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Wool Versus Mutton: Enterprise Budgets from Survey Data for the Karoo and the Effects of Drought on Profitability

Conradie, B.[1]

Corresponding Author: B. Conradie. Correspondence Email: beatrice.conradie@uct.ac.za

ABSTRACT

The study assesses the profitability of Karoo farms. It develops an enterprise wool and mutton production budget from eight years of survey data collected from 73 farms. Costs are presented in constant 2019 Rand so that data from various years can be pooled. According to income composition, farms were classified into mutton, wool or mixed mutton-wool operations. Mutton and mixed farms run similar-sized flocks on similar-sized properties, while wool farms operate larger flocks on more land. Mutton producers stock their land 15% less densely than wool or mixed farms, which use the same stocking density. At R80.89 per hectare, the small stock enterprise on mixed farms is approximately 40% more expensive to operate than the unit cost of production on mutton or wool farms, which are similar. Wool farms generate the best per-hectare incomes, 48% higher than the unit income of livestock on mixed farms and 62% higher than the per-hectare income on mutton farms. Net farm income is presented and discussed, and profitability is related to rainfall.

Keywords: Enterprise Budgets, Net Farm Income, Small Stock Production, Karoo Food Systems

1. INTRODUCTION

Good local information about the relative profitability of farm enterprises is important for public sector extension workers who spend most of their time preparing business plans or shepherding new ventures through their first years of production in pursuit of land reform targets. The performance of the extension service can be substantially improved by keeping enterprise budgets accurate and current, and presenting such data and a new way of collecting

[1] Professor of Economics, University of Cape Town, PBag X1, Rhodes Gift, 7703 beatrice.conradie@uct.ac.za
https://orcid.org/0000-0002-4675-6300

it is the main contribution of this study. A secondary objective is to investigate the effect of the drought on profitability in the Karoo food system.

Traditional enterprise budgets reflected hypothetical production systems built up activity-by-activity from technical information collected from key informants. Representative prices were applied to quantities obtained from field data to calculate gross margin, and estimates were kept current by periodically revising prices only. The main advantage of the traditional method of compiling enterprise budgets is that it harnessed local experience and was technically explicit. Its main drawback was that profit margins did not apply to typical or bottom-third producers. Traditional enterprise budgets typically stopped at the gross margin level, leaving the extensionist to make further assumptions about overhead costs to calculate net farm income.

Developing enterprise budgets from survey data avoids the representativeness problem and creates the opportunity to estimate net farm income directly. Income statement data effectively summarises the typical production activities required in a specific setting. Collecting a few extra costs over and above those needed for gross margin calculation automatically incorporates weights, and a straightforward assumption on how income is constituted allows the analyst to back out a margin above direct cost that is much closer to net farm income than to gross margin.

In this study, three enterprise budgets are developed for small stock, predominantly sheep, farming in the Karoo. We have eight years of survey data for 73 farms divided into mutton, wool and mixed farms. The amount of wool income places a farm in the wool category while a mixed farm runs sheep alongside a crop production activity. The crop enterprise is not part of this analysis. The most recent formal comparison of the relative profitability of wool and mutton sheep based on survey data was made using the first wave of this study (Conradie & Landman, 2015). At that time, relative prices favoured mutton production, but woolled sheep were still more profitable than mutton sheep. However, the limited number of observations on wool farming prevented the difference from being statistically significant. More data is available now, which makes it worthwhile to rerun the comparison.

This study investigates four questions for the Central Karoo District Municipality: 1. Is woolled sheep still more profitable than mutton sheep? 2a. What was the effect of the 2015 drought on profitability? 2b. Does the relative profitability of mutton and wool switch with increasing or decreasing rainfall? 3. How is the profitability of sheep farming affected by the farm's degree of specialisation in small stock production? and 4. What is the productive value of farmland implied by these profit levels? The answers to the first two questions came from farms specialised in sheep and goat production, while question 3 required information from farms where livestock production plays a minor role. To answer question 4, net farm income per hectare was capitalised at a 3% real rate of return.

