1. Introduction

1.1 Background

Since the post-war period, productivity in agriculture world wide has generally risen faster than in many other sectors. This has contributed to a slower rate of increase in agriculture product prices relative to other sectors, particularly the agricultural input sector. Consequently this scenario contributes to the phenomena of decreasing terms of trade, where prices paid are increasing and prices received are decreasing.

Deteriorating terms of trade does not necessarily mean that farmers average net incomes will also fall. It does however mean that farmers have to adjust if farm incomes are not to be eroded. Common forms of adjustment include increasing the business size and the use of technological innovation. Another approach is to diversify the farm business and to invest cash surpluses into non-agricultural investments.

Diversification of investments can also be used by farm managers as a risk management strategy. Risk management has become substantially more important to farmers now than ever before. This situation has been largely influenced by the governments recent "hands-off" approach towards the sector by deregulating rural commodity and financial markets. Examples of such micro-economic reforms include the dismantling of price support and stabilisation schemes. As a consequence, the rural sector in recent years has been submitted to greater influences from external inconsistencies.

1.2 Risk

From a management viewpoint, risk is defined by Hardaker (1991) as the extent of lack of control over performance, or uncertainty in consequences. Similarly, risk is defined by Reilly (1989) as the uncertainty of future outcomes. As decision making by farmers is inevitably made in an environment of uncertainty, risk has a significant influence on farmers production and investment decisions.

The impact of risk on a farm business can be seen in terms of the cost of actions taken to preserve the economic and financial viability of the farm business over the long haul (Malcolm 1992). Consequently risk often discourages decisions that have greater annual profit potential because a farm business cannot 'chance' an adverse outcome of a possible event. It is therefore important to attempt to predict the probability and extent of adverse outcomes.

Makeham and Malcolm (1993) suggested that farmers face two broad types of risk: financial and business. A sound understanding of these types are needed to obtain a better understanding of farmers risk responses if their objectives and aspirations are to be pursued.

1.2.1 Financial risk

In general terms, financial risk refers to the uncertainty of a business to maintain solvency or liquidity. Solvency can be described as the potential of a business's total assets to cover total liabilities. Similarly, liquidity is the ability of the business to cover its current liabilities with its current assets. Uncertainty is introduced when a farm business borrows money to fund its operations which is called debt financing.

Debt financing can be beneficial to the business by increasing the farm's returns per dollar of equity, if the investment has a greater return than the cost of borrowing. However if investment returns are less than the cost of borrowing, it will decrease the earning per dollar of equity. The use of debt financing will also increase the variability in farm earnings and consequently magnify the business risk experienced.

1.2.2 Business risk

Business risk is independent of the financial structure of the farm, and describes the variability of returns to farm assets. It is generally reflected in a farm's cash flow. The range of business risks often faced by the farm manager can be broken down into five main categories. They include production risk, market risk, technological risk, legal and social risk, and human risk. These categories are discussed briefly below.

Production risk involves the uncertainty inherent in a farms biological production process. Typical sources of production risk found within crop and livestock production include weather, genetic performance, and disease and pest infestation.

Market risk encompasses the uncertainty found with saleable commodities and purchased inputs. Common sources of uncertainty can include the relative prices of commodities and inputs, inflation, and interest rates. Another area for concern in market risk may be the availability and quality of specific inputs.

Technological risk occurs when current decisions may be offset by future technological improvements. Investments in durable assets are subjected to high levels of risk, as they are particularly susceptible to dramatic technological changes.

Legal and social risk become more evident for farm managers if their business grows larger and more dependant on non-farm sources of capital. Legal risks may be introduced with family break ups and marketing techniques like forward selling. Also the possibility of government changes are an important source of risk to farmers.

Human factors such as labour and management can significantly influence farm performance. The human factor does however lack some degree of reliability and therefore introduce uncertainty into farm productivity. Examples of human sources of risk can include health of key personnel, management competency, and changing management objectives.

1.3 Business Risk Management Strategies

One of the aims of the present study is to establish a management strategy that will help reduce business risk. Currently there are seven major strategies that are available to farmers to help them manage business risk. These strategies include stable enterprise selection, diversification, production flexibility, forward contracts, plant and machinery, insurance, and the futures market.

1.3.1 Stable enterprise selection

An enterprise that is considered stable is one that offers less variable returns over time than others. Enterprise stability characteristics can be found within the production and marketing systems, and the potential for government policy influences.

1.3.2 Diversification

Diversification can be described as the combination of enterprises and/or investments that have different return patterns over time. The intention of this practice is to reduce the variability of the whole farm business by combining activities and/or investments that have little correlation in their net returns. A good example of diversification would include a farmer investing off-farm in real estate. This allows for a very diverse business structure, as the two have negligible correlation.

1.3.3 Production flexibility

Basically flexibility in farming refers to the potential of the business to readily change production methods in response to external and internal stimuli. Possible strategies that will achieve this include cost asset, product and time flexibility.

To employ a cost flexible strategy would be to select an enterprise with a higher proportion of variable costs, or the hiring of resources rather than buying. The main advantage of this strategy is that it will allow the release of resources which can be used elsewhere in the farm business more efficiently.

The asset flexibility strategy involves the purchase or construction of assets with more than one use. An example of this would be a shearing shed that has a multi-purpose storage capacity.

Farm enterprises with product flexibility are those which grow produce that have more than one end use. One such example may include a crop enterprise that could be harvested for grain or fodder.

Farm enterprises that have relatively short production cycles display time flexibility qualities. These enterprises tend to be less risky as they tie up farm resources for shorter periods, so that alternative production plans can be adopted more rapidly.

1.3.4 Forward contracts

Forward contracts allow farmers to sell their produce to specific buyers at a guaranteed fixed or minimum price prior to harvest. These contracts are now available for a wide range of products including wheat, cotton and beef. This strategy consequently transfers market risk from the farmer to the buyer. However this system does incur some legal risks of failing to meet the contract's quota.

1.3.5 Plant and Machinery

Extra plant and machinery as a business risk management strategy is particularly prevalent in crop growing areas where weather can interrupt essential seeding or harvesting operations. There are cases where a farm business may appear to have excessive levels of plant and machinery for normal conditions, but is in fact adequate when weather restricts the amount of time to plant or harvest. However over capitalisation in plant and machinery can often lead to an increase in financial risk by increasing the farmers debt financing commitments.

1.3.6 Insurance

There are a number of different types of insurance that are relevant to the farm business. A typical form of insurance used in agribusiness is crop yield insurance. Yield loss or crop damage from hail, flood, fire, and frost can be covered by insurance for some crops in Australia. The insurance premium is in proportion to the risk borne by the insurance company.

Other relevant insurance types of insurance include property, personal injury and life. Personal injury and life insurance can be crucial for the farm businesses long-term viability. Without this insurance the viability could be threatened with the loss of key personnel.

1.3.7 Futures market

The futures market is where people make agreements (ie. futures contracts) to buy or sell commodities at a set price at an agreed time in the future. This market allows farmers to lock into a price for their product. It can therefore be considered a price risk management tool.

However, futures trading is not widely practised amongst Australian farmers (Thompson 1994). One significant reason for this, is that farmers generally have a poor understanding of the futures market. Thus if farmers wish to lock onto a future price, they usually find it easier to use a forward contract when it is available.

Another common reason for the general lack of acceptance of futures trading in rural Australia, is that futures contracts are only available in relatively large fixed amounts. Contract sizes are 10,000 kg live weight for cattle and 2,500 kg clean for wool, and will not suit many producers.

Finally, a futures contract will not allow a farmer to benefit from a price rise on the physical market. For this reason purchasing a futures option has advantages and disadvantages. A futures option requires a premium payment to convey the right to participate in futures trading. It differs from a futures contract in that a contract involves an obligation to future trading. The futures option enables the farmer to drop the contract should the physical price rise, or to lock in on the contract price should the physical price fall. A major problem with using futures options is that the premium payment can be relatively high.

1.4 Efficiency Criteria

King and Robison (1984) suggest that the most direct way of measuring a decision makers preferences under uncertainty is to estimate an expected utility function. A utility function refers to a single valued index of desirability to the possible outcomes from a decision. Hence it is an exact representation of preferences. However King and Robison (1984) also suggest that an estimated utility function may not be completely accurate due to problems incurred in the estimation process.

These problems are addressed with the use of the efficiency criteria to order choices. The criteria in effect specify restrictions upon the decision makers' preferences and provide a partial ordering of choices. Efficiency criteria are defined by Levy and Sarnat (1984) as decision rules for dividing all potential investment options into two mutually exclusive sets: an efficient set and an inefficient set. The efficient set contains the desirable investment options for a particular group of investors.

King and Robison (1984) considered efficiency criteria to be useful in; (a) situations involving a single decision maker whose preferences are unknown, (b) situations involving decision makers whose preferences differ yet conform to a specific set of restrictions, and (c) analysing policy alternatives or extension recommendations that affect many diverse individuals. As these situations are very similar to those found in farm management economics, the efficiency criteria should prove useful in the present study.

However, there is one major problem in using efficiency criteria for partially ordering choices. This is the potential to trade-off discriminatory power of investment alternatives with general applicability to decision makers. It is therefore important that the restrictions of the criteria used are relevant to the preferences of the decision maker/s in question.

The common method of decision analysis under uncertainty whilst using the efficiency criteria, is the stochastic dominance rules. These dominance rules vary in the manner in which they restrict the decision makers utility function. Four dominance rules are briefly described below.

1.4.1 First degree stochastic dominance

The first degree stochastic dominance (FSD) technique is based on the assumption that all decision makers have positive marginal utility for the performance measure being considered. Therefore it is relevant for all decision makers who prefer more to less.

When using the FSD decision criterion, cumulative distribution functions are calculated for each alternative and these are used to determine the efficient set. If for example, two feasible alternatives are represented by the cumulative distribution functions F(x) and G(x) (where x is the performance measure), F(x) is preferred to G(x) when $F(x) \leq G(x)$ for all possible values of x, and if the inequality is strict for some value of x. Thus F(x) is said to be stochastically dominant and G(x) is considered the less efficient alternative.

Because of the minimal restrictions imposed on the decision makers utility function, the FSD technique is applicable to a wide range of decision makers. However FSD lacks discriminatory power and therefore relatively few alternatives can be eliminated in this way. This view is supported by Anderson *et al.* (1977) who stated that it tends to be the rule rather than the exception that CDFs from different families and indeed CDFs from the same family intersect at least once, thereby predisposing against the chance of identifying any FSD. Subsequently the second degree stochastic dominance (SSD) technique was introduced by Hadar and Russel (1969) to increase discriminatory power.

1.4.2 Second degree stochastic dominance

This technique is based on the premise that decision makers are risk averse as well as having a positive marginal utility. This imposes greater restrictions on the utility function and allows a more sensitive selection of investments. Hence the SSD efficient investment set is essentially a subset of the FSD efficient set.

Under the SSD decision criterion, the cumulative distribution function of F(x) would be preferred to G(x) if

$$\int_{-\infty}^{x} F(x).dx \leq \int_{-\infty}^{x} G(x).dx$$

for all possible values of x, and if the inequality is strict for some value of x. In this case for F(x) to dominate, the cumulative distribution function may cross but in aggregate the area to the left of F(x) must be greater than the area to the left of G(x), for all values of x.

Thus SSD has greater discriminatory powers than FSD, but it is applicable to a smaller group of investors. If even greater discriminatory powers are required to decide between alternative investments then the third degree stochastic dominance or the stochastic dominance with respect to a function rules can be used.

1.4.3 Third degree stochastic dominance

The third degree stochastic dominance (TSD) technique has a more sensitive selection capabilities than the SSD technique, due to an even greater restriction on the decision makers utility function. The extra restriction includes the assumption that with increasing levels of income, absolute levels of risk aversion will decrease. As the assumption is in addition to that of risk aversion, the TSD efficient set is a subset of the SSD efficient set.

1.4.4 Stochastic dominance with respect to a function

Stochastic Dominance with Respect to a Function (SDRF) or Second Degree Stochastic Dominance with Respect to a Function was derived from the SSD framework by Meyer (1977) who found it to be a more discriminatory efficiency criterion which allowed for greater flexibility in representing preferences. This criterion inherits the SSD restrictions on the decision makers utility function, but has the added restriction that the decision maker's absolute risk aversion function lie within positive lower and upper bounds. As written by King and Robison (1984), the solution procedure for SDRF requires the identification of a utility function $u_o(x)$, which minimises

$$\int_{-\infty}^{\infty} [G(x) - F(y)]u'(x).dx$$

subject to the constraint

$$r_1(x) \leq -u''(x)/u'(x) \leq r_2(x) \quad \text{for all values of } x.$$

Consequently under the SDRF conditions, the cumulative distribution function F(x) is preferred to the cumulative distribution function G(x) by all individuals whose absolute risk aversion function (ie $-u''(x)/u'(x)$) lie between the lower and upper bounds $r_1(x)$ and $r_2(x)$.

1.5 Research Objective

Many farmers who have opportunities for further investment face the problem of choice of investment strategy. Strategies might involve off-farm or on-farm deployment of funds or some combination of on and off-farm investments. The advantages of off-farm investments are that they allow for the spreading of risk through diversification in business, and may offer greater returns.

The objective of the present research dissertation was to examine the financial implications of alternative off-farm investments to the farm business, whilst analysing the risks involved. The losses or gains accruing to such off-farm investments were aggregated over a ten year period, thus the sensitivity of the analysis can be improved.

To achieve this objective a stochastic budgeting model of two case study farms in the New England region were simulated, with three off-farm investment strategies over time. The investment options include selected representatives from broad investment groups and it is intended that the study will determine which off-farm investment strategy is best. Each of the investment scenario's will be assessed by two methods of decision analysis which have a comprehensive consideration for risk.

One model (SDRF) assumes the attitudes of decision makers' and ranks the stochastic choices for them, whilst the other (@Risk presentations) prepares stochastic choices in an intelligible format so that the individual can personally rank the alternatives incorporating his own free choice. The purpose of using the different decision criteria was to strengthen the validity of a result if they are common, but if the results are not then the purpose would be to establish why that these differences may occur.

Of the two case-study properties that have been used for this study, one farm business structure is largely based around one enterprise, namely wool production. The other property has a much more diverse enterprise production base of wool, beef and fat lambs. By comparing the relative riskiness of off-farm investment strategies for enterprises with distinctly different risk profiles, some broader conclusions may be drawn about off-farm investment as a risk management strategy.

1.6 Chapter Outline

The case study approach will be used for obtaining data for the present analysis. Chapter 2 will provide details of management objectives, investment options, and the case study properties and off-farm investments that are targeted.

The purpose of chapter 3 is to describe how risk is taken into consideration in the whole farm planning analysis of the case study farms. The chapter describes in detail how uncertain variables are handled with stochastic budgeting, simulations and the @RISK program. The chapter also describes two methods of decision analysis used to assess the different investment strategies.

Chapter 4 will provide the details and a discussion of the results gained from the two decision analyses. Both analyses derive a ranking of the investment strategies.

The final chapter will contain a discussion about the assessment of investment strategies, limitations of the study, suggestions for future research, and conclusions.

2. The Case Studies

2.1 Background

Predominantly, there are two critical variables that influence financial viability in the farm business; unpredictable seasonal conditions, and market prices. Variable seasonal conditions influence revenue earnings indirectly through varying output levels, whilst variable market prices directly motivate fluctuations in the revenue earned. They can be considered a threat to the business if they cannot absorb the variations in returns.

The degree of control the farm manager can exert over the performance of the farming enterprise is limited by the rapidity with which the physical resources of the business can be re-orientated to meet changing prices and seasonal conditions (Kaine *et al,* 1992). The limitation can be largely attributed to both the lack of liquidity found with most farming situations and the long lead times that are found in production. Hence, there is little scope for redeploying resources in the short term to meet changing circumstances. This limited control re-enforces the vulnerability of the farm business to externalities

2.2 Risk Management Objectives

The basic objective of any farmer's risk management is his or her capacity to plan for and survive unfavourable financial outcomes (Hardaker and Gill 1994). Just how critical risk management is to the farm manager will depend on the individual farm manager's preference towards risk. From a general perspective, Ferguson (1982) states that the survival of the farm business is the goal accorded the highest priority by farmers. Hence it can be assumed that the key objective of most farm managers is the minimisation of the threat that the variability of market prices and seasonal conditions pose to the survival of the farm enterprise.

A common management technique that attempts to monitor, and to some degree control financial performance is 'whole farm planing'. It is a method of financial planning for the farm business and is based on price forecasts and expected production levels. However due to the inherent unpredictability of agricultural prices and production, this method alone has limited value as a decision aid in farm management particularly when dealing with uncertainty.

2.3 Investment Options

A focus of the present study is to illustrate the magnitude and variability in returns from alternative investment strategies. When a farm manager is presented with the opportunity to invest a cash flow surplus there are number of investment options that are normally available and they include; capital reserve, plant and machinery, farm improvements, lower debt levels, rural land, and off-farm or non-agricultural assets.

2.3.1 Capital reserve

The purpose of a capital reserve is to provide a buffer against periods of poor financial performance by supplementing the cash flow when required. Typically capital reserves are non-agricultural assets that are held in a form that can be readily drawn upon to provide money when required. Some flexibility is critical in a farm business for risk management as it provides the capacity to service debt and hence survive unfavourable financial outcomes.

2.3.2 Plant and machinery, and farm improvements

Maximising production efficiency which in turn minimises the average total costs is a common objective for many farm managers. The necessary investments in plant and machinery, and farm improvements are essential to maintain farm productivity. However these investments are not always strategically production driven. They can often result from the farm managers attempts to minimise tax liabilities and can lead to over investment in farm assets than if the investment levels were targeting production efficiency. Over-investment in farm assets can lead to lack of investment flexibility, because generally plant and machinery, and farm improvements cannot be quickly converted to cash to service debt in times of poor financial performance and consequently leaves the farm business vulnerable to risk.

2.3.3 Lowering debt levels

The advantage of paying off debt levels is to lower the level of financial risk faced by the farm manager. However this advantage may well be offset by the gains from leverage which enables the farm business to have a greater overall profit earning potential. The decision to lower debt levels will be largely determined by the farm businesses ability to service that debt and by the individual's preference towards risk. Also it could well be less risky to neglect lowering debt levels to boost capital reserves for later debt servicing requirements.

2.3.4 Rural land

Expansion of the existing farm business can be an attractive option in that it will likely boost production efficiency through the economic phenomenon of 'increasing returns to scale' . However, such a choice should be taken with care, as it may well be encouraging greater vulnerability to poor financial outcomes. Kaine *et al* (1992) made the following conclusions:

> As a general rule, farming enterprises that experience a severe financial crisis during a period of low returns due to poor seasonal conditions, depressed product prices or both, have high levels of debt. Typically, these high debt levels are attributable to recent investment in agricultural land.

Consequently farmers need to be aware of the increased exposure to financial risk that further land acquisition may produce. Kaine *et al* (1992) also suggest that if land acquisition is an objective then the decision to invest should be taken during a period when product and land prices are depressed or at least when they are not at a peak.

2.3.5 Off-farm investments

The greatest attribute of off-farm assets is that they have little or no correlation with agricultural prices and seasonal conditions. This attribute means that investing off-farm is a significant risk management strategy in the form of diversification. Diversification will lead to decreases in variability in returns over time and therefore will reduce uncertainty in financial outcomes and risk to the farm business.

Off-farm investments also in many cases can improve the farm businesses cash flow by giving it a greater profit earning potential. Greater profits also offset risk by allowing for a more rapid accumulation of capital reserves, and the lower demands that are placed on those reserves. There are three main categories of off-farm investments that are covered in this study, these being "shares", "property" and "cash".

Shares

Shares gives an investor the opportunity to be a part owner of a company and consequently receives a share of the profits and capital growth that the company experiences. The greatest advantage of shares is their liquidity which provides flexibility for the farm business. This flexibility can provide an important risk management tool during periods of low financial performance by providing the business with readily available funds. However it is the advantages of liquidity and the ability to buy in small parcels that makes share prices more volatile than other investments.

Another advantage of shares as an investment is that they have a low maintenance requirement which might be expected in real estate. Shares also offer income in the form of dividends and the potential for capital growth. The importance of capital growth is that the investment value in the medium to long term shouldn't be eroded by inflation which would be the case with a cash type of investment.

