COST ESTIMATING PROCEDURES FOR MICRO-, DRIP- AND FURROW-IRRIGATION SYSTEMS AS WELL AS ECONOMIC ANALYSES OF THE RELEVANT IRRIGATION SYSTEMS FOR LARGE- AND SMALL-SCALE FARMERS IN THE ONDERBERG/NKOMAZI REGION

LK Oosthuizen • PW Botha • B Grové •
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Water Research Commission

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Report to the WATER RESEARCH COMMISSION

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MARCH 2005

EXECUTIVE SUMMARY

COST ESTIMATING PROCEDURES FOR MICRO-, DRIP- AND FURROW-IRRIGATION SYSTEMS AS WELL AS ECONOMIC ANALYSES OF THE RELEVANT IRRIGATION SYSTEMS FOR LARGE- AND SMALL-SCALE FARMERS IN THE ONDERBERG/NKOMAZI REGION

1. INTRODUCTION

An irrigation farmer needs to consider many technical, economic and financial factors when choosing or evaluating different irrigation systems. This research project proposes methods to estimate costs for various combinations of irrigation systems in the Onderberg and Nkomazi areas. The research further demonstrates methods to analyse the profitability and financial feasibility of the various irrigation systems on a whole farming level.

The goal of the research was to analyse the most important irrigation systems in the Onderberg/Nkomazi areas on a whole farming level for both large-scale and small-scale farms economically and financially.

The specific project objectives were:

(a) Development of cost estimating procedures for micro-, drip- and furrow-irrigation.
(b) Identification of irrigation methods used by small-scale irrigators.
(c) Analyses of the profitability of the relevant irrigation systems with available financing options.
(d) Economic analyses of typical combinations of irrigation systems on whole farming level.
(e) Economic and financial analyses of the relevant irrigation systems on whole farming level for both large-scale and small-scale farmers.

2. RESEARCH METHOD

The total area under irrigation in the Onderberg/Nkomazi region was estimated to be about 50 000 hectares. The most important crops are sugarcane, orchards, bananas and vegetables. The most common irrigation systems are overhead sprinkler, micro- and drip-irrigation. Some flood-irrigation still occurs in the Nkomazi district for mostly vegetables. The irrigated areas are situated within pumping distance from the rivers. Of the approximately 50 000 hectares under irrigation, 7 500 ha are farmed by about 960 farmers on 17 projects/schemes in the Nkomazi area.

This research focuses on both large-scale and small-scale irrigation farming. The small-scale irrigation farming includes five independent case study farmers in the region, as well as 24 project farmers on three irrigation projects, namely Madadeni (7 ha plots under dragline irrigation), Mbongozi (5 ha plots with centre pivots), and Walda (10 ha plots under floppy irrigation). The data for the large-scale irrigation farming were collected from 74 farmers.

Various research methods were used to complete the study. The SAPFACT questionnaire was adapted to collect data from the five independent small-scale farmers with the aim of drawing up crop enterprise budgets and financial statements. The same farming and financial data for the 24 scheme farmers were collected by one of the project advisors. Structured questionnaires were used to collect the farming data for the large-scale farmers (n = 74). A total of 32 case study farms with different irrigation systems/crop combinations were compiled. Experts were contracted to design micro-, drip-, furrow-, dragline- and centre pivot-irrigation systems in different combinations for the 32 case study farms. The crop water requirements were estimated with the SAPWAT model. Cost estimating procedures were developed (Chapter 3) for micro-, drip- and furrow-irrigation, as well as any combination of these systems, to estimate irrigation costs. The Net Present Value (NPV) method was used to analyse the economic profitability and financial feasibility of the various irrigation systems on whole farming level. Monte Carlo simulation was used to incorporate yield and price risk in the analyses.

3. *RESULTS AND CONCLUSIONS*

The value of the research lies, firstly, in the cost estimating procedures which were developed for drip-, micro- and furrow-irrigation systems; secondly, that any combination of the abovementioned irrigation systems together with centre pivot- and dragline-irrigation systems can be analysed; thirdly, that the economic analyses were done on a whole farm level, taking risk into account, for small-scale farmers on irrigation schemes, independent small-scale farmers as well as large-scale farmers. The universal result was that cash flow is the biggest problem for all the farmers to different degrees. For the small-scale farmers the challenge is to survive financially and for large-scale farmers it is to finance expensive irrigation systems and long-term crops such as orchards.

The major results are presented according to the chapters of the report.

3.1 Cost estimating procedures for micro-, drip- and furrow-irrigation

Cost estimating procedures were developed for micro-, drip- and furrow-irrigation to estimate the annual fixed costs and operating costs of these systems, as well as the cost of applying an extra cubic metre water pumped. The cost estimating procedures were also developed to estimate irrigation costs for any mix of micro-, drip-, furrow-, dragline- and centre pivot-systems. The use of these cost estimating procedures will lead to better economic analyses of irrigation farming.

3.2 Economic evaluation of independent small-scale farmers in Nkomazi

It was found that the independent farmers are part-time entrepreneurs/farmers who followed a progressive learning and growth path. They started their farming businesses with finance they got from different activities and sources. Their critical success factors are their business orientation, entrepreneurial spirit, hard work, dedication, diversification, and their ability to read and interpret economic changes and taking risk.

The farmers can improve the financial survival of their farms with better production methods and financial, risk and marketing management.

3.3 Profitability and feasibility evaluation of small-scale farmer irrigation projects

The 7 ha draglines (Madadeni), 5 ha centre pivots (Mbongozi), and 10 ha floppies (Walda) are all profitable and financially feasible.

However, it was also found that for all three systems there are deficit years in which the farmers do not generate enough cash to cover an assumed living cost of R24 000 per year. The amount which was available varied among the systems.

The three crucial factors in the feasibility analysis were the initial subsidy of the irrigation systems, the plot sizes, and the well-established sugarcane market.

3.4 Whole farm profitability and feasibility analyses of large-scale irrigation farming

All the irrigation system combinations on all 32 case study farms are profitable, taking risk into account. Important factors are economies of size as well as the combination of crops and irrigation systems.

The financial feasibility of these farms differs depending on the timing of capital replacement such as the orchards and irrigation systems.

4. *RECOMMENDATIONS*

4.1 Advisors and farmers

- The cost estimating procedures for micro-, drip-, furrow-, dragline-, centre pivot-, and mainline pipe-systems should be included in the irrigation design sheets of irrigation firms and other irrigation organisations because the procedures are economically and technically soundly grounded.

- The cost estimating procedures should be used to estimate the total fixed and operating costs of the major irrigation systems. These procedures are suitable for on-farm use by irrigators and advisors to decide over the long run which irrigation systems to buy, and in the short run how to manage the operating costs which are directly linked to the decisions of how much, how and what to produce.

- The procedures can also be used to consider changes in a current irrigation system or to evaluate the feasibility of switching to a more water-efficient system. It also may be useful for research regarding the economic viability of various irrigation systems, because it provides a systematic way to determine the annual total costs of the systems.

- Business plans of irrigation farming should include the effects of business and financial risks on survival.

- Reliable crop enterprise budgets for all the relevant crops under irrigation should be developed and maintained for small-scale irrigators.

- Small-scale farmers should be assisted to keep farm records and to use them in planning their farming operations.

- Advisors and farmers should be trained to compile crop enterprise budgets and how to use these budgets in farm planning.

- Advisors should have a broad business approach when giving extension advice to farmers which includes advice on production methods, financial issues and marketing strategies.

- Part-time small-scale farmers should be assisted with extension services.

4.2 Policy-makers

- Part-time farming should be encouraged by providing tax benefits for part-time small-scale entrepreneurs.

- The extension services to small-scale farmers should be improved.

- Policy-makers should see to it that sound financial incentives are accessibly put in place to help small-scale farmers.

- The public sector has a major role to play in providing subsidy for new irrigation development projects.

- New projects should take cognisance of the crucial financial effects of plot size and reliable product markets.

- The COMBUDS of the National Department of Agriculture should be extended to include crop enterprise budgets for typical crops under irrigation.

- A land tenure reform policy in tribal areas is needed to encourage investment and development on these farms. An efficient land market should be developed based on security of property rights and low transaction costs.

- Government institutions could promote and facilitate the development of a land rental market in tribal areas. Institutional changes are needed in existing government organisations to assume responsibility for holding and enforcing land rental contracts.

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CHAPTER 1

INTRODUCTION

1.1 IRRIGATION IN THE ONDERBERG AND NKOMAZI AREAS

The Onderberg/Nkomazi region is situated on the eastern border of Mpumalanga Province, approximately 3 500 km^2, with a population of about 500 000. The total area under irrigation was estimated to be 49 100 ha in 1997 (NOWAC: Nkomazi/Onderberg Water Action Committee, 1997). The mean precipitation is approximately 865 millimetres.

The most important crops are sugarcane (31 000 ha), orchards (7 200 ha) such as mangoes, valencias and grapefruit, bananas (4 000 ha), summer grains (2 000 ha), winter grains (1 300 ha), and vegetables (3 600 ha). The irrigated areas are situated within pumping distance from the rivers. The most common irrigation systems are overhead sprinkler (mostly bananas, grains, sugarcane and vegetables), micro-irrigation (mostly bananas and orchards), and drip irrigation (mostly orchards and sugarcane). A survey conducted along the Komati River has found the following distribution of irrigation systems in Nkomazi district and Onderberg respectively: flood 17% and 5%, overhead sprinkler 83% and 75%, and micro and drip 0% and 20%. Figure 1.1 depicts the study area in the Onderberg and Nkomazi region. In the figure the following can be seen: the towns and villages, rivers, dams, railway lines and roads.

Figure 1.1: Irrigated areas in the Onderberg/Nkomazi areas, 1997.
Source: NOWAC (Nkomazi/Onderberg Water Action Committee), 1997.

1.2 MOTIVATION FOR THE STUDY

There is a published scientific method to estimate centre pivot irrigation costs in South Africa (Meiring & Oosthuizen, 1991). Similar irrigation cost estimating worksheets for micro, drip and flood irrigation under South African conditions are still lacking (Memorandum of Agreement, K5/974, 1998). An additional need was to use these irrigation cost estimating procedures within a whole farming context to analyse the economic and financial situation of both large- and small-scale irrigated farms.

1.3 OBJECTIVES OF THE PROJECT

The goal of the research was to analyse the most important irrigation systems in the Onderberg/Nkomazi area on a whole farming level for both large-scale and small-scale farms economically and financially.

The specific project objectives were:

(a) Development of cost estimating procedures for micro-, drip- and furrow-irrigation.
(b) Identification of irrigation methods used by small-scale irrigators.
(c) Analyses of the economic profitability of the relevant irrigation systems with available financing options.
(d) Economic analyses of typical combinations of irrigation systems on whole farming level.
(e) Economic and financial analyses of the relevant irrigation systems on whole farming level for both large-scale and small-scale farmers.

1.4 COMPOSITION OF THE REPORT

The report consists of seven chapters as well as an executive summary. The Introduction chapter gives the objectives of the research project. In Chapter 2 an overview is given of the Onderberg and Nkomazi irrigation areas, including the Madadeni, Mbongozi and Walda irrigation schemes. The irrigation situation of five independent small-scale commercial farmers is described, as well as the research methods. Chapter 3 presents the cost estimating procedures for micro-, drip- and furrow-irrigation systems. The cost estimating procedures for centre pivot- and dragline-irrigation systems are in the appendices. Chapter 4 contains the case study as a research method, the case study methodology applied and a description of five independent small-scale commercial irrigation farmers in the Nkomazi area. The rest of the chapter contains the financial and risk analyses of one case study farmer, with the details of the remaining four case study farmers in the appendices. Chapter 5 is an economic, financial and risk evaluation of the dragline-irrigation systems (Madadeni scheme), the centre pivot-irrigation systems (Mbongozi scheme), and the floppy-irrigation systems (Walda scheme) in the Nkomazi area. Chapter 6 is an economic, financial and risk analysis of 32 large-scale case study farms in the

Onderberg area. The report ends with the conclusions and recommendations in Chapter 7. Abbreviations used in the report are listed in Appendix 1.A. The appendix numbering corresponds to a specific chapter.

The data in this report are archived at the Department of Agricultural Economics, University of the Free State.

CHAPTER 2

MATERIAL AND METHODS

Chapter 2 consists of four sections. The first section is a short description of the study area. The second section gives the details of three small-scale irrigation projects in the Nkomazi region. In the third section the situation of five independent case study small-scale commercial farmers is discussed. The fourth section gives an outline of the research methods used.

2.1 OVERVIEW OF IRRIGATION IN THE ONDERBERG AND NKOMAZI AREAS

The description of the study area is based on work done by Mr L.J. van Rensburg (NOWAC, 1997). The Onderberg/Nkomazi region is situated on the eastern border of Mpumalanga Province, with Nelspruit as the metropolitan centre. The area of Onderberg is 3 500 km^2. The population of Nkomazi is about 500 000 with an annual growth rate of about 3.4%. The unemployment rate is estimated to be around 40% and the literacy level at about 55%. The Nkomazi area is wedged between Swaziland in the south, Mozambique in the east and the Kruger National Park in the north.

The Nkomazi has relatively good infrastructure. Power is available to virtually all urban and most of the rural communities. There is a good road system, which links all the adjoining areas by tarmac roads as well as secondary roads. The Nkomazi/Onderberg is also linked by rail to Swaziland, Maputo and Gauteng. The average elevation of Nkomazi is 350 m above sea level, hence its description as lowveld. The Department of Agriculture has described Nkomazi as the area with the top one per cent (1%) of agricultural potential in South Africa. This is due to the unique combination of soils, climate, and water that is the lifeblood of the Nkomazi community (Nowac, 1997). The mean precipitation is approximately 865 mm and approximately 85% of the annual rainfall is received during the hot summer months (November to March).

The drainage system of the Nkomazi is such that about nine per cent (9%) of South Africa's run-off water passes through the Nkomazi by way of the Komati basin with its principal rivers as the Crocodile, Lomati and Komati. This run-off water is to some extent stabilized by the Kwena Dam in the Crocodile River, the Driekoppies Dam in the Lomati and the Maguga Dam in the Komati.

Irrigated agriculture is the greatest economic activity in the Onderberg region providing about 95% of job opportunities with dryland contributing about 5% of the job opportunities. This 5% job contribution is mostly from the veld, where game and cotton is cultivated on contract basis.

The total area under irrigation in the Onderberg/Nkomazi region is estimated to be 49 100 ha. The following are the major irrigated crops: sugarcane (31 000 ha), orchards (7 200 ha) such as mangoes, grapefruit and valencias, bananas (4 000 ha), summer grains (2 000 ha), winter grains (1 300 ha), and vegetables (3 600 ha). The irrigated areas are situated within pumping distance from the rivers. Of the approximately 50 000 ha under irrigation, 7 500 ha are farmed by about 960 farmers on 17 projects/schemes in the Nkomazi area. The most important crop in the Nkomazi area is sugarcane (98%) and vegetables, bananas and cotton (2%). The average rainfall in Malelane is 630 mm and 608 mm in Komatipoort. It is a summer rainfall area, receiving 80-85% of the annual rainfall from October to March.

Some flood irrigation still occurs in the Nkomazi district at the original Tonga scheme, occuping an area of about 500 ha, and is mostly for vegetables. Other smaller areas of flood irrigation are scattered throughout the region.

The most common irrigation systems in decreasing order of occurrence are overhead sprinkler (mostly bananas, grains, sugarcane and vegetables), micro-irrigation (mostly bananas and orchards), and drip-irrigation (mostly orchards and sugarcane). A survey conducted along the Komati River has found the following distribution of irrigation systems in use: Nkomazi (flood 17%, and overhead sprinkler 83%), Onderberg (flood 5%, and overhead sprinkler 75%, and drip and micro 20%).

The whole lowveld community is totally dependent on irrigation. Not only those directly involved in irrigated agriculture benefit from it. There are also backward and forward linkages together with spin-offs that come about as a result of the existence of irrigated agriculture. Backward linkages exist when a sector represents or provides a market for products of other sectors. For example, the agricultural sector uses chemicals, machinery, building materials, etc. supplied by other sectors. Forward linkages on the other hand exist when other economic sectors use products as intermediate inputs or when they engage in economic activity to trade, distribute, transport or transform the product. The food and textile industries use farm products as raw materials and in this process, they also provide market outlets for other industries such as packaging materials, metal cans, transport and insurance (Backeberg, *et al.*, 1996).

In irrigated agriculture, the backward linkages in the Nkomazi region are much evident in production where inputs like fertilizer, equipment, fuel and maintenance, etc. are bought from other non-agricultural sectors. The spin-offs or "ripple" effects from irrigated agriculture come in the form of payment to cane cutters, tractor contractors, transporters and hawkers/vendors.

Electricity, better housing, roads, domestic water, and horticultural market stalls are available due to irrigation. Also, irrigated agriculture has forward linkages through secondary processing of primary produce. The most prominent example is the sugar mill, which processes sugarcane, the farmers' primary product. Sugar obtained from the mill is used in other industries, for example in bakery, breweries and home consumption. Generally, irrigated farming is the main source of livelihood in the entire Nkomazi/Onderberg area (Nowac, 1997).

2.2 DESCRIPTION OF THE MADADENI, MBONGOZI AND WALDA IRRIGATION SCHEMES

The description of the Madadeni, Mbongozi and Walda irrigation schemes is based on research done by Monkhei (2001) and Pretorius (2002).

An irrigation development programme to the amount of R180 million was planned in 1993 on 8 500 ha in Nkomazi to establish about 960 farmers. The Department of Agriculture in Mpumalanga initiated the project and was financed by the Development Bank of South Africa. Murray, Biesenbach and Badenhorst (MBB) were appointed by the Development Corporation of Mpumalanga to develop the project. This appointment was supported by ACER Africa (Agriculture, Community, Environmental and Rural Development Advisors).

Progressive farmers were appointed as quality managers to check the quality of work done by the contractors. Water is pumped via channels to smaller reservoirs or cofferdams from where the water is distributed to the irrigators on a time schedule basis. Every individual farmer is responsible for the management of his own irrigation system. The irrigation systems design provided the flexibility so that it is always possible for any farmer to irrigate.

MBB developed a technical model which could facilitate the management of the irrigation systems by the local farmers. Project committees were chosen from the communities who co-operated with the consultants to discuss decisions, the size of the plots, the type of irrigation system and the crop cultivation practices.

Each of the irrigation schemes has a conference facility with administration offices. The facility includes a kitchen, a conference room and storage for the products. With these facilities the communities are responsible to manage their businesses.

The farmers have a trust fund which they use to help their communities financially. Transvaal Sugar Board Limited (TSB) also agreed to contribute to the trust fund on a Rand for Rand basis. For each tonne of sugarcane delivered to TSB, 30 cents levy is deducted. TSB then also contributes 30 cents per tonne. The trust monies are used to build nursery schools, provide school bursaries and also local water facilities. Other levies which growers also have to pay are at the millers, sugarcane committee, small-scale growers' development fund, pest and disease control, sugarcane research board and fire levies.

The following three schemes were selected for the research: Madadeni, Mbongozi and Walda. Table 2.1 is a summary of certain characteristics of the three irrigation projects. The farmers have access to the funds controlled by the financial branch of TSB, the "Financial Aid Fund" (FAF). Farmers can withdraw funds during the production season to buy inputs such as fertilizer, fuel, etc. The method for withdrawing cash is as follows: the farmer has to complete an order. The money is available as soon as FAF has approved. The farmers have to provide collateral at the beginning of the season, by granting a cession of their potential sugarcane crop. The farmer can withdraw up to his/her credit limit.

Table 2.1: A summary of certain characteristics of three irrigation projects: Madadeni, Mbongozi and Walda, 2000

Project	Madadeni	Mbongozi	Walda
Starting date	1994	1998	1998
Irrigation system	Draglines	Centre pivot	Floppy
Area (ha)	405	200	816
River	Komati	Lomati	Komati
Number of farmers	55(8)*	40(12)*	79(20)*
Plot size	7 ha and 10 ha	5 ha	10 ha
Mill	Komati	Malelane	Komati
Distance from mill	42,5 km	52 km	21,5 km

* Women

2.2.1 MADADENI DRAGLINE SYSTEM

Water is pumped from the Komati River directly to the plots. Every irrigator has 14 up-right standing sprinklers which are coupled to 50 m of plastic pipe/hose. A typical 7 ha unit consists of three parallel sub-lines which have 14 outlets. The positioning of the draglines are important for efficient irrigation.

The dragline system is designed in such a manner that all the farmers can irrigate simultaneously, given they only have 14 sprinklers. Depending on the growth stage of the sugarcane the sprinkling time may vary from six to twelve hours. When the sugarcane is still short the sprinklers are shifted twice a day with six hours' spraying time. As soon as the farmer cannot move freely in the sugarcane, the spraying time is extended to twelve hours. It takes seven days to complete an irrigation cycle.

The farmers can only irrigate when the pumps at the river are switched on. A pump station manager, who is appointed by the farmers, is responsible for the maintenance of the pumps and to switch on the pumps. The pumps are switched on from 06:00 tot 18:00. There is no irrigation during the nights.

There is no formal irrigation scheduling, and each farmer has a quota of 10 000m^3/ha. For purposes of the study it was assumed that the farmer uses his full quota. The farmers are responsible for the maintenance and repairs of the system. Each farmer contributes R3 000 per year to cover maintenance and repairs.

2.2.2 MBONGOZI CENTRE PIVOT SYSTEM

Centre pivots can be owned by individual farmers or more than one farmer can own one pivot. Joint ownership of a centre pivot can pose management problems when different crops are grown with different crop water requirements under the same centre pivot. In the case of Mbongozi the problem is eliminated because all the farmers established sugarcane at the same time. The project consists of five 40 ha centre pivots. Each centre pivot is owned by eight farmers, each with five hectares.

Water is pumped from the Lomati River into a balancing dam, and from there it provides the centre pivots with water. The farmers have appointed a manager who is responsible for the maintenance of the pump station, as well as to switch the pumps on and off. The manager switches on the pumps at the river and pumps the cofferdams full. The centre pivots are switched on from 07:00 tot 16:00. There is no formal irrigation scheduling; irrigation applications are done according to gut feel. Each farmer has a quota of 10 000m^3/ha. Each farmer pays R3 000 for maintenance and repairs.

2.2.3 WALDA FLOPPY SYSTEM

The floppy system is a relative new semi-permanent irrigation system to grow sugarcane. Water is pumped from the Lomati River to the balancing dams from where the water is distributed to the respective irrigation blocks. The project of 843 ha is divided into eight irrigation blocks. Each irrigation block has its pump and pipeline system. Each irrigation block is divided into 10 ha units.

Each unit has its own outlet system with twelve outlets. Farmers are allowed to use only one outlet at a time. A typical 10 ha unit has 580 floppies. The field is divided into 12 irrigation units. The system is designed in such a way that a farmer can irrigate only one unit at a time. The spraying time is four hours per unit. Irrigation can take place from 07:00 to 17:00.

Irrigation scheduling is done weekly on a formal basis. Rain meters are installed. Once a week an engineer comes around with a neutron probe. He then determines the irrigation needs and gives the farmers a printout of how much to irrigate the next week. The farmers pay R3 000 per year for maintenance and repairs of the system.

2.3 IRRIGATION SITUATION OF FIVE INDEPENDENT CASE STUDY FARMERS

An adapted framework of the SAPFACT procedure developed by Crosby in 1996 was used to describe the Irrigation Management, Crop Profit Potential, General Management, Labour Management, Farmer Success Potential and Financial aspects of the small-scale commercial irrigation farmers. Other aspects considered important in the description of the case study farmers included Land Tenure, Marketing and Financing. Applicable factors from the SAPFACT factor list were used in the description of cases (see Appendix 4.A). Additional factors that emerged from the study of cases were also used to help give a better understanding of the case farmers' situation.

2.3.1 IRRIGATION MANAGEMENT

Of the five case study farmers, four use flood irrigation to irrigate their crops and one uses sprinkler irrigation. The flood or furrow irrigation farmers use diesel engines to pump water from the river and the farmer who uses sprinkler irrigation uses an electric motor to pump irrigation water from the river. In all the cases, however, action is taken only when there are breakdowns; otherwise there is negligible equipment maintenance. Furrows are opened up every season after harvest in preparation for the next crop. All the case farmers get their irrigation water straight from the river and do not have a problem of water shortage except as a result of the irrigation system inefficiency. The farmers are somewhat enlightened about irrigation from hard hands-on experience they gained over the years. Only one farmer schedules his irrigation; the other four simply use subjective judgement or gut feel to determine when to irrigate and how long to irrigate. In all the cases, the amount of irrigation water applied is not known. Only two case farmers pay for their irrigation water, one pays R65/ha and the other one R200/ha annually.

One sugarcane farmer indicated that furrow irrigation was not a suitable method of irrigation and has taken steps to change to sprinkler irrigation. He also wanted to change from using a diesel engine as a source of power to electricity, partly because of the high diesel costs and the inefficiency of the furrow system.

2.3.2 CROP PROFIT POTENTIAL

Generally, the soils in the lowveld are suitable for crop production and the climate is good for irrigation. Where soils lack nutrients for the crops grown, there is significant awareness and use of fertilisers. For example, after harvesting, sugarcane farmers take soil samples and send them to be tested in order to determine the fertiliser needs for the next cropping season. In this way farmers know exactly what fertiliser to buy and to apply to enhance crop production. Vegetable farmers on the other hand, know what fertilisers to apply to the type of crops they grow and have also shown significant use of fertilisers. Two of the sugarcane farmers have been farming other crops such as maize and cotton. They only changed to sugarcane recently in 1997 and 1998 respectively, and they are fairly new to the sugarcane industry. The other sugarcane farmer started farming sugarcane in 1994 and is also fairly new to sugarcane farming. The two vegetable farmers have been farming from as far back as 1942 and 1977 respectively. They farmed maize and other vegetables, which they changed over time as demand for them also changed.

There is high gross margin potential, especially with sugarcane, which has a sure market. Even with guaranteed market, high gross margin is possible only if good management is adhered to, and the farmer is not overcommitted financially. With vegetables, there is high gross margin potential provided there is a good and reliable market and the produce is appealing to buyers. Farmers face risk that has negative effect on crop profitability. Sugarcane farmers face risk in that they do not know what the price would be each season, because it is seasonally determined depending on the world price and exchange rate. Vegetable farmers face risk in that they do not know in advance whether they will be able to sell their produce and the prices at which their produce will be bought. There are also strategic risks that farmers face. For example, sugarcane farmers contract cane transporters to pick up their cane to take to the mill. The farmer would cut his sugarcane, only to find that the contractor did not keep to the agreed time and shows up late. This has a negative effect on the sucrose content of the cane, and its recoverable value, leading to price risk. There is also some dishonesty shown by vegetable vendors when buying vegetables, and this also poses some price risk.

2.3.3 *GENERAL MANAGEMENT*

Four of the case study farmers manage their own farms and employ both permanent and temporary labour. In one case, family members help with farm work and in the other case, only the wife helps on the farm, the children are grown-up and have jobs elsewhere. The case study farmer who owns his farm employed his brother as farm manager, while he manages his other businesses, and there are permanent and temporary labourers employed. Seasonal planning (if present) is based on past experience, gut feel and rule of thumb. This is because there is no good record-keeping from which plans could be made or which could guide planning. Where the farmer claims to keep records it is only minimal or superficial. There is no proper record-keeping. No financial records or operational records are kept hence it is difficult for farmers to know whether they are making profit or not, an alarm rings only when there is nothing in the bank account as was evident in one case.

The sugarcane farmers have regular contact with TSB extension officers who give them advice pertaining to sugarcane production. They have a forum where they come together to discuss issues of concern such as buying fertilisers and many others, especially farmers who are financed by FAF. But as far as technology is concerned, very little or no advice is given. Any change of technology is solely a farmer's own initiative which can be highly costly since it is not likely that it is based on proper assessment. Vegetable farmers on the other hand indicated that they were not satisfied with the extension service. They raised concerns that they do not get the advice they need. They just depended on their experience and own initiative. There is no training of farmers arranged by extension service, and farmers do not have a forum where they come together to discuss issues that concern them. This has a negative effect on their management ability. Farmers deal with diverse farming activities since there is weak or no management structures, which may not be necessary because they operate on small-scale. Long-term planning seems to be lacking, and farmers are concentrating on making money to better their lives.