The survey process and main sample characteristics are described in Section 2, and farm classification is described in Section 3. Relative profitability is discussed in Section 4. Section 5 turns to the effect of the drought on profitability by asking if farmers are applying purchased feed at the profit-maximising level. The paper ends with a brief overview of conclusions, limitations and implications for extension workers.

2. DATA COLLECTION

The Karoo Management Panel (KMP) dataset is a convenience sample[2] of farm financial data with its origins in a scientific study of predator ecology (Nattrass & Conradie, 2017; Drouilly, Nattrass, & O'Riain, 2018; Nattrass et al., 2020). The scientific study was conceived in 2012 to cover an area of 800 square kilometres in one district, and in 2012 and 2013, the management survey was confined to this district. In 2014, KMP expanded to follow collared predators into two adjacent districts. Eventually, the management survey covered an area of 16 000 square kilometres bounded by the Swartberg Mountains in the south, the N12 in the east, the Great Escarpment in the north and route R354 between Matjiesfontein and Sutherland in the west. This area covers most of the Central Karoo District Municipality, including most of Laingsburg Local Municipality, a small portion of Prince Albert Local Municipality that lies to the west of the N12 and the portion of Beaufort West Local Municipality south of the Great Escarpment and the west of the N12. It was estimated that this region is occupied by 193 farming enterprises, of which the survey covers 112 entities, which is 58% on a head count basis (Conradie, 2019).

Wave 1 of the KMP survey was conducted in December 2012, Wave 2 took place in September 2014, and Wave 3 and 4 followed in October 2015 and October 2016. Financial data for the

[2] A convenience sample means that the researcher interviewed whoever they could convince to be part of the survey. Since we do not know how representative this sample is of the population few claims can be made beyond this case study.

previous financial year was collected on each occasion. By the end of 2016, the science was concluded, and no further management data had been collected for three years. KMP respondents were allowed to exit the panel after Wave 4. In September 2020, KMP returned to the field with Wave 5 to survey from 2016 to 2019. A few additional respondents were recruited at that time.

The recall period is the delay between an activity or outcome and gathering information about the event. Best practice rules are that this period should be as short as possible to minimise recall bias, although it is less of a problem when data are obtained from written farm records. The quality of KMP data improved with every wave as farmers' trust in the research project grew and their farm records improved. However, pushing data collection to four years proved respondents' willingness to tolerate the limit. Ideally, one should be in the field every other year.

TABLE 1: Sample Size and Attrition in the KMP Dataset, 2012 - 2019

Production year	Sample size	Useable responses	Refusals and cumulative attrition
2012	102	62	39%
2013	102	62	39%
2014	102	59	42%
2015	102	58	43%
2016	112	46	59%
2017	112	46	59%
2018	112	47	58%
2019	112	48	57%
Pooled sample	112 x 8 = 896	428	52%

The KMP dataset is a snowball sample whose response and attrition rates change every time a new farmer is recruited to the group. The data in Table 1 is for the end of Wave 5 (2019), at which point cumulative attrition stood at just over 50%. The unbalanced panel dataset of useable data had 428 observations. Two main reasons for the low response rates in the early waves were distrust of the government and a lack of detailed farm records. In 2012, there were 62 complete responses, eight refusals, thirteen incompletes and 29 "missings", with the latter indicating that the respondent in question was recruited in a later wave. In 2015, there were 58 complete responses, no incompletes or refusals, and 54 participants were removed from the sample, usually due to failure to comply during the previous wave. A few respondents left the survey in good standing on retirement or death or because they sold the farm. New owners and heirs could not always be recruited into KMP. Wave 5 recruited ten new participants, of whom seven submitted complete records for 2019, while the remaining three conducted interviews with incomplete financial data. Of the seven who made cost and income data available in Wave 5, five did so for the entire recall period to 2016, and an eighth could go back to 2015. The incomplete panel had 428 observations from 74 farms after Wave 5.

