

Feeding the household, growing the business, or just showing off? Farmers' motivations for crop diversity choices in Papua New Guinea

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Abstract:

Understanding farmers' reasons for growing diverse crop portfolios is essential for supporting the conservation of agricultural biodiversity to foster social-ecological resilience and conserve crop genetic resources. In this paper, Q-methodology is applied to examine the motivations for growing diverse crops among semi-subsistence rural farmers in Papua New Guinea. Various types of farmers are identified including so-called 'marketer-consumers,' who are highly motivated by crop sale, and 'exhibitionists,' who prioritize the 'show' values of crops. This approach can be applied to better target programs seeking to conserve crop diversity and promote new crop varieties in regions undergoing rapid transformation.

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

Highlights:

- We analyze semi-subsistence farmers' motivations for growing diverse crops.
- This is done via Q methodology, a mixed qualitative/quantitative method.
- The case study is Papua New Guinea, a major center of crop diversity.
- Results show five main types of farmers, with highly different motivations.
- Results can be used to target crop conservation and use programs.

1. Introduction

Agricultural systems and the genetic resources associated with them are currently facing a number of overlapping stressors, including economic, climate, and demographic change (FAO 2010). These forces are transforming agricultural practices, including fostering a trend toward prioritizing a limited number of marketable crops in systems often heavily reliant on synthetic agrochemical inputs, unsustainable irrigation schemes, and conversion of forests and fields into mono-cropped operations (Perrings et al., 2006; Jackson 2012). Maintaining agricultural biodiversity (henceforth, agrobiodiversity) on farms is seen as fundamental for the social-ecological resilience of agricultural and cultural landscapes, within which smallholders pursue livelihoods amidst global agricultural intensification processes (Zimmerer 2013). In more intensive agricultural systems agrobiodiversity also plays an important role, including hedging risks and potentially improving economic efficiency (Omer et al 2007; Pascual et al. 2013).

Few countries boast a trove of agrobiodiversity richer than that of Papua New Guinea (PNG), where over 200 different crop species, native and introduced, are conserved almost entirely through *de facto* cultivation by farmers (Sem 1996). This includes both traditional crops and many well-integrated crops (Bourke and Harwood 2009). Diversity varies by farmer, however, with some growing as few as one or two crops, with just one variety of their main staple, and others growing over forty crops and numerous species and varieties. Variety loss could be particularly significant for this global biodiversity hotspot, with its rich plant-connected traditions, as well as for global crop conservation, making it crucial to understand the factors supporting crop choices that lead to diversity maintenance.

Analyses of crop choices in PNG are few and include mainly agronomic selection studies (Deheku 2001) and ethnobotanical studies of traditional plant uses (Sterly 1997; Hays 1974). Work in other regions has considered farmers' own perceptions, such as through surveys (e.g., Zewedde et al. 2014), valuation studies (e.g., Krishna et al. 2014), or in-depth interviews (e.g., Bardsley and Thomas 2005). Though not universally done, work has increasingly sought to merge qualitative and quantitative insights (e.g., Bellon et al. 2003; Birol et al. 2006; Narloch et al. 2011; Zimmerer 2013), such as through econometric modelling combined with informal interviews (e.g., Smale et al. 2001) or environmental analysis combined with ethnographic techniques (e.g., Zimmerer 2003). Such work has rarely been undertaken in PNG, however; elsewhere, it has usually considered only one or two crops at a time, as opposed to the full farm portfolio of diversity. This leaves gaps in our understanding of which farmers grow diverse crop portfolios and why. Additionally, the methods that have previously been used to rigorously identify differences among farmers regarding diversity preferences are limited; additional methodological diversity within this space would help to examine such issues in a more holistic manner.

Indeed, farmers are highly heterogeneous, not least in terms of preferences regarding agrobiodiversity. Brookfield et al. (2002) argue that a minority of 'expert' farmers have superior knowledge and/or appreciation of agrobiodiversity and hence conserve or create biodiversity without sacrificing production. The literature also makes reference to 'custodian' farmer or 'guardians' of biodiversity (e.g., Sthapit et al. 2015), suggesting that some farmers play a role in protecting diversity as a 'public good' (Smale et al. 2001). Other authors have delineated farming styles (of which crop diversity is one manifestation) such as managerial, stewardship-based, or conservative (Walter 1997). Cognizance of such divergence is crucial for understanding agrobiodiversity's role in adaptation and conservation, as 'diversity on the land is better understood if diversity among individuals is recognized' (Brookfield 2001, p.16). With adequate information on farmers' motivations and preferences, conservation interventions can be targeted to be most effective (e.g., Narloch et al. 2012).

This paper examines what motivates semi-subsistence farmers' crop diversity choices and how/whether this varies systematically among them. This is done through a case study of PNG using Q methodology,

an increasingly valued quantitative approach to typically qualitative topics (Brown 1980) that focuses on farmers' *own* conceptions of crop choice/diversity. In Q methodology, the emphasis is placed on allowing subjects to define their own viewpoints; we thus examine farmers' opinions about crop selection and diversity choices and determine whether there are *typologies* of farmers with regards to their views, such as the 'expert famers' identified by Brookfield (2001).

This paper adds to the literature by deepening understanding of how crop diversity choices are motivated and specifically by revisiting historical research on crop diversity in Oceania (Howlett 1962; Sillitoe 1981; Brookfield 1991; Bourke 1988). Given the socio-economic transformation occurring in PNG and associated conservation pressures facing crop diversity, examination of this topic is sorely needed. Methodologically, the paper adds to work on Q methodology by using the methodology to consider crop choice. The results suggest that, in addition to academic research, the method could prove practically useful—e.g., for incentive mechanism design and targeting (e.g., Zabala et al, 2017 forthcoming), given the importance of individual preferences in effective agrobiodiversity conservation and crop outreach interventions. The paper also adds to a limited number of uses of Q in developing-country contexts (e.g., Brannstrom 2011 in Brazil; Robbins 2000 in India; Zabala et al. 2017 in Mexico.)

The next section overviews the PNG context, before considering the literature on crop choice. Section 3 details the methods, fieldwork sites, and data collection and analysis procedures. Section 4 presents the results, identifying five separate groups of viewpoints, with significant differences, on agrobiodiversity conservation in PNG. In Section 5 we discuss the results and highlight some policy implications for agrobiodiversity conservation. Lastly, Section 6 concludes.

