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Management decisions on commercial sugarcane farms in KwaZulu-Natal: a focus on choice bracketing behaviour for risk management

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Abstract

The sugar industry is an important contributor to the South African (SA) economy, with average annual production estimated at 2.5 million tons of sugar. This study aims to quantify actual use of management instruments by a sample of commercial sugarcane farmers in KwaZulu-Natal (KZN) that are commonly associated with risk management, and uses factor analysis to investigate the extent to which these farmers bracket their management decisions. Data were obtained in 2006 via personal interviews of a stratified random sample of 76 large-scale sugarcane farmers in two separate mill-supply areas of KZN. Respondents were asked questions regarding risk-related management strategies, including diversification of on-farm enterprises, investments and management time. Factor analysis identified six management choice brackets, collectively explaining 77% of the variance in all of the 12 risk-related management responses considered. Recommendations that stem from these findings include that policy makers create a more enabling business environment and that government make labour legislation more flexible. Farmers need to search for information more proactively and develop management strategies that reduce barriers to efficiency. Future research based on time series data could be important to identify how management portfolios and choice bracketing levels change over time.

Keywords: Commercial sugarcane farms; KwaZulu-Natal; choice bracketing behaviour; risk management

1. Introduction

The South African (SA) sugarcane industry supports approximately 50,940 small and large-scale producers who collectively farm an estimated area of 426,861 hectares (SACGA, 2006). On average, 22 million tons of sugarcane are produced seasonally in 14 mill supply areas, extending from Northern Pondoland in the Eastern Cape, through the coastal belt and midlands of KwaZulu-Natal (KZN), and into the lowveld of Mpumalanga (SASA, 2006).

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Sugarcane contributes approximately 82% of the income from field crops in KZN (STATSSA, 2002), with 72% of the crop planted by large-scale growers compared with 19% by small-scale growers (SACGA, 2006). The remaining nine percent is planted by millers. According to a 2002 census of commercial agriculture conducted by Statistics South Africa, approximately 87% of the gross farming income earned from sugarcane is by producers in KZN.

SA farmers are faced with many challenges attributable to their uncertain and complex decision making environment. In addition to dealing with the deregulation of domestic agricultural markets in the 1990's, farmers have also had to adapt to changes such as a dynamic global economic and trade environment and a dynamic local political environment. More specifically, other challenges that SA farmers are continuing to face include land reform, AgriBEE (Agricultural Black Economic Empowerment in Agriculture), new labour legislation and minimum wages, property taxes, skills levies, uncertain water rights, HIV/Aids, a volatile exchange rate, and high transport and communication costs (Ortmann, 2005). SA sugarcane farmers also had to deal with a highly variable sugar price in recent years (Illovo Sugar, 2006). Between January and March 2006 sugar prices averaged 37.43 US cents per kilogram, 91% higher than in the same period in 2005 (FAO, 2006). Following a rise to almost 44 US cents per kilogram in early 2006, the price declined to about 26 US cents per kilogram by November 2006. European Union sugar policy reforms are a major market driver and are expected to continue to reduce world exports and contribute to strengthening sugar prices, together with demand growth in China and India (FAO, 2006). Eighty percent of the country's anticipated export raw sugar sales for the 2006-2007 season was sold at 33.58 US cents per kilogram, a price that is significantly higher than in the previous year (Illovo Sugar, 2006). Previous findings by the authors, using the same study sample as in this study, revealed that respondents considered the threats posed by land reform, labour legislation (particularly minimum wages) and crop price variability to be the most important risk sources for their farm businesses (Mac Nicol *et al.*, 2007).

This study is aimed at quantifying the spectrum of risk-related management strategies of a sample of commercial sugarcane farmers in KZN, and investigates whether individual management responses or instruments may be grouped into various dimensions or brackets. It is important to understand the choice bracketing behaviour of farmers to establish the levels at which they are utilising the various beneficial substitution or complementary relationships that exist between many individual management instruments. Choice bracketing refers to the grouping of individual choices into sets, where sets of choices are bracketed together by considering the effect of each choice

on all other choices in the set, but not those outside the set (Pennings *et al.*, 2005). The implications of the revealed bracketing level of respondents for policy makers will also be explained.

The paper is organised as follows: The next section explains why risk is an important consideration in agricultural economics research. This is followed by a section explaining the various shortcomings of previous research and proposed recommendations for future research. The data source for this study is then described and data collection procedures explained. A summary of the characteristics of survey respondents is then presented. The final section deals with the management strategies of survey respondents and includes an investigation of the bracketing of management decisions by respondents using factor analysis. A discussion of results follows, and the paper concludes with policy recommendations.