2.3.4 LABOUR MANAGEMENT

Labour on the farm is not organised or unionised, and the farmers have very good work relationships with the workers who are from the same villages as the farmers. All labour, both permanent and temporary, is paid in cash. On sugarcane farms long service labourers are tractor drivers. Otherwise labour is not trained, but they gained experience on the farm over time as they worked on the farms. One farmer indicated that he does not have problems getting temporary labour. He said that there are Mozambiquans who walk up and down on the road looking for someone to pick them up for a temporary job, and these are a source of temporary labour. In another case, however, the farmer uses school children for temporary labour during weekends and during school holidays. He explained that elderly people are a problem, because after the work is done they do not want to leave, but would like to have a permanent job and the farmer ends up employing permanent labour that he does not need. The farmer also explained that women especially, when they have finished their temporary work assignments, pleaded with him for a permanent job to be able to feed their children.

2.3.5 FARMER SUCCESS POTENTIAL

The reason farmers gave for farming was, most importantly, for them to have a better life and to fend for their families and relatives. This suggests that there is success potential in their farming endeavour. In the villages farmers find farming a rewarding way of life where they can achieve self-fulfilment through their own initiative, and do not have to work for someone else. But they find it, nevertheless, challenging. Some of the farmers, however, feel trapped by the size of their farms. They do not even own the farms they currently operate on, as they are on tribal land. In order for them to expand the sugarcane operations they would have to apply for a bigger quota from the sugar mill, otherwise they would not be able to sell their cane. All the case farmers are male and elderly, about 50 years and above. Only one farmer has tertiary education, while others have not completed primary school. In one case the son is active in farming. In two cases, the children are not interested in farming and have professional jobs in cities and the daughters are married away. In one case, the farmer cares for three grandchildren, and in another case four children are still at school. Wives are supportive, even though farmers tend to take decisions exclusively. Though the farmers indicated that they are not making so much profit, but managing somewhat to provide for their families, one of the farmers showed financial stress. Generally farmers are conservative in their decision-making.

2.3.6 FINANCIAL ASPECTS

Two of the case farmers keep superficial records of purchases; other farmers do not keep any records. Accounting functions can therefore be referred to as poor, since no accounts are drawn up and service of a qualified and/or experienced bookkeeper is not used. The credit sources used by farmers and their general access to credit are important measures of the financial position of the farm. However, it is apparent that money is always a sensitive and often a private issue. It was learnt that vegetable farmers do not borrow money from the banks to run their farming businesses. Instead, they used the profits they got from their farming operations to run their farming businesses.

The farmer who owns the farm he operates on makes use of the bank. He borrowed money to buy his farm and still borrows money from the bank to meet seasonal financial needs. The other two sugarcane farmers received financial aid from the Financial Assistance Fund (FAF) which is a financing branch of the Small Growers Division, which falls under TSB. The farmers obtained both types of loans: an establishment loan, which is a long-term (8 years) loan and a short-term (2 years) loan, which is basically a production loan. The interest charged for both loans is 18% (Monkhei, 2001), but this increases if the farmer defaults. Instalments for both loans are deducted from the cane payments after harvest, together with other charges for contract work, levies and taxes, and the balance is then deposited in the farmer's bank account. To assist farmers with operating capital, the TSB retains R25 per ton of sugarcane delivered to the mill, and this becomes a savings account from which farmers can draw money (through application) to finance their short-term farming operations, especially labour payment and fertiliser purchases. The retention savings earn a monthly interest of 10.04%. Besides this arrangement they make use of financial institutions when they want to make farm developments, such as buying irrigation equipment.

Two of the case study farmers have other businesses that form part of their off-farm income, while other farmers rely solely on farming for income. Marketability of the farm is non-existent for farmers farming on tribal land. This is because the farmers have no ownership rights over tribal land and therefore cannot sell it. The objectives of small-scale commercial irrigation farmers revolved around affording a better or decent lifestyle and running a profitable farming business. Although this is possible, some farmers need to put in more effort, while others have to work really hard to achieve their objectives.

It became apparent that some farmers who are in financial distress, sometimes applied for finance from FAF to pay labour or buy fertiliser, but then used the funds for household food provision. This occurs because after the farmer has received the money it is up to him to utilise the funds for the purpose for which they asked it. There is no policing from FAF to make sure the farmers use the money accordingly. The problem of misdirection of funds prevails, because in the farming operations loans, the item family expenses is not catered for as part of farming expenditures given that farmers do not pay themselves a salary. And even if they did, it would only come after harvest when the farmer has been working for 12 months without payment. In worst cases, even after harvest the farmer would remain with a zero bank balance for the cropping season, and yet the family has to feed. It was found that one farmer had no money left after all deductions, which included income tax of about R13 000. This undoubtedly becomes a cause for concern, especially because the farmer was not even aware that he had paid that amount and that he could fill in a tax return to recover some of the tax amount. Surely this is when the disabling effect of illiteracy really proves to be a handicap to the farmers.

2.3.7 LAND TENURE

One farmer bought the land (farm) he is farming on. The other four farmers utilise their land on the RTO (Right To Occupy) basis. An RTO is a document issued by the tribal chief giving a farmer permission to occupy and/or farm on the piece of land he is currently farming on. New farming land and expansion to existing or currently farmed land is possible through requisition from the chief who may issue an RTO or reserve the right to utilise land depending on his discretion. Currently an RTO is issued on request for a land area of a maximum of 10 hectares, particularly to new sugarcane growers, most of which are on schemes. This RTO is strictly for tribesman and outsiders are not of necessity entitled to tribal land use.

However, all the case farmers who farm on tribal land utilise farm areas of more than 10 hectares. This is because in the olden days, the chief would give persons permission to farm on a piece of land, and depending on how hardworking they were, they would hand-clear as much land area as they were able to, which is why they now have larger land areas. However, the greatest fear that these farmers have is losing the land they worked on so hard and struggled tirelessly to bring to a cultivable status. This could happen if the chief thinks otherwise about land tenure or if the chieftaincy changes and the new chief adopt a different land dispensation policy.

2.3.8 MARKETING

Sugarcane has a sure market since it is delivered directly to the TSB sugar mill for processing. However, some farmers have complained that they are refused quota increases. Understandably, the condition of the quota is that the farmer has to meet or fulfil the quota call; otherwise his or her quota is cancelled and given to someone who should meet the quota allocation. Farmers raised concerns regarding co-ordination of cane transport. In many instances the transport contractors have been blamed for delays and for not coming to pick up the cane at an agreed time, which invariably has detrimental effects on cane quality, which leads to low income. Some farmers, however, have associated this behaviour with racial discrimination. One farmer disclosed that he was a member of a cane transport scheduling committee, and each time a meeting was called he realised that everything was scheduled before the meeting and his views were not recognised. Even after an agreement was reached, he would find that at the cane cutting time, the agreed schedule was changed without him knowing. As a result he quit his membership of the committee.

The local community provides a market for vegetables, but does not buy all of them. Hawkers/vendors from different places also come to buy the vegetables for reselling. However, farmers have raised concerns that sometimes they are not able to sell their produce because vendors are not a sure market. Sometimes they do not come to buy, but if they come, they are able to sell all their produce. Other concerns raised were that some vendors are unreliable and deceitful in their dealings. One farmer disclosed that some vendors do not want to use the scale the farmer uses, but bring along their allegedly deceptive scales to weigh vegetables, and because farmers want to sell their produce, they find themselves being cheated through scale tricks. Some vendors, however, would ask the farmer to harvest some vegetables at an agreed price, but when they come to pick up the order they negotiate price cuts. Since vegetables are already harvested, given that they are also highly perishable, the farmer succumbs to a lower price rather than watch his produce decay.

2.4 RESEARCH METHODS

Various research methods were used to complete this study. A literature study was done on the case study as research method as well as on the cost estimating procedures for micro-, drip- and furrow-irrigation. A survey was conducted on 74 irrigation farmers in the Onderberg area with the aim to draw up case study farms. The SAPFACT questionnaire was adapted to collect data from five independent small-scale farmers. On the three project schemes (Madadeni, Mbongozi and Walda) one of the advisors was contracted to collect the financial and farming data. The case study method and interfarm comparison technique were used to structure the situations of the five independent farmers. Crop enterprise budgets for maize, cabbage, tomatoes, sugar beans, beetroot, peppers, mangoes and sugarcane under furrow-irrigation were compiled for the five independent small-scale farmers. Crop enterprise budgets for sugarcane were also put together for the 24 project farmers under dragline-irrigation (Madadeni), centre pivot-irrigation (Mbongozi) and floppy-irrigation (Walda). An adapted Delphi method as described in Chapter 3 was used to estimate the techno-economic coefficients of micro-, drip- and furrow-irrigation.

Group discussions were used to update the following crop enterprise budgets for the large-scale farmers: sugarcane, mangoes, grapefruit, valencias and bananas. Questionnaires were used to draw up yield and price distributions for the various crops. Mr Pieter van Heerden was contracted to estimate the crop water requirements for the various crops with SAPWAT. Mr Renald Radley developed a linear programming model to design the mechanised irrigation systems. Mr Chris Stimie designed the furrow-irrigation system. The net present value method was used to analyse the profitability and feasibility of the 32 case study farms, taking risk into account. Monte Carlo simulation was used to incorporate yield and price risk in the analyses.

CHAPTER 3

DEVELOPMENT OF COST ESTIMATING PROCEDURES FOR MICRO-, DRIP- AND FURROW-IRRIGATION

3.1 INTRODUCTION

The first step in the analysis of the economics of irrigation is to estimate the costs of the irrigation system. The cost estimating procedures of the irrigation systems must be technically and economically sound. The procedures should also illustrate how the total annual costs of the systems are estimated as well as the marginal factor cost of applied water.

The purpose of this chapter is firstly to illustrate the cost estimating procedures of micro-, drip- and furrow-irrigation. Secondly, the procedures should also make it possible to estimate the irrigation costs of typical combinations of irrigation systems. Thirdly, the total annual costs of a drip-, micro- and furrow-irrigation system in the Onderberg area are estimated as an example.

3.2 METHODS

A literature study was done on the cost estimating procedures of different irrigation systems, particularly in the arid west of the United States. A monograph (1998) was prepared by a task force organized by the American Agricultural Economics Association to recommend standardised practices for generating costs after a careful examination of the relevant theory and the merits of alternative methods. Among other things the task force developed procedures to estimate operating costs. Extension economists in the arid west of the United States of America developed useful guides to estimate irrigation system costs (Selley, 1997), and to evaluate different irrigation distribution systems (Llewelyn *et al.*, 1998). In South Africa a comprehensive Irrigation Design Manual (1999) was published in 1996 and revised in 1999. The Water Research Commission (WRC) funded a research project in which a cost estimating procedure for centre pivot-irrigation was developed and illustrated (Oosthuizen, 1991). The centre pivot cost estimating procedure was subsequently extended for dragline-irrigation systems in another WRC funded project (Oosthuizen *et al.*, 1996; Breytenbach, 1994). A computer program and guide were developed to illustrate the cost estimating procedures for centre pivot- and dragline-irrigation systems with WRC funding (Meiring *et al.*, 1995). The conclusion was drawn that the Spilkost procedure for centre pivots could be used as the basic framework for the other irrigation systems cost estimation. It was also concluded that the mainline pipe system should be treated as a separate system so that different combinations of systems could be analysed, and also to facilitate computer programming of the various combinations of irrigation systems cost estimating procedures.

3.2.1 COST ESTIMATING PROCEDURE

Only cost items which are directly associated with the relevant irrigation system are identified. Costs related to crop production are thus excluded. Next, every cost item should be methodologically correctly estimated. The technical properties of each system type had to be taken into account, as well as the general practices of the local irrigators. Consequently the know-how of engineers, consultants and farmers had to be combined. The cost estimating procedures for micro-, drip- and furrow-irrigation were based on the four-step Spilkost procedure. Firstly the physical items and their prices are identified. Then the capital investment and fixed costs are estimated. Thirdly the variable or operating costs are estimated, and finally a summary of all the costs is given.

The estimation of certain cost components requires explanation. A fixed cost is a cost that occurs no matter how much is produced. For an irrigation system it usually includes depreciation, interest, insurance and the fixed electricity charge. The fixed costs are based upon the initial investment. The capital recovery method is used to estimate depreciation and interest costs because it is more accurate than the traditional methods where depreciation and interest are estimated separately. The formula is:

Capital recovery = [(Purchase price – salvage value) x (capital recovery factor)]
+ [(salvage value) x (real interest rate)] 3.1

The real interest rate must be used when current purchase/list prices are used; with historical prices the nominal interest rate should be used.

The variable costs of the irrigation systems should be based on the annual planned water applications. The variable costs depend on the annual water applicaton. Operating or variable costs are those over which the irrigator has control in the short run. All variable costs, namely electricity, water, labour and repairs should be estimated as a cost per cubic metre water pumped.

Techno-economic coefficients of a relevant irrigation system such as lifespan, salvage value, efficiencies, and repairs vary according to physical conditions, annual use and management practices. Therefore, the cost estimating procedure should provide for the use of different components and techno-economic coefficients. The most important techno-economic coefficients for local conditions were estimated by means of an adapted Delphi method. The coefficients include the salvage value and lifespan of the components of the relevant irrigation system, as well as repairs and maintenance. The Delphi technique (Tersine and Riggs, 1976) is a method to collect and evaluate independent opinions systematically without group discussions. Usually it is a process because opinions that deviate substantially should be explained by each participant. After various rounds the participants are systematically forced to consensus. This process was shortened by means of an adapted Delphi method.

3.2.2 DESIGN OF TYPICAL IRRIGATION SYSTEMS

As was mentioned in Chapter 2 a survey was conducted among 74 farmers to gather farming and financial data to construct case study farms. A total of 32 irrigation system combinations were identified, including 3 farm sizes and 12 crop combinations. An agricultural engineer (Radley, 2002) designed the mechanised irrigation systems, while another engineer (Stimie, 2002) designed the furrow-irrigation system. The crop water requirements for sugarcane under furrow-irrigation and orchards (oranges) were estimated by means of the SAPWAT-model (Van Heerden, 2002).

In order to make it possible to accommodate the different irrigation system and crop combinations, Mr Radley used a linear programming model executed with the help of a MS-Excel solver, to design the appropriate drip-, micro-, centre pivot- and dragline-irrigation systems.

The following design criteria were used:

a) **General design criteria**

The general design criteria include the working days per week, the pumping hours per day, the irrigation cycle, the irrigation system, emitter type, emitter spacing, total area irrigated, and area divided in blocks.

b) **Soil data**

The soil data include the soil water capacity, effective root depth, water withdrawal, irrigation width area, and available soil water.

c) **Irrigation requirements**

The irrigaton needs which were considered are evaporation, gross irrigation application, and irrigation cycle.

d) Emitter specifications

Emitter needs include name and type, outlet size, output, water pressure, spacing, application rate, standing time per cycle, and flow rate per block.

The specifications of the drip-, micro- and furrow-irrigation systems are given in Table 3.1. The furrow-irrigation system was designed to irrigate 25,2 ha sugarcane on a loam soil. The pump rate is 100 m^3/h. The electric motor size is 7,5 kW. The balancing dam is 1 300 m^3.

The drip- and micro-irrigation systems can irrigate 24,8 and 24,9 ha respectively. Each system consists of a 15 ha and 10 ha unit. Each unit consists of six blocks. The pump rate is 48 m^3/h for drip- and 90 m^3/h for the micro-irrigation system. The electric motor sizes are 7,5 kW (drip) and 15 kW (micro).

Table 3.1 summarises the assumptions about repair and maintenance costs, and gives the investment cost as well as the costs of water, electricity, insurance and labour.

Table 3.1: Specifications, assumptions and prices of a drip-, micro- and furrow-irrigation system in the Onderberg area, Mpumalanga Province, 2002.

Irrigation system		Drip	Micro	Furrow
Crop		Oranges	Oranges	Sugarcane
Unit size (ha)		24,8	24,9	25,2
Gross irrigation requirement (mm.ha/yr)		718	814	1 917
Water charge (c/m^3)		13,98	13,98	13,98
Electricity: fixed payment (R/month)		134,53	134,53	134,53
Electricity	0-600 kWh (c/kWh)	31,97	31,97	31,97
	> 600 kWh	18,38	18,38	18,38
Insurance tariff:	Pump station (%)	0,92	0,92	0,92
	Filter station (%)	0,92	0,92	-
Labour costs (R/hour)		3,65	3,65	3,65
Repair and maintenance costs (% of purchase price/1000 h/yr)				
Centrifugal pump		2,0	2,0	2,0
Electric motor		0,4	0,4	0,4
Underground pipes		0,2	0,2	0,2
Balancing dam		-	-	0,5
Laser levelling		-	-	0,0
Filter station		5,0	5,0	-
Branch line		1,5	1,5	-
Laterals		0,0	0,0	-
Real interest rate (%)		5,0	5,0	5,0
Initial investment cost (R)		200 000	277 586	132 012

The techno-economic coefficients are given in Table 3.2.

Table 3.2: Irrigation system components, salvage value and expected lifespan of irrigation systems in the Onderberg area, Mpumalanga Province.

	Drip/micro-irrigation system	
Component	**Salvage value (% of initial investment cost)**	**Expected lifespan (years)**
Centrifugal pump	15	15
Electric motor	20	15
Underground pipes	30	20
Filter station	0	10
Branch line	5	15
Laterals	0	7
	Furrow-irrigation system	
Component	**Salvage value (% of initial investment cost)**	**Expected lifespan (years)**
Centrifugal pump	15	15
Electric motor	20	15
Underground pipes	30	20
Balancing dam	0	20
Laser levelling	0	6

3.3 *RESULTS*

The results in this part are the illustrated cost estimating procedures for drip-, micro-, furrow-, and mainline pipe systems respectively. The adapted four-step Spilkost procedure for each of the systems is shown in full. All the steps and equations are self-explanatory in the respective worksheets. For sake of completeness the cost estimating procedures for centre pivot and draglines are included as Appendix 3.A and 3.B respectively.

For each system the following are illustrated. The first step is to list the physical aspects of the irrigation system, the management of the system, as well as water, electricity and labour costs. The worksheet makes provision for systems where water is pumped in phases.

The second step is to estimate interest and depreciation, insurance and fixed electricity cost. The capital investment in the components of the irrigation system including VAT and construction costs has to be filled in.

The third step is to estimate the amount of water pumped annually and the corresponding number of pumping hours. Next the electricity, water, labour and repairs are estimated. These operating costs are variable and therefore expressed as a cost per cubic metre water pumped.

The fourth step is a summary of the estimated costs. The annual fixed costs and operating costs for the planned water applications are summarized. Then the fixed cost per ha is given, as well as the variable costs per cubic metre of water applied. The marginal factor cost to apply one cubic metre of water is also estimated. With the marginal factor cost, the next irrigation application on the total irrigated area can be estimated which should be compared to the extra crop income as a result of the additional irrigation.

3.3.1 COST ESTIMATING WORKSHEETS FOR DRIP-IRRIGATION

The worksheets have four sections which correspond with the four-step Spilkost procedure. Section 1 contains the general information such as the management of the drip system, irrigation and financial data. In section 2 the initial investment and annual fixed costs are estimated. Section 3 deals with the estimation of the annual operating costs of a drip system, and in section 4 the costs are summarized.

SECTION 1: GENERAL INFORMATION

1. MANAGEMENT OF THE DRIP SYSTEM

1.1 Hours labour required per 24 hours irrigated : 1.33 hrs

1.2 Area annually cultivated: sugarcane : 3.33 ha

2. WATER

2.1 Listed area irrigated with the drip system : 1.67 ha

2.2 Planned water use : 14 130 m^3/ha/yr

2.3 Water charges

Tariff		Quantity		Charge
1	2.3.1.1	14 130 m^3/ha	2.3.1.2	13.98 c/m^3
2	2.3.2.1	- m^3/ha	2.3.2.2	- c/m^3
3	2.3.3.1	- m^3/ha	2.3.3.2	- c/m^3
4	2.3.4.1	- m^3/ha	2.3.4.2	- c/m^3
5	2.3.5.1	- m^3/ha	2.3.5.2	- c/m^3

3. INTEREST AND INFLATION RATE

3.1 Nominal interest rate : 11.0 %

3.2 Annual inflation rate : 5.7 %

4. INSURANCE

4.1 Type of insurance
- 4.1.1 : -
- 4.1.2 : -
- 4.1.3 : -

4.2 Tariff for each type of insurance
- 4.2.1 : - %
- 4.2.2 : - %
- 4.2.3 : - %

5. OTHER COSTS

5.1 Labour costs : R 2.56 /h

5.2 Repair and maintenance costs

5.2.1 Branch line : 1.5 % of the purchase price/1 000hrs/yr

5.2.2 Lateral : 0 % of the purchase price/1 000hrs/yr

Other

5.2.3 - : - % of the purchase price/1 000hrs/yr

5.2.4 - : - % of the purchase price/1 000hrs/yr

5.2.5 - : - % of the purchase price/1 000hrs/yr

6. PUMP RATE

6.1 Design value : 25 m^3/h

SECTION 2: INITIAL INVESTMENT AND ANNUAL FIXED COSTS

7. INTEREST AND DEPRECIATION

7.1 Real interest rate = [(***3.1***/100+1)/(***3.2***/100+1)-1]×100

= 5.0 %

7.2 Details of the initial investment

ITEM NUMBER	COMPONENT	INVESTMENT COSTS (R) 1	SALVAGE VALUE (% OF ***COLUMN 1***) 2	EXPECTED LIFE (YR) 3
1.	Branch line	3 148	5	15
2.	Lateral	6 106	0	7
3.	-	-	-	-
4.	-	-	-	-
5.	-	-	-	-
	Total	9 254		

7.2.1 Total initial investment cost (total ***column 1***) : R 9 254

7.3 The calculation of interest and depreciation

ITEM NUMBER	SALVAGE VALUE (R) ***COLUMN 1***× ***COLUMN 2***/100 4	INTEREST ON THE SALVAGE VALUE (R) ***7.1***/100× ***COLUMN 4*** 5	DEPRECIABLE PORTION (R) ***COLUMN 1***- ***COLUMN 4*** 6	CAPITAL RECOVERY FACTOR[1] (CRF) 7	CAPITAL RECOVERY[2] ON DEPRECIABLE PORTION (R) ***COLUMN 6***× ***COLUMN 7*** 8
1.	157.40	7.87	2 990.60	0.096342	288.12
2.	0	0	6 106.00	0.172820	1 055.24
3.	-	-	-	-	-
4.	-	-	-	-	-
5.	-	-	-	-	-
Total	157.40	7.87	9 096.60		1 343.36

1. CRF = i/100(i/100+1)ⁿ/[(i/100+1)ⁿ-1]

where CRF = Capital recovery factor,

i = Interest rate and

n = life of the component.

2. Comprises interest and depreciation.

7.3.1 Annual interest and depreciation (total ***column 5*** + total ________

column 8) : R 1 351.23

8. OTHER FIXED COSTS

8.1 Insurance

8.1.1 - Annual costs = ***7.2.1×4.2.1***/100
= R -

8.1.2 - Annual costs = ***7.2.1×4.2.2***/100
= R -

8.1.3 - Annual costs = ***7.2.1×4.2.3***/100
= R -

8.1.4 Total insurance cost = ***8.1.1+8.1.2+8.1.3***
= R -

9. ANNUAL OWNERSHIP COSTS

9.1 Total annual fixed cost = ***7.3.1+8.1.4***
= R 1 351.23

SECTION 3: ANNUAL OPERATING COSTS OF A DRIP SYSTEM

10. ANNUAL OPERATION OF THE SYSTEM

10.1 Water pumped (m^3) according to planning = ***2.1×2.2***
= 28 260 m^3/yr

10.2 Water pumped (mm.ha) according to planning = ***10.1***/10
= 2 826[3] mm.ha/yr

10.3 Hours pumped = ***10.1/6.1***
= 1 130 hrs

11. WATER COSTS

11.1 Water purchases at tariff 1

11.1.1 Quantity

If ***2.2*** ≤ ***2.3.1.1*** = ***2.2×2.1***
= 28 260 m^3

If ***2.2*** > ***2.3.1.1*** = ***2.3.1.1×2.1***
= - m^3

11.1.2 Purchases at a higher tariff = ***2.2-2.3.1.1***
= 0 m^3

3 on 2ha

11.1.3 Water costs at tariff 1 = ***2.3.1.2***/100×***11.1.1***

		= R 3 951
11.2	Water purchases at tariff 2	
11.2.1	Quantity	
	If ***11.1.2*** ≤ ***2.3.2.1***	= ***11.1.2***×***2.1***
		= - m^3
	If ***11.1.2*** > ***2.3.2.1***	= ***2.3.2.1***×***2.1***
		= - m^3
11.2.2	Purchases at a higher tariff	= ***11.1.2-2.3.2.1***
		= - m^3
11.2.3	Water costs at tariff 2	= ***2.3.2.2***/100×***11.2.1***
		= R -
11.3	Water purchases at tariff 3	
11.3.1	Quantity	
	If ***11.2.2*** ≤ ***2.3.3.1***	= ***11.2.2***×***2.1***
		= - m^3
	If ***11.2.2*** > ***2.3.3.1***	= ***2.3.3.1***×***2.1***
		= - m^3
11.3.2	Purchases at a higher tariff	= ***11.2.2-2.3.3.1***
		= - m^3
11.3.3	Water costs at tariff 3	= ***2.3.3.2***/100×***11.3.1***
		= R -
11.4	Water purchases at tariff 4	
11.4.1	Quantity	
	If ***11.3.2*** ≤ ***2.3.4.1***	= ***11.3.2***×***2.1***
		= - m^3
	If ***11.3.2*** > ***2.3.4.1***	= ***2.3.4.1***×***2.1***
		= - m^3
11.4.2	Purchases at a higher tariff	= ***11.3.2-2.3.4.1***
		= - m^3
11.4.3	Water costs at tariff 4	= ***2.3.4.2***/100×***11.4.1***
		= R -

11.5 Water purchases at tariff 5

11.5.1 Quantity

If ***11.4.2*** ≤ ***2.3.5.1*** = ***11.4.2×2.1***

= ___-___ m^3

Otherwise maximum ***2.3.5.1*** = ***2.3.5.1×2.1***

= ___-___ m^3

11.5.2 Water costs at tariff 5 = ***2.3.5.2***/100×***11.5.1***

= R___-___

11.6 Total water cost = ***11.1.3+11.2.3+11.3.3+11.4.3+11.5.2***

= R___3 951___

12. Labour costs

12.1 Labour hours required = ***10.3***/24hrs×***1.1***

= ___63___ hrs/yr

12.2 Total labour cost per year = ***5.1×12.1***

= R___161___

12.3 Labour costs per m^3 of water pumped = ***12.2***/***10.1***

= R___0.0057___

13. Repair and maintenance costs

13.1 Annual repair and maintenance costs of the branch line

= (***7.2, column 1, item 1***)×***5.2.1***/100×***10.3***/1 000hrs

= R___53.36___

13.2 Annual repair and maintenance costs of the lateral

= (***7.2, column 1, item 2***)×***5.2.2***/100×***10.3***/1 000hrs

= R___0___

13.3 Annual repair and maintenance costs of the ___-___

= (***7.2, column 1, item 3***)×***5.2.3***/100×***10.3***/1 000hrs

= R___-___

13.4 Annual repair and maintenance costs of the ___-___

= (***7.2, column 1, item 4***)×***5.2.4***/100×***10.3***/1 000hrs

= R___-___

13.5 Annual repair and maintenance costs of the ___-___

= (***7.2, column 1, item 5***)×***5.2.5***/100×***10.3***/1 000hrs

= R___-___

13.6 Total annual repairs and maintenance cost

= ***13.1+13.2+13.3+13.4+13.5***

= R 53.36

13.7 Annual repair and maintenance costs per m^3 of water applied

= ***13.6/10.1***

= R 0.0019

SECTION 4: SUMMARY OF COSTS

14. ANNUAL COSTS FOR PLANNED WATER APPLICATION

14.1 Fixed costs

14.1.1	Total annual ownership cost	= ***9.1***
		= R 1 351.23
14.2	Variable costs	
14.2.1	Total water cost	= ***11.6***
		= R 3 951.00
14.2.2	Total labour cost	= ***12.2***
		= R 161.00
14.2.3	Total repairs and maintenance cost	= ***13.6***
		= R 53.36
14.3	Total cost per year	= ***14.1.1+14.2.1+14.2.2+14.2.3***
		= R 5 516.59

15. COST ALLOCATION

15.1	Fixed costs per hectare of crops grown	= ***9.1/1.2***
		= R 450.41
15.2	Labour costs per m^3 of water pumped	= ***12.3***
		= R 0.0057
15.3	Repair and maintenance costs per m^3 of water pumped	= ***13.7***
		= R 0.0019

15.4 Water costs

	TARIFF	M^3 OF WATER PUMPED		COSTS/M^3 OF WATER	
15.4.1	1	***11.1.1***	= 28 260 m^3	***2.3.1.2***/100	= R 0.1398
15.4.2	2	***11.2.1***	= - m^3	***2.3.2.2***/100	= R -
15.4.3	3	***11.3.1***	= - m^3	***2.3.3.2***/100	= R -
15.4.4	4	***11.4.1***	= - m^3	***2.3.4.2***/100	= R -
15.4.5	5	***11.5.1***	= - m^3	***2.3.5.2***/100	= R -

16. MARGINAL FACTOR COSTS

Additional costs to apply an extra unit of water (m^3)

$$= 15.2 + 15.3 + \begin{bmatrix} 15.4.1 \\ \text{or } 15.4.2 \\ \text{or } 15.4.3 \\ \text{or } 15.4.4 \\ \text{or } 15.4.5 \end{bmatrix}^{4}$$

= R 0.1474

4 Marginal water costs is the total amount for the last tariff increment at which water was purchased divided by quantity applied at this tariff. For example, if water is purchased at the higher tariff 2, then 15.4.1 will not apply but 15.4.2.

