CHAPTER 6

THE DEVELOPMENT OF A MARKETING DECISION SUPPORT SYSTEM FOR GRAIN PRODUCERS

'There is such a choice of difficulties that I am myself at a loss how to determine.'

- Robert Lowth (1710 – 1787)

6.1 INTRODUCTION

The previous chapters have paved the way for the development of a model to assist producers in managing investment risk by optimising the use of the various marketing instruments available to producers. In this study, the model, which is presented in this chapter, is called a marketing decision support system (MDSS). The MDSS includes many, although certainly not all, dimensions of a farm portfolio, concentrating on crop production. The decision alternatives will apply to grain producers rather than to processors or middlemen. At present, producers can market their crops in three different periods. They can sell their crops before harvest, using forward contracts, futures contracts and options on futures contracts; or they can wait and sell in the spot market at or after the harvest.

The general principle underlying portfolio theory is a well-known principle of risk management (Huang & Litzenberger, 1988). The decision-maker, or producer, selects the composition of the farm's portfolio with the aim of maximising expected utility. In this study, utility is assumed to refer to profitability. Utility depends on wealth, and future wealth depends on future returns from the portfolio. Future returns, however, are uncertain. Thus, for the purposes of the study, the farm portfolios are assumed to be those of diversified producers of multiple crops rather than of just single crops. Since assets and liabilities are an integral part of all portfolios, allowance is made for the possible effects of debt and credit on the choice of producers' marketing instruments.

The dynamics of production and price information and their influence on marketing decisions are mimicked through an updated dynamic (the time variable is explicitly contained in equations) deterministic control approach. A deterministic model is one that makes definite predictions for quantities without any associated probability distribution. The MDSS employs a series of open-loop control problems, each of which is solved while assuming that in each period no additional information is forthcoming. This assumption is however, revised after each period, when the information is directly observable (Gad & Ginzberg, 1991). This means, for example, that the producer uses the information available at planting time to plan the marketing of a certain percentage of the expected output and then implements the decisions that seem most appropriate to the planting period. Later, at the growing stage, an additional plan is made using the information available at that point in time, again marketing a further percentage of the expected output. Similar revisions and actions occur during the later growing stages and at harvest. During these later periods, the rest of the expected crop can either be sold or stored for later selling in the spot market. Such an approach reflects the fact that multiple marketing decisions, dependent on evolving information, are made throughout the whole production-marketing period.

The Free State Province was used as the location where the data necessary to test the MDSS was gathered. The chapter begins with a detailed discussion why the Free State Province was selected and which statistical regions in the Free State were finally used to collect the data from. The discussion of the analytical model begins with an explicit statement of the model's underlying assumptions and definitions. This is followed by the development of a decision criterion that includes both production and price uncertainty. This criterion in turn yields marketing strategies implied by decision rules. Finally, the solution of the model provides a framework for a discussion of the expected qualitative effects of an individual farm's characteristics on marketing decisions.

6.2 DATA

6.2.1 Farm unit prototypes

In order to test the ability of farmers to manage risk and market astutely by using forward markets and derivatives markets, farm prototypes which epitomise the essential dimensions of commercial grain farms are needed. The details of these prototypes are discussed in terms of marketing period, location, crop production, production stages and statistical regions.

6.2.1.1 Marketing period

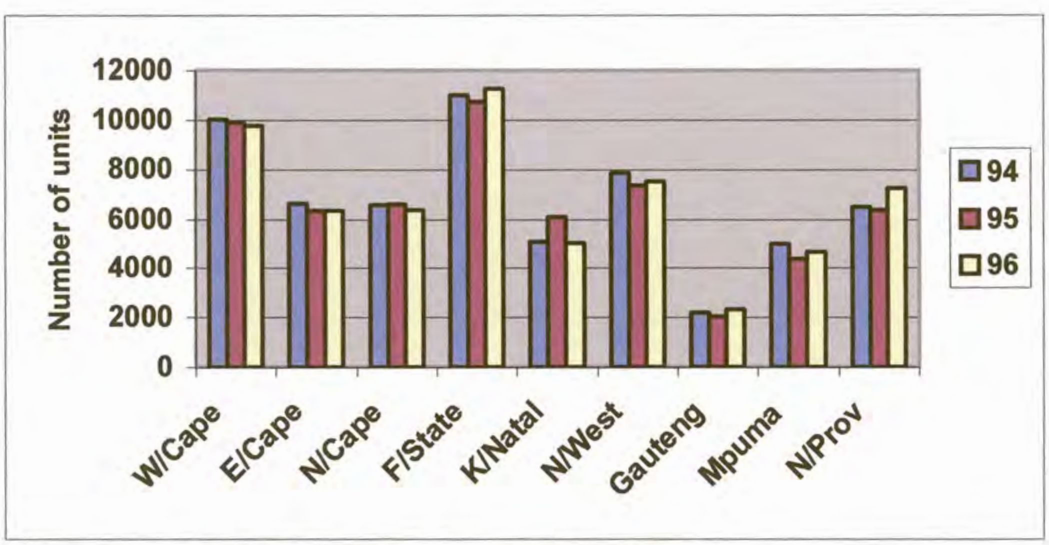
For the purpose of this study, the period from 1996 to 1999 was chosen because it represents the new agricultural marketing era in South Africa. The marketing boards were abolished in 1996 and every producer now carries the responsibility of marketing his/her own crop. Production patterns (as discussed in Chapter 2) changed after 1996 and therefore any data prior to 1996 would be invalid for this study.

6.2.1.2 Location

As a location, the Free State was chosen. The Free State was selected for two main reasons. Firstly, there is the overall prominence of maize, sunflower seed, North West (cf. Figure 6.2). A farming unit consists of one or more separate farms, holdings or portions of land, whether contiguous or not, provided they are situated in the same magisterial district. Furthermore, the following farming operations are carried out for commercial purposes on such farming units (Central Statistical Services, 1996b):

- the cultivation, in the open air or under cover, of field crops, fruit, grapes, nuts, seed, bulbs, vegetables or flowers;
- the operation of a nursery, except a nursery concentrating on purchasing and reselling;
- the operation of a tea, coffee, sugar, wood, or other plantation;
- the breeding of livestock, poultry, game or other animals, including freshwater fish and furred animals, and including speculation in livestock; and
- the production of milk, cream, wool, fur, eggs or honey.

Figure 6.2: Number of farming units



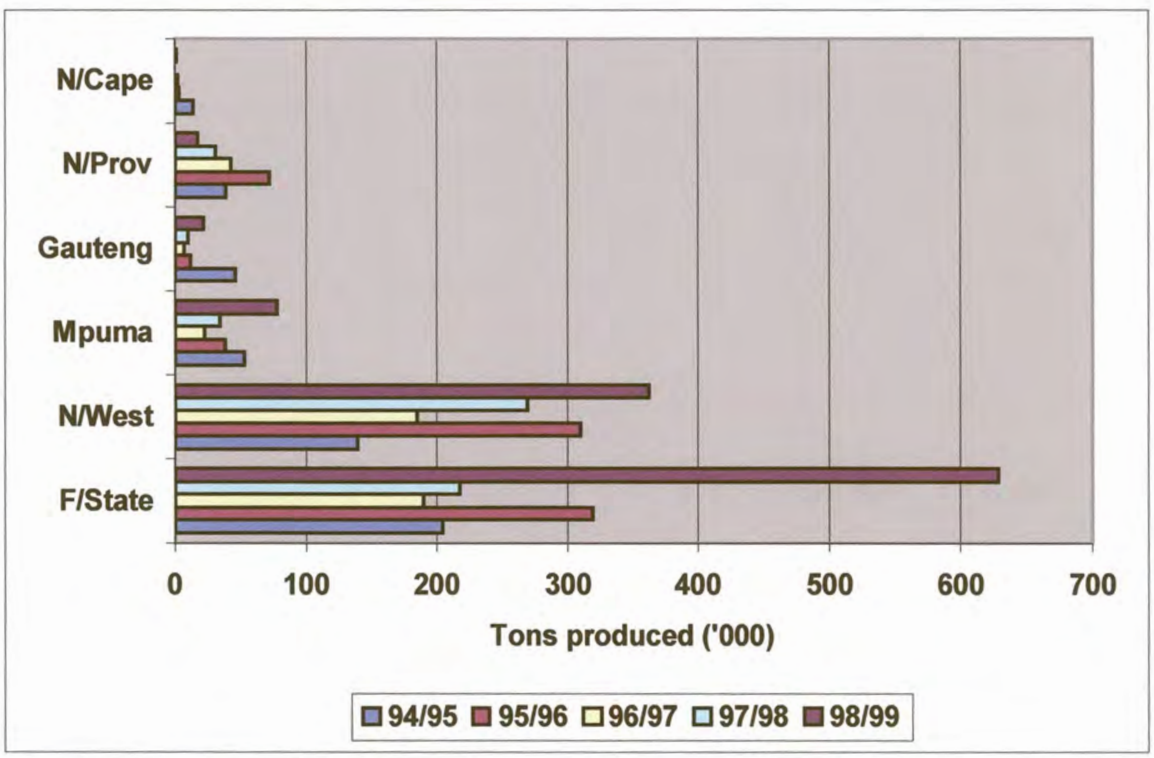
Source: Central Statistical Services (1996b)

At the stage when the study was done, no new data were available on farming units. The study therefore assumes that the greatest percentage of farming units are still in the Free State.

6.2.1.3 Crop production

The next step entailed the justification of the choice of the Free State by looking at the field crops selected for this study (see Chapter 2). Figure 6.3 indicates the total sunflower seed production from 1995/96 to 1998/99 for each of the provinces.

Figure 6.3: Total sunflower seed production by province for the period from 1994/95 to 1998/99

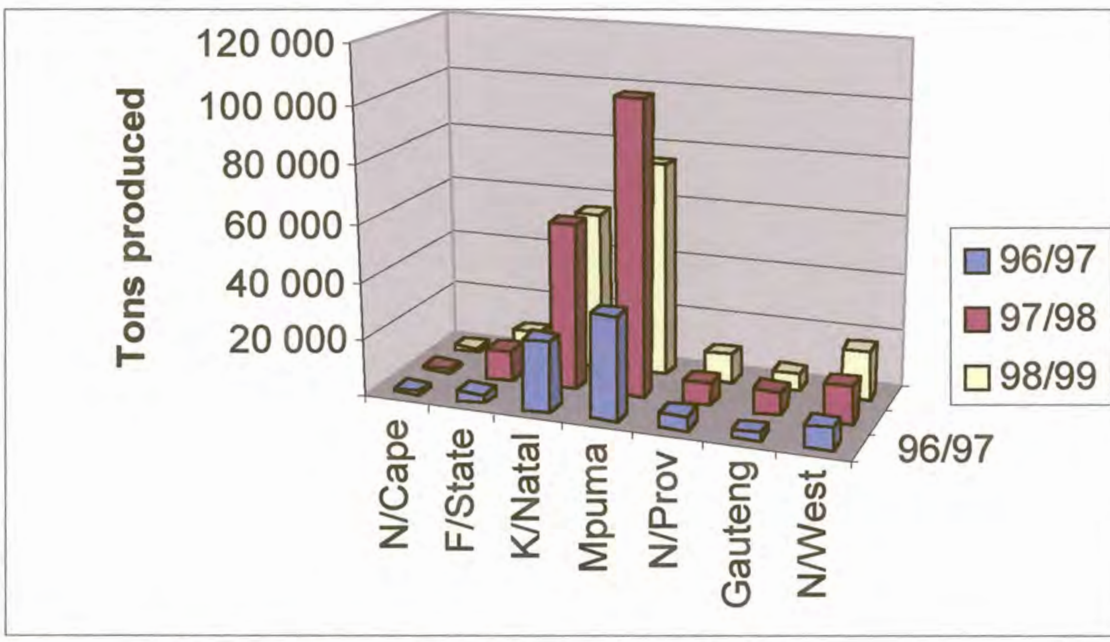


Source: National Crop Estimating Committee (2000a)

More than half the total sunflower seed production comes from the Free State. The average total production over the last six years was 546 579 tons, with the Free State producing 297 669 tons or 54.46% thereof. The Free State produced most of the sunflower seed throughout the study period, except during the 1997/98 marketing season.

Figure 6.4 indicates the total soybean production per province.

Figure 6.4: Total soybean production per province for the period from 1996/97 to 1998/99

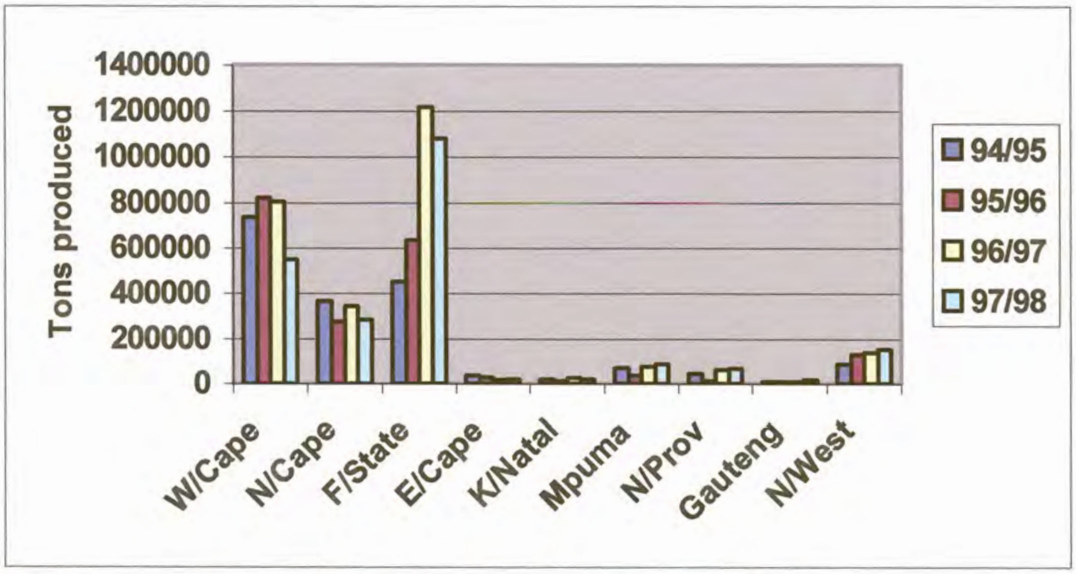


Source: National Crop Estimating Committee (2000a)

The Free State produces only 6.7% (or 10 000 tons) of the total soybean production in South Africa during the 1998/99 marketing season. The primary reason is climatic conditions. Soybeans prefer a colder, more humid climate, indicated by the high volumes produced in Mpumalanga (75 000 tons) and KwaZulu-Natal (55 500 tons) in the 1998/99 marketing season.

Figure 6.5 indicates the total wheat production by province.

Figure 6.5: Total wheat production by province for the period from 1994/95 to 1997/98

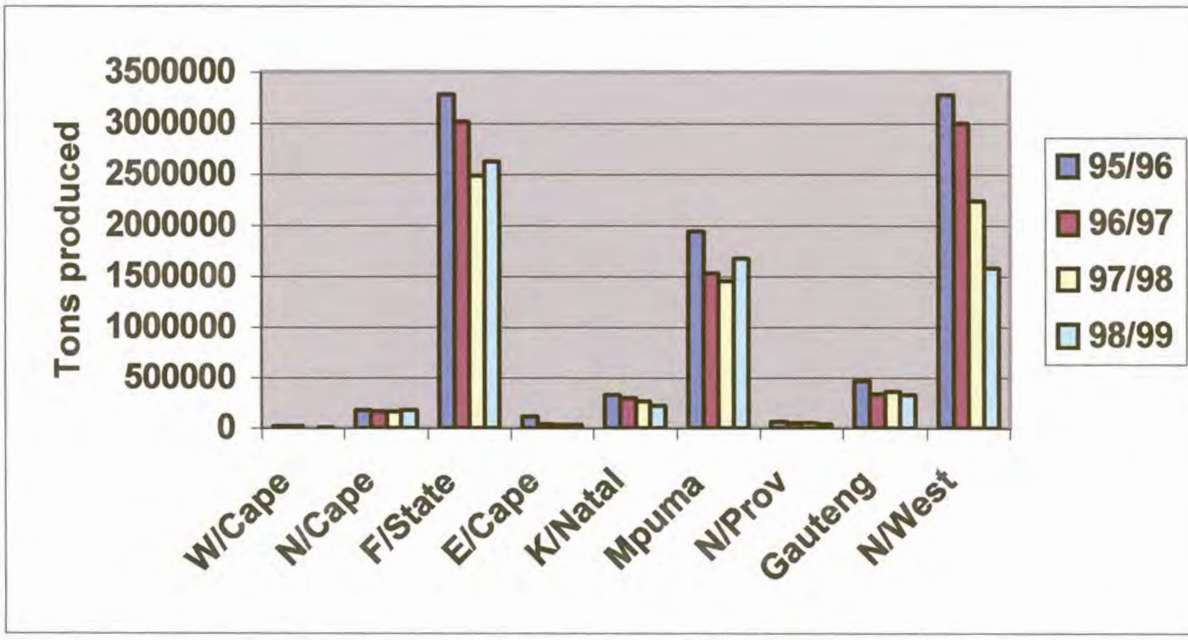


Source: National Crop Estimating Committee (2000b)

Except for a small portion of the southern Free State, the rest of the province produces wheat. The average wheat production in the Free State is 952 000 tons per year. That represents 43.93% of the total yearly wheat production. Except during 1994/95 and 1995/96, the Free State produced most of the wheat in South Africa.