2. Risk as an important consideration in agricultural economics research

Risk is a prevalent feature of the production environment and cannot be escaped when addressing most agricultural economic problems (Moschini & Hennessy, 2001). Studies emphasising the importance of risk include those where risk has been shown to be an important component in supply response models (Aradhyula & Holt, 1989; Antonovitz & Green, 1990), and in acreage allocation decisions (Chavas & Holt, 1990). Foster and Rausser (1991) and Chavas (1994) also showed that risk is an important consideration in agriculture where sunk costs associated with the asset fixity of capital items and human capital exist. Approaches to risk research are historically either parametric or normative in nature. Just (2003) identified the dualistic approach as one of the most commonly used methodologies in past research, and identified its various shortcomings. Following a large body of financial risk-related literature, mathematical programming models, including linear programming solvable models, have started to be more widely used by researchers in an agricultural context (Ogryczak & Krzemienowski, 2003). Most models of this type follow the original Markowitz formulation and attempt to optimise an investment portfolio (Mansini *et al.*, 2003). Although this approach seems to have high potential, it does have various restrictive requirements such as the availability of reliable farm-level panel data (Just, 2003).

Past work has also tried to identify sources of, and management responses to, risks in agriculture. Studies conducted in the United States of America (USA) on commercial crop and livestock farms include those by Boggess *et al.* (1985), Patrick *et al.* (1985), Eidman (1990) and Ortmann *et al.* (1992). In a South

African context, Swanepoel and Ortmann (1993) and Bullock *et al.* (1994) conducted similar studies on livestock and vegetable farms respectively. Woodburn *et al.* (1995) and Stockil and Ortmann (1997) conducted further research on commercial farmers in KZN. Many of these past studies have used multivariate analysis (specifically factor analysis) to identify the main sources of risk and management responses to risk that are prevalent in their respective study samples.

Following the notion that decision makers vary in the extent to which they take the consequences of their decisions into account, and that many individual management responses may behave as substitutes or complements within a management portfolio, the concept of choice bracketing was introduced by Read *et al.* (1999). Pennings *et al.* (2005) used this method to take into account combinations of management instruments and the interaction of the outcomes of using these instruments. Their study is useful in that it separates producers by means of their bracketing level and thus their combinations of management instruments, and uses producer characteristics such as age and risk attitude to explain why certain producers may be associated with a particular bracketing level. The extent to which any individual management tool constituting part of a management portfolio is used within the choice bracketing framework is, however, not accounted for and all management instruments are dealt with as binary variables, therefore somewhat limiting the explanatory power of models of this sort. The choice bracketing framework is, however, helpful in terms of aiding the conceptualisation of models where multiple sources of risk and management responses are incorporated.

3. Limitations of existing risk research and recommendations for the future

Although much research has been conducted on farm risk in the past, this work has failed to convince many of its importance in agricultural economics research (Just, 2003). Antle (1983) states that risk-related research has failed to provide useful information for farm management. This has mainly been a result of the information presented having been pitched at a level that is difficult for farm managers to translate into practical solutions. Just (2003) has attributed this failure to a number of aspects of past research. He states that this has been largely due to the focus of researchers on risk in situations where risk is likely to be less important in terms of its influence on risk management strategies. This is caused by data availability having restricted past studies to the use of aggregate data sets, and to focusing on short-run problems with temporal and spatial aggregation bias (e.g. Just, 2003; Just & Pope, 2003;

Moschini & Hennessy, 2001). Earlier findings by Just and Pope (1999) are consistent with this view, and lead the authors to emphasise the need for micro-level databases that better represent farm and farmer heterogeneity, and in particular, farmer wealth, and that take into account factors such as intra-seasonal variability. Just (2003) lists some of his research as being included in the body of literature at fault in this regard (Just, 1974; Just & Pope, 1979). Just also lists a study by Bar-Shira *et al.* (1997) among a limited number of notable exceptions, where analysis has been based on micro-level farm data. The SA studies of Swanepoel and Ortmann (1993), Bullock *et al.* (1994), Woodburn *et al.* (1995) and Stockil and Ortmann (1997) could be added to the list of notable exceptions in which analysis of farmers' risk management strategies has been based on micro-level farm data.