Property

Property in the present study refers to real estate type of investments. Like shares, property investments also experience capital gains and income (ie. rent from tenants). It also has the inherent nature of relative stability of capital values. However, property does typically require regular management and maintenance which is impossible for many farm managers. For those with the time, the skills and the inclination to add value, real estate can make quite a profitable investment.

Property does lack liquidity and therefore flexibility, as portions of the investment cannot in most cases be sold off. Also it may take months to sell real estate at a reasonable price whilst incurring high transaction costs. In the same context it has a worthy attribute of offering a good borrowing potential. This eliminates the necessity to sell off income earning assets to meet cash flow shortfalls.

Cash

The basic purpose of a cash investment is to provide a secure source of funds which can be accessed quickly. Other advantages that typical cash investments should have over property and shares include:

- Minimal costs to invest or redeem.
- No loss of capital regardless of the time of withdrawal.
- Little or no penalties for early withdrawal of funds.

2.4 The Case Study Properties

The case study approach offers a data collection method for carrying out an intimate study of a properties income earning capabilities with the given management objectives. Other methods of data collection like the representative and average farm approach require a large sample of farms. However, these methods can prove to be very costly and time consuming. Also as the data becomes abstract whilst representing a sample of farms, it lacks a degree of realism that is achieved with the case study approach.

The target group for this study were wool producing farms in the New England region. From this group a sample of two case study properties was selected. A basic comparison of the two properties major production and financial features can be seen in Table 2.1. It can be seen from the table that Farm A is a substantially larger business operation and has a significantly greater level of diversification.

Financial statements and some of the production details used for the analysis were collected from the farm managers records and account for the financial year ending in 1993. Other production details including most of the livestock details and yields have been based on the farm managers subjective estimates.

Typically, a farm owner's level of debt is a sensitive and confidential issue. Consequently the true debt level for the analysis has not been revealed though it has been assumed that both farms operate with a 85% equity level for both properties in the analysis. Both properties also have off-farm assets in real estate and cash-type investments. These have not been included in the analysis to allow for a more direct comparison between the major investment groups.

Both farms are run by owner/managers who have common critical management objectives. Firstly they both see their farms as being a business and hence attempt to maximise profits and production efficiency. Secondly they consider themselves risk averse and consider survival of their farm business of utmost importance. More specific details on each farm are discussed below in the following two sections.

2.4.1 Farm A

Farm A is a 3,080 hectare property located approximately 20 kilometres East of Armidale. Currently the farm obtains an income from three reasonably diverse enterprises, these being cattle, fat lambs and wool. The land is undulating with moderately fertile soils with a range of both improved and native pastures.

Table 2.1 Physical and Financial Features of Case Study Farms

FARM A:			FARM B:		
Area:			*Area:*		
3,080	ha.	$3,692,400	1,340	ha.	$1,139,000
Livestock:		$254,920	*Livestock:*		$89,565
3,400	Merino Ewes		3,200	Merino Ewes	
3,000	X bred Ewes		2,200	Wethers	
6,000	Wethers		100	Cows	
250	Cows				
Machinery:		$85,500	*Machinery:*		$29,500
Structures:		$708,000	*Structures:*		$405,000
Total Assets:		$4,740,820	*Total Assets:*		$1,663,065

2.4.2 Farm B

Located about 50 kilometres South East of Armidale, Farm B has 1,340 hectares. The major production activity is wool from merino wethers and self-replacing merino ewes. Minor activities include beef and crossbred lamb production. The land is primarily undulating with some flatter country found on the eastern edge of the Salisbury plains.

2.5 Selected Investment Alternatives

As previously stated in Chapter 1 the objective of the present study is to examine the financial implications of alternative off-farm investments to the farm business, whilst analysing the risks involved. Consequently the three broad investment groups of shares, property, and cash are targeted. Broad investment groups have been used as it would be impossible to consider all the investment options available.

2.5.1 Shares

To forecast returns from shares in this analysis, historical trends of share performance indicators were required. For this study share performance was observed through monthly all ordinaries accumulation indices from the past ten years. The all ordinaries index is a measure of the price movements of share values on the Australian stock exchange. The accumulation index not only includes the changes in share values but also share returns from dividends.

2.5.2 Property

It is difficult to capture performance trends of property as it is a very broad investment field. For this study the property trust accumulation index has been used as the representative for a property investment. This index measures the unit values and returns from listed property trusts. Property trusts involve the management of property investments for unit holders. Some of the advantages of property trusts for a farm owner are that they are very liquid, and like shares can be bought in relatively small investment parcels. Also the farmer can benefit from the returns found with large and diverse property investments which otherwise would not be available to the small investor.

2.5.3 Cash

The investment used to represent cash in the analysis is commercial bank bills. The performance data required for the analysis was calculated from monthly commercial bank bill indicators for the past ten years.

3. Risk Analysis of the Case Studies

3.1 Stochastic Budgeting

The traditional method of farm business planning and budgeting involves the use of deterministic models. Deterministic models are simple as they only require single point expected values for input and output variables. As these values disregard the consequences of any variation, the deterministic models imply a state of perfect knowledge. However in reality, farmers will rarely know what their important production and marketing variables will be as they are inherently surrounded by uncertainty.

In an attempt to address uncertainty with deterministic models, sensitivity analyses were developed. This technique identifies a range of outcomes from some 'best' and 'worst' case scenarios. In these scenarios, key variables are substituted with optimistic and pessimistic estimates. The sensitivity analysis may offer a range of possible outcomes but they fail to indicate the likelihood of a particular outcome occurring.

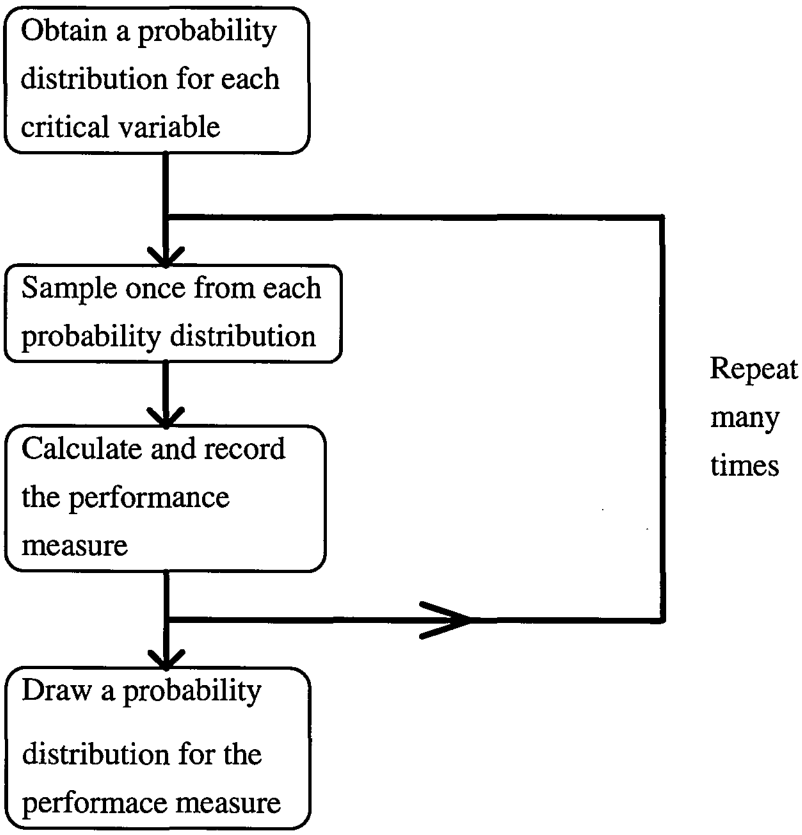
In the farm management field the stochastic budgeting technique involves developing a more comprehensive model which emulates the farm business and provides projections of financial performance whilst allowing for uncertainty. The stochastic model is made more comprehensive by the inclusion of probability distributions to represent key budgeting parameters and a probability distribution to portray the range of values for the expected outcome. Consequently the stochastic budgeting technique takes into consideration a greater wealth of information and supplies a more valuable and realistic result to the decision maker.

Blackie Dent (1979) suggest that stochastic elements are important in bio-economic modelling but they should be introduced with caution. The inclusion of such elements may create confusion and reduce the acceptability to the end users (ie. farm managers and consultants). If the stochastic budgeting model is not presented in a form that is acceptable and understandable, it will fail in the objective of being a practical useable method.

3.2 Simulation

Simulation refers to a method of a obtaining the distribution of possible outcomes from valid combinations of input variables. Simulation is further defined by Anderson (1970) as the 'numerical manipulation of a symbolic model of a system over time.' It allows for farm system performance to be dynamically analysed under all conceivable conditions where production and market parameters can be changed to present any likely occurrence. Subsequently for this type of analysis, simulation provides a considerable increase in decision makers' understanding of how different factors contribute to the risk experienced by the farm business.

Figure 3.1. The Risk Simulation Methodology



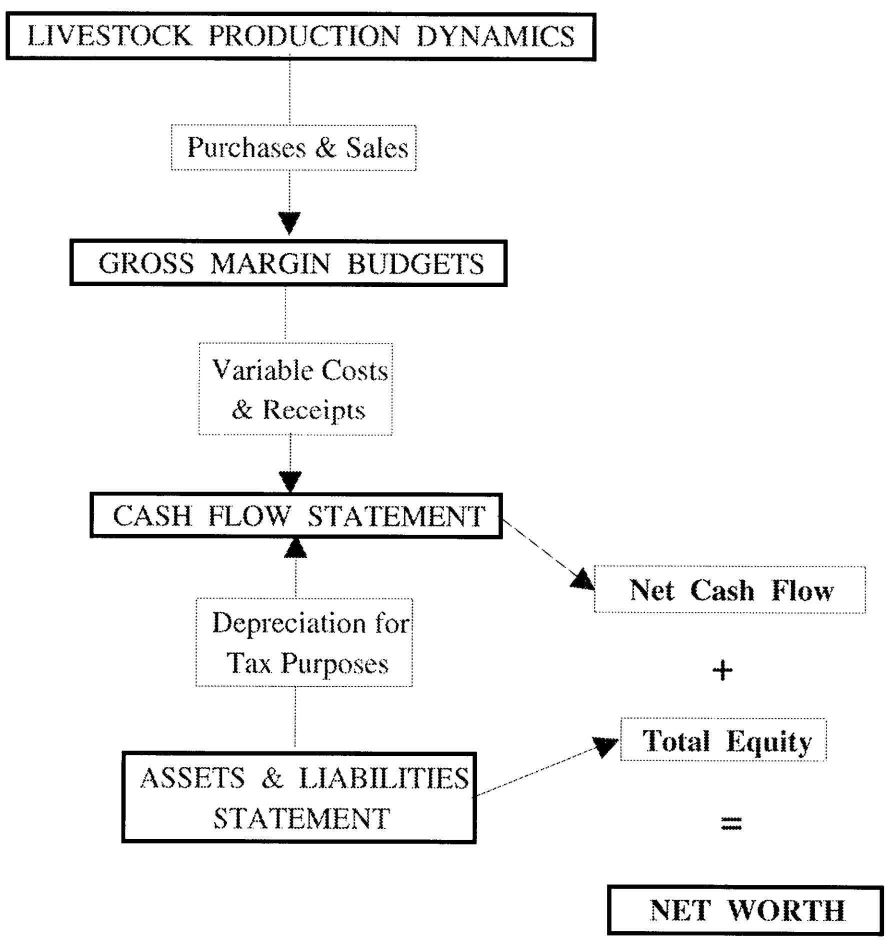
Source: Hull 1980, p. 30.

Hull (1980) suggests that the methodology of risk simulation contains five basic steps and these are well illustrated with a flow diagram in Figure 3.1. With this procedure of stochastic simulation modelling as displayed in the flow diagram, probability distributions for the key variables are obtained from historical data and subjective estimates by the farmer. Each of the distributions are then sampled from once to provide a single value for the performance measure. This process is repeated a large number of times to establish a range of outcomes, so that a probability distribution of the model's performance measure can be established.

3.3 Whole Farm Planning Analysis

An over-riding feature of agricultural production and its markets is that they are subjected to a multitude of influences, and therefore it is important to keep as broad a focus as possible when analysing a farm business. To achieve such a focus, the whole farm planning method of analysis which adopts a holistic view has been adopted by this study.

Figure 3.2 General Flows of Whole Farm Planning Analysis



An example of a simple whole farm planning analysis can be seen in Figure 3.2 where the arrows represent the general information and progression flows of the analysis. In this example, the analysis is started with the livestock production dynamics which imitates the expected production performance of the livestock enterprises. The production dynamics are then linked to gross margins or activity budgets. The gross margins allow for an in depth breakdown of expected returns and costs to be experienced with each enterprise. The whole farm returns and costs (including overhead costs) are then brought together in the cash flow statement. The purpose of the cash flow statement is to calculate the net cash surplus.

The cash flow statement also requires a depreciation figure from the farms assets to assist in taxation calculations. To achieve this an asset and liabilities statement is constructed to include structures, plant, machinery, livestock, long term loans and outstanding creditors. The assets and liabilities statement is also necessary to establish the total equity or net worth of the farm business.

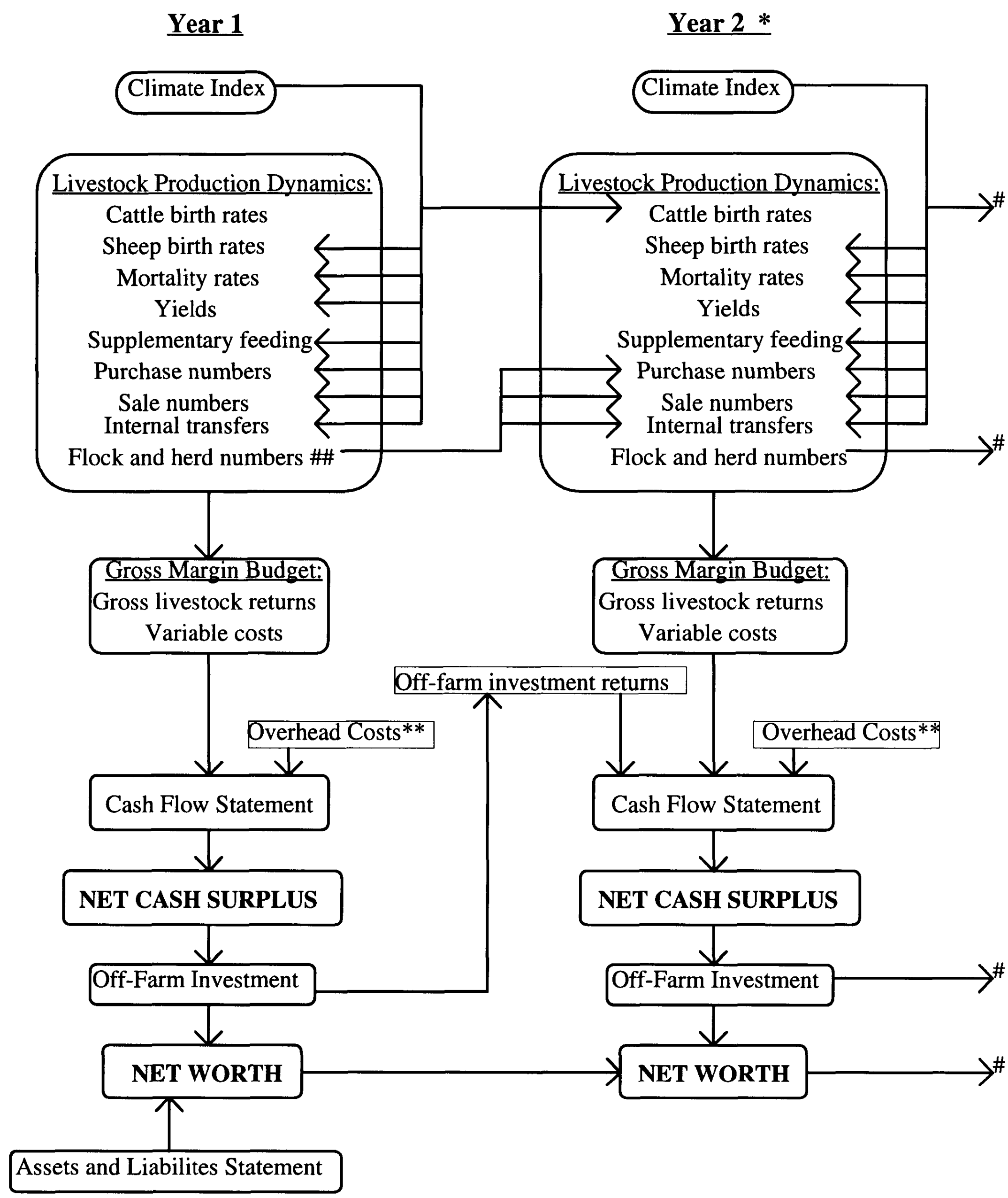
3.4 The Stochastic Budgeting Model

To achieve the research objective of this study a stochastic budgeting model which adopts the whole farm planning method of analysis has been constructed and simulated. The model incorporates the economic, technical, financial and managerial elements of the case-study farms and their inter-relationships over a ten year period. A summary of the general flows and linkages found within the model can be seen below in Figure 3.3.

This diagram helps to highlight the inter-relationships found between production performance, management strategies and climate over time. It also highlights the steps involved with the financial analysis in the model and how the financial gains or losses are transferred from year to year. The model invests the net cash surplus into off-farm investments which are then added to the net worth value. If a cash deficit were to be experienced in the cash flow then that deficit would be met by the sale of off-farm investments and would then lower net worth. The detailed financial statements used in the analysis can be found in Appendices 1 and 2.

Stochastic variables, correlations, climate link and performance measures are all integral features of the stochastic budgeting model in this study and are therefore covered in greater detail below.

Figure 3.3 General Flows and Linkages of Stochastic Budgeting Model



* Years 3 to 10 are constructed the same as year 2.

** Overhead costs include fixed operating costs, capital costs, income tax and personal drawings.

\# Arrows are indicating flows and linkages from year 2 to year 3.

\#\# Closing flock and herd numbers will influence purchases, sales and transfers in following year to help achieve new flock and herd targets.

3.4.1 Stochastic Variables

Many of the important input variables are stochastic because their future values are by nature variable and therefore cannot be estimated with certainty. Subsequently the variables are represented by probability distributions which basically involve a range of values and their likelihood of occurring. The type and size of the probability distribution are essentially based on the farm managers subjective estimates with the assistance of historical data. The details of the stochastic variables used in this analysis are listed in Appendix 3 and discussed further in the following sections on market prices, production characteristics, off-farm investments and loan interest rates.

Market prices

The more important and significantly variable market prices experienced by the case study farms are sheep, wool, and beef prices, and therefore are represented in the model as probability distributions. To the farm managers involved in the case study, it was feasible to forecast future prices with the assistance of past prices at the relevant selling points. Consequently, fortnightly and monthly sale averages were gathered for the last four years (1990-1993) from the New South Wales Meat Industry Authority for the Armidale cattle saleyards and Tamworth sheep saleyards. Similarly Sydney wool sale prices were gathered for the last four years (1990-1993) from Wool International.

The probability distributions used to represent these prices are a normal distribution. Hence a mean and standard deviation were calculated from the historical data. An example of a price variable that has been stochastically represented with a normal distribution in the analysis are steer prices which is graphically displayed in Figure 3.4. The graph illustrates the characteristic 'bell' shape of a normal distribution which has a mean of a 111 cents/kg and a standard deviation of four cents.

Production characteristics

Some of the main production traits that have been stochastically represented include; livestock sale weights, wool yields, and birth and mortality rates. The probability distributions have been based on the subjective estimates of the farm managers. The distribution function used is a risk triangle which uses a lowest expected value, the most likely value, and the highest expected value. An illustrated example of a risk triangle can be seen in Figure 3.5, which graphs the probability distribution of yearling steer sale weights. Some of the main advantages of this type of a function is that requires little data and it allows for a any likely skews in a probability distribution. An example of negative skewness can be seen in Figure 3.5 with the triangle apex (ie. most likely value) to the right of centre.