To be poolable, data were inflated to constant 2019 values using a series of price indices published in the Abstract of Agricultural Statistics (DALRRD, 2020). Gross income includes livestock, mutton and wool sales. Crops and their share of overhead costs are not part of this study. The item "purchased feed" was combined with animal remedies and veterinary services and was inflated with the stock feed index listed with other farm inputs. "Fuel expenditure" includes the cost of hired transport, and the intermediate consumption deflator was for fuel. The item "repairs and maintenance" was recorded separately for vehicles and machinery and farm infrastructure and buildings, and both parts were deflated with the price index for repairs and maintenance. The wage bill and the cost of predator control were deflated with a specially constructed wage index based on the statutory minimum wage for agriculture. To compute the wage index, the statutory minimum of R18.00 per hour for 2019 was set equal to an index value of 100. It was expanded by dividing the index value 100 by the target year's index value by R18.00 per hour and multiplying by the target year's statutory minimum wage. For example, the wage index for 2018 was calculated as follows: $WI_{2018} = \frac{100}{R18/hr} \times R15.96 = 88.7$. The items on the ere electricity, and rented land cost was deflated with the general consumer price index for all items in all areas in the abstract.

3. FARM CLASSIFICATION AND MEASURING DIFFERENCES

The farm classification presented in Table 2 is based on the composition of gross income and how farmers self-identify, and the categories are mutton, wool and mixed farming.

As noted before, the analysis only covers the stock enterprise, the only source of farm income for 75% of the farmers in the sample. The other 25% of crops contribute an average of 44% of gross farm income. Within small stock, almost half of the group derives their entire farm income from livestock sales (mutton), while only 40% reported some wool or mohair income. The sample includes one game farm with a sideline in sheep and one mixed farm with a substantial game enterprise. Game Farm was left out of the classification.

Amongst the 199 observations classified as mutton farms, livestock sales contribute 97.5% of gross farm income. Wool contributes virtually zero income to these businesses, while crops make up less than 1% and other farm income about 1.8% of gross farm income. The 137 observations relating to wool farms reported 52% of gross income from livestock sales, 42% from fibre sales, less than 3% from crops and just over 1% from other farm income. For mixed farms, on which there are 88 observations in the sample, livestock sales contribute 37% of gross farm income, while wool contributes 9% and crops 48%. The remaining 7% is from other farm income.

Testing for meaningful differences across farm types requires applying a single variable analysis of variance (ANOVA) test, and farm types can be described as different if the variation in an attribute is greater than within groups. The ANOVA test assumes equal variances across groups. This assumption is often rejected in survey data; in this case, one must resort to the ANOVA’s non-parametric equivalent, the Kruskal-Wallis test. A series of Kruskal Wallis tests revealed statistically significant differences in farm size, flock size and stocking density across the three farm types. Mutton producers run flocks of 705 ewes on 7 786-hectare farms at an average stocking rate of 95 ewes per square kilometre. Wool producers run flocks of 1355 ewes and wethers on farms of 11 821 hectares at a mean stock rate of 112.5 stock sheep per square kilometre. Mixed farms operate at the same stocking density as wool producers, who have flocks of similar size and the same average farm size as mutton producers. These similarities and differences were determined by calculating pairwise Bonferoni correlations after the ANOVA tests (Dunn, 1961).

4. RELATIVE PROFITABILITY

Calculating farm profits is a three-step process (Louw, Geyer & Jordaan, 2017). Step 1, the gross margin calculation, was done at the enterprise level and involved subtracting enterprise-specific costs like feed and remedies from gross income at the farm gate. In step 2, the gross margin is summed up across all enterprises, and overhead costs, such as the wages of permanent workers, are subtracted from it to compute net farm income. Step 3 involves subtracting payments to foreign factors, like payments to rented land, from net farm income to compute farm profit. This study's overheads were labour, fuel, repairs, maintenance, and electricity. Predator control costs are part of the gross margin calculation. Only if farm profits are positive does anything accrue to the owner-operator. Since feed and remedies make up just a small portion of the total cost of production in a small stock enterprise, gross margin data should be carefully interpreted. For the 75% of the sample for whom the small stock enterprise is the only economic activity, allocating overheads to the enterprise is straightforward. For mixed farms, overhead costs were assigned to the small stock enterprise proportionally to its share of gross income. There is a fourth step in Table 2 in which the cost of rented land is subtracted from net farm income to compute farm income before interest payments and rented management. There are so few non-family managers that the last line in Table 2 could be labelled "profits before interest payments". Proper farm profits could not be calculated since the early data on interest payments are considered unreliable.