Another limitation of past research is that most of the literature involves the modelling of very specific areas within risk management, rather than the simultaneous treatment of multiple sources of and responses to risk (Just, 2003; Chambers & Quiggin, 2004). This poses a major problem by failing to account for the effects of the many risk management instruments that may substitute for or complement one another. These relationships are ignored when dealing specifically with a single risk management instrument or small number of instruments rather than using a holistic approach. This results in findings and recommendations that could be misleading to producers, particularly to those who bracket their management choices broadly.

Recent emphasis in risk-related research has been on duality and nonparametric approaches, which has led to major self-imposed constraints within models. Just (2003) suggests that both of these approaches have been counterproductive because they ignore farmers' risk preferences. This raises the question of model mis-specification arising from the omission of important variables. Just (2003) finds that specification biases in past models also stem from omitting important variables such as human capital. Studies by Foster and Rauser (1991), Bar-Shira *et al.* (1997) and Just and Peterson (2003) support this finding and state that human capital explains a significant proportion of risk-averse behaviour. Generally, risk studies have failed to empirically identify risk behaviour clearly enough or in the context of models broad enough to provide a convincing argument that risk is an important consideration in policy issues (Just, 2003). The result of this failure is the divergence of results between experimental studies of risk and real-world empirical problems (Buschena, 2003). Goodwin (2003) suggests that more attention must be given to achieving a valid representation of the producers' problem.

Just (1974) states that a quantitative knowledge of farmers' reactions to risk is of considerable importance. More recently, Just (2003) suggests that models that capture the interactions of risk somewhat imperfectly yet lend themselves to the efficient use of available data, and characterisations that transcend individual models will be important in future research. "Research is needed to determine what matters to decision-makers, how the correlation of outcomes occurring across time matters, and about when it matters" (Just, 2003:135). Jolly (1983), supported by Chambers (1983), advocate a more holistic approach that provides information that is both understandable and useful to farmers. Just and Pope (2002) agree that factors such as human abilities of identification, comprehension and information processing are important considerations that need to be included in studies involving risk. They also identify other important difficulties that need to be addressed in risk-related research such as the fact that basic risks are endogenous depending on information and other farmer choices. Pennings *et al.* (2005) suggest within their choice bracketing framework that research is needed that allows the factors associated with risk management strategies to have different influence across producers and choice sets.

This study will use factor analysis (also used by Mohammed *et al.*, 2006) to investigate how large-scale commercial sugarcane farmers in KZN consider individual management instruments collectively within choice brackets. The study is based on farm-level data that describes the extent to which farmers actually use multiple management instruments within a management portfolio. Twelve risk-related management instruments are considered in this analysis. The study sample comprises farmers that are homogeneous in terms of sugarcane being their main enterprise. Factor analysis will, therefore, be able to group management responses based on factors other than merely enterprise type.

4. Data source

The sample for this study was drawn from a stratified random sample of commercial sugarcane farmers in KZN. It was expected that the closest to a complete list of sugarcane farmers would be that compiled by the South African Cane Growers' Association (SACGA). Two separate mill-supply areas in KZN were considered in this study, namely the Noodsberg mill-supply area in the KZN Midlands and the Umfolozi mill-supply area on the Zululand Coast. Focusing on two regions was considered necessary to account for regional differences that may exist between inland versus coastal-belt producers. The SACGA regional managers responsible for the study areas were contacted and agreed to provide lists of contact details for all large-scale

commercial sugarcane operations in their respective areas. Large-scale operations were defined by the SACGA representatives as those responsible for annual sugarcane deliveries exceeding 10,000 tons. The decision to focus on large-scale producers was made due to the majority of industry turnover being contributed by larger growers, considering that small-scale growers account for only 19% of the total area planted to cane (SACGA, 2006). Large-scale farmers usually have a broader range of options available to manage risk and are better suited to the objectives of this study. Additionally, land restitution and land redistribution as sources of uncertainty affect mainly large-scale farmers, with most small-scale sugarcane growers in KZN being previously disadvantaged and therefore less vulnerable to land reform. According to Thomson (2007), 80% of sugarcane farms in KZN are currently subject to restitution claims.

Budgetary constraints due to the personal interview approach to be used for data collection limited the maximum size of the sample to about 100 respondents. Based on consultations with SACGA regional managers, and on the results of a pilot survey, it was decided that an initial sample size of 110 farming operations would be used to compensate for possible non-responses. Fifty-five farming operations were randomly selected from a complete list of large-scale growers in each mill-supply area. The principal decision-makers for each business were contacted telephonically in order to arrange interviews. Every effort was made to encourage the participation of those decision-makers contacted. Of the 110 principal decision-makers contacted overall, a total of 76 usable responses were obtained (69%). Equal numbers of usable responses (38) were obtained from both study areas after four responses from the Zululand region were deemed to be non-representative, and were excluded. These respondents operate extensive beef and game enterprises (with 8,100, 7,400, 5,800 and 4,800 hectares of land owned respectively), with sugarcane contributing less than 30 percent of their gross farm income.