Figure 6.6 indicates the per province production of maize.

Figure 6.6: Maize production by province for the period from 1995/96 to 1998/99



Source: National Crop Estimating Committee (2000a)

The Free State produced most of the maize (33.4%) in the country. However, Mpumalanga produced slightly more yellow maize than the Free State. The Free State produced 980 000 tons of yellow maize on average for the four years from 1995/96 to 1998/99, whereas Mpumalanga produced 1 100 000 tons on average for the same period. Due to the relatively slight difference in quantity and the fact that the same principle applies to the marketing of yellow and white maize, it was decided that the Free State can be used to reflect maize sales.

The Free State produced the most maize, sunflower seeds, and wheat in the country and the fourth most soybeans in South Africa over the period from 1996/97 to 1998/99. This led to the choice of the Free State as the area from which farms were chosen for this study.

Crop varieties and growing techniques vary from one geographical region to another. The products from the farms of a given province are not homogeneous in type and quality. Even within a given province, planting and harvesting does not occur simultaneously on all farms. Because the aim of the model developed in this study is to optimise marketing profits, each farm must be investigated individually. The crop choice, crop input costs and marketing strategies followed by the producers were compared with the strategies proposed by the model.

6.2.1.4 Production stages

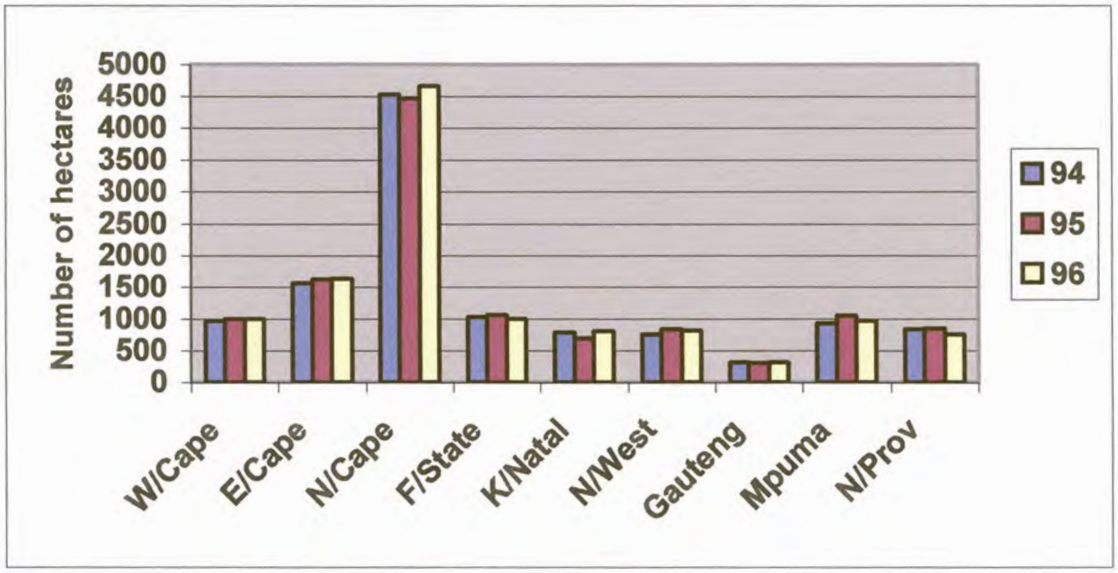
The second step was to allocate months to the production-marketing period for planting, growing, harvesting and storage. These allocations are presented in Table 6.1.

Table 6.1: Allocating months to the production-marketing period of crops

Maize	Planting	October, November, December
	Growing	December to April
	Harvest	May, June, July
	Storage	August to actual selling of crop
Sunflower seed	Planting	November, December, January
	Growing	January to April
	Harvest	May, June
	Storage	July to actual selling of crop
Soybeans	Planting	October, November, December
	Growing	December to April
	Harvest	May, June, July
	Storage	August to actual selling of crop
Wheat	Planting	May, June
	Growing	July to October
	Harvest	November, December
	Storage	December to actual selling of crop

Farm size is the third dimension that needs to be determined for the farm prototypes. Figure 6.7 depicts the average size of a farming unit for the period from 1994 to 1996. Due to the fact that more recent data on the average size of a farming unit in the Free State was not available when the study was done, it is assumed that the same pattern prevailed for the period from 1996 to 1999.

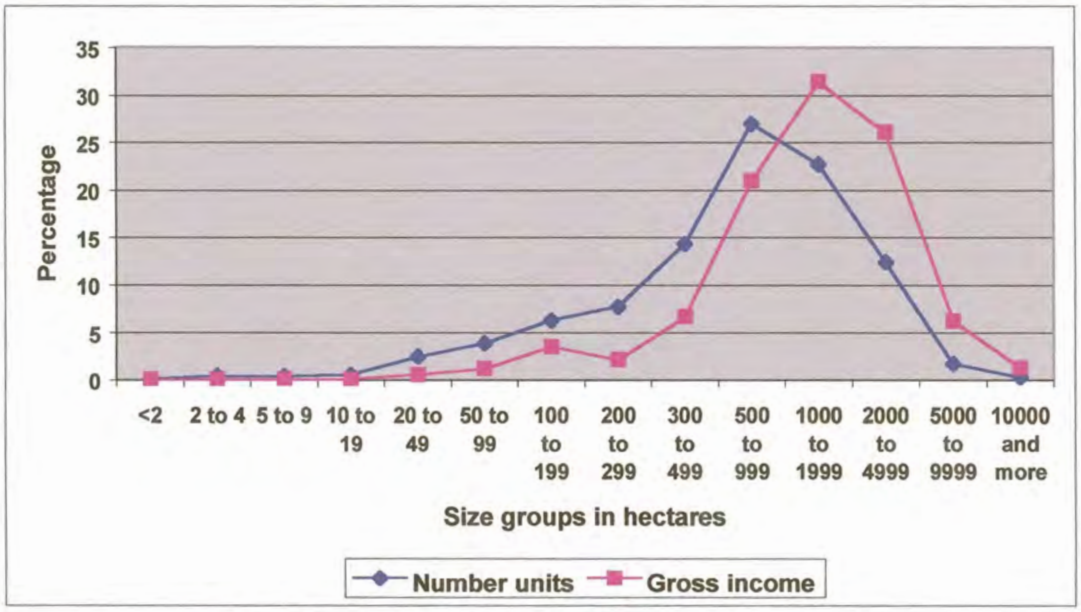
Figure 6.7: Average size of a farming unit (hectares)



Source: Central Statistical Services (1996)

The largest farming units in South Africa were recorded in the drier areas such as the Northern Cape, where most of the farming land was used for grazing purposes and the average size of a farming unit was more than 4 000 hectares. The smallest farming units were recorded in Gauteng, where the average farming unit was approximately 300 hectares. Some of the size characteristics of commercial grain farms in the Free State are set out in Figure 6.8.

Figure 6.8: Characteristics of commercial grain farms in the Free State



Source: Central Statistical Services (1993)

Table 6.8 indicates that about 21% of the farms fall in the category from 599 hectares to 999 hectares, 31% in the category from 1 000 hectares to 1 999 hectares and 26% in the category from 2 000 hectares to 4 999 hectares. The average farming unit in 1996 in the Free State was 1 006 hectares. Due to the fact that farm size is not an indication of total production (due to differences in irrigation and soil type), the farms are grouped into total tons produced rather than hectares. In order to provide the widest possible range in size and yet be sufficiently large to use futures contracts, the categories indicated in Table 6.2 were chosen.

Table 6.2 Farm production categories

Group A	Total crop production less than 1 000 tons
Group B	Total crop production between 1 000 and 1 999 tons
Group C	Total crop production of 2 000 tons and more

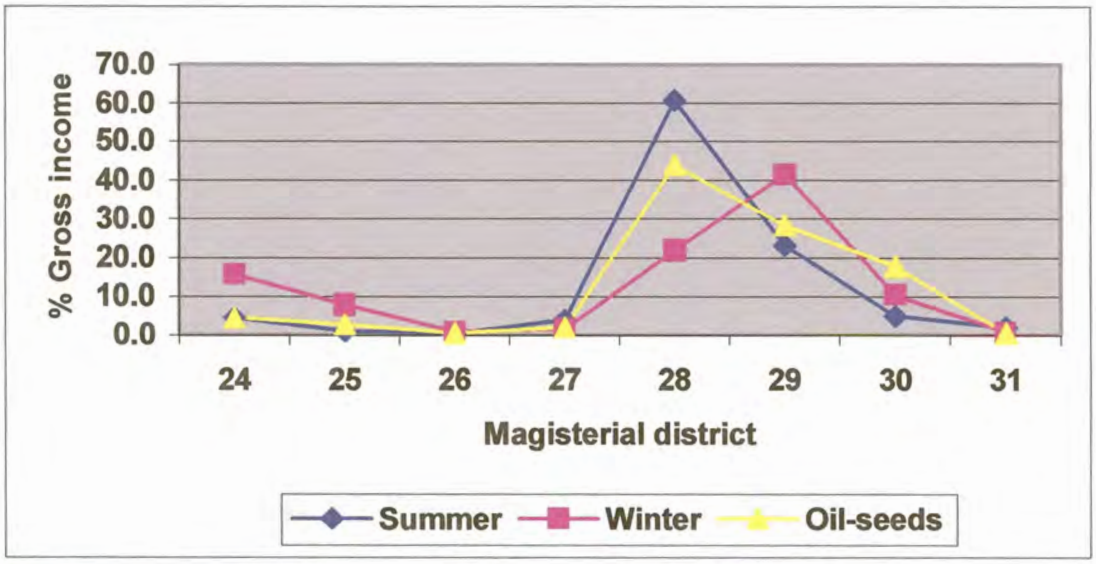
It was not possible to find a farm unit for sunflower seed production for Category C in the Free State. This was due to the fact that the total production of sunflower seed in the Free State for the 1998/99-season was 629 000 tons on 430 000 hectares, resulting in an average yield of 1.46 tons per hectare. On average, 1 370 hectares of sunflower seed have to be planted to qualify for Category C. The average farm size in the Free State is only 1006 hectares, well below the required size for Category C. By looking at the chosen magisterial districts (as discussed later in this chapter), it was again not possible to find a suitable farm unit for Category C.

It is not a prerequisite for the farms chosen for this investigation to have used the futures market or derivatives market as a mechanism to manage their investment risk. Futures markets or derivative markets only provide alternative marketing strategies to producers. It is the aim of the MDSS to determine the optimal strategy, and a producer might achieve optimum results by ignoring the futures market.

6.2.1.5 Statistical regions

The fourth step entailed the identification of statistical regions, in other words the regions that have the biggest total income from summer cereals, oil-seeds, and winter cereals, statistically speaking. Figure 6.9 indicates each statistical region in the Free State with the percentage gross income from summer cereal, oil-seeds and winter cereals.

Figure 6.9: Percentage gross income per statistical region



Source: Central Statistical Services (1993)

Statistical Region 28 produced the biggest percentage of gross income for summer cereals (60.8%) and oil-seeds (44%). Statistical region 29 produced the biggest percentage gross income for winter cereals (41.4%). The districts, which are represented as Regions 28 and 29, are named in Table 6.3.

Table 6.3: Districts represented as Statistical Region 28 and 29

Region 28		Region 29	
Kroonstad	Viljoenskroon	Bethlehem	Senekal
Ventersburg	Bothaville	Harrismith	Fouriesburg
Henneman	Wesselsbron	Vrede	Ficksburg
Parys	Hoopstad	Frankfort	
Vredefort	Bultfontein	Reitz	
Koppies	Theunissen	Lindley	
Heilbron			

Districts from Region 28 were used for data on summer cereals and oil seeds, and Districts from Region 29 for winter cereal crops. Farms from the above districts in Category A, Category B and Category C are used in the model. Farm selection, however, was random to ensure that the MDSS could be tested on producers that had used the derivatives market and also on producers that had not used the derivatives market. The only requirement was that at least one crop had been planted and that the total tons produced would be represented in Categories A, B and C.

6.3 ASSUMPTIONS AND DEFINITIONS

6.3.1 Stage definitions

Assumptions of discrete time were the first step towards making the analysis viable. The production-marketing time span was divided into a small enough number of intervals to reduce the dimensions of the model sufficiently to make it manageable. Yet, the time span of the intervals was narrow enough to reflect the evolution of price and yield information.

Price and yield uncertainties are strongly related to the dynamics of information. At planting time, the price of the current forward contract is assumed to be known. This assumption ignores the possibility that inflation could change the value of the forward spot price by the time the contract is exercised. The futures price (for the harvesting period) is also known to the producer. At planting, however, expected yields are only vague expectations and harvest and post-harvest prices already exist, but the final price expected is only a vague expectation. By the growing stage and especially as harvest nears, the uncertainty of yield and price expectations lessens as producers monitor growing and marketing conditions. At harvest, yields and spot prices during harvest become known and the range of spot prices expected during the storage period narrows.

The production information presented in Chapter 2 shows that wheat is planted in autumn. Therefore, the planting stage for wheat does not correspond with the planting stages for maize, soybeans, and sunflower seeds, which are seeded in early summer. Hence, a multiple production grain farm which grows wheat along with summer crops has a production-marketing period composed of four intervals. These intervals, complete with their specification of production and marketing instruments for each crop, are set out in Table 6.4.

Table 6.4: Production-marketing activities per crop

INTER-VAL	ACTIVITY	MARKETING INSTRUMENT	MAIZE	WHEAT	SUNFLOWER SEED	SOY-BEANS
1	Planting			**X**		
	Marketing	Forward	**X**	X	**X**	**X**
		Futures	X	X	X	X
		Options	X	**X**	X	X
	Growing		X	**X**	X	X
	Planting					
	Marketing	Forward		X		
		Futures		X		
		Options		X		
2	Harvest			**X**		
	Growing		**X**		**X**	**X**
	Marketing	Forward	X		X	X
		Futures	X		X	X
		Options	X	X	X	X
		Spot		X		
3	Storage			**X**		
	Harvest		**X**		**X**	**X**
	Marketing	Spot	X	X	X	X
		Options	X	X	X	X
4	Storage		**X**		**X**	**X**
	Marketing	Spot	X		X	X

Source: Adapted from Bernstein (1987)

The four intervals represent three different marketing stages used by the integer linear programme. The different marketing stages are the following:

- **Pre-harvest marketing stage**. The pre-harvest marketing stage represents the time from planting (and any actions taken before planting) to the end of the growing season. The pre-harvest marketing stage is reflected by Interval 1 for wheat and by Interval 1 and Interval 2 for the summer crops, as depicted by Table 6.4.

- **Harvesting stage.** The harvesting stage represents the time span necessary for producers to harvest the crop. The harvesting stage for wheat is represented by Interval 2 in Table 6.4 and the harvesting stage for summer crops is represented by Interval 3.

- **Post-harvesting stage.** The post-harvesting stage reflects only the timespan for crops stored after the harvesting stage. It represents the time from the end of harvesting to the actual selling of the crops. The post-harvesting stage does not have an upper limit on the time it takes to sell the crop. The producer can store the crop until the harvesting season for the next year, or even later before selling the crop. The post-harvesting stage for wheat is represented by Interval 3 in Table 6.4 and for summer crops by Interval 4.

6.3.2 Price assumptions

For the purposes of this study, it is assumed that all farms, no matter what their size, have the same marketing instruments available to them. Large farms do not have any advantages over their smaller counterparts. It is also postulated that, although production costs are stochastic, they are independent of the prices of all marketing instruments.

Hedgers are temporary substitutes for anticipated actual transactions. This definition is reflected by the assumption that obligations from short sales in the futures market are not satisfied through delivery. In addition, once a short position is taken, the hedge is not lifted by an offsetting futures purchase until the corresponding harvest sales occur simultaneously. This implies that, if a producer enters into a futures contract during the planting stages, this futures position will only be offset during harvest time. Speculation is disregarded.

6.3.3 Crop choice

Although the model is based on well-diversified farms, the producer has the option to choose between the four selected crops, namely white maize, yellow maize, wheat, sunflower seed and soybeans, as discussed in Chapter 2. The only prerequisite is that producers must plant at least one of the specified crops.

