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ECONOMICALLY OPTIMAL MAIZE CULTIVAR SELECTION UNDER CONDITIONS OF RISK*

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ABSTRACT

A representative farm in the Western Transvaal was synthesised. The degree to which risk should be avoided was determined by simulation of general characteristics of the farm and controlled parameters, including four combinations of maize cultivar strategies, two management levels, three combinations of inflation and interest rates and two asset/liability ratios.

Cultivar strategies vary from one with a relatively high expected gross margin and associated high variation in gross margin to one with a relatively low expected gross margin and small variation therein.

Cultivar strategies have a highly significant effect on accumulated net worth. The effect of cultivar strategy is not influenced by the various inflation conditions or asset/liability ratios. Optimal cultivar strategy limits losses in poor years, but simultaneously produces a big enough expected gross margin to compete with other strategies. Farmers with liquidity problems should adopt a conservative strategy. Only in years without liquidity problems should a cultivar strategy with a higher expected yield and at the same time a higher probability of a loss be followed.

INTRODUCTION

Maize cultivars react differently in different environments. Environment is a complex concept and is influenced by a variety of factors and interactions. Due to uncertain climate, environment cannot be predicted with certainty for a production year. There is no certainty on the potential outcome of a specific cultivar selection. This complicates decision-making.

Expectations, preferences and financial management aspects play an important role in cultivar selection. Yield and price expectations are usually based on historical data or probability distributions, while preferences are determined mainly by personality characteristics and the financial circumstances of the producer.

In this study expectations are measured on the basis of adapted cultivar yields as reported in an earlier article (Van Zyl and Groenewald, 1986). (E-V)-frontiers were calculated for the different situations by using the MOTAD model.

The lower the expected gross margin on the (E-V) frontier, the smaller is the variation in gross margin. The point on the (E-V) frontier where a farmer is going to produce, is determined by his preferences. Preference is however a function of age, financial position, standard of living, social status and the goals of the farmer in general. The extent to which a farmer's actions will be risk-avoiding will and should therefore be determined by his circumstances.

A representative farm in the Western Transvaal was synthesised for the purpose of this study. The extent to which actions should be risk-avoiding was determined by the simulation of general characteristics of the farm.

Parts of a simulation model, developed by Eisgrüber (1965, according to Louw 1979:78) and adapted and refined by Patrick (Patrick and Eisgrüber, 1968) and Louw (1979), were used to simulate results with different combinations of maize cultivar strategies (4), management levels (2), inflation and interest rates (3) and asset/liability ratios (2).

The model starts with total assets of R985 259. Two types of situations with differences in liabilities and thus also net worth were however hypothesised. Certain solvency rations of the two farming situations are shown in Table 1.

TABLE 1 - Certain solvency ratios for operators with high and low asset/liability ratios

Ratio	Low asset/liability ratio	High asset/liability ratio
Net capital ratio	1,45	2,50
Leverage ratio	2,25	0,66
Own capital ratio	0,31	0,60

In this study three types of inflation are assumed, namely:

- No inflation as experienced in the period before 1967/68. This is analogous to a period during which all prices increase at the same rate.
- Output price inflation as experienced during the period 1967/68 to 1973/74, when produce prices increased more rapidly than input prices.
- Input price inflation as experienced since 1973/74 with input prices rising faster than output prices.

The situation is shown in Table 2.

*Based on a doctoral dissertation by J van Zyl of the University of Pretoria

**University of Pretoria, April 1985

TABLE 2 - Inflation rates used in the model

Inflation condition	Inflation rate (%) Group 1*	Group 2**
No inflation	0,0	0,0
Output price inflation	5,1	7,6
Input price inflation	14,9	10,7

*Group 1: Labour costs, cost of machinery and buildings, variable costs, land rent and consumption
**Group 2: Livestock inventory, livestock and produce sold and prices of land.

A constant inflation rate is assumed.

It is also assumed that the value of assets and expenditure on cost items will increase annually by the specified rates, and that interest on debt will be paid at rates indicated in Table 3.

Differential interest rates, as shown in Table 3, were used.

TABLE 3 - Interest rates in respect to various terms and inflation rates

Inflation condition	Interest rate (%) Long term	Medium term	Short term
No inflation	7,0	8,0	8,5
Output price inflation	7,0	8,0	8,5
Input price inflation	11,0	12,0	15,5

Two management levels, above-average and average management were taken into consideration. Yields for the above-average operator were equalised with cultivar trial yields with optimum fertilisation levels as calculated by Van Zyl, Geerthsen and Groenewald (1986). For the average farmer 20 per cent lower mean maize yields were chosen.

Four alternative cultivar combinations were assumed for each level of management. Each cultivar combination represents a different strategy. Yield data as obtained in cultivar trials at Potchefstroom, were used.

Strategies vary from one with a relative high expected gross margin and associated high variation in gross margin to one with a relatively low expected gross margin and small variation therein.

Experimentation with the different strategies over time under various constraints, initial situations, interest and inflation rates will give an indication of the best strategy under those circumstances. Strategies can also be varied.

Table 4 shows the various strategies for both above-average and average managers. All the strategies form part of an (E-V) frontier as determined by Van Zyl and Groenewald (1986). The position of each strategy on the (E-V) frontier is shown in Figure 1.

The expected gross margin and standard deviation from it are the highest for both management levels with Strategy 1 and the lowest with Strategy 4. Measured by the coefficient of variation (C.V.), Strategy 3 and Strategy 4 produce the most stable gross margin with above-average and average management respectively.