2. Background: crop diversity in Papua New Guinea

Papua New Guinea is a mountainous tropical half-island north of Australia and one of the world's culturally and geographically least explored yet most socially and biologically diverse regions (Fig. 1). A central spine of mountains divides the country into three regions: highlands, inland lowlands, and coastal lowlands and islands (Bourke and Harwood 2009). Independent from Australia since 1975, PNG faces massive development challenges: the country is ranked 157 of 187 in terms of human development (UNDP 2014), and 85% of the population (approximately six million) subsists on agriculture, using traditional cultivation methods (World Bank 2004), in some areas including shifting cultivation, as in many parts of the tropics (van Vliet et al 2012). Agriculture is the cultural and economic foundation of society and has been practiced for 10,000 years, with extensive cultivation beginning about 5,000 years ago (Bulmer 1975 in Bayliss-Smith 1996).

PNG is a major center of genetic diversity for roots/tubers and other crops, particularly under-utilized species (Kambuou 1996 in Ayalew and Kambuou 2008). Sweet potato is dominant, particularly in the highlands; taro, banana, and yam are other key staples, cultivated in a mixed system with other vegetables, including traditional and novel introductions. In one Eastern Highlands area, Bourke (1988) recorded 71 food crops being grown over a three-year period, though only a handful predominated. Cash cropping is led by smallholders and growing in scale; most rural villagers earn some income from crop sales (Bourke and Harwood 2009). Arabica coffee is widely grown as a cash crop in the highlands, making an important contribution to household incomes (Bourke and Harwood 2009).

PNG's diverse cultures are founded on egalitarian Melanesian norms based on 'equality, diffused power and kin obligations' as opposed to contracts (Sillitoe 2000: 219). Kinship ties are of crucial importance, and reciprocity and exchange are central features, enshrined in the '*wantok*' system of mutual support. Traditional PNG cultures were largely male-dominated, with potential implications for crop choice. The country thus offers a context for examination that is unique both agro-ecologically and socio-culturally.

[FIGURE 1 APPROXIMATELY HERE]

Crop diversity choices and agrobiodiversity conservation are motivated by a large range of context-dependent factors (Bellon 1996; Brush 1992; Zimmerer 2010, 2013), but those most relevant to the PNG context (and generally applicable to semi-subsistence farmers in developing countries worldwide) can be grouped into four broad categories of concerns: marketing; culture, exchange, and status; environment and risk management; and culinary/consumption.

The need for income generation can encourage the adoption or expansion of market-preferred or lucrative crops and varieties (Bellon 1996). Such concerns are of key relevance to the PNG highlands context (Moulik 1973), where market expansion has been rapid in recent decades (Benediktsson 2001; Bourke and Harwood 2009), with potential realigning of opinions about on-farm crops. Nevertheless, even with good market access, farmers may be motivated to grow diverse crops by a desire to maintain self-sufficiency, particularly among women who may not be as involved in selling cash crops (Anderson 2008; Chang and Be'soer 2011).

In many traditional cultures, crops can play important symbolic roles (e.g., Brush 1992); such factors are highly relevant in PNG (Sterly 1997; Wiessner 2005). Diversity may thus be motivated by a desire to supply traditional exchanges and ceremonial uses or for social status reasons (e.g., to demonstrate one's prowess as a farmer)—this entails both direct and indirect use values. Such ceremonial exchanges were traditionally essential to the maintenance of status and norms of exchange in PNG (Sexton 1992; Sillitoe 1981). They continue to be held, sometimes in connection with traditional events, such as marriages, and sometimes incorporated within Western religious practices, such as at Lutheran conferences. The need to supply such exchanges may foster a motivation for 'showy' crops, such as the large yams favored in traditional crop exchanges (Risimeri et al 2001). On a simpler level, crop diversity may be chosen out of a sheer enjoyment of plants, shared by some gardeners worldwide, or simply by following local traditions (Sterly 1997).

Environmental factors can strongly influence crop portfolios. Marginal and varied land conditions encourage farmers to grow a more diverse portfolio, matching crops to conditions (Brush and Perales 2007; Di Falco and Chavas 2006); such trends have also been seen in PNG (Brookfield 2001). In a dynamic context, crop diversity has been argued to increase resilience to climate shocks through spreading the risk of harvest failures and preserving 'option value'—i.e., increasing farmers' scope for changing crop portfolios in response to changing circumstances.¹ Thus agrobiodiversity may be maintained to offer resilience to variable weather/climate conditions (Pascual et al. 2011). PNG is no stranger to such constraints, including periodic floods and droughts, often tied to the El Niño climate phenomenon (Bourke and Harwood 2009). The last severe drought, in 1997/98, resulted in widespread crop losses and hunger throughout highlands areas (Allen and Bourke 1997). Weather and climate concerns may thus shape farmers' opinions about crop choices. However, early examinations of this topic in PNG failed to identify evidence that farmers used crop/cultivar diversity to insure against crop failure or for explicit ecological considerations (Howlett 1962). More recent studies, however, contend that both inter- and intraspecific diversity are used to mitigate risks (Mogina 2002) or are at least somewhat shaped by climate concerns (Nordhagen 2014).

Diversity may be motivated by taste preferences or culinary preparation needs, such as ease of cooking or the need to support a variety of preparation methods (Brush 1992; Bardsley and Thomas 2004; Rana

¹ A parallel argument can be made for responding to cultural changes, such as new tastes, cooking methods, or livelihoods; indeed, resilience in general may gain greater value in such cultures where change is frequent (Buchmann 2009).

2007; Zimmerer 2014). Given that most rural PNG residents cultivate all or the vast majority of their own food, consumption preferences are of key relevance (Gibson 2001). Indeed, Howard (2003) argues that culinary preferences are the main driver of agrobiodiversity conservation. Though this has not been investigated in depth in PNG, participatory crop promotion programs in PNG have confirmed the centrality of taste and culinary needs in motivating farmers' crop preferences (e.g., Lulutel and Pinggen 1997).

Crop diversity can also be used to better manage (or be constrained by) variable labor availability or to spread harvest times throughout the year (Bellon 1991). In PNG, authors have noted farmers' desires to avoid overly labor-intensive crop portfolios (Clarke 1974). Labor dynamics and migration may also impact crop diversity (Zimmerer 1996, 2014); this has not been noted in PNG but has in other parts of Oceania, such as Vanuatu (Mani 2013). Finally, as biodiversity is driven by supply as well as demand, exchange systems for planting materials may also impact crop choice and the maintenance of agricultural biodiversity on farm (e.g., Nagarajan and Smale 2007). Melanesian planting materials systems have been little studied, but work on sweet potato and taro in PNG suggests that the maintenance of diversity may be associated with a lack of planting materials markets and the routine exchange of some (but not all) planting materials (Nordhagen 2014). In some cases, farmers may thus be dependent on their own resources.

