ENTERPRISE COMPARISON: RISK PROGRAMMING ANALYSIS

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Abstract

The Mpumalanga region of the South African sugar industry has conditions suitable for a wide variety of crops. Diversification or expansion of farming operations requires farmers to compare the profitability of various crops and to decide what 'mix' of crops is most desirable. The only effective method of comparing crops is to ascertain the risk associated with each type of crop as well as the risk level of various combinations of crops. A linear programming model is used to analyse data from selected crops to determine the risk and profitability associated with crop combinations. The importance of considering risk in farm planning and research is emphasised.

Introduction

The area known as the Onderberg, which is situated in the Lowveld of Mpumalanga province, is highly fertile and suitable to a wide variety of tropical and sub-tropical crops. Production is highly dependent on irrigation, which is concentrated around the Crocodile, Komati and Lomati rivers.

The agricultural environment has changed rapidly over the past 10 years, specifically in the form of deregulation of local and international markets and new agricultural legislation from government. The result has been increased opportunities as well as greater risk and uncertainty relating to commercial agriculture in South Africa.

Decisions regarding land purchase, expansion and diversification are normally based on annual production, price and cost information provided by producer organisations, government or research institutions. This information is normally based on survey averages over a large area or 'best case' scenarios. Income comparisons between enterprises are often based on a single season's income and expenditure, which ignore seasonal variations in yields, quality, prices and costs.

The purpose of this paper is to highlight the importance of considering agricultural risk in all forms of farm planning and research.

General description of the study area

The Onderberg, situated in the Lowveld of Mpumalanga province, lies east of the Krokodilpoort mountains and is bordered by the Kruger National Park in the north, Mozambique in the east and Swaziland in the south.

Climate

Rainfall in the region varies from below 600 mm per annum to close to 1 000 mm per annum, and summer temperatures are high. Irrigation water for crops is therefore essential and is drawn from three main sources, namely the Crocodile, Lomati and Komati rivers. Water restrictions occur in winter months, although this limitation is expected to decrease due to the completion of the Driekoppies dam on the Lomati river and the construction of the Maguga dam on the Komati river.

Land utilisation

The total area under production in the Onderberg area has increased by nearly 15% over the period 1991 to 1997 (unpublished data[1]). Table 1 indicates that there has been a shift from seasonal cash crops to higher yielding perennial crops. The increase in the area cropped to sugarcane can be attributed to expansion within the Nkomazi area of small scale cane growers. The area under orchard (sub-tropical) crops has increased by 18% and banana production by close to 30% over the period. The large scale commercial sector has exhibited a relatively constant area under cane, but with an increase in orchard crops and bananas over this period.

[1] Conningarth Consultants. Unpublished report prepared for Nkomazi/Onderberg Water Action Committee (1997).

Table 1. Onderberg crop areas (hectares), 1991 versus 1997.

Year	Orchard sub-tropical	Bananas	Sugarcane	Summer vegetables	Winter vegetables	Grain
1991	7 175	3 409	24 297	599	3 004	4 351
1997	8 500	4 400	32 850	1 400	1 130	1 225

Source: Conningarth Consultants, 1997

Within the commercial sector, of the area under orchards, bananas and sugarcane, 65% is planted to cane, 23% to orchard crops and 12% to bananas. Factors such as microclimate and soils influence the type of crops that can be planted on a specific farm. The greatest restriction is probably on bananas, as reflected in the areas planted. The area under bananas has nevertheless shown the greatest increase from 1991 to 1997, and the reasons for this can possibly be related to the income derived from bananas.

Study motivation: agricultural risk

Risk in farm planning and research

Ortmann (1999) defines risk as 'the uncertain consequences of an action', and indicates that it is generally accepted that risk within the agricultural sector will increase. This can be attributed to deregulation within local and international markets as well as the diminishing role of government in agricultural support. Beside the impact of variable weather, fluctuating input and product prices, advancements in technology and rapid changes in government policy, domestic and international, are all factors that will result in greater risk being faced by the agricultural sector.

Studies done on a sample of commercial farmers by Stockil (1996) and Woodburn (1993) identified variability in gross income as one of the major categories of risk. This relates directly to yield and price variability. Stockil (1996) reported that 52% of respondents to the survey expected crop prices to fall in the future and 61% of the respondents believed livestock prices would decrease. The importance of changes in tax and government legislation has, however, increased in importance as a form of risk over the period 1993 to 1996 (Stockil, 1996).