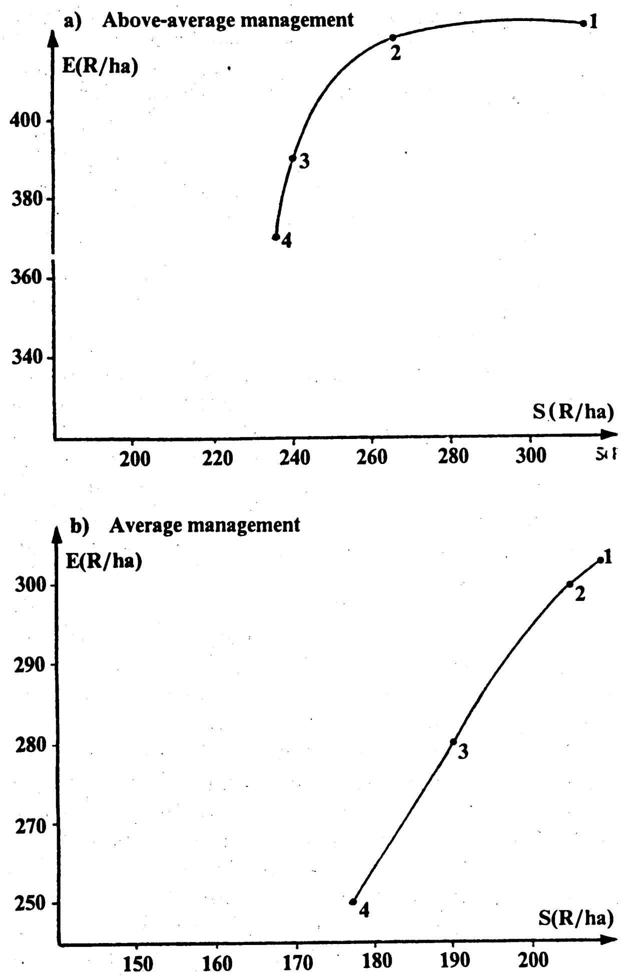

FIG. 1 - Position of the strategies on the (E-V) frontiers for above-average and average managers

The mean gross margin and its variation do not differ significantly between strategies at the same management level, not even at the 40 percent level of significance. All the strategies also form part of the stochastically effective set for the appropriate managerial level; not one of the strategies is stochastically dominated with respect to stochastic dominance of the third degree (Van Zyl and Groenewald, 1986).

In Strategy 1, the total available area is planted with the cultivar that yields the highest expected gross margin for the appropriate management level. Strategies 2, 3 and 4 consist of cultivar combinations only.

The coefficient of variation (C.V.) of physical yields associated with the strategies is consistently smaller than that of the gross margins. Yields are normally distributed for all the strategies with both average and above-average management.

Variable costs of the strategies vary because the variable cost of individual cultivars varies, particularly with respect to fertilisation (Van Zyl, Geerthsen and Groenewald, 1986).

Stochastic variation in maize yields occurs randomly. The IMSL routine GGUBFS was used for generating random numbers. Since the yields of strategies are normally divided, the MDNRIS routine of IMSL was used to generate pseudo-random normal deviations by the

TABLE 4 - Description of cultivar strategies for above-average and average management

Management	Strategy	Mean gross margin of strategy			Cultivars and % area planted with cultivar	Mean yield of strategy					
		$\bar{x}$ R/ha	Sx R/ha	CV %		$\bar{x}$ kg/ha	SX kg/ha	KV %	Normality W	Normality p<W	Skewness
ABOVE-AVERAGE MANAGEMENT	1	423	314	74,4	PNR95 100,0 %	4 451	1 795	44,4	0,9005	0,142	0,429
	2	420	265	63,1	PNR95 25,0 %; A471W 75,0 %	4 318	1 663	38,5	0,9162	0,262	0,236
	3	390	240	59,9	A471W 29,3 %; SSM48 70,7 %	4 163	1 506	36,2	0,9318	0,383	0,413
	4	370	235	62,5	SSM48 90,6 %; PNR88 7,3 %	4 045	1 494	36,9	0,9095	0,211	0,629
AVERAGE MANAGEMENT	1	303	209	68,5	A471W 100,0 %	3 550	1 306	36,8	0,9320	0,384	0,151
	2	300	205	68,5	A471W 93,2 %; SA4 6,8 %	3 527	1 293	36,7	0,9343	0,402	0,190
	3	280	190	68,1	SSM48 21,6 %; PNR88 28,7 %; A471W 49,7 %	3 413	1 200	35,1	0,9259	0,337	0,288
	4	260	177	67,1	PNR88 91,5 %; A471W 8,5 %	3 298	1 098	33,3	0,9205	0,296	0,164

transformation of uniform deviations to normal (0,1) deviations. Stochastic variation is obtained by generating a number randomly and relating it to the yield distribution of a given maize cultivar strategy.

Two approaches were followed. Firstly, the probability of specified changes in financial results of the undertaking was determined for each combination of factors by simulating 100 repetitions of every situation over a planning period of one year. In the second approach, each strategy was evaluated in terms of their average growth rate over a planning period of more than ten years.

Every situation was repeated 20 times in order to ensure a distribution of results. On grounds of certain solvency and liquidity considerations strategies were also alternated within the planning period.

FINANCIAL RESULTS IN YEAR ONE

The means, standard deviations and coefficients of variation of the change in net worth in year one are shown in Table 5.

From Table 5 it appears that Strategy 2 consistently produces the highest mean change in net worth after one year. This change in net worth is also, according to the coefficient of variation (C.V.), most stable for all the situations with a positive mean ($\bar{x}$) with average management. The change in net worth with above average management is the most stable with Strategy 3 for all situations.

Although Strategy 1, consisting of one cultivar, produces the highest expected gross margin per hectare of maize (see Table 4), the mean change in net worth is the highest with Strategy 2. Strategy 1 produces the second highest mean change in net worth with average management in all the situations, and with above-average management in Initial Situation 1 for the no-inflation and the output price inflation conditions. In the other situations with above-average management, Strategy 3 produces the highest means.

Strategy 4 consistently produces the poorest results. However, with above-average management the change in net worth is more stable with Strategy 4 than with Strategy 1.

