of exchange systems for planting materials may also impact crop choice (Sachs et al. 1997; Oakley and Momsen 2007). Environmental factors also strongly influence crop portfolios. Marginal land conditions encourage farmers to grow a more diverse mix of crops, and agrobiodiversity may be maintained to facilitate resilience to variable weather or climate conditions (Pascual et al. 2011). Such influences may also be gendered: women have been shown to react differently to climate change and environmental risk (Denton 2002; Nelson et al. 2002; Ravera et al. 2016), including due to differential use of environmental services.

2.2. Papua New Guinea

Papua New Guinea struggles with low levels of education and health, as well as widespread poverty. With three main zones (highlands, inland lowlands, and coastal lowlands/islands), it is rich in agrobiodiversity and large numbers of crops are grown, though a handful predominate (Bourke and Harwood 2009). Crops are typically cultivated using traditional techniques in mixed systems, including tubers, tree crops, and vegetables and native varieties as well as novel introductions (Bourke and Harwood 2009); distinctions between crops as planted/unplanted or wild/domesticated can be ambiguous (Kennedy 2012). Cash cropping (of coffee, cocoa, copra, and oil palm) is an essential component of rural livelihoods (Bourke and Harwood 2009).

PNG is also culturally diverse, with nearly 800 cultural groups, most adhering to Melanesian norms, with kinship, reciprocity, and exchange as organizing principles (Sillitoe 2000). Most groups retain a male-dominated culture, though there are exceptions (e.g., Lederman 1980). Generally, men are seen as household heads and dominate decision-making (Mikhailovich et al. 2016).[3] Women are underrepresented in power at all levels of society and may face more limited access to government services as well as traditional structures, such as exchange circles (Spark 2010). Men, in contrast, are typically more educated and have had more experiences out of the village, such as by working as laborers (Sharp et al. 2015). Traditional practices, such as bride price, may undermine women's empowerment (Fox 1999). However, women also have their own power through traditional roles and

norms and have developed mutual support networks to bolster this power (e.g., Sexton 1986). Overall, PNG ranks 159 out of 160 countries on the United Nations gender inequality index (UNDP 2018).[4]

Whereas some (e.g., Cahn and Liu 2008) describe gender roles in agriculture as strongly delineated, others (e.g., Bourke and Harwood 2009) argue that men and women work together in gardens, sharing labor. In reality, this varies enormously across (and within) communities: men and women play different roles in cropping and focus on different crops but also cooperate and work together as a household (Koczberski 2007; Curry et al. 2007). Land ownership norms and customs also vary, but speaking generally, women lack legal ownership of land, which is typically held by clans, with its use mainly dictated by men (Howlett 1952; Rumint 1987). Women usually have usufruct rights to use it on a short-term basis – e.g., for gardening, but cannot alienate it on a long-term one – e.g., by planting coffee (Sexton 1986). Partly as a result of this restriction on land use, cash cropping is generally led by men. Though women often contribute to growing cash crops (e.g., coffee, cacao), and may even sell some directly, they typically earn lower returns to their labor for cash crops than for food crops and may have less control over the resulting income; its use is open to negotiation, and a woman cannot be sure she will be compensated fairly for her labor (Sexton 1988; Overfield 1998; Koczberski 2007; Curry et al. 2007).

Instead, women have long dominated food cropping and sale (mainly of vegetables and tubers, including sweet potato). They tend to manage home gardens independent of their husbands and are generally the primary sellers of food crops in most marketplaces, controlling the income they accrue (Sexton 1988; Maclean 1989; Curry et al. 2007; Anderson 2008; Inu 2015; Busse and Sharp 2019; Barnett-Naghshineh 2019; Curry et al. 2019). Until the 1980s, only surplus production was sold, but many have now shifted to deliberate production for sale and, in some areas, a resulting decrease in crop diversity (Curry et al. 2019; Inu 2015; Busse and Sharp 2019). Men have generally been less involved in food crop marketing, only selling crops of higher social value (e.g., sugar cane, banana; Maclean 1989), but this is also changing (Sexton 1992; Benedikttson 2002; Inu 2015; Barnett-Naghshineh 2019). These different market motivations likely play a role in crop diversity choices.

Anthropological work in the 1960s and 1970s noted that crops were considered 'gendered' in most areas of PNG, with some being grown only by men and others only by women (e.g., Stilltoe 1981; Powell et al. 1975; Rappaport 1968; Clarke 1974; Pospisil 1963). Gendered divisions of labor followed these norms (Brookfield 1991): women spent considerably more time with 'female' crops, while men cleared land and planted ceremonial crops (Hays 1974). Opinions on the flexibility of such definitions vary: Sillitoe (1981) asserted that planting crops of the opposite gender brought opprobrium (e.g., physical punishment for women or social ridicule for men), while Clarke (1974) argued that men could plant almost any crop. Where men are involved in selling food crops, it has been argued that they may choose to focus on new, introduced crops (e.g., asparagus) that do not have gendered, ceremonial, or cultural connotations (Barnett-Naghshineh 2019). Social norms, and definitions of masculinity and femininity, are constantly in flux (Curry et al 2012; Overfield 1998; Barnett-Naghshineh 2019; Maclean 1989), and it is unclear how important these gender norms remain in driving crop choices in modern PNG.

Historically, crops played an important symbolic role in ceremonial exchanges in PNG (Sterly 1997; Kocher-Schmid 1998; Wiessner 2005). The specific crops valued for such exchanges varied somewhat by group and agroecology, but men typically took the lead in them (Sexton 1992; Sillitoe 1981). This role could foster a preference for culturally prestigious crops (e.g., yams, sugar cane, taro) amongst men. While still used in traditional exchanges and celebrations, these crops are now sometimes replaced or supplemented by cash (Sexton 1988, 1992; Sillitoe 1981; Koczberski and Curry 2016), perhaps weakening such motivations. Women are largely responsible for household cooking, suggesting they may pay keener attention to culinary needs when choosing crops—though marketing also allows women to substitute store-bought foods, underlining the importance of marketing in driving women's choices, even when related to household food security (Sexton 1988). Crop diversity can also be used to manage marginal and varied land conditions and to remain resilient to cultural and environmental changes or mitigate risks (Brookfield 2001; Mogina 2002), such as the periodic floods and droughts from which PNG suffers (Bourke and Harwood 2009). Such risks and vulnerabilities may also be

gender-related, as noted above. How these various motivations manifest differently between men and women in terms of crop diversity choices will be explored in this paper.