5. Characteristics of respondents

Table 1 summarises the characteristics of the KZN sugarcane survey respondents. Included in this table is information pertaining to general farm and farmer characteristics, enterprise mix, labour force characteristics and off-farm economic activities. Respondents from both study regions were on average 47 years of age, with 22 years of sugarcane growing experience and have been involved with their current farming businesses for an average of 18 years. Respondents from the Zululand region are significantly older than those from the KZN Midlands, by about four years, at the 10% level of probability. Means comparisons in this study were conducted using a two-tailed t-test for

independent samples, with equal variances not assumed (Steel & Torrie, 1980:106). Formal education levels of respondents are similar for the two survey regions except for matrics and diplomas – 18% of respondents from Zululand have no more than a matric qualification compared with three percent of respondents from the Midlands, a difference statistically significant at the five percent level of probability.

Overall, the highest proportion of respondents operate their businesses as sole proprietorships (47%). This is followed by respondents whose businesses are identified as partnerships (19%), trusts (17%), close corporations (12%) and companies (five percent). The farm businesses operate an average of 417 hectares of land. In the Midlands region farm size is on average 599 hectares, of which an average of 66 hectares is rented in by respondents. No respondents from this region indicated that any portion of their land is rented out. In the Zululand region farm businesses operate an average of 236 hectares with no respondents indicating that land is rented in or out. The average area of land owned by respondents in the two regions is statistically significantly different at the one percent level of probability.

The gross income figures in Table 1 are assumed to be representative of an average season as respondents were asked by what percentage gross farm income (GFI) for the 2005-2006 season was above or below average for their farm business, and the GFI's adjusted accordingly. On average, GFI for the farmers in this study is R3,45 million, of which R2,64 million is contributed by sugarcane (77%). Mean GFI's for the two regions are statistically significantly different at the one percent level of probability.

Table 1: Mean values of characteristics of sugarcane survey respondents, KwaZulu-Natal, 2006

Characteristics of respondents		Overall (n=76)	Zululand (n=38)	Midlands (n=38)	Mean comparison t (assume ≠ variances)
Age (years)		47	49	45	0.061*
Years experience:	Growing sugarcane	22	22	22	0.915
Formal education: (% respondents)	University degree	42	47	37	0.359
	Diploma	42	32	52	0.064*
	Trade	5.5	3	8	0.311
	Matric	10.5	18	3	0.025**
Business Arrangement: (% respondents)	Sole proprietorship	47	39	55	0.173
	Partnership	19	8	29	0.018**
	Trust	17	21	13	0.368
	Close corporation Company	12 5	21 11	3 0	0.014** 0.044**
Farm size:	Total farm area (Ha)	417	236	599	0.000***
	Gross farm income (R million)	3,45	3,02	3,88	0.004***
Enterprise mix: (% contribution To GFI)	Sugarcane	77	88	70	0.000***
	Timber	12	1	22	0.000***
	Beef	3	1	5	0.001***
	Citrus	2	4	0	0.047**
	Vegetables	1	2	0	0.092*
Labour force:	Permanent labourers	31	23	40	0.000***
	Proportion skilled labour (%)	25	26	23	0.080*
Off-farm economic activities:	Off-farm employment (% respondents)	47	55	39	0.173
	Spouse off-farm employment (% respondents)	30	47	13	0.001***
	Farm business interests in other areas (% respondents)	24	26	21	0.595
	Possession of material off-farm investments (% respondents)	84	82	87	0.536
	Percentage of asset value off-farm	22	16	28	0.012**

Note: ***, **, * indicate means statistically significantly different at the one, five and ten percent levels of probability, respectively.

Sugarcane constitutes the major enterprise in both regions, contributing on average 77% to GFI overall. The average proportion of GFI stemming from sugarcane is significantly higher for respondents in Zululand (88%) compared to the KZN Midlands (70%). This indicates higher average levels of farm

enterprise diversification for sugar producing farm businesses in the Midlands. The second largest enterprise on average is timber, although the regional average for the Midlands (22% of GFI) is statistically significantly greater than that for Zululand (one percent of GFI). Overall, timber is followed by beef, citrus and vegetables. Other enterprises, such as macadamias, maize, bananas, contract harvesting, flowers, pigs and wildlife (game) are reported by some respondents in the overall sample but, on average, contribute less than one percent to GFI. Since the KZN Midlands and Zululand differ in terms of location (inland versus coastal regions respectively), certain enterprises that are viable in one region may not be so in the other. In Zululand the second largest enterprise is citrus contributing 4.4% to GFI on average.