All of these diverse motivations are connected to social norms and livelihood approaches, which are flexible and change with time. However, much of the research on crop decision-making in PNG agriculture may represent discarded traditions of a bygone era. For example, the four decades since Sillitoe's (1981) work on status motivations for crop choice have seen increasing commercialization of crop production in the PNG highlands (Benediktsson 2001) and growing connection to the "modern" economy and information technology (Watson 2011). It can be expected that these shifts have impacted traditions and livelihood strategies—and therefore decisions related to the maintenance of agricultural biodiversity. Thus, while past research offers a reason to appreciate the importance of agrobiodiversity in PNG, it also leaves a clear lacuna: examination of this topic within a modern, market-integrated context. The methodology used to fill this gap in this study is explained in the next section.

3. Methodology, Data Collection, and Analysis

3.1. Q Methodology

Q methodology (Stephenson 1953; Brown 1980) has been used to consider several topics broadly related to natural resource management, such as US farmers' images of 'success' (Walter 1997), farmer's environmental viewpoints in England (Davies and Hodge 2007), farming styles in New Zealand and California (Fairweather and Keating 1994; Brodt et al. 2006), state versus local environmental knowledge in India (Robbins 2000), environmental governance in Brazil (Brannstrom 2011), forestry policy in Finland (Kangas et al. 2010), international conservationists' values (Sandbrook et al. 2011), and motivations for adoption of silvicultural practices in Mexico (Zabala et al. forthcoming). The approach has thus recently emerged as a tool for studies of rural and agricultural issues (Fairweather and Klonsky 2009; Zagata 2009). However, it has not yet been applied to crop-choice or agrobiodiversity-related questions.

Understanding farmers' motivations and choices can be difficult due to the embedded, almost subconscious nature of crop choices: farmers rarely articulate their own decision-making processes on this issue. Q methodology is well suited for making the question less abstract, as it allows one to systematically study subjectivity, including opinions and motivations, through a ranking-based interview, with factor analysis used to derive empirical results (Stephenson 1953; Barry and Proops

1999). Participants are provided with a set of statements of opinion on a topic (“the Q set”), obtained through participant observation, interviews, media, or scientific literature (van Exel and de Graaf 2005; van Exel et al. 2004). The number of people interviewed can vary widely, from 10 to 140, as can the size of the Q set (Dziopa and Ahern 2011); as large Q sets place a burden on even well-educated participants (Dziopa and Ahern 2011), a smaller set is beneficial when working with a low-literacy population.

Participants then rank these statements according to a rule, typically their point of view, on a quasi-normal distribution along a continuum (e.g., ‘most disagree’ to ‘most agree’; see Fig. 2) (van Exel et al. 2004). To facilitate this, the statements are typically printed on cards and a visual representation of the distribution is provided. This process, known as a Q sort, is followed by an interview about the research topic. The method is inherently subjective (Brown 1980), meant to elucidate individuals’ views on an issue with no ‘right’ answers. It can thus compel the researcher to discard their *a priori* conceptions and face potentially surprising, complex, or contradictory positions (Robbins and Krueger 2000).

The results of the Q sort are examined via factor analysis (Watts and Stenner 2005; Zabala and Pascual 2016) in which response options, not individuals, obtain factor scores. The analysis involves three main steps: correlation, factor analysis, and score computation. Principal-components analysis (PCA) on a correlation matrix identifies groups highly correlated with one another but not with other groups, considered to form a viewpoint group. Next, *factor loadings*, the correlation coefficients between factors and Q sorts, are calculated to show how much each individual Q sort *loads* on a particular factor: how much does this individual agree with this viewpoint? (Sandbrook et al. 2011) The factors accounting for the maximum variability (based on eigenvalues or number of significant loadings, Davies and Hodge 2007) are retained and rotated for clarity (Brown 1980).

The rotated factors are re-expressed via ordering of factor Z-scores into statement scores (i.e., -3 to +3). Each group is then represented by an ‘ideal’ Q sort, which shows how a hypothetical respondent with 100% loading on that factor would have ordered the statements (Watts and Stenner 2005). These are not representative of any individual, but for each factor, individual ‘defining sorts’ (i.e., those most defining the viewpoint) can be identified by the significance their loadings on the factor (Walter 1997).

Q methodology interpretation is based largely on consideration of a given group’s ideal-type sort. The interpretation of the ideal-type sort thus pays most attention to extreme statements (those with scores of +2, +3, -2, or -3) and statements the group rated significantly ($p < 0.05$ or $p < 0.01$) differently than did other groups. These are interpreted in the context of the overall sort, including statements that are not collectively salient. Finally, individuals with defining sorts are considered in the context of the interviews and researchers’ previous work.

A major advantage of Q methodology is bringing quantitative weight to qualitative research and allowing the population studied to categorize itself rather than be categorized by the researcher (van Exel and de Graaf 2005). Further, interrelated questions are analyzed holistically, not as single questions (van Exel and de Graaf 2005). Trade-offs and prioritization are key, as in on-farm decision making (e.g., Zimmerer 2003). Q methodology’s weaknesses include demanding a close interaction between researcher and subject (Zagata 2009), as well as potentially low reliability and generalizability (Dziopa and Ahern 2011).

[FIGURE 2 APPROX. HERE]

3.2. Study Sites and Data Collection Methods

The fieldwork was undertaken in 2013 as part of a larger multi-year (2010 – 2013) study (Nordhagen 2014) in four sites: two in Eastern Highlands Province and two in lowland Morobe Province (see Fig. 1). Although economic and market integration varied somewhat across sites, all areas are amongst the more developed rural areas in PNG. The statements were collected drawing on qualitative responses to earlier (September-December 2011) fieldwork by the lead author, including a socioeconomic survey (n= 369), 15 focus group interviews (142 farmers), statements of local extension agents and researchers, and a review of agricultural newspaper articles published in local papers, *The National* and *Post-Courier*. The set was refined by deletion of overly similar statements and piloting in the field to make a final set of 31 items, which were translated into *Tok Pisin*² and printed onto cards. These statements are listed along with the ideal sort for each group in Table A1.

Two villages were randomly selected in each site. Strict random sampling was not possible given absent census information, hence participants were recruited to a meeting through local leaders, who were asked to reach out broadly to farmers. From those gathered, participants were chosen randomly, with composition checked to ensure roughly representative differentiation in terms of age, market selling, and extension service contact. The sample was initially intended to include equal numbers of men and women, but the agriculturally active population was slightly skewed towards women (more men were normally absent from the village or working off farm). The final sample included 92 farmers, a fairly large number of respondents for Q methodology (Dziopa and Ahern 2011)

Interviews began by introducing the research, obtaining oral consent, and collecting basic demographic data. The exercise was explained and participants were asked to do an initial three-pile sort (agree with, don't agree with, neutral), then gradually sort the cards onto a seven-point (+3 to -3) distribution matrix, as depicted on a sheet of poster paper, with a space for each card (Figure 1). This relatively narrow distribution was chosen to lower the cognitive barrier by allowing more 'neutral' opinions. The final layout was recorded and used to begin a semi-structured conversation about the respondents' views and experiences. This included discussing crops grown, crop selection (including seed systems), land use, marketing, and general agricultural plans/aspirations. A challenge of the setting was low literacy (50-70% literacy rate, depending on the village). As interviewing only the literate might bias results, the methodology was modified. While those able to read independently did so, the exercise was conducted orally for most farmers.³

4. Results

4.1 Identified Viewpoint Groups

Of the 92 interviewed farmers, 46% were male, and the average age was 35.5 years; 26% of participants had never attended school while 20% had completed secondary school, with the remainder having attended some school but not finished. These are representative of demographics of the target population except for a slightly higher proportion of women.