3. Sites and Methods

3.1. Study Sites

The fieldwork was part of a three-year (2011-2013) study in four sites (two in Eastern Highlands Province, two in lowland Morobe Province) in moderately developed rural areas of PNG. All sites have sufficient market access to enable selling of food and cash crops. The population is almost entirely semi-subsistence farmers, using traditional methods of cultivation to grow for own consumption and selling either excess produce or deliberately produced surpluses. Households are generally poor, with limited access to improved water and sanitation. Access to cash from non-farm sources is limited: less than one quarter of adults worked in wage employment in the past year. Table 1 summarises the crops grown in each site and their main uses.

[Table 1 here]

The two highlands sites (codes H1, H2) are similar in terms of their agroecological characteristics. They have a year-round growing season, moderate rainfall seasonality, and hilly topography; fallow periods are declining due to land shortages. Sweet potato is the main staple, important for home, market, and feeding pigs (Bourke and Harwood 2009). Market-lucrative, fast-maturing cultivars have gained in popularity in both sites, but particularly in H2, enabling multiple annual harvests. About half of land area is planted with sweet potato; other root crops, including cassava, taro, Chinese taro, and yam are widely grown but make minor contributors to diet (Bourke and Harwood 2009). Winged bean, yams, bananas, sugar cane, and pandanus fruit also have important ceremonial uses (Howlett 1962). Aside from winged bean, all ceremonially important crops are associated with men; sweet potato and greens are traditionally associated with women, who lead their cultivation (Sexton 1988). Arabica coffee is commonly grown as an export cash crop. Men manage coffee, in gardens are separate from food gardens. Many also grow recently introduced vegetables for market (e.g., broccoli); these are not associated with either gender. The sites differ in market linkages. H1 is further from major markets,

with more limited transportation—though still comparatively well connected by PNG standards—whereas H2 is 15km from Goroka (the province's major market). Large-scale marketing of sweet potato and vegetables is highly developed in H2, which is near an area (Asaro Valley) known for its prominence in fresh food marketing; coffee production has declined in response. This change has led to some reshaping of roles of men and women in agriculture, with men playing greater roles in production and sale of food crops than previously. Land availability is also a concern, and land shortages have led to declining fallow periods as well as migration to urban areas, primarily for men.

The two lowland sites, L1 and L2, experience a unimodal rain pattern, and shifting cultivation is practised (Vance and Sumbak 1979; Bourke and Harwood 2009). Taro and banana are staples; sweet potato, cassava, and yam are of secondary importance. Peanut and betel nut are key market crops in L1, as are fruit and introduced vegetables (e.g., cucumber, aubergine) in both L1 and L2 and taro in L2. Taro and yams have important ceremonial uses in L1, considered signs of wealth (Read 1946); for these cultural reasons, they are not sold. Such traditions exist in L2 but with less salience and without a taboo on sale. Both crops are seen as traditionally male; there are no major ceremonial crops associated with women. The main social change in L2 has been an influx of regional migrants, creating linguistic and cultural diversity and weakening adherence to tradition, including gender norms related to crops. In contrast, L1 residents have a strong social identity, with adherence to traditions (including crop-related gender norms). L2 is also much closer to a city (Lae) and more integrated with its market; market-oriented food production is highly important for livelihoods, whereas it is secondary in L1.

In addition to the growing influence of the market and the cash economy, recent social changes impacting all four sites include mobile telephony, making rural farmers better connected and informed than before (Watson 2011), and continuing social issues related to violence, alcohol use, and crime. Some farmers also note changes in climate and crop seasonality, including more irregular rains and shifting altitudinal ranges of crops.

With considerable variation, men and women divide responsibility for cropping but also cooperate in some tasks. Women and men may decide jointly about the location of a new garden, and both clear the

land. Men and women may manage separate plots, or areas within plots, though planting and maintenance decisions may also be negotiated. Men may grown crops within women's gardens or maintain their own (smaller) gardens, managing and making decisions on those gardens independently. However, a planter typically has the rights to any produce, including whether to sell it and to use the revenues; though there is some negotiation and discussion, this makes the choice of which crops to plant within a given garden largely an individual one.

3.2. Data Collection and Analysis Methods

As this paper builds on prior work, Nordhagen, Pascual, and Drucker (2017), full methodological details are reported there. In summary, Q methodology is an approach to studying opinions, motivations, or attitudes (van Exel et al. 2004). The method is subjective, allowing individuals to reveal their personal viewpoints and uncover viewpoint typologies existing within the population as a whole (Brown 1980; van Exel et al., 2004). It analyzes interrelated questions holistically (van Exel and de Graaf 2005), forcing trade-offs and prioritization—as in on-farm decision-making. Researchers collect a range of statements expressing existing opinions on a given topic, obtained through observation, interviews, media, or scientific literature (van Exel and de Graaf 2005; van Exel et al. 2004). A broadly representative subset of these statements is printed on cards, which are presented to participants who rank them according to their point of view on a quasi-normal distribution along a continuum (e.g., 'Don't agree' to 'Agree very much'; Fig. 1). This 'Q-sort' is followed by an interview about the exercise and research topic (van Exel et al. 2004). Past applications have examined related topics, such as farming styles in California (Brodt et al. 2006) and Mexican silvicultural practices (Zabala et al. 2017), but we do not know of a prior application using Q method to examine gender issues in agriculture.

Don't agree at all			**Neutral**	**Agree Very Much**		
-3	-2	-1	0	1	2	3

Figure 1. Distribution of Statements Used in the Q Methodology

The results of this Q-sorting exercise are examined using principal-components analysis (Watts and Stenner 2005) to identify clusters of correlations: groups of statements highly correlated with one another but not with others are considered to form a viewpoint typology (henceforth, 'typology') or 'factor'. *Factor loadings* are then calculated based on the correlation between the factor and each Q-sort; this shows how much a participant's Q-sort *loads* on that factor (i.e., how much that participant agrees with that viewpoint). Factors are rotated and re-expressed into statement scores (i.e., -3 to +3, as in Fig. 1) so that each typology is represented by an 'ideal' Q-sort. This ideal Q-sort shows how a participant with 100% loading on that factor would have ordered the statements (Watts and Stenner 2005). The researcher interprets these results to suggest origins and implications of the views (Walter 1997).