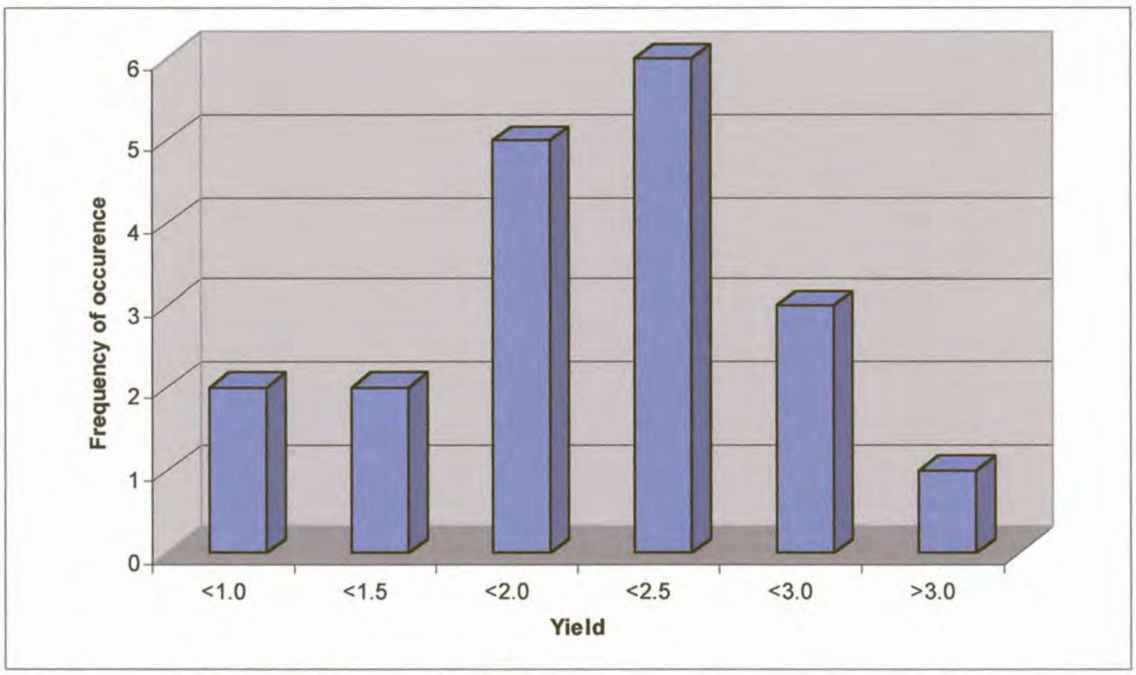
6.3.4 Marketing decisions

The producer can choose between the marketing instruments available in any of the four production-marketing stages. The producer uses the information available at Interval 1 to plan the pricing of a percentage of the expected output. During the early parts of Interval 2, another percentage of the expected output is priced. The rest of the expected output is priced during the later parts of Interval 2, Interval 3 and Interval 4. The same principle applies to producers who plant only winter crops. They focus on Intervals 1 to 3, and the same principles apply.

6.3.5 Production estimates and marketing constraints

Most production uncertainty results from the effect of weather on crop yields. Although weather is commonly accepted as the principal determinant of annual crop yields, the possible influence it has on the probability distributions of those yields is often overlooked. Figure 6.10 indicates the national average yield for maize for the period from 1980/81 to 1996/97.

Figure 6.10: Average maize yield from 1980/81 to 1996/97



Source: http://www.fao.org (1999)

The average yield from 1980/81 to 1996/97 was 2 tons per hectare. As suggested by Day (1965), positive skewness of the probability distributions of crop yields may mean that the expected output is an overly optimistic forecaster. This being the case, a total commitment of expected output to forward contracts, option contracts or futures positions may often result in a consistent tendency to oversell. Such oversales necessitate compensating cash purchases in the spot market at harvest in the case of a crop shortfall. From the graph in Figure 6.10 is it clear that this is not the case in South Africa. Table 6.5 indicates the average tons per hectare and the standard deviation thereof for maize, sunflower seeds, soybeans and wheat obtained in the Free State.

Table 6.5 Average tons per hectare and standard deviations from 1995/96 to 1998/99

	Average yield	**Standard deviation**
Sunflower seed	1.22 t/Ha	0.24
Soybeans	1.44 t/Ha	0.32
Wheat	1.29 t/Ha	0.26
Maize	2.48 t/Ha	0.10

Using the mean as a forecaster of a random variable with a positively skewed distribution does not result in repeated overestimation. It is therefore not necessary to adjust yields by making use of Chebyshev's inequalities (Day, 1965).

It is assumed that the decision-maker does not believe that the probability distributions of crop yields are positively skewed. The MDSS functions on a continuous basis and the producer can adjust the information as the crop nears maturity. No producer is committed to sell 100 percent of the crop at planting. Decision-makers tend to be cautious and want to avoid forward cash and futures oversales. Therefore, a safety-first strategy is assumed. To obtain this safety-first strategy, only a portion of the expected crop is sold before the critical growing stages have passed. The rest of the expected crop can be sold after the critical growing stages or can be reserved to be sold in the harvest or post-harvest stages. These reserves are then available to satisfy forward and futures commitments if an unanticipated production shortfall occurs. If a producer decided not to make use of a safety-first strategy the MDSS then also ignored the safety-first strategy. In order to compare the results obtained by the producer with those of the MDSS, the MDSS must use the same percentage of crop sold in every stage as the producer.

As the crop year advances and especially as the critical stages of growth for each product are reached, yield uncertainty diminishes. The probability distribution of yields becomes more concentrated around the expected value as weather information is accumulated and the critical growing stages for each crop are passed. Although the yield uncertainties lessen as the season progresses, the price risk faced by producers does not diminish over time. This makes it all the more important to develop an MDSS to assist producers in managing their price risk.

6.4 ELEMENTS OF THE MDSS

Decision support systems (DSSs) are an important application of management information systems (Davis & Olsen, 1985). According to Fang and Puthenpura (1993), DSSs require the use of computers to improve decision-making, and to allow users to retrieve data and evaluate alternatives based on models appropriate to the decisions to be made. **Reports on DSSs to optimize marketing returns for crop farms in South Africa are not available.** The MDSS developed in this chapter allows for the possible effects of farm location, size, and debt on marketing decisions. It also provides for variations in attitude towards production and price uncertainty.

The aim of the MDSS is to maximise net return. Net return is the sum of all the net cash flows generated by all the marketing activities in the different marketing stages. Net cash flow represents the difference between cash inflows and cash outflows associated with crops produced on the farm. Other returns and non-production expenses are excluded.

The MDSS aims to determine the optimal combination of marketing strategies available to producers to maximise net return, given the constraints imposed by the individual producers. In order to present the model logically, all the cost components are discussed, followed by the marketing components.

6.4.1 Input cost components

For the purposes of this study, production costs are grouped into three broad categories:

- **Pre-harvest variable cost**
  Pre-harvest variable costs include items such as seed, fertiliser, weedicides, pesticides, labour, transport, fuel and repairs. Interest on production loans incurred prior to harvesting the crop also have to be included.

- **Harvest cost per hectare**
  Harvesting costs per hectare include costs such as fuel, repairs, labour and contract work when the crop is harvested. These costs are not affected by crop yield. The reason for treating these costs separately from pre-harvest costs is the possibility that the crop may not be harvested due to crop failure.

- **Harvest cost per production unit**
  Harvesting costs per unit of production include cash costs for items such as drying, transport and contract work, which are sensitive to crop yield.

Contract work represents work done by additional labour on a contract basis. This is normally done in one of two ways. The contract worker can either be paid per hectare or per ton, so that contract work is distinguished both in harvest cost per hectare and harvest cost per production unit. Farm overhead expenses should not be included in any of the three input cost categories. For example, items such as general farm insurance premiums, and returns to operator and family living expenses should be excluded. The aim of the MDSS is to optimize crop return by optimizing the net cash flows generated by the various marketing instruments. Overhead expenses should also be allocated to the rest of the farm operations. Due to the difficulty in deciding the percentage allocation of overhead expenses to the crop production process, overhead expenses were ignored in the development of the MDSS.

Due to the fact that the MDSS aims to maximise net return by choosing an optimal marketing strategy, the MDSS attempts not to determine the type of crop to be planted, but only the marketing strategy to be used for marketing the crop. All input costs used ignore the influence of the time value of money because the aim is to optimise the marketing strategy and not to optimise crop choice.

Production costs in general are assumed to be independent of marketing return. However, marketing strategies cannot be taken in isolation from input costs. There is a direct relationship between input cost and the importance of price risk management. The higher the input cost, the more important effective price risk management is.

The requirements for managing cash flows so as to service debt obligations can also influence marketing decisions. The MDSS incorporates the effects of debt in the input cost categories by allocating the interest on debt proportionally to the above categories, and in the discount rate used to determine the present value of the net cash flow generated by a marketing instrument.

6.4.2 Marketing information

For the purposes of this study, producers can decide between pricing their crops preceding harvest using forward contracts, options on futures contracts and futures contracts or waiting and selling in the spot market at or after harvest. The effect of the time value of money is taken into consideration because the different marketing instruments available lead to different timings of cash flows. All strategies are discounted back to the harvest date of the representative crop. If a producer has debt obligations, the interest rate associated with debt is used as the discount rate to calculate the present value of the relevant cash flows. If the producer has investments, the applicable percentage interest return on these investments is used as discount rate. If the producer has neither debt nor investments, the SAFEX interest rate is used as the appropriate discount rate.

For every marketing instrument, the following information is required:

- selling price (contract price);
- storage cost (if any);
- handling cost (if any);
- transport cost (if any);
- brokerage fees (if any);
- premium costs (option contracts);
- delivery date;
- prevailing interest rate (lending rate or investment rate); and
- initial margin costs (futures contracts).

In order to determine the net cash flow of each marketing instrument, the cash inflows and cash outflows of each marketing instrument must be calculated. Below, cash outflows are defined and discussed, followed by cash inflows.

6.4.2.1 Cash outflows of a marketing strategy

Cash outflows represent all costs that producers incur during the pre-harvest marketing stage, the harvest marketing stage and the post-harvest marketing stage. Cash outflows are therefore all costs associated with the planting, harvesting, storing and marketing of crops. The following costs are used in the equations developed for the model, and they are defined as follows:

- **Storage cost** is the cost producers incur if they choose to store their crops to sell at a later stage.
- **Initial margin** is the initial amount required by SAFEX before a producer can enter into a futures contract. Due to the varying nature of the mark-to-market prices and the fact that all deposits to SAFEX are paid back after the contract has been fulfilled, the influence of the maintenance margin is ignored. It is also assumed that the full amount is always payable.
- **Transaction costs** consist of the SAFEX contract cost and commission fees charged by the trader.
- **Area differential cost** consists of basis cost (the difference between the local spot price and the futures price of a crop), transport cost from the local elevator to Randfontein, and handling costs for loading the crop in and out of the elevator.
- **Premium cost** is the cost per ton to purchase an option on a futures contract.
- **Commission fees** represent the total amount to be paid when engaging in a futures or an option contract. It includes commission fees payable to the trader and all the SAFEX costs (except margin costs) associated with the action.

Table 6.6 indicates the cost item associated with each marketing instrument.

Table 6.6: Cost items associated with marketing alternatives

	Storage	Initial margin	SAFEX contract	Commis-sion	Handling	Transport	Premium
Spot							
Store	X						
Forward	X						
Futures	X	X	X	X	X	X	
Options	X		X	X	X	X	X

Only spot sales during harvest incur no marketing costs, but the risk associated with spot sales is much greater. The reason being that producers cannot protect themselves against any possible downside movement of prices. Normally, during harvest, the spot price is lower than usual, due to an oversupply of the crop. The opposite can be true as well. Dramatic weather phenomena can push prices upwards, resulting in higher than average spot sales during harvest. Because the price movement during harvest cannot be predicted at any time during the growing season of the crop, it is risky to wait and sell all the crop during harvest only.

6.4.2.2 Cash inflows of a marketing strategy

Cash inflows represent all cash receipts from the sale of the crop. Cash inflows therefore represent all cash receipts of crop sales during the harvesting and post-harvesting marketing stage. The effect of the time value of money is taken into consideration and all cash inflows are discounted back to the harvest date of the respective crop. The MDSS does not take a short put and a short call option into consideration. For the purposes of the study, it is assumed that all producers are not speculative and are only trying to obtain the highest possible price for their crop. SAFEX (2000) confirmed that it is more often larger companies who participate in short puts and short calls. Therefore, the cash inflows from the various marketing instruments are only the price received for the selling and/or for buying of the crop and not for selling the right to sell the crop or to buy the crop, as is the case with a short put and a short call.

The aim of the MDSS is to determine the optimal combination of marketing instruments to optimize the net return of producers by taking the specific limitations of the producers into consideration. Equations were developed to enable the MDSS to choose the optimal combination of marketing instruments. In order to test the MDSS, the net cash flows of the producers in every marketing stage are compared to the net cash flows of the MDSS. Finally, the net return generated by the producer's decisions is compared to the net return generated by the decisions suggested by the MDSS. The first step was to develop equations to determine the net cash flow of producers for every marketing instrument. Thereafter, these equations are adapted to enable the MDSS to determine the optimal combination of marketing instruments. In Section 6.4.3, the net cash flow of producers, as a result of their marketing actions, is determined. Section 6.4.3 is followed by an explanation of integer linear programming and the development of the MDSS in this study.

6.4.3 Net cash flow per crop of producers

First, the net cash flow per crop is determined. The net cash flow per crop represents the difference between the cash inflows and the cash outflows of a given marketing instrument. The net cash flow per crop is determined by summarising the net cash flows for each instrument used. To obtain the total net cash flow of crop sales, the following determinants of net cash flow and the equations to calculate these cash flows are developed:

6.4.3.1 *Net cash flow from spot sales during harvest*

The net cash flow from spot sales during harvest is comprised of the following equations. First, the cash inflow from spot sales during harvest is determined:

$$Cf_{s/in} = P*Q \qquad (6.1)$$

Where:

$Cf_{s/in}$ = cash inflow from spot sales

P = price per ton

Q = number of tons allocated

Thereafter, the cash outflows of crop sold on the spot market during harvest is determined:

$$CF_{input} = \{(PHVC/Y) + (HCPHe/Y) + HCPU\}Q \qquad (6.2)$$

Where:

CF_{input} = input cost

Y = yield per hectare (ton)

$PHVC$ = pre-harvest variable cost per hectare

$HCPH_e$ = harvest cost per hectare

$HCPU$ = harvest cost per ton

The combination of Equations 6.1 and 6.2 results in the net cash flow from spot sales during harvest for all the crops covered by the MDSS.

$$NCF_{spot} = Cf_{s/in} - CF_{input} \qquad (6.3)$$

Where:

NCF_{spot} = net cash flow from spot sales during harvest

Equations 6.1, 6.2 and 6.3 can only be used to determine the cash flows from spot sales during harvest. The receipts from the spot sales during harvest are received immediately and it is therefore not necessary to take the effects of the time value of money into consideration. If a producer decides to delay the selling and delivery of the crop, the effect of time value of money must be taken into consideration and does not form part of the harvesting marketing stage.

6.4.3.2 Net cash flow from storage

The equations developed to determine the net cash flow from storage (all the sales that occur in the post-harvesting marketing stage) differ from the equations developed in Section 6.4.3.1. The reason for this is the effect of the time value of money. The discount rate used in determining the present value is influenced by the producer's debt position. If the producer uses a production loan from a co-operative, and/or makes use of a bank overdraft facility in the crop production process, the highest debt interest rate is used. If the producer does not use any debt financing and has investments, the percentage interest return on these investments is used in the discounting process. If the producer does not use any debt financing, nor has any investments, the SAFEX interest rate on the day the contract is entered into, is used as a fixed rate throughout the marketing season. To determine the net income from storage, the equations below therefore apply.

First, the cash outflows associated with the storage decision is calculated:

$$CF_{store/out} = PV\{(S^*T)Q\} \qquad (6.4)$$

Where:

$CF_{store/out}$ = cash outflows resulting from the storage decision

PV	=	present value
S	=	storage cost per ton per day
T	=	length of storage (in days)

The net cash flow from the storage decision is determined by:

$$Net_{store} = PV(P^*Q) - CF_{Input} - CF_{store/out} \quad (6.5)$$

Where:

Net_{store}	=	net cash flow from store alternative
CF_{Input}	=	input costs (Equation 6.2)
$CF_{store/out}$	=	cash outflows resulting from storage decision

The cash inflows and cash outflows are discounted to the present value at harvest time. This enables a comparison between the different marketing strategies. The storage alternative only forms part of the post-harvesting marketing stage and the net return generated by storage is therefore only reflected in the post-harvest marketing stage.

6.4.3.3 Net cash flow from forward contracts

The net cash flow for forward contracts (all the forward sales that occur in the pre-harvest marketing stage) can consist of two possible equations. If the delivery is made during harvest, the following equation is applicable:

$$NCF_{fwh} = Cf_{s/in} - CF_{Input} \quad (6.6)$$

Where:

NCF_{fwh}	=	net cash flow from forward sales delivered during harvest
$Cf_{s/in}$	=	cash inflow from spot sales (Equation 6.1)

CF_{Input} = input cost (Equation 6.2)

Although the producer can already enter into the forward contract during the pre-harvest marketing stage, the payment is only received on delivery. Because the payment is received during harvest, the effect of the time value of money can be ignored and the net cash flow represents a spot sale during harvest.