Thus, it appears that Strategy 2 consistently produces the highest mean values, but that some values of Strategy 3 are more stable. However, in general the various means for the same situation are relatively close to each other with the different strategies.

The mean change in net worth is negative for all the strategies with average management and Initial Situation 2 at input price inflation. Thus it appears that Initial Situation 2 (low asset/liability ratio), in an input price inflation situation causes serious liquidity problems regardless of the strategy followed particularly for average managers. As the planning horizon lengthens and the cost price squeeze becomes more severe, it can be expected that liquidity problems will become more acute and that even established above-average managers can encounter liquidity problems. Although no initial solvency problems are foreseen, liquidity problems might eventually influence solvency, especially in two or three successive bad years. Even increases in the values of land might be too small to rescue the enterprise from insolvency.

From a liquidity viewpoint the probability of a certain net expendable income is of great importance. The probability of a specified net expendable income is shown in Table 6; in reality this represents the riskiness of the various strategies under varying circumstances. Liquidity considerations concern cash flow in particular and therefore the probability of a negative net expendable income is particularly important.

From Table 6 it appears that Strategy 3 yields the smallest probability of a negative net expendable

TABLE 5 - Mean ($\bar{x}$), standard deviation (Sx) and coefficient of variation (C.V) of the change in net worth for the different situations in year 1

Strategy	Inflation*	Initial situation**	Above-average management			Average management		
			$\bar{x}$ (R)	Sx (R)	CV (%)	$\bar{x}$ (R)	Sx (R)	CV (%)
1	0	1	51 694	118 727	229,7	21 051	82 147	390,2
1	0	2	41 144	122 091	296,7	9 980	86 607	867,8
1	1	1	60 057	126 632	210,9	26 968	87 027	322,7
1	1	2	49 612	129 794	261,6	15 966	91 191	571,2
1	2	1	42 231	134 218	317,8	8 018	94 377	1 177,1
1	2	2	23 227	140 467	604,8	(11 216)	102 573	914,5
2	0	1	55 025	92 823	168,7	21 414	76 756	358,4
2	0	2	45 486	95 524	210,0	10 674	81 217	760,9
2	1	1	63 310	98 999	156,4	27 250	81 252	298,2
2	1	2	53 610	101 475	189,3	16 603	85 386	514,3
2	2	1	46 740	105 011	224,7	8 700	88 399	1 016,1
2	2	2	29 628	110 529	373,0	(10 146)	96 701	953,1
3	0	1	51 226	80 043	156,3	16 921	69 185	408,86
3	0	2	42 131	82 581	196,0	6 618	74 064	1 119,1
3	1	1	59 056	85 333	144,5	22 425	73 026	325,6
3	1	2	49 783	87 591	176,0	12 104	77 473	640,1
3	2	1	42 917	90 711	211,4	3 973	80 278	2 020,7
3	2	2	26 210	96 178	366,9	(14 770)	89 219	604,1
4	0	1	45 573	78 607	172,5	12 318	63 460	515,2
4	0	2	36 317	81 476	224,3	2 400	68 932	2 872,7
4	1	1	52 916	83 721	158,2	17 330	66 736	385,1
4	1	2	43 747	86 251	197,2	7 446	71 674	962,6
4	2	1	36 605	89 354	244,1	(1 143)	74 248	6 495,9
4	2	2	19 451	95 291	489,9	(20 323)	83 653	411,6

**Inflation 0 = No inflation
Inflation 1 = Output price inflation
Inflation 2 = Input price inflation

**Initial situation 1 = High asset/liability ratio
Initial situation 2 = Low asset/liability ratio

income in all the situations with above-average management and high asset/liability ratios, while Strategy 2 has the smallest probability of a negative net expendable income in all the situations with average management and high asset/liability ratios.

Strategy 2 and Strategy 1 yield the smallest probability of a negative net expendable income for Initial Situation 2 (low asset/liability ratio) at all the inflation conditions with above-average and average management respectively.

It generally appears from Table 6 that Strategy 1 has the greatest probability of a high net expendable income. This probability decreases as one moves from Strategy 1 to Strategy 4.

From the results of year one it appears that Strategy 3 and Strategy 2 are generally best for above-average management and that Strategy 1 and Strategy 2 are generally best for average managers in the different situations.

CHANGE OF ACCUMULATED NET WORTH OVER TIME

In a stochastic model the time pattern of a specific variable will contain a distribution of results for every planning period (Louw, 1979:201). In this case the change of net worth over time was determined by simulating 20 replications of each situation. The present value of future net worth was calculated in order to be able to compare directly end net worth values under different inflation conditions. Discounting rates of 4 per cent, 7 per cent and 11 per cent were respectively used in the no, output-price and input-price inflation conditions.

Table 7 shows the mean, standard deviation and coefficient of variation of the present value of future net worth after 5,10 and 15 years. It appears that the coefficient of variation increases for all the strategies with above-average management from year 5 to year 10, but then decreases to year 15. Initial Situation 2 produces exceptions in the output price and input price inflation conditions. With output price inflation the coefficient of variation decreases steadily with Strategy 1 and 2, while it increases consistently in the input price inflation condition. The coefficient of variation reacts the same over time with average management, except in the input price inflation condition where it steadily increases with both Initial Situation 1 as with Initial Situation 2.

Table 7 also shows that with output price inflation, the present value of mean net worth increases over time in all the situations and strategies. With average management it decreases, however, over time in the no and input price inflation conditions, while with above-average management it also increases from year 5 to year 10, but then decreases to year 15 in the no and input price inflation conditions.