Here, statements were collected drawing on earlier fieldwork (including a survey [n=369] and 15 group interviews), interviews with local extension agents and researchers, and agriculture-related articles in local newspapers. The final Q-set included 31 statements, as listed in Appendix Table 1; these were printed in *Tok Pisin*, the national language, on index cards. Two villages were randomly selected in each site, and individuals were selected quasi-randomly, aiming to ensure rough representativity in age, market orientation, and extension contact. Informed consent was obtained from all participants, and no personally identifying information was collected.

Participants were given instructions, including to focus on food crops, not coffee, when interpreting the statements. They were asked to sort statements into three piles (Agree with, don't agree with, neutral), then guided to progressively sort across a seven-point (+3 to -3) distribution, which was drawn on a poster with spaces for all of the cards (Fig. 1). Once this was completed, the researchers noted the final layout and used it as the basis of a semi-structured interview covering the participant's opinions related to crop choice, gender roles, agricultural decision-making, and marketing. Given low literacy (50-70% literacy rates, depending on the village), the exercise was conducted orally for most farmers.

The final sample included 92 farmers (fairly large for Q methodology, Dziopa and Ahern 2011). The participants' demographics were representative of the case study sites' population aside from a slightly higher percentage of women: 54% of participants were female, the average age was 35.5, and 26% had not attended school, 54% had attended primary and/or some secondary school, and 20% had completed secondary school.

4. Results

Data analysis was conducted using PQMethod software (Schmlock 2012) and Stata SE10/SE12. After rotation, five factors were retained. These factors were re-expressed by rank-ordering the factor Z-scores into statement scores (i.e., the lowest two Z-scores were expressed as -3); these statement scores were then used to depict an 'ideal' Q-sort. For example, the ideal Q-sort for Group A (see Appendix Table 1) would include statement 1 ranked as +2 (agree moderately) and statement 12 as -3 (disagree strongly). Each typology contained 8-16 defining individuals (i.e., those who loaded significantly more strongly on that factor than on any other). Seven farmers loaded on multiple factors significantly, while 13 had no significant loadings on any factor. These results are consistent with prior similar-size Q-method studies (e.g., Walter 1997).

Q-methodological interpretation considers the ideal sort for each typology, paying most attention to the extreme statements (scores of +2, +3, or -2, -3) and statements rated significantly ($p<0.05$ or $p<0.01$) differently than by other typologies. These are interpreted in the context of the overall ideal-type sort, including (if relevant) statements that were not salient. Finally, individuals with defining sorts (i.e., those whose sorts most define the typology, identified by the significance of their loading on the factor) for each typology are considered in the context of their post-sort interviews and the researchers' previous work in the same communities (Watts and Stenner 2005)—here, we drew on post-sort interviews as well as prior group interviews, field walks, and survey data.[5]

4.1. Background Results: Farmer Types

Full results on the identified types of farmers are given in Nordhagen, Pascual, and Drucker (2017); we summarize them in this section before focusing on the gender aspects. Appendix Table 1 provides the

list of statements and scores given by the ideal sort for each typology, noting those rated significantly differently by a given typology. Through this analysis, five typologies were identified.

The ***Marketer-consumers*** (Group A in Appendix Table 1) have the market as their most resonant, though not sole, motivation. They rank economic values of crops higher than other typologies, see themselves primarily as sellers, and prioritize marketable crops over ceremonially important ones. However, their crops are also essential for household consumption, and they weigh use values about as highly as other typologies. The ***Pragmatists*** (Group B) have a practical focus on crop utility (primarily for consumption) and balancing various constraints on cropping, with less interest in culturally impressive crops. They also readily note that new crops are regularly being introduced; when these new arrivals displace old varieties, they feel a greater loss than do other typologies. The ***Proud exhibitionists*** (Group C) prioritize image concerns: crops' ceremonial/traditional uses are key, and status is weighted more heavily than by other typologies. Supplying marketing is an unimportant motivator of diversity, compared to other typologies, and crops' monetary values are seen as less important than their value for traditional uses. The ***Novelty seekers*** (Group D) experiment more than other typologies, regularly seeking new crops. They do not focus on maintaining old varieties for the future or have sentimental attachments to them. Finally, the smallest typology, the ***Secondary farmers*** (Group E) uniquely consider food cropping as less important, in financial terms, than their other work. They do not place much weight on seeking new varieties or creating attractive gardens when making crop diversity choices, and they do not actively look for and adopt new crops.

Across farmer typologies, there was considerable agreement regarding the importance of crops as food and consumption values as key drivers of crop choices (S28, S27, S29). The most divisive statements were those related to marketing and income generation, being a strong motivation for Marketer-Consumers but not Secondary Farmers or Proud Exhibitionists. There was also considerable disagreement related to how status concerns drove crop choice (S25, S24): this was important for Secondary Farmers and Proud Exhibitionists but not Marketer-Consumers.

