FINANCIAL INTERPRETATION OF LONG-TERM SOYBEAN / MAIZE CROP ROTATION SYSTEMS

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A PROTEIN RESEARCH FOUNDATION PROJECT

FINAL ADDITIONAL REPORT

SEPTEMBER 2003

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EXECUTIVE SUMMARY

AIMS

The overall aim of this project was the financial interpretation by way of sensitivity analysis of crop rotation systems of soybeans and maize for typical farming situations based on ARC trial data from crop trials conducted at Bethlehem and Viljoenskroon in the Eastern and Northern Free State Province respectively.

METHODOLOGY

Based on the previous study “Crop Rotation Systems Incorporating Soybeans: An Economic And Financial Interpretation” prepared for the PRF in March 2002, this study is an extension, looking only at crop rotation systems including Soybeans and Maize. The following activities were conducted:

(i) The old model was restructured
(ii) The CEBs had to be updated
(iii) A Dynamic Linear Programming (DLP) optimisation model was included
(iv) Model runs were conducted
(v) The results were analysed and interpreted
(vi) The report was written

RESULTS

The typical farm for which the model was developed comprised 600 ha arable land suitable for maize and soybean production, with the soybean cropping area constrained to 25% or 150 ha, except in summary Figure 2 (**Error! Reference source not found.** in the report) where this constraint was relaxed to constrain soybeans to a maximum of 50% of arable land.

This report concludes that maize in rotation with soybeans financially outperforms monoculture maize for all reasonable price and nitrogen application rate scenarios tested. Model results confirm that soya in rotation is a financially viable crop for most soya/maize price ratios. Only at very high maize prices and / or very low soya prices is monoculture maize viable. This is however not sustainable over the long term due to soil depletion and pest build-up.

Where maize GMASC is below zero, planting only soya is the obvious financially optimal solution. However first and even second year GMASC of soybeans can be below zero, but soya in rotation will still be brought into the optimal solution, because of the beneficial effect on the following maize crop and the potential for better soya yields in subsequent years.

The following are the most important findings of this report:

Summary Table 1 (**Error! Reference source not found.** in the report) shows the minimum and maximum maize and soybean prices derived from the DLP model shadow prices, indicating the optimal crop compositions to plant within specified price boundaries. At soya prices of R1 600 & R2 000 / ton the maize price for example has to be greater than R1 363 & R1 599 / ton respectively (last column in Summary Table 1) to justify planting only monoculture maize. Regardless of the soya price, if the maize price is R 625 and less, it is not financially feasible to plant maize at all. It must however clearly be noted that these values cannot be used as a norm for all farms as they are very sensitive to changes in the CEB, which vary considerably from farm to farm. A sensitivity analysis on the exact prices of maize and soya proves to be difficult to conduct for a specific farmer because of the multitude of factors that affect the GMASC of both maize and soybeans. It is therefore suggested that if a farmer wants a sensitivity analysis in order to make a decision he should apply the model to his specific circumstances.