3.3.2 COST ESTIMATING WORKSHEETS FOR MICRO-IRRIGATION

Again the worksheets consist of four sections which correspond with the four-step Spilkost procedure.

SECTION 1: GENERAL INFORMATION

1. MANAGEMENT OF THE MICRO-SYSTEM

1.1 Hours labour required per 24 hours irrigated : 1.34 hrs

1.2 Area annually cultivated: grapefruit : 3.35 ha

2. WATER

2.1 Listed area irrigated with the micro-system : 1.68 ha

2.2 Planned water use : 8 140 m^3/ha/yr

2.3 Water charges

Tariff		Quantity		Charge
1	2.3.1.1	: 8 140 m^3/ha	2.3.1.2	: 13.98 c/m^3
2	2.3.2.1	: - m^3/ha	2.3.2.2	: - c/m^3
3	2.3.3.1	: - m^3/ha	2.3.3.2	: - c/m^3
4	2.3.4.1	: - m^3/ha	2.3.4.2	: - c/m^3
5	2.3.5.1	: - m^3/ha	2.3.5.2	: - c/m^3

3. INTEREST AND INFLATION RATE

3.1 Nominal interest rate : 11.0 %

3.2 Annual inflation rate : 5.7 %

4. INSURANCE

4.1 Type of insurance
- 4.1.1 : -
- 4.1.2 : -
- 4.1.3 : -

4.2 Tariff for each type of insurance
- 4.2.1 : - %
- 4.2.2 : - %
- 4.2.3 : - %

5. OTHER COSTS

5.1 Labour costs : R 2.56 /h

5.2 Repair and maintenance costs

5.2.1 Branch line : 1.5 % of the purchase price/1 000hrs/yr

5.2.2 Lateral : 0 % of the purchase price/1 000hrs/yr

OTHER

5.2.3 - : - % of the purchase price/1 000hrs/yr

5.2.4 - : - % of the purchase price/1 000hrs/yr

5.2.5 - : - % of the purchase price/1 000hrs/yr

6. **PUMP RATE**

6.1 Design value : 37 m³/h

SECTION 2: INITIAL INVESTMENT AND ANNUAL FIXED COSTS

7. **INTEREST AND DEPRECIATION**

7.1 Real interest rate = [(***3.1***/100+1)/(***3.2***/100+1)-1]×100

= 5.0 %

7.2 Details of the initial investment

ITEM NUMBER	COMPONENT	INVESTMENT COSTS (R) 1	SALVAGE VALUE (% OF ***COLUMN 1***) 2	EXPECTED LIFE (YR) 3
1.	Branch line	2 767	5	15
2.	Lateral	10 652	0	7
3.	-	-	-	-
4.	-	-	-	-
5.	-	-	-	-
	Total	13 419		

7.2.1 Total initial investment cost (total ***column 1***) : R 13 419

7.3 The calculation of interest and depreciation

ITEM NUMBER	SALVAGE VALUE (R) ***COLUMN 1***× ***COLUMN 2***/100 4	INTEREST ON THE SALVAGE VALUE (R) ***7.1***/100× ***COLUMN 4*** 5	DEPRECIABLE PORTION (R) ***COLUMN 1***- ***COLUMN 4*** 6	CAPITAL RECOVERY FACTOR[1] (CRF) 7	CAPITAL RECOVERY[2] ON DEPRECIABLE PORTION (R) ***COLUMN 6***× ***COLUMN 7*** 8
1.	138.35	6.92	2 628.65	0.096342	253.25
2.	0	0	10 652.00	0.172820	1 840.88
3.	-	-	-	-	-
4.	-	-	-	-	-
5.	-	-	-	-	-
Total	138.35	6.92	13 280.65		2 094.13

1. CRF = i/100(i/100+1)^n/[(i/100+1)^n-1]

where CRF = Capital recovery factor,

i = Interest rate and

n = life of the component.

2. Comprises interest and depreciation.

7.3.1 Annual interest and depreciation (total ***column 5*** + total ***column 8***) : R 2 101.05

8. OTHER FIXED COSTS

8.1 Insurance

8.1.1 - Annual costs = ***7.2.1×4.2.1***/100 = R -

8.1.2 - Annual costs = ***7.2.1×4.2.2***/100 = R -

8.1.3 - Annual costs = ***7.2.1×4.2.3***/100 = R -

8.1.4 Total insurance cost = ***8.1.1+8.1.2+8.1.3*** = R -

9. ANNUAL OWNERSHIP COSTS

9.1 Total annual fixed cost = ***7.3.1+8.1.4*** = R 2 101.05

SECTION 3: ANNUAL OPERATING COSTS OF A MICRO-SYSTEM

10. ANNUAL OPERATION OF THE SYSTEM

10.1 Water pumped (m^3) according to planning = ***2.1×2.2*** = 16 280 m^3/yr

10.2 Water pumped (mm.ha) according to planning = ***10.1***/10 = 1 628 mm.ha/yr

10.3 Hours pumped = ***10.1/6.1*** = 440 hrs

11. WATER COSTS

11.1 Water purchases at tariff 1

11.1.1 Quantity

If ***2.2*** ≤ ***2.3.1.1*** = ***2.2×2.1*** = 16 280 m^3

If ***2.2*** > ***2.3.1.1*** = ***2.3.1.1×2.1*** = - m^3

11.1.2 Purchases at a higher tariff = ***2.2-2.3.1.1*** = 0 m^3

11.1.3	Water costs at tariff 1	= ***2.3.1.2***/100×***11.1.1***
		= R 2 276
11.2	Water purchases at tariff 2	
11.2.1	Quantity	
	If ***11.1.2*** ≤ ***2.3.2.1***	= ***11.1.2***×***2.1***
		= - m^3
	If ***11.1.2*** > ***2.3.2.1***	= ***2.3.2.1***×***2.1***
		= - m^3
11.2.2	Purchases at a higher tariff	= ***11.1.2-2.3.2.1***
		= - m^3
11.2.3	Water costs at tariff 2	= ***2.3.2.2***/100×***11.2.1***
		= R -
11.3	Water purchases at tariff 3	
11.3.1	Quantity	
	If ***11.2.2*** ≤ ***2.3.3.1***	= ***11.2.2***×***2.1***
		= - m^3
	If ***11.2.2*** > ***2.3.3.1***	= ***2.3.3.1***×***2.1***
		= - m^3
11.3.2	Purchases at a higher tariff	= ***11.2.2-2.3.3.1***
		= - m^3
11.3.3	Water costs at tariff 3	= ***2.3.3.2***/100×***11.3.1***
		= R -
11.4	Water purchases at tariff 4	
11.4.1	Quantity	
	If ***11.3.2*** ≤ ***2.3.4.1***	= ***11.3.2***×***2.1***
		= - m^3
	If ***11.3.2*** > ***2.3.4.1***	= ***2.3.4.1***×***2.1***
		= - m^3
11.4.2	Purchases at a higher tariff	= ***11.3.2-2.3.4.1***
		= - m^3
11.4.3	Water costs at tariff 4	= ***2.3.4.2***/100×***11.4.1***
		= R -

11.5	Water purchases at tariff 5	
11.5.1	Quantity	
	If **11.4.2** ≤ **2.3.5.1**	= **11.4.2×2.1**
		= ___-___ m^3
	Otherwise maximum **2.3.5.1**	= **2.3.5.1×2.1**
		= ___-___ m^3
11.5.2	Water costs at tariff 5	= **2.3.5.2**/100×**11.5.1**
		= R___-___
11.6	Total water cost	= **11.1.3+11.2.3+11.3.3+11.4.3+11.5.2**
		= R__2 276__

12. LABOUR COSTS

12.1	Labour hours required	= **10.3**/24hrs×**1.1**
		= __25__ hrs/yr
12.2	Total labour cost per year	= **5.1×12.1**
		= R__64__
12.3	Labour costs per m^3 of water pumped	= **12.2/10.1**
		= R__0.0039__

13. REPAIR AND MAINTENANCE COSTS

13.1 Annual repair and maintenance costs of the branch line

= (***7.2, column 1, item 1***)×**5.2.1**/100×**10.3**/1 000hrs

= R__18.26__

13.2 Annual repair and maintenance costs of the lateral

= (***7.2, column 1, item 2***)×**5.2.2**/100×**10.3**/1 000hrs

= R__0__

13.3 Annual repair and maintenance costs of the ________-________

= (***7.2, column 1, item 3***)×**5.2.3**/100×**10.3**/1 000hrs

= R__-__

13.4 Annual repair and maintenance costs of the ________-________

= (***7.2, column 1, item 4***)×**5.2.4**/100×**10.3**/1 000hrs

= R__-__

13.5 Annual repair and maintenance costs of the ________-________

= (***7.2, column 1, item 5***)×**5.2.5**/100×**10.3**/1 000hrs

= R__-__

13.6 Total annual repairs and maintenance cost

= 13.1+13.2+13.3+13.4+13.5

= R 18.26

13.7 Annual repair and maintenance costs per m^3 of water applied

= 13.6/10.1

= R 0.0011

SECTION 4: SUMMARY OF COSTS

14. ANNUAL COSTS FOR PLANNED WATER APPLICATION

14.1 Fixed costs

14.1.1 Total annual ownership cost **= 9.1**

= R 2 101.05

14.2 Variable costs

14.2.1 Total water cost **= 11.6**

= R 2 276.00

14.2.2 Total labour cost **= 12.2**

= R 64.00

14.2.3 Total repairs and maintenance cost **= 13.6**

= R 18.26

14.3 Total cost per year **= 14.1.1+14.2.1+14.2.2+14.2.3**

= R 4 459.31

15. COST ALLOCATION

15.1 Fixed costs per hectare of crops grown **= 9.1/1.2**

= R 700.35

15.2 Labour costs per m^3 of water pumped **= 12.3**

= R 0.0039

15.3 Repair and maintenance costs per m^3 of water pumped **= 13.7**

= R 0.0011

15.4 Water costs

	TARIFF	M^3 OF WATER PUMPED		COSTS/M^3 OF WATER	
15.4.1	1	**11.1.1**	= 16 280 m^3	**2.3.1.2**/100	= R 0.1398
15.4.2	2	**11.2.1**	= - m^3	**2.3.2.2**/100	= R -
15.4.3	3	**11.3.1**	= - m^3	**2.3.3.2**/100	= R -
15.4.4	4	**11.4.1**	= - m^3	**2.3.4.2**/100	= R -
15.4.5	5	**11.5.1**	= - m^3	**2.3.5.2**/100	= R -

16. **MARGINAL FACTOR COSTS**

Additional costs to apply an extra unit of water (m^3)

$$= \mathbf{15.2} + \mathbf{15.3} + \begin{bmatrix} \mathbf{15.4.1} \\ \text{or } \mathbf{15.4.2} \\ \text{or } \mathbf{15.4.3} \\ \text{or } \mathbf{15.4.4} \\ \text{or } \mathbf{15.4.5} \end{bmatrix}^{4}$$

= R 0.1448

4. Marginal water cost is the total amount for the last tariff increment at which water was purchased divided by quantity applied at this tariff. For example, if water is purchased at the higher tariff 2, then 15.4.1 will not apply but 15.4.2.

3.3.3 COST ESTIMATING PROCEDURES FOR FURROW-IRRIGATION

The worksheets have four sections which correspond with the four-step Spilkost procedure.

SECTION 1: GENERAL INFORMATION

1.	**MANAGEMENT OF THE FURROW SYSTEM**						
1.1	Hours labour required per 24 hours irrigated					: 40.32	hrs
1.2	Area annually cultivated: Sugarcane					: 50.40	ha
2.	**WATER**						
2.1	Listed area irrigated with the furrow system					: 25.20	ha
2.2	Planned water use					: 19 170	m^3/ha/yr
2.3	Water charges						
	TARIFF		QUANTITY			CHARGE	
	1	2.3.1.1	: 19 170	m^3/ha	2.3.1.2	: 13.98	c/m^3
	2	2.3.2.1	: -	m^3/ha	2.3.2.2	: -	c/m^3
	3	2.3.3.1	: -	m^3/ha	2.3.3.2	: -	c/m^3
	4	2.3.4.1	: -	m^3/ha	2.3.4.2	: -	c/m^3
	5	2.3.5.1	: -	m^3/ha	2.3.5.2	: -	c/m^3
3.	**INTEREST AND INFLATION RATE**						
3.1	Nominal interest rate					: 11.0	%
3.2	Annual inflation rate					: 5.7	%
4.	**INSURANCE**						
4.1	Type of insurance		4.1.1	: -			
			4.1.2	: -			
			4.1.3	: -			
4.2	Tariff for each type of insurance				4.2.1	: -	%
					4.2.2	: -	%
					4.2.3	: -	%
5.	**OTHER COSTS**						
5.1	Labour costs					: R 2.56	/h

5.2 Repair and maintenance costs

5.2.1 Underground pipe : 0.2 % of the purchase price/1 000hrs/yr

5.2.2 Balancing dam : 0.5 % of the purchase price/1 000hrs/yr

5.2.3 Laser levelling : 0 % of the purchase price/1 000hrs/yr

OTHER

5.2.4 - : - % of the purchase price/1 000hrs/yr

5.2.5 - : - % of the purchase price/1 000hrs/yr

5.2.6 - : - % of the purchase price/1 000hrs/yr

6. PUMP RATE

6.1 Design value : 100 m^3/h

SECTION 2: INITIAL INVESTMENT AND ANNUAL FIXED COSTS

7. INTEREST AND DEPRECIATION

7.1 Real interest rate = [(***3.1***/100+1)/(***3.2***/100+1)-1]×100

= 5.0 %

7.2 Details of the initial investment

ITEM NUMBER	COMPONENT	INVESTMENT COSTS (R) 1	SALVAGE VALUE (% OF ***COLUMN 1***) 2	EXPECTED LIFE (YR) 3
1.	Underground pipe	53 000	30	20
2.	Balancing dam	20 000	0	20
3.	Laser levelling	50 400	0	6
4.	-	-	-	-
5.	-	-	-	-
6.	-	-	-	-
	Total	123 400		

7.2.1 Total initial investment cost (total ***column 1***) : R 123 400

7.3 The calculation of interest and depreciation

ITEM NUMBER	SALVAGE VALUE	INTEREST ON THE SALVAGE VALUE	DEPRECIABLE PORTION	CAPITAL RECOVERY FACTOR[1] (CRF)	CAPITAL RECOVERY[2] ON DEPRECIABLE PORTION
	(R)	(R)	(R)		(R)
	COLUMN 1× ***COLUMN 2***/100	***7.1***/100× ***COLUMN 4***	***COLUMN 1***- ***COLUMN 4***		***COLUMN 6***× ***COLUMN 7***
	4	5	6	7	8
1.	15 900	795	37 100	0.080243	2 977.02
2.	0	0	20 000	0.080243	1 604.86
3.	0	0	50 400	0.197017	9 929.66
4.	-	-	-	-	-
5.	-	-	-	-	-
6.	-	-	-	-	-
Total	15 900	795	107 500		14 511.54

7.3.1 Annual interest and depreciation (total ***column 5*** + total ***column 8***) : R 15 306.54

8. OTHER FIXED COSTS

8.1 Insurance

8.1.1 _____ - _____ Annual costs = ***7.2.1×4.2.1***/100
= R __ - __

8.1.2 _____ - _____ Annual costs = ***7.2.1×4.2.2***/100
= R __ - __

8.1.3 _____ - _____ Annual costs = ***7.2.1×4.2.3***/100
= R __ - __

8.1.4 Total insurance cost = ***8.1.1+8.1.2+8.1.3***
= R __ - __

9. ANNUAL OWNERSHIP COSTS

9.1 Total annual fixed cost = ***7.3.1+8.1.4***
= R 15 306.54

1. $CRF = i/100(i/100+1)^n/[(i/100+1)^n-1]$

where CRF = Capital recovery factor,
i = Interest rate and
n = life of the component.

2. Comprises interest and depreciation.

SECTION 3: ANNUAL OPERATING COSTS OF A FURROW SYSTEM

10. ANNUAL OPERATION OF THE SYSTEM

10.1 Water pumped (m^3) according to planning = ***2.1*×*2.2***
= 479 250 m^3/yr

10.2 Water pumped (mm.ha) according to planning = ***10.1***/10
= 47 925 mm.ha/yr

10.3 Hours pumped = ***10.1*/*6.1***
= 4 793 hrs

11. WATER COSTS

11.1 Water purchases at tariff 1

11.1.1 Quantity

If ***2.2*** ≤ ***2.3.1.1*** = ***2.2*×*2.1***
= 479 250 m^3

If ***2.2*** > ***2.3.1.1*** = ***2.3.1.1*×*2.1***
= - m^3

11.1.2 Purchases at a higher tariff = ***2.2*-*2.3.1.1***
= 0 m^3

11.1.3 Water costs at tariff 1 = ***2.3.1.2***/100×***11.1.1***
= R 66 999

11.2 Water purchases at tariff 2

11.2.1 Quantity

If ***11.1.2*** ≤ ***2.3.2.1*** = ***11.1.2*×*2.1***
= - m^3

If ***11.1.2*** > ***2.3.2.1*** = ***2.3.2.1*×*2.1***
= - m^3

11.2.2 Purchases at a higher tariff = ***11.1.2*-*2.3.2.1***
= - m^3

11.2.3 Water costs at tariff 2 = ***2.3.2.2***/100×***11.2.1***
= R -

11.3 Water purchases at tariff 3

11.3.1 Quantity

If ***11.2.2*** ≤ ***2.3.3.1*** = ***11.2.2*×*2.1***
= - m^3

If ***11.2.2*** > ***2.3.3.1*** = ***2.3.3.1*×*2.1***
= - m^3

11.3.2	Purchases at a higher tariff	= ***11.2.2-2.3.3.1***
		= ___-___ m^3
11.3.3	Water costs at tariff 3	= ***2.3.3.2***/100×***11.3.1***
		= R___-___
11.4	Water purchases at tariff 4	
11.4.1	Quantity	
	If ***11.3.2*** ≤ ***2.3.4.1***	= ***11.3.2×2.1***
		= ___-___ m^3
	If ***11.3.2*** > ***2.3.4.1***	= ***2.3.4.1×2.1***
		= ___-___ m^3
11.4.2	Purchases at a higher tariff	= ***11.3.2-2.3.4.1***
		= ___-___ m^3
11.4.3	Water costs at tariff 4	= ***2.3.4.2***/100×***11.4.1***
		= R___-___
11.5	Water purchases at tariff 5	
11.5.1	Quantity	
	If ***11.4.2*** ≤ ***2.3.5.1***	= ***11.4.2×2.1***
		= ___-___ m^3
	Otherwise maximum ***2.3.5.1***	= ***2.3.5.1×2.1***
		= ___-___ m^3
11.5.2	Water costs at tariff 5	= ***2.3.5.2***/100×***11.5.1***
		= R___-___
11.6	Total water cost	= ***11.1.3+11.2.3+11.3.3+11.4.3+11.5.2***
		= R 66 999

12. Labour costs

12.1	Labour hours required	= ***10.3***/24hrs×***1.1***
		= 8 052 hrs/yr
12.2	Total labour cost per year	= ***5.1×12.1***
		= R 20 613
12.3	Labour costs per m^3 of water pumped	= ***12.2***/***10.1***
		= R 0.0430

13. Repair and maintenance costs

13.1 Annual repair and maintenance costs of the underground pipe

= (***7.2, column 1, item 1***)×***5.2.1***/100×***10.3***/1 000hrs

= R 508.06

13.2 Annual repair and maintenance costs of the balancing dam

= (***7.2, column 1, item 2***)×***5.2.2***/100×***10.3***/1 000hrs

= R 479.30

13.3 Annual repair and maintenance costs of the laser levelling

= (***7.2, column 1, item 3***)×***5.2.3***/100×***10.3***/1 000hrs

= R 0

13.4 Annual repair and maintenance costs of the -

= (***7.2, column 1, item 4***)×***5.2.4***/100×***10.3***/1 000hrs

= R -

13.5 Annual repair and maintenance costs of the -

= (***7.2, column 1, item 5***)×***5.2.5***/100×***10.3***/1 000hrs

= R -

13.6 Annual repair and maintenance costs of the -

= (***7.2, column 1, item 6***)×***5.2.6***/100×***10.3***/1 000hrs

= R -

13.7 Total annual repairs and maintenance cost

= ***13.1+13.2+13.3+13.4+13.5+13.6***

= R 987.36

13.8 Annual repair and maintenance costs per m^3 of water applied

= ***13.7/10.1***

= R 0.0021

SECTION 4: SUMMARY OF COSTS

14. ANNUAL COSTS FOR PLANNED WATER APPLICATION

14.1 Fixed costs

14.1.1 Total annual ownership cost = ***9.1***

= R 15 306.54

14.2 Variable costs

14.2.1 Total water cost = ***11.6***

= R 66 999.00

14.2.2 Total labour cost = ***12.2***

= R 20 613.00

14.2.3 Total repairs and maintenance cost = ***13.7***

= R 987.36

14.3 Total cost per year = ***14.1.1+14.2.1+14.2.2+14.2.3***

= R103 905.90

15. COST COST ALLOCATION

15.1	Fixed costs per hectare of crops grown	= ***9.1/1.2***
		= R 306.13
15.2	Labour costs per m^3 of water pumped	= ***12.3***
		= R 0.0430
15.3	Repair and maintenance costs per m^3 of water pumped	= ***13.8***
		= R 0.0021

15.4 Water costs

	TARIFF	M^3 OF WATER PUMPED		COSTS/M^3 OF WATER	
15.4.1	1	***11.1.1***	= 479 250 m^3	***2.3.1.2***/100	= R 0.1398
15.4.2	2	***11.2.1***	= - m^3	***2.3.2.2***/100	= R -
15.4.3	3	***11.3.1***	= - m^3	***2.3.3.2***/100	= R -
15.4.4	4	***11.4.1***	= - m^3	***2.3.4.2***/100	= R -
15.4.5	5	***11.5.1***	= - m^3	***2.3.5.2***/100	= R -

16. MARGINAL FACTOR COSTS

Additional costs to apply an extra unit of water (m^3)

= ***15.2+15.3+*** [***15.4.1*** or ***15.4.2*** or ***15.4.3*** or ***15.4.4*** or ***15.4.5***][4]

= R 0.1849

4. Marginal water costs is the total amount for the last tariff increment at which water was purchased divided by quantity applied at this tariff. For example, if water is purchased at the higher tariff 2, then 15.4.1 will not apply but 15.4.2.

3.3.4 *COST ESTIMATING WORKSHEETS FOR MAINLINE PIPE SYSTEM*

Again the worksheets have four sections which correspond with the four-step Spilkost procedure.

SECTION 1: GENERAL INFORMATION

1. MANAGEMENT OF THE MAINLINE

1.1 Type of irrigation system on the mainline

1.1.1	:	Centre pivot
1.1.2	:	Draglines
1.1.3	:	Micro
1.1.4	:	Drip
1.1.5	:	-
1.1.6	:	-
1.1.7	:	-

1.2 Most common time setting of the centre pivot

1.2.1	:	70	%
1.2.2	:	-	%
1.2.3	:	-	%
1.2.4	:	-	%
1.2.5	:	-	%
1.2.6	:	-	%
1.2.7	:	-	%

2. PROPERTIES

2.1 Pipes

	STAGE	TYPE OF PIPE		LENGTH			DIAMETER	
2.1.1	1-2	Asbestos	2.1.1.1	573	m	2.1.1.2	350	mm
2.1.2	2-3	PVC	2.1.2.1	548	m	2.1.2.2	153.6	mm
2.1.3	2-9	PVC	2.1.3.1	516	m	2.1.3.2	240.2	mm
2.1.4	3-4	PVC	2.1.4.1	3	m	2.1.4.2	134.4	mm
2.1.5	3-10	PVC	2.1.5.1	318	m	2.1.5.2	86.4	mm
2.1.6	4-5	PVC	2.1.6.1	144	m	2.1.6.2	120	mm
2.1.7	5-6	PVC	2.1.7.1	126	m	2.1.7.2	105.6	mm
2.1.8	6-7	PVC	2.1.8.1	326	m	2.1.8.2	72	mm
2.1.9	7-8	PVC	2.1.9.1	70	m	2.1.9.2	60	mm
2.1.10	10-11	PVC	2.1.10.1	24	m	2.1.10.2	72	mm
2.1.11	-	-	2.1.11.1	-	m	2.1.11.2	-	mm
2.1.12	-	-	2.1.12.1	-	m	2.1.12.2	-	mm
2.1.13	-	-	2.1.13.1	-	m	2.1.13.2	-	mm

2.2	Number of high-speed electric motors for drive of the centre pivot	2.2.1	: 4	
		2.2.2	: -	
		2.2.3	: -	
		2.2.4	: -	
		2.2.5	: -	
		2.2.6	: -	
		2.2.7	: -	
2.3	Size of the high-speed motors		: 1.12	kW
2.4	Number of low-speed electric motors for drive of the centre pivot	2.4.1	: 2	
		2.4.2	: -	
		2.4.3	: -	
		2.4.4	: -	
		2.4.5	: -	
		2.4.6	: -	
		2.4.7	: -	
2.5	Size of the low-speed motors		: 0.56	kW

3. HYDRAULICS

3.1	Vertical height of each irrigation system	3.1.1	: 14.10	m
		3.1.2	: 17.65	m
		3.1.3	: 18.50	m
		3.1.4	: 20.20	m
		3.1.5	: -	m
		3.1.6	: -	m
		3.1.7	: -	m
3.2	Operating pressure of the irrigation system	3.2.1	: 28.00	m
		3.2.2	: 40.00	m
		3.2.3	: 19.50	m
		3.2.4	: 13.00	m
		3.2.5	: -	m
		3.2.6	: -	m
		3.2.7	: -	m

4. WATER

4.1	Listed area per irrigation system	4.1.1	: 51	ha
		4.1.2	: 10	ha
		4.1.3	: 10	ha
		4.1.4	: 10	ha
		4.1.5	: -	ha
		4.1.6	: -	ha
		4.1.7	: -	ha
4.2	Planned water use per irrigation system	4.2.1	: 15 790	m^3/ha/yr
		4.2.2	: 17 900	m^3/ha/yr
		4.2.3	: 8 140	m^3/ha/yr
		4.2.4	: 7 180	m^3/ha/yr
		4.2.5	: -	m^3/ha/yr
		4.2.6	: -	m^3/ha/yr
		4.2.7	: -	m^3/ha/yr

5. ELECTRICITY

5.1	Planned use of Landrate and Ruraflex			
5.1.1	Landrate		: 100	%
5.1.2	Ruraflex		: -	%
5.2	Landrate			
5.2.1	Basic charge per month	5.2.1.1	: R 219.07	
		5.2.1.2	: R 163.92	
		5.2.1.3	: R -	
		5.2.1.4	: R -	
		5.2.1.5	: R -	
5.2.2	Network charge per month	5.2.2.1	: R -	
		5.2.2.2	: R -	
		5.2.2.3	: R -	
		5.2.2.4	: R -	
		5.2.2.5	: R -	
5.2.3	Energy charge		: 19.04	c/kWh