Mean rainfall varied from 86 millimetres p.a. in Laingsburg to 211 millimetres p.a. in Beaufort West during the survey period, and these figures are 23% and 11% lower than the long-term average for these locations (Conradie & Theron, 2019). The small stock enterprise on the typical Central Karoo farm produced a gross income of R72.18 per hectare from 2012 to 2019. The unit cost of production was R60.29 per hectare, leaving a net farm income of R12.04 per hectare. The amount spent renting land equals R5.14 per hectare, which leaves a farm profit before finance costs of R6.84 per hectare. Capitalising this income stream at a rate of 3% into perpetuity sets the productive value of farmland at R228 per hectare across good and bad years, and a farmer without debt and rented land would be willing to pay R401 per hectare. Market prices over the last four years were R1828 per hectare in constant 2019 prices (Western Cape Department of Agriculture, 2021).

Labour is the largest cost item at R18.09 per hectare, or 30% of direct and allocated overhead costs, followed by feed and livestock remedies at R17.17 per hectare or 28%. The item fuel and rented transport add 15% of the cost, and repairs and maintenance account for 16% of the total cost. Electricity represents 8% of the cost of small stock production and predator control for less than 2% of direct and allocated overhead cost in this enterprise, which was surprising given how highly farmers rated the predation risk in 2015 (Wustro & Conradie, 2019).

Wool farms were the clear winners regardless of whether the farm types were compared in terms of gross income, net farm income or profit before interest. At a gross income of R95.92 per hectare, wool farms generated almost 60% more than other farms, and according to the Bonferroni correlations obtained after ANOVA, this difference was statistically significant. Net farm income on wool farms was R39.15 per hectare, while other farms, on average, lost R0.84 per hectare before payments of foreign factors. Most of these losses occurred on mixed farms, where half the observations lie in negative territory, while less than 30% of mutton farms recorded negative net farm incomes. There were also loss-making observations in the wool farming category, but they were less frequent than in the other two categories. The degree of losses among loss-making farms varied surprisingly little; loss-making wool farms, on average, generated -R80.51 per hectare compared to -R74.83 on mixed farms and -R55.57 on mutton farms and this difference was marginally significant at a probability of $p \leq 0.0998$ on the Kruskal Wallis test although the Bonferroni correlations do not indicate robust differences between any two of the three farm types.

TABLE 2: Enterprise Budget For Small Stock in 2019 Rand Per Hectare by Farm Type

Year	**Mutton farms**	**Wool farms**	**Mixed farms**	**All farms**
	n = 199	n = 137	n = 88	n = 424
Gross income	59.16	95.92	64.65	72.18
Feed and remedies	13.68	14.97	28.48	17.17
Fuel and transport	9.38	8.10	10.07	9.11
Labour	14.57	22.48	19.22	18.09
Repairs: vehicles	4.17	4.02	4.26	4.14
Repairs: Infrastructure	6.98	4.62	4.83	5.77
Predator control	1.12	0.96	1.26	1.10
Electricity	3.55	1.61	12.77	4.84
Total direct and overhead cost	53.57	56.77	80.89	60.29
Net farm income	5.85	39.15	-16.23	12.04

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Cost of rented land	3.23	9.23	3.08	5.14
Profit before interest payments	2.47	29.93	-19.32	6.84

The difference in total costs was significant, but individual line items varied more within than between farm types. On wool farms, the labour item includes shearing costs, which partly explains why wool farms incurred 40% higher labour costs than other farms, but the Bonferroni results indicated that this was not always so on all wool farms. The other noticeable difference was in the cost of feed and remedies, where mixed farms spent double the amount that other farms did. However, if one outlier was ignored, mixed farms only spent R17.07 per hectare on feed and remedies, roughly 20% more than other farms. The third glaring difference in cost structure is in the cost of electricity, where mixed farms spend more than 3.5 times more than other farms, mainly due to pumping costs for irrigation. These small differences added to a total expenditure of R80.89 per hectare on mixed farms, which is almost 50% higher than the corresponding figure for other farms. This time, the difference between mixed and mutton farms was marginally significant at $p \leq 0.055$. In contrast, the difference between mixed and wool farms was marginally insignificant at $p \leq 0.151$ on the Bonferroni test.