Figure 3.4: Probability Distribution for Steer Prices as a Normal Function

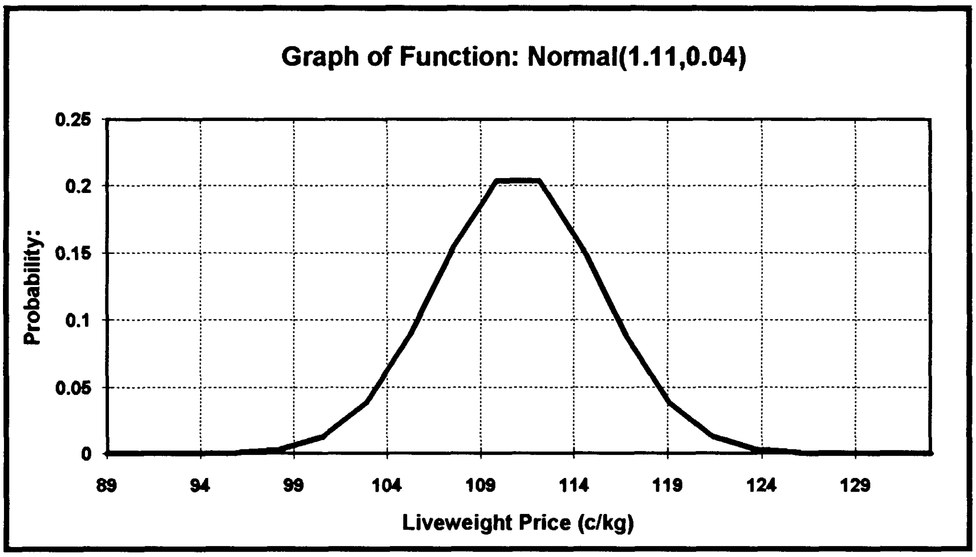
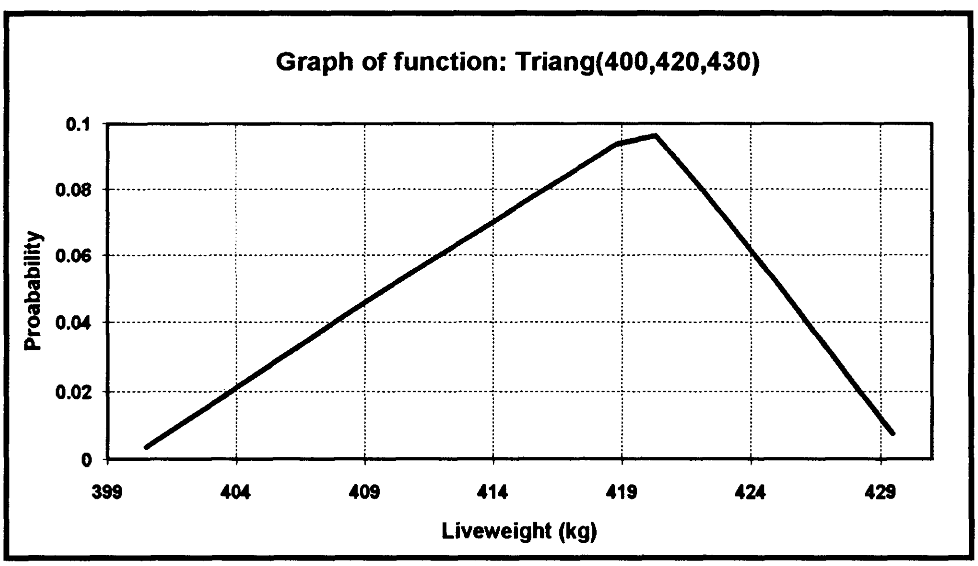


Figure 3.5: Probability Distribution for Steer Weights as a Triangular Function



Off-farm investments returns and loan interest rates

To capture the long-term trends of some of the off-farm investments available to farmers and the money market, monthly indicators were gathered for the last ten years (1984-1994) and were published by the Reserve Bank of Australia. Milham (1992) assumed the distribution of loan interest rates to be normal, and in the present study investment returns were also assumed to be normally distributed.

3.4.2 Correlations

A major difficulty associated with stochastic simulation models is that if stochastic dependencies are neglected, then significant biases can be found in the outcomes. Pouliquen (1970) supports a view that if correlations are overlooked, it may lead to a completely wrong interpretation in the analysis. He also suggests that the correlation between stochastic variables have an important influence on the reliability of the final financial outcome distribution. Consequently it is critical that significant correlations are accounted for in this present study.

A correlation occurs when a change in one factor is related to the change in another. The association between two stochastic variables with correlation maybe causal or non-causal. For example, variation in rainfall maybe reflected in fleece weight (causal), or the price of 19 micron wool maybe correlated with 26 micron wool (non-causal). Therefore the terms referred to as "dependent" and "independent" in this text do not necessarily imply a causal relationship.

The @Risk stochastic simulation program (Pallisade Corporation, 1992) used in this analysis provides a function which takes into consideration the correlated stochastic variables and their level of influence in the simulation. The level of influence is dictated by the statistically measured correlation co-efficient. The @Risk program incorporates the correlation co-effecients in the present study with the "DepC" and "IndepC" functions. The function determines that after a large number of samples or simulations the two stochastic variables will be correlated to the degree specified (ie. the correlation co-efficient).

There are four separate correlation groups of stochastic variables which have been accounted for in the simulation model. The four "independent" stochastic variables of each group are annual rainfall, nineteen micron wool price, fat lamb price, and yearling steer price. The "dependent" stochastic variables and their correlation coefficients are listed in the correlation table found in Appendix 5. Where appropriate, the correlation coefficients are calculated from the same historical data used to establish the stochastic variables probability distribution. However, historical data was not available for all the correlated stochastic variables, and therefore subjective estimates of the degree of correlation by the farm managers were also used.

In the simulation model annual rainfall is linked to four types of "dependent" production variables through correlation. These "dependents" are sale cattle weights, fleece yields, and livestock birth and mortality rates. In reality livestock birth rates are largely dependant upon the previous years season, and therefore this attribute has been accounted for by correlating birth rates to the previous years rainfall. Also livestock mortality rates have a reciprocal relationship with rainfall. This means that when rainfall is high, death rates are low and when rainfall is low, death rates are high. To factor this reciprocal relationship into the model, a negative correlation co-efficient is used.

All beef prices in the model have been adjusted to be "dependent" upon the yearling steer price. The yearling steer price was chosen as the "independent" variable because it was regarded by the farm manager's that the demand for steer meat for the domestic market has generally the greatest influence on all the beef prices in the Armidale sale yards.

In the correlation group with 19 micron wool price as the independent variable, the dependant variables are 26 micron wool sold from the crossbred flock, merino weaners sold, merino rams and replacement wethers purchased. In the final group, fat lamb price is the independent variable, largely because it inherits the greatest demand of all the sheep meat. The variables that are dependant upon the fat lamb price in the model are cast for age ewes, border leicester rams, and cull wethers.

3.4.3 Climate Link

One of the realistic attributes of the stochastic simulation model used in the analysis, is that it takes into consideration the inter-relationships between climate and production performance as seen in Figure 3.3. Already there is a climate link that has been discussed in the section on correlations, where livestock production traits that are dependent upon rainfall are accounted for by correlation coefficients. The integration of climate into the model is taken one step further by linking rainfall to livestock numbers and supplementary feeding and is graphically shown in Figure 3.3. This is done by regulating livestock selling, livestock replacements, and supplementary feeding practices according to simulated rainfall levels with a series of 'IF' statements included in the spreadsheet.

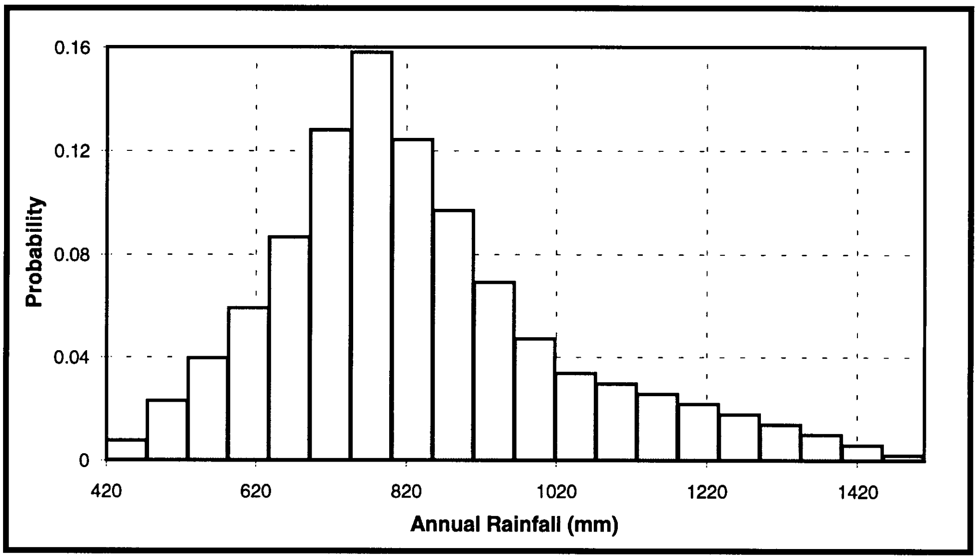
The simulation model attempts to imitate as realistically as possible actual management practices in different rainfall groups. Subsequently it was ascertained from the case study farmers the most critical annual rainfall ranges which would influence significant livestock management practices such as stocking rates and supplementary feeding. In a year where annual rainfall is above 700mm, livestock management practices are expected to be at the 'norm'. In these conditions livestock transfers will be expected to occur as in a normal year without a drought. However if the annual rainfall falls below 700mm and above 650mm, the case study farms would be considered to be in drought conditions and management practices would change to accept it. Furthermore if the annual rainfall falls below 650mm then the case study farms would be considered to be in a severe drought.

To allow for these two significant drought rainfall ranges, the model has two drought management strategies built into it to accommodate them. The strategy adopted in the model for drought conditions is to decrease the adult sheep numbers by 5% from numbers run in normal conditions and by selling all the steers as weaners. The strategy used for serious drought conditions involves the lowering of adult sheep numbers to 90 percent from normal, increase culling rates of cows, and supplementary feed wheat to the sheep breeding flock.

The model also accounts for seasonal conditions and the subsequent management responses that may have occurred in the previous year. This dynamic link is well shown in Figure 3.3 where livestock numbers in one year will influence the livestock purchases, sales and internal transfers in the following year.

There are innumerable climatic factors which influence pasture production and therefore livestock production, but in the present study annual rainfall was taken to be the most important. To stochastically represent the rainfall distribution in the model, a general probability distribution was constructed. This distribution is based around percentile data for the case study region and was published by the Bureau of Meteorology (1988). A histogram can be seen in Figure 3.6 which graphically illustrates the distribution. An advantage of using the general distribution function is that it allows for a skewness which is an inherent characteristic of historical rainfall distributions.

Figure 3.6 Probability Distribution of Annual Rainfall



3.4.4 Performance Measures

The two performance measures used in this analysis are net cash surplus and net worth. The net cash surplus after tax provides an indication of the real business returns or losses experienced by the farm for each year. One critical importance of using net cash surplus as a performance measure is that it portrays the ability of the business to meet debt requirements and hence displays the annual viability of the farm as a business.

The net worth is calculated by adding the cash surplus to the farm's total equity. In effect the net worth incorporates the accumulation of annual profits whilst considering the growing asset value included in the property's equity. Consequently net worth will indicate the total gains of an investment option to the whole farm over time. The time span used for this analysis is ten years. Ten years has been selected so that the long term sustainability and potential of the alternative investment strategies can be assessed.

An assumption of the analysis is that a rational farmer's preference will be for the investment strategy with the highest net worth but retains a desirable level of net cash surplus. This analysis as discussed later will also provide the actual farmer's preference for investment strategies after interpreting the different simulation outputs.

3.5 Stochastic Dominance with Respect to a Function

With the use of a stochastic simulation model in the analysis, it enables the stochastic dominance rules to be used to identify an assumed preference of outcomes for the decision maker. Milham (1993) supported the use of stochastic dominance rules and more specifically the stochastic dominance with respect to a function (SDRF) for the following circumstances and reasons.

> The case for stochastic dominance arises when either there is no single identifiable decision maker (as when formulating advice for many decision makers), or when it is not feasible to derive a utility function for the identified decision maker. The latter may occur due to lack of time or limited introspective ability of the individual. However, if something is known about the risk attitudes of the decision maker, the methods of stochastic efficiency analysis can be used to partition risky prospects. In the field of agricultural economics, stochastic dominance with respect to a function (Meyer 1977), also referred to as the Meyer criterion, generalised stochastic dominance and generalised stochastic efficiency analysis, has been widely used for this purpose. (See, for example, da Cruz and da Fonseca Porto 1988, King and Robison 1981a and Kramer and Pope 1981.) (Milham 1993, p38)

Before the SDRF can be implemented, the upper and lower bounds of the decision makers level of risk aversion needs to be established. The function used by Patten *et al* (1988) to derive absolute risk aversion is:

$$r_a = r_r / w$$

r_a : absolute risk aversion
r_r : relative risk aversion
w : wealth

Wealth in the analysis model is the current net worth (ie. equity) of the case study farm in question. It can be seen in the absolute risk aversion formula that wealth and relative risk aversion are inversely related. Therefore as wealth declines, the decision maker's level of relative risk aversion will increase.

The maximum range of relative risk aversion that Anderson and Dillon (1991) suggests, is between 0.5 (ie. barely risk averse) and 4 (ie. extremely risk averse). Little and Mirlees (1974) also suggest that the range of relative risk aversion should be close to 2. Milham (1993) adopted a relative risk aversion range of 1 to 3 in his analysis of farms where net worth varied between $0.7m and $2.3m. The net worth values of the case study farms in the present study ($1.4m to $4.0m) also entered this range and the relative risk aversion values chosen by Milham (1993) were employed.

To apply the SDRF analysis to the simulated outcome distributions, a software program called Generalised Stochastic Dominance was used in the analysis. This program was developed in the Department of Agricultural Economics and Rural Sociology at the University of Arkansas (Raskin and Cochran 1986).

3.6 @Risk Presentations

To model the many complexities and inter-relationships found in a stochastic simulation of a whole farm, a computer application for risk analysis was required. The program used in this study for risk analysis is @Risk which was developed by Palisade Corporation. Not only does the program permit the modelling of the above mentioned complexities, but also provides informative graphical capabilities.

With the use of the @Risk graphical presentations, stochastic outcomes over time can be seen in a well informed and easy to understand diagram. Consequently, it has the ability to provide the farm owner with a wealth of information to make a decision with his own preference as opposed to being just theoretically assumed. This is important as it stays in the mould of being a case study orientated analysis by utilising the case specific preferences and objectives of the individual. The @Risk presentation also plays an important part in decision analysis in allowing for a greater consideration of the decision maker's preference which may be difficult to quantify and therefore identify.

The analysis will offer interesting findings from comparing the farmer's interpretations and hence preferences of the @Risk presentations against the orderings made by the stochastic dominance rules. Consequently the validity of stochastic dominance rules to case-specific studies can also be recognised.

4. Results

4.1 Data Generation

In the present study, a stochastic budgeting model of the case study farms was simulated with three different investment strategies. The simulation provided data which was then analysed in two ways (Analysis A and B). Analysis A is a deductive approach and includes the stochastic efficiency criterion of stochastic dominance with respect to a function (SDRF). Analysis B is an inductive approach and relies upon the individual farm manager to rank the strategies from a set of illustrated simulation results. The two approaches are itemised and discussed below.

4.2 Analysis of Data

4.2.1 Analysis A: Stochastic dominance with respect to a function (SDRF)

Before the investment strategies (shares, property and cash) could be compared using the SDRF method, cumulative probability distributions needed to be derived from the simulation results of each alternative. A diagrammatic representation of cumulative probability distribution curves can be seen in Figure 4.1. In this graph the curve represents the cumulative probability (ie. Y-axis values) of net cash surplus levels (ie. X-axis values) being achieved.

When visually assessing alternative stochastic outcomes, it is difficult to establish stochastic dominance with respect to a function if the results are close. The reason for this difficulty, is that the upper and lower bounds that are imposed upon the decision maker's absolute risk aversion function by the SDRF criterion, cannot be illustrated in this type of graphical presentation. However the second degree stochastic dominance criterion can be used to help indicate which curve is likely to be dominant. A second degree stochastic dominant outcome on a cumulative probability distribution curve may cross another but in aggregate the area to the left of the curve must be greater than the area to the left of the alternative curves, for all values of the performance measure (net cash surplus).

Figure 4.1 Cumulative Distribution Functions of Net Cash Surplus for Farm A in Year 10 with the Three Investment Strategies

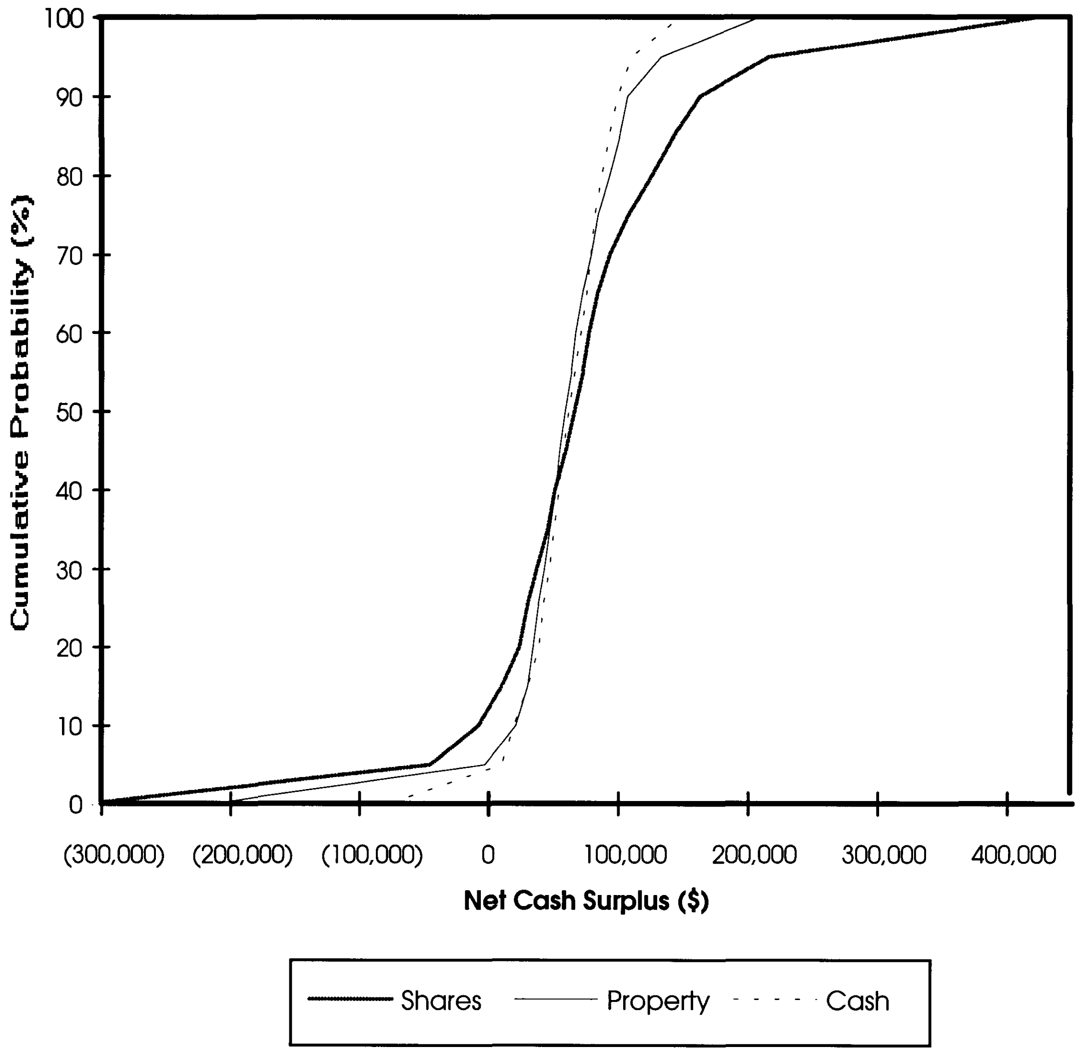
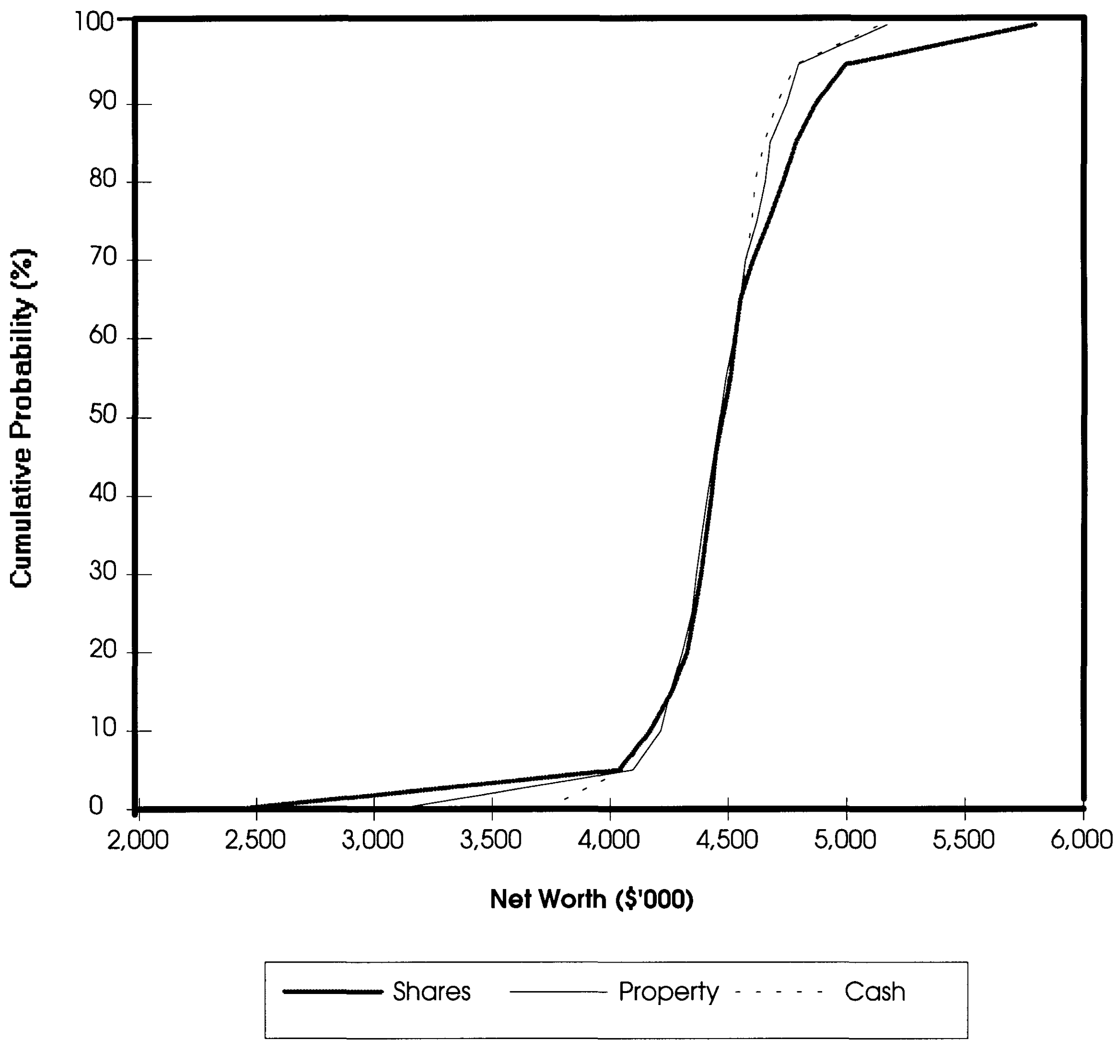