Data analysis used the software package PQMethod (Robbins and Krueger 2000) and Stata SE10. Five factors were retained based on the Kaiser Criterion, confirmed by Davies and Hodge's (2007, similar

² *Tok pisin* is the national language of PNG. There is great linguistic diversity in PNG, with each area having its own local vernacular, which may differ greatly from even those of its nearest neighbours. Desire to compare results across sites and a lack of sufficient translators precluded use of these local languages. *Tok Pisin* is widely spoken and understood.

³ As a robustness check, results from the two types of interviews were compared to ensure no systematic differences. None were found: Pearson's test of independence could not reject the null hypothesis that the associations with the viewpoint groups were independent of oral/written administration ($X^2 = 1.55$, $p=0.956$).

sample size) criterion: retaining factors with >2 individuals' significant loadings.⁴ These factors correspond to five groups of viewpoints, as discussed below. Factors were rotated using a Varimax rotation then re-expressed via rank-ordering of factor Z-scores into statement scores (i.e., the highest two Z-scores were translated to +3) to generate the 'ideal' sort—i.e., the sort for a hypothetical respondent with 100% loading on that factor. For example, the ideal Q sort for group A (see Table A1) would rank statement 1 as +2 (agree moderately) and statement 12 as -3 (disagree strongly). After the statistical analysis was completed, each factor group (i.e., typology) contained 8-16 defining individuals (with 1-2 additional *negative* loadings—i.e., those holding opposite views—for three factors). Seven farmers were mixed (loading on multiple factors significantly), and 13 did not load significantly on any factor. These findings are in line with Q studies of similar size (e.g., Walter 1997).

Table A1 (annex) provides the results of this analysis. Each column depicts the scores given by the ideal sort for each farmer group (A – E); asterisks indicate those statements that are rated significantly differently by a given group. For example, statement 9 “I would rather make money growing more crops to sell than grow old traditional crops” was ranked significantly highly, at +3 (agree strongly), by Group A (labeled as “Marketer-Consumers”) but significantly lowly (disagree moderately), at -2, by Group C (“Proud Exhibitionists”). No sort loaded perfectly ($a=1$) on any factor; 0.80 was the largest, but numerous sorts loaded significantly on a factor.⁵ Such a result is typical in Q methodology (Watts and Stenner 2005) and reflects the fact that such types are indeed meant to represent ‘ideals’: actual individuals may associate most strongly with one group but will also have attitudes that are more strongly associated with another.

The groupings and associated statement scores are derived from the results of the factor analysis. They are given meaning through interpretation. This is the more subjective phase of Q analysis; indeed, naming and interpreting the groups is considered the most ‘problematic’ portion of the method (Eden, Donaldson, and Walker 2005). Here, following norms in the literature (Dziopa and Ahern 2011; Robbins and Kruger 2000), they were interpreted based on the groups’ ideal sorts and defining individuals (those loading most strongly on each factor). As explained in the previous section, we consider mostly (i) statements the group rated significantly ($p<0.05$ or $p<0.01$) differently than did other groups and (ii) extreme statements (+2, +3, -2, or -3); these are interpreted in the context of the overall ideal sort, including (iii) statements that are (perhaps surprisingly) not salient. Descriptive names are given to groups to aid discussion based on these interpretations; these were decided by considering both the local context and the broader literature (e.g., the themes of market orientation, status concerns, and such discussed in Section 2).

We name the five farmer groups as follows: *Marketer-Consumers* (A), *Pragmatists* (B), *Proud Exhibitionists* (C), *Novelty Seekers* (D), and *Secondary Farmers* (E). In the following, we discuss each of the five farmer groups in turn, based on our analysis of the data. Statements are referred to by statement number (i.e., S3 = statement 3), which is noted (i) in bold for significant statements, (ii) in normal font for extreme value statements, and (iii) in *italics* for not particularly salient statements. The number of respondents with sorts that factor-load significantly for a given group (‘significant loads’, shown in Table 1), reveals the relative frequency of each type within the sample.

[TABLE 1 APPROX. HERE]

⁴ Significant at $p>0.01$ ($>2.58*1/\sqrt{q}$, where $q=31$, thus 0.463). For robustness, the analysis was repeated retaining six factors. The broad groups were similar, but the sixth category included only two defining statements and was thus difficult to interpret saliently, while failing to further enrich the analysis. A four-factor solution, conversely, appeared to conflate two viewpoints.

Group A – Marketer-consumers

This group, comprised of 19 solely significant loading individuals and 14 defining sorts, prioritizes economic values of crops more than any other group. They are active agents of crop choice within their households (S12), see themselves as sellers (S1), and prioritize lucrative market crops over traditional ones (S9). Their strong agreement with these statements is in stark contrast to the views of all other groups—such as the ‘*Proud Exhibitionists*,’ who rank S9 as contrary to their beliefs. It would be a mistake, however, to consider marketing the sole motivation for these farmers: their crops are also essential for household consumption. They take pride in feeding their households via their garden and prioritize use values to the same extent or not significantly less than others (S11, S28, S27), though they place more weight on the *ease* of cooking (S29). They value the ascetic and image-boosting qualities of crop diversity (S6, S25) but to no significantly greater extent than others. Their indifference towards discarding old varieties (S16) and maintaining some crops to buffer against adverse weather contrasts with most other groups (S10). Perhaps surprisingly, they do not value the market-buffering aspect of crop diversity any more than others, suggesting a further willingness to specialize in a narrower set of crops as part of their marketing strategy (S8). Indeed, they have significantly lower than average crop diversity (Table 1). They recognize novelty (S4), pay attention to others’ crop choices (S23), and remain interested in attractive gardens (S25), though to no significantly greater extent than other groups. Thus the market is the most resonant, though not sole, motivation for this group.