Respondents were asked to provide information regarding both the permanent and casual components of the labour force involved in operation of their farm businesses. In order to gauge the proportion of skilled labour amongst their permanent labour force, respondents were asked how many of their permanent staff possessed the skills necessary for the positions of foreman, supervisor and tractor driver. The proportion of skilled labour was subsequently calculated as the ratio of skilled permanent to total permanent labourers. On average, 31 permanent labourers are employed, 25% of whom are skilled. Midlands respondents employ significantly more permanent labour, while Zululand respondents, on average, have a significantly higher proportion of skilled labour among their permanent labour. Respondents were also asked to rate their use of casual labour relative to other farmers in their area on a Likert-type scale where a response of 1, 2 or 3 indicated much less, similar and much more casual labour use, respectively. Respondents from both the Midlands and Zululand reported that they make use of similar proportions of casual labour (mean value of 2.0) compared to other farmers in their areas. This indicates that the study sample for both regions (and overall) is representative.

Forty-seven percent of respondents engage in off-farm employment of some kind. Of these, 55% of respondents from Zululand are employed off-farm, compared to 39% of respondents from the KZN Midlands. Thirty percent of all respondents indicated that their spouses are employed off-farm. Forty-seven percent of respondents from Zululand and 13% from the Midlands reported that their spouses engage in off-farm employment, a difference statistically significant at the one percent level of probability. Twenty-four percent of all respondents indicated that they have farm business interests in other areas (26% of Zululand respondents compared to 21% of KZN Midlands respondents). Eighty-four percent of principal decision makers indicated that they possess material off-farm investments. KZN Midlands respondents have,

on average, a statistically significantly greater proportion of their asset value invested off-farm (28%) compared to Zululand respondents (16%).

6. Risk-related management strategies of survey respondents

Respondents to the survey questionnaire were asked a number of questions regarding various risk-related management instruments that they may have at their disposal and use actively in their farm businesses. Where possible, measures of farmers' actual use of these management instruments were obtained; otherwise measures of farmers' perceptions of use relative to other farmers were used. What follows is a summary of this information.

The level of mechanisation as a management response (Roka, 2000) was based on a question in which farmers were asked whether their sugarcane operations are relatively more or less mechanised than other farmers in their area (not including mechanical harvesters). This variable was measured on a Likert-type scale (1-3), with values of one and three representing relatively less and relatively more mechanisation respectively. There was no significant difference in levels of mechanisation between the two regions with a mean overall value of 2.21 on the Likert-type scale. This may be due to the decision to focus on large-scale producers in this study and due to the representativeness of the sample. Similarly, the use of casual labour as a management response (Roka, 2000) was measured on a Likert-type scale (1-3) with values of one and three representing a relatively smaller or relatively larger proportion of casual labour respectively. The mean overall rating was found to be 2.0. The extent to which a farmer uses on-farm diversification as a management instrument was measured using an "enterprise diversification index", calculated as the sum of the squared proportions of the GFI stemming from each enterprise. Index values of zero and one represent farms that are highly diversified and highly specialised in terms of their enterprises, respectively. Respondents from the KZN Midlands were found to be significantly more diversified than those in Zululand, with mean diversification indexes of 0.58 and 0.83, respectively. This may be attributable to a larger proportion of farmland in the Midlands being unsuitable for sugarcane cultivation. This suggests that on-farm diversification is influenced mainly by land characteristics rather than by risk management considerations.

Principal decision makers were asked two separate questions in an attempt to estimate their propensities to both purchase and sell land. Respondents were asked dichotomous choice questions to determine if they would be willing to trade agricultural land, should either neighbouring land become available at a market-related price, or should they be offered a market-related price for a

portion of their existing land. Eighty-seven percent of all respondents indicated that they would consider buying an adjacent piece of land, should one become available at a market-related price. Only 24% of respondents indicated a willingness to sell a portion of their land should they be offered a market-related price. Both regions were similar in terms of respondents' propensities to purchase and sell farmland. These two variables were then transformed into a variable to be used in the factor analysis, the "propensity to trade land" variable. This variable was obtained by subtracting respondents' propensity to sell land from their propensity to purchase land. Values of -1.0 and 1.0 for the propensity to trade land variable therefore represent respondents who are more willing to sell land or more willing to buy land, respectively. A value of zero for this variable represents respondents that are indifferent to buying or selling land. This variable measures the ability of a farmer to respond to factors such as rising cost structures by adjusting the scale of the sugarcane operation.