It can also be concluded from Table 7 that Strategy 3 and Strategy 2 produce the greatest present value of net worth over time with above-average and average management respectively

TABLE 6 – Probability of a specified minimum net expendable income for the different situations in year 1

Strategy	Inflation*	Initial Situation**	Above-average management													Average management												
			R180 000	R150 000	R120 000	R 90 000	R 60 000	R 30 000	R 0	-R 30 000	-R 60 000	-R 90 000	-R120 000	-R150 000	-R180 000	R180 000	R150 000	R120 000	R 90 000	R 60 000	R 30 000	R 0	-R 30 000	-R 60 000	-R 90 000	-R120 000	-R150 000	-R180 000
1	0	1	0,10	0,16	0,20	0,28	0,45	0,53	0,77	0,81	0,84	0,87	0,88	0,92	0,92	0,00	0,01	0,05	0,14	0,20	0,36	0,68	0,79	0,84	0,87	0,91	0,94	0,96
1	0	2	0,07	0,13	0,17	0,21	0,35	0,48	0,66	0,77	0,81	0,84	0,87	0,88	0,91	0,00	0,00	0,02	0,07	0,14	0,21	0,43	0,71	0,79	0,84	0,87	0,89	0,94
1	1	1	0,14	0,19	0,21	0,35	0,50	0,56	0,78	0,81	0,85	0,87	0,88	0,92	0,92	0,01	0,02	0,08	0,16	0,21	0,38	0,73	0,80	0,84	0,87	0,91	0,94	0,95
1	1	2	0,10	0,14	0,20	0,27	0,38	0,52	0,70	0,79	0,81	0,84	0,87	0,88	0,90	0,00	0,01	0,04	0,10	0,17	0,27	0,58	0,74	0,82	0,86	0,89	0,91	0,94
1	2	1	0,13	0,16	0,20	0,28	0,38	0,52	0,74	0,77	0,79	0,82	0,85	0,86	0,89	0,00	0,01	0,05	0,13	0,19	0,30	0,60	0,75	0,80	0,84	0,87	0,89	0,92
1	2	2	0,07	0,13	0,17	0,21	0,28	0,40	0,60	0,72	0,77	0,80	0,82	0,86	0,87	0,00	0,00	0,01	0,06	0,13	0,19	0,50	0,58	0,68	0,76	0,80	0,85	0,88
2	0	1	0,05	0,12	0,17	0,24	0,39	0,54	0,81	0,86	0,88	0,92	0,94	0,95	0,97	0,00	0,01	0,04	0,12	0,19	0,35	0,69	0,80	0,85	0,88	0,92	0,94	0,97
2	0	2	0,02	0,06	0,14	0,19	0,28	0,47	0,74	0,81	0,85	0,87	0,91	0,92	0,94	0,00	0,00	0,01	0,05	0,14	0,21	0,54	0,72	0,80	0,84	0,87	9,92	0,94
2	1	1	0,08	0,14	0,20	0,31	0,47	0,58	0,81	0,87	0,88	0,92	0,94	0,95	0,97	0,00	0,01	0,06	0,14	0,21	0,38	0,74	0,81	0,86	0,88	0,92	0,94	0,96
2	1	2	0,05	0,10	0,16	0,21	0,36	0,52	0,75	0,82	0,87	0,88	0,92	0,93	0,94	0,00	0,00	0,02	0,08	0,16	0,25	0,58	0,75	0,81	0,85	0,88	0,92	0,94
2	2	1	0,06	0,13	0,17	0,22	0,37	0,52	0,78	0,82	0,87	0,88	0,91	0,92	0,94	0,00	0,01	0,03	0,10	0,18	0,28	0,61	0,75	0,81	0,85	0,88	0,92	0,94
2	2	2	0,02	0,06	0,13	0,19	0,24	0,38	0,64	0,77	0,81	0,84	0,87	0,88	0,92	0,00	0,00	0,01	0,05	0,12	0,19	0,51	0,59	0,70	0,78	0,82	0,87	0,89
3	0	1	0,01	0,06	0,14	0,20	0,36	0,53	0,81	0,87	0,89	0,92	0,94	0,97	0,98	0,00	0,00	0,01	0,06	0,16	0,27	0,66	0,80	0,85	0,88	0,92	0,95	0,97
3	0	2	0,00	0,02	0,08	0,16	0,21	0,40	0,74	0,82	0,87	0,88	0,92	0,94	0,97	0,00	0,00	0,00	0,02	0,08	0,19	0,52	0,70	0,79	0,85	0,88	0,92	0,95
3	1	1	0,04	0,10	0,17	0,24	0,41	0,56	0,83	0,87	0,89	0,92	0,94	0,97	0,97	0,00	0,00	0,02	0,10	0,19	0,35	0,71	0,81	0,82	0,88	0,92	0,95	0,97
3	1	2	0,01	0,05	0,13	0,19	0,28	0,48	0,75	0,84	0,87	0,89	0,92	0,94	0,97	0,00	0,00	0,01	0,05	0,14	0,21	0,55	0,74	0,81	0,86	0,88	0,92	0,95
3	2	1	0,02	0,07	0,14	0,20	0,34	0,51	0,79	0,84	0,87	0,89	0,92	0,94	0,96	0,00	0,00	0,01	0,06	0,14	0,21	0,58	0,75	0,81	0,86	0,88	0,92	0,94
3	2	2	0,01	0,02	0,07	0,14	0,20	0,35	0,62	0,77	0,81	0,86	0,88	0,92	0,94	0,00	0,00	0,00	0,01	0,06	0,14	0,44	0,58	0,66	0,77	0,82	0,86	0,90
4	0	1	0,01	0,05	0,13	0,19	0,27	0,48	0,77	0,83	0,84	0,88	0,90	0,93	0,96	0,00	0,00	0,00	0,02	0,13	0,21	0,64	0,79	0,86	0,89	0,94	0,96	0,98
4	0	2	0,00	0,01	0,06	0,14	0,21	0,37	0,69	0,81	0,86	0,88	0,92	0,94	0,96	0,00	0,00	0,00	0,01	0,05	0,14	0,51	0,66	0,79	0,85	0,88	0,94	0,96
4	1	1	0,02	0,08	0,14	0,21	0,37	0,53	0,81	0,87	0,88	0,92	0,94	0,96	0,97	0,00	0,00	0,01	0,05	0,14	0,27	0,68	0,81	0,87	0,89	0,94	0,96	0,98
4	1	2	0,01	0,03	0,10	0,17	0,24	0,44	0,74	0,82	0,87	0,88	0,92	0,94	0,96	0,00	0,00	0,00	0,01	0,08	0,17	0,52	0,71	0,80	0,86	0,88	0,94	0,96
4	2	1	0,01	0,05	0,13	0,19	0,28	0,47	0,77	0,82	0,87	0,88	0,92	0,94	0,96	0,00	0,00	0,00	0,02	0,10	0,19	0,55	0,72	0,80	0,86	0,88	0,92	0,96
4	2	2	0,00	0,01	0,05	0,14	0,19	0,28	0,59	0,75	0,81	0,85	0,87	0,90	0,94	0,00	0,00	0,00	0,00	0,02	0,11	0,36	0,54	0,64	0,76	0,82	0,87	0,92