If delivery on the forward contract is delayed to a later stage, the following equation that takes the storage cost and time value of money into account is used:

$$NCF_{fw} = PV(P^*Q) - CF_{input} - CF_{store/out} \qquad (6.7)$$

Where:

$CF_{store/out}$ = cash outflows resulting from the storage decision (Equation 6.4)

6.4.3.4 Net cash flow from futures contracts

In the case of futures contracts, the net cash flow can be influenced by the following two sets of scenarios:

- whether the producer can maintain the margin calls or not; and
- whether the producer closes out his/her futures position, or delivers on the futures position.

Futures contracts are discounted to harvest time to enable comparison between the various instruments. The length of time used in the discounting process is the time from harvest to the expiry date of the futures contract.

If the producer **maintain the margin calls** and decided **to deliver** on the futures position, the net cash flow is determined by the equations below.

First, the **cash inflow** resulting from a futures position is determined:

$$CF_{fut/in} = PV(FP^*Q) + (i^*Mar) \tag{6.8}$$

Where:

$CF_{fut/in}$ = cash inflow from futures sales

FP = futures price per ton

i = interest rate per day

Mar = initial margin

The **cash outflow** resulting from the futures position is determined:

$$CF_{fut/out} = (TC^*n) \tag{6.9}$$

Where:

$CF_{fut/out}$ = cash outflows resulting from futures contracts

TC = total transaction cost per contract

n = number of contracts

The net cash flow from delivery on futures sales is determined by:

$$NCF_{fut} = CF_{fut/in} - CF_{fut/out} - PV(A^*Q) - CF_{Input} \tag{6.10}$$

Where:

NCF_{fut} = net cash flow from futures contract sales

A = area differential cost

If the producer **cannot maintain margin calls** and has **decided to deliver** on the futures position, the following equations apply:

First, the cash inflow from the futures position is determined:

$$CF_{fut/in} = PV(FP*Q) \quad (6.11)$$

Where:

$CF_{fut/in}$ = cash inflow from futures sales

The net cash flows resulting from the futures position is thereafter determined:

$$NCF_{fut/dl} = CF_{fut/in} - CF_{fut/out} - CF_{Input} - PV\{(A*Q) + (i*Mar)\} \quad (6.12)$$

Where:

$NCF_{fut//dl}$ = net cash flow resulting from futures contracts

Due to the fact that the producer has to borrow the initial margin, the interest earned by the margin account (i*Mar) is seen as a cost. If the producer could maintain the margin calls, the interest generated by the margin account is seen as a cash inflow and it is assumed that the producer could have invested the initial margin amount to earn an interest income.

If the producer **can maintain the margin calls** and decides to **close out** the short futures position with a long futures position, the net cash flow is determined by the following equations:

$$NCFs_{futcl} = PV(FPs - FPl)*Q - (TC*n) \quad (6.13)$$

Where:

$NCFs_{futcl}$ = net cash inflow of short futures position closed out

FPs = short futures price per ton

FPl = long futures price per ton

And if the producer decides to close out the long futures position with a short futures contract, the net cash flow resulting from this action is determined by Equation 6.14:

$$NCFl_{futcl} = PV(FPl - FPs)*Q - (TC*n) \quad (6.14)$$

Where:

$NCFl_{futcl}$ = net cash inflow of long futures position closed out

On the other hand if the producer **cannot maintain the margin calls** and decides to **close out** the short futures position with a long futures position, the net cash flow is determined by the following equation:

$$NCFs_{fut} = PV(FPs - FPl)*Q - (TC*n) - (i*Mar) \quad (6.15)$$

Where:

$NCFs_{fut}$ = net cash inflow of short futures position

And if the producer **cannot maintain the margin calls** and decides to **close out** the long futures position with a short futures contract, the net cash flow resulting from this action is determined by Equation 6.16:

$$NCFl_{fut} = PV(FPl - FPs)*Q - (TC*n) - (i*Mar) \quad (6.16)$$

Where:

$NCFl_{fut}$ = net cash inflow of long futures position

It is assumed that in the pre-harvesting marketing stage the producer will deliver on the futures contract. Equation 6.10 is therefore used in determining the net cash flow of futures sales during the pre-harvest marketing stage.

6.4.3.5 Net cash flow from options on futures contracts

When producers use option contracts, a choice can be made between put options and call options. Producers normally enter into a put option contract if they expect prices to decline. Producers normally enter into a call option contract to protect themselves against a price rise if they used forward contracts to sell a percentage of their crop. If producers choose a call option contract, they have the right to buy the commodity at a specific price. Producers can also use call option contracts to lengthen the marketing time of their crops. Producers sell their crop during harvest and purchase, for instance, a March call option contract if they expect prices to increase. If the price of the grain rises, producers can, for example, exercise their option before the expiry date of the call option, buy the commodity at the predetermined price and sell it immediately in the spot market for a higher price. To determine the net cash flow from options on futures contracts, the following scenarios apply:

- put option contracts exercised and delivered;
- put option contracts exercised and futures position closed out;
- put option contracts expired worthless;
- call option contracts exercised and delivery received;
- call option contracts exercised and futures position closed out; and
- call option contracts that expired worthless.

The following equations were developed to determine the net cash flow for various scenarios of options on futures contracts.

If a producer decides to **exercise a put** option contract and to **deliver** on the contract, the following equation is used to determine the net cash flow:

$$NCF_{put/ex} = PV\{(P*Q) - (A*Q)\} - (TC*n) - (Prem*Q) - CF_{input} \quad (6.17)$$

Where:

$NCF_{put/ex}$ = net cash flow from put option contracts exercised and delivered upon

Prem = premium per ton

If a producer decides to **exercise a put** option contract, to **close out** the futures position and the sell the crop on the spot market, the following equation is used in determining the net cash flow:

$$NCF_{put/cl} = PV\{(P*Q) + NCFs_{fut}\} - (TC*n) - CF_{input} \quad (6.18)$$

Where:

$NCF_{put/cl}$ = net cash flow from put option contracts exercised and closed out

$NCFs_{fut}$ = net cash inflow of short futures position

If the put option contract **expired worthless**, the net cash flow is determined as follows:

$$NCF_{put/nex} = -\{(TC*n) + (Prem*Q)\} \quad (6.19)$$

Where:

$NCF_{put/nex}$ = Net cash flow from put option contracts not exercised

Call options initially lead to a net loss, because the producer buys the right to buy crop at a predetermined price. However, if the producer exercises the option, the producer profits from the higher spot price. To determine the net cash flow from call option contracts, the equations below were developed.

For call option contracts that are **exercised** and for which **delivery** received the net cash flow can be determined as follows:

$$CF_{in/callex} = PV\{Q(CP - SP)\} \quad (6.20)$$

Where:

$CF_{in/callex}$ = cash inflow from call option sales exercised

CP = call option price

SP = spot price

and

$$CF_{call/out} = PV\{(A^*Q)\} - (TC^*n) - (Prem^*Q) \quad (6.21)$$

Where:

$CF_{call/out}$ = cash outflow of call option contract

Resulting in:

$$NCF_{callex} = CF_{in/callex} - CF_{call/out} \quad (6.22)$$

Where:

NCF_{callex} = Net cash flow from call sales exercised

If a call option contract is **exercised** and the position is **closed out**, the net cash flow is determined by:

$$NCF_{callcl} = PV\{(Q^{*}\ NCFI_{fut})\} - (TC^{*}n) \quad (6.23)$$

Where:

$NCFI_{fut}$ = net cash inflow of long futures position

NCF_{callcl} = net cash flow from call option sales exercised and closed out

For call option contracts that **expired worthless**, the following equation is developed:

$$NCF_{callnex} = -\{(TC^{*}n) + (Prem^{*}Q)\} \quad (6.24)$$

Where:

$NCF_{callnex}$ = net cash flow of call option contract that expired worthless

In the pre-harvest marketing stage, it is assumed that all option contracts are exercised and delivered. The net cash flow from put option contracts is therefore determined by Equation 6.17.

Finally, the net return generated by the producer is determined as follows:

$$\text{Net return} = NCF_{spot} + Net_{store} + NCF_{fwh} + NCF_{fw} + NCF_{fut} + NCFs_{futcl} + NCFl_{fwcl} + NCFs_{fut} + NCFl_{fut} + NCF_{putex} + NCF_{put/cl} + NCF_{put/nex} + NCF_{callex} + NCF_{callcl} + NCF_{callnex} \quad (6.25)$$

Where:

Net reurn = net return of crop sales

Appendix A serves as an example to illustrate how the various net cash flows and returns is calculated and shows the marketing decision making process of producers.

6.5 SOLUTION METHOD

Optimisation problems can be divided into unconstrained and constrained (any restriction the decision variables must satisfy) variables, and the latter into problems with equality constraints (where $x = 0$) and problems with inequality constraints (where normally $x \leq 0$). Inequality constraint problems also exist for $x > 0$. Thus there are three broad categories in which problems can be classified, and the corresponding solution methods were determined in two different eras.

Unconstrained optimisation problems were first solved with the methods of calculus, developed in the seventeenth century by Sir Isaac Newton (1642-1727) and Gottfried Wilhelm Leibniz (1646-1716). The solution to optimisation problems constrained by equalities was found a century later by Joseph-Louis Lagrange (1736-1813). For inequality-constrained problems, the solution procedures were not found until the 1940's, by John von Neumann and George Dantzig (Fang & Puthenpura, 1993). Optimisation with inequality constraints differs in one fundamental respect from the earlier problems: there is no closed, analytic expression that describes the solution. Therefore, it is necessary to know the optimal basis, or the list of the variables that appear in the optimal solution.

Linear programming is a mathematical model that is often helpful in solving decisions requiring a choice between a large number of alternatives. The theoretical concepts underlying the methods of linear programming have been known for many years. However, it was during World War II and immediately thereafter that the application of linear programming to planning problems was stressed. Since then these techniques have been applied increasingly to management decisions in various industries, including in agriculture. Linear programming is concerned with problems in which a linear objective function in terms of decision variables is to be optimised (i.e., either minimised or maximised) while a set of linear equations, inequalities, and signs (positive or negative values) are imposed on the decision variables as requirements. Optimisation problems for linear programming are made up of three basic ingredients:

- an **objective function** which has to be minimised or maximised;
- a set of **unknowns** or **variables** which affect the value of the objective function; and
- a set of **constraints** that allow the unknowns to take on certain values but exclude others.

If the objective function is for example:

Find x_1 and x_2 so as to:

$$\text{Maximise } Z = 5x_1 + 2x_2$$

Where:

x_1 = variable 1

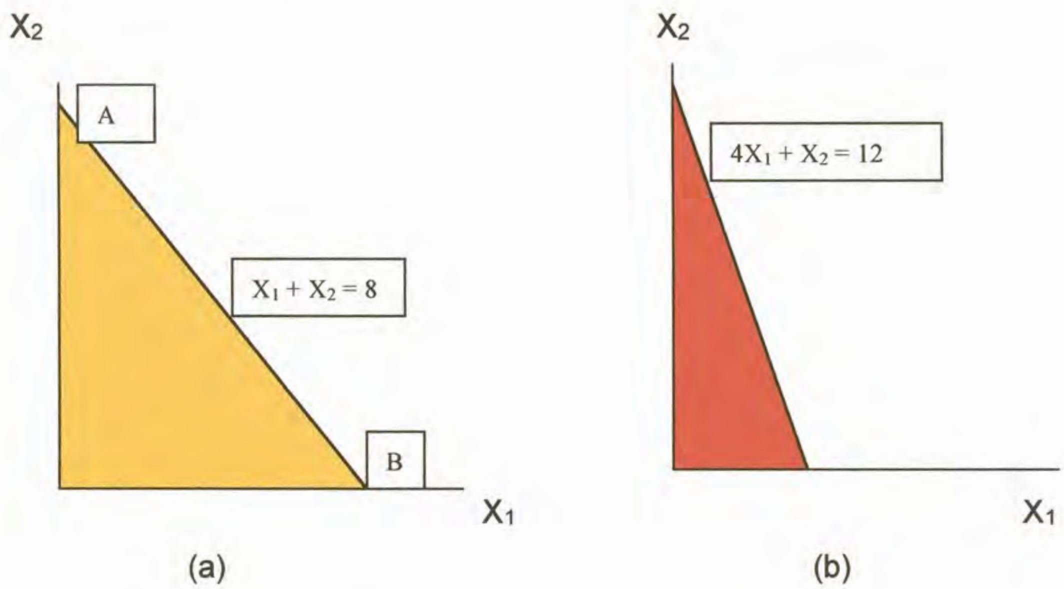
x_2 = variable 2

The following step entails the identification of all the different constraints on the problem. Assume the constraints are the following:

$$x_1 + x_2 \leq 8$$
$$4x_1 + x_2 \leq 12$$
$$x_1, x_2 \geq 0$$

The model formulation of the above maximisation problem is presented graphically in Figure 6.11. In order to graph the two constraint inequalities ($\leq$), it is necessary to treat each as an equality (=). By finding two points common to each equation, the lines can be determined and plotted on the graph. A method of plotting a line is to let one variable in an equation equal zero. For example, in $x_1 + x_2 \leq 8$ let $x_1 = 0$, then $x_2 = 8$ and let $x_2 = 0$, then $x_1 = 8$. These points are connected with a line in Figure 6.11 (a). For the constraint, $4x_1 + x_2 \leq 12$ let $x_1 = 0$, then $x_2 = 12$ and let $x_2 = 0$, then $4x_1 = 12$ and $x_1 = 3$. These points ($x_1 = 0$, $x_2 = 12$ and $x_1 = 3$, $x_2 = 0$) are then plotted on each axis and connected with a line in Figure 6.11 (b).

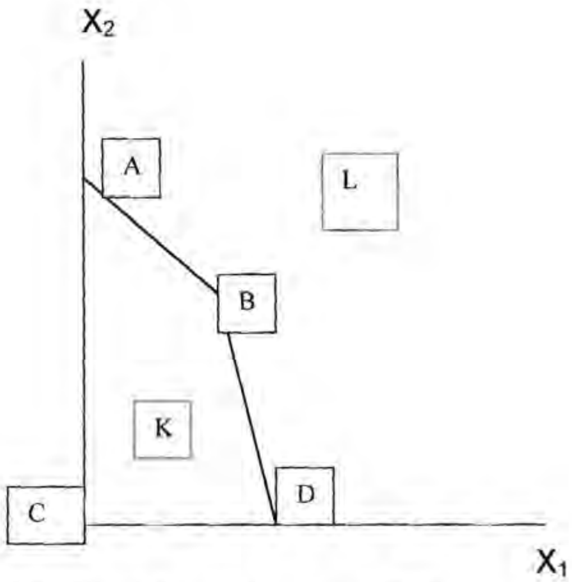
Figure 6.11: Graphic presentation of a maximisation problem



Source: Adapted from (Fang & Puthenpura, 1993)

By reinserting the ≤ inequalities in each constraint, a region is formed that simultaneously satisfies both the constraint relationships. This region, the shaded area ABDC in Figure 6.12 is defined as the feasible solution area, because it satisfies all system constraints. The feasible solution area is restricted to positive values because the variables x_1 and x_2 must be positive – $x_1, x_2 \geq 0$. Any set of x_1, x_2 values outside this region is not a feasible solution since it violates one or more of the constraints. For example, in Figure 6.12 point K is a feasible solution, while L is infeasible. Point K is feasible because it lies within the boundaries of ABDC and Point L is infeasible because it is outside the boundary lines. Although Point K is feasible, it is not the optimal combination. The optimal combination will normally fall on the boundary lines (ABDC).

Figure 6.12: Feasible and infeasible solutions



Source: Adapted from (Fang and Puthenpura, 1993)

The final step is to evaluate the objective function ($5x_1 + 2x_2$) at points A, B, D and C to determine which one(s) is optimal. This is accomplished in Table 6.7.

Table 6.7: Candidate solutions

Extreme points	Co-ordinates (x_1, x_2)	Objective function value ($5x_1 + 2x_2$)
A	0,8	16
B	(4/3),(20/3)	20
C	0,0	0
D	3,0	15

Point B occurs at the intersection of ($x_1 + x_2 = 8$) and ($4x_1 + x_2 = 12$), or {$x_1 = (4/3)$ and $x_2 = (20/3)$}. Since point B gives the maximum value (20) for the objective, it is the optimal combination.

The mathematical specification of an integer linear programming problem is the same as for a linear programming problem, with one exception. In addition to requiring the levels of all variables in a solution to be greater than or equal to zero, some or all variables can be required to take only zero or integer values, as opposed to fractional values. Integer linear programmes have the advantage of being more valuable for the purposes of this study as compared to ordinary linear programming, in the sense that integer values is now also taken into consideration. The most widely used general-purpose approach in integer linear programming requires a series of linear programmes to manage the search for integer solutions and to prove optimality.