A measure of the extent to which back-up management is kept as a response is whether or not additional management would have to be hired by the business should the farmer become unexpectedly incapacitated for a period of six months. Responses from both areas are similar with 46% of respondents indicating a lack of back-up management. Another management response is having back-up skilled labour available on the farm. The extent to which a manager keeps skilled labour in reserve is defined as the proportion of permanent labour employed as tractor drivers or assigned alternative responsibilities requiring an equivalent level of skill. Zululand respondents, on average, have significantly higher proportions of skilled labour (26%) among their permanent staff than Midlands respondents (23%). This may be due to Midlands respondents having to retain relatively more permanent labourers to service timber enterprises.

The extent of geographical dispersion of farming operations as a management response to risk is measured by a question in which farmers were asked whether or not they have farm business interests in other areas. Respondents from both areas are similar in this regard with 24% of all respondents indicating that they had farm businesses in other areas. Another management response measured is the use of contract machinery, specifically contract mechanical harvesters. Respondents from both areas reported similar usage of contract mechanical harvesters with an overall average of 12% of cane land being mechanically harvested by contractors.

The extent to which credit is kept in reserve is measured by the proportion of the businesses' overdraft facility used, on average, during the previous season.

Zululand respondents maintained relatively lower credit reserves in the previous season as compared to respondents from the Midlands, with 43% versus 25% of available overdraft being used on average, respectively, a difference significant at the one percent level of probability. Zululand respondents also utilise significantly higher total levels of insurance, namely 3.6% of GFI spent on insurance versus 1.8% in the Midlands.

Midlands respondents have significantly higher proportions of their wealth invested off-farm as compared to respondents from Zululand (28% versus 16%). This was captured in an “investment diversification index” that is calculated by summing the squared proportions of asset value invested on and off-farm. Index values of 0.5 and one represent an investment portfolio that is highly diversified and highly specialised, respectively. This index shows that Midlands respondents, on average, have a significantly higher proportion of asset value invested off-farm than Zululand respondents, with mean index values of 0.72 and 0.79, respectively.

Finally, respondents were asked whether they engage in off-farm employment and, if so, what proportion of their time is spent involved in this activity. The results show that respondents from both areas are similar in this regard with an overall average of 15% of a principal decision maker’s time being spent engaged in off-farm employment activity. This management response is captured in the form of a “time diversification index”, calculated by summing the squared proportions of time spent on and off-farm. Index values of 0.5 and one represent a principal decision maker whose time is shared between many sources of employment and highly specialised towards a single source of employment, respectively. The mean index value for respondents is 0.83.

6.1 Factor analysis of risk-related management strategies

The 12 risk-related management responses or instruments defined in the preceding section were included in a factor analysis incorporating all sample respondents. The multivariate technique of Principal Component Analysis (PCA) was used to determine the number of factors to include in the factor analysis. The main aim of PCA is to reduce the dimensionality of a data set, while retaining as much of the variation present in that data set as possible. This reduction is achieved by transforming data to a new set of variables, the principal components (PCs), which are orthogonal and ordered so that successive PCs contain diminishing proportions of the total variation present in the original data (Jolliffe, 1986:1). Principal components were extracted using the correlation matrix due to variables having different units of measure. The first six PCs had eigenvalues greater than one and collectively explained

77% of the variance in all 12 risk-related management responses. Eight of the 12 management responses had PC loadings exceeding 0.40 in absolute value in more than one PC and therefore a varimax rotation with Kaiser Normalisation was used in order to obtain factors that are easier to interpret. The extraction communalities for management responses all exceeded 0.68. This is another indication that most of the variance in management responses was accounted for by the first six common factors (Manly, 1986). The results of the factor analysis are summarised in Table 2.

Factor one was called the “Mechanisation and Management” factor due to the relatively large loadings for degree of mechanisation (0.871), proportion of sugar mechanically harvested on contract (0.804) and the level of backup management (0.650). This is a logical grouping of management responses because as the proportion of the crop that is mechanically harvested by contractors increases, so would the degree of mechanisation be expected to increase. This is due to the quicker supply of cut cane obtained through mechanical harvesting compared to manual harvesting. The increase in supply rate means that greater demands are placed on other machines such as mechanical loaders and tractor haulers. These spikes in supply rate also result in an increased demand for management time and, therefore, an increased pool of backup management is expected. An alternative to the hiring of additional staff to meet this increased demand is the use of contract mechanical harvesters, although most respondents reported the absence of such contractors in their areas. Mean factor scores indicate that the two survey areas are similar in terms of the use of the three main management responses contributing to the variance in this factor. This is to be expected as there is no statistically significant difference between the proportions of sugarcane mechanically harvested between respondents from the two regions.