5.3	Ruraflex		
5.3.1	Size of the supply	5.3.1.1	: ______-______ kVA
		5.3.1.2	: ______-______ kVA
		5.3.1.3	: ______-______ kVA
		5.3.1.4	: ______-______ kVA
		5.3.1.5	: ______-______ kVA
5.3.2	Planned seasonal irrigation		
5.3.2.1	High-demand season (June – August)		: ______-______ %
5.3.2.2	Low-demand season (September – May)		: ______-______ %
5.3.3	Planned time of irrigation		
5.3.3.1	Peak		: ______-______ %
5.3.3.2	Standard		: ______-______ %
5.3.3.3	Off-peak		: ______-______ %
5.3.4	Service charge per month	5.3.4.1	: R______-______
		5.3.4.2	: R______-______
		5.3.4.3	: R______-______
		5.3.4.4	: R______-______
		5.3.4.5	: R______-______
5.3.5	Administration charge per month	5.3.5.1	: R______-______
		5.3.5.2	: R______-______
		5.3.5.3	: R______-______
		5.3.5.4	: R______-______
		5.3.5.5	: R______-______
5.3.6	Network charge per month		: R______-______ /kVA
5.3.7	Reactive energy charge		: ______-______ c/kvarh
5.3.8	Active energy charge – high-demand season (June – August)		
	TIME		CHARGE
	Peak	5.3.8.1	: ______-______ c/kWh
	Standard	5.3.8.2	: ______-______ c/kWh
	Off-peak	5.3.8.3	: ______-______ c/kWh
5.3.9	Active energy charge – low-demand season (September – May)		
	TIME		CHARGE
	Peak	5.3.9.1	: ______-______ c/kWh
	Standard	5.3.9.2	: ______-______ c/kWh
	Off-peak	5.3.9.3	: ______-______ c/kWh

5.3.10	Voltage surcharge	5.3.10.1	: - %
		5.3.10.2	: - %
		5.3.10.3	: - %
		5.3.10.4	: - %
		5.3.10.5	: - %
5.3.11	Transmission surcharge	5.3.11.1	: - %
		5.3.11.2	: - %
		5.3.11.3	: - %
		5.3.11.4	: - %
		5.3.11.5	: - %

6. INTEREST AND INFLATION RATE

6.1	Nominal interest rate	: 11.0 %
6.2	Annual inflation rate	: 5.7 %

7. INSURANCE

7.1	Type of insurance	7.1.1	: Pumping-station
		7.1.2	: Filter station
		7.1.3	: -
7.2	Tariff for each type of insurance	7.2.1	: 0.92 %
		7.2.2	: 0.92 %
		7.2.3	: - %

8. OTHER COSTS

8.1	Repair and maintenance costs		
8.1.1	Centrifugal pump	: 2.0	% of the purchase price/1 000hrs/yr
8.1.2	Electric motor	: 0.4	% of the purchase price/1 000hrs/yr
8.1.3	Underground pipe	: 0.2	% of the purchase price/1 000hrs/yr
8.1.4	Filter station	: 5.0	% of the purchase price/1 000hrs/yr
	OTHER		
8.1.5	-	: -	% of the purchase price/1 000hrs/yr
8.1.6	-	: -	% of the purchase price/1 000hrs/yr
8.1.7	-	: -	% of the purchase price/1 000hrs/yr

9. Pump rates

9.1	Irrigation system	9.1.1	: 180 m^3/h
		9.1.2	: 27 m^3/h
		9.1.3	: 36.5 m^3/h
		9.1.4	: 19.2 m^3/h
		9.1.5	: - m^3/h
		9.1.6	: - m^3/h
		9.1.7	: - m^3/h
9.2	Mainline		: 453 m^3/h

10. Total pressure

10.1 The calculation of friction

10.1.1 Centre pivot

10.1.1.1 Friction in stage 1-2

$= b\mathbf{2.1.1.1}\times\mathbf{9.1.1}^{p}/(\mathbf{2.1.1.2}/1\,000)^{r}$

= 0.41 m

10.1.1.2 Friction in stage -

$= b\mathbf{2.1.11.1}\times\mathbf{9.1.1}^{p}/(\mathbf{2.1.11.2}/1\,000)^{r}$

= - m

10.1.1.3 Friction in stage -

$= b\mathbf{2.1.12.1}\times\mathbf{9.1.1}^{p}/(\mathbf{2.1.12.2}/1\,000)^{r}$

= - m

10.1.1.4 Friction in stage -

$= b\mathbf{2.1.13.1}\times\mathbf{9.1.1}^{p}/(\mathbf{2.1.13.2}/1\,000)^{r}$

= - m

10.1.1.5 Total friction to the centre pivot

= ***10.1.1.1+10.1.1.2+10.1.1.3+10.1.1.4***

= 0.41 m

10.1.2 Draglines

10.1.2.1 Friction in stage 1-2

$= b\mathbf{2.1.1.1}\times\mathbf{9.1.2}^{p}/(\mathbf{2.1.1.2}/1\,000)^{r}$

= 0.01 m

Type pipe	ofb×(10^{-10})	p	r
Asbestos	4.3828	1.7857	4.7857
Metal	1.8192	1.9200	5.1264
PVC	4.5472	1.7715	4.7715

10.1.2.2 Friction in stage 2-9

= b**2.1.3.1**×**9.1.2**^{e}/(**2.1.3.2**/1 000)^{f}

= 0.07 m

10.1.2.3 Friction in stage -

= b**2.1.11.1**×**9.1.2**^{e}/(**2.1.11.2**/1 000)^{f}

= - m

10.1.2.4 Friction in stage -

= b**2.1.12.1**×**9.1.2**^{e}/(**2.1.12.2**/1 000)^{f}

= - m

10.1.2.5 Friction in stage -

= b**2.1.13.1**×**9.1.2**^{e}/(**2.1.13.2**/1 000)^{f}

= - m

10.1.2.6 Total friction to the draglines

= ***10.1.2.1+10.1.2.2+10.1.2.3+10.1.2.4+10.1.2.5***

= 0.08 m

10.1.3 Micro

10.1.3.1 Friction in stage 1-2

= b**2.1.1.1**×**9.1.3**^{e}/(**2.1.1.2**/1 000)^{f}

= 0.02 m

10.1.3.2 Friction in stage 2-3

= b**2.1.2.1**×**9.1.3**^{e}/(**2.1.2.2**/1 000)^{f}

= 1.11 m

10.1.3.3 Friction in stage 3-10

= b**2.1.5.1**×**9.1.3**^{e}/(**2.1.5.2**/1 000)^{f}

= 10.05 m

10.1.3.4 Friction in stage 10-11

= b**2.1.10.1**×**9.1.3**^{e}/(**2.1.10.2**/1 000)^{f}

= 1.81 m

10.1.3.5 Friction in stage -

= b**2.1.11.1**×**9.1.3**^{e}/(**2.1.11.2**/1 000)^{f}

= - m

10.1.3.6 Friction in stage -

= b**2.1.12.1**×**9.1.3**^{e}/(**2.1.12.2**/1 000)^{f}

= - m

10.1.3.7 Friction in stage -

= b**2.1.13.1**×**9.1.3**^{e}/(**2.1.13.2**/1 000)^{f}

= - m

10.1.3.8 Total friction to the micro-system

= ***10.1.3.1+10.1.3.2+10.1.3.3+10.1.3.4+10.1.3.5+10.1.3.6+10.1.3.7***

= 12.99 m

10.1.4 Drip

10.1.4.1 Friction in stage 1-2

= b***2.1.1.1***×***9.1.4***^{c}/(***2.1.1.2***/1 000)^{r}

= 0.01 m

10.1.4.2 Friction in stage 2-3

= b***2.1.2.1***×***9.1.4***^{c}/(***2.1.2.2***/1 000)^{r}

= 0.36 m

10.1.4.3 Friction in stage 3-4

= b***2.1.4.1***×***9.1.4***^{c}/(***2.1.4.2***/1 000)^{r}

= 0 m

10.1.4.4 Friction in stage 4-5

= b***2.1.6.1***×***9.1.4***^{c}/(***2.1.6.2***/1 000)^{r}

= 0.30 m

10.1.4.5 Friction in stage 5-6

= b***2.1.7.1***×***9.1.4***^{c}/(***2.1.7.2***/1 000)^{r}

= 0.49 m

10.1.4.6 Friction in stage 6-7

= b***2.1.8.1***×***9.1.4***^{c}/(***2.1.8.2***/1 000)^{r}

= 7.88 m

10.1.4.7 Friction in stage 7-8

= b***2.1.9.1***×***9.1.4***^{c}/(***2.1.9.2***/1 000)^{r}

= 4.04 m

10.1.4.8 Friction in stage -

= b***2.1.11.1***×***9.1.4***^{c}/(***2.1.11.2***/1 000)^{r}

= - m

10.1.4.9 Friction in stage -

= b***2.1.12.1***×***9.1.4***^{c}/(***2.1.12.2***/1 000)^{r}

= - m

10.1.4.10 Friction in stage -

= b***2.1.13.1***×***9.1.4***^{c}/(***2.1.13.2***/1 000)^{r}

= - m

10.1.4.11 Total friction to the drip system

= ***10.1.4.1+10.1.4.2+10.1.4.3+10.1.4.4+10.1.4.5+10.1.4.6+10.1.4.7+10.1.4.8+10.1.4.9+10.1.4.10***

= 13.08 m

10.1.5 -

10.1.5.1 Friction in stage -

$= b\,\mathbf{2.1.11.1}\times\mathbf{9.1.5}^{p}/(\mathbf{2.1.11.2}/1\,000)^{y}$

= - m

10.1.5.2 Friction in stage -

$= b\,\mathbf{2.1.12.1}\times\mathbf{9.1.5}^{p}/(\mathbf{2.1.12.2}/1\,000)^{y}$

= - m

10.1.5.3 Friction in stage -

$= b\,\mathbf{2.1.13.1}\times\mathbf{9.1.5}^{p}/(\mathbf{2.1.13.2}/1\,000)^{y}$

= - m

10.1.5.4 Total friction to the -

= ***10.1.5.1+10.1.5.2+10.1.5.3***

= - m

10.1.6 -

10.1.6.1 Friction in stage -

$= b\,\mathbf{2.1.11.1}\times\mathbf{9.1.6}^{p}/(\mathbf{2.1.11.2}/1\,000)^{y}$

= - m

10.1.6.2 Friction in stage -

$= b\,\mathbf{2.1.12.1}\times\mathbf{9.1.6}^{p}/(\mathbf{2.1.12.2}/1\,000)^{y}$

= - m

10.1.6.3 Friction in stage -

$= b\,\mathbf{2.1.13.1}\times\mathbf{9.1.6}^{p}/(\mathbf{2.1.13.2}/1\,000)^{y}$

= - m

10.1.6.4 Total friction to the -

= ***10.1.6.1+10.1.6.2+10.1.6.3***

= - m

10.1.7 -

10.1.7.1 Friction in stage -

$= b\,\mathbf{2.1.11.1}\times\mathbf{9.1.7}^{p}/(\mathbf{2.1.11.2}/1\,000)^{y}$

= - m

10.1.7.2 Friction in stage -

$= b\,\mathbf{2.1.12.1}\times\mathbf{9.1.7}^{p}/(\mathbf{2.1.12.2}/1\,000)^{y}$

= - m

10.1.7.3 Friction in stage ___-___

= b**2.1.13.1×9.1.7**^{m}/(**2.1.13.2**/1 000)^{n}

= ___-___ m

10.1.7.4 Total friction to the ___-___

= ***10.1.7.1+10.1.7.2+10.1.7.3***

= ___-___ m

10.2 Total pressure

10.2.1 Pressure, centre pivot = ***3.1.1+3.2.1+10.1.1.5***

= 42.51 m

10.2.2 Pressure, draglines = ***3.1.2+3.2.2+10.1.2.6***

= 57.73 m

10.2.3 Pressure, micro = ***3.1.3+3.2.3+10.1.3.8***

= 50.99 m

10.2.4 Pressure, drip = ***3.1.4+3.2.4+10.1.4.11***

= 46.28 m

10.2.5 Pressure, ___-___ = ***3.1.5+3.2.5+10.1.5.4***

= ___-___ m

10.2.6 Pressure, ___-___ = ***3.1.6+3.2.6+10.1.6.4***

= ___-___ m

10.2.7 Pressure, ___-___ = ***3.1.7+3.2.7+10.1.7.4***

= ___-___ m

11. POWER REQUIREMENTS

11.1 Net power required

11.1.1 Net kW for the centre pivot = ***9.1.1×10.2.1***×10/3 600

= 21.26 kW

11.1.2 Net kW for the draglines = ***9.1.2×10.2.2***×10/3 600

= 4.33 kW

11.1.3 Net kW for the micro-system = ***9.1.3×10.2.3***×10/3 600

= 5.17 kW

11.1.4 Net kW for the drip system = ***9.1.4×10.2.4***×10/3 600

= 2.47 kW

11.1.5 Net kW for the ___-___ = ***9.1.5×10.2.5***×10/3 600

= ___-___ kW

11.1.6 Net kW for the ___-___ = ***9.1.6×10.2.6***×10/3 600

= ___-___ kW

11.1.7 Net kW for the ___-___ = ***9.1.7×10.2.7***×10/3 600

= - kW

11.1.8 Total net kW = ***11.1.1+11.1.2+11.1.3+11.1.4+11.1.5+11.1.6+11.1.7***

= 33.23 kW

11.2 Size of the electric motors

11.2.1 : 37.0 kW

11.2.2 : 75.0 kW

11.2.3 : - kW

11.2.4 : - kW

11.2.5 : - kW

11.3 Total supply capacity of the motors = ***11.2.1+11.2.2+11.2.3+11.2.4+11.2.5***

= 112 kW

11.4 Power factor of the motor : - ∩

SECTION 2: INITIAL INVESTMENT AND ANNUAL FIXED COSTS

12. INTEREST AND DEPRECIATION

12.1 Real interest rate = [(***6.1***/100+1)/(***6.2***/100+1)-1]×100

= 5.0 %

12.2 Details of the initial investment

ITEM NUMBER	COMPONENT	INVESTMENT COSTS (R) 1	SALVAGE VALUE (% OF ***COLUMN 1***) 2	EXPECTED LIFE (YR) 3
1.	Centrifugal pump	12 132	15	15
2.	Electric motor	49 047	20	15
3.	Underground pipe	236 891	30	20
4.	Filter station	28 875	0	10
5.	-	-	-	-
6.	-	-	-	-
7.	-	-	-	-
	Total	326 945		

12.2.1 Total initial investment cost (total ***column 1***) : R 326 945

12.3 The calculation of interest and depreciation

ITEM NUMBER	SALVAGE VALUE	INTEREST ON THE SALVAGE VALUE	DEPRECIABLE PORTION	CAPITAL RECOVERY FACTOR[1]	CAPITAL RECOVERY[2] ON DEPRECIABLE PORTION
	(R)	(R)	(R)	(CRF)	(R)
	COLUMN 1× ***COLUMN 2***/100	***12.1***/100× ***COLUMN 4***	***COLUMN 1***- ***COLUMN 4***		***COLUMN 6***× ***COLUMN 7***
	4	5	6	7	8
1.	1 819.80	90.99	10 312.20	0.096342	993.50
2.	9 809.40	490.47	39 237.60	0.096342	3 780.23
3.	71 067.30	3 553.37	165 823.70	0.080243	13 306.19
4.	0	0	28 875.00	0.129505	3 739.46
5.	-	-	-	-	-
6.	-	-	-	-	-
7.	-	-	-	-	-
Total	82 696.50	4 134.83	244 248.50		21 819.38

12.3.1 Annual interest and depreciation (total ***column 5*** + total ***Column 8***) : R 25 954.21

13. OTHER FIXED COSTS

13.1 Insurance

13.1.1 Annual insurance costs of the pumping-station

= (***12.2, column 1, item 1***)+(***12.2, column 1, item 2***)×***7.2.1***/100

= R 562.85

13.1.2 Annual insurance costs of the filter station

= (***12.2, column 1, item 4***)×***7.2.2***/100

= R 265.65

13.1.3 Annual insurance costs of the -

= (***12.2, column 1, item 5***)+(***12.2, column 1, item 6***)+(***12.2, column 1, item 7***)×***7.2.3***/100

= R -

1. $CRF = i/100(i/100+1)^n/[(i/100+1)^n-1]$

where CRF = Capital recovery factor,

i = Interest rate and

n = life of the component.

2. Comprises interest and depreciation.

13.1.4 Total annual insurance cost

= ***13.1.1+13.1.2+13.1.3***

= R 828.50

13.2 Electricity

13.2.1 Landrate

13.2.1.1 Annual basic charge

= ***5.2.1.1+5.2.1.2+5.2.1.3+5.2.1.4+5.2.1.5***×12mos

= R 4 595.88

13.2.1.2 Annual network charge

= ***5.2.2.1+5.2.2.2+5.2.2.3+5.2.2.4+5.2.2.5***×12mos

= R -

13.2.1.3 Total annual electricity cost at the Landrate tariff

= ***13.2.1.1+13.2.1.2***

= R 4 595.88

13.2.2 Ruraflex

13.2.2.1 Annual service charge

= ***5.3.4.1+5.3.4.2+5.3.4.3+5.3.4.4+5.3.4.5***×12mos

= R -

13.2.2.2 Annual administration charge

= ***5.3.5.1+5.3.5.2+5.3.5.3+5.3.5.4+5.3.5.5***×12mos

= R -

13.2.2.3 Annual network charge

= ***5.3.1.1+5.3.1.2+5.3.1.3+5.3.1.4+5.3.1.5×5.3.6***

= R -

13.2.2.4 Total annual electricity cost at the Ruraflex tariff

= ***13.2.2.1+13.2.2.2+13.2.2.3***

= R -

14. ANNUAL OWNERSHIP COSTS

14.1 Total annual fixed cost = ***12.3.1+13.1.4+13.2.1.3+13.2.2.4***

= R 31 378.59

SECTION 3: ANNUAL OPERATING COSTS OF A MAINLINE

15. ANNUAL OPERATION OF THE SYSTEM

15.1 Water pumped (m³) according to planning

= (***4.1.1×4.2.1***)+(***4.1.2×4.2.2***)+(***4.1.3×4.2.3***)+(***4.1.4×4.2.4***)+(***4.1.5×4.2.5***)+(***4.1.6×4.2.6***)+(***4.1.7×4.2.7***)

= 1 137 490 m³/yr

15.2 Water pumped (mm.ha) according to planning

= ***15.1***/10

= 113 749 mm.ha/yr

15.3 Hours pumped

= ***15.1/9.2***

= 2 511 hrs

16. ELECTRICITY COSTS

16.1 Annual electricity consumption

16.1.1 Pumping of the water

= ***11.3×15.3***

= 281 232 kWh

16.1.2 Drive of the centre pivot

16.1.2.1 = ***2.2.1×2.3***+(***2.4.1×2.5***)***×4.1.1×4.2.1/9.1.1×1.2.1***/100

= 17 537 kWh

16.1.2.2 = ***2.2.2×2.3***+(***2.4.2×2.5***)***×4.1.2×4.2.2/9.1.2×1.2.2***/100

= - kWh

16.1.2.3 = ***2.2.3×2.3***+(***2.4.3×2.5***)***×4.1.3×4.2.3/9.1.3×1.2.3***/100

= - kWh

16.1.2.4 = ***2.2.4×2.3***+(***2.4.4×2.5***)***×4.1.4×4.2.4/9.1.4×1.2.4***/100

= - kWh

16.1.2.5 = ***2.2.5×2.3***+(***2.4.5×2.5***)***×4.1.5×4.2.5/9.1.5×1.2.5***/100

= - kWh

16.1.2.6 = ***2.2.6×2.3***+(***2.4.6×2.5***)***×4.1.6×4.2.6/9.1.6×1.2.6***/100

= - kWh

16.1.2.7 = ***2.2.7×2.3***+(***2.4.7×2.5***)***×4.1.7×4.2.7/9.1.7×1.2.7***/100

= - kWh

16.1.3 Total electricity consumption

= ***16.1.1+16.1.2.1+16.1.2.2+16.1.2.3+16.1.2.4+16.1.2.5+16.1.2.6+16.1.2.7***

= 298 769 kWh

16.1.4 Electricity consumption per hour

= ***16.1.3*/*15.3***

= 118.98 kW

16.2 Electricity costs – Landrate

16.2.1 Water pumped at the Landrate tariff

= ***16.1.3*×*5.1.1***/100/***16.1.4*×*9.2***

= 1 137 522 m^3

16.2.2 Total electricity cost at the Landrate tariff

= ***16.1.3*×*5.1.1***/100×***5.2.3***/100

= R 56 885.62

16.2.3 Electricity costs per m^3 of water applied

= ***5.2.3***/100×***16.1.4*/*9.2***

= R 0.0500

16.3 Electricity costs – Ruraflex

16.3.1 Water pumped at the Ruraflex tariff

= ***15.1-16.2.1***

= - m^3

16.3.2 Reactive energy

16.3.2.1 Reactive energy consumption

= $\cos^{-1}$ ***11.4***tan×***16.1.3*×*5.1.2***/100-(0.3×***16.1.3*×*5.1.2***/100)

= - kvarh

16.3.2.2 Reactive energy costs

= ***16.3.2.1*×*5.3.7***/100

= R -

16.3.3 Active energy

16.3.3.1 High-demand season – peak

= ***5.3.2.1***/100×***5.3.3.1***/100×***16.1.3*×*5.1.2***/100

= - kWh

16.3.3.2 High-demand season – standard

= ***5.3.2.1***/100×***5.3.3.2***/100×***16.1.3*×*5.1.2***/100

= - kWh

16.3.3.3 High-demand season – off-peak

= ***5.3.2.1***/100×***5.3.3.3***/100×***16.1.3*×*5.1.2***/100

= - kWh

16.3.3.4 Energy costs for the high-demand season

= (***16.3.3.1*×*5.3.8.1***/100)+(***16.3.3.2*×*5.3.8.2***/100)+(***16.3.3.3*×*5.3.8.3***/100)

= R -

16.3.3.5 Low-demand season – peak

= ***5.3.2.2***/100×***5.3.3.1***/100×***16.1.3***×***5.1.2***/100

= ____-____ kWh

16.3.3.6 Low-demand season – standard

= ***5.3.2.2***/100×***5.3.3.2***/100×***16.1.3***×***5.1.2***/100

= ____-____ kWh

16.3.3.7 Low-demand season – off-peak

= ***5.3.2.2***/100×***5.3.3.3***/100×***16.1.3***×***5.1.2***/100

= ____-____ kWh

16.3.3.8 Energy costs for the low-demand season

= (***16.3.3.5***×***5.3.9.1***/100)+(***16.3.3.6***×***5.3.9.2***/100)+(***16.3.3.7***×***5.3.9.3***/100)

= R____-____

16.3.3.9 Total cost of the active energy

= ***16.3.3.4+16.3.3.8***

= R____-____

16.3.4 Voltage surcharge

16.3.4.1 = ***5.3.1.1***×***5.3.6***+[***16.3.3.9***×***5.3.1.1***/(***5.3.1.1+5.3.1.2+5.3.1.3+5.3.1.4+5.3.1.5***)]×***5.3.10.1***/100

= R____-____

16.3.4.2 = ***5.3.1.2***×***5.3.6***+[***16.3.3.9***×***5.3.1.2***/(***5.3.1.1+5.3.1.2+5.3.1.3+5.3.1.4+5.3.1.5***)]×***5.3.10.2***/100

= R____-____

16.3.4.3 = ***5.3.1.3***×***5.3.6***+[***16.3.3.9***×***5.3.1.3***/(***5.3.1.1+5.3.1.2+5.3.1.3+5.3.1.4+5.3.1.5***)]×***5.3.10.3***/100

= R____-____

16.3.4.4 = ***5.3.1.4***×***5.3.6***+[***16.3.3.9***×***5.3.1.4***/(***5.3.1.1+5.3.1.2+5.3.1.3+5.3.1.4+5.3.1.5***)]×***5.3.10.4***/100

= R____-____

16.3.4.5 = ***5.3.1.5***×***5.3.6***+[***16.3.3.9***×***5.3.1.5***/(***5.3.1.1+5.3.1.2+5.3.1.3+5.3.1.4+5.3.1.5***)]×***5.3.10.5***/100

= R____-____

16.3.4.6 Total voltage surcharge

= ***16.3.4.1+16.3.4.2+16.3.4.3+16.3.4.4+16.3.4.5***

= R____-____

16.3.5 Transmission surcharge

16.3.5.1 = ***5.3.1.1***×***5.3.6***+[***16.3.2.2***+***16.3.3.9***×***5.3.1.1***/(***5.3.1.1***+***5.3.1.2***+***5.3.1.3***+***5.3.1.4***+***5.3.1.5***)]+***16.3.4.1***×***5.3.11.1***/100

= R____-____

16.3.5.2 = ***5.3.1.2***×***5.3.6***+[***16.3.2.2***+***16.3.3.9***×***5.3.1.2***/(***5.3.1.1***+***5.3.1.2***+***5.3.1.3***+***5.3.1.4***+***5.3.1.5***)]+***16.3.4.2***×***5.3.11.2***/100

= R____-____

16.3.5.3 = ***5.3.1.3***×***5.3.6***+[***16.3.2.2***+***16.3.3.9***×***5.3.1.3***/(***5.3.1.1***+***5.3.1.2***+***5.3.1.3***+***5.3.1.4***+***5.3.1.5***)]+***16.3.4.3***×***5.3.11.3***/100

= R____-____

16.3.5.4 = ***5.3.1.4***×***5.3.6***+[***16.3.2.2***+***16.3.3.9***×***5.3.1.4***/(***5.3.1.1***+***5.3.1.2***+***5.3.1.3***+***5.3.1.4***+***5.3.1.5***)]+***16.3.4.4***×***5.3.11.4***/100

= R____-____

16.3.5.5 = ***5.3.1.5***×***5.3.6***+[***16.3.2.2***+***16.3.3.9***×***5.3.1.5***/(***5.3.1.1***+***5.3.1.2***+***5.3.1.3***+***5.3.1.4***+***5.3.1.5***)]+***16.3.4.5***×***5.3.11.5***/100

= R____-____

16.3.5.6 Total transmission surcharge

= ***16.3.5.1***+***16.3.5.2***+***16.3.5.3***+***16.3.5.4***+***16.3.5.5***

= R____-____

16.3.6 Total electricity cost at the Ruraflex tariff

= ***16.3.2.2***+***16.3.3.9***+***16.3.4.6***+***16.3.5.6***

= R____-____

16.3.7 Electricity costs per m^3 of water applied

= ***16.3.6***/***16.3.1***

= R____-____

16.4 Total electricity cost

= ***16.2.2***+***16.3.6***

= R 56 885.62

17. REPAIR AND MAINTENANCE COSTS

17.1 Annual repair and maintenance costs of the centrifugal pump

= (***12.2, column 1, item 1***)×***8.1.1***/100×***15.3***/1 000hrs

= R 609.27

17.2 Annual repair and maintenance costs of the electric motor

= (***12.2, column 1, item 2***)×***8.1.2***/100×***15.3***/1 000hrs

= R 492.63

17.3 Annual repair and maintenance costs of the underground pipe

= (***12.2, column 1, item 3***)×***8.1.3***/100×***15.3***/1 000hrs

= R 1 189.67

17.4 Annual repair and maintenance costs of the filter station

= (***12.2, column 1, item 4***)×***8.1.4***/100×***15.3***/1 000hrs

= R 3 625.26

17.5 Annual repair and maintenance costs of the -

= (***12.2, column 1, item 5***)×***8.1.5***/100×***15.3***/1 000hrs

= R -

17.6 Annual repair and maintenance costs of the -

= (***12.2, column 1, item 6***)×***8.1.6***/100×***15.3***/1 000hrs

= R -

17.7 Annual repair and maintenance costs of the -

= (***12.2, column 1, item 7***)×***8.1.7***/100×***15.3***/1 000hrs

= R -

17.8 Total annual repairs and maintenance cost

= ***17.1+17.2+17.3+17.4+17.5+17.6+17.7***

= R 5 916.83

17.9 Annual repair and maintenance costs per m^3 of water applied

= ***17.8/15.1***

= R 0.0052

SECTION 4: SUMMARY OF COSTS

18. ANNUAL COSTS FOR PLANNED WATER APPLICATION

18.1 Fixed costs

18.1.1 Total annual ownership cost = ***14.1***

= R 31 378.59

18.2 Variable costs

18.2.1 Total electricity cost = ***16.4***

= R 56 885.62

18.2.2 Total repairs and maintenance cost = ***17.8***

= R 5 916.83

18.3 Total cost per year = ***18.1.1+18.2.1+18.2.2***

= R 94 181.04

19. COSTS PER UNIT

19.1 Electricity costs per m³ of water pumped

19.1.1 Landrate

16.2.1	= 1 137 522 m³	***16.2.3***	= R 0.0500

19.1.2 Ruraflex

16.3.1	= - m³	***16.3.7***	= R -

19.2 Repair and maintenance costs per m³ of water pumped = ***17.9***

= R 0.0052

20. MARGINAL FACTOR COSTS

Additional costs to pump an extra unit of water (m³)

= ***19.1.1+19.1.2+19.2***

= R 0.0552

SECTION 5: COST ALLOCATION

21. FIXED COSTS

21.1 Interest and depreciation as well as insurance on the filter station

21.1.1 = ~~***4.1.1/(4.1.1+4.1.2+4.1.3+4.1.4+4.1.5+4.1.6+4.1.7)×[(12.3, column 5, item 4)+(12.3, column 8, item4)+13.1.2]***~~[3]

= R -

21.1.2 = ~~***4.1.2/(4.1.1+4.1.2+4.1.3+4.1.4+4.1.5+4.1.6+4.1.7)×[(12.3, column 5, item 4)+(12.3, column 8, item 4)+13.1.2]***~~

= R -

21.1.3 = ***4.1.3/(~~4.1.1+4.1.2~~+4.1.3+4.1.4~~+4.1.5+4.1.6+4.1.7~~)×[(12.3, column 5, item 4)+(12.3, column 8, item 4)+13.1.2]***

= R 2 002.56

21.1.4 = ***4.1.4/(~~4.1.1+4.1.2~~+4.1.3+4.1.4~~+4.1.5+4.1.6+4.1.7~~)×[(12.3, column 5, item 4)+(12.3, column 8, item 4)+13.1.2]***

= R 2 002.56

21.1.5 = ~~***4.1.5/(4.1.1+4.1.2+4.1.3+4.1.4+4.1.5+4.1.6+4.1.7)×[(12.3, column 5, item 4)+(12.3, column 8, item 4)+13.1.2]***~~

= R -

21.1.6 = ~~***4.1.6/(4.1.1+4.1.2+4.1.3+4.1.4+4.1.5+4.1.6+4.1.7)×[(12.3, column 5, item 4)+(12.3, column 8, item 4)+13.1.2]***~~

= R -

3. If an irrigation system does not make use of a specific component then the interest and depreciation cost of this component do not exist.