According to net farm income, wool farming is statistically more profitable than other farms, and the difference is robust. The final expenditure item considered was the cost of rented land, and on this item, wool farms spent almost three times as much as other farms because more of them rent land. The difference between wool and mutton farms in rent paid per hectare is marginally significant at $p \leq 0.074$, while the differences between wool and mixed farms and mutton and wool farms are insignificant. Mixed farms are, on average lost, while wool operations are twelve times more profitable per hectare than mutton farms.

5. THE RELATIONSHIP BETWEEN RAINFALL AND PROFITABILITY

It is possible that the difference in profitability established in Table 2 reflects a difference in microclimate and that if operated under the same rainfall conditions, wool farming would be no more profitable than mutton production. The approach to analysing this question is first to test if there is a difference in the distribution of reported rainfall across farm types and then run separate regressions of profitability on rainfall for each farm type. The latter will establish if there is a statistically robust relationship between the two factors and will show how a 1% increase in rainfall affects profitability.

Figure 1 presents histograms of reported rainfall by farm type and for the pooled sample (labelled total), and the Kruskal Wallis test fails to reject the equality of populations hypothesis of rainfall by farm type. This means that the difference in profitability shown in Table 2 is not only, or even mainly, due to rain.

In Figure 2, net farm income per hectare is regressed on the natural logarithm of annual rainfall. Usually, the regression would have a double log specification in which the coefficient on rainfall can be interpreted as an elasticity measuring the percentage change in profits for a percentage change in rainfall. However, since the logarithm of a negative number is undefined and net farm income is negative for many observations in this sample, the dependent variable in these regressions could not be logged. As a result, the coefficient on the rainfall log is interpreted as the change in profits measured in real 2019 Rand per hectare for a 1% change in rainfall. The coefficient for the model fitted on the pooled sample, whose relationship is illustrated in the bottom right-hand corner of the composite graph, is R28.30 per hectare. The shaded area around the regression line illustrates the confidence interval, and its narrow distribution indicates that the net farm income–reachage relationship is highly significant.