A study of the liberalisation process followed by the New Zealand government has, on balance, assisted the agricultural sector (Stockil, 1996). Over 50% of the respondents in the Stockil (1996) and Woodburn (1993) surveys believed that free, unrestrained international trade would be beneficial to South African farmers.

This indicates that, while farmers appear to accept that trade liberalisation will open up opportunities that can be beneficial to their businesses in the long run, there is also a feeling that current changes within the country, as well as the world, will result in a greater degree of risk being faced by the agricultural sector.

Crop prices

In the future, crop prices are expected to decrease, or show greater variability, from season to season. Table 2 shows historical prices received for a number of crops produced in the Onderberg.

It is evident from the above table that crops sold predominantly within the country such as mangoes, bananas and sugarcane have shown an increase in price, in nominal terms, over the period in question. However, export crops such as the citrus varieties shown in Table 2, have experienced constant to declining nominal prices over the indicated time period.

Referring to Ortmann's (1999) definition of risk as 'the uncertain consequence of an action', the longer the time period from an action such as planting to the consequence of harvesting, the greater the risk associated with that decision. Orchard crops have a large time interval from plant to first harvest (three to five years) and this must increase the risk associated with these crops in comparison with crops such as bananas and sugarcane, with a year between plant and harvest.

Budgeting: farm purchase and farm expansion

Uncertainty is defined as 'imperfect knowledge caused by a lack of information' (Ortmann, 1999). Farmers' decisions relating to farm expansion or changing the mix of crops on the farm will be based on information collected from their own farm records, neighboring farms, magazines, research institutions, producer organisations and government. The first motivation for this study is to assess the risk profile of farmers within the Onderberg region as well as to emphasise the use of improved information in decision making at the farm level.

Table 2. Crop prices in the Onderberg, 1993 to 1997.

Crop	1993	1994	1995	1996	1997
Sugarcane (R/ton sucrose)	797,00	826,00	882,00	864,00	943,00
Valencia oranges (R/carton)	20,49	17,05	23,13	23,69	22,89
Grapefruit (Marsh) (R/carton)	18,51	21,31	20,43	20,51	10,05
Grapefruit (Star Ruby) (R/carton)	29,80	30,92	28,98	26,79	14,25
Bananas (R/ton)	945,00	1 520,00	1 128,00	1 672,00	1 455,00
Mangoes (R/ton)	1 819,00	1 699,00	2 179,00	2 472,00	

Sources: Anon (1997); [2]Personal communication; [3]Unpublished data.

[2] Outspan International, Nelspruit (1998).
[3] SA Cane Growers' Association, statistical data 1988-89 to 1997-98.

Table 3. Grapefruit: projected income and expenditure.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Land preparation	2 622					
Seed	3 010					
Fertiliser	267	690	690	690	690	690
Chemicals	682	524	1 680	1 680	2 857	2 857
Labour	573	2 024	2 326	2 930	3 762	4 114
Mechanical		383	383	383	383	383
Packaging			1 203	4 472	9 779	11 853
Energy	600	650	800	1 150	1 150	1 150
Other	559	559	559	559	559	559
Total costs	8 313	4 830	7 641	11 864	19 180	21 606
Yield/ha	-	-	6	18	33	40
Export %	-	-	30%	45%	60%	60%
Export tons	-	-	2	8	20	24
Local tons	-	-	4	10	13	16
Export income	-	-	3,000	13,500	33,000	40,000
Local income	-	-	622	1,465	1,954	2,368
Total income			3,622	14,965	34,954	42,368
Gross margin	-8,313	-4,830	-4,019	3,101	15,774	20,762

Table 3 gives a normal gross margin analysis that is generally used in decision making. The sources of this information vary from producer organisations to the Department of Agriculture in the form of COMBUD enterprise budgets. Gross margin is defined as the enterprise gross income less variable attributable costs (Barnard and Nix, 1988).

Variability in seasonal production (yield and quality) and product prices are not catered for in the projection of income and expenditure. The risk associated with planting the crop is thus excluded.

Table 4 is a further example of the information used in decision making. This is a gross margin analysis for a single season, based on the area average long term yield and quality trends. Costs of production are based on surveys over a large area within the Onderberg.

Water tariffs: risk in research

Water policy within South Africa is currently under review and a number of studies have been completed by research institutions, water boards and government investigating the issue of economic return per unit of water used by various crops. This research could influence future water policy decisions and have a negative influence on crops seen to have a low economic return per unit of water used.