21.1.7 = ~~***4.1.7/(4.1.1+4.1.2+4.1.3+4.1.4+4.1.5+4.1.6+4.1.7)×[(12.3, column 5, item 4)+(12.3, column 8, item 4)+13.1.2]***~~

= R -

21.2 Other fixed costs

21.2.1 = ***4.1.1/(4.1.1+4.1.2+4.1.3+4.1.4+4.1.5+4.1.6+4.1.7)×[14.1-(12.3, column 5, item 4)-(12.3, column 8, item 4)-13.1.2]***

= R 17 235.15

21.2.2 = ***4.1.2/(4.1.1+4.1.2+4.1.3+4.1.4+4.1.5+4.1.6+4.1.7)×[14.1-(12.3, column 5, item 4)-(12.3, column 8, item 4)-13.1.2]***

= R 3 379.44

21.2.3 = ***4.1.3/(4.1.1+4.1.2+4.1.3+4.1.4+4.1.5+4.1.6+4.1.7)×[14.1-(12.3, column 5, item 4)-(12.3, column 8, item 4)-13.1.2]***

= R 3 379.44

21.2.4 = ***4.1.4/(4.1.1+4.1.2+4.1.3+4.1.4+4.1.5+4.1.6+4.1.7)×[14.1-(12.3, column 5, item 4)-(12.3, column 8, item 4)-13.1.2]***

= R 3 379.44

21.2.5 = ***4.1.5/(4.1.1+4.1.2+4.1.3+4.1.4+4.1.5+4.1.6+4.1.7)×[14.1-(12.3, column 5, item 4)-(12.3, column 8, item 4)-13.1.2]***

= R -

21.2.6 = ***4.1.6/(4.1.1+4.1.2+4.1.3+4.1.4+4.1.5+4.1.6+4.1.7)×[14.1-(12.3, column 5, item 4)-(12.3, column 8, item 4)-13.1.2]***

= R -

21.2.7 = ***4.1.7/(4.1.1+4.1.2+4.1.3+4.1.4+4.1.5+4.1.6+4.1.7)×[14.1-(12.3, column 5, item 4)-(12.3, column 8, item 4)-13.1.2]***

= R -

21.3 Total fixed cost

21.3.1 = ***21.1.1+21.2.1***

= R 17 235.15

21.3.2 = ***21.1.2+21.2.2***

= R 3 379.44

21.3.3 = ***21.1.3+21.2.3***

= R 5 382.00

21.3.4 = ***21.1.4+21.2.4***

= R 5 382.00

21.3.5 = ***21.1.5+21.2.5***

= R -

21.3.6 = ***21.1.6+21.2.6***

= R ___-___

21.3.7 = ***21.1.7+21.2.7***

= R ___-___

22. OPERATING COSTS

22.1 Electricity costs for drive of the centre pivot

22.1.1 = ***16.1.2.1×5.2.3***/100

= R 3 339.13

22.1.2 = ***16.1.2.2×5.2.3***/100

= R ___-___

22.1.3 = ***16.1.2.3×5.2.3***/100

= R ___-___

22.1.4 = ***16.1.2.4×5.2.3***/100

= R ___-___

22.1.5 = ***16.1.2.5×5.2.3***/100

= R ___-___

22.1.6 = ***16.1.2.6×5.2.3***/100

= R ___-___

22.1.7 = ***16.1.2.7×5.2.3***/100

= R ___-___

22.2 Total electricity cost for drive of the centre pivot

= ***22.1.1+22.1.2+22.1.3+22.1.4+22.1.5+22.1.6+22.1.7***

= R 3 339.13

22.3 Other operating costs

22.3.1 = ***11.1.1/11.1.8***×(***18.2.1-22.2+18.2.2***)

= R 38 043.64

22.3.2 = ***11.1.2/11.1.8***×(***18.2.1-22.2+18.2.2***)

= R 7 748.31

22.3.3 = ***11.1.3/11.1.8***×(***18.2.1-22.2+18.2.2***)

= R 9 251.44

22.3.4 = ***11.1.4/11.1.8***×(***18.2.1-22.2+18.2.2***)

= R 4 419.93

22.3.5 = ***11.1.5/11.1.8***×(***18.2.1-22.2+18.2.2***)

= R ___-___

22.3.6 = ***11.1.6/11.1.8***×(***18.2.1-22.2+18.2.2***)

= R ___-___

22.3.7 = ***11.1.7/11.1.8***×(***18.2.1-22.2+18.2.2***)

= R____-____

22.4 Total operating cost

22.4.1 = ***22.1.1+22.3.1***

= R 41 382.77

22.4.2 = ***22.1.2+22.3.2***

= R 7 748.31

22.4.3 = ***22.1.3+22.3.3***

= R 9 251.44

22.4.4 = ***22.1.4+22.3.4***

= R 4 419.93

22.4.5 = ***22.1.5+22.3.5***

= R____-____

22.4.6 = ***22.1.6+22.3.6***

= R____-____

22.4.7 = ***22.1.7+22.3.7***

= R____-____

23. TOTAL COST

23.1 = ***21.3.1+22.4.1***

= R 58 617.92

23.2 = ***21.3.2+22.4.2***

= R 11 127.75

23.3 = ***21.3.3+22.4.3***

= R 14 633.44

23.4 = ***21.3.4+22.4.4***

= R 9 801.93

23.5 = ***21.3.5+22.4.5***

= R____-____

23.6 = ***21.3.6+22.4.6***

= R____-____

23.7 = ***21.3.7+22.4.7***

= R____-____

3.3.5 Estimating the annual costs of a drip-, micro- and furrow-irrigation system in the Onderberg area

The results are the estimated total annual fixed and operating costs for drip-, micro- and furrow-irrigation.

For each system the following are illustrated. The first step is to calculate the investment in the components of the irrigation system (Tables 3.1 and 3.2), and then the depreciation and interest costs are estimated, as well as insurance and fixed electricity cost (Table 3.3).

The total investment cost of the drip-, micro- and furrow-irrigation system is R200 000, R277 586 and R132 012 respectively (Table 3.1).

The total fixed cost is R28 509, R39 817 and R17 763 for the drip-, micro- and furrow-irrigation systems respectively.

The next step is to estimate the operating costs of the systems (water, electricity, labour and repairs (Table 3.4)). The number of pumping hours is derived from the amount of water pumped annually, which depends on the crop water requirements and area irrigated. The electricity cost is based on the total electricity used (kWh) by operating the system at the different charging rates. Firstly, the volume of water pumped must be estimated, which depends on the area under irrigation and the crop water requirements. The number of hours pumped is calculated by dividing the water pumped by the pump rate. Secondly, the electricity use is estimated for pumping the water. Thirdly, the total electricity cost is estimated by multiplying the electricity use for pumping the water with the high and low electricity charge.

Table 3.3: Annual fixed costs of a drip-, micro- and furrow-irrigation system in the Onderberg area, Mpumalanga Province, 2002.

Irrigation system	**Drip**	**Micro**	**Furrow**
Crop	Oranges	Oranges	Sugarcane
Annual interest and depreciation (R)	26 689.19	37 985.50	16 070.00
Insurance costs (R)	212.32	217.24	79.23
Electricity: basic charge/yr (R)	1 614.36	1 614.36	1 614.36
Total annual fixed cost (R)	28 509.87	39 817.10	17 763.61

Table 3.4: Annual operating costs of a drip-, micro- and furrow-irrigation system in the Onderberg area, Mpumalanga Province, 2002.

Irrigation system	Drip	Micro	Furrow
Crop	*Orchard (oranges)*	*Orchard (oranges)*	*Sugarcane*
Water pumped (m^3)	178 388	202 725	483 084
Hours pumped	3 716	2 253	7 831
Total water cost (R)	24 938,70	28 340,97	67 535,14
Electricity consumption/hour (kWh)	7,5	15,0	7,5
Total electricity use (kWh)	27 873	33 788	36 231
Total electricity cost (R)	6 088,61	7 175,16	7 624,83
Labour hours required/yr	517	310	8 116
Total labour costs (R)	1 884,55	1 131,65	29 600,14
Total annual repairs and maintenance costs (R)	4 045,52	2 331,97	1 615,43
Total annual operating costs (R)	36 957,38	38 980,05	106 375,54

The total annual labour cost depends on the wage rate (Basic Conditions of Employment Act, 2002) and the number of labour hours required. The number of labour hours required depends on the hours pumped and the labour hours required per 24 hours of irrigation. The Irrigation Design Manual gives the labour requirements for the different irrigation systems (Burger *et al.*, 1999, p10-19).

The total annual repairs and maintenance costs of the irrigation systems are estimated based on the percentage of purchase price/1 000 hours used/year for each component (Table 3.1). The total annual operating cost of the drip-, micro- and furrow-irrigation system is R36 957, R38 980 and R106 375. The total operating costs of the furrow-irrigation system is the highest because of the crop (sugarcane), the water use and labour use. Table 3.5 gives a summary of the total annual costs of the irrigation systems, the costs/m^3 water pumped and the marginal factor cost. The marginal factor cost of water applied for the drip-, micro- and furrow-irrigation system is R0,20/m^3, or R2,00/mm.ha, R0,19/m^3 or R1,90/mm.ha, and R0,22/m^3 or R2,20/mm.ha.

Table 3.5: Summary of the total annual costs of a drip-, micro- and furrow-irrigation system, the cost allocation, and the marginal factor cost in the Onderberg area, Mpumalanga Province, 2002.

	Drip	Micro	Furrow
Total annual ownership/fixed cost (R)	28 509,87	39 817,10	17 763,61
Operating costs (R)			
Electricity	6 088,61	7 175,66	7 624,83
Water	24 938,70	28 340,97	67 535,14
Labour	1 884,55	1 131,65	29 600,14
Repairs and maintenance	4 045,52	2 331,77	1 615,43
Total operating costs (R)	36 957,38	38 980,05	106 375,54
Total annual fixed and operating costs (R)	65 467,25	78 797,15	124 139,15
Cost allocation per unit			
Fixed costs/ha (R)	1 147,50	1 598,77	352,45
Labour cost/m^3 water pumped (R)	0,0106	0,0056	0,0613
Repairs and maintenance/m^3 (R)	0,0227	0,0115	0,0033
Electricity costs/m^3 (R)	0,0287	0,0306	0,0138
Water costs/m^3 (R)	0,1398	0,1398	0,1398
Marginal factor cost of water applied (R/m^3)	0,2018	0,1875	0,2182

The marginal factor cost for an application of 25 mm on approximately 25 ha is R1 250, R1 187,50 and R1 375 for the drip-, micro- and furrow-irrigation system. For decision-making purposes the irrigator must therefore decide whether the expected additional income (crop response) will, for example, cover the above-mentioned irrigation application costs.

3.4 CONCLUSION

The proper estimation of irrigation costs is critical for irrigators to be able to evaluate efficient water use techniques. Computer worksheets were developed to estimate the irrigation costs of a drip-, micro- and furrow-irrigation system and the results were demonstrated in this chapter. The main result is that the existing cost estimating procedures of centre pivot- and dragline-irrigation systems were extended to estimate the total annual irrigation costs of drip-, micro- and furrow-systems. The equations used in calculating these costs are documented. In addition, the cost of an extra irrigation application can be estimated, which is valuable information needed to decide how much to irrigate.

These computerised cost estimating procedures can therefore be used to estimate the total fixed and operating costs of the major irrigation systems. These procedures are suitable for on-farm use by irrigators and advisors to decide over the long run which irrigation systems to buy, and in the short run how to manage the operating costs which are linked directly to the decisions of how much, how and what to produce. The procedures can also be used to consider changes in a current irrigation system or to evaluate the feasibility of switching to a more water-efficient system. It also may be useful for research regarding the economic viability of various irrigation systems, because it provides a systematic way to determine the annual total costs of the systems.

CHAPTER 4

A CASE STUDY ANALYSIS OF FIVE INDEPENDENT SMALL-SCALE COMMERCIAL IRRIGATION FARMERS IN NKOMAZI DISTRICT

4.1 INTRODUCTION

In this chapter an economic analysis is presented of a case study farmer in Nkomazi district as an example. It describes the farmer's situation, how profitable the business is and how he can improve his financial survival as well as how he is affected by risk. The other four case study farmers are enclosed in the appendices (4.B, 4.C, 4.D, 4.E).

4.2 THE CASE STUDY RESEARCH METHOD

4.2.1 INTRODUCTION

Every discipline depends on research activity to expand its knowledge base. Research on the other hand can be referred to as a systematic inquiry. There are, however, numerous well-tested designs and techniques to help guide the inquiry, and the case study is one such research design that will be used in an economic evaluation of the small-scale commercial irrigation farmers in Nkomazi district. A research design is like an architectural blueprint or a plan for assembling, organising, and integrating information (data), and it results in a specific end product, in the form of research findings (Merriam, 1988).

4.2.2 CASE STUDY METHOD DEFINED

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident, and in which multiple sources of evidence are used (Yin, 1993). As a research tool, the case study provides a detailed and holistic process for observing the structure and flow of real-life events. Case studies get as close to the subject of interest as they possibly can - partly by means of direct observation in natural settings, and partly by their access to subjective factors such as thoughts, feelings and desires, whereas experiments and surveys often use convenient derivative data. Also, case studies tend to spread the net for evidence widely, whereas experiments and surveys usually have a narrow focus (Merriam, 1988).

Merriam (1988) refers to a case as a single bounded system or an instance of a class of phenomena and not a representative of a class. Unlike in the statistical experimental paradigm where one is interested in selecting a sample that is representative of a certain population, a case is selected because it is an example of some phenomenon of interest. Furthermore, unlike experimental survey, or historical research, case study does not claim any particular methods for data collection or data analysis. Any or all methods of gathering data from testing to interviewing can be used in a case study, although certain techniques are used more than others (Merriam, 1988). Gall, Borg and Gall (1966) define the case study as a method of conducting qualitative research that evolved as a distinctive approach to scientific inquiry, partly as a reaction to perceived limitations of quantitative research.

The lack of precise universal definition of the case study is compounded by the flexible and adaptive nature of the typology (Winegardner, 2001). That is, a case study can accommodate a variety of research designs, data collection techniques, epistemological orientations, and disciplinary perspectives, each with its own standards of scholarship. Whereas quantitative research takes apart a phenomenon to examine component parts, which then become the variables of the study, qualitative research can reveal how all the parts work together to form a whole (Winegardner, 2001). Westgren and Zering (1998) argue that case study research should be a tool in the agricultural economist's toolbox, since it can be "good science" even though it is different from the norms of research methodology in the profession of agricultural economics. Yin, (1994) does not insist on applying a qualitative label to case study research, rather, he supports using quantitative analysis to augment more qualitative observations in doing good case research. According to Winegardner (2001), however, there appears to be a growing trend away from considering case study exclusively and reflexively in a qualitative context to a more expansive view of case study as an adaptive research structure which can accommodate qualitative and quantitative perspectives, techniques and standards.

4.2.3 CHARACTERISTICS OF THE CASE STUDY METHOD

According to Merriam (1988) the properties or characteristics of a qualitative study include the following:

Particularistic – This means that case studies focus on a particular situation, event, programme, or phenomenon.

Descriptive – This means that the end product of a case study is a rich description of the phenomenon under study.

Heuristic – It means that case studies illuminate the reader's understanding of the phenomenon under study, bringing about the discovery of new meaning, extend the reader's experience, or confirm what is known.

Inductive – Meaning that, for the most part, case studies rely on inductive reasoning. Generalisations, concepts or hypotheses emerge from an examination of data grounded in the context itself.

Merriam (1988) characterises qualitative research as an umbrella concept covering several forms of inquiry that help explain the meaning of social phenomena with as little disruption of the natural setting as possible, and in which the focus of the study is on interpretation and meaning. Qualitative research manifests an interest in understanding how people make sense of their world and the experiences they have in the world. It strives for a depth of understanding as an end in itself, not as an attempt to predict what may happen in the future, or to generalise to a universe (Patton, 1990). It shows a direct concern with experience as it is lived or felt or undergone (Sherman and Webb, 1988.) Other characteristics, which are more or less common to most forms of qualitative research, are that the design is emergent, flexible and responsive to changing conditions of the study in progress. The sample selection is usually non-random, purposeful, and small, and the researcher spends considerable time with participants in the natural setting of the study (Winegardner, 2001).

4.2.4 COMPONENTS OF THE CASE STUDY METHOD

4.2.4.1 Data Collection

Case study data collection is typically multi-method, usually involving interviewing, observing, and analysing documents (Winegardner, 2001). Multiple sources of information are sought and used because no single source of information can be trusted to provide a comprehensive perspective. By using a combination of observations, interviewing, and document analysis, the field worker is able to use different data sources to validate and crosscheck findings (Patton, 1990). Merriam (1988) notes that rarely are all three strategies used equally. One or two predominate, while the other(s) provide supporting information.

4.2.4.2 Data Analysis

Data analysis is an iterative process in which analysis begins with the first data collected, and emerging insights and tentative hypothesis direct the next phase of data collection. This leads to refinement of questions, collection of more data, which leads to more insights and so on (Winegardner, 2001). Three methods of analysing case study data include interpretational, structural, and reflective analysis. Interpretational analysis is a process for close examination of case study data in order to find constructs, themes, and patterns. Because interpretational analysis aims to make a case study as objective as possible, a computer organisation of the data is recommended by Gall, Borg and Gall (1966). Structural analysis is the process of examining case study data to identify patterns inherent in discourse, text, events, or other phenomena. Very little inference is required of the researcher, in contrast to interpretation analysis, in which the researcher overlays meaning on the data. Structural analysis is used in conversational analysis and ethnoscience to investigate patterns in verbal or narrative data. Reflective analysis on the other hand describes data based on the researcher's intuition and judgement rather than as a result of categorising it. Reflective analysis is ideal for thick description, in which the researcher attempts to depict and conceptualise a phenomenon by recreating it contextually, accompanied by the meanings and intentions inherent in the actual situation (Gall *et al.*, 1966).

4.2.4.3 The Case Study Report

Writing the results of qualitative research involves determination of the right balance of description and interpretation and the use of a style which integrates them in an interesting and informative narrative (Merriam, 1988). However, Erickson (1986) recommends inclusion of three components, particular description, general description, and interpretative commentary. Where particular description consists of quotes from interviews and field notes and narrative vignettes, general description tells the reader whether the quotes and vignettes are typical of the data as a whole and relates the parts to the whole. Interpretative commentary provides a framework for understanding both forms of description.

Two dominant styles of case reporting include analytic reporting and reflective reporting (Gall *et al.*, 1966). The major characteristics of analytic reporting are an objective writing style in which the researcher's voice is silent or minimised and there is conventional organisation of topics, namely introduction, literature review, methodology, results and discussion. This is essentially the same style and organisation used to report quantitative research. Reflective reporting on the other hand uses literary devices to bring the case alive, and the researcher's voice is clearly heard in the report. The researcher often weaves case study data into a story. Furthermore for reporting a multiple-case study, Gall *et al.* (1966) recommend reporting the results for each case, including sufficient thick description to bring the case alive for the reader, and also providing a cross-case analysis, noting consistencies and differences in constructs, themes, and patterns across the cases.

4.2.5 WHEN TO USE CASE STUDY DESIGN

The question of when to use a qualitative case study for research versus some other design essentially depends on what the researcher wants to know. However, how the problem is defined and the questions it raises determine the study's design (Merriam, 1988). According to Gall *et al.* (1966), the case study method focuses on holistic description and explanation and as a general statement, any phenomenon can be studied by case study method, while other qualitative research traditions, although compatible, are limited to a particular category of phenomena.

The case study method can accommodate different epistemologies and has application to a wide range of disciplines. It can be customised to address a wide range of research questions and types of cases and to incorporate a variety of data collections, analyses, and reporting techniques (Winegardner, 2001). Because case study is exceptionally useful for exploratory research, theory generation, and examination of atypical phenomena, it is particularly appropriate for applied research related to contemporary issues of people in the real world. However, it can also be used to test hypotheses and modify existing theory (Winegardner, 2001).

From the research problem comes the selection of the case or cases to study, and those cases are selected by a sampling process for a specific reason. According to Merriam (1988), however, the most appropriate case sampling strategy for qualitative research is non-probability sampling strategy, of which two widely used methods are purposeful and theoretical sampling. The former relates to the purpose for which the case was chosen and the latter relates to the theoretical orientation of the study (Winegardner, 2001). Furthermore, two levels of sampling are usually necessary in qualitative case studies, one for the case itself and the other for the study sample within the case. Unless all persons, events, documents and the like within the case are to be reviewed, some sampling is required (ibid).

4.2.6 STRENGTHS AND LIMITATIONS OF CASE STUDY DESIGN

The merits of a particular design are inherently related to the rationale for selecting it as the most appropriate plan for addressing the research problem (Merriam, 1988). One selects a case study design because of the nature of the research problem and the questions being asked. It is often because it is the best plan for answering one's questions, implying its strengths outweigh its limitations (Merriam, 1988). The case study offers a means of investigating complex social units consisting of multiple variables of potential importance in understanding the phenomenon. Anchored in real-life situations, the case study results in a rich and holistic account of a phenomenon (Merriam, 1988). Furthermore, Merriam argues that case study offers insights and illuminates meanings that expand its reader's experiences. These insights can be construed as tentative hypotheses that help structure research, hence case study plays an important role in advancing a field's knowledge base.

Because of its strengths, case study is a particularly appealing design for applied fields of study such as agriculture (Winegardner, 2001). Agricultural processes, problems, and programmes can be examined to bring about understanding that in turn can affect and perhaps even improve practice. Case study has proved particularly useful for studying innovations, for evaluating programmes, and for informing policy. It has also proven to be in complete harmony with the three key words that characterise any qualitative method, namely describing, understanding and explaining the case under investigation (Hamel, *et al.*, 1993). According to Winegardner (2001), a very pragmatic limitation of case studies from the perspective of the researcher is the labourintensiveness of the method and the time and sometimes expense required to carry out the study.

4.2.7 *Criticisms of the Case Study Method*

Case study methodology has been attacked for many reasons. One of the frequently cited limitations of the case method is the difficulty in generalising the findings (Stone, 1978; Merriam, 1988 and Hamel, *et al.*, 1993). The counter-argument by Winegardner (2001) is that generalisation of case study findings is a legitimate outcome, based on an understanding of the nature of that generalisation. In Yin's view, generalising from case studies is not a matter of statistical generalisation but a matter of analytic generalisation (using single or multiple cases to illustrate, represent, or generalise to a theory). Hence, case studies involve only analytic generalisations. Stake (1978) describes the generalisation of case studies as "naturalistic" or context specific and in harmony with a reader's experience, and therefore "a naturalistic basis for generalisation". This means that case study findings often resonate experientially or phenomenologically with a broad cross-section of readers, and therefore facilitate greater understanding of the phenomenon in question (Snow and Anderson, 1991). According to Feagin, Orum, and Sjoberget (1991), it is considered legitimate to generalise based on the degree to which a case is representative of some larger population. It is not merely a question of how many units are under study, but rather, what kind of unit. Therefore it is the nature of the phenomenon that is the true gauge of the population to which one seeks to generalise. Another criticism of the case method is that it can oversimplify or exaggerate a situation, leading the reader to distorted or erroneous conclusions about the actual state of affairs, as distinct from the report itself (Guba and Lincoln, 1981). Winegardner (2001) counter-argues that skilful data collection, analysis and reporting can reduce the possibility of this outcome, although it is characteristic of the case study that interpretation goes beyond the mind of the researcher to that of the reader.

Because many case studies cannot exploit long time series of data to test hypotheses using widely accepted statistical tests, Westgren and Zering (1998) are of the view that the design and execution of the studies must be held to some standard of process rigour. The following are some important elements of this process rigour: a) identifying the intent of the case, that is, whether the research is testing and modifying existing theory or exploratory research; b) including explicit discussion of relevant theories and published literature on the phenomenon being studied, just as in any empirical analysis that uses quantitative methods to test theory; c) being careful with data; d) using analytical aids; e) using multiple sources of data for as many variables as are feasible; f) telling a good story - being sure that the manuscript is complete and logically constructed, relating the results of the case study to other published work as conclusions are drawn; g) being forthright about limitations and questions for further tests, empirical or logical (Westgren and Zering, 1998).

4.3 THE CASE STUDY METHOD

4.3.1 SAMPLE SELECTION AND SIZE

After a reconnaissance visit to Mpumalanga, Lowveld, in August 1999, extension officers in the Lowveld area were contacted to help identify small-scale commercial irrigation farmers who were independent or not on schemes or farming in a group. This rendered the selection criterion purposeful.

A total of six such farmers were identified and were in different extension areas. According to the extension officers, these were the only farmers who satisfied the category that was described. Because most of the small-scale farmers in the area farm in schemes or groups and only few small-scale farmers farm independently, only five of the six case farmers were included in the study. The other farmer was not available to arrange with him to participate. At the time of the survey he was still not available. This left the researchers with only five participating farmers. The number and location of these farmers led to five agricultural extension areas being included in the survey, namely: Mtata, Magudu, Barberton, Vlakplaas, and Mzinti.

4.3.2 METHODS OF DATA COLLECTION

A purposeful sampling was carried out to obtain data from the case farmers. Both formal and informal interviews were conducted to solicit information from the farmers. A prepared checklist of questions was used to obtain preliminary information from farmers about their farming businesses. See Appendix 4.A. Two follow up interviews were also arranged to obtain further information. All interviews took the form of discussion between the farmer and the researcher. Where language seemed to be a problem, the extension officers in the respective extension areas were very helpful in getting the questions to the farmers and the answers from them. The first interview was carried out in November 2000, the second one was administered in April 2001, and the third one was in September 2001 by the researcher with the help of the extension officers dealing directly with the farmers. Visual observation of farming operations and crops was a valuable tool for data collection. Continuous and interactive communication was maintained with both farmers and their advisors. Telephone communication was also used to obtain some of the information needed from the farmers directly and through the extension officers where the farmer could not be reached by telephone. E-mail communication was another method used to obtain information from farmers through extension officers and from extension officers. Some of the information on input prices was obtained from the co-operatives from which the farmers bought their inputs, in cases where farmers had forgotten and could not remember the input prices. Useful data was also obtained from the farmer's income statements, especially the sugarcane farmers. These income statements constituted some of the quantitative measures used to obtain the necessary data.