Table 2: Rotated factor loadings^(a) of risk-related management strategies and regional factor scores for sugarcane survey respondents, KwaZulu-Natal, 2006

Factor		1	2	3	4	5	6
Initial eigenvalue		2.336	1.909	1.543	1.292	1.082	1.054
Percentage variance explained (cumulative)		19.47	35.37	48.23	59.00	68.02	76.80
Management Instrument	Communalities (b)						
Proportion skilled labour	0.764						.820
Time diversification index	0.751		-.846				
Farm businesses in other areas	0.887				.888		
Investment diversification index	0.773				-.671		
Use of casual labour	0.680					.488	.515
Propensity to trade land	0.798					.855	
Mechanical harvesting	0.754	.804					
Proportion of GFI ^(c) spent on insurance	0.770			.776			
Use of an overdraft facility	0.783			.853			
Need for back-up management	0.681	.650					
Degree of mechanisation	0.885	.871					
Enterprise diversification index	0.721		.784				
Zululand	Mean factor scores	0.042	0.067	0.061	-0.343	0.001	0.464
KZN Midlands	Mean factor scores	-0.042	-0.067	-0.061	0.343	-0.001	-0.464
	t-test						
Means comparison	(significance)	0.719	0.563	0.600	0.002***	0.995	0.000***

Note: (a) Only factor loadings with an absolute value greater than 0.4 are shown.

(b) That part of the variance of a management instrument that is related to the common factors.

(c) GFI represents Gross Farm Income.

*** Indicates means statistically significantly different at the one percent level of probability.

The second factor was labelled the "Enterprise and Time Diversification" factor due to the relatively high factor loadings for the time diversification index (-0.846) and enterprise diversification (0.784). This may be explained by the decrease in time available for off-farm employment as on-farm enterprise

diversification increases (McNamara & Weiss, 2001; Goodwin & Mishra, 2004; Windle & Rolfe, 2005). It may be expected that a farm highly specialised towards sugarcane production demands less management time than a farm that is diversified in terms of its enterprises. A farm that is specialised toward sugar production would, therefore, free relatively more management time for alternative, off-farm, employment. Mean factor scores for the two regions were not statistically significantly different, however, in spite of Midlands respondents reporting statistically significantly higher levels of enterprise diversification than those from Zululand. This would suggest expected higher levels of time diversification among Zululand respondents. Results show that this is the case, although the difference between off-farm employment for Zululand and Midlands respondents is only statistically significant at the 17% level of probability. Off-farm employment by the spouses of the principal decision makers is, however, statistically significantly higher for respondents from Zululand. This suggests that respondents and their spouses may be collectively involved in decision making processes (Davis, 1976).

The third factor was named the “Insurance and Credit Reserve” factor. The average proportion of an overdraft facility used in the 2005-2006 season (0.853) and proportion of gross farm income spent on insurance (0.776) were the management instruments that explained the majority of the variance in this factor. This shows that as proportion of income spent on insurance increases, so the extent of overdraft use increases, which is synonymous with decreased liquidity. This relationship may be explained by the increased mitigation of risk through increased insurance cover enabling a farmer to operate with lower credit reserves (Harwood *et al.*, 1999). This is evident in Zululand where respondents spend significantly higher proportions of total farm income on insurance and maintain significantly lower credit reserves compared to Midlands respondents. Despite this, mean factor scores for the two study areas are not statistically significantly different. This may be due to the larger average farm size in the Midlands, as the proportion of total farm income spent on insurance is expected to be negatively related to farm size (Sherrick *et al.*, 2004). This is due mainly to scale economies; for example, an increased ability to efficiently utilise insurable assets such as buildings and machinery as output increases. The potential for decreased credit availability is expected to be negatively related to this factor.