Group B – Pragmatists

Group B had the largest number of significant loadings (23). Emergent from this group is a practical focus on use amid constraints, with a pronounced but somewhat contradictory conservation aspect. Their main motivation for maintaining agrobiodiversity lies in consumption: in particular, they grow diverse crops to have diverse diets (S27) and are like most others in seeing food cropping as integral to their livelihoods (S18, S11), heavily weighting the health value of diversity (S28) and valuing easily prepared food crops (S29). More than other groups, they feel their crop choices are constrained by their land (S19, S31) and do not place much weight on aesthetics or image (S24, S25, S6). They more readily recognize that new crops are regularly entering their areas (S4) and feel a greater loss than any other group when these supplant old varieties (S5). Like others, they place weight on conservation for the future (S30) and are similarly unwilling to discard older varieties as new ones come along (S16). Perhaps surprisingly, though, they are more indifferent than others to maintaining traditional crops (S2). This apparent contradiction, when read in the context of the other choices, seems to stem from a general pragmatic approach to farming amid resource constraints. Aligning to these results, farmers loading on this factor tend to have somewhat smaller landholdings and slightly higher crop diversity (Table 1).

Group C – Proud exhibitionists

These farmers, above all others, value image concerns—crop choice and diversity are points of pride. They place the greatest weight on creating attractive gardens (S25) that demonstrate their farming ability (S6). Crops’ ceremonial and traditional uses are key (S22), and though status is not an overwhelming concern, it is weighted more heavily than by other groups (S24). Like most other groups, they are self-sufficient and produce mainly for themselves (S11, S1, S18) with high value on consumption (S27, S28); however, marketing is a less important motivator of diversity for them than for other groups (S8) and they more readily consider crops’ monetary values as subservient to their traditional ones (S9). Although these farmers are like others in recognizing the importance of having diverse crops in the future (S30) and considering traditional crops important (S2), they are less aware of new crops (S4) and are not particularly bothered by discarding old varieties (S5). Clarity with regard to this comes from realizing that ‘old’ crops are not necessarily the same as ‘high-status’ crops that can

meet traditional needs. As an example, in the post-sort interview, one farmer from this group proudly described his impressively large yams. Though cultivating large yams has long been a point of cultural pride in PNG, he was referring not to old, long-prized native yam varieties but recently introduced African yams.

Group D – Novelty seekers

This group of farmers enjoys novelty, always seeking new crops (S13) and not seeing inherent option value in maintaining old varieties for the future (S30). They are ready to discard older varieties in favor of new ones (S16), with less worry about sentimental attachments (S5). They may not make decisions about all crops in their homesteads (S12), but where they do, they experiment more readily than other groups (S3) and are less likely to see land types as a constraint on crop choices (S31), despite having smaller average landholdings (Table 1). Crop diversity is not motivated by status concerns (S6, S24) but maintaining an attractive garden is not unimportant (S25). Though they notice other farmers' crop choices to a similar extent to other groups (S23), this tendency (when read in conjunction with the other highly-rated statements) seems more aimed at discovering new crops than considerations of status. In sum, crop choices are dynamic for this group, and they are willing to change crop portfolios.

Group E – Secondary farmers

Farmers in this group are unique due to their consideration of food cropping as secondary, in financial terms, to other work (S18). Though still getting most of their own food from their gardens (S11, S27), this is not mainly an economic activity (S1). They are the only group not to maintain some crops for times of weather stress (S10), perhaps because they find no real difference in weather tolerance across crops (S17). They do not actively seek out new crops (S13) and pay little attention to novelty (S4) or aesthetics (S25) in crop choice. Although they see some level of status reflected in their crop choices (S6, S24), this is neither an overwhelming concern nor does it seem linked to traditional or ceremonial needs (S22). Conservation and maintaining old varieties are not unimportant concerns but are not defining ones, either (S16, S2). As an illustrative example, a farmer loading strongly on this factor had recently quit growing all food crops but coffee: though his wife still maintained a food crop garden for their house, he preferred coffee for its more lucrative nature, though he had suffered lately from the poor prices, encouraging him to seek extra land to grow alternative income-generating crops.

3.2. Points of Disagreement and Consensus across farmer group typologies

By flagging statements that were ranked approximately the same by all groups, Q methodology can highlight shared views, even between different 'types.' The left-hand panel of Figure 3 displays the levels of agreement between groups for the most divisive statements. Each plotted line represents a group, while each radial axis of the web represents a statement (with the statement number indicated at the end of each axis) and each transversal axis shows a rating for that statement (-3 to +3). Where the plotted lines cross the radial axis for a given statement thus shows the ideal sort scores given to that statement for all five groups. Agreement can be seen by the general overlap of all the groups (lines) across all these statements (radial axes) on the left-hand side of Figure 3. (Consensus and disagreement decrease clockwise from top (i.e., S14 is the statement of greatest consensus, S1 that of greatest disagreement), based on the deviations in z-scores for the statement across the five factors.)

[FIGURE 3 APPROX. HERE]

As noted above, a chief consensus area was the centrality of consumption in shaping crop choices (S28, S27, S29). As consumers, all groups valued crops as food, first and foremost. The health value of a crop-diverse diet (S28) was overall the highest-rated statement in the exercise, with only two farmers

giving it a negative rating and none rating it below -1 (mild disagreement). This was confirmed by the fact that all groups strongly disagreed with the idea of *buying* crops instead of growing them; this was the most universally negatively rated statement, rated positively by only five farmers, none above +1. Household self-sufficiency was a shared value, even for *Secondary Farmers* (S11). Across all groups, planting materials supply was generally seen as a mild or non-existent constraint (S21). Consensus was strongest around the key role of crop diversity amid unreliable weather (S14), with none disagreeing—but also none holding this belief as strongly as their allegiance to food- and income-related aspects of crop choice. It was thus of universal but only slight importance.

There is thus considerable common ground in perspectives across farmers about the reasons for growing diverse crops. Correlations between groups were all moderate (0.163-0.377): the statements one group placed at an extreme tended to be near the middle for other groups, with few truly polar statements.⁵ This suggests considerable overlap between types, particularly between the *Pragmatists* and *Novelty Seekers* and between the *Marketers-consumers* and all types but the *Pragmatists*. Amongst the 92 individuals, there were only four significant negative loads. Correlations were lowest between the *Secondary Farmers* and the *Exhibitionists* and between the *Secondary Farmers* and the *Novelty Seekers*—i.e., their views shared the least common ground.

Although Q studies (e.g., Sandbrook et al. 2011) commonly identify strong divergence, the overlap in perspectives found here is not unique (Porter and Pelletier 2012). This confirms that, even across the different farmer groups, certain values are shared regarding the underlying reasons for crop diversity and crop choice, particularly regarding consumption values in terms of health, cooking ease, and dietary diversity. Across groups, farmers shared considerable common ground as consumers of their own produce: a shared food security goal built consensus around the importance of consumption attributes.