4.2. Gender alignment to farmer typologies

Turning to the central research question, differences between men and women farmers' viewpoints regarding crop diversity, we first consider how alignment with the different typologies summarized above varies across the genders. This is interpreted in light of farmers' comments in the post-sort interviews; individual farmers used as examples are identified with a number preceded by M, "male", or F, "female." Table 2 reveals cross-gender differences in the individuals loading uniquely significantly on each factor, as well as providing basic demographic and agricultural characteristics for the individuals who were associated with each typology. The data suggests that gender and crop choice typologies are interrelated: Pearson's test of independence rejects the null hypothesis that typologies are independent of gender (X^2=60.87, p=0.000), and there are significant cross-gender differences in factor loadings (i.e., levels of agreement) for two of the five factors.[6]

Table 2. Demographic Characteristics and Gender Differences, by Typology

	Marketer-Consumers		Pragmatists		Proud Exhibitionists		Novelty seekers		Secondary Farmers	
Demographic Characteristics of the Defining Individuals for Each Group										
Num. defining individuals	**15**		**22**		**17**		**7**		**5**	
Percent Male	13%	***	50%		53%		29%		60%	
Avg. Age	35.1		33.3		41.6	***	35.0		31.0	
Avg. Education (years)	2.5	***	7.4	***	5.1		1.6	***	5.2	
Significant impact 1997/8 drought	47%		73%	**	88%	***	29%	*	20%	*
Avg. interspecific Diversity	20		27		44	***	27		29	
Percent in top local quartile for inter-specific crop diversity	0%	***	18%		41%	**	0%		0%	
Pct. Of farmers in each site aligning with group	H1: 13%, H2: 33% L1: 5%, L2: 0%		H1: 43%, H2: 20%, L1: 9%, L2 10%		H1: 7%, H2: 7%, L1: 55%, L2: 10%		H1: 10%, H2: 7%, L1: 5%, L2: 10%		H1: 3%, H2: 3%, L1: 5%, L2: 20%	
Gendered Differences in Factor Loadings										
Men: *Avg. Loading*	0.2193*		0.30		0.31***		0.08		0.12	
No. of uniquely significant loads	2		11		9		2		3	
Women: *Avg. Loading*	0.2855*		0.24		0.19***		0.12		0.10	
No. of uniquely significant loads	13		11		8		5		2	
p (difference in loadings)	0.079		0.118		0.022		0.205		0.407	

Notes: Data source: interviews after Q sorts. All data come from participants' own reports. Significant differences are marked as such: p<0.10 (*), p<0.05 (**), p<0.01 (***). P-values are taken from sample comparison t-tests. In cases where Bartlett's X-squared statistic for difference in the variance between individuals across the two groups was significant, we use Welch's approximation of t in these cases. 'Inter-specific diversity' refers to the number of food crops grown, with quartiles calculated separately for each zone, due to agroecological variations. The percent of farmers aligning to each group by site do not add to 100% as some farmers loaded on multiple or no factors--and thus were not associated with any group.

The *Marketer-Consumers* emerge as the most strongly *female* typology, with loadings and number of defining individuals significantly larger for women than men. This squares well with past research in PNG showing women to be the main sellers of food crops in rural markets, as discussed in Section 2. The main market crops mentioned in the highlands, where most Marketer-Consumers were, included introduced vegetables (e.g., carrot, cabbage, cucumber) and, particularly in H2, sweet potato (where a lucrative fast-growing variety, *Gimane*, was most common); in L1, peanuts, watermelon, and cucumber

were mentioned. No farmers defined this typology in L2, where the main marketed crops were taro and banana.

In addition to being one of these women's few options for income, the temporal stability of income is also crucial. For example, one highland woman (F7) who loaded strongly on the Marketer-Consumer typology explained in the post-sort interview that her husband focused on coffee, but she considered food crops more important because coffee was only seasonal, in contrast to year-round household needs. This aligns to the difference in budgeting timeframes among men and women found by Mikhailovich et al. (2016) and the preference for steady income found by Sharp (2013) when examining betel nut sales. The income earned from this market-oriented production is central to household welfare, as it is available year-round and used to buy store-bought goods, such as soap and cooking oil. Although men in their post-sort interviews also noted buying these items with their money, they were also likely to mention alcohol, cigarettes, betel nut, and gambling. Few men or women mentioned buying traditional staple foods (e.g., sweet potato, banana) instead of growing them; money was used, however, for store-bought foods (e.g., tinned meat and fish), aligning to Sexton (1988). For example, for farmer F7, the income obtained from selling crops was generally spent on household goods, including food in trade stores; her husband retained the money from coffee and she had little knowledge of how it was used. (It is commonly reported that men in highlands towns spend considerable amounts of their coffee earnings on non-food expenses such as gambling, alcohol, or betel nut or ceremonial exchanges; see e.g., Eves and Titus 2017; Curry et al. 2019.)

Marketing is not only a source of income but also of identity. Studying women's mental health in PNG, Hinton and Earnest (2007) regularly heard the statement *mi meri blong maket* ('I am a market woman') as an expression of identity. This sentiment was also frequently heard in the post-sort interviews for this study. Another key motivation was the social environment of the market: filled with women, it was an area for social (and material) exchanges in which women felt at home. This motivated market sale, which in turn shaped diversity viewpoints, as captured in the Q-sorting exercise. Diversity in plant production thus allowed women to both meet varied market demands (and the differing demands between local and regional markets) and smooth revenues across seasons.

These marketing concerns thus manifested themselves strongly for the women (and men) in the Marketer-Consumer typology. They also drive crop choices: the aforementioned woman, for example, grows several kinds of sweet potatoes, prioritizing fast-maturing 'commercial' varieties and planting them to be ready all at once, for bulk marketing, in contrast to traditional staggered harvesting that ensured stability of food supplies and helped spread environmental risk. Although Anderson (2008), argued that 'diversity of crops is an environmental and a livelihood concern', based on women's key role in marketing, the farmers defining the Marketer-Consumer typology have significantly *lower* inter-specific diversity than the average Exhibitionist.

Factor loadings on the *Proud Exhibitionist* typology were significantly larger for men. This squares well with past research documenting men's key roles in ceremonial exchanges, including crops (Sexton 1992), and the traditional importance of yam—a 'male' crop. In the highlands, yams, taro, and bananas were seen as important ceremonial crops (and winged bean for women); in L1, it was yam and taro, and in L2 to taro and banana. As an example, an older man (M13) who loaded strongly on this typology was very vocal in his interview about the importance of traditional crops and the key role that yams played in maintaining the local cultural values. He was not personally involved in growing his household's main market crops, which were maintained by his wife and daughters/daughters-in-law, but he cultivated several species of native and non-native yams. Indeed, those farmers defining the Exhibitionists, in addition to being male, generally had significantly greater inter-specific diversity[7] and were older (Table 2). Thus, while three of five typologies show no significant gender-related differences, there is a clear male-female division in terms of the most market-oriented farmers (more likely to be women) and the most status-oriented famers (more likely to be men).

