

**FINANCIAL INTERPRETATION OF LONG TERM SOYBEAN
MAIZE CROP ROTATION**

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With the increases in input prices over the years, producers had to start thinking out of the box for ways to improve their profitability. An option that exists for crop producers is to incorporate an additional crop in the yearly schedule. Adding an additional crop to the schedule, especially a crop that puts back valuable elements into the soil, is an advantage to the following crop. One such crop rotation system that is currently used in South Africa is a maize-soybean rotation. Previous studies incorporating a maize-soybean rotation system have found that it is an advantage to farming systems to incorporate a rotation system. Producers that are currently incorporating these rotation systems were consulted to obtain data about the production process of the rotation system in the northern and eastern Free State. These data were then analyzed using a linear programming model to optimize the return over a period of eight years. A sensitivity analysis, to determine the sensitivity of the rotation system to different maize and soybean prices, also indicated that the Gross Production Value (GPV) for incorporating the rotation system, provides a bigger advantage to the farm. Results indicated that it is to the advantage of the producer to incorporate the rotation system as the GPV over the eight years is higher than when a monocropped maize system is used. The advantage does have certain requirements, according to expert meeting panels, such as certain price ratios between maize and soybean prices.

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



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OUTLINE

- Introduction
- Aims
- Study area
- Data used and DLP model
- Results
- Sensitivity
- Sensitivity summary
- Conclusions

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INTRODUCTION



- **Project begin** (2002) – Crop rotation system incorporating Soyabeans: an economic and financial interpretation (Armour en Viljoen, 2002).
- Soybean production extensively research in RSA
- Beneficial effect of legumes in production system
- Improved performance by follow up crops
- **PROBLEM STATEMENT**
 - **To build a linear programming model to mathematically optimise financial returns of crop rotation over an 8 year cycle.**



- The financial interpretation of crop rotation systems incorporating only soybeans and maize for typical farming situations
- The construction of a DLP model:
 - To aid in selecting the optimal cropping combination within a crop rotation system over the long term; and
 - Use DLP model to construct a sensitivity analysis,
- sensitivity analysis indicate the effect of the maize price, and the ratio of the soya to maize prices, on the optimal crop rotation system.

STUDY AREA



- Eastern and Western Free state
- Mpumalanga (no till vs. conventional)





DLP MODEL AND DATA USED

- Meetings with farmers to obtain real world data
- Development of scenarios
- Maize price – R 2 409
- Soybean price – R 4 400
- Maize rotation premium – producing better quality /grade maize

DLP MODEL AND DATA USED



	Eastern and Western Free State	Mpumalanga
Farm size	600 ha	800 ha
Maize rotation premium	5%	0%
Yields		
Maize	5 t/ha	5.5 t/ha
Soybeans	1t/ha – 2.5 t/ha	2.3 t/ha
Maize in rotation	5.65 t/ha	7 t/ha
Discount factor	10 %	

SCENARIOS



- **Scenario 1** – Producing maize and soybeans from year 1, with a maximum soybean production of 25%. This scenario is forced to plant soybeans from year 1.
- **Scenario 2** – All the aspect of scenario 1 with the soybeans restriction 50 %.
- **Scenario 3** – Producing maize and soybeans, but the soybeans are produced for two consecutive years before maize in rotation are produced.
- **Scenario 4** – Basis scenario of producing monoculture maize.

DLP MODEL



- Objective function: **Maximize 8-yr TGMASC**

- **Max 8-yr TGMASC** = $\sum_i \sum_t C_{it} \cdot X_{it}$

- Subject to the following constraints:
- $\sum_i \sum_j \sum_t a_{ijt} \cdot X_{jt} \leq, \geq \text{or} = R_{jt}$
- Non-negativity constraint:
- **all $X_{it} \geq 0$;**
- Where: C_{it} are the simulated GMASC for each crop in each year
- X_{it} are the decision variables i.e. how many ha of crop with GMASC C_{it} to plant?
- a_{ijt} is the coefficient matrix linking X_{it} and R_{jt}
- R_{jt} are the constraints j for each time period t (j = 1 to 4 and t = 1 to 8)
- j = 1 is the total land constraint (**Land yr t = 1..8**)
- j = 2 is the Max Soya constraint (**Max Soya t = 1..8**)
- j = 3 is the soya and maize on soya balance (**Bal S+MS t = 1..8**)
- j = 4 is the permission to transfer soya t to soya t+1 (**Perm S_t to t+1**)



- | | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
|-------------------|--------|--------|--------|--------|--------|-------|--------|--------|--------|--------|--------|
| | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% |
| | 6362 | 1490 | 6362 | 5968 | 1490 | 8879 | 6362 | 7162 | 5968 | 1490 | 8879 |
| | Y1 | | Y2 | | | | | Y3 | | | |
| | 450 | | 300 | | | | | 300 | | | |
| | 0 | | 150 | | | | | 150 | | | |
| | 150 | | 150 | | | | | 150 | | | |
| | M | S1 | M | S2 | S1 | MS | M | S3 | S2 | S1 | MS |
| Crop GMASC | 5783,6 | 1354,5 | 5257,9 | 4931,8 | 1231,4 | 7338 | 4779,9 | 5380,5 | 4483,5 | 1119,5 | 6670,9 |
| Decision variable | 450,0 | 150,0 | 300,0 | 150,0 | 0,0 | 150,0 | 300,0 | 150,0 | 0,0 | 0,0 | 150,0 |
| Land 1 | 1 | 1 | | | | | | | | | |
| Land 2 | | | 1 | 1 | 1 | 1 | | | | | |
| Land 3 | | | | | | | 1 | 1 | 1 | 1 | 1 |
| Max Soya 1 | | 1 | | | | | | | | | |
| Max Soya 2 | | | | 1 | 1 | | | | | | |
| Max Soya 3 | | | | | | | | 1 | 1 | 1 | |
| Soya 1 | | 1 | | | | | | | | | |
| Soya 2 | | | | 1 | 1 | | | | | | |
| Soya 3 | | | | | | | | 1 | 1 | 1 | |
| Total Maize 1 | 1 | | | | | | | | | | |
| Total Maize 2 | | | 1 | | | 1 | | | | | |
| Total Maize 2 | | | | | | | 1 | | | | 1 |
| Max Maize R | | | | | | 1 | | | | | |
| Max Maize R | | | | | | | | | | | 1 |
| Max Maize R | | | | | | | | | | | |
| Soya perm 1-2 | | -1 | | 1 | | | | | | | |
| Soya perm 2-3 | | | | -1 | | | | 1 | | | |
| Soya perm 1-2 | | | | | -1 | | | | 1 | | |
| Soya perm 3-4 | | | | | | | | -1 | | | |
| Soya perm 2-3 | | | | | | | | | -1 | | |
| Soya perm 1-2 | | | | | | | | | | -1 | |
| Soya Maize 1-2 | | 1 | | | | -1 | | | | | |
| Soya Maize 2-3 | | | | 1 | 1 | | | | | | -1 |
| Soya Maize 3-4 | | | | | | | | 1 | 1 | 1 | |
- GMASC R 22 474 741,45

RESULTS



- Eastern Free State
- Best Scenario – scenario 2, highest percentage of soybeans
- All scenarios better than producing mono culture maize

	TGMASC discounted (R)	TGMASC normal (R)
Maize only	14 118 657	21 171 662
Scenario 1	14 757 934	22 630 207
Scenario 2	15 397 230	24 088 752
Scenario 3	13 782 958	21 062 730

RESULTS CONT..



- Western Free State
- Best scenario – scenario 2
- All rotation scenarios better than monoculture maize

	TGMASC discounted (R)	TGMASC normal (R)
Maize only	14 018 265	21 021 120
Scenario 1	14 521 261	22 252 775
Scenario 2	15 024 257	23 484 430
Scenario 3	13 541 088	20 676 958



RESULTS CONT....