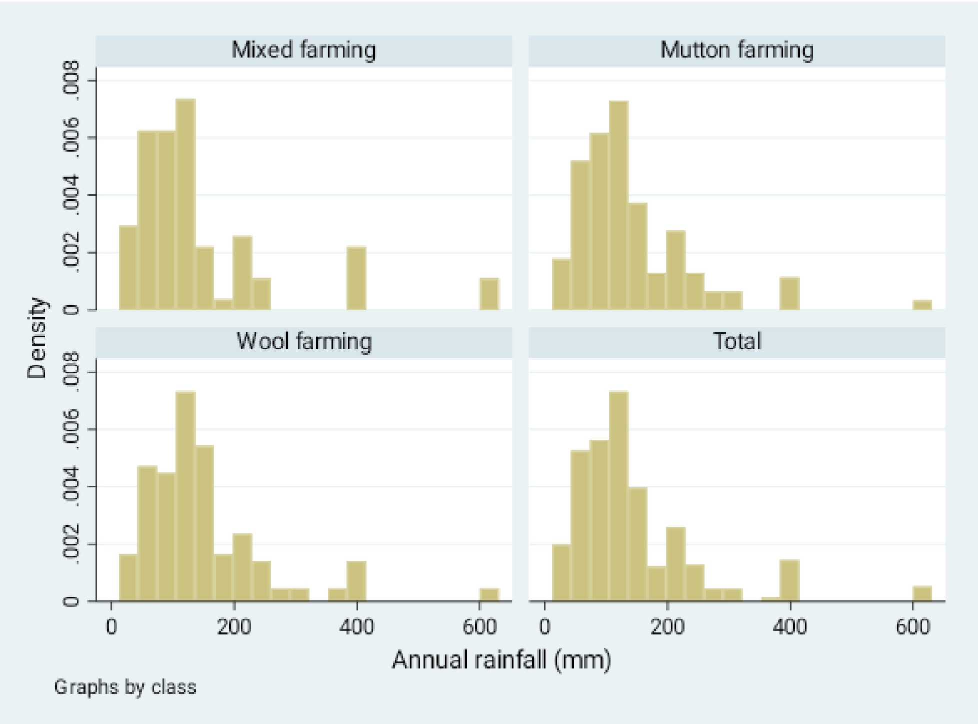

FIGURE 1: Distribution of Annual Rainfall Data by Year of KMP

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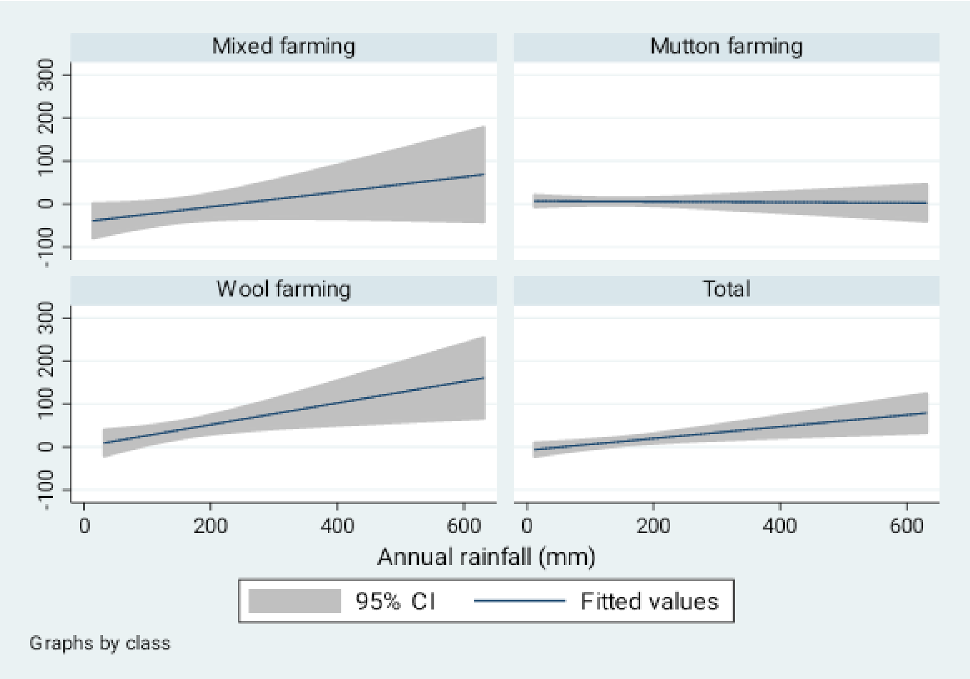

FIGURE 2: The Relationship Between Net Farm Income and Annual Rainfall by Farm Type

The relationship between rainfall and profitability on mutton farms is illustrated in the top right-hand panel of Figure 2. While the confidence interval is equally narrow, this line is flatter than the one for the pooled sample, indicating that changes in rainfall have minimal effect on the profitability of mutton farms. The coefficient of R9.26 per hectare for every 1% increase in rainfall was not significantly different from zero with a probability $p \leq 0.1698$. This statistically flat line means that mutton farmers get the same results in wet and dry years, which could be interpreted as a successful adaptation to drought or equally as overgrazing, which prevents these operations from recovering in a good year. This question can only be resolved if plant cover data is available.

The left-hand panels of Figure 2 illustrate the relationship between profitability and rainfall for mixed farms at the top and wool farms at the bottom. The marginal profit of 1% higher rainfall is R31.05 per hectare on mixed farms. Still, this estimate is only marginally significant at a probability level of $p \leq 0.103$ due to the small sample size for this type and the high degree of variability in the group. In contrast, a 1% increase in rainfall causes the profits on wool farms to rise by R45.67 per hectare, and this coefficient is significant at the highest level. In both

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cases, the relatively steep slopes indicate a lower degree of adaptation to the drought or faster recovery when it does rain than mutton farms.