4.3. Gender Differences in Agreement with Statements

Turning to the statements themselves, there are several notable gender-specific differences. Table 3 examines these differences by displaying average statement rating scores for men and women: an average rating above 1 suggests fairly strong agreement of men or women with that statement, whereas one below -1 suggests fairly strong disagreement. P(diff) indicates the p-value on a test of the

significance of the difference in mean rankings across the two typologies—i.e., whether there are significant differences between men and women in agreement with that statement. In the following, statements are referred to by statement number (i.e., S3 = statement 3).

In line with the above discussion, the perception about the importance of market/commercial farming (S1) was found to be much stronger among women: only 18% of men agreed that commercial/market farming was their primary aim, while 35% of women did. Interestingly, however, this statement had a higher degree of variance amongst women than men, as shown through Bartlett's X^2 statistic for difference in the variance ($p=0.009$), with ratings spanning the full spectrum from extreme agreement to extreme disagreement. Similarly, women were in much stronger agreement with 'I would rather make money growing more crops to sell than grow old traditional crops' than men. In contrast, the statements 'I would rather grow nice crops to give to others or for ceremonies or feasts, than grow more crops just to eat' (S22) and 'It is important to keep growing old local crops because they may be needed in the future' (S30) resonated more strongly with men than women.

Table 3. Statements and Mean Rankings by Gender

Statements and Mean Rankings, by Gender					
		Mean Ranking			
	Statement	Men	Women	P(diff)	
1	I am a commercial farmer; the main point of my farming is to produce crops for the market.	-0.84	-0.11	0.03	*
2	Growing traditional crops, like winged bean and special yams, is not important anymore	-0.76	-0.61	0.29	
3	I like to experiment with my garden, trying new crops or varieties	-0.13	0.27	0.09	*
4	There are no new crops, the same crops have always been here and always will be	-0.79	-1.09	0.18	
5	I miss the varieties that we used to grow but do not now.	0.26	0.11	0.31	
6	Growing many different crops shows others that I am a good farmer	0.92	0.80	0.36	
7	I do not choose the crops that I grow, I grow what we have always grown	-0.63	-0.32	0.14	
8	Growing many crops and varieties makes me ready if the market prices change	0.58	0.77	0.23	
9	I would rather make money growing more crops to sell than grow old traditional crops	-0.34	0.55	0.00	***
10	I make sure to grow some crops that will do OK if there is drought or a lot of rain.	1.05	0.50	0.03	*
11	Instead of growing all the plants I eat myself, I just buy them in the market.	-2.03	-1.86	0.28	
12	I only make decisions about a few crops; my wife / husband makes most of them	-0.37	-0.61	0.22	
13	In markets or while travelling, I am always looking for new crops and varieties.	0.39	0.66	0.19	
14	Growing more types of crops is good when the weather is unpredictable or the seasons are mixed up	0.68	0.39	0.18	
15	If I grow only a few crops, it would be too risky; they could be damaged by insects or weather.	-0.66	-0.66	0.50	
16	I do not mind not growing a crop or variety if I find another I like better	-0.32	-0.34	0.47	
17	If there is not enough or too much rain, all the crops suffer the same, none do better	-0.68	-0.25	0.07	*
18	Growing food crops is less important to me than making money through growing coffee or other work.	-1.55	-1.07	0.06	*
19	I would like to grow more crops, but I do not have the right land.	-0.29	-0.57	0.21	
20	A garden with many different crops will do better if there are pests, like weevils	-0.18	-0.39	0.26	
21	I sometimes cannot grow the varieties I want because I cannot get their planting materials	0.58	0.02	0.03	**
22	I would rather grow nice crops to give to others or for ceremonies or feasts than grow more crops just to eat.	0.63	0.16	0.07	*
23	I do not pay attention to what other farmers grow	-0.63	-0.77	0.29	
24	Because of my status in the community, I must grow impressive crops	-0.34	-0.52	0.30	
25	I make sure my garden is attractive, with many different plants.	0.82	0.91	0.38	
26	Growing more kinds of crops would be too much work.	-0.74	-0.52	0.25	
27	The main reason I grow a lot of crops is to have a variety of things to eat.	1.74	1.00	0.00	***
28	It is more healthy to eat many kinds of crops	2.00	1.68	0.10	
29	Most important to me is growing things that are easy to cook	0.79	1.25	0.08	
30	It is important to keep growing old local crops because they may be needed in the future	0.82	0.32	0.08	*
31	All crops grow well here, it does not matter what type of land they are grown on.	0.03	0.32	0.22	

Significant cross-gender differences are marked as such: p<0.10 (*), p<0.05 (**), p<0.01 (***). in cases where Bartlett's X2 statistic for difference in the variance between individuals across the two groups was significant, a standard two-sample t-test is inappropriate, hence, we use Welch's approximation of t in these cases (statements 1,6,10,12,29).

Interestingly, both men and women gave considerable weight to having a varied diet as a crop choice motivation (S27), but this was significantly more important for men than women, while women gave

greater weight to the ease of cooking (S29). Conversely, while both men and women generally agreed with the statement 'I make sure to grow some crops that will do okay if there is drought or a lot of rain' (S10), women gave significantly less weight to this; while only two men disagreed, neither strongly, 27% of women did. Again, the variation among women was also greater: this statement was a key area of disagreement among women as well as between the genders (Bartlett's X^2 $p = 0.012$). Planting materials were seen as a constraint significantly more by men than women (S21).

The set included one explicitly gendered statement (S12: "I only make decisions about a few crops, my wife/husband makes most of them"), with which men were more likely to agree, seemingly recognizing the chief role of women in crop cultivation. Though the difference between mean ratings was not significant, it should be noted that no men strongly disagreed with this, while no women strongly agreed. In post-sort interviews, all participants were asked about their roles in cropping (e.g., the intra-household division of labor) and which (if any) crops were reserved for men or women. Views of both men and women varied widely: some saw gendering of crops as a thing of the past, with prohibitions no longer applying, while others opined that they remained a crucial aspect of the culture. While this variation was seen across all sites, those in sites H1 and L2 were most likely to agree with the latter view and those in site H2 with the former view. Though some of those interviewed mentioned certain traditional crop-gender taboos, such as women not being permitted in taro gardens during menstruation, as still carrying force, none expressed crop gendering as having the same opprobrium-engendering social importance as previously noted by Sillitoe (1981).