A further motivation behind this study is to highlight the necessity for the inclusion of seasonal variability in income (risk) in assessing the long-term income from a particular crop.

Research methodology

Risk programming

Conventional linear programming models ignore uncertainty associated with yields, prices and costs. Farmers generally behave in a risk averse manner and are prepared to sacrifice income for less risk (Stockil, 1996). Linear programming has been developed to incorporate uncertainty and thereby generate risk efficient farm plans. These farm plans will be farmer specific, as risk is subjective. Individual farmers have different levels of risk aversion.

Table 4. Sugarcane gross margin.

Average sucrose price (R)	920,00
Tons per hectare	100
Sucrose %	13,80%
GROSS RECEIPTS	
Income (R)	12 696
ALLOCATED COSTS	
Ripener	80
Fertiliser/lime	1 255
Weedicide	350
Labour	1 489
Fuel/lubricants	260
Maintenance	716
Electricity	1 255
Harvest labour	600
Load	500
Transport	2 000
Levies	155
Total harvest costs	8 660
GROSS MARGIN PER HECTARE	4 036
GROSS MARGIN PER TON	40

Source: Unpublished data.

The most commonly used programming techniques include MOTAD and Baumol's L = E-Ø criterion (Barnard and Nix, 1988). The Baumol criterion is related to MOTAD and enables the user to derive a farm enterprise mix that has a certain probability of achieving a certain income. The implicit assumption is that the farmer wishes to maximise L, his estimate of utility, given his level of risk aversion.

In this analysis the MOTAD technique is used. MOTAD is concerned with fluctuations in gross margins. The objective function is the 'minimisation of total absolute deviations' in gross margins, hence the name MOTAD. Enterprise gross margin deviations from their sample mean are incorporated into the model. These deviations must always sum to zero for each activity. An E-A boundary can be determined by plotting expected income (E) against absolute deviation (A). Income is parameterised at specific amounts to develop a set of activity mixes. The risk level (A) is then plotted against the income level (E) to develop efficient risk-income (E-A) pairs. A farmer would, theoretically, restrict his choice to those farm plans for which risk (A) is a minimum for a given expected income (E) level.

Data collection

Farmers in the Onderberg were approached in order to obtain gross margins for various crops for an eight-year period. No farmer produces all the crops included in the study and it was necessary to source information from various areas within the Onderberg. Large farms with orchards in full production were chosen. No averaging of gross margins across various areas was done, as this would 'dilute' the risks associated with drought, wind or hail damage that a specific area experienced.

Table 5 lists the gross margins obtained for the various crops included in the study.

The crop mix (Table 6) is expressed in percentage terms due to the fact that only variable costs are included in the model. The crop percentages at the various risk levels can then be applied to any size farm, as no size economies of scale are applicable without the inclusion of fixed costs. The mean gross margin expressed as Rand per hectare is expectantly low at R4 300/ha for the risk averse plan, rising to R8 025/ha for the risk indifferent, profit maximisation plan.

Comparisons of the model solutions to actual farming practice in the Onderberg (Table 1) where, of the crops studied, 65% of the area is planted to cane, 23% to orchards and 12% to bananas, draws a distinct comparison to the risk averse, plan 1 in Table 6. The comparison relates specifically to the emphasis on cane as a risk diversifier. This is in line with agricultural literature that maintains that the farming sector generally behaves in a risk averse manner.

The risk indifferent plan indicates a farm planted totally to bananas. This can be expected given the returns obtained from bananas recently (Table 5). The general tendency within the Onderberg appears to be a move towards cane and bananas, where the establishment of bananas is possible. At all other risk levels the main crops that feature are cane, bananas and valencia oranges. The Onderberg climate favours the production of grapefruit over that of valencia oranges, hence the emphasis on grapefruit in practice.

Litchis and mangoes do not enter any of the solutions, possibly due to their low gross margin combined with large seasonal variations. Marsh grapefruit does not enter a plan and

Table 5. Gross margins for selected crops in the Onderberg (R/ha).