A short-term (one-year) analysis was done because of unavailability of farming data. Case study farmers kept no farming data. Almost half of the research time was spent collecting and compiling enterprise data for individual case study farmers through personal visits to the farmers and discussion with their advisors. Co-operatives where farmers bought their inputs were also contacted to get input prices. The FAF manager, Mr T.A. Khumalo, was contacted about farmers' FAF loans and the Small Growers' Division of TSB provided the farmers' income statements at the authorisation of the case study farmers. A continuous and interactive communication was maintained with the farmers as well as their advisors throughout the study period.

4.3.3 METHODS OF DATA ANALYSES AND PRESENTATION

4.3.3.1 The FARMS model

The three major categories of data needed to run the FARMS model include i) general information such as input prices, product prices and machinery database; ii) economic variables like interest and inflation rates, loans, assets, living expenses, land use, irrigation system data, labour and other machinery data; iii) crop enterprise data: enterprise information, products irrigation, the operations done, yield independent inputs and yield variable inputs, labour information and cost categories. The outputs that could be expected from the FARMS model include the asset and resource management items such as annual fixed and variable machinery cost, annual machinery cost summary such as hours used and variable cost per hour as well as labour. The irrigation cost summary includes water used, and hours pumped. Labour includes number of man hours needed and available. The enterprise analyses reports include the flow of funds and enterprise budgets. Financial reports include the credit flow, cash flow statement, income statement and the balance sheet.

Data obtained from the survey and different other sources were inputted/fed into the FARMS model. The model was run to get the FARMS output for each participating farmer. The model outputs included the enterprise budgets, cash-flow statements, income statements and the balance sheets. These financial statements were used to analyse the financial position of each farmer. From the financial statements, the solvency, profitability and liquidity of the individual farmer's business were determined and the financial position of the farmers and their ability to take financial risk were assessed.

4.3.3.2 RISKMAN

The enterprise names and main products of each enterprise together with the cost and constant values can be imported from FARMS into RISKMAN. However, extra data such as changes in interest rates, product price and yield levels are needed. There are five program options that can be linked to RISKMAN. These include FARMS, IRRICOST, WAS, SWB and SWB addresses. RISKMAN can allow up to 3 000 iterations. The run results include a yield correlation matrix, and cumulative distribution functions. Risk preferences such as risk averse, risk neutral and risk seeker are available options. The output comprises graphs, statistics of the three production strategies and the strategy evaluation, which can be used as evaluation criteria.

Data obtained from the interviews of the farmers on yield/production and prices were imported from FARMS into RISKMAN in order to quantify risk. The risk quantifying method used was the triangulation method. This method of risk measurement defines yield/production and prices by providing the input for these variables as a triangular distribution or a three-point estimation. The decision-maker (farmer) was asked to provide the lowest, most likely and highest likely value that he expects for his crop for the two variables (yield and price).

This method of risk quantification was chosen because of lack of information from the case farmers, and because in instances where only little information is available (as is the case here) the triangulation distribution is considered the ideal method to utilise as a method to include risk in economic analyses. Risk measurement using the triangulation method was done for vegetable farmers since they can exercise their beliefs or express their expectations on yield and prices of their crops. Production risk was determined for sugarcane farmers 1, 2 and 3. In the case of the sugarcane farmers, prices are determined by the Sugar Board each growing season and it was not easy for an individual farmer to say what his or her three-point belief or expectation on price would be each season. Also, since the unit price is determined on the basis of the sucrose content of the cane and not necessarily the sugarcane tonnage, it was difficult for the farmers to express their expectation of the percentage sugar content of their cane. For sugarcane farmers, historical distributions or empirical probabilities could be used to determine price risk and not the subjective probabilities.

Nelson *et al.* (1978), however, are of the view that empirical probabilities based on past data may be quite useful for some management phenomena, but less useful for others. They contend that past rainfall data may be a good guide to future rainfall, while price probabilities based on historical data may be a poor guide for the future. Also, given that to use empirical probabilities one needs quite a number of empirical observations collected over years, and that the participating farmers are relatively new in the sugar industry, it would take a long time to collect their historical production and price data.

4.3.3.3 *Descriptive Method*

This method of data analysis involves a reflective or a rich portrayal of the participants' views. This was applied mainly to marketing strategies and some strategic risks that the farmers encountered in their farming businesses and could not be handled adequately in the models because of their nature and the difficulty to quantify and/or measure them. It involves a description of views of the participants and experiences as expressed by the farmers.

4.3.3.4 *Comparative Analysis*

A comparative analysis was carried out on sugarcane farmers to evaluate their production efficiency. Production levels of individual case farmers were compared with the industry averages to find out how they fared.

4.4 *DESCRIPTION OF THE CASE STUDY FARM BUSINESS*

4.4.1 *INTRODUCTION*

The case study method was used to collect both soft and hard information needed for use in the FARMS model. The inter farm comparative technique was also used to collect the needed data. A SAPFACT framework is used to describe the case study farm businesses and the individual farmer's crop budgets are presented.

4.4.2 *GENERAL MANAGEMENT*

The farmer is about 56 years of age and has not completed primary education. He has a wife, six children and four grandchildren. The wife supervises at their shop/bottlestore. The farmer started farming in 1982, and from that year to 1989 he farmed cotton. From 1990 to 1997 he farmed maize. In 1998 the farmer started growing sugarcane which occupies 29.9 ha, and the other 8 ha is planted maize. The farmer used to work for CARGO, a transport company from which he got the initial finance to start his farming business. Currently the farmer owns a bottlestore and a shop, which provide another source of income. He also received financial assistance from FAF.

The farmer's objectives included a better living standard for his family and to run a profitable farming business. The farmer is experienced in maize production and is still on a learning curve regarding sugarcane production. He keeps superficial records that are less helpful in planning, decision-making and as a basis for control. However, the farmer has long-term plans of changing from using a diesel engine to using electricity, and switching from furrow irrigation to a sprinkler system. He is a part-time farmer.

4.4.3 LAND TENURE

When asked about the land that he is farming on, the farmer explained that he got permission to farm the land from the chief in 1982 and there was no such thing as an RTO. He then hand-cleared the land; it was the ability to clear the land manually that afforded him the 38 ha he is now farming on. The 38 ha was not cleared at once, but piece by piece over the years, each time increasing the cultivated area.

The farmer has acquired the RTO from the chief and though he has the desire to expand, he is not sure whether the chief will allow him to expand his enterprise. He also fears the chief might take back the land he has so much struggled to clear and get to a cultivable status. This is because under communal/tribal law no one is allowed to own land; one can only occupy and/or use land but not own it. The farmer does not pay any royalties to the chief.

4.4.4 IRRIGATION MANAGEMENT

The farmer uses furrow irrigation to water his crops (sugar and maize), that is, the whole 38 ha is under furrow irrigation. The farmer uses a diesel engine to pump water from the Nkomazi River. The farmer does not pay for irrigation water, but he is given forms to fill in his land area (ha) so that in the future he will have to pay for water. Irrigation water is not rationed and the farmer could not tell how much water is available per hectare for irrigation in a production year. The farmer indicated that he gets funds to finance his irrigation farming from the Financial Aid Fund (FAF). The farmer also indicated that he does not schedule his irrigation; he just uses subjective judgement and gut feel in irrigating his crops.

The farmer does not find the furrow irrigation suitable for his crops, since it is inefficient. He prefers sprinkler irrigation and has made plans to change to it. He has paid a down payment of R20 000 for the installation of electricity, which will cost R90 000. The farmer is alone in the area and unfortunately he has to pay the initial installation costs alone. (It should be advisable that every farmer who has electricity installed in that area should pay a portion to this farmer.) The farmer does not experience water shortages during drought periods.

When asked about the problems he experiences in irrigation farming, the farmer outlined the following:

- It is very expensive to run a diesel pump, e.g. the farmer indicated that he spends about R7 000 to R8 000 per month on diesel under normal circumstances, and it can be as high as R12 000 to R13 000 per month in other instances.
- The irrigation system design itself. The farmer finds the furrow system much of a problem, because with the furrow system there is no even distribution of water, more especially, the end of the field does not get much irrigation water.

- The farmer also indicated that transport of sugarcane to the mill is sometimes a problem. When many people are harvesting one does not get transport on time. Also when weather is not favourable, e.g. when it rains, trucks do not transport cane to the mill because it is feared they will get stuck in the mud in the fields.

The farmer owns the following machinery and implements: one 188 Massey Ferguson bought secondhand in 1989 for R18 000, as the one he had before was sold out; disc plough bought in 1986 for R3 000; ridger bought in 1999 for R3 500; trailer for the tractor also bought secondhand and estimated at R1 000. The farmer has not insured his mechanization, hence does not pay any insurance premium. The farmer also indicated that he does not pay any license fees. The farmer reported no machinery problems, and machinery parts are available from Malelane. The farmer services his own tractor. When asked how much he would charge for labour if he were to service somebody's tractor, the farmer quoted R40.00. The farmer was not able to say how much he spends per year on machinery repairs. He indicated that he spends much money if he has to replace some parts of the tractor, e.g. he indicated that he spent R6 000 on gearbox replacement that year.

4.4.5 LABOUR MANAGEMENT

The farmer employs permanent as well as temporary labourers. Family members, however, do not work on the farm. There are 12 family members, that is, parents, 6 children and 4 grandchildren. The wife works as a supervisor at their shop and bottlestore. The farmer experiences peak labour demand around May-June for maize and around November for sugarcane. Activities involved are planting, weeding, harvesting, fertilization, opening up of furrows (immediately after harvesting sugarcane).

The farmer has six permanent workers. Four of them (male) are paid R12.00 per day, one woman is paid R13.00 per day and she has served for a long time. The other male is paid R16.00 per day, because he is also a driver.

Most temporary work is done by scholars, who are paid R8.00 per day. When asked why he employed school children, the farmer responded by saying that he is certain that scholars will go back to school after the weekend. And if it is during school holidays, he is also certain that when school reopens, scholars will go back to school. He finds it a problem to hire elderly local people, because when the temporary work is over, they do not want to leave and he ends up employing full-time labourers that he does not need. The farmer said that it is so painful to send away workers, more especially women, who would often plead with him for a job, saying that they have children and have nothing to provide.

4.4.6 CROP ENTERPRISE ANALYSES

(a) Crop management practices

The farmer grows maize and sugar on 8 ha and 29.9 ha respectively, and all the area is under furrow irrigation. There is a reliable supply of maize seed from Swaziland cooperative, since the farmer is close to the border with Swaziland. A 12.5 kg seed bag is sold for R89.00. There are also nurseries for sugarcane seedlings. The farmer has access to fertilizers, pesticides, equipment parts and maintenance. Both government and private (TSB) extension advice is available to the farmer, and is completely free according to the farmer. He finds the advice very useful and very much needed. The farmer was not able to give his average production in tons, but could tell the researcher that maize gave him cash to run the farming business and that he has not found any profit in sugar as yet. The farmer confessed that he is growing sugar because the extension officers have told him that there is money in sugarcane production and that sugarcane has a sure market. He said he is yet to see the profits alleged by the extension officers.

The farmer also indicated that he grows his maize later than other farmers so that he is able to sell his maize when there is not much on the market and he can reap high profits. For example, the farmer finds it profitable to do so in that, when farmers have maize on their farm, a cob of maize (green maize) is sold for 50c-70c, but when there is a smaller supply of green maize a cob of maize sells for R1.00. The farmer says in a row of about 200 maize stalks, estimating about 2 cobs per plant, he is sure of about R400, and this he finds satisfying and affording him much profit. Only on the side of maize is the farmer satisfied with how he is doing, but with sugarcane, the farmer thinks that he compares badly with other farmers.

The farmer noted that he receives financial assistance from the Financial Aid Fund (FAF) and that he has a loan with Stannic Bank of about R30 000 and pays R1 500 per month. The loan was used to buy a van. For other assets the farmer said he had two vans, a Toyota and a Nissan, as well as a trailer. However, the bank repossessed the Toyota van and the Nissan was written off after his nephew was involved in a road accident. For yearly family expenses the farmer quoted the following: R9 600 for food; R3 600 for pre-school fees; and R3 840 for high school fees.

The crop enterprise budgets for the farmer were developed and are presented below.

(b) Crop enterprise budgets

The maize and sugarcane enterprise budgets were developed for farmer 1 and are presented in Tables 4.1 and 4.2. The analyses of the crop enterprise budgets are also presented and their profitability determined.

Maize

The crop enterprise analysis showed that maize was very profitable, yielding a gross margin of R10 427.50 per hectare and income above specified costs of R9 993.53 per hectare as seen in Table 4.1. Maize contributed about 35% of the total farm income. The cost of production was R0.34/cob. Since this was less than the farmer's selling price of R1.00/cob, the farmer made profit. The farmer grows his maize strategically so that he supplies it when there is a shortage in the market, hence reaping better profits. The break-even yield was 5 206 cobs/ha and the break-even price R0.34 for a cob of maize. If the selling price is lower than the break-even price, the farmer faces the risk of making losses. When compared with other case farmers who produced maize it was found that he was doing better than they were in terms of profit-making.

Table 4.1: Crop enterprise budget for case farmer 1: maize, 8ha, flood irrigation, 2001

Gross income	Unit	R/unit	Quantity	R/ha	Total Value (R)
Maize	Cob	1.00	15 200.00	15 200.00	121 600.00
Gross Income					121 600.00
Variable costs:					
Fertilizers 2:3:2 (22)	Kg	1.94	100.00	194.00	1 532.00
Seed	Kg	7.12	10.00	71.20	570.00
Fuel	L	3.80	9.32	35.42	283.35
Lubrication	R	1.00	7.10	7.10	56.67
Repairs	R	1.00	31.71	31.71	253.67
Labour	R/h	1.39	660.00	915.83	7 326.64
Interest	R			21.53	172.26
				1270.45	10 163.59
Irrigation cost:					
Repairs	R			1 072.72	8 581.76
Diesel	R			2 032.80	16 262.40
Lubrication	R			374.35	2 994.82
Labour	R/h			22.23	177.85
					28 016.83
Total variable costs:				4 772.55	38 180.42
Gross margin				10 427.50	83 420.00
Fixed costs					
Machinery	R			295.88	2 367.00
Irrigation	R			138.04	1 104.32
Total fixed costs:				433.92	3 471.32
Total specified costs				5 206.00	41 651.74
Income above specified costs				9 993.53	79 948.26

1. Crop water requirement per season = 300 mm

Sugarcane

The analysis of the sugarcane showed that it was profitable. It yielded a gross margin of R1 104.08 per hectare and income above specified costs of R966.04. The cost of production per hectare of sugarcane was R127.13/ton. The selling price for the farmer's sugarcane was more than the production cost at R145.55/ton hence making a profit. The break-even yield was 41.21 tons/ha and the break-even price was R127.13/ton. When the farmer's production was compared with the industry average, it was found that the farmer is producing 52.43 tons/ha, which is far below the industry level of 100 tons/ha. However, there is still room for improvement since the farmer is still at a learning stage in sugarcane production. The farmer also complained about the inefficiency of flood irrigation, which might have contributed to the low yields. The sugarcane is in the 2-7 years production stage. The establishment costs for sugarcane ranged from R9 938 to R13 184/ha and the income above specified costs in the first year ranged from -R123 to R2 703 for small-scale commercial irrigation farmers who are on schemes. The income above specified costs for these farmers in the 2-7 years production stage ranged from R1 893 to R5 356/ha (Pretorius, 2000). When this farmer is compared with farmers on schemes it was realised that he received a low income of only R996.04 above specified costs. The reason for this could be that the farmer applied low levels of fertilizers, hence realising low yields, which translates into low income. The farmer can increase his income by increasing his yield levels, since he has good quality crop.

Table 4.2: Crop enterprise budget for case farmer 1: sugarcane, 30 ha, year 2-7, flood irrigation, 2001

Gross income	Unit	R/unit	Quantity	R/ha	Total Value (R)
Sugarcane	Ton	145.55	52.43	7 631.19	228 936.00
Gross income				7 631.19	228 936.00
Variable costs:					
Fertilisers:5:1:5 (46)	Kg	1.57	300.00	471.00	14 130.00
Harvesting	Ton	6.50	52.43	341.00	10 224.00
Transport	Ton	31.10	52.43	1 631.00	48 917.00
Levies and charges	Ton	4.34	52.43	238.00	7 141.00
Labour	R/h	1.45	212.00	308.00	9 240.00
Interest	R		1.00	34.95	1 048.53
Irrigation costs					
Repairs	R			1 072.72	32 181.60
Diesel	R			2 032.80	60 984.00
Lubrication	R			374.35	11 230.50
Labour	R			22.23	666.90
Total variable costs				6 527.11	195 813.53
Gross margin				1 104.08	33 122.47
Fixed costs					
Irrigation	R			138.04	4 141.18
Total specified costs				6 665.16	199 954.71
Income above specified costs				966.04	28 981.29

1. Crop water requirement per season = 1 200 mm
2. Recoverable Value (RV) = 13.51%

Generally, the maize and sugarcane enterprises are profitable. However, maize is very profitable as shown by its high income above specified costs. This could be attributed to the fact that the farmer grows it strategically so that he supplies it when there is a shortage for it in the market and this ensures him a higher price. The farmer realised low yield for his sugarcane at 52.43 tons/ha when the industry average is 100 tons/ha. The farmer applied low levels of fertilisers and the fact that he is still on a learning curve could be a contributing factor to such low yield level.

4.5 CONCLUSION

The description of the case study farmers with the help of the SAPFACT framework gave an in-depth understanding of the individual cases' situation and the practical experiences as lived and or faced in a real-life context. Direct observation of farmers in their natural settings and access to their subjective factors such as thoughts, feelings and desires have helped to understand their situations as different in their own ways, and this meant that each case study farmer's situation could be treated differently.

Farmers differed in their general management, irrigation management and labour management aspects. The crop profit potential was shown in the farmers' individual crop enterprise budgets analysis. The case study farmers differed in their financial aspects: two sugarcane farmers (farmers 1 and 2) had financial assistance from FAF; farmer 3 uses loans from banks to run his farming operations; farmers 4 and 5 use their own equity to run their farming businesses. Four of the case study farmers (farmers 1, 2, 4 and 5) do not own the land they farm on, they only utilise it on an RTO basis. This land tenure system is seen to be a hindrance to farm development. Sugarcane farmers have a sure market for their crop as it is delivered to the TSB sugar mill, and vegetable farmers sell their produce to the local market and hawkers. However, farmer 5 who managed to reach a contract selling agreement with Spar retail shop in Malelane, newly adopted the contract marketing strategy.

An evaluation of the case study farm businesses showed that farmers 1, 2, 3 and 4 operated profitable crop enterprises as revealed by the crop budgets analysis. Farmer 5 realised profit in only three of his six crop enterprises (maize, cabbage and beetroot) while peppers, sugar beans and tomato enterprises made losses. The sugarcane enterprises for farmer 1 and 3 produced below industry average while farmer 2 realised above average yields. Low yield levels could be attributed to the fact that generally farmers applied low levels of fertilisers to their crop and this could have affected crop productivity. All sugarcane farmers are, however, still new to sugarcane production and therefore still on the learning curve. It is hoped that productivity will increase as they gain experience in sugarcane production. Generally there is room for improvement for farmers with regard to crop management practices in order to reap the best out of farming. This may require appropriate advice and training of farmers in critical production aspects.

4.6 FINANCIAL AND RISK ANALYSES OF THE CASE STUDY FARM BUSINESS

4.6.1 FINANCIAL ANALYSIS

4.6.1.1 The Balance Sheet

Table 4.3 below shows the balance sheet for case farmer 1, for the year ending on 31 May 2001. The debt-to-asset ratio was determined from the balance sheet to show the farmer's solvency position.

The debt-to-asset ratio was 0.50 indicating that the farmer was solvent. It is worth noting that the farming land is tribal land used on an RTO basis and was valued at a market rate for flood irrigated land (R2 500) since it is a production asset. The farmer should be careful not to use further loans because he does not own the land he farms on.

Table 4.3: Balance sheet for case farmer 1 for the year ending on 31 May 2001

Assets	R	Liabilities	R
Current assets		**Current liabilities**	
Bank account	144 010.00	Production loan	40 248.14
Medium-term assets			
Machinery	3 892.00		
Irrigation system	8 193.00		
Subtotal	12 085.00		
Fixed assets		**Medium term liabilities**	
Land	74 750.00	Loan	75 391.86
		Total liabilities	115 640.00
		Net worth	115 205.00
Total assets	230 845.00	**Total liabilities + net worth**	230 845.00

1. Dry land at R1 000 – R1 500, irrigated land valued at R3 000 – R4 000, R2 500 for flood irrigated land. These are not open land market values, but indicate the collateral values of the land according to the farmer.
2. Medium-term assets were valued at market price.

4.6.1.2 The Income Statement

Table 4.4 below shows the farmer's income statement for the period starting from 1 June and ending on 31 May 2001. The returns to total capital and returns to own equity were determined and are presented below.

Table 4.4: Income statement for case farmer 1 for the year ending on 31 May 2001

Period Covered: 1 June 2000 to 31 May 2001				
Farm Operating Receipts	**(R)**	**Farm Operating Expenses**		**(R)**
Sugarcane sales	228 936.00	Expenses:	Sugarcane	195 813.53
Maize sales	121 600.00		Maize	38 180.42
Interest received	7 702.00		Other	6 720.00
			Interest paid	18 860.00
Total:	358 238.00	**Total:**		259 574.74
Net cash operating income				98 663.26
Non-cash adjustment:				
Depreciation				5 245.50
Farm profit				93 417.76
Less: Living expenses				17 040.00
Income tax				15 887.00
Addition to own capital				60 490.76

1. The farmer's off-farm income (bottlestore/shop) was not included in the financial statements.

The farm profitability (Net farm income/Total capital) was 42.73% indicating that the farm business was very profitable. Returns to own capital (Farm profit/Own capital) were very high at 81.08%; it indicates the rate of return the farmer earns on his farming investment.

The profitability on own capital was greater than the profitability on total capital employed (farm profitability); this indicated that the farmer employed his borrowed capital profitably, and it shows positive financial leverage. This also implied that the return to borrowed capital exceeded the cost of capital.

4.6.1.3 The Cash-Flow Statement

An examination of the cash-flow statement of the case study farmer revealed that in nine of the twelve months of the analysis period, the farmer experienced deficits. Surplus cash flow was only realised when the farmer received income from the sale of maize and sugarcane. Because sugarcane is harvested once a year the farmer explained that he grows maize to help him meet the short-term financial needs. However, the farmer's total cash inflow exceeds the total cash outflow. August and November are the months he experiences very high cash deficits.

Analysing the financial statements of the farmer in general, it was found that in the short run farmer 1's financial position was acceptable and that he may take financial risk. However, it was uncertain how risk would influence the farmer's net cash flow position.

Table 4.5 below shows a summary of the cash flow statement for farmer 1 for the year starting on 1 June 2000 and ending on 31 June 2001.

Table 4.5: A summary of cash flow statement for case farmer 1: 1 June 2000 – 31 May 2001

Rand	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
Beginning cash balance	20 000												20 000
Cash inflow	60 800	60 800		194 595	34 340								350 536
Cash outflow	61 299	14 438	59 540	3 405	3 405	17 535	3 405	3 405	3 405	8 511	7 444	7 596	193 390
Cash difference	-499	46 632	-59 540	191 190	30 935	-17 535	-3 405	-3 405	-3 405	-8 511	-744	-7 596	157 146
Loan amortisation:													
Principal				22 608									
Interest				17 640									
Ending cash balance	19 583	66 123	6 734	157 676	188 611	171 076	167 671	164 266	160 861	152 350	151 606	144 010	144 010
Loan balance end of period													
	Balance end of last year												
Intermediate loan	98 000	75 392											

4.6.1.4 Marketing

Regarding marketing of the crops, the Komati Transport Company is contracted to deliver sugarcane to the TSB mill, and green maize or maize cobs are sold to vendors around the lowveld and from Badplaas who come to buy at the farm gate.

4.6.2 RISK ANALYSIS

The study identified production and price risk to be the most common risks faced by the case study farmers. In some instances financial risk was experienced. Farmer 1 experienced production risk, price risk and financial risk. Farmer 2 experienced production risk and financial risk. Farmer 3 experienced production risk. Farmers 4 and 5 experienced production and price risk. Farmers 1, 2, 4 and 5 who did not own the farming land, but utilised it on an RTO basis experienced strategic risk, as they were uncertain of their land tenure. Financial institutions do not accept land held under such tenure as collateral since it cannot be sold. Having identified the risks faced by case study farmers, RISKMAN was used to quantify risk to find out how it influenced individual farmers' cash flow position. The risk quantifying method used was the triangulation method. This method of risk measurement defines production and price by providing the input for these variables as a three-point estimation. The farmer was asked to provide the lowest, most likely and highest value that he expected for his crop for the two risk variables.

A cautionary note to the user is appropriate here. When using the RISKMAN simulation model different results/output will be obtained from each risk simulation even with the same model inputs. This could be due to the random number generator, which generates a different set of random numbers with each simulation run.

4.6.2.1 The effect of production and price risk on net cash flow

The input specification for sugarcane production risk was 51.00 tons/ha as a pessimistic yield level, 52.43 tons/ha as most likely and 100 tons/ha as the optimistic yield level. Input specification for maize production risk was 15 000 cobs/ha pessimistic yield, 15 200 cobs/ha as the most likely yield and 15 400 cobs/ha as the optimistic yield level. Input specification for maize price risk was 50c/cob as pessimistic, 70c/cob as the most likely price and R1.00/cob as the optimistic price.

Considering both production and price risk (All risk) for sugarcane and maize, there was an approximately 95% probability that the farmer would realise a negative cash flow, and thus only 5% probability that he would realise a positive net cash flow. The net cash flow ranged from -R148 077 to R47 124 as seen in Figure 4.1 below.

When taking yield risk into consideration and holding price risk constant, the probability was approximately 85% that the farmer would realise a negative cash flow. Thus the probability was 15% that he would realise a positive cash flow. The net cash flow ranged from -R132 532 to R45 567. When considering price risk on maize and holding production risk constant, the probability was approximately 60% that the farmer would realise a negative cash flow and approximately 40% that he would realise a positive cash flow. The net cash flow ranged from – R59 332 to R49 914. This is also shown in Figure 4.1.

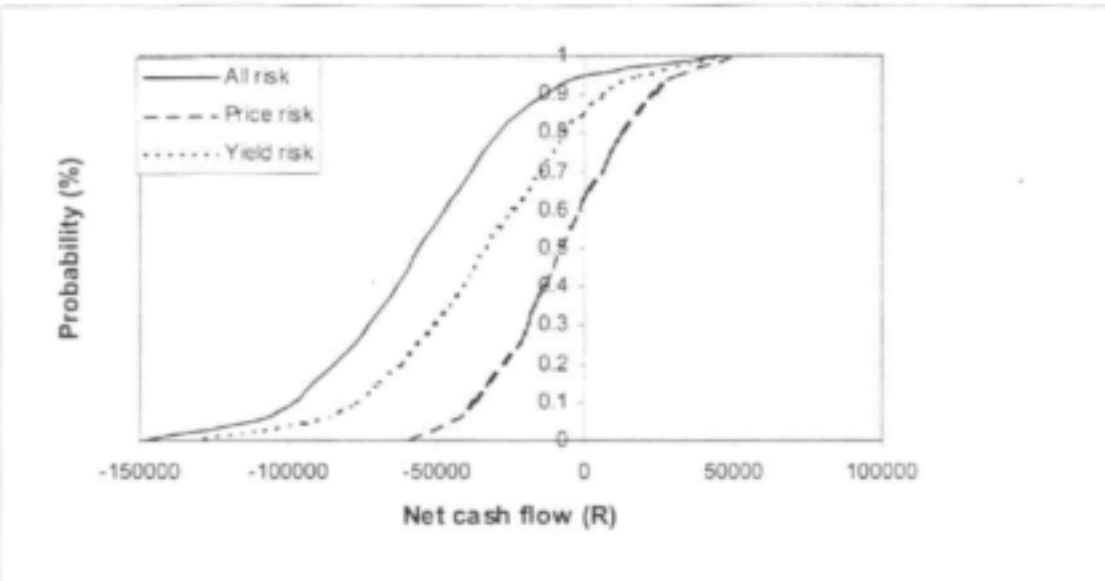

Figure 4.1: A cumulative probability distribution function of net cash flows for farmer 1 taking into account production and price risk on sugarcane and maize, 2001.