4.4. Differences Across Case Study Sites

Considering differences across case study sites, Marketer-Consumers tended to be particularly common in H2, followed by H1 (Table 2); this is not surprising, as H2 is near an area known for the fresh produce trade and a major market, while H1 is further from the market, and large-scale marketing remains less developed in PNG's lowlands than the highlands (Benediktsson 2001). However, *male* Marketer-Consumers were uncommon in site H2, which is somewhat surprising given reports (during key informant interviews) of men playing important roles in production and sale of food crops in that area.

This, combined with the greater salience of S12 in H2, suggests that the relationship between increasing food crop marketing and the redefining of views and gender norms around crop choice is not straightforward. In contrast, the Proud Exhibitionists were by far most common in L1, which is in an area known for strong cultural traditions and ceremonially valuing yams (the Markham Valley). The contrast with the low prevalence of this type in the highlands sites suggests decreasing importance of ceremony—however, both H1 and H2 are relatively market-integrated, so this should not be generalized widely. Secondary Farmers were most common in L2, a site not far from the city of Lae and thus having more opportunities for wage employment. Surprisingly, this well-connected site had no 'Marketer-Consumers.' This may be because marketing, as an activity, remains less developed; L2 was also the site with the highest percentage of farmers aligning to no or multiple factors, suggesting considerable diversity in views in this site.

4. Discussion

Overall, the results suggest that there is no monolithic 'female farmer' typology: even for the two most 'gendered' factors, *Marketer-Consumers* and *Pragmatists,* the distributions of men and women largely overlap, with male and female farmers aligning to both. Three of the five typologies were subscribed to equally by men and women, and male and female farmers were among those aligning to each of the five typologies (and those aligning to none of them). In addition, for 21 of the 31 statements included, men and women ranked them similarly. However, there were significant differences between men and women in their allegiance to several of the different typologies, creating a picture of overlapping yet non-identical spheres in the views of men and women regarding crop choices in PNG.

Women's stronger tendency to align with the Marketer-Consumer typology contrasts with general assumptions in the literature (beyond PNG, see Section 2.1) of women's crop choices as less income-motivated but aligns clearly with the socio-economic context and past research in PNG (Section 2.2). Selling food crops is a key source of year-round income revenues for women in PNG and other low-to-middle-income countries generally, as women often have few other options for gaining revenue (in comparison men, who are more likely to grow coffee, work as laborers or in mining, or migrate to urban

areas). Being a "market woman" is also a sort of identity for many highland PNG women, with the market playing a key role as a social structure and support network.

Despite growing male involvement in PNG's lucrative food crops such as sweet potato (Benediktsson 2001; Sexton 1992), men were notably less likely to associate with the Marketer-Consumer typology. In contrast, men showed significantly stronger alignment with the Exhibitionist typology than did women, reflecting some continued salience of traditional customs associating certain 'show' crops (particularly yams) with masculinity and power. Thus while questions of identity may help drive crop diversity choices for both genders, these flow in different streams: marketing for women and exchange/custom for men.

This difference (and, equally, the lack differences by gender for many statements and typologies) has implications for policies related to agricultural development, crop choice, and conservation. In the academic literature, as noted by Doss et al. (2018), women worldwide are often argued to be intrinsically more conservation-minded than men, including as custodians of biodiversity; they are thus targeted for interventions that aim at conserving crop diversity. However, women's crucial role in household food security, with limited access to non-farm income sources, may lead them to prioritize income generation over conservation. For many women in PNG and elsewhere, conservation may be overridden by crop marketability—not only crucial for income generation but also an expression of identity. For example, while PNG women's crops may be diverse, much of this diversity is comprised of non-indigenous hybrid crops, such as broccoli, for marketing purposes.

Women in PNG and other low- and middle-income countries also already face a larger burden of care and agricultural work and may have little time for additional agrobiodiversity conservation duties (e.g., Torri 2010). A better approach than slotting women into the role of 'diversity guardians' may thus be to approach farmers depending on their preferences regarding crop diversity, bearing in mind considerable variations within the genders—as well as the gender dynamics between men and women. At the same time, agricultural extension services can seek to understand male and female farmers' motivations for crop portfolio choices, directly addressing their needs for market-oriented production

and/or crops that can fulfill cultural needs. Such efforts would include better outreach and involving women of all types in agricultural extension, particularly training in marketing.

These results also have implications for nutrition, a key development issue in PNG. Many current 'nutrition-sensitive agriculture' initiatives focus on crop diversification and target women as more likely to directly impact household nutrition (Ruel et al. 2018). The salience of marketing for women (and the key nutritional gaps in inland PNG, which largely arise from limited intake of protein and iron-rich foods) indicates that supporting marketing (and providing nutrition education to encourage women to spend that income on such foods) may be a more likely route towards improving nutrition in PNG than encouraging production and consumption of nutrient-rich crops. Of course, such tendencies are very context-specific and should be examined more widely across varied contexts.

The lack of salience of crop gendering for all but the Proud Exhibitionists and many women's disagreement with the statement regarding the existence of gender-specific crop decision-making (S12) suggest that norms may have shifted considerably since earlier work on crop gendering in PNG (e.g., Howlett 1962; Sillitoe 1981). In post-sort interviews, the majority of farmers (both men and women, across sites), described food crop choices as a joint decision, and far more women felt they would make these without consulting their husband than the inverse. That said, it was clear that women undertook considerable agricultural labor, and nearly all women expressed the sentiment that intra-household work-sharing placed greater burdens on women than men, aligning with Mikhailovich et al. (2016). Moreover, it is important not to lose sight of the broader context in which women's crop choices are embedded: poorer access to land, agricultural extension, credit and financial services, education, and political power. An assumption of a process of active decision-making (as opposed to responding to severe constraints) and an emphasis on 'small' choices, such as crop diversity, may create the illusion of freedom in a context wherein true 'choice' is structurally precluded.