Integer programming has proved valuable for modelling many and diverse types of problems in planning, routing, assignment and design. Industries that use integer programming include transport, energy, telecommunications, manufacturing and agriculture (Ferris, 1998).

Mixed integer programming requires that only some of the variables need to have integer values, whereas pure integer programming requires all variables to be integers. The MDSS developed in this chapter is based on **mixed integer linear programming**. The reason for this lies in the fact that futures contracts and options on futures contracts can only be for values of 100 tons and the multiples thereof.

6.5.1 Net cash flow used by MDSS

The mathematical model developed in this chapter consists of marketing activities as the basic building blocks. With the aid of an integer linear programme built on a spreadsheet, various combinations of these actions can be evaluated in terms of their impact on cash inflows and cash outflows, as well as other constraints that might be placed on their combination, and the objectives of the farm concerned.

The MDSS uses constraint optimisation to determine the optimal combination of marketing instruments that result in the highest net return. The net return is defined as the sum of the net cash flows from all the various marketing instruments available. Before integer linear programming can be used to solve an optimisation problem, certain constraints must be defined. The constraints used in this MDSS were the minimum and maximum number of tons that a producer was willing to allocate to a certain marketing instrument and the cash flow position of the producer. If the producer experienced cash flow problems, futures contract can be excluded from determining the optimal combination.

In order to determine the optimal combination of marketing instruments, the **net cash flow per ton** of each marketing instrument has to be determined. Furthermore, the various equations developed in Section 6.4.3.1 to Section 6.4.3.5 were adjusted for application to the MDSS to determine the net cash flow per ton. The MDSS used therefore the same equations with the only change that the net cash flow is determined per ton.

Appendix A serves as an example to illustrate how the various net cash flows and returns by the MDSS is calculated in determining the optimal combination of marketing actions.

6.6 CONCLUSION

Producers must repeatedly make decisions about what commodities to produce, by what production method, in what quantities, and how to sell them. Decisions are made subject to the prevailing physical and financial constraints of the farm and often in the face of considerable uncertainty about the planning period ahead. Uncertainty may arise in the expected yields, costs and prices for the individual farm enterprises, in fixed asset requirements and in the total supplies of the fixed assets available.

Traditionally, producers have relied on experience, intuition and comparisons with their neighbours to make their financial decisions. However, formal techniques of budgeting and comparative analysis have now been developed by farm management specialists, and these can be useful aids for making decisions in less complex situations or for analysing selected decisions when all the other farm decisions are taken as given. More recent advances in computers and in mathematical programming software mean that satisfactory procedures have now been developed for total farm planning in more complex situations.

Total farm planning can assist producers to adapt efficiently to a changing economic and technological environment. Mathematical programming in agriculture had its origins in attempts to model the economics of agricultural production, including its spatial dimension. The mathematical programming format is particularly suitable for agriculture. Producers, agronomists, and other agricultural specialists share a common way of thinking about agricultural inputs and outputs in terms of the annual crop cycle, and about input-output coefficients per hectare. Yields are conceived in tons per hectare, fertiliser applications in kilograms per hectare and so on.

By means of integer linear programming, attempts were made to develop the first MDSS suitable for South African producers. The aim of the MDSS developed in this chapter is to determine the optimal combination of marketing instruments to optimize crop net return. First, the net cash flows of producers by using various marketing instruments were determined. Thereafter, the net return per ton for each marketing instrument was determined. Using integer linear programming the optimal combination of marketing strategies was determined. The next chapter indicates how the MDSS was tested to prove its viability.

CHAPTER 7

APPLICATION OF THE MARKETING DECISION SUPPORT SYSTEM

If a man look sharply and attentively, he shall see Fortune; for though she is blind, she is not invisible

- Francis Bacon (1561 – 1626)

7.1 INTRODUCTION

The previous chapters discussed the changing agricultural environment in South Africa, the different types of risk that producers are faced with and various pricing instruments available to producers who wish to manage price risk. Chapter 6 focused on the development of a Marketing Decision Support System (MDSS) for grain producers in South Africa. This chapter discusses the application of the MDSS and its empirically testing. The MDSS allows for the possible effects of farm location, farm size and debt on marketing decisions. It also provides for variations in attitudes towards production and price uncertainty.

In economic terms, a well-managed farm is one that consistently makes larger net profits than similarly structured neighbouring farms. Because random localized events such as weather patterns often mask differences or similarities in management, it is important to observe differences in profits that persist over time. A crop producer can enhance the farm's revenue by better use and application of technology, improved cost management, improved yields and higher prices due to better marketing strategies. This chapter focuses on the application of the MDSS in its primary function of managing price risk. Producers have many alternatives for managing agricultural risk. They can diversify the farm business or the financial structure of the business. In addition, producers have access to various instruments, such as insurance and hedging, that can help reduce their farm's level of risk. Indeed, most producers combine many different strategies and instruments and formulate strategies to hedge against the risk of possible losses.

Because producers vary in their attitudes towards risk, risk management cannot be viewed using a 'one size fits all' approach. Different producers have to confront different situations, and their preferences regarding risk and their risk-return trade-offs have an important effect on decision-making in each given situation. This chapter investigates the application and usefulness of the MDSS as developed in this study for grain producers in South Africa.

7.2 AREAS OF RISK EXPOSURE

The preceding chapters discussed the various price risk management instruments available to producers in South Africa. It is essential that producers understand how to use the various pricing instruments to manage price risk and how to select the most appropriate pricing instrument to accomplish their objectives of sustainable, profitable farming. Some instruments manage only one of the primary market risks, while others may manage several types of risk. Knowing how to use the various instruments involves understanding the mechanics of such aspects as opening a trading account with SAFEX, placing orders with a broker and meeting margin requirements. It also includes understanding obligations and responsibilities for delivery, and conditions under which contracts can be cancelled or modified.

Selecting the most appropriate pricing instrument for a farm's financial and marketing situation is complex. The most appropriate pricing instrument is mainly determined by the following aspects:

- the producer's risk management objective(s) and expectations regarding future price movements;
- current price relationships and expectations regarding changes in those relationships; and
- the producer's attitude towards risk.

More than one pricing instrument may be available to accomplish a producer's objective. An important aspect of the decision process is to assess the risk associated with each pricing instrument. The following two questions provide guidelines in choosing the right instrument:

(i) What does the producer want to accomplish?

(ii) What is the best way to reach the financial objectives of the producer?

The main areas of farm risk were identified and examined in Chapter 3 as yield risk, price risk, institutional risk, personal risk, exchange rate risk and financial risk. These risks affect a producer's net income and should also be considered in the selection and implementation of pricing instruments. These risks can be summarised as follows:

- **Cash flow risk** is typically associated with trading in futures. It is the risk that the producer is unable to maintain a margin account due to a shortfall of cash on hand. Once a margin account is established and a futures position is taken, adverse price movements may require additional deposits in the margin account. Rising prices from a short futures sale position, for example, would result in margin calls. Conversely, declining prices would result in money flowing into the margin account of a short futures position to offset the decline in the value of the grain owned.

- **Business or counter-party risk** is the risk associated that the grain buyer will not be able to fulfil part or all of the contract agreement. The risk is especially important for producers who have forfeited their title to the grain, but have not yet received payment. Business failure is likely to result in the cancellation of forward contracts, leaving the producer in an open position on grain that was priced earlier.

- **Volatility risk** (as discussed in Chapter 5) is associated with the options market. The risk lies in the fact that option premiums do not change one-for-one with cash or futures prices, so that the net prices on such contracts do not move one-for-one with the change in price level. The extent of the risk varies with market volatility, the closeness of the options strike price to the underlying futures price, the length of time until the contract expires and whether the producer intends to hold the option position until maturity or to exit early.

- **Yield risk** arises when the producer sells a crop prior to harvest. The primary concern is that production volumes may fall short of expectation. The extent of yield risk varies with the type of pricing instrument used. When a producer enters into a short futures position or a forward contract, the producer is liable to deliver on the size of the contract. When yield is lower than expected, the producer can offset a short futures position by entering into a long futures position. This might occur at a higher price than the original short futures position. Producers can protect themselves against lower than expected production volumes in forward contracts by a *force majeure*. A *force majeure* gives producers the right to deliver volumes smaller than originally signed for. The seller of the forward contract normally grants this protection at a discounted price compared to a forward contract without a *force majeure*.

Although the following risks are not discussed at length in Chapter 3, they also affect price risk management alternatives:

- **Grain quality risk** is the risk that grain is graded lower due to disease or extreme weather conditions, and is subject to price discounts. This risk is associated with all pricing instruments.

- **Tax risk** includes the risk that losses associated with positions in the futures and options markets will be capital losses versus ordinary business expenses.

- **Control risk** is the risk associated with the number of decisions required to implement a pricing instrument fully. Some instruments require only one decision, a cash grain sale, for example. Other instruments, such as futures and options, require an initial decision and one or more subsequent decision(s). When a series of decisions is required, there is a risk of adverse market action that will reduce the net profit before subsequent decisions are made.

Farming, like any business enterprise, involves taking risks to obtain a higher income than might be obtained otherwise. Some producers appear to virtually disregard risk. But for most, the risk they can accept is limited. Thus, price risk management is not a matter of minimising price risk, but of determining how much risk to take, given a producer's alternatives and preference trade-offs. Therefore, the producer's choice between different pricing instruments is also influenced by the sensitivity of the pricing instruments towards the areas of risk exposure, as indicated by Table 7.1.

Table 7.1: Areas of risk exposure

Pricing alternative	Price level	Cash flow	Volatility	Business	Tax	Control	Yield	Quality	Risk rating
Selling out of inventory or establishing pre-harvest price levels									
Cash sales	x						x	x	Moderate to high
Forward contracts				x			x	x	Low to high
Short futures		x				x	x	x	Low to high
Buy put options	x		x			x	x	x	Low
Price grain & buy call option	x		x	x	x	x	x	x	Low
Minimum price contracts	x		x	x		x	x	x	Low
Retaining ownership									
Storage	x							x	Moderate to high
Sell grain, buy futures	x	x			x	x			Moderate to high
Sell grain, buy call options	x		x		x	x			Low
Minimum price contracts	x		x	x		x			Low
Delayed pricing contracts	x			x		x			Moderate to high

Source: Adapted from Ferris (1998)

It is clear from Table 7.1 that some grain pricing instruments are exposed to higher risk than others. Some instruments are designed to manage several aspects of risk. Instruments can be used in combination to extend risk management capabilities. The usefulness of the MDSS is compared with the areas of risk exposure of each instrument. Some producers in the study indicated that they are not interested in certain instruments, due to the level of risk exposure of that instrument, and they were consequently excluded from the analysis. Table 7.1 serves as a guideline for producers in their decision-making process and the suggested instruments of the MDSS are examined in respect of risk exposure (see Table 7.16).

7.3 THE SURVEY

A questionnaire was developed to collect data from crop producers in the Free State Province. The data was collected in the form of a postal survey, followed by telephonic interviews and personal interviews. Crop producers in Statistical Regions 28 and 29 in the Free State Province were randomly selected from address lists provided by local co-operatives and agri-businesses. From the postal survey, a response rate of 28% was obtained. The postal survey was augmented by telephonic interviews and personal visits. The data for the analysis were obtained from 14 producers in the above statistical regions. This resulted in a final response rate of 78%. None of the questionnaires were unusable due to incomplete information. Information regarding marketing strategies was collected from the producers during the 1998/99-marketing season for summer crops and the 1999/2000-marketing season for wheat. The reason why the MDSS was not tested for longer periods was that during its initial years SAFEX was used as a guaranteed forward pricing market with high levels of physical deliveries. Options on futures contracts only started trading in March

1998 and therefore the marketing seasons before the 1998/99 marketing season were unusable.

From the responses to the questionnaire, it seems that respondents spend an average of 3.2 hours per week reviewing marketing information. Weekly agricultural magazines were rated the most important sources of price information, followed by subscription-based information providers and SAFEX. When producers were asked to identify their needs for additional information and services to manage their grain marketing better, the most commonly requested service was information on price and production trends in international markets. Producers generally rated their skills in marketing management lower, than their production and financial management skills.

7.4 EVALUATION PROCUDURE FOR THE MDSS

The MDSS is based on the principles of integer linear programming. Firstly, the information pertaining to the producer was entered into the model. Every time a producer made a decision, the result was compared to the net effect suggested by the MDSS. From there on, the decisions suggested by the linear programme were taken into consideration in future decisions. For instance, when the model suggested that the producer should engage in a short futures position, the futures position was reflected in the next set of decisions. All option contracts suggested by the model were at-the-money, due to the difficulty in deciding how much an option must be in- or out-of-the-money.

Secondly, one month prior to harvest, the MDSS was run again to sell a total of about 80% of the producer's crop. If the producer had already sold more than 80% of the crop one month prior to harvest, this action of the MDSS was ignored. The primary reason for this action was that the spot price during harvest normally tends to be lower than prior to the harvest. By selling about 80% of the crop, a producer protects himself/herself from price risk, and the possibility of yield risk is much smaller than earlier in the season.

It is important to take note that in the case of sunflower seed, the first contracts were traded on 1 February 1999. Any decisions made by producers before that date could not be compared with other marketing alternatives available to producers. Soybean prices and strategies available to producers were limited to local prices. No international price risk instrument was taken into consideration, due to the fact that South Africa is a net importer of soybeans and therefore the soybean prices always reflect the import parity price of international soybeans. All the pricing tools available to producers for maize and wheat were taken into consideration by the MDSS (except in cases where producers specifically excluded certain instruments).

7.5 ANTICIPATED EFFECTS AND CASES INVESTIGATED

The analytical model used in this study allows for the possible effects of farm location, size and debt on marketing decisions. The model also provides for variations in attitudes towards production and price uncertainty. The complexity of the solution presented by the model resulting from the interrelatedness of these factors, however, is not conducive to simple, mathematically derivable comparative statistics. The purpose of this investigation, as stated previously, was therefore to investigate the sensitivity of the model to the instruments used in order to obtain the highest possible profit generated from the crops planted.

7.5.1 Investigation results

The marketing strategies corresponding to the 14 cases investigated are set out in Tables 7.2 to 7.15. For each case, information on the actual quantities (in tons) of each crop sold using each marketing alternative during the 1998/99 marketing season for summer crops and the 1999/2000 marketing season for wheat are also given. The net returns obtained by the producer and the MDSS are calculated using Equations 6.1 to Equation 6.25.

The sales in tons reported in these tables were not conducive to comparisons in terms of farm size or location. Therefore, the information was converted to the percentage of annual output marketed by the producer using each alternative. The marketing actions of the producers and the MDSS were divided into three different marketing stages:

- pre-harvest stage (actions taken before planting, during the growing season until harvest time);
- harvest stage (actions taken during the harvest season); and
- post-harvest stage (actions pertaining to the current marketing season after the harvest period, with no time limitation on the post-harvest stage).

The dates used in the testing of the MDSS are the same dates as those used by the individual producer when a marketing decision was made. Producers did not make marketing decisions on the same date, however, which means that the dates used in the testing of the model also vary for each individual producer.

7.5.1.1 White maize producers

The investigation took into account the different categories discussed in Section 6.2.1.4, Category A with a total crop production of less than 1 00 tons, Category

B with a total crop production between 1 000 tons and 1 999 tons, and Category C with a total crop production of 2 000 tons and more.

- **Producer A1**

The farm unit of Producer A1 is situated in Statistical Region 28 of the Free State Province. Producer A1 planted 133 hectares of white maize with a realised yield of 4,7 tons per hectare (classified in Category A). On 25 February 1999 he entered into a forward contract to deliver 200 tons of maize, which represents 32% of the total white maize crop, to a local elevator owner at a price of R850 per ton. During the harvest period, he sold the remainder of his crop on the spot market, at a price of R700/ton. Table 7.2 displays the results of Producer A1's actions as well as the results of the actions suggested by the MDSS.

Table 7.2 Comparative net returns – Producer A1

Actions	Producer A1	MDSS
Pre-harvest stage		
25/2/99		
Pricing instrument and % sold	Forward (32%)	Forward (32%)
Net cash flow	R93 715	R93 715
14/05/99		
Pricing instrument and % sold	0%	Short futures (48%)
Net cash flow		R99 387
Harvest stage		
14/06/99		
Pricing instrument and % sold	Spot market (68%)	Long futures (48%) Spot market (68%)
Net cash flow	R105 768	R115 400
Net return	**R199 483**	**R209 116**
% improvement		**4.85%**

The MDSS suggested the following marketing instruments during the 1998/99 marketing season:

Pre-harvesting stage

In the pre-harvesting stage the MDSS suggested that 32% of the crop should be sold using forward contracts. One month prior to harvest, the MDSS was run again to sell a total of 80% of the expected crop of Producer A1. The instruments suggested by the MDSS were to:

- sell 200 tons of maize on a forward contract on 25 February 1999; and
- engage in a short futures position (three contracts) at a price of R884/ton on 14 May 1999.

Harvest stage

The MDSS suggested that the producer should:

- deliver on the forward contract; and
- close out the short futures position with long futures contracts at a price of R863/ton and sell the rest of the crop on the spot market.