* Inflation 0 = No inflation
Inflation 1 = Output price inflation
Inflation 2 = Input price inflation

**Initial situation 1 = High asset/liability ratio
2 = Low asset/liability ratio

TABLE 7 – Mean ($\bar{x}$), standard deviation (Sx) and coefficient of variation (Cv) of the present value of net worth at different strategies and situations

Management	Inflation	Initial situation*	Measure	Year 0	Strategy 1 Year 5	Strategy 1 Year 10	Strategy 1 Year 15	Strategy 2 Year 5	Strategy 2 Year 10	Strategy 2 Year 15	Strategy 3 Year 5	Strategy 3 Year 10	Strategy 3 Year 15	Strategy 4 Year 5	Strategy 4 Year 10	Strategy 4 Year 15
ABOVE-AVERAGE MANAGEMENT	NONE	1	$\bar{x}$	591 843	508 550	601 591	597 214	591 932	696 645	705 741	608 898	700 347	706 124	590 459	664 441	661 356
			Sx	–	205 923	327 903	245 521	115 798	249 537	182 446	130 799	213 324	154 414	128 339	207 994	151 502
			Cv	–	40,59	54,51	41,11	26,00	35,82	25,85	21,48	30,46	21,87	21,74	31,30	22,91
		2	$\bar{x}$	303 618	178 595	279 082	291 595	263 773	376 605	406 977	281 916	382 306	412 057	263 484	347 432	368 091
			Sx	–	211 659	332 938	257 562	158 646	251 925	191 415	135 415	214 665	162 148	134 192	210 936	161 717
			Cv	–	118,51	119,30	88,33	60,14	66,89	47,03	48,03	56,15	39,59	50,93	60,71	43,93
	OUTPUT PRICE	1	$\bar{x}$	591 843	767 558	1 187 899	1 472 532	844 457	1 251 366	1 550 726	857 652	1 244 297	1 532 880	838 422	1 205 059	1 481 111
			Sx	–	211 385	380 069	244 170	158 301	286 018	181 464	135 020	255 617	153 445	131 879	248 607	149 740
			Cv	–	27,54	32,00	16,58	18,75	22,86	11,70	15,74	20,54	10,01	15,73	20,63	10,11
		2	$\bar{x}$	303 618	469 993	927 379	1 247 697	548 460	996 674	1 330 265	562 340	987 843	1 313 799	543 353	949 409	1 262 670
			Sx	–	215 532	379 946	247 728	160 991	281 239	182 545	136 970	254 308	153 562	134 467	246 874	150 002
			Cv	–	45,86	40,97	19,85	29,35	28,22	13,72	24,36	25,74	11,69	24,75	26,00	11,88
	INPUT PRICE	1	$\bar{x}$	591 843	670 858	749 065	539 847	744 466	828 740	659 897	758 121	830 160	667 761	740 667	799 118	623 163
			Sx	–	200 755	329 688	236 118	150 310	248 034	181 716	128 310	215 620	158 622	127 132	208 612	157 868
			Cv	–	29,93	44,01	43,74	20,19	29,93	27,54	16,92	25,97	23,75	17,16	26,11	25.33
		2	$\bar{x}$	303 618	378 435	493 861	292 348	454 664	577 764	417 290	469 691	582 055	425 188	451 976	549 350	378 136
			Sx	–	210 428	339 864	243 936	159 093	256 845	189 791	136 896	220 497	164 925	135 829	218 507	163 111
			Cv	–	55,60	68,82	83,44	34,99	44,46	45,48	29,15	37,88	38,79	30,05	39,78	43,14
AVERAGE MANAGEMENT	NONE	1	$\bar{x}$	591 843	491 633	491 015	449 174	505 215	500 500	464 635	507 650	493 168	447 642	506 507	478 466	426 837
			Sx	–	137 679	214 815	163 105	127 870	191 687	150 858	114 167	176 939	134 106	103 221	159 057	121 042
			Cv	–	28,00	43,75	36,31	25,13	38,30	32,47	2,49	35,88	29,96	20,38	32,26	28,36
		2	$\bar{x}$	303 618	162 799	173 107	153 130	176 986	184 544	171 470	180 175	180 174	159 103	179 547	167 627	140 946
			Sx	–	144 734	223 641	179 197	134 720	199 167	167 111	120 450	186 414	150 985	109 130	168 385	137 385
			Cv	–	88,90	129,19	117,02	76,12	107,92	97,46	66,85	103,46	94,90	60,78	100,45	94,47
	OUTPUT PRICE	1	$\bar{x}$	591 843	737 614	1 027 612	1 246 342	749 859	1 031 904	1 256 273	750 134	1 016 041	1 227 136	746 531	992 310	1 193 475
			Sx	–	138 187	243 937	153 512	127 845	219 856	141 291	113 263	1 200 979	123 336	101 383	178 393	108 603
			Cv	–	18,73	23,74	12,32	17,05	21,31	11,25	15,10	19,78	10,05	13,58	17,98	9,10
		2	$\bar{x}$	303 618	442 494	768 388	1 025 485	455 325	773 734	1 036 776	456 369	759 320	1 009 452	453 265	736 017	977 267
			Sx	–	144 360	246 403	160 088	133 949	219 820	147 101	119 417	202 881	129 420	107 464	180 399	115 055
			Cv	–	32,62	32,07	15,61	29,42	28,41	14,19	26,17	26,72	12,82	23,71	24,51	11,77
	INPUT PRICE	1	$\bar{x}$	591 843	647 789	645 686	406 363	659 688	651 773	421 277	660 150	643 367	395 590	657 698	624 439	362 423
			Sx	–	138 504	228 193	165 006	128 938	208 073	155 817	115 737	194 363	141 466	105 016	179 385	131 444
			Cv	–	21,38	35,34	40,61	19,55	31,92	36,99	17,53	30,21	35,76	15,97	28,73	36,27
		2	$\bar{x}$	303 618	356 219	389 318	149 750	368 667	396 239	164 472	368 767	385 067	135 061	365 953	362 785	96 671
			Sx	–	145 489	240 001	168 831	136 126	214 517	159 412	123 136	206 572	147 056	113 929	192 866	135 561
			Cv	–	40,84	61,65	112,74	36,92	54,14	96,92	33,39	53,65	108,88	31,13	53,16	140,23