The results are specific to the setting in which they were generated; caution should be used when extrapolating them to shed light on changing gender norms in other traditionally agricultural societies undergoing rapid transitions. However, we suspect that research in other contexts would also find

income-earning to be a key driver of women's (and men's) decisions in many low- and middle-income countries—and we urge more such studies to be conducted. Considering other limitations of the results, the study's focus was on subjective perceptions and did not necessarily reveal all possible perspectives in the population. Though they have been grouped for the ease of discussion, actual farmers have varying levels of association with a given typology and are not the pure archetypes elucidated above. In addition, some researchers (Carr 2008a and references therein) have criticized certain work on gender and crop choice as simplifying 'men' and 'women' into monolithic categories and thereby masking variation within each typology. Similarly, feminist post-structural approaches (Lawson 1994) argue that gender identities only gain meaning through interactions with other characteristics, such as class and race; this has been explored in agriculture by, e.g., Ravera et al. (2016) and Thompson-Hall, Carr, and Pascual (2016). Indeed, the considerable levels of variance in statement rankings among women within this study's results are testimony to this fact: as with most other topics, women cannot be seen as a monolithic block in terms of their crop diversity choices. Though our approach explicitly recognized a diversity of farmers of both genders, sample size constraints did not allow us here to investigate in-depth how such typologies might vary across sub-groups. Additional work should seek to examine this topic more deeply.

5. Conclusion

This paper has considered how farmer viewpoint typologies with respect to crop diversity choices differ between men and women in semi-subsistence agricultural areas in Papua New Guinea. Alignment with five typologies, identified via Q methodology, was found to vary across men and women. Women were found more likely to place importance on marketing concerns; men, in contrast, tended to be more prevalent among those farmers who highly ranked status and traditional use values. This aligned to prior work emphasizing women's key role in crop marketing and men's roles in traditional exchanges. However, explicit gender differences in crop decision-making did not emerge as particularly salient, in contrast to historical work noting strong crop gendering in PNG. Though uncovering differences, the study also focused on considerable commonality and shared values, both across and within the genders, particularly around the importance of consumption concerns motivating farmers' crop diversity choices.

The results, based on a novel application of Q methodology to examine gender-related differences, offer new insights about the ways in which gender shapes crop choice in modern PNG, with potentially useful implications for development policy and interventions. At the same time, they also underline the complexity of gender and its interaction with other individual characteristics and systematic factors in shaping agricultural livelihoods. By recognizing this diversity amongst farmers, both their own needs and wider development objectives can be better met.

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Table 1 – Crops grown, by site

Crops Grown and Uses, Across Sites								
Greens and Vegetables								
	H1		H2		L1		L2	
Pumpkin Leaves*	100%	*h*	85%	*h*	97%	*h*	82%	*h*
Pitpit	94%	*h*	53%	*h*	85%	*h*	81%	*h*
Other local greens	93%	*h*	84%	*h*	66%	*h*	66%	*h*
Onion*	82%	*h,m*	79%	*m,h*	53%	*m,h*	25%	*m,h*
Cucumber*	79%	*m*	62%	*m*	87%	*m*	74%	*m*
Cabbage*	67%	*m*	66%	*m*	6%	*m*	46%	*m*
Chilli*	56%	*m*	52%	*m*	54%	*m*	47%	*m*
Tomato*	54%	*m*	59%	*m*	85%	*m*	76%	*m*
Chinese Cabbage*	51%	*m*	47%	*m*	7%	*m*	39%	*m*
Aibika	50%	*h*	57%	*h*	100%	*h*	91%	*h*
Carrot*	49%	*m*	64%	*m*	0%		3%	
Ginger	39%	*h,m*	33%	*m,h*	1%	*m*	0%	
Broccoli*	26%	*m*	22%	*m*	3%	*m*	2%	*m*
Lettuce*	13%	*m*	9%	*m*	0%		0%	
Spring Onion*	13%	*m*	0%	*m*	6%	*m*	0%	
Capsicum*	8%	*m*	9%	*m*	3%	*m*	0%	
Aubergine*	7%	*m*	9%	*m*	53%	*m*	3%	*m*
Legumes								
	H1		H2		L1		L2	
Common bean*	97%	*h,m*	88%	*h,m*	90%	*h,m*	88%	*h,m*
Peanut*	76%	*h,m*	57%	*h,m*	79%	*h,m*	61%	*h,m*
Winged Bean	67%	*h,x*	47%	*h,x*	6%	*h,x*	34%	*h,x*
Pea*	8%	*m*	0%	*m*	0%		0%	
Soya Bean*	8%	*m*	0%	*m*	0%		0%	

Fruit and Tree Crops								
	H1		H2		L1		L2	
Sugar Cane	90%	*h,x*	79%	*h,x*	81%	*h,m,x*	81%	*h,m,x*
Coffee*	70%	*c*	86%	*c*	0%		0%	
Guava*	46%	*m*	56%	*m*	54%	*m*	41%	*m*
Orange*	46%	*m*	40%	*m*	9%	*m*	11%	*m*
Pineapple*	46%	*m*	50%	*m*	84%	*m*	80%	*m*
Papaya*	43%	*h,m*	62%	*h,m*	75%	*h,m*	71%	*h,m*
Pandanus	38%	*h*	51%	*h*	7%	*h*	21%	*h*
Passion Fruit*	35%	*m*	39%	*m*	0%		2%	*h*
Watermelon*	10%	*m*	11%	*m*	90%	*m*	57%	*m*
Mango	8%	*h*	21%	*h*	75%	*h,m*	34%	*h,m*
Melon*	3%	*h*	2%	*h*	44%	*m*	22%	*m*
Coconut	1%		1%		76%	*m*	64%	*m*
Betel Nut	7%	*c*	0%		41%	*c*	58%	*c*
Starch Crops								
	H1		H2		L1		L2	
Sweet Potato	100%	*h,m*	98%	*h,m*	79%	*h*	89%	*h*
Banana	96%	*h,x*	92%	*h,x*	96%	*h*	97%	*h*
Maize*	94%	*h*	90%	*h*	71%	*h*	77%	*h*
Cassava	90%	*h*	89%	*h*	79%	*h*	88%	*h*
Taro	82%	*h,x*	40%	*h,x*	82%	*h,x*	99%	*h,m,x*
Chinese Taro*	75%	*h*	74%	*h*	46%	*h*	61%	*h,m*
Rice*	71%	*h,m*	5%	*h,m*	18%	*h,m*	31%	*h,m*
Yam	42%	*h,x*	44%	*h,x*	82%	*h,x*	57%	*h,x*
Irish potato*	33%	*m*	24%	*m*	0%		0%	
Swamp taro	24%	*h*	6%	*h*	16%	*h*	2%	*h*
White (African) yam*	19%	*h,m*	41%	*h,m*	75%	*h,m*	67%	*h,m*
Sago	0%		0%		4%	*h*	12%	*h*