The farmer needs to support the production loan with his off-farm income to stay liquid in adverse economic times. The production risk of the two crops had a bigger effect on net cash flow than the maize price risk taken separately.

4.6.2.2 The effect of borrowed capital on net cash flow

If the farmer changes his flood irrigation system to sprinkler (29.9 ha sugarcane), he will need an extra capital investment of R171 855 (pump and motor R19 620, mainline pipes R36 035 and equipment for blocks R116 200). Assuming that he pays R60 000 as deposit (from the income statement) his new loan would be R112 000. Taking the new loan into consideration in the financial risk analysis, it was found that the farmer's financial risk increased as shown by the increase in the range of net cash flow from -R197 841 to R54 292. This is shown in Figure 4.2 below.

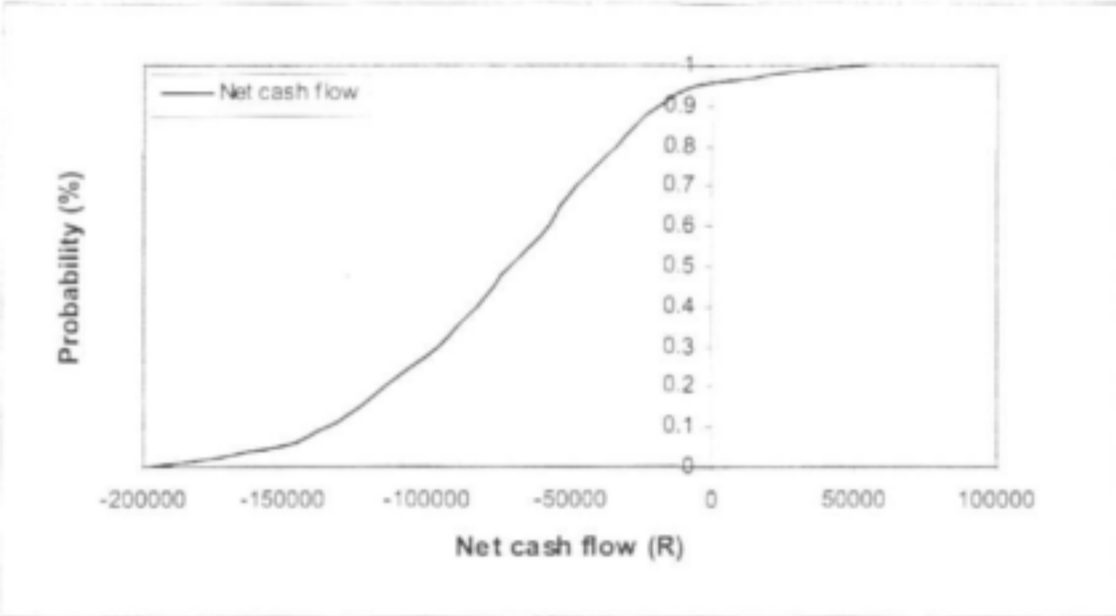

Figure 4.2: A cumulative probability distribution function of net cash flows for farmer 1 taking into consideration financial risk on the farmers' cash flow as a result of changing from flood irrigation to sprinkler irrigation system, 2001.

It is recommended that the farmer should take care not to over-commit himself in borrowing capital from financial institutions, because his debt to asset ratio is already at the margin (0.50). Taking into consideration that he does not own the land he farms on (strategic risk), it suggests that the loan he may take might not be self-liquidating. If the farmer strongly desires to change his flood irrigation he may have to use capital from his other sources of income, for example the bottlestore/shop (owner equity) or be able to negotiate a flexible loan payment schedule and an adequate loan maturity from FAF. This is because the longer the loan maturity, the lower the annual payment needed to fully amortise the loan. He also has to make sure that he will be able to pay the annual loan amortisation from his cash flow. The farmer will therefore have to follow both production and financial risk management strategies. The farmer operates a sustainable business.

4.7 *CONCLUSIONS*

4.7.1 *INTRODUCTION*

This chapter gives a summary of the research findings to show the situation of the small-scale commercial irrigation farmers, how profitable the case study farmers' businesses are and how they can improve their financial survival as well as how they are affected by risk in their farming businesses. A summary of marketing strategies used by case study vegetable farmers and marketing alternatives is also given. The other section of this chapter gives the limitations, policy implications and suggestions for further research.

4.7.2 DESCRIPTION OF CASE STUDY FARMERS AND FARM BUSINESSES

The case study methodology with the help of the SAPFACT framework gave an indepth understanding of the individual cases' situation and practical experiences as lived and/or faced in a real-life context. Direct observation of farmers in their natural settings and access to their subjective factors such as thoughts, feelings and desires has helped to understand their situations as different in their own ways. The insight is that farmers started their farming businesses with finance they got from working in different sectors or job opportunities, and through saving family income they acquired some of the production inputs. Some farmers started operations on small areas of land and expanded their operations little by little over time.

Through this progressive agricultural growth path they came to the current sizes of operation. For example, farmer 1, with his savings from working for CARGO Transport Company started farming cotton in 1982, in 1990 he changed to maize, and in 1998 he changed to sugarcane. He currently farms about 30 ha of sugarcane and 8 ha of maize. The farmer has taken steps to change from flood irrigation to a sprinkler irrigation system and to using electricity as a source of power. Because of his high business orientation the farmer also owns a bottlestore and a shop to augment his net cash flow as well as to spread business risk. His critical success factors are his entrepreneurial spirit, hard work, dedication and his ability to read economic changes, that makes him change from one crop enterprise to the other and to integrate the farming business with non-farm businesses. He looks at business as a whole and supports the growing part from other established business segments. The farmer does not own the land he farms on, but utilises it on an RTO basis.

Farmer 2 also used family savings to start his farming business. In 1962 he started farming cotton on 6 ha and maize on 4 ha, and in 1997 he changed to sugarcane. He is business-oriented and has an entrepreneurial spirit and dedication. The farmer is able to take risk putting almost all his income into business expansion, and these are his critical success factors. The farmer is full-time in farming, and he currently farms sugarcane on 10 ha flood-irrigated land and has taken steps to expand it to 20 ha with drip irrigation in the expansion area. The farmer utilises farming land on an RTO basis, which poses strategic risk.

Farmer 3 started as a secondary school teacher. He invested in a filling station in 1989, and with the savings from the filling station together with a loan from the bank he bought his 80 ha farm in 1993 and started growing sugarcane. The farmer is highly business-oriented and adopts technology well. His critical success factors are a diversified business portfolio and an entrepreneurial spirit. Education is an added advantage for him.

Farmer 4 started farming melons for sale in 1977 on half a hectare piece of land and expanded it over time. Currently the farmer farms maize, cabbage, mangoes, peppers and tomatoes on a 7 ha flood-irrigated piece of tribal land. The farmer is business-minded and his critical success factors are his ability to read and interpret the market to which he responds by changing the crops he grows as their market demand also change. The farmer is an entrepreneur and knows what he is doing.

Farmer 5 started farming in 1942 and expanded the farming area by hand-clearing it over time. The farmer currently produces maize, cabbage, sugar beans, beetroot, peppers and tomatoes on 4 ha flood-irrigated tribal land. His son has now taken over the farming business after the father went blind. The son is an entrepreneur, a hard worker and highly business-oriented. He has a contract selling agreement with Spar in Malelane to supply it with vegetables.

4.7.3 CROP ENTERPRISE ANALYSIS

The analysis of the case study farmers' crop budgets revealed that the crop enterprises contributed positively to the farmers' capital, except in case 5 where three of the six crop enterprises contributed negatively to the farmer's capital. The negative contribution was attributed to the marketing strategy used as well as human risk as shown by some dishonest traders. The analysis of the case farmers' cash flow statements showed that they experienced cash flow problems. From the analysis of the income statements it was found that one farmer (farmer 2) out of the five case study farmers realised losses, other case farmers (1, 3, 4 and 5) realised positive addition to own capital. The analysis of the farmers' balance sheet statements revealed that the debt-to-asset ratios of the farmers were 0.50 for farmer 1, 1.05 for farmer two, 0.95 for farmer 3, 0.02 for farmer 4 and 0.019 for farmer 5. In all the five cases, however, it was uncertain how risk would influence net cash flow. Generally it was revealed that sugarcane farmers were financially more indebted than vegetable farmers. The fact that vegetable farmers did not use borrowed capital in their farming operations could explain this.

4.7.4 FINANCIAL AND RISK ANALYSIS

The study identified production, and price risk as well as financial risk in other cases as the risks experienced by small-scale commercial irrigation farmers. Farmers who utilise farming land on an RTO basis faced strategic risk since land ownership is uncertain. However, the risk analysis of the case study farmers revealed that considering both production and price risk for farmer 1, there was approximately 95% probability that he would realise a negative net cash flow. His net cash flow ranged from –R148 077 to R42 124. Maize price risk had more effect on net cash flow than yield risk, and production and price risk taken together had a lesser effect. Financial risk increased the farmer's net cash flow variability from –R197 841 to R54 292. It was recommended that the farmer be careful not to over-borrow and to use his off-farm income to change from flood irrigation to sprinkler irrigation (financial risk management strategy).

The farmer should follow price risk management strategies for his maize and production risk management strategies for his sugarcane.

Considering production risk for farmer 2, there was no probability that the farmer would realise a negative net cash flow, as it ranged from R55 781 to R87 625. Taking into consideration financial risk, there was negligible effect on the farmer's net cash flow. The increase in production area from 10 ha to 20 ha showed a significant improvement on the net cash flow of the farmer, as it ranged from R111 503 to R175 232. It was recommended that the farmer continue with his decision to expand the production area, and he should follow production risk management strategies increasing his production efficiencies. It would also help the farmer if he had other businesses.

Farmer 3 was adversely affected by production risk and there was a 100% probability that he would realise a negative net cash flow. The net cash flow ranged from –R281 368 to –R133 673. It was recommended that the farmer follow production risk management strategies, increasing his production efficiencies. Also, he should follow financial risk management strategies, being cautious of over-borrowing and to use his off-farm income to support his farming operations and short-term financial obligations.

For farmer 4, considering both production and price risk, there was no probability that the farmer would realise a negative net cash flow. The net cash flow ranged from R38 911 to R80 556. Price risk had more effect on net cash flow than production risk, but combined production and price risk had a larger effect on net cash flow than when taken separately. A risk-efficient crop production strategy was identified and recommended to the farmer since it yielded better net cash flow than the existing crop production strategy. He was also advised to follow price risk management strategies.

Considering both production and price risk on the existing crop rotation for farmer 5, there was no probability that the farmer would realise a negative net cash flow with the current marketing strategy (selling to the local market and hawkers). Price risk had more effect on the farmer's net cash flow than production risk. Combined production and price risk (all risk) had less effect on net cash flow than price risk. A risk-efficient crop production strategy was identified and recommended to farmer 5, since it realised better net cash flow than the existing crop production strategy. The farmer should follow price risk management strategies, for example contract selling.

4.7.5 MARKETING STRATEGIES

The marketing strategy commonly used by vegetable case farmers was direct or spot market, whereby farmers sold to the local community and hawkers who came to buy at the farm gate. Contract selling was a recently adopted marketing strategy by farmer 5 who had a contract agreement with a retail shop (Spar-Malelane) to supply it with vegetables. Alternative marketing strategies including spreading of sales, market information, vertical integration and value adding were offered for farmers to exploit. Sugarcane farmers have a certain market for their sugarcane as they just deliver it to the sugarcane mill.

4.7.6 GENERAL CONCLUSIONS

Taking a broad view of the small-scale commercial irrigation farming it can be concluded generally that farmers need to diversify their farming businesses. They may have other businesses to augment their farm income or should grow crops that bring in cash in a short time period, especially sugarcane farmers since sugarcane is a year-round crop bringing in cash only once a year. Vegetable farmers had better cash flow compared to sugarcane farmers, because vegetables take a shorter time to produce and sell, unlike sugarcane. For small-scale commercial irrigation farmers, full-time farming has proven to be causing more financial stress than part-time farmers, especially for sugarcane farmers. This suggests that sugarcane farmers should hold other businesses or find off-farm employment that will serve as an added source of income during the year while they wait to harvest their sugarcane.

The progressive agricultural growth path as shown by farmers saving their family incomes, starting small and expanding over time shows a sense of self-reliance and dedication as well as lack of initial capital to start a sizeable farming business. This suggests that farmers need financial support to start their farming businesses. On the other hand, it also serves as a learning experience for farmers most of whom have up to primary education except in one case where tertiary education was reached. However, the disadvantage of this agricultural ladder is the years it takes for farmers to reach an established farming business stage, therefore there is a likelihood of farmers ageing, and hence retiring, in the growth path before they reach their maximum business potential.

The following can be said to be some of the small-scale commercial irrigation farmers' critical success factors: their entrepreneurial spirit, hard work, dedication, diversification, high business-orientation, ability to read and interpret economic changes and taking risk. For example, changing from one crop to the other which is believed to have a higher potential for bringing better net returns and the ability to adopt appropriate and efficient technology as shown by changing from flood irrigation on sugarcane to sprinkler- or drip-irrigation systems by some farmers. Education plays a significant role in enhancing decision-making as shown by the farmer who obtained tertiary education being the only one who owned the farm he operated on.

Only one farmer owns farming land and the other four utilise it on an RTO basis, which poses strategic risk to farmers in that ownership of land held under such tenure is uncertain. Banks do not accept land held under tribal land tenure system, as collateral and tribal law does not allow sale of tribal land. These factors have negative effects on farm development and efficient use of land resources.

4.7.7 *LIMITATIONS, POLICY IMPLICATIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH*

The economic analysis of small-scale commercial irrigation farmers was done in the short run (one year) because of unavailability of farming records for case study farmers. It is important, however, to evaluate the financial position of the small-scale commercial irrigation farmers over a number of years to establish the trend. This is because one year's assessment is not enough to tell the direction of the business in terms of whether it is growing in profitability or not. Past financial statements are essential for comparison so that corrective measures could be taken if there are deviations from what was planned or set performance criteria. This suggests that farmers should be encouraged to keep farm records and to use them in planning their farming operations. Since sugarcane is a year-round crop providing cash inflow to its producers only once a year after its harvest, it is important for farmers to hold other businesses to augment their net cash flow and as a tax management instrument. This would also help spread business risk.

Policy implications of this study are that the question of land tenure needs to be addressed by policy-makers, because the current land tenure system hinders farm development. Farmers revealed their uncertainty regarding long-term occupancy of the farmland, since the land belongs to the community under the custody of the tribal chief. They also raised concerns that they are not able to make permanent farm developments because they fear the land might be taken from them. The unsatisfactory extension service as experienced by farmers revealed institutional failure, and this calls for urgent attention of policy-makers. However, advisors should not follow a narrow agricultural approach in advising farmers, but should have a business-orientation. This is because farmers concentrate on the big business picture. Despite the fact that efficiencies could be increased in crop production, it would therefore be misleading to call for the attention of farmers to small technical discrepancies. Learning from the growth path followed by these case study farmers, it is evident that financial support is much needed, which suggests that policy-makers should see to it that sound financial incentives are accessibly put in place to help these farmers.

As the government of South Africa has recognised the importance of the small-scale sector, there is need for a countrywide economic evaluation of the small-scale commercial irrigation sub-sector, especially independent farmers. This would help in the development of policies that are specific to the sub-sector in the attempt to address the national agricultural economic problem. This could be extended to other countries in the SADC region so that effective policies could be jointly tailored to address the agricultural economic problem as a regional challenge.

CHAPTER 5

ECONOMIC AND FINANCIAL EVALUATION OF SMALL-SCALE FARMER IRRIGATION PROJECTS IN THE NKOMAZI AREA

5.1 INTRODUCTION

The purpose of this chapter is to determine the economic profitability and financial feasibility of three irrigation projects in the Nkomazi area.

5.2 METHODOLOGY

In this section the components of the deterministic and stochastic model is described to determine the economic profitability and financial feasibility of small-scale irrigation farming. The analyses are done on a plot basis, and not per hectare. The period of analysis is 30 years.

5.2.1 DETERMINISTIC MODEL

The model consists of four parts, namely the inputs, the economic profitability module, the financial feasibility module, and the cost of living section.

5.2.1.1 Inputs

The inputs of the Excel model consist of the sugarcane crop enterprise budgets, capital budgets of the various irrigation systems, and information about the financing methods. The inputs of the model is based on the Madadeni (405 ha dragline system), Mbongozi (200 ha centre pivot system) and Walda (843 ha floppy system) projects.

The irrigation management systems are described in Capter 2. Each scheme has a centrally administered record system, with details of each farmer. In co-operation with TSB, it was decided to take a random sample of eight farmers per scheme. The financial and farming information of each of the 24 farmers for 2 calender years were then compiled. The condition was that the farmers should remain anonymous.

The information was used to construct the crop enterprise budgets for the different irrigation systems.

(a) Crop enterprise budget for sugarcane

The majority of the farming costs are the same for farmers on the same project. The only exception was fertilizer, as the soils could differ among plots. For study purposes it was decided to work with an "average" farm situation. It is further assumed that the sample is representative of all the farmers on the same project. Average costs for the items in the crop enterprise budget were estimated. Two crop enterprise budgets for sugarcane were constructed: one budget for the establishment year, and the other one for sugarcane from year 2 to year 7 (end of useful life). The crop enterprise budgets are in Appendix 5.A (Tables A1-A6).

The variable cost category in the crop enterprise budget has items of which the costs vary according to yield levels, and on the other hand vary according to area planted. Yield-dependent costs include levies, transport and harvesting cost. Area-dependent costs include soil preparation, seed, fertilizer, administration, salary of pump manager, water levies and variable electricity costs. The fixed cost items are fixed monthly electricity rent, fixed maintenance charge, soil tests and permanent labour.

<u>Area-dependent cost</u>

Right seedbed preparation is necessary before sugarcane can be planted. A fixed amount of R550/ha for all the schemes are charged for seedbed preparation. Cane seed of 10 tonne/ha at R180/tonne amounts to R1 800/ha. The farmers apply different amounts of fertilizer according to the soil tests. For study purposes the average fertilizer cost for the eight farmers was estimated as R1 446, R1 099 and R2 180 for draglines, centre pivots and floppies. All the farmers are under obligation to use a prescribed pesticide. The pesticide costs are estimated at R338/ha.

Each scheme has to pay its own pump manager and administrative clerk. The number of pump managers is determined by the number of pumps per project, which varies from one to six. The salaries vary between R500 and R600 per month. These costs are allocated per hectare basis to each farmer.

The water levies charged by the two irrigation boards differ, and amounts to R33/ha from the Lomati River and R65/ha from the Komati River. It was not possible to determine how much water was applied by each farmer. The assumption was made that each farmer utilizes his/her full quota of 10 000m^3/ha per year.

Yield-dependent cost

All the scheme farmers make financial contributions towards their communities via levies which are calculated on a per tonne basis. The various levies are the following: the Mill Group Board, Cane Growers' Association, Mill Cane Committee, Small Growers' Development Fund, Lowveld Pest and Disease, Cane Testing Service and Fire Insurance.

The other yield-dependent costs are associated with harvesting such as cane-cutting and transport to the nearest mill. The farmers contract a designated team to cut the cane at R6.50/tonne. Two local transport contractors do the transportation. The transport costs vary according to the distances. Transport services are contracted at the beginning of the season and run at R32.00, R33.74 and R23.86 per tonne for draglines, centre pivots and floppies.

Fixed costs

The fixed cost component of the irrigation system consists of the fixed electricity levy as well as the costs associated with soil testing, the fixed maintenance charge of R3 000/farmer at all the schemes, and the permanent labour.

It was originally assumed that family labour would be used, but the reality is that labourers are hired. It is assumed that the farmers with 5 ha and 7 ha plots have two permanent labourers and hire three additional seasonal workers during the first three months of the production season when more labour is needed to control weeds. The farmers with 10 ha plots employ three permanent labourers and need two extra seasonal workers during the first three months of production. The seasonal workers were paid R10/day in 2000.

(b) Capital budgets

Capital budgets are constructed for the dragline-, centre pivot- and floppy-irrigation systems based on the cost estimating procedures of Chapter 3. The respective systems were subsidized by R49 052 (centre pivot), R93 150 (floppy) and R40 488 (floppy). A medium-term loan for eight years was granted that amounts to R28 637, R114 020 and R25 659 for centre pivots, floppies and draglines respectively. The amount of the loan is based on plot size which was 5 ha, 7 ha and 10 ha for pivots, floppies and draglines respectively.

(c) Financing

In this section of the model provision is made for the payback period of the loan which is based on the purpose of the loan. Consequently the loans consist of three parts. The main infrastructure serves as a bridging facility which the farmers need not pay back. This portion is financed by the Development Bank of South Africa. The infrastructure consists of the pumping station, pumps, mainline and sub-mainline pipes. Secondly, the irrigation system was financed by Mpumalanga Development Corporation. The farmers have a medium-term loan, with a payback period of eight years and a market-related interest rate which was 16,5% in 2000. Thirdly, the establishment cost of sugarcane was financed by FAF (TSB), with a payback period of three years and 19,5% interest rate in 2000. Production loans are also provided and are based on plot size with a maximum credit limit to each farmer.

5.2.1.2 Profitability module

The components of the profitability model are the capital investments, cash income, cash expenses, subsidy, depreciation, salvage value, income tax and net after-tax cashflow. The net present value of an investment is the maximum amount which can be paid without being financially worse off. The net present value of an investment is calculated by subtracting the net present value of the after-tax net cashflow from the net present value of the capital investment. The following equation was used:

$$\sum_{t=1}^{30}(RATNI_t - I_t)/(1+v)^{t-1} > 0 \qquad 5.1$$

Where RATNI = real after-tax net cashflow

I = investment

V = real discount rate

t = time

The analyses are done in real terms with a discount rate of 8% which is more than the normal 5% because of the higher expected risk and scarcity of capital. The irrigation investment components which are subsidized do not form part of the investment. The components which are replaced by the farmers are included.

The real after-tax net cashflow is estimated by the following equation:

$$\text{RATNI}_t = \text{KI} - \text{KU}_t + \text{RES}_t - \text{BLS}_t \qquad 5.2$$

Where KI = cash income

KU = cash expenses

RES = salvage value at end of useful lifespan of component

BLS = tax

t = time

KI is calculated by multiplying the sugarcane with the sucrose percentage, multiplied by the price of sucrose and the plot size. KU consists of a fixed cost component, irrigation costs and various area-dependent costs such as fertilizer as well as yield-dependent costs such as transport. BLS is calculated as cash income minus cash expenses plus salvage value minus depreciation, multiplied by the marginal tax rate. If the calculated value is less than zero, the farmer made a loss and no tax is payable. The marginal tax rate for all calculations was 20%. The capital components are depreciated over three years on the basis of 50% in year one, 30% in year two, and 20% in year three. The different projects are not compared with one another because the analyses are done on plotsize basis. The plot sizes differ among the projects.

5.2.1.3 Feasibility module

Although investment decisions may be profitable, they may not be financially feasibile. The following equation was used to determine whether the investment was financially feasibile:

$$RATNI_t - RATP_t > 0 \qquad 5.3$$

Where RATNI = real after-tax net cashflow

RATP = real after-tax instalment

RATNI was estimated in the previous module. Only the real after-tax payment has to be calculated. If a surplus is generated then the investment is financially feasible.

The real after-tax payment is estimated by the following equation:

$$RATP_t = \sum_{i=1}^{4} \left[PMT_{it} - (R_{it} x\%BLS)\right] / (1-INF)^{t-1} \qquad 5.4$$

Where PMT = instalment calculated with nominal interest rate

R = interest component of instalment

%BLS = marginal income tax

INF = inflation rate

In equation 5.4 it is clear that tax savings on interest is taken into account. The nominal after-tax instalment is converted in real terms by discounting with the inflation rate. The model makes provision for the financing of the initial investment, the components with different useful lifespans, and the production loan. Each category is divided into interest and principal. The interest parts of all the components are added to determine the total tax savings. The real after-tax instalment is estimated and then subtracted from the after-tax cashflow to determine the surplus or deficit. If there is a deficit it means the investment is not financially feasible. However, a decision rule is needed to determine whether an investment is feasible or not. If more than one hundred repetitions out of two hundred render a cashflow deficit in a specific year, that year is regarded as a deficit year. The investment is financially not feasible when at least one of the years of analysis is a deficit year according to the definition and then there is at least a 50% probability that the investment will not generate enough cash to meet the instalment obligations.

5.2.1.4 *Living expenses*

Living expenses constitute an important cost component. Consequently, in this research the financial feasibility analysis was done on the assumption that the basic living expenses of an average family were R2 000/month. The following equation was used to determine whether an investment generated enough cash to meet an average living cost of R24 000 per year.

$$\text{Living expenses} = RATNI_t - RATP_t > R24000 \qquad 5.5$$

Where RATNI = real after-tax net cash flow

RATP = real after-tax instalment

If the estimated value was less than R24 000, it implies that the investment cannot generate enough cash to meet the living expenses of an average family.

The same criteria for financial feasibility applied when taking living expenses into consideration. If, in a specific year, more than hundred out of two hundred repetitions cannot generate more than R24 000 to meet the instalment obligations, that year is a deficit year. The probability is at least 50% that the cashflow generated will not be enough to cover the living expenses. If deficit years occur, it means farmers have to use off-farm income to pay for living expenses.

5.2.2 *INCORPORATING YIELD RISK*

To incorporate risk in the deterministic economic model, it is necessary to quantify the variability of sugarcane yields under dragline-, centre pivot- and floppy-irrigation.

5.2.2.1 Quantifying yield risk

In this section the procedures to estimate subjective yield distributions for sugarcane under dragline-, centre pivot- and floppy-irrigation are described. An expert was asked to characterize the variability of sugarcane yields by means of cumulative distribution functions for the different irrigation methods. Firstly, a minimum, maximum and most probable yield was estimated for each system. Secondly, three relatively low yield levels were estimated where the probability for a lower yield is 5%, 10% and 25% respectively. Next, three average yield levels were estimated where the probability to realize a lower yield is 40%, 50% and 60%. Finally, three relatively high yield levels were estimated where the probability for a lower yield is 75%, 90% and 95%.

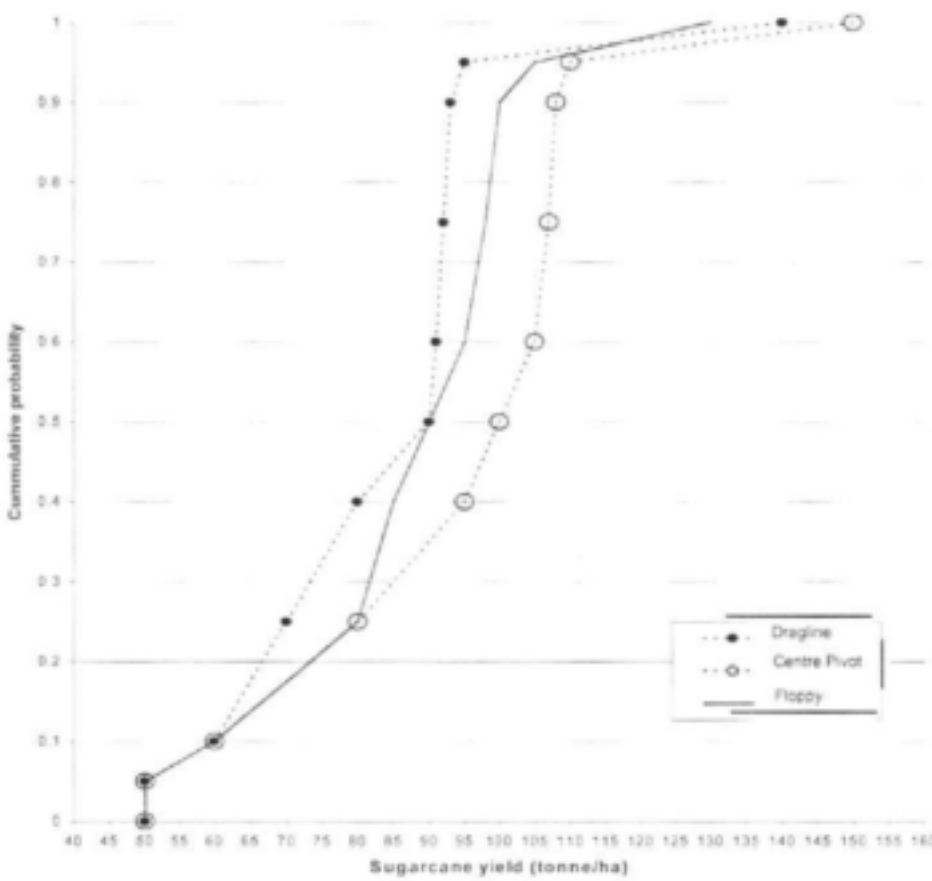

Figure 5.1: Subjective cumulative probability distributions for dragline-, centre pivot- and floppy-irrigation systems, Onderberg area, 2000.