Figure 4.2 Cumulative Distribution Functions of Net Worth for Farm A after Year 10 with the Three Investment Strategies



Primarily there are two other significant features which can be displayed by a cumulative probability distribution curve when assessing the simulation results. Firstly, the outcomes that are most likely to occur are found where the curve is at its steepest. Secondly when a curve is flatter and has a greater spread than another, it is surrounded by greater uncertainty.

The options for Farm A

The cumulative probability distributions of the net cash surplus and net worth outcomes from the analysis are shown in Figures 4.1 and 4.2 respectively. The data used for these graphs are totals for the five percentile intervals generated by the stochastic simulation model and are displayed in Appendix 4.

It is difficult to distinguish between the different investment strategies in these graphs, as the curves representing the alternative investment strategies intersect each other and are relatively tightly grouped. However with the use of the SDRF decision criterion a ranking for Farm A can none the less be achieved (see Table 4.1).

Table 4.1 SDRF Ranking of Net Worth and Net Cash Surplus with the Alternative Investment Strategies for Farm A

Ranking[a]:	Net Worth	Net Cash Surplus
1	Shares	Shares
2	Cash	Cash
3	Property	Property

[a]The ranking portrays most preferred investment strategy at 1 to least preferred strategy at 3.

It can be seen from Table 4.1 that shares is the dominant investment strategy for both net cash surplus and net worth outcomes. An interesting feature of this result, is that the dominant strategy displays large possible negatives which can be seen in Figure 4.1. However, why the strategies distribution dominates in an SDRF sense is that the downside risks associated with shares are small relative to the decision maker's wealth (net worth).

Figure 4.3 Cumulative Distribution Functions of Net Cash Surplus for Farm B in Year 10 with the Three Investment Strategies

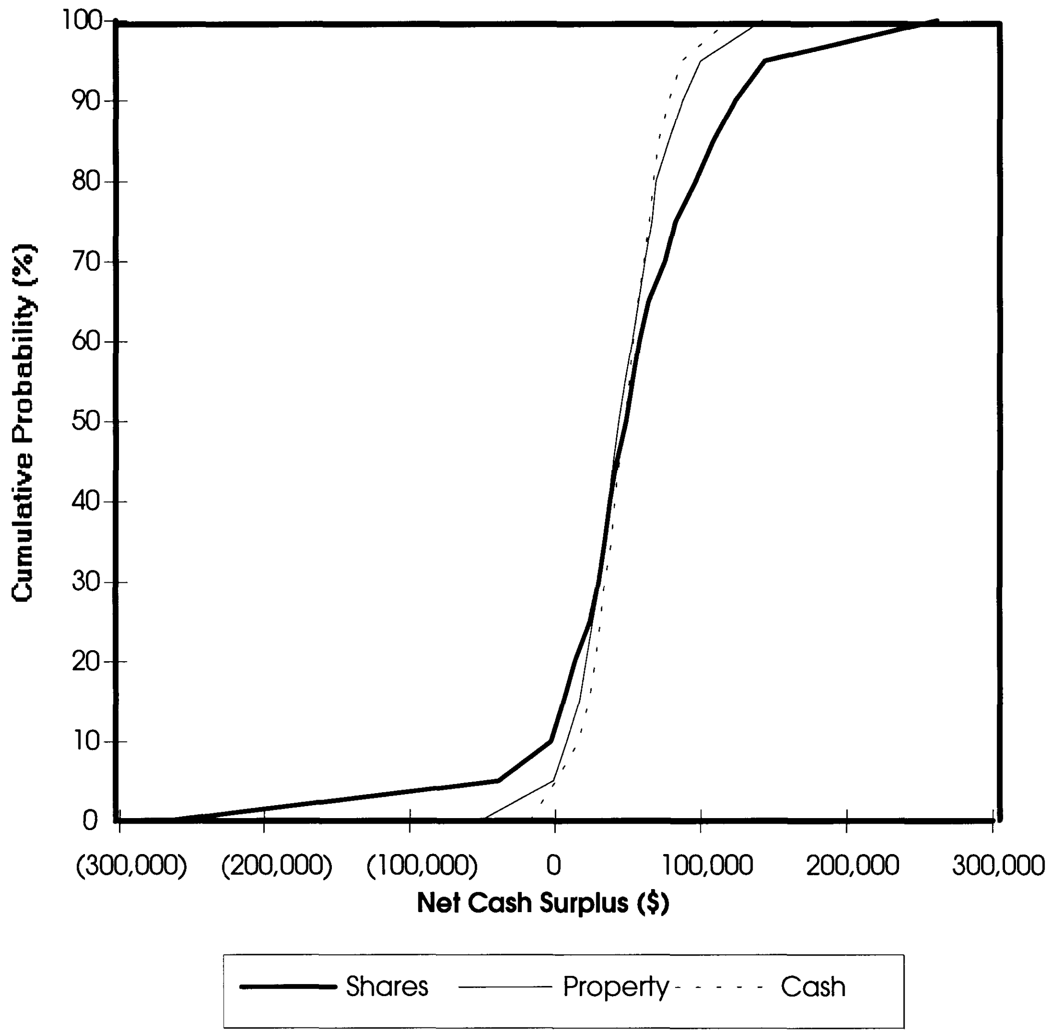
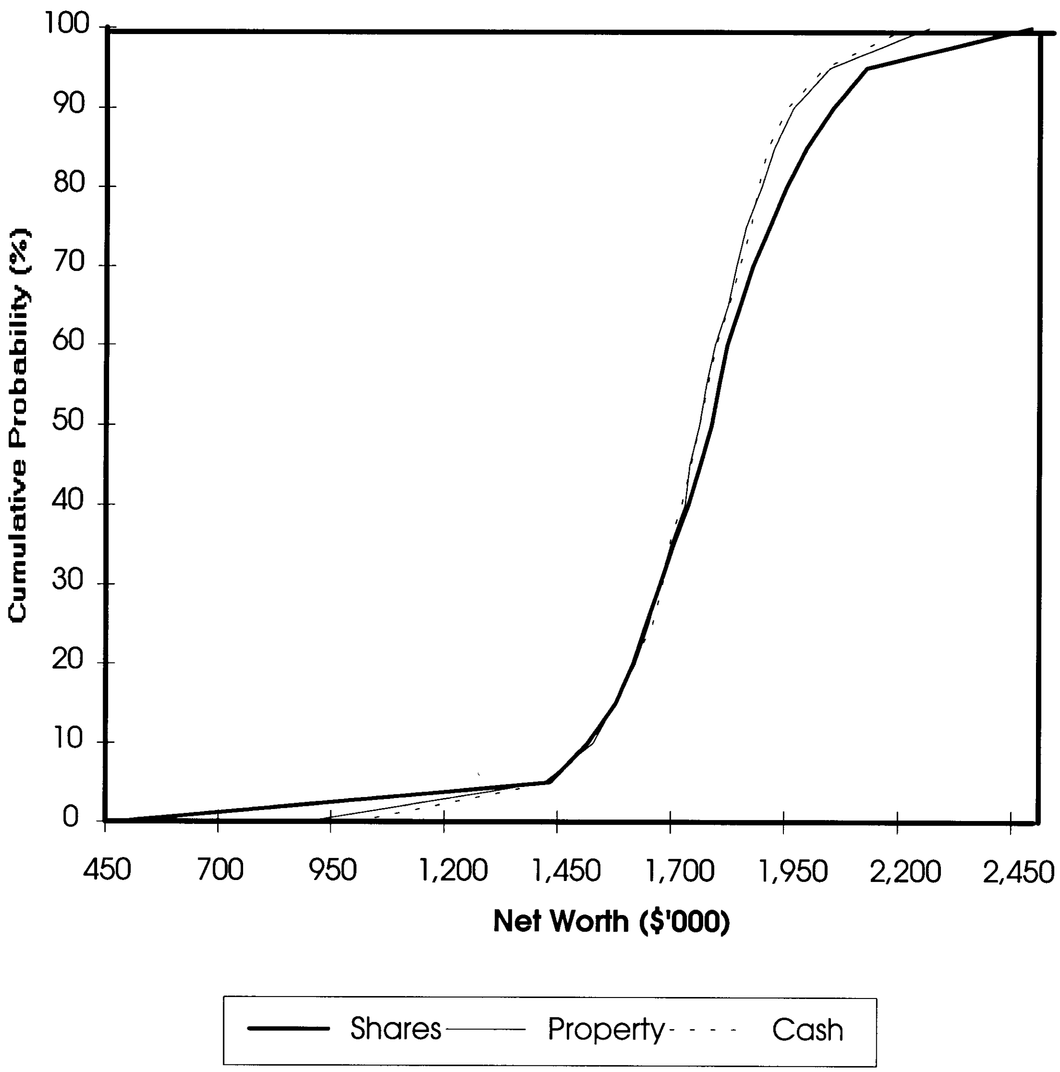


Figure 4.2 Cumulative Distribution Functions of Net Worth for Farm B after Year 10 with the Three Investment Strategies



The options for Farm B

Figures 4.3 and 4.4 display the cumulative probability distributions of the net cash surplus and net worth outcomes for Farm B and illustrate the same problems identified for Farm B. The data used for these graphs are percentile values which can be found in Appendix 4. The results from the SDRF decision analysis for Farm B can be seen in Table 4.2.

The most stochastic efficient investment strategy with the simulated net cash surplus outcome for Farm B is cash which is then followed by shares and then property. However the SDRF decision criteria could not discriminate between the two leading investment strategies from the simulated net worth outcome, namely cash and shares.

Table 4.2 SDRF Ranking of Net Worth and Net Cash Surplus with the Alternative Investment Strategies for Farm B

Ranking[a]:	Net Worth	Net Cash Surplus
1	Shares/Cash[b]	Cash
2		Shares
3	Property	Property

[a]The ranking portrays most preferred investment strategy at 1 to least preferred strategy at 3.
[b]Where strategies are listed adjacent to each other, it indicates that the SDRF decision analysis could not discriminate between the two.

4.2.2 Analysis B: @Risk presentations

As described in Chapter 3, the use of the @Risk graphical presentations allows stochastic outcomes over time to be seen in an easy to interpret manner. Such a presentation enables the individual decision maker to view the risks involved with choices over time. Consequently the individual's preferences can be better addressed and identified because the individual is better informed.

With this type of approach the individual's preferences have not been assumed or explicitly revealed. If this were to be done it may potentially guide the individual's reaction and subsequent ranking of alternatives. Consequently by using the inductive approach in Analysis B it is attempted to avoid such biases that may be found with a deductive approach.

The @Risk presentations used in this analysis are summary graphs of net cash flow and net worth outcomes for three investment strategies, simulated over a ten year period. These graphs are displayed in Figures 4.5 to 4.16. In these graphs the simulated stochastic outcomes represented by vertical lines. The stochastic outcomes or outcome distributions are bordered by two critical horizontal lines and bisected by another. The middle line which bisects the outcome distributions, represents the mean or 50th percentile. While the upper and lower bordering lines depict the 90th and 10th percentile respectively.

In simpler terms, the middle line of the simulated investment strategies represent the expected outcome for the net cash surplus or net worth. The upper most line represents the best case expected outcome while the lower line represents worst case expected outcome. The area between the lower and upper lines illustrate all the possible outcomes for the simulated investment strategy.

The level of uncertainty surrounding a strategy choice is displayed by the width spread between the upper and lower lines. The greater the width between the two lines, the greater the expected uncertainty. This display of uncertainty also includes the risk that the farm business will experience with each investment strategy choice.

The extent of riskiness can be seen in the summary graph between the lower band and the middle mean line. Subsequently the risk to the farm owner is that the outcome could fall below the expected outcome. Whilst observing simulated net worth outcomes, there is a risk of the business experiencing poorer than expected capital growth. The critical risk of financial loss may be observed in the net cash flow outcomes, when the actual outcome falls below zero (ie. deficit). A deficit may prevent the farm business from meeting its debt servicing requirements.

However these @Risk presentations as seen in Figures 4.5 to 4.16, may well contradict many statisticians expectations of a result from a dynamic stochastic system. Statisticians may expect the stochastic outcomes to be much more explosive (ie. rapid spread of distribution) over time than those recorded in the present study. The outcome distributions recorded in this study are stabilised by real physical constraints. For example livestock numbers are constrained by management targets for each one of the three possible seasonal conditions that could occur in a year. These particular constraints were discussed in detail in Chapter 3.

The options for Farm A

The summary graphs for net cash flow outcomes for Farm A can be seen in Figures 4.5 to 4.7. A significant feature of these graphs is that the shares investment strategy has a very high return potential with a 'best case' outcome of $160,000 after ten years. However the strategy also experiences a significantly greater deficit potential of approximately ($30,000) against ($19,000) by the other two strategies.

Another feature of the net cash flow outcomes is that there are significant drops experienced in year five and nine. These drops are a result of forecasted capital purchases. In year five the farmer wishes to purchase a motor vehicle and in year 9 the farmer intends to purchase a second hand tractor. These capital purchases are treated as stochastic variables in the model and their parameters are listed in Appendix 3.

The net worth summary graphs for Farm A can be seen in Figures 4.8 to 4.10. Again the shares investment strategy has the greatest return potential but displays the greatest risk and uncertainty. This strategy is then followed by the property alternative, then by the cash alternative which experiences the lowest uncertainty and return potential.

The summary graphs of both the net cash flow and net worth outcomes for the three investment strategies were displayed to the farm owner to elicit personal preferences. The subsequent ranking of most preferred to least preferred strategy is listed as follows;