Producer A1 sold all the crop during harvest and did not participate in any post-harvesting strategies. The actions suggested by the MDSS generated an improvement of 4.85% on the net return of Producer A1. Producer A1 received exceptionally good prices from his forward contract compared to the futures contracts at that stage. The prevailing futures price during the same time was only R723 per ton, resulting in a very strong basis. The only negative aspect of the producer's strategy was that the producer had locked himself out of any possible future price increase.

- **Producer A2**

The farm unit of Producer A2 is in Statistical Region 28 of the Free State province. Producer A2 planted 400 hectares of white maize with a realised yield of 4 tons per hectare. The total production volume of Produce A2 is 1 600 tons and he is therefore classified in Category B. The producer followed the following marketing strategies:

- On 15 March 1999 he entered into a forward contract to deliver 800 tons of maize to a local elevator owner at a price of R550 per ton.
- He sold the remainder of his crop (800 tons) on the spot market during the harvest period and received an average price of R550 per ton.

The producer indicated that he did not want to sell any maize on the futures market due to cash flow problems. No further constraints were indicated on any other pricing alternative. Table 7.3 combines the results of Producer A2 to those of the MDSS.

Table 7.3: Comparative net returns – Producer A2

Actions	Producer A2	MDSS
Pre-harvest stage		
15/03/99		
Pricing instrument and % sold	Forward (50%)	R880 put (50%)
Net cash flow	R129 120	R336 236
21/05/99		
Pricing instrument and % sold	0%	R900 put (30%)
Net cash flow		R249 402
Harvest stage		
20/06/99		
Pricing instrument and % sold	Spot market (50%)	Exercise puts (80%) Spot market (20%)
Net cash flow	R129 120	R511 223
Net return	**R258 240**	**R511 223**
% improvement		**97.96%**

The MDSS suggested the following actions during the 1998/99 marketing season, which generated a 97.96% increase in net returns:

Pre-harvest stage

- Eight put option contracts with a strike price of R880/ton should be purchased on 15 March 1999.
- Six put option contracts with a strike price of R900/ton should be purchased on 21 May 1999, one month prior to harvest.

Harvest stage

- On 21 June 1999 all the put option contracts were to be exercised and 200 tons of maize were to be sold on the spot market.

- **Producer A3**

The farm unit of Producer A3 was in Statistical Region 28 of the Free State Province. Producer A3 planted 850 hectares of white maize with a realised yield of 4.59 tons per hectare (classified in Category C). The producer followed the following marketing strategies:

- On 12 November 1998, he entered into a forward contract to deliver 1 000 tons of maize to a local elevator owner at a price of R540 per ton.
- On 10 December 1998, he bought five put option contracts with a strike price of R680/ton.
- He sold 2 200 tons of his crop on the spot market during harvest and received an average price of R602 per ton.
- He exercised his put option contracts at a strike price of R680/ton.
- The producer chose a storage alternative, storing 200 tons of maize until March and sold the maize for R800 per ton on the spot market.

The producer indicated that he did not want to sell more than 600 tons of maize on the futures market. No further constraints were indicated on any other pricing alternative. Table 7.4 displays the results achieved by Producer A3 actions as well as those of the MDSS proposals.

Table 7.4: Comparative net returns – Producer A3

Actions	Producer A3	MDSS
Pre-harvest stage		
12/11/98		
Pricing instrument and % sold	Forward (25.6%)	Short futures (15.4%) R650 put (10.2%)
Net cash flow	R306 363	R374 413
10/12/98		
Pricing instrument and % sold	R680 put (12.8%)	R650 put (12.8%)
Net cash flow	R133 941	R159 766
26/05/99		
Pricing instrument and % sold	0%	R870 put (43.6%)
Net cash flow		R1 049 855
Harvest stage		
22/06/99		
Pricing instrument and % sold	Spot market (56.4%) Exercise R680 puts	Exercise R870 puts Spot market (66.4%) Long futures (15.4%)
Net cash flow	R957 838	R1 432 398
Post-harvest stage		
01/07/99 - 01/03/00		
Pricing instrument and % sold	Storage until March Spot market (5.1%)	Short futures (5.1%) Long futures (5.1%) Spot market (5.1%)
Post-harvest return	R96 077	R141 641
Net return	**R1 360 278**	**R1 948 452**
% improvement		**43.24%**

The MDSS suggested the following actions which resulted in a net improvement of 43.24%:

Pre-harvest stage

- Four put option contracts with a strike price of R650/ton were to be bought on 12 November 1998.
- A short futures position (six contracts) at R650/ton was to be taken on 12 November 1998.
- Five put option contracts with a strike price of R650/ton were to be bought on 10 December 1998.
- Seventeen put option contracts with a strike price of R870/ton were to be bought on 26 May 1999.

Harvest stage

- The short futures position was to be closed out and the maize was to be sold on the spot market.
- The nine put option contracts, with strike price of R650, were to be allowed to expire worthless and the maize was to be sold on the spot market.
- The 17 put option contracts with a strike price of R870 were to be exercised.

Post-harvest stage

- A short position was to be taken on 1 July 1999 on the futures market for two March futures contracts at a price of R943/ton.
- The short futures position was to be closed out on 1 March 2000 at a price of R816/ton and the 200 tons of maize were to be sold on the spot market at a price of R800/ton.

In all three instances, the MDSS delivered better results than the producers did. Therefore, the development of the MDSS could be regarded as successful in the case of white maize. The MDSS improved the results by 4.83% for the producer in Category A, 97.96% for the producer in Category B and 43.24% for the producer in Category C. The choice of the various marketing instruments varied from forward contracts to futures contracts and options on futures contracts. The improvement obtained by the MDSS for Producer A1 was relatively low. This was due to the fact that the producer had engaged in a forward contract at a price higher than the prevailing futures contract. The dramatic improvement achieved by the MDSS for Producer A2 was due to the fact that the producer had closed a forward contract for 50% of the crop at a low price and had given up his chances of benefiting from future price increases. The improvement achieved by the MDSS for Producer A3 was mainly due to better post-harvest marketing actions such as engaging into a short futures position. The MDSS improved on the returns of all three producers by engaging in further marketing actions one month prior to harvest, resulting in a sale of 80% of the expected harvest.

7.5.1.2 Yellow maize producers

- **Producer B1**

The farm unit of Producer B1 is in Statistical Region 28 of the Free State Province. Producer B1 planted 150 hectares of yellow maize with a realised yield of 3.7 tons per hectare (classified in Category A). The producer did not enter into any pre-harvest marketing strategies. He sold 355 tons of his crop on the spot market during harvest and stored 200 tons until March 2000. On 1 March 2000 he sold the maize for R700/ton. The producer did not place a constraint on any marketing alternative. Table 7.5 sets out the results of Producer B1's actions as well as of those proposed by the MDSS.

Table 7.5: Comparative net returns – Producer B1

Actions	Producer B1	MDSS
Pre-harvest stage		
18/05/99		
Pricing instrument and % sold	0%	Short futures (36%)
Net cash flow		R143 000
Harvest stage		
18/06/99		
Pricing instrument and % sold	Spot market (64%)	Long futures (36%) Spot market (64%)
Net cash flow	R106 850	R105 429
Post-harvest stage		
01/07/99 - 01/03/00		
Pricing instrument and % sold	Storage until March Spot market (36%)	Short future (36%) Long future (36%) Spot market (36%)
Net cash flow	R74 575	R104 976
Net return	**R181 425**	**R210 405**
% improvement		**15.97%**

The MDSS suggested the following marketing actions:

Pre-harvest stage

- The MDSS engaged in two short futures contracts at a price of R795/ton on 18 May 1999.

Harvest stage

- The MDSS closed out the short futures position and sold the maize on the spot market on 18 June 1999.

Post-Harvest stage

- On 1 July 1999 the MDSS entered into two short futures contracts for March at a price of R895/ton.
- The March futures contract was closed out on 1 March 2000 at R816/ton and the maize was sold on the spot market for a price of R700/ton.

These actions resulted in an improvement of 15.97%. During the harvest stage, the return of the MDSS was smaller than the return of the producer. The reason was that the futures hedge resulted in a loss, due to the fact that there was a small difference between the short and long futures position and a low spot market price.

- **Producer B2**

The farm unit of Producer B2 is in Statistical Region 28 of the Free State Province. Producer B2 planted 250 hectares of yellow maize with a realised yield of 4.8 tons per hectare (classified in Category B). The producer engaged in the following marketing actions:

- On 15 March 1999, he sold 600 tons of his crop on a forward contract at a price of R600/ton.
- The remainder of the crop was sold on the spot market during harvest at a price of R600/ton.

Producer B2 did not place any constraints on any marketing alternative. Table 7.6 sets out the results of Producer B2's actions as well as of those proposed by the MDSS.

Table 7.6: Comparative net returns – Producer B2

Actions	Producer B2	MDSS
Pre-harvest stage		
15/03/99		
Pricing instrument and % sold	Forward (50%)	Short futures (50%)
Net cash flow	R186 250	R210 455
10/05/99		
Pricing instrument and % sold	0%	Short futures (33%)
Net cash flow		R203 367
Harvest stage		
10/06/99		
Pricing instrument and % sold	Spot market (50%)	Long futures (83%) Spot market (100%)
Net cash flow	R186 250	R372 500
Net return	**R372 500**	**R401 992**
% improvement		**7.91%**

To achieve an increase of 7.91%, the MDSS suggested the following marketing actions:

Pre-harvest stage

- A short position was to be taken for six July 1999 contracts for R735/ton on 15 March 1999.
- A short position was to be taken for four July 1999 contracts for R795/ton 10 May 1999, one month prior to harvest.

Harvest stage

- The short futures contracts were to be closed out and the crop was to be sold on the spot market during harvest.

- **Producer B3**

The farm unit of Producer B3 was in Statistical Region 28 of the Free State Province. Producer B3 planted 650 hectares of yellow maize with a realised yield of 3.57 tons per hectare. The total production volume of yellow maize for Producer B3 was 2 320ton. Producer B3 was therefore classified in Category C. The producer engaged in the following marketing actions:

- On 19 February 1999, he sold 1 300 tons of his crop on a forward contract at a price of R650/ton.
- The remainder of the crop was sold on the spot market during harvest acquiring a price of R850/ton.

Producer B3 placed a constraint of 800 tons on any futures position. Table 7.7 displays the results of Producer B3's actions as well as of those proposed by the MDSS.

Table 7.7: Comparative net returns – Producer B3

Actions	Producer B3	MDSS
Pre-harvest stage		
19/02/99		
Pricing instrument and % sold	Forward (56%)	Forward (56%)
Net cash flow	R304 156	R304 156
21/05/99		
Pricing instrument and % sold	0%	Short futures (26%)
Net cash flow		R217 483
Harvest stage		
21/06/99		
Pricing instrument and % sold	Spot market (44%)	Long futures (26%) Spot market (44%)
Net cash flow	R442 645	R434 183
Net return	**R746 801**	**R738 339**
% improvement		**(1.13%)**

In this example, the producer obtained better results (1.13%) than the MDSS. The MDSS suggested the following marketing actions, but failed to produce better results:

Pre-harvest stage

- Forward contracts were to be engaged in at a price of R500/ton on 19 February 1999.
- A short position was to be taken for six July 1999 contracts for R795/ton on 21 May 1999.

Harvest stage

- The short futures position was to be closed out and the remainder of the crop was sold on the spot market.

The primary reason for the producer's achieving a higher return was that the spot price he received was R45/ton higher than the prevailing futures price. No marketing instrument of the futures or derivatives market would have beaten the returns obtained by this producer.

The MDSS obtained better results for Producers B1 and B2 but not for Producer B3. Given the explanation, the MDSS may be regarded as having been successfully developed for yellow maize producers.

7.5.1.3 Sunflower seed producers

Only two categories are investigated. This was due to the fact that the total production of sunflower seed in the Free State Province for the 1998/99 season was 629 000 tons on 430 000 hectares, resulting in an average yield of 1.46 tons per hectare. On average, 1 370 hectares of sunflower seed have to be planted to qualify for Category C. The average farm size in the Free State is only 1006 hectares, well below the required size for Category C. It is important also to bear in mind that the first futures contracts on sunflower seed were traded for the first time only on 1 February 1999. Therefore, if a producer engaged in forward contracts before this date, the MDSS can only suggest the same marketing actions.

- **Producer C1**

The farm unit of Producer C1 is in Statistical Region 28 of the Free State Province. Producer C1 planted 135 hectares of sunflower seed with a realised yield of 2.1 tons per hectare (classified in Category A). The producer engaged in the following marketing actions:

- On 7 December 1998, the producer sold 170 tons of sunflower seed on a forward contract at a price of R1 250/ton.
- The remainder of his crop was sold on the spot market during harvest at a price of R1 150/ton.

The producer did not put a constraint on any marketing alternative. Table 7.8 sets out the results of Producer C1's actions as well as of those proposed by the MDSS.

Table 7.8: Comparative net returns – Producer C1

Actions	Producer C1	MDSS
Pre-harvest stage		
07/12/98		
Pricing instrument and % sold	Forward (60%)	Forward (60%)
Net cash flow	R132 248	R132 248
12/03/99		
Pricing instrument and % sold	0%	Short futures (35%)
Net cash flow		R70 888
Harvest stage		
12/04/99		
Pricing instrument and % sold	Spot market (40%)	Long futures (35%) Spot market (40%)
Net cash flow	R77 284	R88 907
Net return	**R209 532**	**R221 155**
% improvement		**5.56%**

The MDSS suggested the following marketing actions:

Pre-harvest stage

- 170 tons of sunflower seed were to be sold with a forward contract at a price of R1 250/ton on 7 December 1998.
- In order to secure a selling level of 80%, a short futures position was to be taken on 12 March 1999, one month prior to harvest, for one contract at a price of R1 200/ton.

Harvest stage

- The futures position was to be closed out on 12 April 1999 with a long futures contract at a price of R1 080/ton and the sunflower seed was to be sold on the spot market at a price of R1 150/ton.

These marketing actions resulted in an improved return of 5.56%. It is important to note that the number of marketing instruments available during the first decision was limited due to the fact that contracts on sunflower seed only started trading on 1 February 2000. This example proves that the MDSS can be used by even very small producers. Producer C1 only harvested 284 tons of sunflower seed.

- **Producer C2**

Producer C2 also operated in Statistical Region 28 of the Free State Province. Producer C2 planted 650 hectares of sunflower seed with a realised yield of 1.9 tons per hectare (classified in Category B). The producer engaged in the following marketing actions:

- On 2 October 1998, he sold 370 tons of sunflower seed on a forward contract at a price of R1 250/ton.
- He sold 670 tons of his crop during harvest on the spot market at a price of R1 080/ton.

- The remainder was stored until December and sold on the spot market for R975/ton.

The producer indicated that he did not want to engage in any futures position after harvest. Table 7.9 sets out the results of Producer C2's actions as well as of those proposed by the MDSS.

Table 7.9: Comparative net returns – Producer C2

Actions	Producer C2	MDSS
Pre-harvest stage		
02/10/98		
Pricing instrument and % sold	Forward (30%)	Forward (30%)
Net cash flow	R232 825	R232 825
14/03/99		
Pricing instrument and % sold	0%	Short futures (40%)
Net cash flow		R280 501
Harvest stage		
14/04/99		
Pricing instrument and % sold	Spot market (54%)	Long futures (40%) Spot market (54%)
Net cash flow	R305 407	R378 526
Post-Harvest stage		
20/04/99 - 01/12/99		
Pricing instrument and % sold	Storage till December Spot market (16%)	R1220 puts (16%) Exercise puts on 24/11/99
Net cash flow	R51 971	R63 715
Net return	**R590 202**	**R675 066**
% improvement		**14.38%**

The MDSS suggested the following marketing actions:

Pre-harvest stage

- 30% of the expected crop was to be sold on 2 October 1998 with a forward contract at a price of R1 250/ton.
- Five short futures contracts were to be taken on 14 March 1999 at a price of R1 200/ton.

Harvest stage

- The short futures position was to be closed on 14 April 1999 with long futures contracts at a price of R1 050/ton and the crop was sold on the spot market.

Post-Harvest stage

- Two December put option contracts were to be bought on 20 April 1999 with a strike price of R1 220/ton and the contract was to be exercised just before the expiry date of 24 November 1999.

The MDSS provided better results than both producers. The MDSS was successfully developed for sunflower seed producers. Although the choice of marketing instruments was limited by Producer C2, the MDSS could still improve on the return by 14.38%. If producers use a greater variety of marketing instruments, not only forward contracts, producers could ensure higher returns. This proves the importance of using of futures and derivative contracts.

7.5.1.4 Soybean producers

It is important to bear in mind that there are no futures contracts for soybeans in South Africa. Due to the fact that South Africa is a net importer of soybeans, the South African price closely follows import parity prices for soybeans. Because no SAFEX marketing alternatives are available to producers, the MDSS can only suggest the same marketing actions as those followed by the producers.