When a drought causes veld conditions to deteriorate, the most common adaptation is to buy feed. Although farmers could also adjust stocking density, they seldom do. Economic theory holds that profit is maximised where marginal revenue equals marginal cost. In Figure 3, profit-maximising production occurs in Zone 2 of the production function, where total revenue per hectare increases at a decreasing rate with extra spending on feed. In Zone 2, marginal revenue is decreasing and below average (not shown).

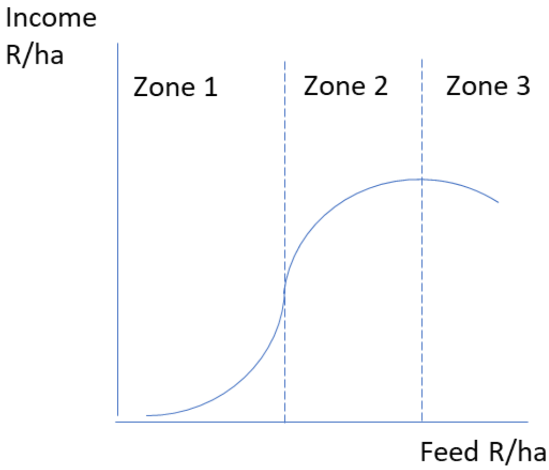

FIGURE 3: Profit Maximising Behaviour

To implement this theoretical model, real income per hectare was regressed on real feed cost per hectare and its square term while controlling for stocking density and rainfall, as follows:

$$ln\ ln\ incomeperha_{it} = \alpha_0 + \alpha_1 \cdot ln\ ln\ feedperha_{it} + \alpha_2 \cdot ln\ ln\ feedperha\_sq_{it} + \alpha_3 \cdot ln\ ln\ precip_{it} + \alpha_4 \cdot ln\ ln\ precip\_sq_{it} + \alpha_5 \cdot ln\ ln\ stockingdensity_{it} + \alpha_6 \cdot ln\ ln\ density_{\_sqit} + \varepsilon_{it} \quad [1]$$

In this model, the natural logarithm of $incomeperha_{it}$ is measured in real 2019 Rand for farm i in year t, $feedperha_{it}$ is the amount spent on purchased feed and $feedperha\_sq_{it}$ is its square term. These two explanatory variables are in logarithms like rainfall, stocking density, and their square terms. The square terms allow a non-linear response between the independent variable and the model outcome. The α_js are parameters to be estimated and ε_{it} is the usual independently and identically normally distributed error term associated with an ordinary least squares regression model. A positive sign on α_1 indicates that farmers apply feed somewhere

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in Zone 1 or 2 of the production function and combined with a negative sign on α_2 it indicates that the optimal feed application is in Zone 2, which aligns with profit-maximising behaviour. If neither α_1 nor α_2 The farmer is statistically significantly different from zero, operating on the boundary between Zones 2 and 3, where he probably uses too much feed. If the sign-on coefficient $\alpha_1$is negative, and the feed is over-applied. The expected signs on precipitation and stocking density are positive, and since this model has a double log specification, the coefficients α_1 , α_3 and α_5 are elasticities that measure the effects of a 1% increase in the independent variable on the dependent variable, income.

TABLE 3: Regression Results Explaining the Logarithm of Real Income From Sheep Per Hectare

Year	**Mutton farms**	**Wool farms**	**Mixed farms**	**All farms**
	Coefficient			
	Standard error			
Feed	0.1467	0.1439	0.4000	0.1357
	0.0503	0.0713	0.1090	0.0391
	***	**	***	***
Feed squared	-0.0089	0.0250	-0.1018	-0.0177
	0.0139	0.0168	0.0232	0.0100
			***	*
Precipitation	0.2028	0.4376	0.1725	0.2198
	0.1003	0.1236	0.1025	0.0662
	**	***	*	***
Stocking density (sheep / km^2)	1.0497	0.2979	1.9287	1.2206
	0.1738	0.3098	0.3609	0.1378
	***		***	***
Stocking density squared	-8.16e-06	1.1e-05	-6.0e-05	-1.6e-05
	7.42e-06	9.38e-06	1.6e-05	5.60e-06
			***	***
Constant	-1.9648	0.2805	-5.1747	-2.5712