*Notes: The portion of households growing the crop are reported; those grown by less than 5% in all sites are not included. Source: 2014 farmer survey data. *-Crop introduced post 1870 (Bourke & Harwood 2009); h - main home consumption crop; c - non-food cash crop; m - important local market crop; x - ceremonial crop.*

Appendix Table 1 Statement Scores for the Five Groups

	Statement	Ideal-Type Score, by Group				
		A	B	C	D	E
1	I am a commercial farmer; the main point of my farming is to produce crops for the market.	2 **	-1	-3	-1	-3
2	Growing traditional crops, like winged bean and special yams, is not important anymore	-1	0 **	-2	-1	-2
3	I like to experiment with my garden, trying new crops or varieties	1	0	0	1 **	0
4	There are no new crops, the same crops have always been here and always will be	-2	-3 **	0 **	-1	-1 *
5	I miss the varieties that we used to grow but do not now.	-1	2 **	0 *	0 *	-1
6	Growing many different crops shows others that I am a good farmer	3	-1 **	3	-3 **	2
7	I do not choose the crops that I grow, I grow what we have always grown	-1	-1	-1	-1	0
8	Growing many crops and varieties makes me ready if the market prices change	1	2	0 **	2	2
9	I would rather make money growing more crops to sell than grow old traditional crops	3 **	0	-2 **	0	0
10	I make sure to grow some crops that will do OK if there is drought or a lot of rain.	0 *	1	1	1	-1 *
11	Instead of growing all the plants I eat myself, I just buy them in the market.	-3	-2	-3 *	-1	-3
12	I only make decisions about a few crops; my wife / husband makes most of them	-3 **	-1	1 **	0 *	-1
13	In markets or while travelling, I am always looking for new crops and varieties.	0	1	0	3 **	-2 **
14	Growing more types of crops is good when the weather is unpredictable or the seasons are mixed up	1	1	1	1	1
15	If I grow only a few crops, it would be too risky; they could be damaged by insects or weather.	-2	0	-1	0	1
16	I do not mind not growing a crop or variety if I find another I like better	0 **	-2	1	2	-2
17	If there is not enough or too much rain, all the crops suffer the same, none do better	0	-1	-1	0	1 **
18	Growing food crops is less important to me than making money through growing coffee or other work.	-1 *	-3	-2	-2	3 **
19	I would like to grow more crops, but I do not have the right land.	-2	1 **	-2	0	-1
20	A garden with many different crops will do better if there are pests, like weevils	-1	1	-1	0	1
21	I sometimes cannot grow the varieties I want because I cannot get their planting materials	0	1	0	1	1
22	I would rather grow nice crops to give to others or for ceremonies or feasts than grow more crops just to eat.	0	0	2 **	-1	0
23	I do not pay attention to what other farmers grow	-2	0	-1	-2	0
24	Because of my status in the community, I must grow impressive crops	1	-2	1	-3	0 *
25	I make sure my garden is attractive, with many different plants.	2	0 *	3	1 *	-2 **
26	Growing more kinds of crops would be too much work.	-1	-1	-1	-2	-1
27	The main reason I grow a lot of crops is to have a variety of things to eat.	1	3 *	2	2	2
28	It is more healthy to eat many kinds of crops	2	3	2	2	3
29	Most important to me is growing things that are easy to cook	2 *	2	1	1	1
30	It is important to keep growing old local crops because they may be needed in the future	0	2	2	-2 **	0
31	All crops grow well here, it does not matter what type of land they are grown on.	1	-2 **	0	3 *	2 *

Note: **,** denote that the statement in question is a distinguishing statement for that group, with significance at $p<0.05$, $p<0.01$, respectively. The groups are as follows: A - Marketer-Consumers; B - Pragmatists C - Proud Exhibitionists; D - Novelty Seekers; E - Secondary Farmers.*

Endnotes

[1] Agrobiodiversity refers broadly to the biodiversity present in and sustained by agricultural landscapes, though this study focuses more narrowly on on-farm crop diversity.

[2] "Gender" differences arise from socially constructed relationships between men and women, which affect the distribution of resources and responsibilities and are shaped by economic and socio-cultural determinants (Moser 1989; Oakley 1972). These differences can change and be changed, whereas "sex" refers to innate biological differences between men and women.

[3] While the country does have some matrilineal cultures (e.g., East New Britain), all areas studied here are patrilineal.

[4] Theft, banditry, alcoholism, and gender violence are all common in PNG and disproportionally impact women (Rumint 1987; Hinton and Earnest 2007; Jewkes et al. 2013). Indeed, Human Rights Watch (2017) cites PNG as "one of the most dangerous places in the world to be a woman."

[5] For full details of the analysis and interpretation process, see Nordhagen, Pascual, and Drucker (2017).

[6] The sample sizes in question (i.e., the number of significant loads) are quite small; such small groups are common in Q methodology but do constrain the significance of the p-values.

[7] Table 2 presents both the average number of different crops (not including multiple varieties of the same crop) and the percentage of those in each group who were in the top quartile of inter-specific diversity for their site. The large variations in the latter measurement reflects that the farmers growing the most diverse crop portfolios were heavily concentrated in the Proud Exhibitionists and, to a lesser extent, the Pragmatists. They do not average to 25% due to variations in sample size by site and category, and because some participants did not load on any factor (i.e., are not included in Table 2 but were included in the calculations for crop diversity quartiles).