- **Producer D1**

The farm unit of Producer D1 is in Statistical Region 29 of the Free State Province. Producer D1 planted 105 hectares of soybeans with a realised yield of 2.23 tons per hectare (classified in Category A). The producer engaged in the following marketing actions:

- On 1 March 1999, he entered into a forward contract to deliver 100 tons of soybeans to a local buyer at a price of R1 200/ton.
- He sold the remainder of his crop on the spot market during harvest, receiving a price of R1 050/ton.

There was no forward contract available to the producer between the date that he entered into the contract and his harvest date. The MDSS did not suggest any other marketing action and the results obtained by the MDSS were thus obviously the same as those of Producer D1. The net return of Producer D1's actions (endorsed by the MDSS) is reflected in Table 7.10.

Table 7.10: Comparative net returns – Producer D1

Actions	Producer D1	MDSS
Pre-harvest stage		
01/03/99		
Pricing instrument and % sold	Forward (42.7%)	Forward (42.7%)
Net cash flow	R49 761	R49 761
Harvest stage		
01/05/99		
Pricing instrument and % sold	Spot market (57.3%)	Spot market (57.3%)
Net cash flow	R42 756	R42 756
Net return	**R92 517**	**R92 514**
% improvement		**0%**

The MDSS followed exactly the same actions as the producer, due to the fact that the MDSS could not propose any other marketing instruments.

- **Producer D2**

The farm unit of Producer D2 is in Statistical Region 29 of the Free State Province. Producer D2 planted 550 hectares of soybeans with a realised yield of 2.3 tons per hectare (classified in Category B). The producer engaged in the following marketing actions:

- On 1 December 1998, he entered into a forward contract to deliver 380 tons of soybeans at a price of R1 100/ton.
- He sold 630 tons of his crop on the spot market, receiving a spot price of R1 050/ton.
- The remainder of his crop was stored until 1 December 1999 and sold on the spot market at a price of R1 300/ton.

The producer could enter into a forward contract during the latter half of March for a price of R1 200/ton. The producer expected higher spot prices and declined the offer. The net returns of Producer D2's actions and of those proposed by the MDSS are reflected in Table 7.11

Table 7.11: Comparative net returns – Producer D2

Actions	Producer D2	MDSS
Pre-harvest stage		
01/12/98		
Pricing instrument and % sold	Forward (30%)	Forward (30%)
Net cash flow	R215 774	R215 774
23/03/99		
Pricing instrument and % sold	0%	Forward (40%)
Net cash flow		R155 348
Harvest stage		
12/05/99		
Pricing instrument and % sold	Spot market (50%)	Spot market (10%)
Net cash flow	R232 466	R122 118
Post-harvest stage		
20/05/99 - 01/12/99		
Pricing instrument and % sold	Storage until December Spot market (20%)	Storage until December Spot market (20%)
Net cash flow	R134 952	R134 952
Net return	**R583 185**	**R628 192**
% improvement		**7.72%**

The higher return obtained by the MDSS was due to the fact that the producer disregarded the forward contract presented to him at a later stage.

- **Producer D3**

The farm unit of Producer D3 is in Statistical Region 29 of the Free State Province. Producer D3 planted 525 hectares of soybeans with a realised yield of 4 tons per hectare. Producer D3 was classified in Category C because the total production volume of soybeans is 2 100 tons. Producer D3 produced soybeans under irrigation, which explains the higher yield. The producer engaged in the following marketing actions:

- On 2 November 1998, he entered into a forward contract to deliver 1 200 tons of soybeans to a local buyer at a price of R1 100/ton.
- He sold the remainder of his crop (900 tons) on the spot market during harvest, receiving a price of R1 080/ton.

No further forward contracts were available to the producer between the date when he entered into the contract and his harvest date. The MDSS did not suggest any other marketing action and the results obtained by the MDSS are the same as those of Producer D3. The net return of Producer D3's actions is reflected in Table 7.12.

Table 7.12: Comparative net returns – Producer D3

Actions	Producer D3	MDSS
Pre-harvest stage		
02/11/98		
Pricing instrument and % sold	Forward (57%)	Forward (57%)
Net cash flow	R392 700	R392 700
Harvest stage		
01/05/99		
Pricing instrument and % sold	Spot market (43%)	Spot market (43%)
Net cash flow	R276 525	R276 525
Net return	**R669 225**	**R669 225**
% improvement		**0%**

From the above examples one can deduce that an MDSS cannot yet successfully be developed for soybean producers in South Africa. The only application for the MDSS so far is that producers can use the model to hedge their crops on the Chicago Board of Trade (CBOT). The usefulness of hedging on the CBOT has, to date, not yet been established, mainly due to the fact that South Africa is not a soybean exporter and the spot prices reflect the import parity prices of soybeans. The MDSS might become more applicable once the total soybean production in South Africa exceeds the total consumption of soybeans and soybean products in this country.

7.1.5.5 Wheat producers

The MDSS used December futures and options contracts in attempting to optimise the returns of the producers in the sample. All contracts referred to represent December contracts, unless a post-harvest action is indicated. In post-harvest actions, the MDSS used May contracts. The December contracts were used because they reflect the harvesting time of wheat, as with the July contract for maize.

- **Producer E1**

The farm unit of Producer E1 is in Statistical Region 29 of the Free State Province. Producer E1 planted 200 hectares of wheat with a realised yield of 2 tons per hectare (classified in Category A). The producer engaged in the following marketing actions:

- On 2 August 1999, he sold 120 tons of his crop on a forward contract at a price of R1 200/ton.
- The remainder of the crop was sold on the spot market during harvest, attaining a price of R1 150/ton.

Producer E1 did not want to participate in any futures contracts or derivative contracts. Table 7.13 displays the results of Producer E1's actions as well as of those proposed by the MDSS.

Table 7.13: Comparative net returns – Producer E1

Actions	Producer E1	MDSS
Pre-harvest stage		
02/08/99		
Pricing instrument and % sold	Forward (30%)	Forward (30%)
Net cash flow	R82 808	R82 808
06/11/99		
Pricing instrument and % sold	0%	0%
Net cash flow		-
Harvest stage		
21/06/99		
Pricing instrument and % sold	Spot market (70%)	Spot market (70%)
Net cash flow	R179 218	R179 218
Net return	**R262 026**	**R262 026**
% improvement		**0%**

In this example, the MDSS suggested the same marketing actions as those that the producer engaged in. The producer was not interested in any futures or option contracts. Due to the fact that there were no forward contracts available one month before harvest, the MDSS could not suggest any other marketing actions.

- **Producer E2**

The farm unit of Producer E2 is in Statistical Region 29 of the Free State Province. Producer E2 planted 500 hectares of wheat with a realised yield of 2.2 tons per hectare. Producer E2 produced 1 000 tons of wheat and is therefore classified in Category B. The producer engaged in the following marketing actions:

- On 29 June 1999, he sold 400 tons of his crop on a forward contract at a price of R1 100/ton.
- On 1 September 1999, he entered into a short futures position (500 tons), at a price of R1 210/ton.
- The producer closed out his short futures position and sold the remainder of his crop on the spot market during harvest, acquiring a price of R1 170/ton.

Producer E2 imposed no marketing constraints. Table 7.14 sets out the results of Producer E2's actions as well as of those proposed by the MDSS.

Table 7.14: Comparative net returns – Producer E2

Actions	Producer E2	MDSS
Pre-harvest stage		
29/06/99		
Pricing instrument and % sold	Forward (36%)	Short futures (36%)
Net cash flow	R250 509	R281 535
01/09/99		
Pricing instrument and % sold	Short futures (45%)	Long futures (36%) Short futures (82%)
Net cash flow	R358 483	R642 129
Harvest stage		
30/11/99		
Pricing instrument and % sold	Long futures (45%) Spot market (64%)	Long futures (82%) Spot market (100%)
Net cash flow	R458 023	R712 445
Net return	**R708 532**	**R712 445**
% improvement		**0.55%**

In this example, the MDSS improved on the results obtained by the producer by 0.55%. The MDSS suggested the following marketing actions:

Pre-harvest stage

- Four short futures contracts were to be purchased on 29 June 1999 at a price of R1 189/ton.
- The short futures contracts were to be closed out on 1 September 1999 and a short position was to be taken for nine December 1999 contracts at a price of R1 210/ton.

Harvest stage

- The short futures position was to be closed out and the crop was sold on the spot market during harvest.

No marketing action was suggested for 30 October 1999 (one month prior to harvest) because 82% of the expected crop had already been committed.

- **Producer E3**

The farm unit of Producer E3 is in Statistical Region 29 of the Free State Province. Producer E3 planted 800 hectares of wheat with a realised yield of 2.6 tons per hectare (classified in Category C). The producer engaged in the following marketing actions:

- On 10 August 1999, he sold 1 000 tons of his crop on the futures market at a price of R1 200/ton.
- On 4 November 1999, he closed out his futures position at R1 180/ton.
- During harvest he sold 1 300 tons of wheat on the spot market, obtaining a price of R1 150/ton.
- The remainder of the crop was stored until 15 May 2000 and sold on the spot market, acquiring a price of R1 250/ton.

Producer E3 imposed no marketing constraints. Table 7.15 sets out the results of Producer E3's actions as well as of those proposed by the MDSS.

Table 7.15: Comparative net returns – Producer E3

Actions	Producer B3	MDSS
Pre-harvest stage		
10/08/99		
Pricing instrument and % sold	Short futures (48%)	Short futures (48%)
Net cash flow	R304 156	R304 156
04/11/99		
Pricing instrument and % sold	Long futures (48%)	Long futures (48%)
Net cash flow	R15 932	R15 932
Harvest stage		
04/12/99		
Pricing instrument and % sold	Spot market (62%)	Spot market (100%)
Net cash flow	R949 319	R1 575 515
Post-harvest stage		
10/12/99 - 15/05/00		
Pricing instrument and % sold	Storage Spot market (38%)	Long futures (38%) Short futures (38%)
Net cash flow	R591 918	R16 800
Net return	**R1 557 169**	**R1 608 247**
% improvement		**3.28%**

The MDSS achieved an improvement of 3.28% on the producer's actions. The MDSS suggested the following marketing actions:

Pre-harvest stage

- A short futures position was to be taken on 10 August 1999 on ten December wheat contracts at a price of R1 200/ton.

- The short futures position was to be closed out on 4 November 1999 at a price of R1 180/ton.

Harvest stage

- The entire crop was to be sold on the spot market at a price of R1 150/ton.

Post-Harvest stage

- A long futures position was to be taken on eight May 2000 wheat contracts on 10 December 1999 at a price of R1 296/ton.
- The long futures position was to be closed out at a price of R1 320/ton on 15 May 2000.

The MDSS could not improve on the net return of Producer E1. Producer E1 was not interested in any derivative contract, therefore the same net return was achieved. The MDSS obtained better returns for both Producer E2 (0.55%) and Producer E3 (3.28%). It can therefore be declared that the MDSS was successfully developed for wheat producers in South Africa.

7.6 SUMMARY

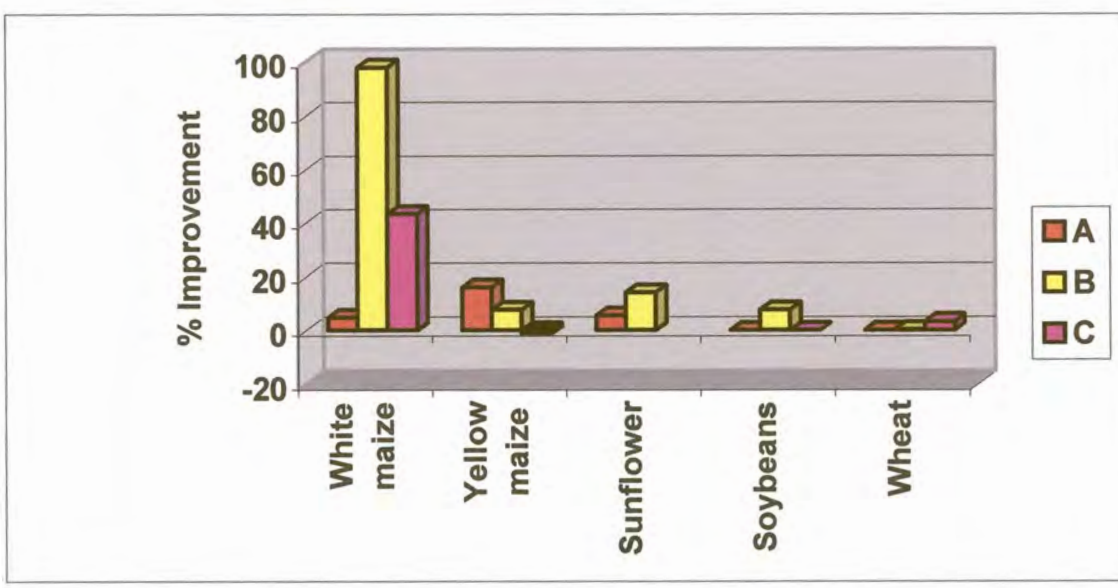
When one compares the results obtained using the MDSS with the results obtained by the individual producers, the following conclusions can be drawn:

- White maize producers: The MDSS produced better results than the individual producers did in Categories A, B and C.
- Yellow maize producers: The MDSS produced better results in Categories A and B, but failed to produce better results in Category C. Producer B3 received a spot market price of R45/ton more than the prevailing futures price.

- Sunflower seed producers: The MDSS produced better results in both Categories A and B.
- Soybean producers: The MDSS could not improve the returns of producers D1 and D3. This was because no other marketing instrument was available. The MDSS could only improve the results in Category B. The reason for this improvement was that the producer failed to sell more of the crop before harvest on a forward contract.
- Wheat producers: The MDSS improved on the results of Category B and C. It failed to improve on the results in Category A, due to the unwillingness of the producer to participate in any SAFEX contracts.

Figure 7.1 provides an overview of the improvement obtained by the MDSS above the results of the producers.

Figure 7.1: Percentage improvement achieved by MDSS compared to the results of the individual producers

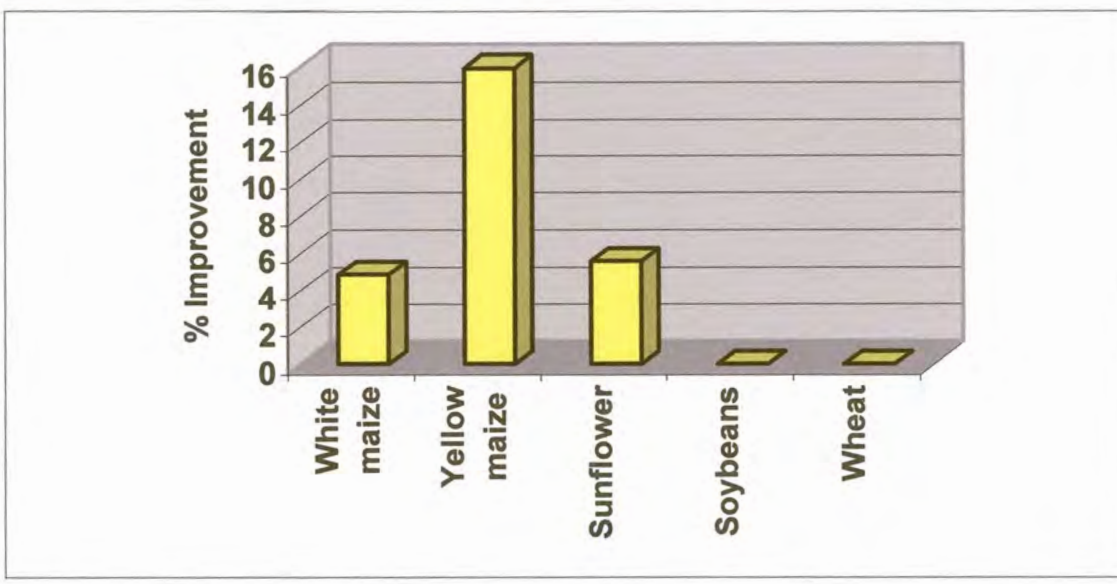


When the different categories are examined in isolation, the following conclusions can be drawn:

- **Category A** (as depicted in Figure 7.2)

  There was an improvement on the returns of three different producers of white maize, yellow maize and sunflower seed. The model failed to obtain better results for soybean and wheat producers. Wheat producer E1 was not interested in any other marketing instrument, and the MDSS could not optimise the net return. There was only one choice available, and that was a forward contract. More than one type of marketing instrument is normally necessary to optimise decisions. Therefore, the development of the MDSS could be regarded as successful in the case of Category A producers.