Crop	1991	1992	1993	1994	1995	1996	1997	1998
Sugarcane	592	3 664	4 881	7 349	3 700	4 191	5 275	5 568
Bananas	3 179	7 130	845	9 491	14 220	5 751	16 153	19 491
Litchis	1 403	2 711	1 031	3 429	6 481	341	3 503	16 164
Mangoes	2 644	2 261	164	2 354	3 512	830	3 307	2 043
Valencia oranges	8 493	7 747	5 633	2 676	5 292	13 577	-2 297	1 083
Grapefruit (Marsh)	6 120	507	5 339	9 655	4 669	857	-13 431	-10 803
Grapefruit (Star Ruby)	19 446	6 530	4 964	26 225	10 767	3 024	-7 652	-7 525

Table 6. Enterprise combinations at various risk levels.

Crop Mix	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5
Cane (%)	65,44	46,23	18,78		
Banana (%)	17,33	29,68	47,24	68,23	100,00
Litchi (%)					
Mango (%)					
Valencia orange (%)	17,23	24,09	33,79	30,27	
Grapefruit (Marsh) (%)					
Grapefruit (Star Ruby) (%)			0,19	1,50	
Mean gross margin (R/ha)	4 300	5 000	6 000	7 000	8 025

Star Ruby grapefruit only features slightly in plans 3 and 4. Grapefruit has recently experienced poor income due to low export prices. It can be argued that the specific study period does not do grapefruit justice, but the trend is evident and it is this trend that must be used in future planning.

Conclusion

The model results clearly indicate that risk is an important factor to consider when deciding on an enterprise mix. It is also evident that the Onderberg, on average, appears to consider risk, hence the establishment of cane as the most risk efficient crop in the area. The study clearly emphasises that care must be taken in basing decisions on a one-off enterprise budget that does not fully take into account the annual risk associated with that enterprise. Clearly, if income were the only consideration, only bananas would be planted, with the highest risk factor.

With respect to research pertaining to water use efficiencies and economic return per enterprise, the model clearly indicates the necessity for considering the risk factor associated with a particular crop. The annual income, based on 'best case' scenarios or average yield and quality figures, totally excludes the 'risk' of having one high income enterprise. Future studies could focus on the impact that water tariffs may have on the enterprise combinations given, through the use of a MOTAD risk model.

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Note: The opinions expressed in this paper are those of the author and do not necessarily reflect the opinions of the South African Cane Growers' Association.

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A COMPARISON OF THE ECONOMICS OF SUGARCANE PRODUCTION IN DIFFERENT WARDS IN THE SOUTH COAST AREA

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Abstract

South Coast growers supply cane to the Umzimkulu and Sezela mills. These mill areas are divided into "Coastal" growers and "Inland" growers. Conditions near the coast have higher temperatures and better rainfall, and thus are better for growing sugarcane, but "Inland" growers tend to grow better quality cane. In the Umzimkulu group, 60 percent of the cane supplied is grown inland and for the Sezela group, 40 percent.

The comparative profitability between different wards in the inland and coastal areas was estimated, based on profit per hectare per annum and taking into account the sucrose produced and general costs of production. Growers in coastal wards a better return per unit of land, so "Coastal" land under cane is expected to carry a higher market related price per hectare.

If accurate information were available over a sufficiently long period, this model could be of assistance in decision making to prospective land purchasers and financial institutions.

Keywords: sugarcane, production costs, profitability

Introduction

South Coast growers supply cane to the Umzimkulu and Sezela mills. These mill areas are divided into "Coastal" growers and "Inland" growers according to climatic conditions and topography.

Conditions along the coast tend to be warmer and have better rainfall than inland, and are thus better suited to growing sugarcane. However, "Inland" growers tend to grow better quality cane which matures over a longer period. For the Umzimkulu mill area, approximately 60 percent of the cane supplied is grown inland and for Sezela, approximately 40 percent.

Both mill areas are divided into wards based on homogenous areas. Sezela has seven wards (four coastal and three inland) and Umzimkulu eight wards (three coastal and five inland).

The profitability of sugarcane production in the different wards was estimated according to the sucrose price, mean variable costs and the assumption that fixed costs are constant in all wards. The relative value of the land can therefore be determined from these data.

Methods

Comparative profitability of the various wards must be estimated for an "average" hectare for each ward over a fixed period of time. In this model a *per annum* basis is used. It is then possible to estimate which area generates the most profit, taking into account sucrose yield and the costs of production over the twelve month period.

Coastal and inland wards differ mainly in respect of the length of the cutting cycle, cane quality and the distance to the mill.

Cutting Cycles

Coastal growers usually cut their cane over a 12 to 16 month cycle, whereas inland growers harvest their cane up to 24 months of age.

Cane quality

Inland growers generally have better quality cane, i.e. they produce more sucrose per ton of cane.