* Initial Situation 1 = High asset/liability ratio
Initial Situation 2 = Low asset/liability ratio

in each situation. Thus it appears that, if net worth is taken as criterion, Strategy 3 produces the best results for above-average management and Strategy 2 the best for average management. From the stability point of view, as measured by the coefficient of variation, Strategy 3 is probably best for all the situations with above-average management, as well as in the input price inflation condition with average management. Strategy 4 however seems to be the most stable with no inflation and output price inflation at average management.

Mean present value of net worth differs significantly between strategies in only two instances; in both cases between Strategy 1 and Strategy 3 with above-average management, and no inflation. Variances in present value of net worth however differ more frequently significantly, especially between Strategies 1 and 3 and 4.

The riskiness of each strategy at the various situations is shown in Table 8 as the probability of insolvency after 5,10 and 15 years. It was assumed in the model that credit would be available as long as net worth was positive. Insolvency sets in when liabilities exceed assets. In practice liquidity problems will probably terminate production earlier.

Table 8 shows that the probability of bankruptcy within 15 years, irrespective of strategy, is virtually zero with Initial Situation 1 and is zero with Initial Situation 2 in the output price inflation condition. However, Initial Situation 2 produces bankruptcies with all the strategies with average management. This tendency is repeated for the average manager, except in the input price inflation condition where only Strategy 1 has a probability of insolvency. In general Strategy 1 is associated with the largest probability of insolvency.

From Tables 7 and 8 it appears that no strategy produces problems with net worth in the output price inflation condition. Problems are, however, experienced by average management especially in the no inflation condition. Although the initial solvency position of the farm is good with input price inflation, problems depending on the strategy followed, are experienced from about the fifth year. These problems are already earlier detectable with farmers with low asset/liability ratios (Initial Situation 2).

The above-mentioned phenomena are probably embedded in the nature of the three types of inflation and are strictly according to prior expectations. With output price inflation produce prices increase faster than input prices so that increasing growth can be expected over time. Input price inflation implies the opposite. The initial increase in net worth is however caused by the increase in the value of assets, especially land. As production losses increase over time as input prices increase faster than product prices, growth in net worth decreases and eventually becomes negative. The decrease in net worth with average management and no inflation implies that the relative relationship between input and produce prices is such that yields of average managers are too low to permit growth. This is analogous to the findings of Louw (1979) that if the high inflation condition of that period was to continue, the break-even point between input and output price inflation would be reached in the foreseeable future. It appears that this situation had already been realised for average managers at the beginning of the simulation period.

ANALYSIS OF VARIANCE

An analysis of variance was done to determine the effect and importance of the various factors that affect end net worth (after 15 years). Results are shown in Table 9.

It appears that the main effects differ significantly from zero, but that no interaction is significant. The only interaction approaching significance at an acceptable test level is the B x I interaction with average management. According to Jooste and Havenga (Louw, 1975; 77 & 78), the accent in the interaction of an analysis of variance must fall on the most significant set of higher order interactions. In this case only the main effects are significant. It can thus be concluded that the effects

TABLE 8 - Probability of insolvency after 5, 10 and 15 years at the different strategies and situations

Management	Inflation	Initial Situation*	Strategy 1 Year 5	Strategy 1 Year 10	Strategy 1 Year 15	Strategy 2 Year 5	Strategy 2 Year 10	Strategy 2 Year 15	Strategy 3 Year 5	Strategy 3 Year 10	Strategy 3 Year 15	Strategy 4 Year 5	Strategy 4 Year 10	Strategy 4 Year 15
ABOVE-AVERAGE MANAGEMENT	None	1	0,00	0,00	0,05	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
		2	0,25	0,25	0,25	0,05	0,15	0,15	0,00	0,05	0,05	0,05	0,15	0,15
	Output price	1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
		2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Input price	1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
		2	0,05	0,15	0,20	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
AVERAGE MANAGEMENT	None	1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
		2	0,15	0,25	0,30	0,10	0,20	0,20	0,10	0,20	0,20	0,10	0,20	0,20
	Output price	1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
		2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Input price	1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
		2	0,00	0,10	0,20	0,00	0,05	0,15	0,00	0,50	0,20	0,00	0,05	0,30