- Mpumalanga
- No till vs. conventional
- Best scenario – Scenario 2

	Conventional		No till	
	TGMASC normal (R)	TGMASC discounted (R)	TGMASC normal (R)	TGMASC discounted (R)
Maize only	16 697 142	11 134 753	22 780 879	15 191 788
Scenario 1	23 064 120	15 213 193	28 796 318	19 035 823
Scenario 2	27 30 772	17 932 153	32 806 610	21 598 513
Scenario 3	19 225 258	12 811 685	25 045 663	16 692 329

SENSITIVITY



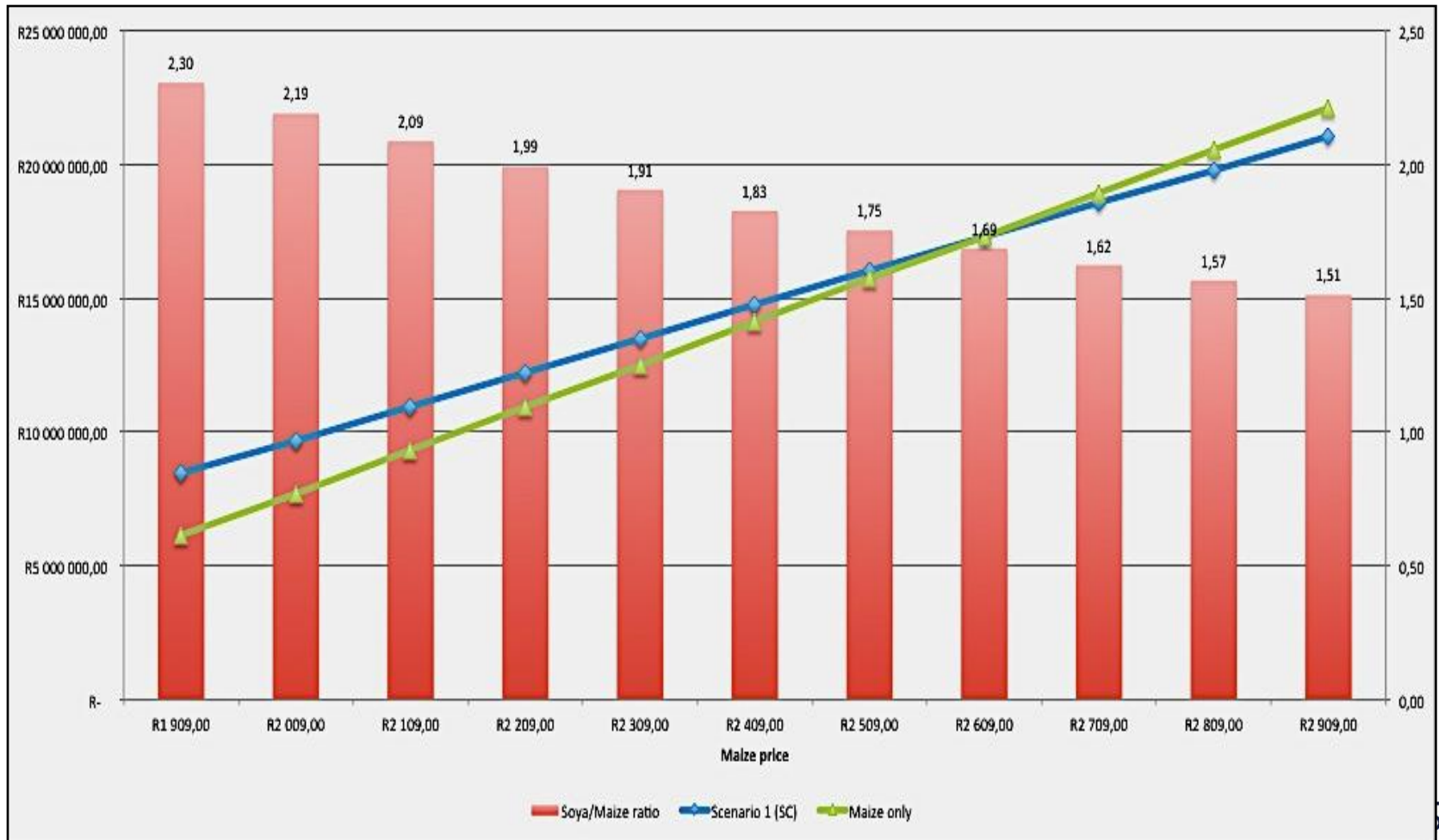
- Variations in maize and soybean prices
- Effect on TGMASC????
- Assumptions for sensitivity analysis

		EFS	WFS	MP Conv	MP NT
Yields (t/ha)	Soybeans	1 – 2.5 over 8 years	1 – 2.5 over 8 years	2.3	2.3
	Mono Maize	5	5	5.5	5.5
	Rotation maize	5.65	5.65	7	7
Maize price		Variable in R 100 interval		Variable in R 200 interval	
Soybean price		R 4 400			