1. Shares
2. Property
3. Cash

Figure 4.5 Net Cash Flow For Farm A with Shares Investment Strategy

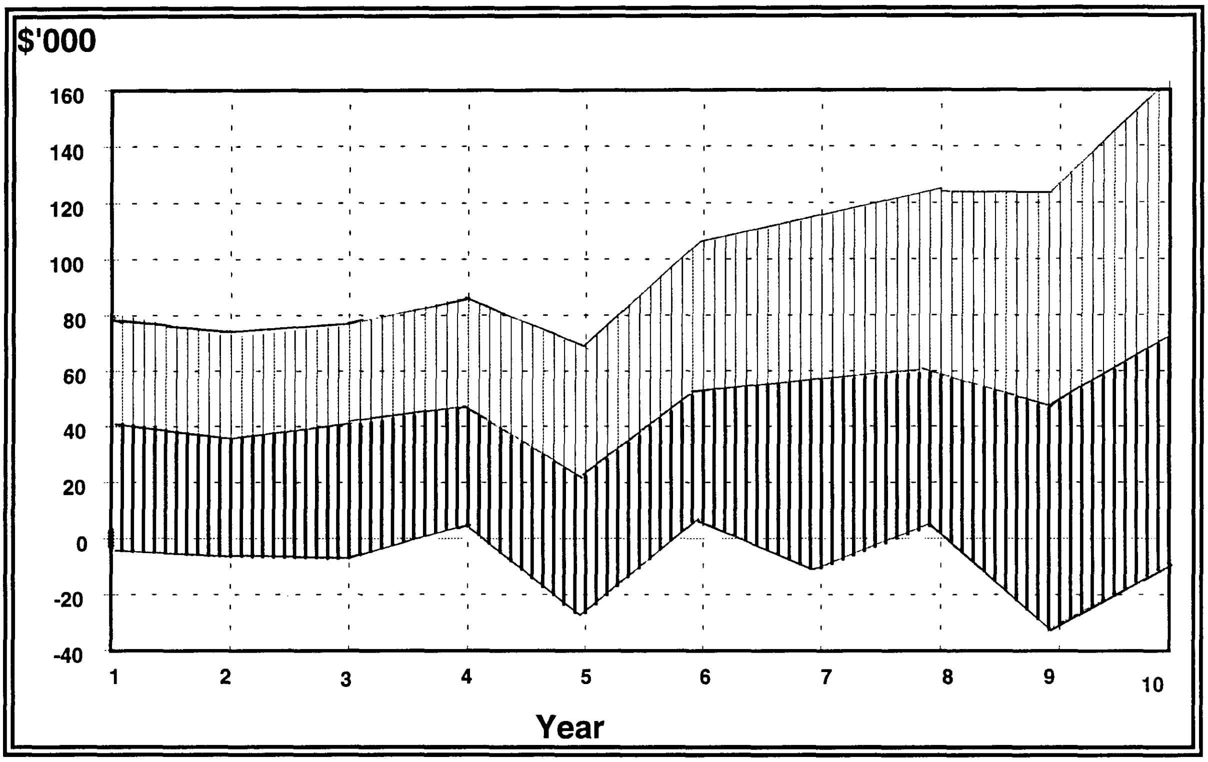


Figure 4.6 Net Cash Flow For Farm A with Property Investment Strategy

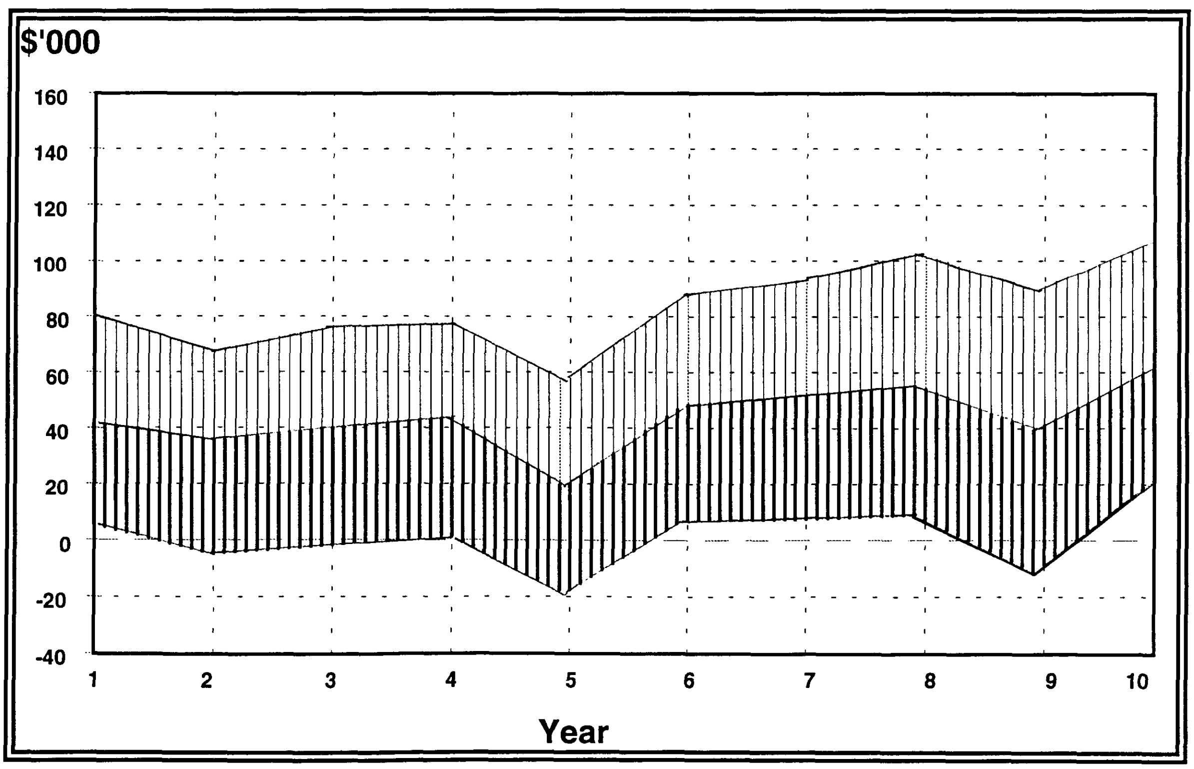


Figure 4.7 Net Cash Flow For Farm A with Cash Investment Strategy

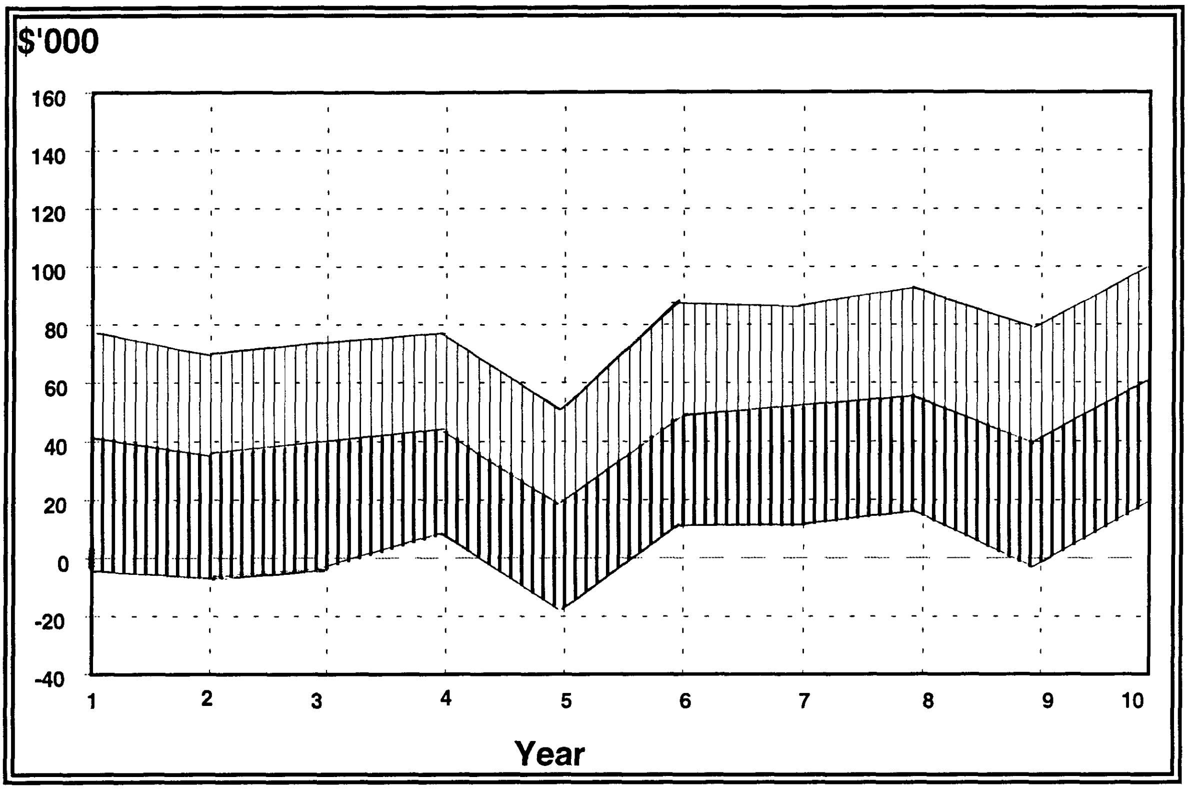


Figure 4.8 Net Worth For Farm A with Shares Investment Strategy

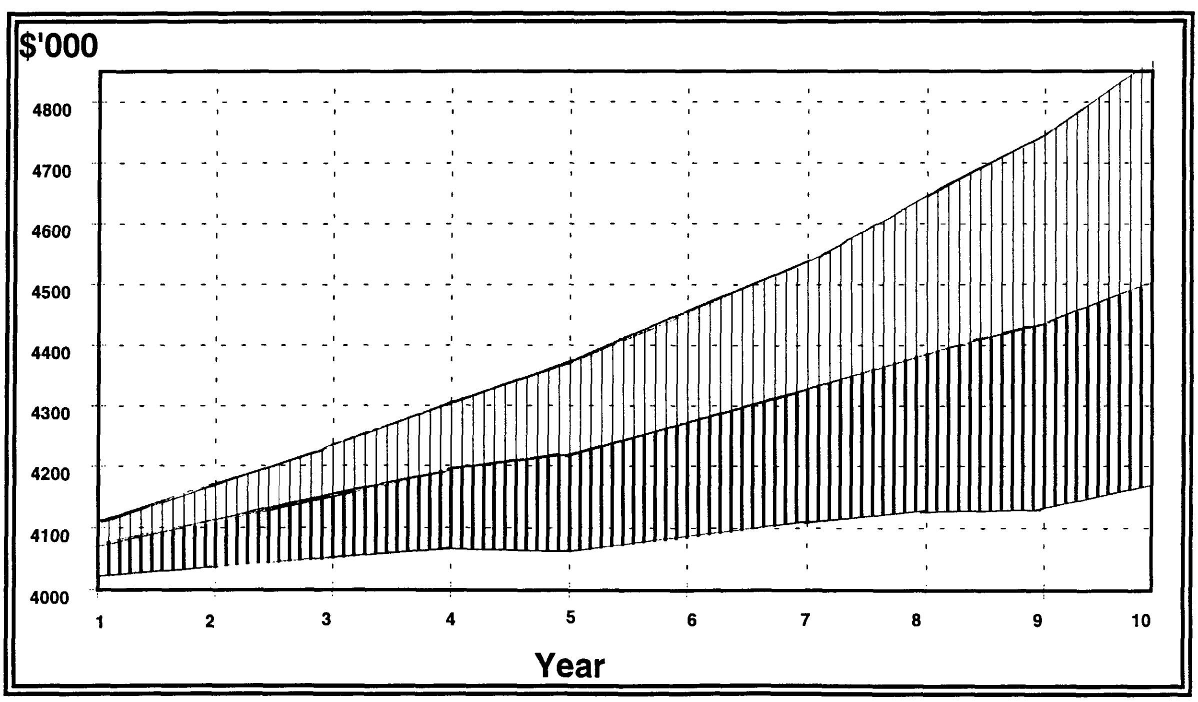


Figure 4.9 Net Worth For Farm A with Property Investment Strategy

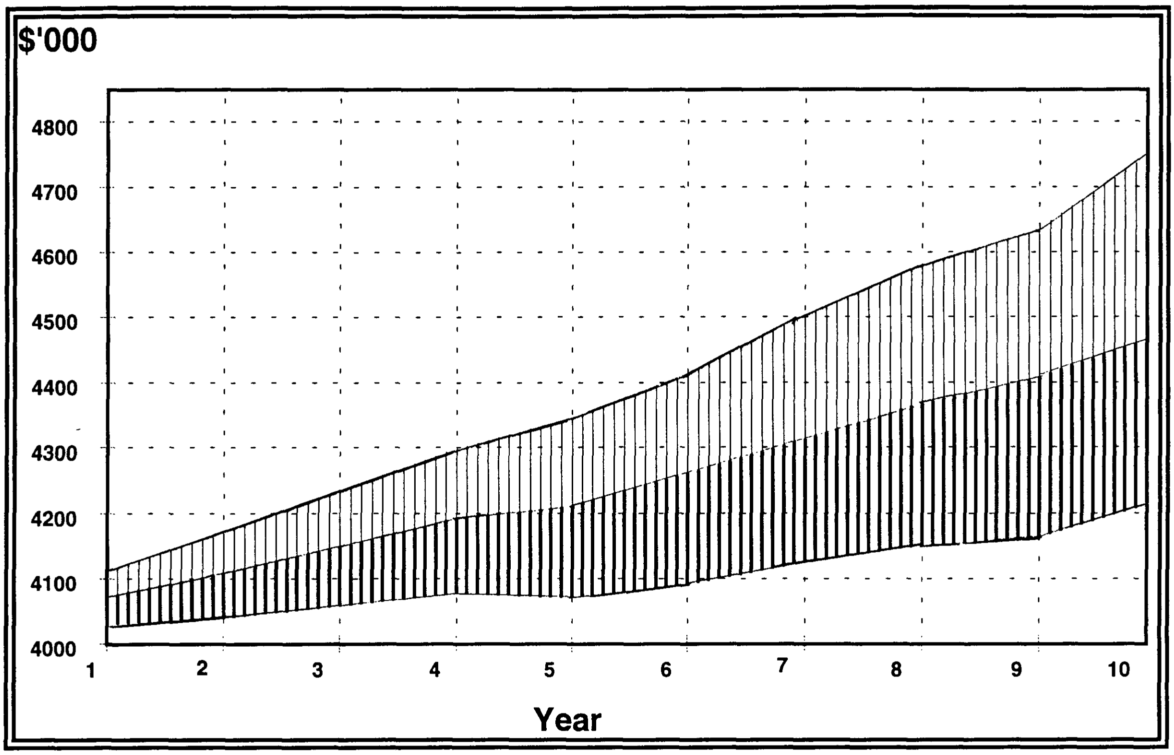
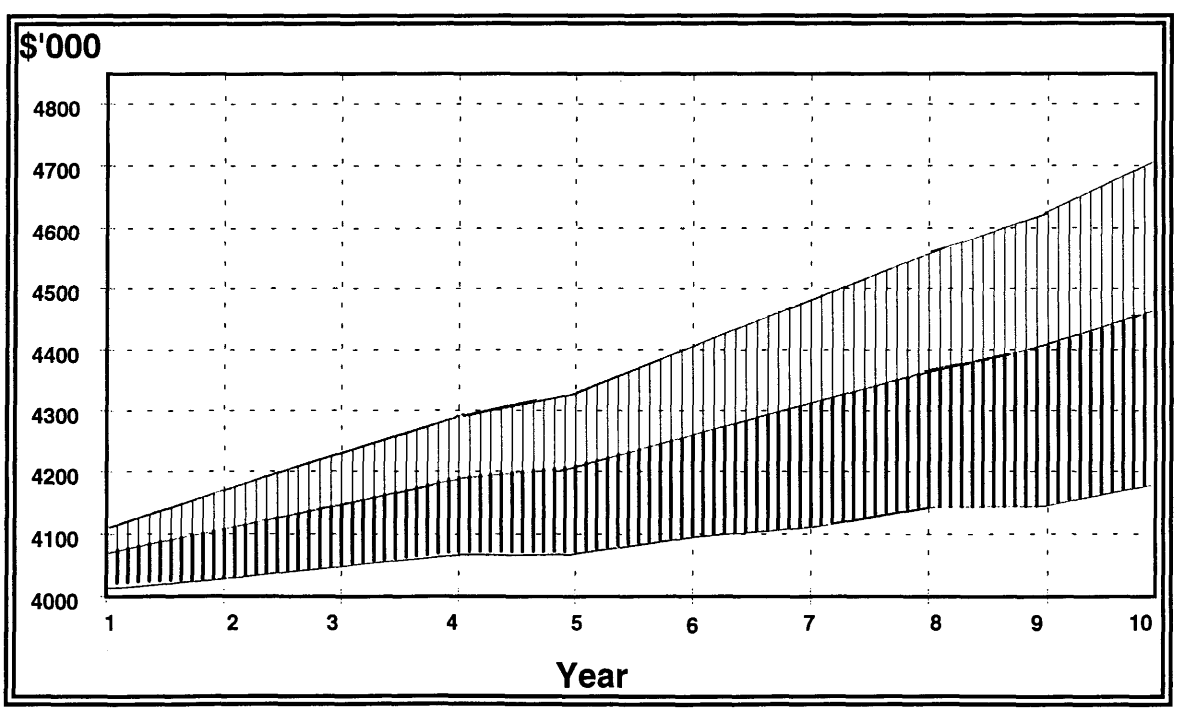


Figure 4.10 Net Worth For Farm A with Cash Investment Alternative



The major reason behind the owner choosing the shares strategy, was that it provided a much greater return potential than the other options. With the choice of shares it was noted that the risks associated with a loss were slightly higher than for the property or cash options, even though the prospects for higher returns were seen to be greater.

The preference of the farm owner for a property investment strategy ahead of cash is largely due to his knowledge in the property investment field. The owner is confident that he can achieve better than normal expected returns which is displayed by the mean line in the summary graph. Whereas with the cash investment, potential returns are kept relatively constant over the range of cash investments that are available.

The options for Farm B

The summary graphs of net cash flow outcomes for Farm B can be seen in Figures 4.11 to 4.13. The largest potential deficit predicted by the model is the shares investment strategy. This peak deficit is approximately ($18,000) as compared to around ($10,000) which was simulated for the alternative strategies.

With reference to the graphs of both the net cash flow and net worth outcomes in Figures 4.11 to 4.16, the shares strategy can be seen to have a significantly greater profit earning potential. However it is difficult to differentiate between the cash and property alternatives. The small difference that can be seen in the graphs, is where the property strategy is a little more variable after ten years but the mean doesn't significantly change.

A feature of the net cash flow is that there are slight drops in all of the outcomes in year three an eight, and a more significant drop experienced in year six. Again these in the net cash flow outcomes are a result of capital expenditure. The smaller depressions are created by forecasted purchases of motor bikes whilst the larger drop in year six is because of the budgeted purchase of a motor vehicle.

An important observation made by the owner of Farm B, is that the risks of each alternative only differed marginally. The owner considered that the bottom band on the summary graphs didn't change enough between the alternatives to warrant significant concern. Consequently his preferences for the investment strategies lay in the alternative with greatest profit earning potential and displays the greatest spread above the zero axis. Hence the ranking by the farm owner of most preferred to least preferred options is listed as follows;