*Initial 1 = High asset/liability ratio
Situation 2 = Low asset/liability ratio

TABLE 9 - Analysis of variance of factors and their interactions that influence end net worth with average and above-average management

Source of variation	Above-average management			Average management		
	Degrees of freedom	F value	P < F	Degrees of freedom	F value	P < F
Main effects						
Initial situation (B)	1	200,80	0,0001	1	349,66	0,0001
Inflation rate (I)	2	1 807,69	0,0001	2	2 492,14	0,0001
Strategy (S)	3	7,80	0,0001	3	8,05	0,0001
Two-factor interactions						
B x I	2	0,88	0,4166	2	2,92	0,0547
B x S	3	0,01	0,9959	3	0,00	0,9990
I x S	6	0,48	0,8246	6	0,27	0,9493
Three-factor interactions						
B x I x S	6	0,00	1,000	6	0,01	1,000
Model	23	167,14	0,0001	23	232,64	0,0001
Error	456			456		
Total	479			479		
		Value			Value	
Coefficient of determination (R^2)		0,8939			0,9214	
Repeatability (R)		0,8926			0,9205	

of the factors are independent from each other. However, each factor separately has a highly significant influence on present value of end net worth.

It therefore appears that the effect of cultivar selection (strategies) on present value of end net worth is highly significant, but independent of inflation rate and initial asset/liability ratio. This is valid for both above-average and average management.

CHANGING STRATEGIES OVER TIME

The question arises whether better results cannot be obtained by changing strategies over time. It was therefore decided to base the variation of strategies over time on liquidity considerations.

Because of practical considerations only the two strategies with the smallest coefficient of variation for each management level were selected for this purpose. Strategies 2 and 3 were selected at both levels of managerial ability. Two alternatives are laid down. In Alternative 1 the operator follows the strategy with the smallest coefficient of variation (Strategy 3) every time when liquidity problems are experienced. If no liquidity problems are experienced, the strategy with the highest mean accumulated net worth (Strategy 2) is followed. In Alternative 2 the opposite is done. Hence Strategy 2 is implemented in years with liquidity problems, while Strategy 3 is followed in years without liquidity problems. Years with liquidity problems are defined as years that follow on those years in which not all short-term debts and obligations could be fully met.

The present values of accumulated net worth after 15 years for Alternatives 1 and 2 in the various situations are shown in Table 10. Results of Strategies 2 and 3 are added to facilitate comparisons. It appears that Alternative 1 consistently produces a higher mean present value of net worth in all situations. The standard deviations of these net worths are also consistently smaller with Alternative 1. This results in a smaller coefficient of variation (C.V.) of present value of net worth with Alternative 1 than with Alternative 2. Thus Alternative 1 is superior to Alternative 2, because of higher mean net worth values in each situation for Alternative 1 and also more stability of these net values under all situations.

Alternative 1 also consistently produces higher mean present values of net worth than Strategies 2 and 3, while those of Alternative 2 are consistently lower. With above-average management the coefficient of variation of both alternatives is smaller than that of Strategy 2, but higher than the coefficient of variation of Strategy 3. However, with average level of management the coefficient of variation with Alternative 1 is consistently smaller, and with Alternative 2 consistently larger than with both strategies. It therefore appears that Alternative 1 is a better choice than any of the strategies in all the situations with average management. With above-average management Alternative 1 has the greatest mean present value of net worth, but Strategy 3 has a smaller coefficient of variation and thus is more stable.

STOCHASTIC DOMINANCE

Differences between means and between variances with Alternatives 1 and 2 and Strategies 2 and 3 are not significant. Choices between alternatives and strategies is considerably complicated thereby and other considerations should also be taken into account. Stochastic dominance was thus used to choose meaningfully between alternatives and strategies.

According to this it appears that all the tested possibilities, namely Alternatives 1 and 2 and

TABLE 10 - Mean ($\bar{x}$), standard deviation (Sx) and coefficient of variation in present value of accumulated net worth after 15 years

Management	Inflation	Initial situation*	Measure		Alternative 1	Alternative 2	Strategy 2	Strategy 3
ABOVE-AVERAGE MANAGEMENT	NONE	1	$\bar{x}$	R	709 886	703 222	705 741	706 124
			Sx	R	166 415	170 251	182 446	154 414
			CV	%	23,44	24,21	25,85	21,87
		2	$\bar{x}$	R	412 811	406 816	406 977	412 057
			Sx	R	176 082	179 351	191 415	163 148
			CV	%	42,65	44,09	47,03	39,59
	OUTPUT PRICE	1	$\bar{x}$	R	1 551 725	1 532 141	1 550 726	1 532 880
			Sx	R	160 270	175 195	181 464	153 445
			CV	%	10,33	11,43	11,70	10,01
		2	$\bar{x}$	R	1 337 814	1 306 018	1 330 265	1 313 799
			Sx	R	165 722	173 297	182 545	153 562
			CV	%	12,39	13,27	13,72	11,69
	INPUT PRICE	1	$\bar{x}$	R	669 629	658 143	659 897	667 761
			Sx	R	169 604	172 246	181 716	158 622
			CV	%	25,33	26,17	27,54	23,75
		2	$\bar{x}$	R	427 617	415 508	417 290	425 188
			Sx	R	171 376	184 651	189 791	164 925
			CV	%	40,08	44,44	45,48	38,79
AVERAGE MANAGEMENT	NONE	1	$\bar{x}$	R	466 481	444 263	464 635	447 642
			Sx	R	138 610	146 195	150 858	134 106
			CV	%	29,71	32,91	32,47	29,96
		2	$\bar{x}$	R	171 904	155 298	171 470	159 103
			Sx	R	147 719	166 995	167 111	150 985
			CV	%	85,93	107,53	97,46	94,90
	OUTPUT PRICE	1	$\bar{x}$	R	1 265 342	1 222 868	1 256 273	1 227 136
			Sx	R	126 689	130 457	141 291	123 336
			CV	%	10,01	10,67	11,25	10,05
		2	$\bar{x}$	R	1 037 866	991 845	1 036 776	1 009 452
			Sx	R	131 717	143 226	147 101	129 420
			CV	%	12,69	14,44	14,19	12,82
	INPUT PRICE	1	$\bar{x}$	R	424 558	393 355	421 277	395 590
			Sx	R	144 165	155 431	155 817	141 466
			CV	%	33,96	39,51	36,99	35,76
		2	$\bar{x}$	R	165 614	130 938	154 472	135 061
			Sx	R	137 930	160 861	159 412	147 056
			CV	%	83,28	122,85	96,92	108,88