SENSITIVITY EASTERN FREE STATE



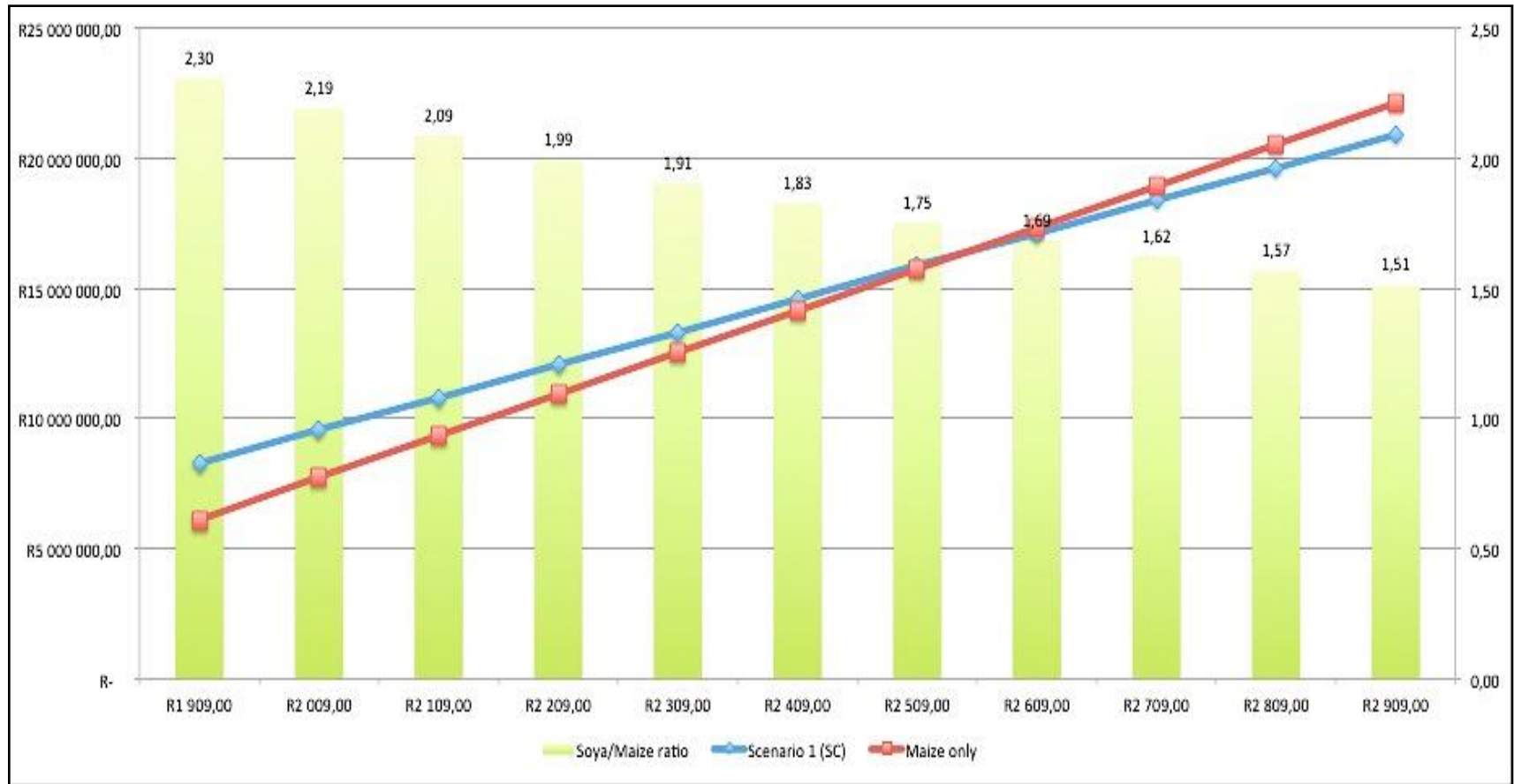
- Variable maize price, constant soybean (R 4 400)