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	0.7785	1.1984	1.1436	0.05991
	**		***	***
Observations	198	137	87	426
Adjusted R-squared	0.3249	0.2657	0.4278	0.3028
F-statistic	19.96	10.84	13.86	37.92

*** signifies $p \leq 0.01$, ** signifies $p \leq 0.05$, * signifies $p \leq 0.10$. Variables in logarithms.

Table 3 contains results for the pooled model and sub-models. The square term on precipitation was consistently insignificant and dropped everywhere. The positive sign on feed and the negative sign on its squared term in the model fitted to the pooled data indicate that feeding decisions are generally profit maximising. Rainfall is beneficial, as expected, and the feed elasticity is lower than the rainfall elasticity, which is also significant.

In the pooled results, the stocking density decision is also consistent with profit maximising behaviour since the coefficient on stocking density is positive and the sign on its squared term is negative. Still, in this instance, the elasticity is enormous compared to the feed and rainfall elasticities. The estimate of 1.22 indicates that a 1% increase in stocking density will increase per-hectare real income by 1.22%, compared to an elasticity of 0.22 for rainfall. The elasticity for feed is even smaller. Of course, farmers do not control rainfall. Still, when choosing between what they can control, these results counterintuitively suggest that the best way to combat low rain would be to increase, and not decrease, stocking density. This points to an already dangerously low level of stocking.

The feed result is robust across farm types, except that its elasticity is almost three times larger for mixed farms than for the whole group. For mixed farms, the squared term is negative, indicating that the optimal input level falls firmly in Zone 2, while the lack of significance on the square term for the first two subsamples points to a linear relationship between the expenditure on feed and income, and an optimal allocation somewhere on the boundary between zones 1 and 2.

The precipitation result is also robust, with the rainfall elasticity varying around 0.20 except on wool farms, which are twice as large as on other farms.

The effect of stocking density on per-hectare income is less robust than the rainfall and feed expenditure results. This coefficient is significant in the model fitted to the mutton and mixed farm subsamples and insignificant for wool producers, which was a surprise. Increasing stocking density by 1% on mutton farms increases income by more than 1%. There is no effect on wool farms, and on mixed farms, raising stocking density by 1% increases income by almost 2%. The effect on mutton farms is linear, and on mixed farms, income per hectare rises at an increasing rate, which is difficult to explain. More work needs to be done to optimise stocking density in drought and under normal rainfall conditions.

6. CONCLUSIONS

This study departed from the simple goal of compiling representative enterprise budgets from survey data for sheep farming in the Karoo. This exercise confirmed industry claims that wool farming is more profitable than mutton farming and revealed that the small stock enterprise on mixed farms is often not profitable. This result comes with the usual caveats that the high attrition rate creates uncertainty about the performance of big and small farms on which we failed to collect data.

In addition, these estimates do not account for the contribution of government drought relief and private fodder donations received during the past eight years of drought. If these donations were included, feed cost per hectare would rise dramatically, and many farms would become unprofitable. It is clear from the survey data that different farm types respond differently to drought. Mutton producers seem to be best adapted or perhaps the least able to take advantage of good times when they come. While mutton and mixed farmers follow the same feeding strategy and get the same results, wool farmers are doing something different with stocking density than mutton farms in response to drought. It is not yet clear how the strategies differ.

There are three important extension messages from this study. Firstly, effective monitoring of drought and climate change begins with good data, and compiling an adequate time-series dataset takes a while. Therefore, extension workers should be trained in data collection and fundamental analysis and should be required to report periodically on the effect of weather on their clients' performance. Secondly, this study clearly shows that small changes to production systems could significantly affect profitability. Therefore, the extension worker's horizon scanning role should be developed and supported by the relevant livestock or crop production research. Thirdly the accepted wisdom that diversification is advantageous under risky conditions was disproved in this case, where the small stock enterprise on diversified mixed farms performed much worse than similar activities on farms that specialised in sheep production. Preliminary results for the Overberg point to the same conclusion (Conradie & Genis, 2021). In this case, the explanation is that managers should be undivided in their attention rather than attempt to be good crop and stock farmers.

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