*Initial Situation 1 = High asset/liability ratio
Initial Situation 2 = Low asset/liability ration

Strategies 2 and 3, comply with the requirements of stochastic dominance of the first degree. Alternative 1 also consistently satisfies the requirements of stochastic dominance of the second and third degree, while Strategy 2 forms part of the second degree dominant set in all cases with average management, as well as with output price inflation at above-average management. Strategy 3 is part of the third degree stochastic dominant set in both the input price and no inflation conditions with above-average management.

From the above it can be concluded that Alternative 1 will probably be best in all situations.

CONCLUSION

Cultivar strategies have a highly significant effect on accumulated net worth. Interactions between strategies, inflation and initial situations (asset/liability ratio) are not significant; this implies that optimal cultivar strategy or the execution of any cultivar strategy is not influenced by type of inflation or initial situation (asset/liability ratios).

In general differences in mean net worth and variances of net worth are not significant between strategies at the 5 per cent level.

Although the expected gross margin per hectare of Strategy 1 is higher than any of the other strategies, it appears that the higher variance causes both Strategies 2 and Strategy 3 to perform better over time. Strategy 4 performs more poorly because the expected gross margin per hectare is too small to compete with the other strategies in enough years.

From the foregoing it may be deduced that cultivar strategy should therefore satisfy two conditions namely:

- The variance, or standard deviation, in gross margin must be small enough in a specific strategy to ensure that losses in less favourable years, and thus interest and loan obligations, are limited.
- Expected gross margin per hectare must be

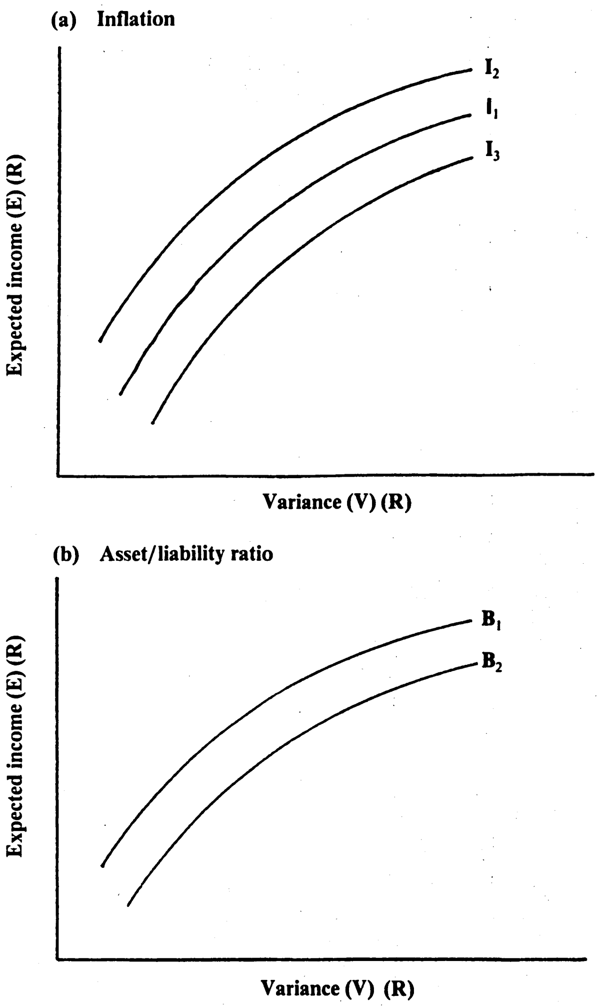

FIG. 2 - (E-V)-frontiers for different inflation conditions and asset/liability ratios

large enough to ensure that sufficient funds are generated to compete with other strategies.

Liquidity considerations also affect optimal cultivar selection. If the more stable Strategy 3 is followed in years with carry-over debts and Strategy 2 is followed in years with cash surpluses, the mean present value of accumulated net worth is consistently higher and the coefficient of variation usually smaller than any individual strategy. The opposite action using Strategy 2 in years with carry-over debt and Strategy 3 in years with cash surpluses produces a lower mean net worth, as well as less stable net worth values. This tendency seems to be valid regardless of management level or time of measurement of accumulated net worth. Although the mean accumulated net worth in both instances do not differ significantly from those of Strategies 2 and 3, the conservative alternative is consistently part of the third degree stochastic dominant set.

This implies that a farmer with liquidity problems should follow a more conservative strategy with a higher expected yield and at the same time a higher probability of a loss only in years without liquidity problems. It thus follows that farmers with liquidity problems should not try to recover by following an optimistic cultivar strategy.

The effect of inflation and the initial situation (asset/liability ratio) on cultivar strategy is shown in Figure 2. From this it can be concluded that parallel (E-V)-frontiers exist for different inflation types and different initial asset/liability ratios. This can be attributed to the insignificant interaction between respectively cultivar strategy and inflation, and cultivar strategy and initial asset/liability ratio.

The above inplies that (E-V)-frontiers are parallel at different asset/liability ratios and inflation rates. Cultivar selection is therefore much more simple than would otherwise have been the case, because only the expected revenue and variation thereof in a specific set of production conditions are necessary to determine the optimum cultivar combination for those production conditions.

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