The fourth factor was called the “Geographic and Investment Diversification” factor with two management instruments, namely, owning farm business interests in other areas (0.888) and the investment diversification index (-0.671), being responsible for most of the variance observed in this factor. This indicates that farmers with a higher proportion of asset value invested off-

farm are more likely to also have farm business interests in other areas. Mean factor scores indicate that Zululand respondents have significantly less off-farm investments and that Midlands respondents have significantly more farm business interests in other areas. Results confirm that Midlands respondents have, on average, significantly higher proportions of asset value invested off-farm; however, geographical diversification of farm business interests is similar for both areas. This anomaly may be due to higher levels of enterprise diversification among Midlands respondents compensating for the need to diversify geographically. A possible explanation for this complementary effect is that both forms of diversification serve to mitigate certain common risk sources such as the influence of climatic variability on crop yield (Pope & Prescott, 1980; Norstea & Barry, 1994).

The fifth factor was termed the "Land Trade" factor with most of the variation explained by respondents' propensity to trade agricultural land (0.855). The level of use of casual labour also received a relatively high factor loading in this factor (0.488). This suggests that respondents who are relatively more able to purchase land also consider themselves to be employing relatively more casual labour than other farmers in their areas. A possible explanation of this finding is that respondents, who have responded to restrictive labour legislation by replacing permanent staff with relatively greater proportions of casual labour, are more confident in terms of expanding their current farm sizes. Conversely, this factor may indicate that farmers with relatively higher proportions of permanent labour are less willing to sell existing sugarcane land. This may be due to the costs involved in the retrenchment of permanent staff.

The final factor was named the "Labour" factor, with most of the variation being explained by two management instruments, namely, the proportion of permanent labour that is skilled (0.820) and the level of use of casual labour (0.515). Mean factor loadings suggest that as average skill levels increase among the permanent labour force, so does the extent to which casual labour is employed. This may be explained by respondents having consolidated their permanent labour forces due to restrictive government labour policies, retaining those with relatively higher skills, and substituting the less skilled with casual labour (Simbi & Aliber, 2000; Sparrow *et al.*, 2006; Vink, 2004; Valodia *et al.*, 2006). Mean factor scores for the two study regions are statistically significantly different at the one percent level of probability. This suggests that Zululand respondents have substituted significantly larger proportions of their permanent staff for casual labour. One plausible explanation is that Midlands respondents, on average, are forced to retain higher proportions of skilled permanent staff such as chainsaw operators and

timber loader and tractor hauler machinery operators due to the higher levels of enterprise diversification in this area.

7. Conclusions and policy recommendations

This study identifies some of the important risk-related management strategies available to commercial sugarcane farmers in KwaZulu-Natal. It also provides evidence that farmers respond to changes in the risk environment by using both individual management instruments and combinations of these instruments. Findings are consistent with those of Pennings *et al.* (2005) and tend to suggest the bracketing of management decisions at fairly narrow levels. This is evident from the six management dimensions or choice brackets identified in the factor analysis where the majority of the variation in each dimension is attributable to one or two individual management instruments. Regional differences in the levels of adoption of individual risk-related management instruments are identified from the factor analysis and explained based on farm, farmer and various other socioeconomic characteristics.

The study shows that government should review restrictive labour legislation such as minimum wages to reduce the costs associated with permanent labour and slow the casualisation process, thereby promoting permanent employment rates and job security. An indication by government as to the maximum annual increase in minimum wages that farmers may expect would serve to decrease some of the uncertainty surrounding this legislation. Government also needs to decrease uncertainty surrounding the land restitution process by providing farmers with detailed information regarding the process of land valuation and informing those farmers whose land is subject to restitution according to the new legislation.

Farmers may also need to make better use of available information by considering the effects of any single management decision on other decisions. Improved information processing by decision makers will allow relevant decisions to be made, taking into account not only the effects of those decisions on all other decisions included in the existing choice bracket, but also on decisions previously restricted to other brackets. This would enable the improved anticipation of the outcomes of a management decision and, therefore, the ability to bracket these decisions at broader levels. This improved cognitive capacity will enable decision makers to take advantage of further substitution and complementary effects that may exist between management strategies previously considered in separate decision brackets. The fact that mechanisation and labour use occur in separate brackets in this

study is an example of one such substitution effect that respondents do not seem to be utilising in terms of their management decision making.

This study has identified new means of more accurately quantifying farmers' actual use of multiple risk-related management strategies and the extent to which individual management responses or instruments are combined, by identifying six factors that are interpreted as management choice brackets. These choice brackets show that farmers have the potential to utilise further beneficial relationships that exist between individual management instruments. Future research based on time series data could be important to identify how risk management portfolios and risk bracketing levels change over time. Further research could also be aimed at investigating the effects of risk aversion on the levels of use of individual risk-related management instruments and on how these are combined within choice brackets.

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