1. Shares
2. Property
3. Cash

Figure 4.11 Net Cash Flow For Farm B with Shares Investment Strategy

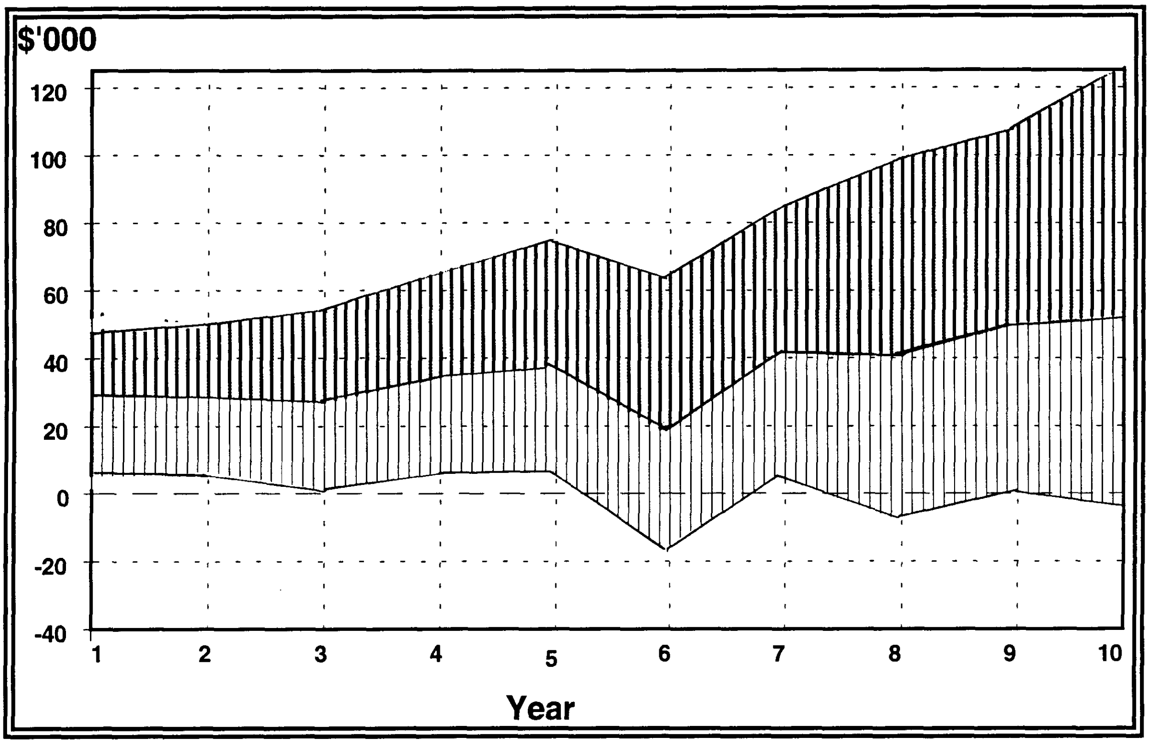


Figure 4.12 Net Cash Flow For Farm B with Property Investment Strategy

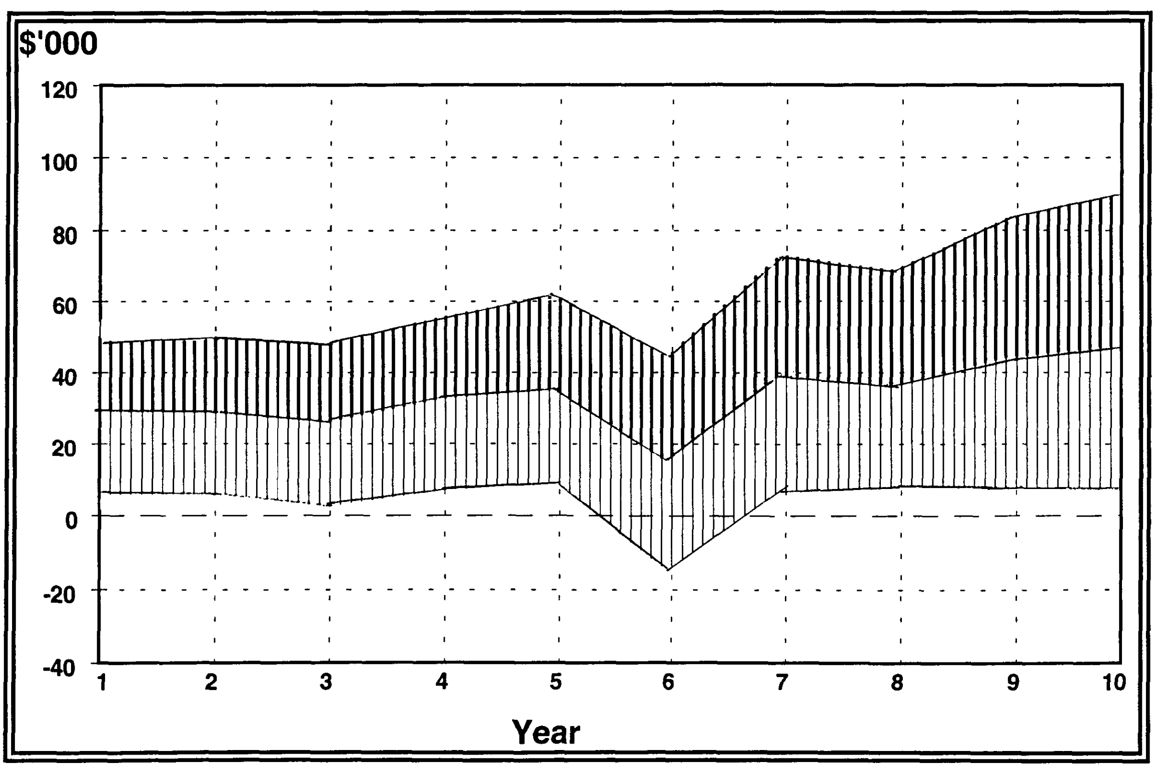


Figure 4.13 Net Cash Flow For Farm B with Cash Investment Strategy

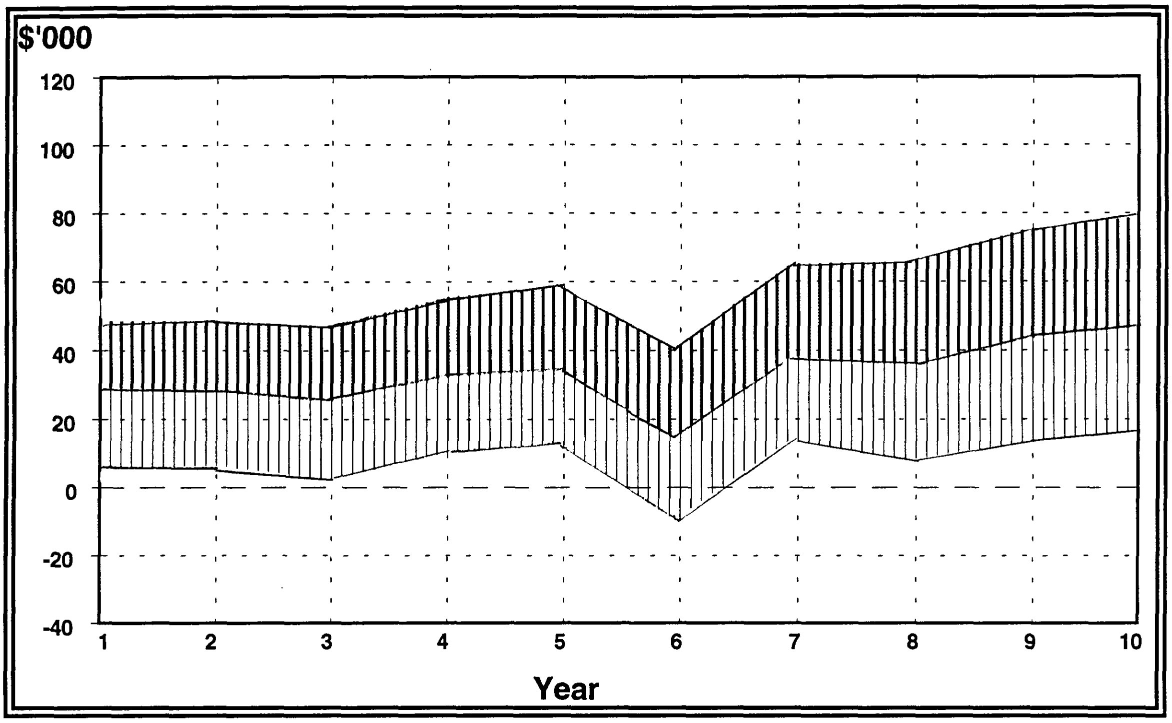


Figure 4.14 Net Worth For Farm B with Shares Investment Strategy

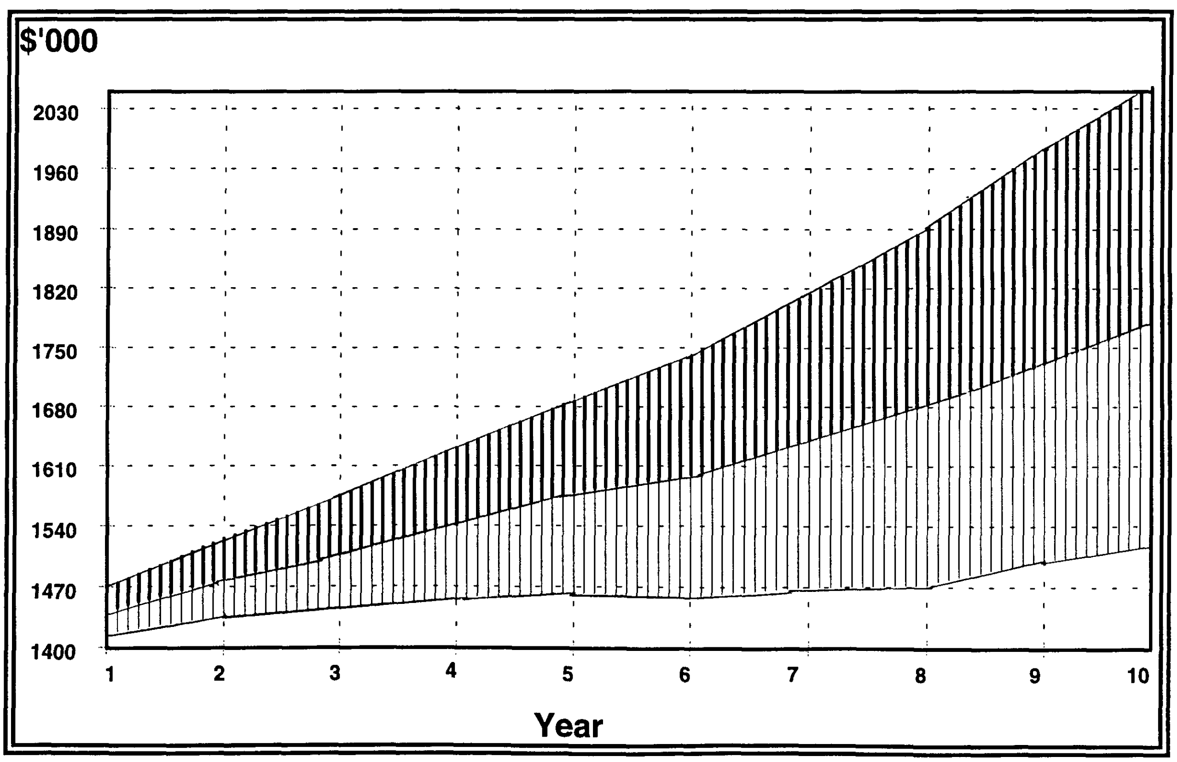


Figure 4.15 Net Worth For Farm B with Property Investment Strategy

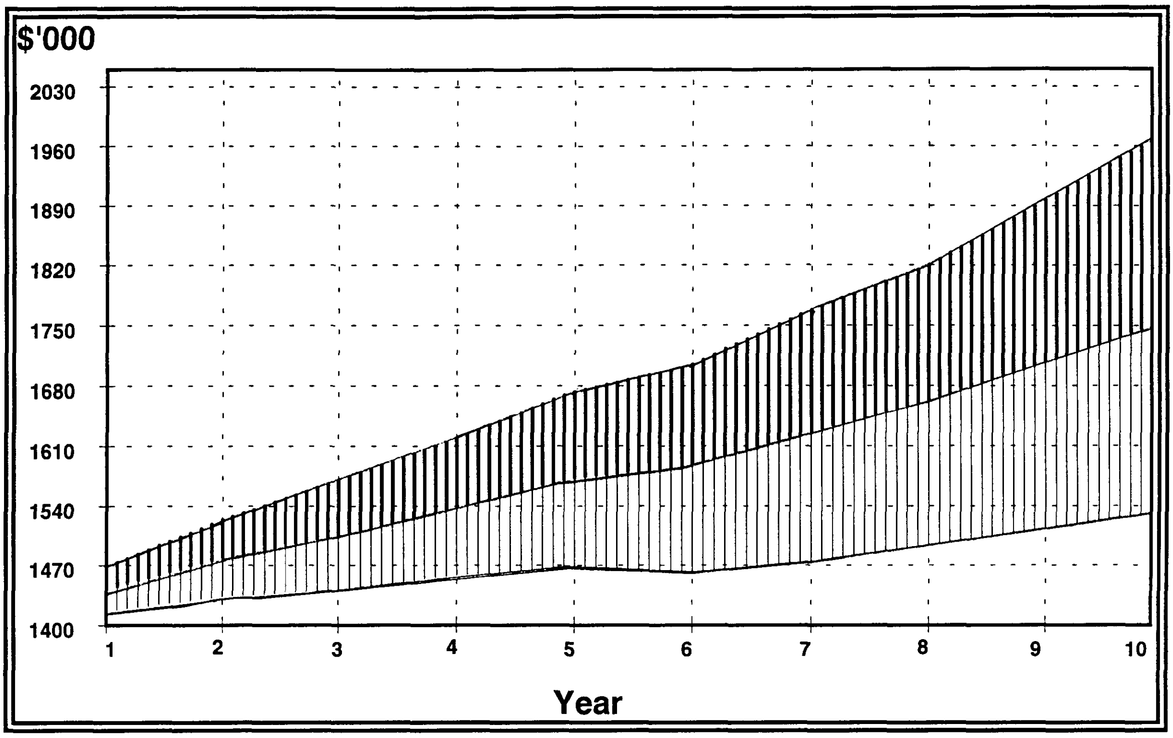
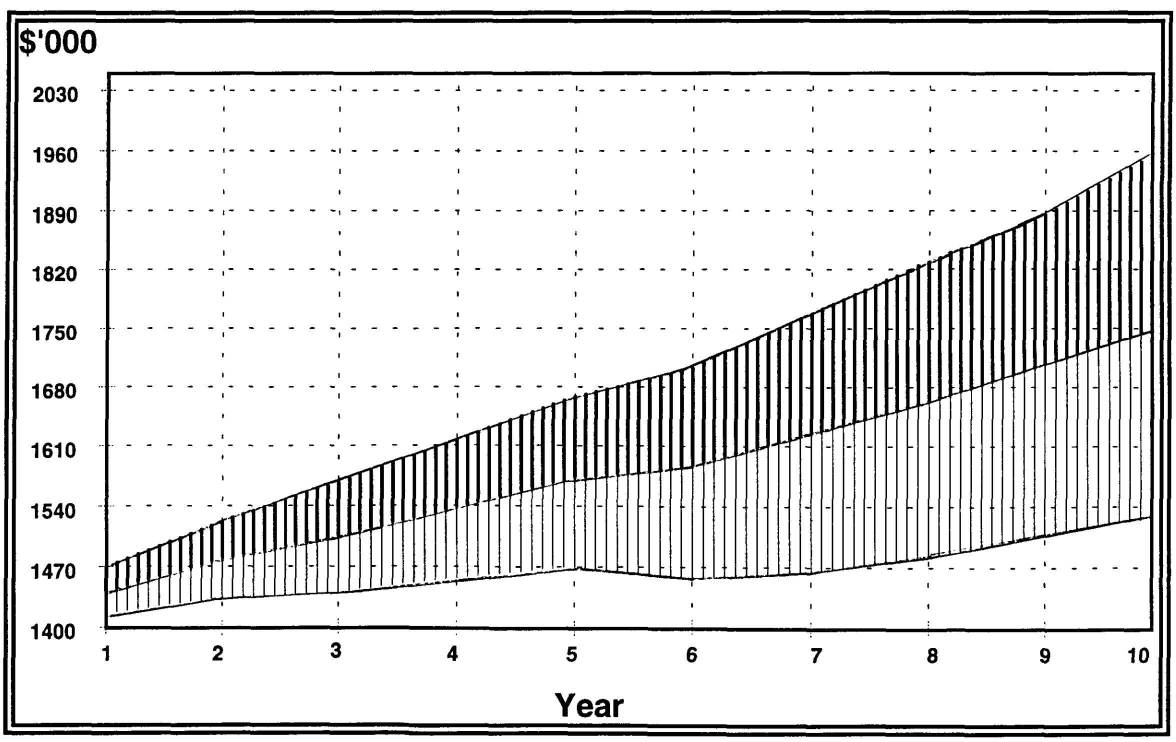


Figure 4.16 Net Worth for Farm B with Cash Investment Strategy



5. Discussion and Conclusions

5.1 Assessment of Investment Strategies

The stated research objective of this dissertation is "to examine the financial implications of alternative off-farm investments to the farm business, whilst analysing the risks involved". To achieve this objective, a stochastic budgeting model of two case study farms were simulated with three investment options. The stochastic results from the simulations were then assessed by two methods of decision analysis.

One method (SDRF) was a deductive approach which was based on the use of stochastic efficiency criteria. The second approach (@Risk presentations) was inductive and was based on the interpretations of stochastic results plus the free choice of the actual decision maker involved.

5.1.1 Stochastic dominance with respect to a function (SDRF)

The results of the SDRF analysis are listed below in Table 5.1. The interesting feature of these results, is that the SDRF ranking of investments differ between farms. For Farm A the best option was "shares" which is a high risk and potentially high return investment, whilst the best option for Farm B was "cash" which is a low risk and low return investment. What will explain these selections is that the Farm A's wealth value (net worth) is significantly higher than Farm B's, so that the decision maker from Farm A will have a lower level of risk aversion than the decision maker from Farm B.

5.1.2 @Risk presentations

It can be seen from the @Risk graph presentations that the investment alternatives with the highest return potential also have the greatest uncertainty and risk. It can be seen from the case-study farmer's ranking of alternatives in Table 5.1, that both farmer's have decided to pursue the possibility of higher returns and accept the greater uncertainty associated with that choice.

5.1.3 Method comparison

A comparison of the ranking's of choices from the two approaches in the study proved to differ and can be seen in Table 5.1. There are two likely reasons which would help explain why the two should differ.

One possibility is that the SDRF decision criteria failed to imitate the preferences of the case-study farmers. The failure may occur if the SDRF assumptions fail to include other decision making influences such as the farm managers specialised management skills, investment biases due to relevant past experiences, and the possible lack of risk averseness (where the individual's level of relative risk aversion falls below the range adopted).

Another possibility is that farmers may not have fully comprehended comparisons of @Risk presentations on different graphs. To avoid this problem, the presentations could be super imposed upon the same graph. Unfortunately though, at present the computer software available to the researcher is not advanced enough to handle this.

Table 5.1 Ranking of Alternative Investment Strategies

	Farm A:		Farm B:	
Ranking[a]:	SDRF	Owner	SDRF	Owner
1	Shares	Shares	Cash	Shares
2	Cash	Property	Shares	Property
3	Property	Cash	Property	Cash

[a]The ranking portrays most preferred investment strategy at 1 to least preferred strategy at 3.

5.2 Limitations of the Study

One of the major limitations of the study was that the case study approach can be too case specific to allow broad generalisations to be made from the results with confidence. To overcome this a greater number of sample farms could be analysed or the representative farm approach could be used. The problem with the representative approach is that it becomes abstract whilst representing a sample of farms and therefore lacks the degree of realism that is achieved with the case study approach.

To achieve an informative comparison between the three investment types for the study, only single investment types were included. Both farm managers commented that realistically they would prefer to have a diverse portfolio.

There was one critical judgement of the simulation model which was offered by both of the case study farmers. They commented that a year with high annual rainfall doesn't necessarily mean a year of high production, and hence annual rainfall can be a misleading indicator of effective rainfall. For rainfall to be effective for pasture production, it is influenced by many other climatic factors. Some of these include rain sequence with daylight hours, temperature, humidity, and the density of rain falls.

5.3 Suggestions for Further Research

One area which requires further research is to find a climatic indicator that has stronger correlation with effective rainfall than annual rainfall. The owner of Farm B suggested that there should be a larger correlation between effective rainfall and rainfall in critical seasonal periods. He also suggested that the suitable seasonal rainfall periods for the New England region would include September through to November, and March and April.

There is also need to further investigate integrating the two methods of decision analyses used in the study. Stochastic dominance rules with minimal assumptions imposed upon a decision maker's beliefs could be used to narrow down a large set of choices to find a smaller efficient set, which could then be presented to the actual decision makers with @Risk summary graphs. A major advantage of doing this would be to capture the benefits of using an inductive approach whilst not confusing the decision maker with too many graph presentations.

In the study there were three broad investment alternatives compared in the analysis. There is considerable potential for further research into the comparison of more specific investment types, and to diversify the off-farm investment portfolios.

An advantage of investing in agricultural land for the farm business is noted in Chapter 2 as boosting production efficiency through increasing returns to scale. The study has also highlighted the advantages of investing off-farm. Consequently it could well prove worthwhile to compare the two investment strategies with stochastic simulation modelling.

The stochastic simulation modelling method of whole farm budgeting presents the opportunity to assess the long-term benefits of other risk management strategies for farm managers. Such strategies could include storing silage, low stocking rate numbers, and commodity futures trading.

5.4 Conclusions

In the present study two methods were used in evaluating the investment options; SDRF and @Risk graphical presentation methods. An advantage of using the @Risk presentation in a study like this is that it supplies more information of an intuitively acceptable nature to the farmer, and hence allows for the inclusion for the potentially complex beliefs and preferences of individual farmers.

In ranking the investment options (shares, cash and property), it was concluded that with the exception of Farm B assessed with SDRF, the most preferred option was the shares option on both case study farms. Property and cash differed in ranking between case study farms and between decision criteria.

From this study it was concluded that when using the SDRF decision analysis, the ranking of various investment options can differ between individual farms because of unique features such as wealth (net worth). When the @Risk presentation method was employed, the free choice of the decision maker was used in addition to the knowledge in addition to the knowledge of stochastic outcomes. Finally, SDRF and @Risk presentations was shown to rank off-farm investment options differently, depending on the individual characteristics of farm and decision maker.