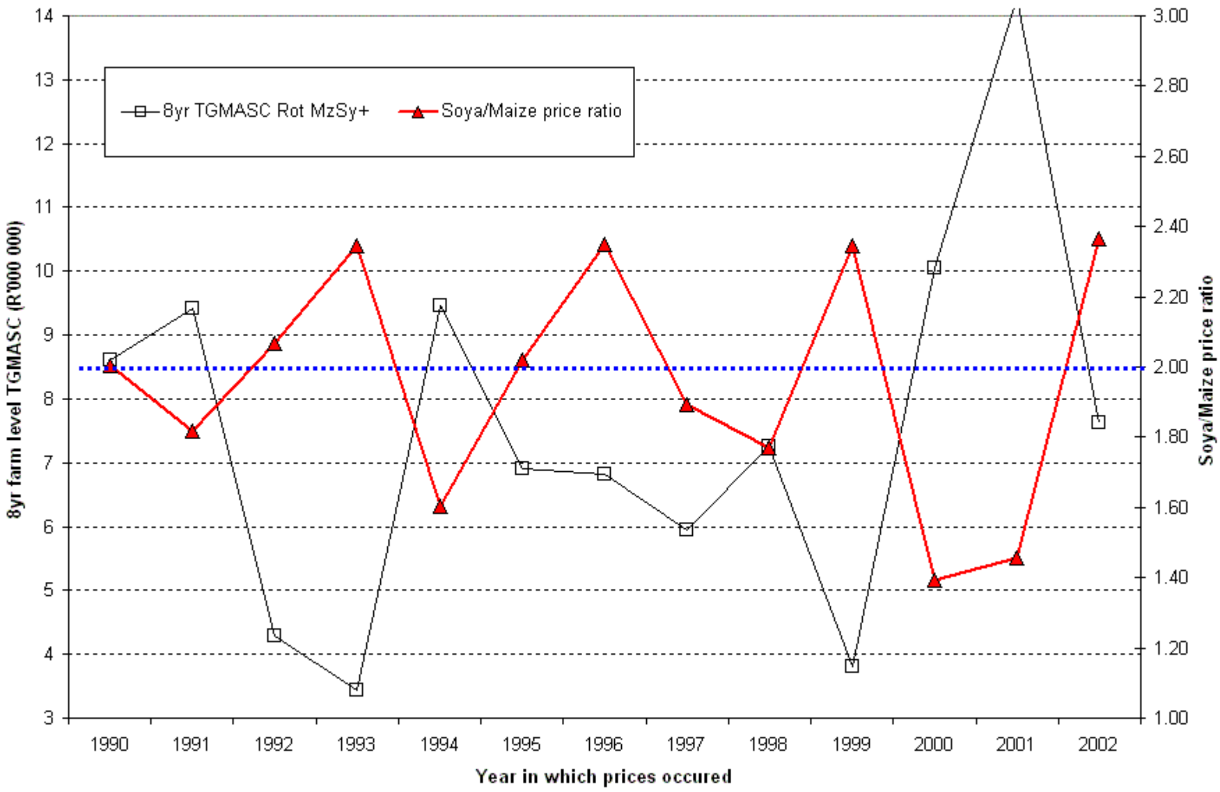
Summary Table 1. Results from the DLP model: shadow prices indicating crop price boundaries for optimal rotations. Nitrogen application rate 50 kg / ha for monoculture maize and 30 kg / ha for maize in rotation with soybeans

Soya Price (R/ton)	Maize Price (R/ton)	Rotation (Mz=Maize in ha, S=Soya)	TGMASC 8yr Cumulative R/farm	Maize Price Max +	Maize Price Max -
1 600	625	Mz 0 - S150 1,2,3,4,etc	2 728 813	626	∞
1 600	1 250	Mz 450 - S150 1,2,3,4,etc	10 347 751	1 490	645
1 600	1 360	Mz 450 - S150 1,2,3,4,etc	11 690 679	1 386	648
1 600	1 500	Mz 600 - S 0	14 228 064	∞	1 363
2 000	625	Mz 0 - S150 1,2,3,4,etc	3 934 813	626	∞
2 000	800	Mz 450 - S150 1,2,3,4,etc	6 059 952	1 832	631
2 000	1 520	Mz 450 - S150 1,2,3,4,etc	14 850 030	1 838	653
2 000	1 600	Mz 450 - S150 1,2,3,4,etc	15 826 706	1 841	655
2 000	1 850	Mz 600 - S 0	19 925 338	∞	1 599

*Mz 450 – S150 1,2,3,4,etc refers to planting only Maize (Mz) on 450 ha and Soya (S) year after year on the same 150 ha. The DLP model being linear was not able to calculate the soya on soya effect on yield increase and thus the simulation model was used for that purpose – The DLP model was however useful to generate shadow price values.

In Summary Figure 1 (or **Error! Reference source not found.** in the text), the soya / maize price ratio and long-term financial results (TGMASC) are depicted. Caution must be taken not to interpret this figure as, that there is a negative correlation between high soya /maize price ratios (i.e. soya price is greater than twice the maize price) and the long-term TGMASC.

This inverse relationship occurs as a result of the dominance of the maize price in the model and the fact that the area that can be planted to soybeans is constrained to 25% of total arable land. Poor financial results are thus a factor of a poor maize price (in relation to the soya price) and not due to a