Areas of disagreement across groups (i.e., statements that were rated highly by some groups and lowly by others) can be seen by the non-overlap of the groups' affinities with the statements plotted in Figure 3, right-hand side. Chief among these are statements related to the economic importance of growing food crops and how the respondent views the objective of their cultivation in terms of income generation (S1, S18, S9). Crop choice with a view towards the market was a strong motivation for the ideal *Marketer-Consumer* but antithetical to the *Secondary Farmers*, who considered food crops a secondary (or tertiary) income-generation endeavor, and *Proud Exhibitionists*, who were drawn to the aesthetic and status-demonstrating values of crops. Status concerns as related to crop choice (S25, S24) proved to be highly contentious among the typologies of farmers as well, with the opposite tendencies displayed.

The suitability of crops to land (S31) was another area of considerable disagreement, with the *Pragmatists* feeling constrained by not having enough land while the *Novelty Seekers* strongly agreeing that land types did not limit what crops they could grow. Conservation motivations for crop choice also varied, with *Novelty Seekers* seeing little role for maintaining old crops for the future, while *Pragmatists* and *Exhibitionists* ranked this highly (S30, S16).

5. Discussion

Here we discuss the main results in the context of farmers' views on crop choice, drawing three main insights related to the importance of consumption, the relationship between marketing and diversity,

⁵ The correlation structure is partly a construct of the methodology: perfect negative correlation of two factors would simply be represented by negative loads on one factor. However, much lower correlations have been reported in past research.

and the relative unimportance of climate factors. We compare the results briefly to other similar studies and then note some limitations and policy implications.

First, across the five distinct crop-diversity-choice ‘groups’, consumption remained the primary motivator of farmers’ crop choices despite the salience of income-generation. Statements eschewing self-sufficiency fostered near-universal disagreement, and few mentioned substituting store-bought goods for traditional foods (in contrast to Stratigos and Hughes 1987). Considering this in the context of the broader literature, it has been argued that market integration drives agrobiodiversity loss through competition with cash crops, promotion of high-yielding varieties, and off-farm work cannibalizing on-farm time. This is context-specific, however: studying loss of crop diversity amidst economic growth in the Andes, Zimmerer (1996) and Brush (1995) concluded that fewer varieties than expected had disappeared amidst growing market integration (in Brookfield 2001). Years later, de Haan et al. (2012) still found little evidence of lost diversity and even positive valuation of potato diversity amongst Andean farmers. Zimmerer (2014) found consumption motivations to remain key motivators for diversity even amid economic transformation.

Second, although speculative, this study’s findings do not fully support the contention that increased market integration will make PNG farmers specialize in marketable crops at the expense of supplying the household. Even in a widely integrated area, self-sufficient home production was almost universally valued, and cultural/traditional uses still had salience for a key group (*Exhibitionists*), who revealed strong preferences for crops useful for establishing status and traditional exchanges. Despite widespread access to markets and near-universal crop sale, whether cropping was aimed primarily at cash income generation was a highly contentious viewpoint amongst respondents. Even within the *Marketer-Consumers*, many non-economic motivations had salience. Still, inter-specific diversity was lower for these farmers, and average age differences (see Table 1)—with *Exhibitionists* having the highest diversity but also being the oldest on average—indicate a possible cross-generational shift from traditional values towards greater reliance on crop purchase and sale. This suggests that while greater orientation towards marketing *may* lead to lower diversity, such an orientation represents only one viewpoint among many. The broader question of how complex livelihoods influence diversity, as noted by Zimmerer (2014), also shows some salience here in the form of the *Secondary Farmers*.

Third, it is interesting to consider these results with respect to climate variability (and change) concerns, as agrobiodiversity is often noted as helping buffer such risks (Pascual et al. 2011). Of the 31 statements, five related to resilience to environmental change (S10, S14, S15, S17, S20), with one directly related to climate change (S14), the effects of which have been observed in these villages (Nordhagen 2014). Few of these statements were highly resonant with any of the groups, and all tended to be areas of comparable consensus, particularly S14 and S10. Thus, environmental resilience seems to be a motivator of crop diversity choices across groups but is only slightly important, being subordinate to other concerns such as household consumption, marketability, image, or novelty. While diversity may help households remain resilient to environmental and climate stresses, it is not generally maintained for this reason. This offers useful insight for, for example, formulating climate change adaptation policies and promoting the uptake of climate-smart agriculture (FAO 2013).

As we are not aware of prior studies of crop choice using Q methodology, it is difficult to directly compare these results to others. We find only limited salience of the ‘custodian’/‘expert’ conservationist farmer (Brookfield et al. 2002; Sthapit et al. 2015) or the Environmentalist, Environmental Steward, and Steward found in Q-methodological studies of farming styles in New Zealand, California, and Illinois (Fairweather and Keating 1994; Brodt et al 2006; Walter 1997, respectively). Instead, multiple groups maintain high levels of diversity and several put some weight on conserving varieties, but it is not an overwhelming motivator for any single group. We do find some similarities between our

‘Novelty Seekers’ and the ‘Pioneers’ of Zabala et al. (forthcoming). The groups emerging from Robbins’ (2000) Q methodological examination of farmers’ preferences towards forest plant species were largely grouped around different livelihoods and forest uses (e.g., grazers versus timber producers); in this study’s context, livelihoods are generally less diverse and the issue finds resonance only for separating the ‘Secondary Farmers,’ some of whom pursue other livelihoods.

Methodologically, this was the first known application of Q methodology to the topic of crop diversity choice, especially in a developing-country agricultural context. The method had both strengths and limitations. Though requiring considerable time and attention, participants generally responded well, remaining attentive and carefully considering decisions throughout the interviews. This is partly attributed to the verbal format adopted here, which did not appear to alter results when compared to a written administration. Some respondents found prioritization difficult: they agreed with many statements. This does not necessarily generate analytical difficulty, as Q methodology aims to compel participants to make trade-offs and prioritize (Barry and Proops 1999). Here, the distribution’s kurtosis helped ameliorate this; similar approaches should be considered in other low-literacy populations. Another weakness proved to be an inability to accommodate new statements that emerged mid-research within the methodology; such comments can enter the analysis during interviews and thus interpretation, however. The methodology does not necessarily reveal all possible perspectives in the population (McKeown and Thomas 1998), and the results are specific to the culture and setting in which they were generated; generalization must thus be done very cautiously. The number of statements that can feasibly be included is constrained; this injects additional researcher subjectivity and precluded including certain topics in the literature but not explicitly mentioned by farmers during preliminary field research (e.g., nutrition). Finally, naming groups under Q methodology may give a false impression of simplicity: factors in fact represent not groups of people but rather continuums along which people can be expected to vary, and each individual will have varying levels of association with a group (Fairweather and Klonsky 2010). Overall, however, the methodology proved highly useful for obtaining a clearer understanding of farmers’ diverse drivers and motivations.