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Figure A1.1: Merino Ewe Gross Margin and Flock Dynamics

FARM 'A' MERINO EWE GROSS MARGIN

Enterprise: Fine Wool Self-Replacing Merino Flock and First Cross Spring Lambs
Flock Size 3,400 Merino Ewes

INCOME:						Per Unit ($)		Total ($):
Wool:	3,382	ewes	4.50	kg	@	$4.89	/kg	$74,491
	1,230	hoggets	3.50	kg		$4.89	/kg	$21,062
	51	rams	5	kg	@	$3.23	/kg	$819
	51	B.L. rams	6	kg	@	$1.52	/kg	$462
	3,382	crutching	0.2	kg	@	$2.16	/kg	$1,461
Sheep:	503	CFA ewes			@	$5.36	/head	$2,696
	16	CFA rams			@	$8.00	/head	$131
	729	1st X lambs			@	$25.57	/head	$18,645
		TOTAL INCOME						**$119,767**
VARIABLE COSTS:								
Replacements:								
	10	Merino rams			@	$457	/head	$4,476
	10	Border Leicester rams			@	$147	/head	$1,438
Shear:	4,612	ewes & hoggets			@	$3.30	/head	$15,219
	101	rams			@	$8.00	/head	$812
Crutch:	3,382	ewes			@	$0.90	/head	$3,044
Drench:	3,484	Ewes and rams			@	$0.81	/head	$2,822
	2,566	Lambs			@	$0.35	/head	$898
Jet:	3,484	Ewes and rams			@	$0.57	/head	$1,986
	2,566	Lambs			@	$0.25	/head	$641
Dipping:	3,484	Ewes and rams			@	$0.04	/head	$139
Vaccine:	3,484	Ewes and rams			@	$0.16	/head	$557
	2,566	Lambs			@	$0.07	/head	$180
Marking:	2,566	Lambs			@	$0.55	/head	$1,411
Cartage:	1,248	sheep			@	$0.90	/head	$1,124
	85	wool bales			@	$7.00	/bale	$597
Selling Costs:		Livestock	4%	gross	+	$0.23	/head	$1,039
		Wool (included in price of wool)						
Sup. Feed:	0	t. feed wheat			@	$147	/tonne	$0
Misc.Costs:								$700
		TOTAL VARIABLE COSTS						**$37,082**
		GROSS MARGIN						**$82,685**

1. Ewes Wool Details

Desription:	**Fleece**	**Skirtings**	**Bellies**	**Locks**	**Crutchings**
Micron	19	19	19	19	19
Wool type	60P	161P	R161PS	282PY	299Y
Clean price	812	625	775	416	360
Yield (%)	72%	63%	58%	50%	60%
Gross Greasy price (c/kg)	585	394	450	208	216
% of clip	80%	15%	3%	2%	100%
Deductions:					
Wool levy & taxes	8.50%	8.50%	8.50%	8.50%	8.50%
Broking charges	1.60%	1.60%	1.60%	1.60%	1.60%
Net greasy price (c/kg)	526	354	404	187	194
Total net greasy price (c/kg)	489				

2. Flock Production Details:

Target ewe flock size		3,400
Average lambing rate		80%
Mortality rate	- adult sheep	3%
	- weaners	4%
	- lambs	5%
Rams	- as a % of ewes	3%
Ewes	- age when culled	6
Replacement strategy	- self replacing	

3. Flock Structure:

Sheep Age:	**No's @ joining**	**Lambs**	**Weaners:**	**Rams**	**Transfers:**	
1.5	610			101	635	wnr merino ewes *
2	591		1,230		500	wnr first X ewes*
3	572	2,566			615	wnr merino wthrs *
4	554		1,230		729	1st cross wnrs sold
5	536				503	cfa ewes
6	519				16	cfa rams
					20	rams purch

* Stock retained from self-replacing ewe flock

Figure A1.2: Merino Wether Gross Margin and Flock Dynamics

FARM 'A' MERINO WETHER GROSS MARGIN

Enterprise: Fine Wool Merino Wether Flock
Flock Size: 6,000 Wethers

						Per Unit ($)		Total ($):
INCOME:								
Wool:	6,000	Wethers	4.73	kg	@	4.89	/kg	$138,999
	6,000	crutching	0.40	kg	@	2.16	/kg	$5,184
Sheep:	890	Cull wethers			@	$6.78	/head	$6,037
				TOTAL INCOME				**$150,220**
VARIABLE COSTS:								
Replacements:								
	510	Wethers			@	$14.33	/head	$7,313
Shear:	6,000	Wethers			@	$3.30	/head	$19,800
Crutch:	6,000	Wethers			@	$0.90	/head	$5,400
Drench:	6,000	Wethers			@	$0.48	/head	$2,880
Dipping:	6,000	Wethers			@	$0.36	/head	$2,160
Jet:	6,000	Wethers			@	$0.27	/head	$1,620
Vaccine:	6,000	Wethers			@	$0.16	/head	$960
Cartage:	1,401	Wethers			@	$0.90	/head	$1,261
	154	Bales			@	$7.00	/bale	$1,075
Selling Costs:		Sheep	5% gross		+	$0.23	/head	$507
		Wool (included in price of wool)						
Misc.Costs:								$1,200
				TOTAL VARIABLE COSTS				**$44,175**
				GROSS MARGIN				**$106,045**

1. Wethers Wool Details:

Description:	**Fleece**	**Skirtings**	**Bellies**	**Locks**	**Crutchings**
Micron	19	19	19	19	19
Wool type	60P	161P	R161PS	282PY	299Y
Clean price	812	625	775	416	360
Yield (%)	72%	63%	58%	50%	60%
Gross Greasy price (c/kg)	585	394	450	208	216
% of clip	80%	15%	3%	2%	100%
Deductions:					
Wool levy & taxes	8.50%	8.50%	8.50%	8.50%	8.50%
Broking charges	1.60%	1.60%	1.60%	1.60%	1.60%
Net greasy price (c/kg)	526	354	404	187	194
Total net greasy price (c/kg)	489				

2. Flock Production Details:

Target flock size		6,000
Mortality rate	- adult sheep	3%
	- weaners	4%
Wethers	- age when culled	6
Replacement strateg	- transfer replacements in from ewe flock & purchase remainder	

3. Flock Structure:

Sheep Age:	Sheep No's	Lambs	Weaners:	Transfers:	
1.0	1,080				
2	1,046			510	replacement
3	1,013				wethers puchased
4	981			615	replacement
5	950				wethers retained
6	919			890	cfa wethers

Figure A1.3: Cross Bred Ewe Gross Margin and Flock Dynamics

FARM 'A' CROSS BRED EWE GROSS MARGIN

Enterprise: First Cross Ewes Joined to Dorset Rams for Prime Lamb Production
Flock Size: 3,000 Ewes

					Per Unit ($)		Total ($):
INCOME:							
Wool:	3,089	ewes	3.90 kg	@	$2.28	/kg	27,503
	81	rams	6 kg	@	$1.51	/kg	729
	3,089	crutching	0.2 kg	@	$1.01	/kg	621
Sheep:	400	CFA ewes		@	$5.36	/head	2,143
	13	CFA rams		@	$9.36	/head	122
	3,692	Prime lambs		@	$25.57	/head	94,413
		TOTAL INCOME					**$125,531**
VARIABLE COSTS:							
Replacements:							
(1st X ewes transfered from merino ewe flock)							
	16	Dorset rams		@	$300	/head	4,914
Shear:	3,089	ewes		@	$3.30	/head	10,194
	81	rams		@	$8.00	/head	645
Crutch:	3,089	ewes		@	$0.90	/head	2,780
Drench:	3,170	Ewes and rams		@	$0.81	/head	2,567
	3,861	Lambs		@	$0.35	/head	1,351
Jet:	3,170	Ewes and rams		@	$0.57	/head	1,807
	3,861	Lambs		@	$0.25	/head	965
Dipping:	3,170	Ewes and rams		@	$0.04	/head	127
Vaccine:	3,861	Lambs		@	$0.10	/head	386
Marking:	3,861	Lambs		@	$0.05	/head	193
Cartage:	4,105	sheep		@	$0.90	/head	3,695
	68	wool bales		@	$7.00	/bale	474
Selling Costs:		Livestock	4% gross	+	$0.23	/head	5,778
		Wool (included in price of wool)					
Sup. Feed:	0	t. feed wheat		@	$147	/tonne	0
Misc.Costs:							700
		TOTAL VARIABLE COSTS					**$36,577**
		GROSS MARGIN					**$88,954**

1. Ewes Wool

Wool Description:	Fleece	Skirtings	Bellies	Locks	Crutchings
Micron	26	26	26	26	26
Wool type	434AB	486AB	572AY	588Y	589Y
Clean price	439	375	230	160	150
Yield (%)	64%	60%	52%	48%	67%
Gross Greasy price (c/kg)	281	225	120	77	101
% of clip	75%	15%	6%	3%	100%
Deductions:					
Wool levy & taxes	8.50%	8.50%	8.50%	8.50%	8.50%
Broking charges	1.60%	1.60%	1.60%	1.60%	1.60%
Net greasy price (c/kg)	253	202	108	69	90
Total net greasy price (c/kg)	228				
Wool Bales					

2. Flock Production Details:

Target ewe flock size		3,000
Average lambing rate		125%
Mortality rate	- adult sheep	3%
	- weaners	4%
	- lambs	5%
Rams	- as a % of ewes	3%
Ewes	- age when culled	7
Replacement strateg	- transfer replacements in from ewe flock & purchase remainder	

3. Flock Structure:

Sheep Age:	No's @ joining	Lambs	Weaners:	Rams	Transfers:	
1.5	485			81	500	replacement ewes
2	470		1,850			from ewe flock
3	455	3,861			3,692	lambs sold
4	440		1,850		400	cfa ewes
5	426				13	cfa rams
6	413				16	rams purch
7	400					

Figure A1.4: Cattle Gross Margin and Herd Dynamics

FARM 'A' CATTLE GROSS MARGIN

Enterprise: Commercial Cross Bred Herd
Herd Size: 250 Cows

							Per Unit ($)		Total ($):
INCOME:									
Cattle	50	Steer weaners	$344	/head	@		$1.16	/kg	17,207
	20	Heifer weaners	$314	/head	@		$1.12	/kg	6,272
	60	Steers	$463	/head	@		$1.11	/kg	27,937
	55	Heifers	$337	/head	@		$0.94	/kg	18,370
	27	CFA & dry cows	$356	/head	@		$0.79	/kg	9,752
	2	CFA bulls	$615	/head	@		$0.82	/kg	1,230
			TOTAL INCOME						**$80,767**
VARIABLE COSTS:									
Replacements:									
	2	Bulls			@		$1,500	/head	3,000
Drench:	378	head			@		$4.00	/head	1,513
Delouse:	8	Bulls			@		$2.80	/head	21
	252	cows			@		$2.00	/head	505
	118	heifers & steers			@		$1.50	/head	178
Vaccine:	(5 in 1):								
	225	calves			@		$0.18	/head	40
	(Leptospirosis):								
	252	cows			@		$0.89	/head	225
	36	heifers			@		$0.89	/head	32
	8	bull			@		$0.89	/head	7
	(Vibriosis):								
	8	bull			@		$1.25	/head	9
Vet cost:	252	cows			@		$4.00	/head	1,009
Sundry:	225	ear tags			@		$0.28	/head	63
Selling costs:			214 sale cattle						
	Saleyard charge @ 4% & $2/hd								
	AMLC levy @ $5.83/hd								4,909
Cartage:	@ $6.0/hd								1,286
			TOTAL VARIABLE COSTS						**$12,797**
			GROSS MARGIN						**$67,970**

1. Livestock Trading

Stock Class:	Trade	Age	RF10	No.	$/kg	$/head
Replacement Bulls	buy	2		2		
cfa Bulls	sell	6	750	2	0.82	615
cfa Cows	sell	9	450	27	0.79	356
Wnr. Steers	sell	0.8	297	50	1.16	344
Wnr. Heifers	sell	0.8	280	20	1.12	314
Yearling Steers	sell	1.5	417	60	1.11	463
Yearling Heifers	sell	1.5	358	55	0.94	337
Yearling Heifers	retained	1.5		36		

2. Herd Production Details:

Target cow herd size		250
Average calving rate		89%
Mortality rate	- adult stock	3%
	- calves	4%
Bulls	- as a % of cows	3%
Cows	- age when culled	9.0yrs
	- age at first calf	2.0yrs

3. Herd Structure:

Cow Age:	No's @ joining	Bulls	Calves	Weaners	Yearlings not joined	Transfers:
1	35	8			56 heifers	36 replacement heifers
2	34			112		20 heifer weaners sold
3	33					50 steer weaners sold
4	32		225			55 heifers sold
5	31					60 steers sold
6	30			112		27 cfa cows
7	29				62 steers	2 cfa bulls
8	28					2 bulls purchased

Figure A1.5: Assets and Liabilities Statement

FARM 'A' STATEMENT OF ASSETS AND LIABILITIES						
Opening Val.($)			*Assets:*			Closing Val.($)
3,692,400	3,077 Ha. @ $1050/ha. with 2% Appreciation					3,766,248
			Structures:	deprctn.:	17,860	
	200,000		Homestead	0%	200,000	
	150,000		House	0%	150,000	
	200,000		4 x Cottages	5%	191,000	
	45,000		Stock yards	8%	41,625	
	80,000		Wool shed	5%	76,000	
	25,000		Sheds	5%	23,875	
708,000	8,000		Silos	5%	7,640	690,140
			Machinery:	deprctn.:	21,875	
	25,000		Bulldozer	23%	19,375	
	32,000		3 x Tractors	23%	24,800	
	3,000		Header	23%	2,325	
	5,000		Toyota 4x4	23%	3,875	
	2,000		Landrover 4x4	23%	1,550	
	8,500		Ag. bikes	50%	4,250	
	3,000		Ploughs	15%	2,550	
85,500	7,000		Other (tools etc.)	30%	4,900	63,625
		No's	***Livestock:***	@		
	36,000	6,000	Merino wethers	$6	36,000	
	33,822	3,382	Merino ewes	$10	33,822	
	55,601	3,089	1st X ewes	$18	55,601	
	12,683	51	Merino rams	$250	12,683	
	10,513	131	Dorset & B.L. rams	$80	10,513	
	100,000	250	Cows	$400	100,000	
256,119	7,500	8	Bulls	$1,000	7,500	256,119
4,742,019			TOTAL ASSETS			4,776,132
			Liabilities:			
711,303			Debt			711,303
0			Bank Overdraft			0
711,303			TOTAL LIABILIITY			711,303
$4,030,716			TOTAL EQUITY			**$4,064,829**

Figure A1.6: Cash Flow Statement

FARM 'A' CASH FLOW										
YEAR:	1	2	3	4	5	6	7	8	9	10
RECEIPTS:										
Merino ewes	119,767	119,767	119,767	119,767	119,767	119,767	119,767	119,767	119,767	119,767
Merino wethers	150,220	150,285	150,285	150,285	150,285	150,285	150,285	150,285	150,285	150,285
2nd X lambs	125,531	125,531	125,531	125,531	125,531	125,531	125,531	125,531	125,531	125,531
Cattle	80,767	80,767	80,767	80,767	80,767	80,767	80,767	80,767	80,767	80,767
Shares		3,075	10,927	19,770	29,460	34,690	45,811	57,999	71,355	82,482
Total Receipts:	476,285	478,714	487,277	496,120	505,811	511,041	522,162	534,350	547,705	558,833
PAYMENTS										
A. Capital Payments:										
Stock purch.										
-bulls	3,333	3,333	3,333	3,333	3,333	3,333	3,333	3,333	3,333	3,333
-wethers	7,313	7,167	7,167	7,167	7,167	7,167	7,167	7,167	7,167	7,167
-rams	10,828	10,828	10,828	10,828	10,828	10,828	10,828	10,828	10,828	10,828
Pasture improvement										
-super	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200
Motor Bikes	4,867	4,867	4,867	4,867	4,867	4,867	4,867	4,867	4,867	4,867
Tractor									18,667	
Motor Car					28,667					
A . Sub-Total:	28,541	28,395	28,395	28,395	57,061	28,395	28,395	28,395	47,061	28,395
B. Variable Costs:										
Sheep:										
Shearing @ $3.3	46,669	46,669	46,669	46,669	46,669	46,669	46,669	46,669	46,669	46,669
Crutching @ $0.90	11,224	11,224	11,224	11,224	11,224	11,224	11,224	11,224	11,224	11,224
Drench @ $0.81	10,519	10,519	10,519	10,519	10,519	10,519	10,519	10,519	10,519	10,519
Dip & Jet @ $0.57	9,445	9,445	9,445	9,445	9,445	9,445	9,445	9,445	9,445	9,445
Marking	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,604	1,604
Vaccination @ $0.16	2,083	2,083	2,083	2,083	2,083	2,083	2,083	2,083	2,083	2,083
Cartage	8,225	8,224	8,224	8,224	8,224	8,224	8,224	8,224	8,224	8,224
Selling costs	7,323	7,101	7,329	7,329	7,329	7,329	7,329	7,329	7,329	7,329
Supp. feed	0	0	0	0	0	0	0	0	0	0
Misc. costs	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600
Cattle:										
Drench	1,513	1,513	1,513	1,513	1,513	1,513	1,513	1,513	1,513	1,513
Delouse	703	703	703	703	703	703	703	703	703	703
Vaccine	313	313	313	313	313	313	313	313	313	313
Vet	1,009	1,009	1,009	1,009	1,009	1,009	1,009	1,009	1,009	1,009
Sundry	63	63	63	63	63	63	63	63	63	63
Selling costs	4,909	4,909	4,909	4,909	4,909	4,909	4,909	4,909	4,909	4,909
Cartage	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286
B . Sub-Total:	108,204	107,981	108,209	108,209	108,209	108,209	108,209	108,209	108,209	108,209
C. Overhead Costs:										
Labour	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000
Accounting charges	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Bank charges	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Ins. & workers comp.	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000
Telephone	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Fuel & oil	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000
Staitonary etc.	300	300	300	300	300	300	300	300	300	300
Repairs & maintenanc	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000
Rates	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000
Vehicle rego.	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Electricity	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400
Fodder crops	15,820	15,820	15,820	15,820	15,820	15,820	15,820	15,820	15,820	15,820
Interest on Debt	77,319	77,319	77,319	77,319	77,319	77,319	77,319	77,319	77,319	77,319
Drawings	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000
C. Sub-Total:	272,339	272,339	272,339	272,339	272,339	272,339	272,339	272,339	272,339	272,339
TOTAL COSTS:	409,084	408,714	408,942	408,942	437,609	408,942	408,942	408,942	427,609	408,942
Net Cash Surplus	67,202	67,999	78,335	87,178	68,202	102,099	113,220	125,408	120,097	149,891
Taxable Income	67,333	68,131	78,467	87,310	97,000	102,231	113,352	125,539	138,895	150,022
Tax	25,844	26,235	31,300	35,633	40,381	42,944	48,393	54,365	60,910	66,362
Net Cash Surplus (after tax)	41,357	41,764	47,036	51,545	27,821	59,155	64,827	71,042	59,187	83,529
Trading A/C	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
Investment Value	16,357	58,121	105,157	156,702	184,523	243,678	308,505	379,547	438,734	522,263
Net Worth	4,072,074	4,113,838	4,160,873	4,212,419	4,240,239	4,299,394	4,364,221	4,435,264	4,494,451	4,577,980

Figure A2.1: Merino Ewe Gross Margin and Flock Dynamics

FARM 'B' MERINO EWE GROSS MARGIN

Enterprise: Fine Wool Self-Replacing Merino Flock and First Cross Spring Lambs
Flock Size 2,200 Merino Ewes joined to Merino Rams
1,000 Merino Ewes joined to Border Leicester Rams

					Per Unit ($)	Total ($):
INCOME:						
Wool:	3,188	ewes	4.50 kg	@	$4.89 /kg	$70,217
	1,600	hoggets	3.50 kg	@	$4.89 /kg	$27,400
	66	rams	5.00 kg	@	$3.23 /kg	$1,066
	30	B.L. rams	6 kg	@	$1.52 /kg	$273
	3,188	crutching	0.2 kg	@	$2.16 /kg	$1,377
Sheep:	474	CFA ewes		@	$5.36 /head	$2,541
	15	CFA rams		@	$8.00 /head	$124
	727	1st X lambs		@	$25.57 /head	$18,591
	593	Merino weaners		@	$14.33 /head	$8,500
		TOTAL INCOME				**$130,090**
VARIABLE COSTS:						
Replacements:						
	12	Merino rams		@	$457 /head	$5,434
	5	Border Leicester rams		@	$147 /head	$784
Shear:	4,788	ewes & hoggets		@	$3.30 /head	$15,799
	96	rams		@	$8.00 /head	$768
Crutch:	3,188	ewes		@	$0.90 /head	$2,869
Drench:	3,284	Ewes and rams		@	$0.81 /head	$2,660
	2,419	Lambs		@	$0.35 /head	$847
Jet:	3,284	Ewes and rams		@	$0.57 /head	$1,872
	2,419	Lambs		@	$0.25 /head	$605
Dipping:	3,284	Ewes and rams		@	$0.04 /head	$131
Vaccine:	3,284	Ewes and rams		@	$0.16 /head	$525
	2,419	Lambs		@	$0.07 /head	$169
Marking:	2,419	Lambs		@	$0.55 /head	$1,330
Cartage:	1,810	sheep		@	$0.90 /head	$1,629
	80	wool bales		@	$7.00 /bale	$562
Selling Costs:		Livestock	4% gross +		$0.23 /head	$1,458
		Wool (included in price of wool)				
Sup. Feed:	0 t.	feed wheat		@	$147 /tonne	$0
Misc.Costs:						$700
		TOTAL VARIABLE COSTS				**$38,143**
		GROSS MARGIN				**$91,947**

1. Ewes Wool Details

Desription:	**Fleece**	**Skirting**	**Bellies**	**Locks**	**Crutchings**
Micron	19	19	19	19	19
Wool type	60P	161P	R161PS	282PY	299Y
Clean price	812	625	775	416	360
Yield (%)	72%	63%	58%	50%	60%
Gross Greasy price (c/kg)	585	394	450	208	216
% of clip	80%	15%	3%	2%	100%
Deductions:					
Wool levy & taxes	8.50%	8.50%	8.50%	8.50%	8.50%
Broking charges	1.60%	1.60%	1.60%	1.60%	1.60%
Net greasy price (c/kg)	526	354	404	187	194
Total net greasy price (c/kg)	489				