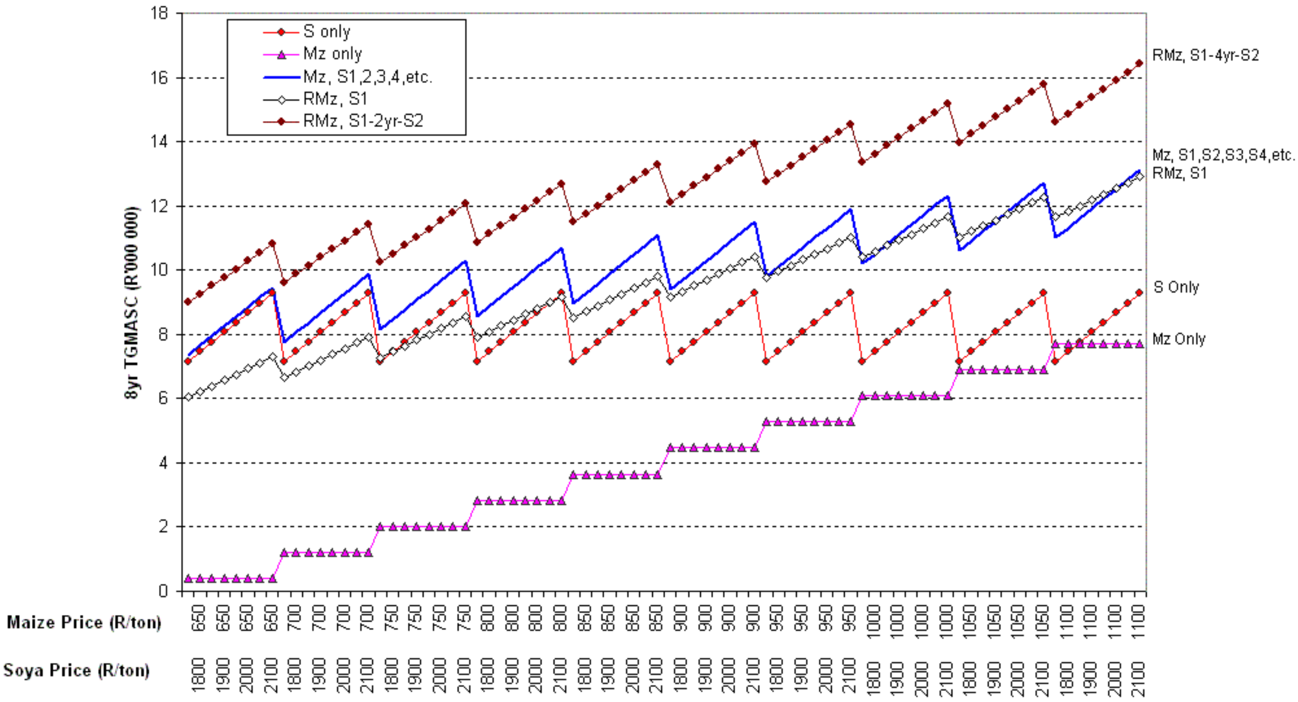
high soya price. With a high maize price and a high soya / maize price ratio very good financial results can still be obtained.

Summary Figure 1. The effect of the actual Soya / Maize price ratio for the years 1990 to 2002 on the farm level 8yr TGMASC (each years results are an 8 year model run using only that years prices)

Results displayed in the form of a graphic sensitivity analysis of the calculated 8 yr TGMASC in Summary Figure 2 (see **Error! Reference source not found.** to **Error! Reference source not found.** in the report) summarize the relative profitability of different crop rotation systems. Summary Figure 2 clearly shows that rotation maize with an improvement in soya yield after every second year (RMz, S1-2yr-S2) outperforms:

a) rotation maize where soya yield is not adjusted (RMz, S1),
b) mono-cropped maize and soya planted in the same fields each year with soya yields increasing year after year (Mz, S1,2,3,4,etc.),
c) maize only on all the land (Mz only) and
d) soya only on 50% of the land (S only).

Monthly cash flow and discounting are not included in these analyses. This is done in the simulation model.



Summary Figure 2. 8-yr TGMASC sensitivity analysis results with R50 intervals in the maize (Mz) & soya (S) prices, Soya ranging from R1 750 – R2 100. Nitrogen application rate for mono-maize (Mz) is 50 kg / ha & for rotation maize (RMz) 50 kg / ha. Max Soya = 50%. CEBs are based on 2002 prices

In conclusion, the maize price is clearly the dominant factor in the analyses' conducted in this study, as the maize price has the greatest influence on the TGMASC for the farm, especially when soybeans are also grown in rotation. Another important factor was the Nitrogen (N) application rate difference between monoculture and rotation maize used in the model – if the same nitrogen application rate is used for monoculture and rotation maize model results clearly show that crop rotation yields better financial results, but if nitrogen application rates are reduced on rotation-maize, financial results are more sensitive. Over and above the unquantified benefits of reduced risk, the use of less synthetic chemicals and nitrogen, the improved sustainability of the soil and a better spread and utilization of the mechanization component, the incorporation of soybeans into a crop rotation system with maize, for a typical farm in the Northern and Eastern Free State, dramatically improves the financial efficiency of the farm over the long term.