To note some other limitations, this study’s focus was on subjective perceptions, with no claims to objective ‘fact’ being discovered. We focused on *farmers’* demand for crops, but crop choices are also supply-driven, depending on the systems that farmers use to access planting materials. Though not considered here, PNG’s seed systems were examined in depth in another part of this research project and found to be generally able to provide crop diversity via informal transactions, a result further supported by the lack of salience of seed supply constraints in this study. Nevertheless, the topic merits further research.

The study offers some policy implications. As Zabala et al. (forthcoming) argue, policy instruments that do not mesh with the motivations of those who are supposed to carry out their ‘groundwork’ may hamper the achievement of a policy goal by eroding pre-existing beneficial social norms or crowding out pro-environmental behavior (e.g., Narloch et al. 2012; Midler et al. 2015). Understanding motivations and viewpoints can thus help policymakers anticipate how conservation programs and initiatives will be received.

In this study, *Pragmatist* farmers may be the optimal targets for conservation initiatives: they consider conservation for the future to be crucial (S30), recognize that new crops are regularly entering their areas (S4), and feel a greater loss when these supplant old varieties (S5). However, they are practically motivated, placing less weight on tradition and feeling constrained by their land area, which might limit in their ability to reallocate land towards conservation purposes. This suggests a role for incentive mechanisms (e.g., Narloch et al., 2012; Midler et al., 2015; Zabala et al., forthcoming) even after targeting. In contrast, interventions aimed at spreading new varieties may choose to target *Novelty*

Seekers, who view actively seeking novel crops as a key aspect of their farming. Considering implications for crop development and promotion, consumption-related aspects had widespread resonance, again underlining the centrality of these aspects in agricultural outreach aimed at new-variety promotion. Even in a fast-changing, widely integrated area, it is important to bear in mind that cultural and traditional uses still have salience for a key group of farmers (*Exhibitionists*), who may be disproportionately important for conservation given their comparatively large landholdings (Table 1). Yet ‘traditional’ usage does not necessarily equate to traditional *crops*; these farmers placed no great importance on maintaining older varieties for posterity. Hence, they may be highly receptive to novel varieties that can manifest ‘showy’ qualities (e.g., large taro corms and yam tubers.)

To implement such targeting in practice, instead of utilizing the full set of opinion statements applied here, factor analysis could be used to identify a handful of statements that are the most useful for distinguishing between farmer viewpoints within the chosen geographic area and these could then be administered rapidly and analyzed instantly via mobile-phone-based data collection. Of course, this process would need to be undertaken for the specific area in question, as farmer preferences will vary with culture and agro-ecology. As Q methodology is generally used with samples much smaller than that chosen here, however (e.g., ideideal 2000), this process need not be excessively time-consuming or labor intensive.

6. Conclusions

This study has examined Papua New Guinean farmers’ perceptions of diverse crop choices, using their own words (as conveyed via Q methodology) to depict five distinct groups of viewpoints. The results indicated significant differences across these groups, particularly with regards to income generation and environmental concerns. However, the study also noted considerable commonality and shared values, such as the centrality of consumption-related traits. The results indicate the overlapping motivators of pursuing a livelihood and maintaining tradition, which can exist simultaneously within the same individual: we do not find, as others have argued, that agrobiodiversity and agricultural marketization are necessarily incompatible, at least within the studied farmers’ own views. Nor do we find an overwhelming resonance of crop diversity as a buffer against environmental change, another point emergent from the literature. The answer to both questions, instead, is complex and depends on the farmer, their livelihood strategy and cultural background, and how they choose to weigh their diverse interests amid changing economic and social forces. The divergence in farmer viewpoints uncovered here should lend others caution when making wide judgements about these issues, whether in policy or research.

There is considerable scope for expanding on this research. Given the comparatively low salience of climate-risk concerns among farmers in our case study, it would be interesting to undertake a similar study in areas where extreme climate events were regular to discover if climate risk bore greater weight. Applications in less-market-oriented areas would shed further light, particularly on ‘status’ and ‘tradition’ as motivators, as would those in other regions. To make the results more specific to existing crop species or diversity configurations, a pictorial approach (like that used by Robbins 2000) could be used. Specifically using the method within the context of incentive mechanism design (e.g., for targeting REDD+ or payments for ‘agrobiodiversity conservation services’, as in Narloch et al 2011) could provide opportunities to test its practical relevance, as could integration into participatory plant breeding approaches. We leave these intriguing options as avenues to be pursued in future work. Given the rapid cultural and economic transformation currently occurring in PNG, cognizance of these diverse motivations for farmers’ choices can help ensure continued conservation and utilization of diverse crop species in this key center of global biodiversity.

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FIGURES



Figure 1. Map of Papua New Guinea and the study sites

[NOTE: Black and white printing expected, see B&W version below]