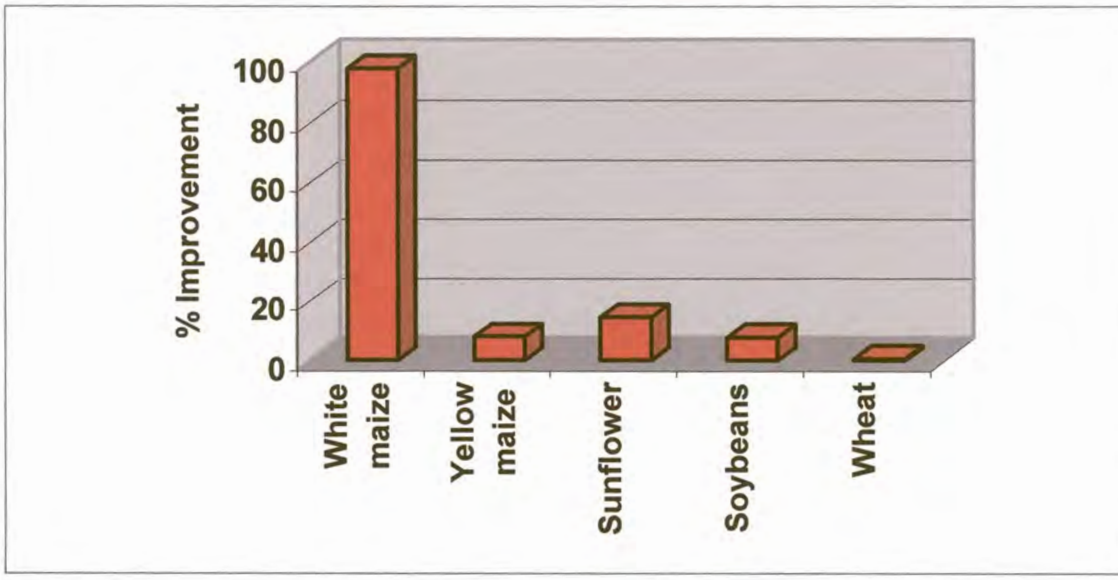
Figure 7.2: Summary of the results of Category A producers



- **Category B producers** (as set out in Figure 7.3):

  The MDSS improved on the returns of all five (white maize, yellow maize, sunflower seed, soybeans and wheat) types of individual producers. The greatest improvement was for white maize and the smallest improvement was for wheat. Therefore, the development of the MDSS could be regarded as successful in the case of Category B producers.

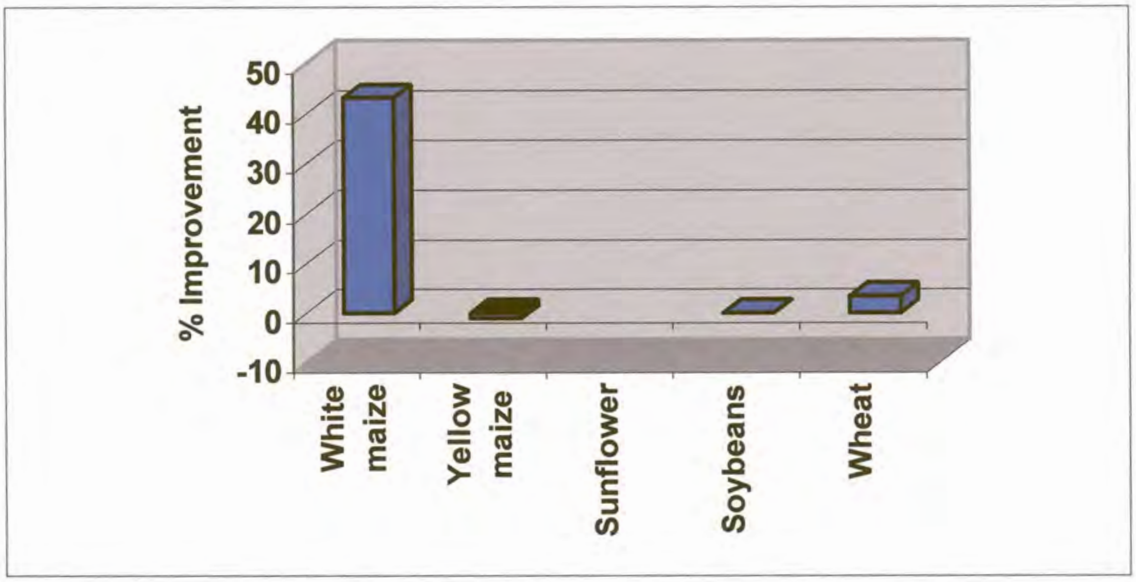
Figure 7.3: Summary of the results of Category B producers



- **Category C producers** (as set out in Figure 7.4):

The model failed to produce better net returns for two of the four producers. The yellow maize producer achieved a better return than the MDSS. The primary reason for the higher return for the yellow maize producer was the high harvest spot price achieved by the producer in question. The harvest spot price was R45/ton higher than the futures price. The spot price during harvest was R95/ton higher than the futures price, considering an average area differential of R50/ton for Statistical Region 28. The MDSS was not successfully developed for soybean producers. Overall, however, the development of the MDSS could be regarded as successful in the case of Category C producers.

Figure 7.4: Summary of the results of Category C producers



The development of the MDSS for crop producers in South Africa could be regarded as successful overall and the following conclusions can be drawn:

- An MDSS was successfully developed for white maize, yellow maize, sunflower seed, and wheat producers.
- An MDSS could not successfully be developed for soybean producers. For the model to work, it is necessary that futures contracts and options on futures contracts are available. If the producer only has a choice between one forward contract and the next forward contract during each marketing decision, the function is not optimisation, but mere calculation.
- There is no limitation regarding production levels on the usage of the MDSS. The MDSS optimises returns for crops smaller than 500 tons to crops of more than 2000 tons. It is not even necessary to have any crop to participate in the futures market. However, the MDSS was developed to improve the price risk management of crop producers and the aim was not to improve the returns of speculators.
- The MDSS can only be successfully implemented for crops trading on SAFEX. For other crops, the MDSS represents a purely financial system

determining the net returns of the marketing actions taken. Cross-hedging alternatives should be investigated to ensure better price risk management for crops not traded on SAFEX.

- The MDSS also improved the results of producers already participating on SAFEX. Producer A3's return was improved by 43.24%, Producer E2's return was improved by 0.55% and producer E3's return was improved by 3.28%. This indicates that the MDSS was also successfully developed even for producers making use of a wider variety of marketing instruments.

In order to manage price risk effectively, producers should use more than one type of marketing instrument. Producers should strive to secure marketing instruments that protect them from downside price movements, but also provide opportunities to participate in an upward price movement. It is important for producers to sell more of the expected crop during the pre-harvest marketing phase. Prices normally tend to be lower during the harvest period and any pre-harvest decision could enhance the return.

Table 7.16 analyses the sensitivity to risk exposure of the strategies followed by the producers (marked as ♦) and the strategies suggested by the MDSS (marked as ♣).

Table 7.16: Strategy sensitivity towards areas of risk exposure

	Price level	Cash flow	Volatility	Business	Tax	Control	Yield	Quality
White maize								
A1	♦			♦			♦	♦
MDSS	♣	♣				♣	♣	♣
A2	♦						♦	♦
MDSS	♣		♣			♣	♣	♣
A3	♦		♦	♦		♦	♦	♦
MDSS	♣	♣	♣			♣	♣	♣
Yellow maize								
B1	♦							♦
MDSS		♣				♣	♣	♣
B2	♦			♦			♦	♦
MDSS	♣	♣				♣	♣	♣
B3	♦			♦			♦	♦
MDSS	♣	♣		♣		♣	♣	♣
Sunflowers								
C1	♦			♦			♦	♦
MDSS		♣		♣		♣	♣	♣
C2	♦			♦			♦	♦
MDSS	♣		♣			♣	♣	♣
Soybeans								
D1	♦			♦			♦	♦
MDSS	♣			♣			♣	♣
D2	♦			♦			♦	♦
MDSS	♣			♣			♣	♣
D3	♦			♦			♦	♦
MDSS	♣			♣			♣	♣
Wheat								
E1	♦			♦			♦	♦
MDSS	♣			♣			♣	♣
E2	♦	♦		♦		♦	♦	♦
MDSS	♣	♣				♣	♣	♣
E3	♦	♦				♦	♦	♦
MDSS	♣	♣				♣	♣	♣

The actions suggested by the MDSS for all the crops except soybeans increased the areas of risk exposure. The producers should compare this exposure to the higher returns that they could have obtained by following the strategies suggested by the MDSS. The more complex the strategy, the higher the return and the more the areas of risk exposure. This therefore requires a constant revision of the marketing plan. The risk rating of the various marketing actions was decreased by the fact that the MDSS suggested that about 80% of the crop must be priced prior to harvesting. Doing so decreased the level of price risk dramatically.

Marketing is too often an afterthought in the production process. Consequently, producers are often forced to accept the spot price at harvest in a highly variable spot market. Thus, price variability in the market translates into price risk, which compounds with production risk and increases income variability. Effective management of marketing activities will become increasingly important for farm business survival as the market becomes more volatile.

7.7 CONCLUSION

This chapter investigated the application of the MDSS developed in Chapter 6. This chapter shows how producers can manage investment risk with the aid of an MDSS. While some general conclusions can be drawn from this chapter, they do not apply to all producers because marketing risk varies across different crops. Furthermore, price levels and price variability vary from year to year, depending on market conditions. For example, in years of high planting time prices, the chances that prices will fall increase, because producers (if weather allows) may respond to the high prices with a lot of plantings, resulting in an oversupply of the crop. If the high planting season price is due to short carryover from the previous year, then the chances of a very high price also increases, due to the good chance that crops will be in short supply for two years. Producers need to look at the forward, futures and options markets during planting. They must consider their own yield potential and variability to understand the degree of investment risk during the marketing season. The MDSS developed in the previous chapter can be used by producers to customise the results obtained in this chapter for their own farm conditions and a particular year's price conditions.

CHAPTER 8

CONCLUSION AND RECOMMENDATIONS

Nam et ipsa scientia potestas est.

Francis Bacon (1561 - 1626)

8.1 INTRODUCTION

Unfortunately, agricultural producers cannot dictate what price they receive for their products. The price is determined by the market and, given the transition to freer global trade and the abolition of the various marketing boards, the market is likely to become increasingly volatile. All too often, marketing is an afterthought in the production process. Hence, producers are often forced to accept the price at harvest. Thus, price variability in the market translates into price risks, which compound production risks and increase income variability and investment risk. In future, effective management of marketing activities will become increasingly important for the survival of any farm business.

Against this backdrop, the overall objective of this study, as formulated in the introductory chapter, was therefore to develop a marketing decision support system (an MDSS) for crop producers to manage their investment risk. Decision support systems are an important application of management information systems (Davis & Olson, 1985). According to Keen and Morton (1978), decision support systems imply the use of technology to improve decision-making, and allow users to retrieve data and evaluate alternatives based on models fitted for the decisions that have to be made. There are virtually no reports available on decision support systems for crop marketing in South Africa.

8.2 APPROACH FOLLOWED

In order to accomplish the objectives, the following approach was adopted in the study:

- A critical overview of grain production in South Africa was given. In this overview the most important crops were established and the deregulation of the marketing process was discussed.
- Risk management in agriculture was examined. The study also analysed risk management tools available to producers in South Africa to manage investment risk.
- The history and application of the futures market in South Africa was investigated.
- The development and applications of options on futures contracts as viable risk management tools were investigated.
- A theoretical description, and the development and testing of a proposed decision support system to aid producers to manage their production risk were set out.

From this study, a number of conclusions can be drawn, as is set out in Section 8.3 below.

8.3 RESEARCH RESULTS

The aim of the study was to develop a decision support system to help crop producers to manage investment risk. A postal survey, followed by telephonic interviews and personal interviews, was conducted during the 1998/1999 marketing season for summer crops and the 1999/2000 marketing season for wheat, using a sample of grain producers in Statistical Regions 28 and 29 in the

Free State Province. Data collected from producers in the Free State were used in the study for two main reasons. Firstly, there was the overall prominence of the province (27.3% of the total production) in the production of maize (33.4%), sunflower seed (54.5%), wheat (43.9%) and soybeans (6.7%) in South Africa. Secondly, most of the farming units (18,5%) in South Africa are situated in the Free State. From the postal survey, a response rate of 28% was obtained. The postal survey was augmented by telephonic interviews and personal visits. This resulted in a final response rate of 78%. None of the questionnaires were unusable due to incomplete information.

The farm units were divided into three different categories. Category A refers to a farm unit size less than 1000 hectares, the farm unit size for Category B is from 1000 hectares to 1999 hectares, and for Category C, the farm unit size is from 2000 hectares upwards. Due to the fact that the products from farms are not homogeneous in type and quality, each farm was investigated individually. The crop choice, input costs and marketing strategies followed by each producer were compared to the strategies proposed by the model. It was assumed that producers were hedgers and that obligations from short sales in the futures market are not satisfied through delivery. Speculation was disregarded in the testing of the decision support system.

In the testing of the MDSS, the following steps were followed:

- Firstly, the information regarding input costs and marketing strategies followed by the producer was entered into the programme. Every time when a producer made a decision, the result was compared to the net effect suggested by the linear programme. From there on, the decisions suggested by the linear programme were taken into consideration in future decisions. For instance, when the programme suggested that the producer should engage in a short futures position, the futures position would be reflected in the next set of decisions. All option contracts suggested by the model were at-the-money.

- Secondly, one month prior to harvest, the MDSS was run again to sell a total of about 80% of the producer's crop. If the producer did sell more than 80% of the crop one month prior harvest, this action by the MDSS was ignored.

After comparing the results obtained by the MDSS with the results obtained by the individual producers, the following conclusions could be drawn:

- White maize producers: In all three categories (from 4.8% in Category A to 98% in Category B) the MDSS produced better results than the individual producers.
- Yellow maize producers: In Categories A (16%) and B (7.9%), the MDSS produced better results, but it reduced the return in Category C (-1.1%).
- Sunflower seed producers: The MDSS produced better results in both Categories A (5.6%) and B (14.4%).
- Soybean producers: The MDSS could only improve the results of Category B (7.7%).
- Wheat producers: The MDSS improved the results of Category B (0.55%) and C (3.28%). It failed to improve the results in Category A, due to the unwillingness of the producer concerned to participate in any SAFEX contracts.

Table 8.1 shows the individual and average improvement of the MDSS obtained per crop and per category.

Table 8.1: Individual and average improvement using the MDSS

Percentage improvement				
	Category A	**Category B**	**Category C**	**Average**
White maize	4.8	98.0	43.2	**48.7**
Yellow maize	16.0	7.9	-1.1	**7.6**
Sunflower seed	5.6	14.4		**10.0**
Soybeans	0	7.7	0	**2.6**
Wheat	0	0.6	3.3	**1.3**
Average	**5.3**	**25.7**	**11.3**	

From the table, some conclusions can be drawn:

- An MDSS has been successfully developed, and producers can apply it successfully to manage marketing risk and minimise investment risk.
- An MDSS system has been successfully developed for white maize, yellow maize, sunflower seed and wheat.
- An MDSS system has not yet been developed for crops such as soybeans, which are not actively traded on the South African Futures Exchange.
- Any size producer, from a small producer to a large producer, can use the MDSS developed in this study.
- The MDSS developed in this study incorporates all the different marketing tools available in South Africa to producers to manage their investment risk. It is the first model developed that implements more than one or two strategies at a time.
- The MDSS has added value to agricultural risk management in South Africa.

8.4 RECOMMENDATIONS AND AREAS FOR FURTHER RESEARCH

This investigation may be regarded as an exploratory step towards the development of an intelligent decision support system to aid producers to manage their investment risk. The results by no means provide the final answer to understanding the complicated processes involved in price risk management. Within the stated limitations, the findings nevertheless represent, in addition to obvious financial benefits and implications, a new approach to price risk management for producers, with direct implications and research opportunities in the following areas:

- empowering producers with knowledge to make more use of SAFEX in their quest for price risk management;
- empowering producers to see price risk management as part of total farm risk management – producers should focus on the farm's risk-bearing capacity when they develop their marketing plan;
- the proposed model employs very elementary methods for optimising the net returns of producers, but research in the application of synthetic strategies must be undertaken;
- tax implications on the net returns of the various strategies should be investigated;
- daily price changes and their effects on margin accounts were ignored, which implies that an investigation on daily closing price movements could produce additional information that should be taken into consideration when comparing the different marketing alternatives; and
- the proposed model was implemented and tested for one marketing season only, suggesting that testing the model over a longer period with different price movements may provide further proof of the viability of the application of the decision support system.

8.5 CONCLUSION

The risks confronted by crop producers are of particular interest, given the changing role of the government since the 1996 Agricultural Products Marketing Act was passed. A more sophisticated understanding of risk and risk management is important to help producers make better decisions in marketing their produce in the new deregulated environment. An ideal price risk management tool would cost a small amount, reduce the chances of low net returns, and not sacrifice upside price potential. Against this background, the question posed in this study is whether a decision support system could be developed to manage investment risk faced by grain producers in the marketing of their crop. This chapter has provided a summary of the most important conclusions of this investigation. The important limitations and the implications of this investigation have also been discussed and the areas that warrant further research indicated.

Learning from mistakes can be an effective educational tool, but learning from marketing mistakes may be too costly a lesson. Provided they are used with sufficient realism, decision support systems can help producers to explore marketing management matters without having to pay too much for possible mistakes.