Distance to the Mill

As both mills are situated at the coast, inland growers incur higher transport costs.

As an example, if an inland grower produces cane over a 24 month cycle and cuts 100 tons cane/ha at 13% sucrose, his production over 12 months is 50 tons cane/ha or 6.5 tons sucrose/ha. This can be compared with a coastal grower, who produces 70 tons cane/ha at 12.5% sucrose, yielding 8.75 tons sucrose/ha/annum. There is therefore a positive difference in favour of the coastal grower of 2.25 tons sucrose/ha/annum. Although the inland growers produce better quality cane, coastal growers produce more sucrose per annum.

Results and discussion

Taking into consideration variable costs, including transport, and assuming that fixed costs per hectare are the same, the net profit/ha in each ward can be calculated, as shown in Table 1 (ward names have been omitted because of the sensitive nature of the information). Mean values for coastal and inland wards in the two mill supply areas are shown in Table 2.

The results show that coastal growers can expect a better return per hectare per annum on a fixed area of land over a fixed period of time, justifying a higher market-related value. Some caution is necessary, as data are available from

Table 1. Cane and sucrose yields and profitability of sugarcane production in different wards in the Sezela and Umzimkulu mill supply areas.

Ward	Cane/ha/ann (tons)	Sucrose/ha/ann (tons)	Gross margin (R/ha)	Ha equiv	R/ton cane
Ward 1 (Coastal)	68	8.4	3661	1.00	54
Ward 2 (Coastal)	66	8.0	3583	1.02	54
Ward 3 (Coastal)	64	7.8	3241	1.13	50
Ward 4 (Inland)	58	7.3	3148	1.16	52
Ward 5 (Coastal)	60	7.2	3018	1.21	52
Ward 6 (Coastal)	60	7.1	3012	1.22	50
Ward 7 (Coastal)	60	7.0	2854	1.28	52
Ward 8 (Inland)	53	6.7	2474	1.48	49
Ward 9 (Inland)	52	6.7	2460	1.49	47
Ward 10 (Coastal)	55	6.5	2335	1.57	39
Ward 11 (Inland)	50	6.5	2289	1.60	48
Ward 12 (Inland)	52	6.4	2209	1.66	45
Ward 13 (Inland)	49	6.2	2181	1.68	42
Ward 14 (Inland)	48	6.0	1804	2.03	38
Ward 15 (Inland)	48	5.9	1627	2.25	31

Table 2. Mean yields and comparative profitability of sugarcane production in coastal and inland wards in the Sezela and Umzimkulu mill supply areas.

Area	Cane/ha/ann (tons)	Sucrose/ha/ann (tons)	Gross margin (R/ha)	Mean ha equiv
Coastal	7.4	62	3101	1.20
Inland	6.4	51	2274	1.67

only one season for the Sezela Group and two seasons for the Umzimkulu Group. If data from a longer period were available (perhaps 10 years), this model could be of value to prospective land purchasers and financial institutions.

The usefulness of the model is dependent on growers providing accurate information on areas under cane and area harvested. Some growers have used a GPS mapping system, which is a more accurate method of measuring the area under cane than the old SASA mapping system. As the GPS system does not include loading zones, infield roads and perhaps waterways, the cane areas measured tend to "shrink" by an estimated 10%. It would be more acceptable if all growers were to standardize on GPS in the future.

The following points should be considered when considering the data in Tables 1 and 2.

- Data from only one season are available for the Sezela mill area and two seasons for Umzimkulu.
- Transport costs are based on charges quoted by the Umzimkulu Planters Co-op. Mean distances from farm to mill are used for each ward.
- The sucrose prices used were for the 1998/99 season.
- Capital costs, e.g. planting costs, were not considered.
- Management skills are assumed to be similar in all areas.
- Drought years will tend to favour inland growers as their crop is grown over a longer period, as experienced in the 1992-94 drought, therefore they are at lower risk during seasons with low rainfall.
- Coastal growers are more prone to damage from the eldana borer, but inland growers are more likely to suffer frost and hail damage.
- Coastal growers recover more quickly from unfavourable periods than inland growers, due to better growing conditions.
- Inland farms are generally less steep and therefore more amenable to mechanization.

Conclusions

The model enables a reliable value to be placed on farms in the South Coast region, which are based on their relative profitability per hectare per annum. Farm profitably was found to differ mainly between the coastal and inland areas, but also among wards in both the coastal and inland areas.

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