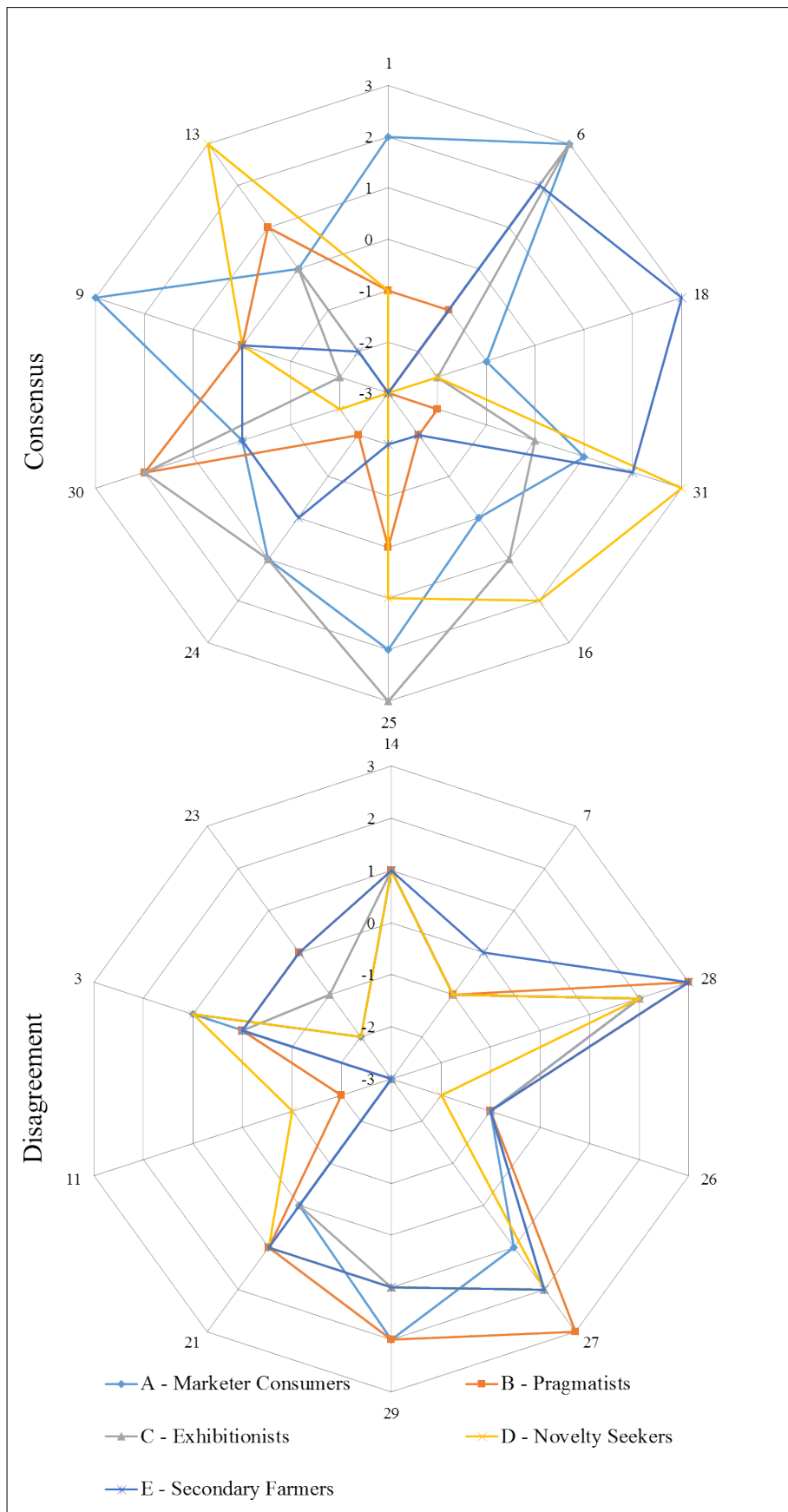
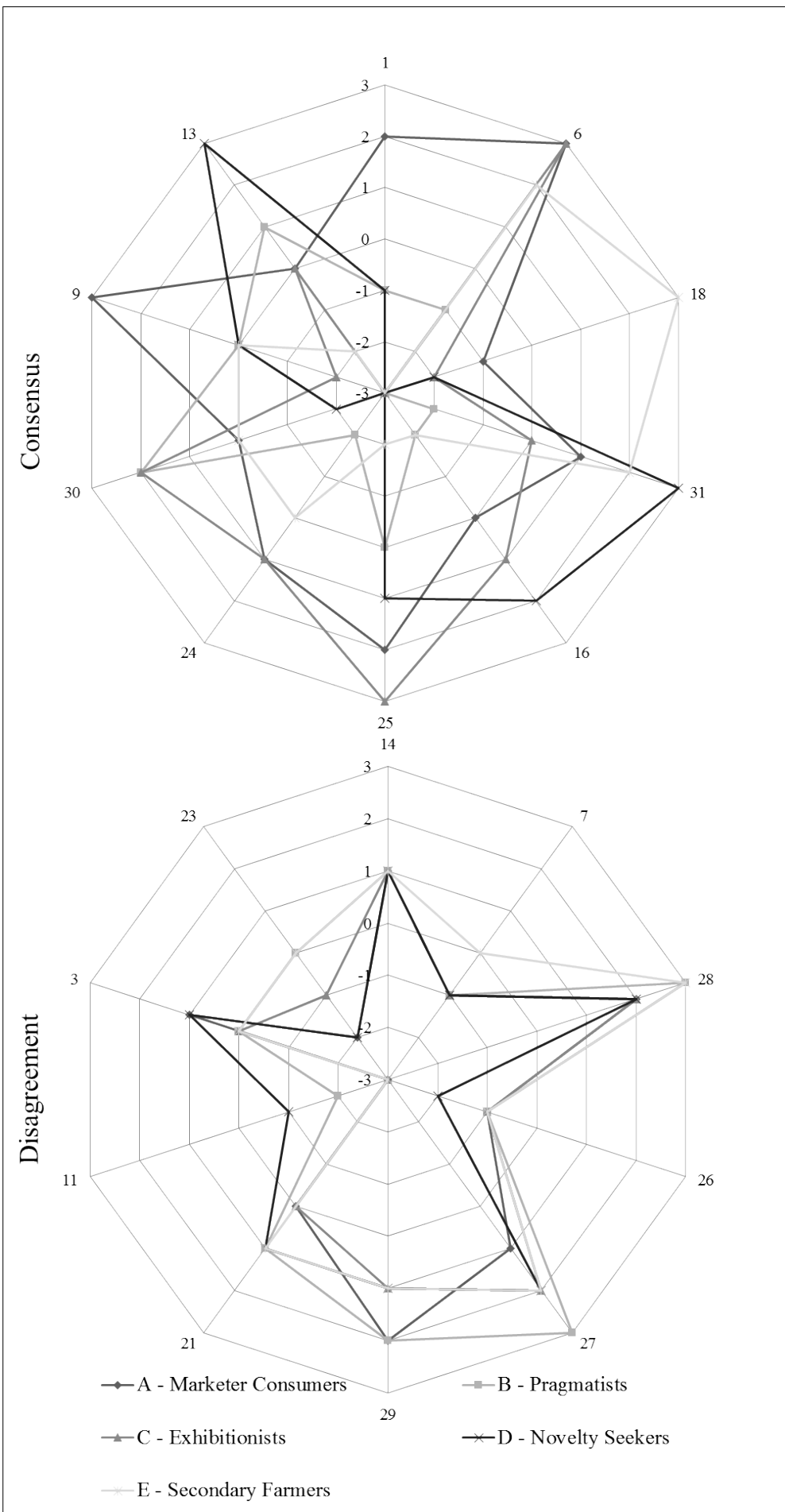


Figure 3. Consensus and Disagreement across Statements for the Five Groups

[NOTE: Black and white printing expected, see B&W version on next page]



TABLES

Table 1 Demographic Characteristics of the Defining Individuals for Each Group

	Marketer- Consumers		Pragmatists		Exhibitionists		Novelty seekers		Secondary Farmers
Num. significant (positive) loads	19		23		23		10		6
Avg. Age	35.1		33.3		41.6	***	35.0		31.0
Pct. Male	13%	***	50%		53%		29%		60%
Avg. Education (years)	2.5	***	7.4	***	5.1		1.6	***	5.2
Farm Size (ha)	1.4		1.3	*	2.4	***	0.8	***	1.8
Pct. In top local quartile for inter-specific diversity	0%	***	18%		41%	**	0%		0%

Notes: Significant differences are marked as such: $p < 0.10$ (), $p < 0.05$ (**), $p < 0.01$ (***). 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 crops being grown on household land.*

Appendix Table A1 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.