2. Flock Production Details:

Target ewe flock size		3,188
Average lambing rate		80%
Mortality rate	- adult sheep	3%
	- weaners	4%
	- lambs	5%
Rams	- as a % of ewes	3%
Ewes	- age when culled	6
Replacement strategy	- self replacing	

3. Flock Structure:

Sheep Age:	**No's @ joining**	**Lambs**	**Weaners**	**Rams**	**Transfers:**
1.5	575			66 Merino's	599 wnr merino ewes *
2	557			30 B.L.	408 wnr merino wthrs *
3	539	2,419	1,600 merino's		593 wnr merino's sold
4	522		727 x breds		727 1st cross wnrs sold
5	506				474 cfa ewes
6	490				15 cfa rams
					17 rams purch

* Stock retained from self-replacing ewe flock

Figure A2.2: Merino Wether Gross Margin and Flock Dynamics

FARM 'B' MERINO WETHER GROSS MARGIN									
Enterprise:	Fine Wool Merino Wether Flock								
Flock Size:	2,200 Wethers								
INCOME:						Per Unit ($)			Total ($):
Wool:	2,190	Wethers	4.73	kg	@	4.89	/kg		$50,737
	2,190	crutching	0.40	kg	@	2.16	/kg		$1,892
Sheep:	326	Cull wethers			@	$6.78	/head		$2,208
				TOTAL INCOME					**$54,837**
VARIABLE COSTS:									
Replacements:									
	0	Wethers			@	$14.33	/head		$0
Shear:	2,190	Wethers			@	$3.30	/head		$7,227
Crutch:	2,190	Wethers			@	$0.90	/head		$1,971
Drench:	2,190	Wethers			@	$0.48	/head		$1,051
Dipping:	2,190	Wethers			@	$0.36	/head		$788
Jet:	2,190	Wethers			@	$0.27	/head		$591
Vaccine:	2,190	Wethers			@	$0.16	/head		$350
Cartage:	326	Wethers			@	$0.90	/head		$293
	56	Bales			@	$7.00	/bale		$392
Selling Costs:		Sheep	5% gross +			$0.23	/head		$185
		Wool (included in price of wool)							
Misc.Costs:									$1,200
				TOTAL VARIABLE COSTS					**$14,051**
				GROSS MARGIN					**$40,787**

1. Wethers Wool Details:					
Description:	**Fleece**	**Skirting**	**Bellies**	**Locks**	**Crutchings**
Micron	19	19	19	19	19
Wool type	60P	161P	R161PS	282PY	299Y
Clean price	812	625	775	416	360
Yield (%)	72%	63%	58%	50%	60%
Gross Greasy price (c/kg)	585	394	450	208	216
% of clip	80%	15%	3%	2%	100%
Deductions:					
Wool levy & taxes	8.50%	8.50%	8.50%	8.50%	8.50%
Broking charges	1.60%	1.60%	1.60%	1.60%	1.60%
Net greasy price (c/kg)	526	354	404	187	194
Total net greasy price (c/kg)	489				

2. Flock Production Details:		
Target flock size		2,190
Mortality rate	- adult sheep	3%
	- weaners	4%
Wethers	- age when culled	6
Replacement strateg	- transfer replacements in from ewe flock & purchase remainder	

3. Flock Structure:					
Sheep Age:	Sheep No's	Lambs	Weaners:	Transfers:	
1.0	395				
2	382				
3	370				
4	359			408	replacement
5	347				wethers retained
6	336			326	cfa wethers

Figure A2.3: Cattle Gross Margin and Herd Dynamics

FARM 'B' CATTLE GROSS MARGIN

Enterprise:	Commercial Cross Bred Herd						
Herd Size:	100 Cows						
INCOME:					Per Unit ($)		Total ($):
Cattle	25	Steer weane	$344	/head @	$1.16	/kg	8,603
	0	Heifer wean	$314	/head @	$1.12	/kg	0
	19	Steers	$463	/head @	$1.11	/kg	8,788
	30	Heifers	$337	/head @	$0.94	/kg	9,962
	11	CFA & dry c	$356	/head @	$0.79	/kg	3,901
	1	CFA bulls	$615	/head @	$0.82	/kg	615
			TOTAL INCOME				**$31,868**
VARIABLE COSTS:							
Replacements:							
	1	Bulls		@	$1,500	/head	1,500
Drench:	134	head		@	$4.00	/head	538
Delouse:	3	Bulls		@	$2.80	/head	8
	101	cows		@	$2.00	/head	202
	49	heifers & steers		@	$1.50	/head	74
VaCine:	(5 in 1):						
	90	calves		@	$0.18	/head	16
	(Leptospirosis):						
	101	cows		@	$0.89	/head	90
	14	heifers		@	$0.89	/head	13
	3	bull		@	$0.89	/head	3
	(Vibriosis):						
	3	bull		@	$1.25	/head	4
Vet cost:	101	cows		@	$4.00	/head	404
Sundry:	90	ear tags		@	$0.28	/head	25
Selling costs:		86 sale cattle					
	Saleyard charge @ 4% & $2/hd						
	AMLC levy @ $5.83/hd						1,945
Cartage:	@ $6.0/hd						513
			TOTAL VARIABLE COSTS				**$5,334**
			GROSS MARGIN				**$26,534**

1. Livestock Trading

Stock Class:	**Trade**	**Age**	**Weight**	**No.**	**$/kg**	**$/head**
Replacement Bulls	buy	1		1		
cfa Bulls	sell	6	750	1	0.82	615
cfa Cows	sell	9	450	11	0.79	356
Wnr. Steers	sell	0.8	297	25	1.16	344
Wnr. Heifers	sell	0.8	280	0	1.12	314
Yearling Steers	sell	1.5	417	19	1.11	463
Yearling Heifers	sell	1.5	358	30	0.94	337
Yearling Heifers	retained	1.5		14		

2. Herd Production Details:

Target cow herd size		100
Average calving rate		89%
Mortality rate	- adult stock	3%
	- calves	4%
Bulls	- as a % of cows	3%
Cows	- age when culled	9.0yrs
	- age at first calf	2.0yrs

3. Herd Structure:

Cow Ag	No's @ joining	Bulls	Calves	Weaners	Yearlings not joined	Transfers:
1	14	3			30 heifers	14 replacement heifers
2	14			45		
3	13					25 steer weaners sold
4	13		90			30 heifers sold
5	12					19 steers sold
6	12			45		11 cfa cows
7	12					1 cfa bulls
8	11					1 bulls purchased

Figure A2.4: Assets and Liabilities Statement

FARM 'B' STATEMENT OF ASSETS AND LIABILITIES						
Opening Val.($)			*Assets:*			Closing Val.($)
1,139,000	1,340 Ha. @ $850/ha. with 2% Appreciation					1,161,780
			Structures:	DepCrctn.:	13,175	
	150,000		House	0%	150,000	
	60,000		Cottages	5%	57,300	
	35,000		Stock yards	8%	32,375	
	130,000		Wool shed	5%	123,500	
	25,000		Sheds	5%	23,875	
405,000	5,000		Silos	5%	4,775	391,825
			Machinery:	DepCrctn.:	8,725	
	8,000		Tractors	23%	6,200	
	5,000		Toyota 4x4	23%	3,875	
	6,500		Ag. bikes	50%	3,250	
	3,000		Ploughs	15%	2,550	
29,500	7,000		Other (tools etc.)	30%	4,900	20,775
		No's	***Livestock:***	@		
	14,849	2,190	Merino wethers	$7	14,849	
	17,088	3,188	Merino ewes	$5	17,088	
	16,500	66	Merino rams	$250	16,500	
	3,600	30	Dorset & B.L. rams	$120	3,600	
	35,550	100	Cows	$356	35,550	
89,432	1,845	3	Bulls	$615	1,845	89,432
1,662,932			**TOTAL ASSETS**			1,663,812
			Liabilities:			
249,440			Debt			249,440
0			Bank Overdraft			0
249,440			**TOTAL LIABILIITY**			249,440
$1,413,493			**TOTAL EQUITY**			**$1,414,373**

Figure A2.5: Cash Flow Statement

FARM 'B' CASH FLOW										
YEAR:	1	2	3	4	5	6	7	8	9	10
RECEIPTS:										
Merino ewes	130,090	130,090	130,090	130,090	130,090	130,090	130,090	130,090	130,090	130,090
Merino wethers	52,629	52,629	52,629	52,629	52,629	52,629	52,629	52,629	52,629	52,629
Cattle	31,868	31,868	31,868	31,868	31,868	31,868	31,868	31,868	31,868	31,868
Shares		3,040	10,494	16,250	23,473	31,388	35,800	44,898	53,952	64,790
Total Receipts:	216,795	217,627	225,081	230,837	238,060	245,975	250,388	259,485	268,539	279,377
PAYMENTS										
A. Capital Payments:										
Stock purch.										
-bulls	1,667	1,667	1,667	1,667	1,667	1,667	1,667	1,667	1,667	1,667
-wethers	0	0	0	0	0	0	0	0	0	0
-rams	6,218	6,218	6,218	6,218	6,218	6,218	6,218	6,218	6,218	6,218
Pasture improvement										
-super	19,667	19,667	19,667	19,667	19,667	19,667	19,667	19,667	19,667	19,667
Motor Bikes			4,867					4,867		
Tractor										
Motor Car						22,667				
A. Sub-Total:	27,551	27,551	32,418	27,551	27,551	50,218	27,551	32,418	27,551	27,551
B. Variable Costs:										
Sheep:										
Shearing @ $3.3	23,795	23,795	23,795	23,795	23,795	23,795	23,795	23,795	23,795	23,795
Crutching @ $0.90	4,840	4,840	4,840	4,840	4,840	4,840	4,840	4,840	4,840	4,840
Drench @ $0.81	4,558	4,558	4,558	4,558	4,558	4,558	4,558	4,558	4,558	4,558
Dip & Jet @ $0.57	3,988	3,988	3,988	3,988	3,988	3,988	3,988	3,988	3,988	3,988
Marking	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330
VaCination @ $0.16	1,045	1,045	1,045	1,045	1,045	1,045	1,045	1,045	1,045	1,045
Cartage	2,876	4,588	2,876	2,876	2,876	2,876	2,876	2,876	2,876	2,876
Selling costs	1,643	3,460	1,458	1,458	1,458	1,458	1,458	1,458	1,458	1,458
Supp. feed	0	0	0	0	0	0	0	0	0	0
Misc. costs	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900
Cattle:										
Drench	538	717	538	538	538	538	538	538	538	538
Delouse	284	348	305	305	305	305	305	305	305	305
VaCine	125	125	125	125	125	125	125	125	125	125
Vet	404	404	404	404	404	404	404	404	404	404
Sundry	25	25	25	25	25	25	25	25	25	25
Selling costs	1,945	1,137	1,945	1,945	1,945	1,945	1,945	1,945	1,945	1,945
Cartage	513	775	513	513	513	513	513	513	513	513
B. Sub-Total:	49,296	49,131	49,131	49,131	49,131	49,131	49,131	49,131	49,131	49,131
C. Overhead Costs:										
Labour	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
ACounting charges	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Bank charges	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600
Ins. & workers comp.	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500
Telephone	700	700	700	700	700	700	700	700	700	700
Fuel & oil	6,700	6,700	6,700	6,700	6,700	6,700	6,700	6,700	6,700	6,700
Staitonary etc.	750	750	750	750	750	750	750	750	750	750
Repairs & maintenance	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600
Rates	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500
Vehicle rego.	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Electricity	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
Interest on Debt	27,114	27,114	27,114	27,114	27,114	27,114	27,114	27,114	27,114	27,114
Drawings	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
C. Sub-Total:	89,864	89,864	89,864	89,864	89,864	89,864	89,864	89,864	89,864	89,864
TOTAL COSTS:	166,711	166,711	171,413	166,546	166,546	189,213	166,546	171,413	166,546	166,546
Net Cash Surplus	50,084	50,916	53,668	64,291	71,514	56,762	83,842	88,072	101,993	112,831
Taxable Income	53,184	54,016	61,635	67,391	74,614	82,529	86,942	96,039	105,093	115,931
Tax	18,911	19,207	23,052	25,873	29,412	33,290	35,452	39,910	44,347	49,657
Net Cash Surplus (after tax)	31,173	31,709	30,616	38,418	42,102	23,472	48,389	48,162	57,647	63,174
Trading A/C	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000
Investment Value	16,173	55,819	86,436	124,854	166,956	190,428	238,817	286,979	344,626	407,799
Net Worth	1,444,665	1,484,312	1,514,928	1,553,347	1,595,448	1,618,920	1,667,310	1,715,472	1,773,118	1,836,292

Appendix 3: Parameters for Stochastic Variables

Table A3.1: Parameters for Normal Probability Distributions used in the Analysis

Distribution Category:		Parameters: Mean	Std. Dvtn.[a]
Clean wool price ($/kg):	19 micron	8.12	1.97
	26 micron	4.39	0.63
Sheep prices ($/head)	Cross bred lambs	25.57	2.21
	Cull weathers	6.78	1.50
	Cull ewes	5.36	1.21
Live cattle prices ($/kg)	Yearling steers	1.11	0.04
	Yearling heifers	0.94	0.04
	Weaner steers	1.16	0.05
	Weaner heifers	1.12	0.05
	CFA Bulls	0.82	0.11
	CFA Cows	0.79	0.08
Feed prices ($/t)	Feed wheat	146.5	15.7
Share returns (%/annum)	Shares	18.78	24.09
	Property	14.05	11.53
	Cash	13.61	3.2
Interest on debt (%/annum):	Long term loan	10.87	2.88

[a]Std. Dvtn. denotes the standard deviation for the probability distribution.

Table A3.2: Triangular Probability Distribution Parameters for Expected Production

Production Category:		Parameters Minimum	Most Likely	Maximum
Fleece weights (kg's):	Merino ewes	4	4.5	5
	Hoggets	3.2	3.5	3.8
	Rams	4.5	5	5.5
	Wethers	4.5	4.7	5
	Cross bred ewes	3.5	4	4.2
	Fat lamb rams	5.5	6	6.4
Cattle sale weights (kg's):	Bulls	700	750	800
	Cows	400	450	500
	Weaner steers	280	300	310
	Weaner heifers	260	280	300
	Yearling steers	400	420	430
	Yearling heifers	340	360	375
Birth Rates (%):	Merino ewes	75	80	85
	Cross bred ewes	120	125	130
	Cows	85	90	92
Mortality Rates (%):	Adult sheep	2.5	3	3.5
	Weaners	3.5	4	5
	Lambs	4	5	6.5
	Adult cattle	2.5	3	4
	Calves	3.5	4	5
Sundry livestock prices: ($/head)	Merino rams	400	450	520
	Border Leicester rams	100	150	190
	Dorset rams	220	300	350
	Bulls	1,000	1,500	2,500
Sundry Capital Payments: ($)	Superphosphate[a]	8,000	19,000	25,000
	Motorbikes	4,600	4,800	5,200
	Motor car[a]	20,000	22,000	26,000
	Motor car[b]	26,000	28,000	32,000
	Tractor	16,000	18,000	24,000

[a]These capital payment distributions are found in the Farm 1 analysis and not the analysis for farm 2.
[b]This motor car purchase distribution is used only for the Farm 2 analysis.

Appendix 4: Stochastic Simulation Results

Table A4.1 Stochastic Simulation Results in Five Percent Intervals for Farm A

	Net Cash Surplus:			Net Worth:		
Percentile	Shares	Property	Cash	Shares	Property	Cash
	$	$	$	$	$	$
0	(307,601)	(212,830)	(76,789)	2,426,859	3,095,584	3,730,192
5	(45,473)	(3,439)	9,625	4,035,824	4,096,753	4,053,353
10	(8,741)	20,509	19,143	4,170,984	4,214,601	4,181,244
15	9,657	29,562	29,848	4,263,085	4,256,198	4,262,741
20	23,405	33,845	38,233	4,324,653	4,305,610	4,316,157
25	29,032	37,667	41,370	4,354,553	4,344,947	4,358,346
30	36,833	42,775	46,874	4,384,656	4,364,394	4,378,910
35	45,275	46,992	50,302	4,405,445	4,386,528	4,403,431
40	50,694	51,434	53,833	4,428,857	4,412,422	4,430,626
45	59,126	54,430	57,059	4,444,454	4,439,230	4,451,827
50	65,587	58,489	61,387	4,477,445	4,464,071	4,471,105
55	72,331	63,549	66,009	4,507,557	4,488,246	4,499,000
60	77,278	66,948	71,234	4,526,514	4,522,234	4,519,746
65	83,734	72,127	75,372	4,550,575	4,549,163	4,552,053
70	93,086	78,837	78,589	4,605,191	4,571,739	4,574,456
75	107,431	83,977	81,460	4,671,323	4,621,833	4,599,990
80	125,373	92,929	86,511	4,732,547	4,655,795	4,612,864
85	141,962	100,587	92,704	4,784,452	4,674,194	4,651,664
90	162,903	106,904	99,344	4,867,931	4,745,704	4,703,927
95	215,600	132,491	109,767	4,995,067	4,796,426	4,785,299
100	425,111	209,357	147,272	5,796,530	5,170,365	5,141,035
mean	71,693	61,109	60,538	4,499,902	4,463,194	4,461,293
variance	6.23E+09	1.92E+09	1.12E+09	9.42E+10	5.14E+10	4.44E+10

Table A4.2 Stochastic Simulation Results in Five Percent Intervals for Farm B

	Net Cash Surplus:			Net Worth:		
Percentile	Shares	Property	Cash	Shares	Property	Cash
	$	$	$	$	$	$
0	(267,560)	(51,764)	(17,650)	476,986	894,570	1,003,327
5	(39,074)	(1,380)	603	1,434,548	1,422,100	1,434,179
10	(2,906)	7,860	16,099	1,516,969	1,529,605	1,526,670
15	5,506	16,508	22,973	1,578,141	1,576,971	1,576,709
20	13,481	21,029	27,265	1,616,516	1,622,269	1,617,673
25	23,646	25,723	30,818	1,645,250	1,651,085	1,659,608
30	29,555	30,616	33,838	1,675,786	1,674,097	1,681,101
35	33,871	33,613	38,433	1,704,437	1,698,902	1,695,172
40	37,529	36,726	40,941	1,737,656	1,730,694	1,722,698
45	42,072	39,805	43,786	1,763,683	1,740,899	1,743,002
50	48,603	43,596	47,511	1,788,209	1,761,268	1,761,679
55	52,852	47,755	50,746	1,805,063	1,777,059	1,779,591
60	57,600	52,619	53,345	1,821,950	1,795,765	1,798,585
65	63,709	57,161	56,578	1,850,484	1,824,143	1,825,554
70	75,392	61,223	60,659	1,878,230	1,842,162	1,849,071
75	82,225	66,127	64,302	1,915,459	1,862,990	1,874,271
80	96,035	68,846	67,231	1,952,302	1,897,010	1,890,268
85	108,453	77,826	70,841	1,997,300	1,926,113	1,911,562
90	123,402	87,118	77,442	2,055,220	1,966,735	1,954,287
95	143,457	99,438	86,440	2,129,231	2,048,296	2,035,419
100	262,019	142,015	118,429	2,492,469	2,266,687	2,217,726
mean	52,481	46,453	45,999	1,780,092	1,750,391	1,749,746
variance	3.52E+09	1.02E+09	7.12E+08	5.18E+10	3.55E+10	3.33E+10

Appendix 5: Correlated Variables

Table A5.1 Correlated Variables with Correlation Co-efficients

"Independent" Variable:	"Dependant" Variable:	Co-ef.[a]
Yearling steers sale price (c/kg)	Yearling heifers sale price	0.72*
	Weaner steers sale price	0.71*
	Weaner heifers sale price	0.69*
	CFA Bulls sale price	0.68*
	CFA Cows sale price	0.71*
Fat lambs sale price ($/head)	CFA Ewes sale price	0.67*
	Cull wethers	0.61*
	Border leicester rams	0.8**
	Dorset rams	0.8**
19 Micron clean wool price (c/kg)	26 Micron wool price	0.9**
	Merino Rams	0.8**
	Merino Weaners sold	0.8**
	Replacement wethers	0.8**
Annual Rainfall	Cattle sale weight	0.9**
	Shawn fleece weight	0.9**
	Livestock mortality rates	-0.8**
	Livestock birth rates[b]	0.8**

[a] The correlation Co-efficient.

[b] Birth rates are correlated to the previous years rainfall.

*Correlation co-efficients calculated from historical data.

**Correlation co-efficients based on subjective estimates by farm manager's.