SENSITIVITY WESTERN FREE STATE



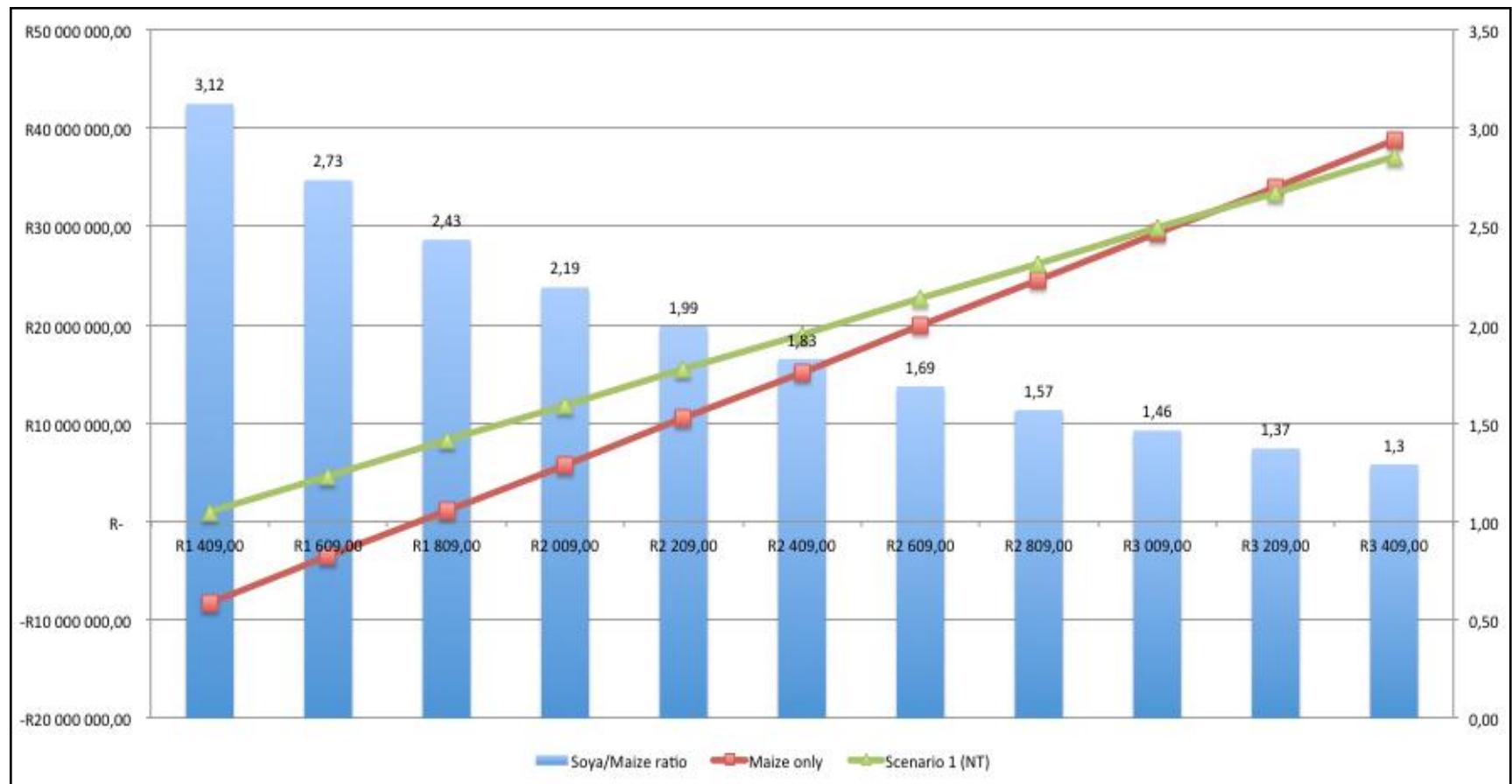
- Variable maize price, constant soybean (R 4 400)



SENSITIVITY MPUMALANGA (NO TILL)



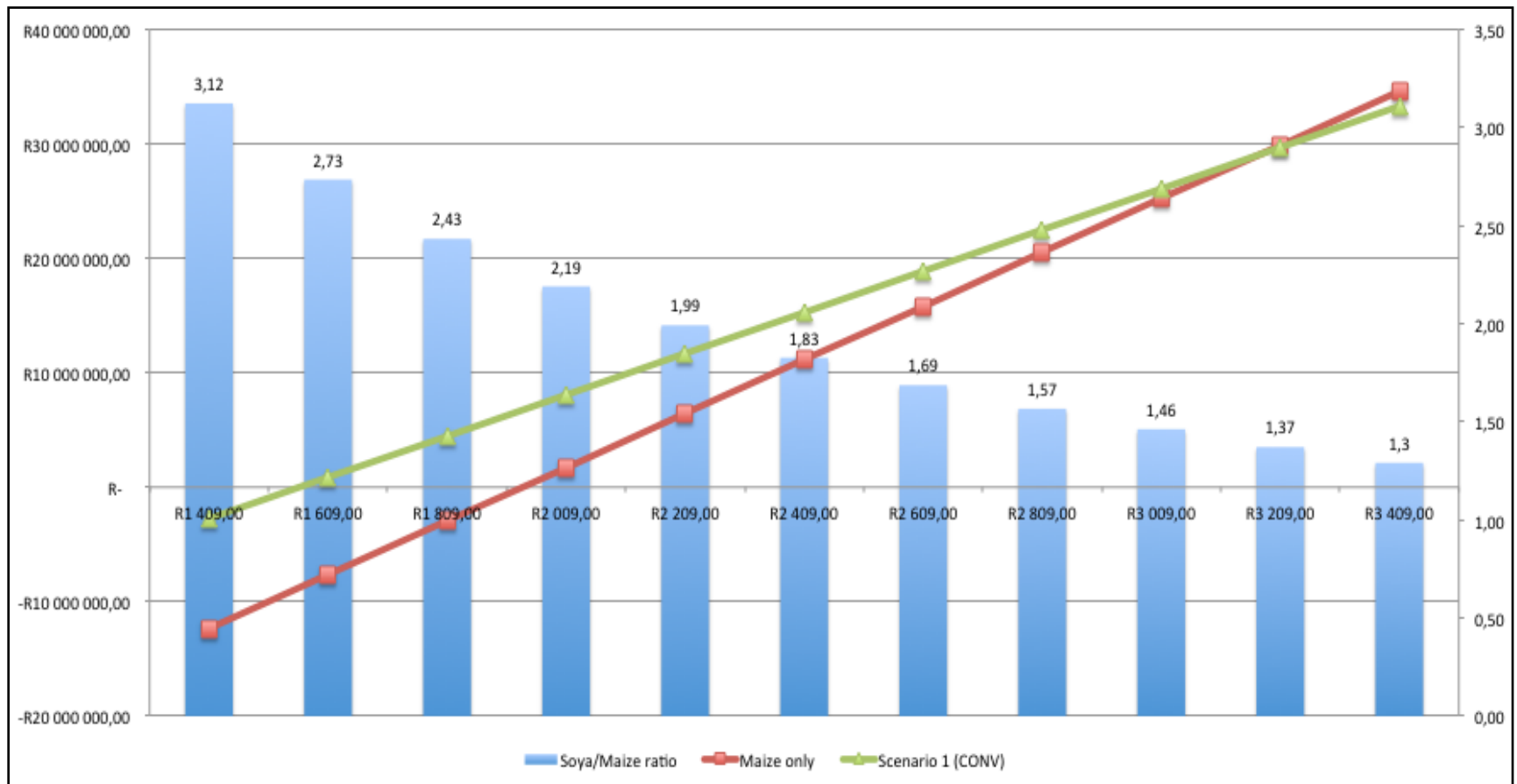
- Variable maize price, constant soybean (R 4 400)



SENSITIVITY MPUMALANGA (CONVENTIONAL)



- Variable maize price, constant soybean (R 4 400)





SENSITIVITY SUMMARY

- Sensitive to production costs
- Guidelines for decision making implementing rotation system
- Soybean prices to maize ratio summary table

	EFS	WFS	MP Conv	MP NT
Price ratio	1.69-1.75	1.69-1.75	1.37-1.46	1.37-1.46

SUMMARY AND CONCLUSION



- Maize in rotation outperforms mono culture maize
- Costs of production and yield performance important
- Soybean prices must be between 1.4 to 1.75 times the price of maize
- Maize in rotation, by incorporating soybean in production does improve financial results

Thank You Dankie

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