Figure 5.1 illustrates the cumulative probability distributions of yield for three irrigation methods. It is clear that the maximum yield levels for centre pivots, floppies and draglines differ. Various factors are responsible for these differences. Firstly, the irrigation efficiencies of the systems differ. Secondly, the flexibility of the systems to adjust irrigation cycles according to changing conditions varies. The centre pivots and floppies are more flexible than the dragline system. Consequently, the dragline system is dominated by the centre pivots and floppies according to first-order stochastic dominance. The minimum yield level is 40 tonne/ha for all three systems.

but the maximum yields range from 130 tonne/ha for floppies, 140 tonne/ha for draglines and 150 tonne/ha for centre pivots.

5.2.2.2 *Monte Carlo Simulation*

In this section the method to incorporate yield risk in the model is described. Random values are drawn from the cumulative probability distribution and then plugged into the model each time. Monte Carlo simulation involves both cumulative probability distribution and random numbering. With each simulation a random probability distribution is drawn. The combination of simulations is used to determine for each year an estimated cash flow for the useful lifespan of the project. Consecutive annual cash flow is then discounted, and the discounted random observations are then used in combination to estimate the net present value (NPV) of the project. This process is repetitive, not only to create one NPV, but a NPV distribution. The form of the NPV distribution reflects the level of uncertainty related to the cash flow of the invested project.

The empirical yield distributions which were quantified in the previous section, do not have a fixed function for $F(x)$, and are characterized as discrete points on a cumulative probability function. A continuous function of $F(x)$ can be found through interpolation with the following formula:

$$F(x) = \frac{(x - x_i)}{(x_{i+1} - x_i)}(p_{i+1} - p_i) + p_i \,, \quad x_i \le x < x_{i+1} \qquad 5.6$$

The values of x and the corresponding calculated values of p should then be arranged from small to large as inputs. In equation 5.6, i and $(i + 1)$ are the lower and upper bounds for which the value of x should be interpolated. Since the minimum value has a 20% chance to realise if there are five outcomes possible for a risky variable, the pseudo-minimum is used to interpolate between the points. A cumulative probability of zero and one is assigned respectively to the pseudo-minimum and maximum, while the observed minimum in this specific case assumes a p-value of 10% (i/n – observations/2) and the maximum a value of 1-10% or 90%.

The inverse transformed continuous empirical function which was used to draw stochastic variables from an empirical function, can be written as:

$$x = \frac{(u - p_i)(x_{i+1} - x_i)}{(p_{i+1} - p_i)} + x_i \,, \quad p_i \le u < p_{i+1} \qquad 5.7$$

By applying equation 5.7, it is possible to simulate risky variables from the empirical distribution by introducing uniform generated values in the relevant equations. The risk simulation is done for two hundred iterations. This implies that two hundred sets of randomly generated yields for a period of 30 years are determined with no correlation between years. A macro was developed with which the economic model could estimate the profitability and feasibility of each of two hundred sets of yield values.

5.2.3 MODEL OUTPUT

In this section the output which is generated by the model is described, including the graphs for the net present values, as well as the tables with results.

The first output of the model is the NPV of the project for each of the two hundred repetitions. The surplus/deficit which may occur for each iteration that is given, and lastly the yields which were generated. Cumulative probability distributions for NPV, surplus/deficit and yields are then constructed. The cumulative probability distributions of yields are represented graphically to check whether the generated yields are a true representation of the cumulative probability distributions which were constructed from the given yields. The closer the repetitions are to the real yield distribution, the better are the simulations. The values for NPV and surplus/deficit are written in table format. The table is then used to arrange the values from small to large. The cumulative probability is then presented graphically. This information is used to draw up a table where the probabilities are shown together with the statistical moments.

5.3 RESULTS AND DISCUSSION OF RESULTS

In this section the profitability and financial feasibility analyses, incorporating yield risk, are reported. See also the appendices for the Madadeni draglines (5.B: Tables B1-B12), the Mbongozi centre pivots (5.C: Tables C1-C12) and the Walda floppies (5.D: Tables D1-D12).

5.3.1 PROFITABILITY

The cumulative probability distribution of NPV for dragline-, centre pivot- and floppy-irrigation systems as well as statistical moments for the baseline situation are displayed in Table 5.1. The cumulative probabilities (α) in the table indicate the probability of realizing a corresponding NPV or less. The baseline situation is the case where a farmer receives an initial subsidy, with a loan payback period of eight years for the irrigation system at an interest rate of 16.5%.

Table 5.1: The Net Present Value (NPV) for dragline-, centre pivot- and floppy-irrigation systems, with subsidy, a payback period of 8 years and an interest rate of 16,5%, 2000.

Cumulative Probability (α)	DRAGLINE Net Present Value	CENTRE PIVOT Net Present Value	FLOPPY Net Present Value
Minimum	R 204,106	R 142,387	R 217,428
0.05	R 246,865	R 185,159	R 285,522
0.1	R 260,699	R 196,634	R 306,372
0.2	R 279,217	R 212,161	R 333,642
0.3	R 287,798	R 220,344	R 343,419
0.4	R 293,865	R 227,778	R 358,147
0.5	R 301,957	R 234,604	R 368,723
0.6	R 310,397	R 240,193	R 380,692
0.7	R 319,737	R 250,486	R 393,608
0.8	R 324,752	R 256,182	R 402,454
0.9	R 338,996	R 265,301	R 414,971
0.95	R 349,378	R 274,121	R 433,204
Maximum	R 383,772	R 304,906	R 486,882
Average	R 301,329	R 233,504	R 366,452
Standard deviation	R 31,258	R 27,693	R 45,637
Variance (x 10 000)	181203	181203	181203
Skewness	-0.5020	-0.6271	-0.5821
Curtosis	0.5001	0.5041	0.4679
Coefficient of variation	0.1037	0.1186	0.1245

A project is economically profitable if the NPV is positive. The minimum NPV for dragline-, centre pivot- and floppy-irrigation systems are respectively R204 106, R142 387 and R217 428, implying that for each iteration a positive NPV was generated. Thus the baseline situation for all three irrigation systems is economically profitable. The maximum NPVs for draglines, centre pivots and floppies are respectively R383 772, R304 906 and R486 882. The average NPV for draglines is R301 329, R233 504 for centre pivots, and R366 452 for floppies. The profitability analysis was done on whole plot-size basis, and not per hectare. The plot-sizes vary from 5 ha, 7 ha and 10 ha for draglines, centre pivots and floppies respectively. Direct comparison of the systems is therefore not possible.

Although the plot sizes differ, the NPV of the floppy system is relatively large given the specific yield distribution and high capital investment. However, the amount of subsidy received for the main infrastructure is substantial. In addition to that, the farmers also receive the tax deductability of the depreciation on the main infrastructure. The larger the initial subsidy of the main infrastructure, the larger are the benefits to the farmer. For this reason the profitability of the systems may be misleading.

An indication of the riskiness of the project can be obtained from the coefficient of variation, calculated by dividing the standard deviation by the average. The coefficient of variation can assume a value between zero and one. The bigger the variation from the average, the riskier the investment. Thus the standard deviation is expressed as a percentage of the average. The coefficient of variation for the baseline expressed as a percentage is 10,37%, 11,86% and 12,45% for draglines, centre pivots and floppies respectively. Although the floppy system has greater variation in NPV than the other systems, the riskiness of all three systems is acceptable. However, to evaluate an investment only on the NPV without a financial feasibility analysis can be very misleading.

5.3.2 *FINANCIAL FEASIBILITY OF IRRIGATION SYSTEMS*

The results of the financial feasibility of the three irrigation systems are given separately. The sensitivity analysis of the effect of interest rate and payback period is also shown. Further analyses to determine whether the projects can provide for family living expenses are also given.

5.3.2.1 *Financial feasibility of dragline systems (Madadeni)*

Table 5.2 shows the years where there is a probability of a cash flow deficit, having taken into consideration the instalment payments. The corresponding minimum, maximum and average balances, after instalment payments, are also given. The breakeven yield column gives the minimum yield (tonne/ha) required to ensure no cash flow deficit, after instalment payments, implying not one iteration realized a cash flow deficit.

Table 5.2: Financial feasibility for a dragline-irrigation system, with subsidy, a payback period of 8 years at an interest rate of 16,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Breakeven Yield Tonne/ha
1	32	-21,949	46,237	5,846	74.94
2	7	-1,758	54,335	21,021	52.00
3	4	-763	57,900	21,143	50.87
8	30	-16,137	44,124	6,537	68.33
15	8	-5,104	53,814	17,220	55.80
22	18	-11,408	51,212	11,419	62.96

From the table it is clear that the probability to realize a cash flow deficit occurs only in six years of the 30-year period. These probabilities vary from 4% in year 3 to 32% in year 1. The decision rule for a cash flow deficit year was a year in which there was a 50% (100 out of 200 iterations) probability for a cash flow deficit. Therefore, if there was one year with a probability of 50% for a cash flow deficit, then the dragline system would not be financially feasible. Consequently it is concluded that the baseline for draglines was financially feasible, as the probabilities did not exceed 50%.

The cash flow deficit years are 1, 8, 15 and 22. The sugarcane is established in year 1 and re-established after 7 years which are years 8, 15 and 22. The sugarcane is not replaced in year 29, but the lifespan is extended by one year to fit into the 30-year analysis. If it is taken into consideration that the production season during establishment and re-establishment of sugarcane is 15 months, while the production period is 12 months for the rest of the period, it is clear why the probabilities for deficits in the establishment years are greater. The farmers have to bridge 3 months financially before the sugarcane is harvested.

It is clear from the table that the average cash flow balance is positive for all 30 years, with the lowest average of R5 846 in year one. The minimum balances for deficit years vary from -R763 in year 3 to -R21 949 in year one. The maximum balances in deficit years vary from R44 124 in year 8 to R57 000 in year 3. In year 2 and 3 the minimum balances are very small, which means that at the lowest outcomes the farmers cannot meet their financial obligations. The corresponding breakeven yields required for no deficits are 50 tonnes and 51 tonnes per hectare in year 2 and 3 respectively. The minimum sugarcane yield under draglines is 50 tonnes/ha.

A breakeven yield of 75 tonnes/ha in year one will ensure that not one iteration would realize a cash flow deficit. The maximum sugarcane yield under draglines is 140 tonnes/ha, with the most probable yield of 95 tonnes/ha. Reading the cumulative probability distributions of yield, it can be determined that the farmers have a 30% chance to realize 75 tonnes/ha or less. Differently worded it means 60 out of 200 iterations realized 75 tonnes/ha or less. Thus it is clear that the dragline system is financially feasible.

A sensitivity analysis was done for six alternative situations to determine the effect of interest rate, payback period and subsidy on the financial feasibility of the project. The results for the financial feasibility of each of the alternatives are supplied in the appendices. A summary of the deficit years is given in Table 5.3.

From the table it is clear that there are deficit years for all six alternatives as well as the baseline. The deficit years are 1, 2, 8, 15 and 22. The highest probabilities are in year 1 and 8 when the probabilities are higher than 20%. The establishment of sugarcane is responsible for that. The probabilities vary from 2% in year 5 of alternative 1 to 43% in year 1 for alternative 1.

Applying the decision rule for a cash flow deficit year, it is clear that all the scenarios for draglines are financially feasible. Also for the scenario with no subsidy the dragline system was financially feasible.

The variation in probabilities within the same year for the various alternatives is small when subsidy was included, but the variation is greater with subsidy excluded. The conclusion is that the effects of interest rate and payback period is not as crucial on financial feasibility of draglines as with the exclusion of subsidy.

Table 5.3: A comparison of the financial feasibility of six alternatives* of a dragline-irrigation system, 2000.

Year	Alternative 1 SS8j16,5 %	Alternative 2 MS8j13,5 %	Alternative BASE MS8j16,5 %	Alternative 3 MS8j19,5 %	Alternative 4 MS10j13,5 %	Alternative 5 MS10j16,5 %	Alternative 6 MS10j19,5 %
1	43	31	32	32	30	30	31
2	12	7	7	7	6	7	7
3	12	4	4	4	-	-	4
4	8	-	-	-	-	-	-
5	7	-	-	-	-	-	-
6	3	-	-	-	-	-	-
7	2	-	-	-	-	-	-
8	37	29	30	30	27	28	29
15	8	8	8	8	8	9	9
22	18	18	18	19	16	17	18

***SS8j16,5** Financial feasibility, without subsidy, a payback period of 8 years and an interest rate of 16,5%.
MS8j13,5 Financial feasibility, with subsidy, a payback period of 8 years and an interest rate of 13,5%.
MS8j16,5 Financial feasibility, with subsidy, a payback period of 8 years and an interest rate of 16,5%.
MS8j19,5 Financial feasibility, with subsidy, a payback period of 8 years and an interest rate of 19,5%.
MS10j13,5 Financial feasibility, with subsidy, a payback period of 10 years and an interest rate of 13,5%.
MS10j16,5 Financial feasibility, with subsidy, a payback period of 10 years and an interest rate of 16,5%.
MS10j19,5 Financial feasibility, with subsidy, a payback period of 10 years and an interest rate of 19,5%.

Table 5.4: Probability of not covering living expenses of R24 000 per year, for a dragline-irrigation system, a payback period of 8 years and an interest rate of 16,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	94	-21,949	46,237	5,846
2	48	-1,758	54,335	21,021
3	47	-763	57,900	21,143
4	43	3,809	63,465	25,816
5	43	4,112	64,230	25,090
6	35	4,384	63,837	26,843
7	33	4,627	64,671	27,741
8	98	-16,137	44,124	6,537
9	41	4,341	62,152	25,074
10	39	5,049	63,543	26,512
11	30	7,947	67,936	30,201
12	30	7,783	54,835	28,703
13	38	7,713	66,022	28,455
14	32	7,542	67,771	29,527
15	81	-5,104	53,814	17,220
16	31	6,201	66,693	28,893
17	36	6,479	61,448	27,625
18	31	7,595	61,217	28,953
19	35	6,627	58,182	27,877
20	29	7,108	67,263	29,538
21	34	7,142	63,956	28,263
22	96	-11,408	51,212	11,419
23	33	6,089	58,069	27,973
24	32	6,887	66,875	29,253
25	30	7,732	67,149	30,381
26	37	7,740	67,839	28,455
27	35	7,747	62,716	28,556
28	37	7,753	67,963	29,893
29	35	7,838	67,088	28,372
30	8	18,901	78,686	41,365

5.3.2.2 *Incorporating living expenses (Madadeni)*

Table 5.4 shows the years for the baseline when there is a probability of not covering the family living expenses of R24 000 per year. The corresponding minimum, maximum and average cash flow balances, after instalment payments, are also given.

It can be seen that for each year of the 30-year analysis period there is a probability of not covering the annual family living expenses of R24 000. Year 30 has the lowest probability of 8%, but if it is taken into consideration that all assets are sold in the last year, it is better to ignore this year in the analysis.

The probabilities of not covering the living expenses may vary from 29% in year 20 to 98% in year 8. Using the 50% decision rule, it means if a hundred or more of the 200 iterations produce a cash flow deficit then that year is a deficit year. A probability of more than 50% is realized in four years over the period, and includes year 1 (98%), year 8 (98%), year 15 (81%) and year 22 (96%). The probabilities in these years are very high, indicating that for these years the farmers have to obtain off-farm income to meet their living expenses.

The minimum cash flow balance, showing the poorest possible outcome, has a negative balance in only six of the 30 years. This means that the farmers could generate extra money under very bad conditions, but that these amounts were less than R24 000 per year. The average cash flow balances are positive, implying that under average conditions enough money is generated to cover living expenses. The average cash flow balance does not meet the required R24 000 annually in only six years over the period. It can be assumed that the farmers can generate enough cash to survive under normal conditions.

It is interesting to note that the average cash flow balance is less than R24 000 in seven years, but the probability is more than 50% for a deficit in only four of those years. There are three years when the probability for a deficit is less than 50%, while the average cash flow balance is also less than R24 000. The shape of the probability distribution can explain why this is the case. The gradient of the probability distribution is very steep around the R24 000 interval. The probabilities do not improve over the 30-year period, because high probabilities for deficits also occur in the later years. Under optimal conditions the farmers can generate enough cash to maintain a very good living standard, taking into consideration that the lowest maximum cash flow is R44 124 and the highest balance is R67 963.

It is therefore concluded that although the dragline system generates deficits in 4 years over the 30-year period, the cash flow surpluses are mostly more than R24 000. The farmers with sugarcane under dragline-irrigation can therefore generate sufficient cash to cover living expenses, but there will be years in which they will have to use off-farm income to survive. However, with savings in the better years it should be possible to bridge the poor years.

5.3.2.3 Financial feasibility of centre pivots (Mbongozi)

Table 5.5 shows for the baseline those years with a cash flow deficit. The corresponding minimum, maximum and average cash flow balances are also given. The breakeven yield column indicates the required yield level for no deficit year to occur.

From the table it is clear that there are nine years with a probability to realize a cash flow deficit over the period of 30 years. These probabilities occur in the first 8 years of the project as well as in year 22. The reason why these probabilities occur in the first 8 years is because the farmers made greater capital investments with centre pivots than with draglines, which implies higher instalment payments. The probabilities vary from 2% in year 7 to 31% in year 1. The same decision rule for financial feasibility applies for centre pivots. Therefore it means if the probability is more than 50% for a deficit, it is a deficit year. Consequently the conclusion is that the baseline for the centre pivot-irrigation systems is financially feasible.

Table 5.5: Financial feasibility for a centre pivot-irrigation system, with subsidy, a payback period of 8 years at an interest rate of 16,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Breakeven Yield Tonne/ha
1	31	-22,377	32,665	3,330	86.01
2	12	-7,258	38,461	14,858	61.68
3	12	-6,094	40,457	15,144	59.81
4	9	-2,368	43,453	17,748	53.81
5	7	-1,784	44,320	17,546	52.87
6	3	-1,260	44,437	19,352	52.03
7	2	-791	45,267	20,693	51.27
8	29	-15,604	30,866	5,119	75.11
22	19	-9,743	37,993	10,854	65.68

Table 5.6: A comparison of the financial feasibility of six alternatives* of a centre pivot-irrigation system, 2000.

Year	Alternative 1 SS8j16,5 %	Alternative 2 MS8j13,5 %	Alternative BASE MS8j16,5 %	Alternative 3 MS8j19,5 %	Alternative 4 MS15j13,5 %	Alternative 5 MS15j16,5 %	Alternative 6 MS15j19,5 %
1	44	30	31	32	27	28	30
2	21	12	12	14	9	11	12
3	20	10	12	13	8	8	9
4	13	8	9	9	-	7	8
5	13	7	7	7	-	-	6
6	9	3	3	5	-	-	-
7	6	2	2	3	-	-	-
8	33	28	29	30	25	26	27
9	-	-	-	-	8	8	9
10	-	-	-	-	-	6	8
22	19	18	19	19	16	17	18

***SS8j16,5** Financial feasibility, without subsidy, a payback period of 8 years and an interest rate of 16.5%.
MS8j13,5 Financial feasibility, with subsidy, a payback period of 8 years and an interest rate of 13.5%.
MS8j16,5 Financial feasibility, with subsidy, a payback period of 8 years and an interest rate of 16.5%.
MS15j19,5 Financial feasibility, with subsidy, a payback period of 15 years and an interest rate of 19.5%.
MS15j13,5 Financial feasibility, with subsidy, a payback period of 15 years and an interest rate of 13.5%.
MS15j16,5 Financial feasibility, with subsidy, a payback period of 15 years and an interest rate of 16.5%.
MS15j19,5 Financial feasibility, with subsidy, a payback period of 15 years and an interest rate of 19.5%.

It is also clear that the average cash flow balances are positive for all the years, which means that under normal conditions farmers will be able to cover the instalments. The same criteria apply for the minimum and maximum cash flow balances as were described for draglines in the previous section.

The breakeven yield to ensure no cash flow deficit in year one, is 86 tonnes/ha. The maximum yield for sugarcane under centre pivot-irrigation is 150 tonnes/ha, with the most probable yield of 110 tonnes/ha. From the cumulative probability distributions of sugarcane, it can be deducted that there is only a 30% chance to realise 86 tonnes or less. Consequently the centre pivot investments are financially feasible.

The financial feasibility is also determined for six alternatives to analyse the effect of interest rates, payback period, and subsidy. The results of the financial feasibility analyses for each of the alternatives are given in the appendices. A summary of the deficit years for the alternatives is shown in Table 5.6.

In Table 5.6 it can be seen that all six alternatives as well as the baseline have years in which there are cash flow deficits, namely years 1, 2, 3, 8 and 22. The highest probabilities, as was the case with draglines, occur in year 1 and 8 with probabilities of more than 20%. The main reason is the re-establishment costs of sugarcane after 7 years. The probabilities vary from 2% to 44%. Applying the decision rule, it is clear that all the alternatives are financially feasible. It is also clear that also for the case of no subsidy the centre pivots are financially feasible.

The variation of the probabilities within the same year for the different alternatives, when subsidy was included, was not great. However, without subsidy the variation was greater. Consequently it is concluded that the effects of interest rates and payback period were not as crucial as the effect of no subsidy on the financial feasibility of the centre pivots.

5.3.2.4 Incorporating living expenses (Mbongozi)

Table 5.7 contains for the baseline centre pivot-irrigation system those years when there is a probability of not covering the living expenses. The corresponding minimum, maximum and average cash flow balances are also shown.

From the table it can be seen that in every year over the period there is a probability of not meeting the living expenses of R24 000. Year 30 has the lowest probability of 10%, but it is also the year when all the assets are liquidated.

Table 5.7: Probability of not covering living expenses of R24 000 per year, for a centre pivot-irrigation system, a payback period of 8 years and an interest rate of 16,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	97	-22,377	32,665	3,330
2	95	-7,258	38,461	14,858
3	97	-6,094	40,457	15,144
4	75	-2,368	43,453	17,748
5	69	-1,784	44,320	17,546
6	55	-1,260	44,437	19,352
7	55	-791	45,267	20,693
8	98	-15,604	30,866	5,119
9	42	2,894	47,584	22,027
10	43	3,121	48,230	23,020
11	32	5,392	51,416	25,949
12	37	5,392	43,489	24,991
13	41	5,392	50,387	24,373
14	35	5,392	51,563	25,580
15	37	4,364	49,382	24,510
16	31	2,361	53,012	26,333

17	37	2,727	48,191	24,525
18	35	4,117	47,468	25,105
19	39	2,972	43,828	22,618
20	35	3,154	49,280	23,905
21	42	3,317	47,397	22,787
22	97	-9,743	37,993	10,854
23	37	2,936	44,052	23,137
24	36	4,794	50,818	25,489
25	34	5,392	51,065	26,138
26	39	5,392	51,484	24,540
27	40	5,392	48,340	24,740
28	31	5,392	51,552	25,669
29	38	5,392	50,964	24,357
30	10	19,172	65,072	39,738

The probabilities vary from 31% in year 16 and 28 to 98% in year 8. Applying the decision rule, it implies that the first eight years as well as year 22 are deficit years. The average cash flow balances for the first eight years, except year 7, are less than R20 000. The farmers need off-farm income in those years to cover their living expenses.

Although the average cash flow balances are positive for all the years, the balance is less than R24 000 in 15 years. The plot-sizes of the centre pivots are the smallest of the three schemes, and it may be deducted that the plots are too small to survive financially.

If the maximum cash flow balances are analysed, it can be seen that the farmers can generate enough cash under optimal conditions to survive, with the lowest maximum balance of R30 866 and the highest balance R53 012.

The probability of not meeting the instalment payments occur in six years, while the probability of not covering the living costs occur in all the years. Therefore, the project is financially feasible, but the farmers need off-farm income to support their families. The conclusion is therefore that the centre pivot-irrigation project is economically profitable and financially feasible, but not enough cash is generated to make a living with only sugarcane production.

5.3.2.5 *Financial feasibility of floppies (Walda)*

Table 5.8 shows for the baseline only those years with a probability of not being able to pay the instalments. The corresponding minimum, maximum and average cash flow balances are also given. The breakeven yield column (tonnes/ha) gives the minimum yield level to prevent cash flow deficits.

From the table it is clear that there are nine years with a probability for a cash flow deficit. These deficits occur in the first eight years of the project as well as year 22. The reason for these deficits in the beginning is the high instalments the farmers have to pay based on the high capital investments on 10 ha floppies. The probabilities vary from 4% in year 7 to 46% in year one. According to the decision rule for deficit years, no probability is more than 50%, and therefore the baseline for floppies is financially feasible.

Table 5.8: Financial feasibility for a floppy-irrigation system, with subsidy, a payback period of 8 years at an interest rate of 16,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Breakeven Yield Tonne/ha
1	46	-46,616	44,071	-3,362	89.69
2	16	-18,225	59,986	21,704	65.52
3	15	-15,675	61,335	22,122	63.35
4	10	-7,842	64,666	25,912	56.68
5	8	-6,494	66,362	25,847	55.53
6	7	-5,286	67,068	29,251	54.50
7	4	-4,205	68,595	31,681	53.58
8	32	-31,791	42,367	3,237	77.07
22	18	-18,534	57,186	16,279	65.78

It can be seen from the table that the average cash flow balance is negative (-R3 362) only in the first year, while in all the other years the average is positive. The farmers may possibly not survive a bad starting year, because the loss will impact negatively on the consecutive years. If we look at the poorest possible outcomes with reference to the minimum cash flow balances, it is possible that farmers may realize great losses initially, which may affect the financial feasibility of the floppies negatively. In addition to this, a substantial part of the initial capital investment in the floppies is already subsidized. The criteria with regards to the minimum and maximum cash flow balances are similar to those described for the other irrigation systems.

The minimum yield to ensure no deficit year, is 90 tonnes/ha for year one. The maximum sugarcane yield under floppy-irrigation is 140 tonnes/ha, with a most probable yield of 105 tonnes/ha. From the cumulative probability distribution for yields, it can be determined that the farmers have a 46% chance to realize 90 tonnes/ha or less. Or put differently, 91 of the 200 iterations produced a yield of 90 tonnes/ha. Although the floppy system is riskier than the other two irrigation systems, it is still financially feasible.

Table 5.9: A comparison of the financial feasibility of six alternatives* of a floppy-irrigation system, 2000.

Year	Alternative 1 SS8j16,5 %	Alternative 2 MS8j13,5 %	Alternative BASE MS8j16,5 %	Alternative 3 MS8j19,5 %	Alternative 4 MS15j13,5 %	Alternative 5 MS15j16,5 %	Alternative 6 MS15j19,5 %
1	93	46	46	49	34	39	43
2	32	15	16	17	12	12	13
3	23	13	15	16	8	10	12
4	21	9	10	10	8	8	9
5	21	7	8	8	6	7	7
6	16	6	7	8	-	3	3
7	8	3	4	5	-	-	2
8	59	30	32	35	25	27	27
9	-	-	-	-	9	10	10
10	-	-	-	-	8	8	9
15	-	-	-	-	5	5	6
22	18	18	18	19	15	16	16

***SS8j16,5** Financial feasibility, without subsidy, a payback period of 8 years and an interest rate of 16,5%.
MS8j13,5 Financial feasibility, with subsidy, a payback period of 8 years and an interest rate of 13,5%.
MS8j16,5 Financial feasibility, with subsidy, a payback period of 8 years and an interest rate of 16,5%.
MS8j19,5 Financial feasibility, with subsidy, a payback period of 8 years and an interest rate of 19,5%.
MS15j13,5 Financial feasibility, with subsidy, a payback period of 15 years and an interest rate of 13,5%.
MS15j16,5 Financial feasibility, with subsidy, a payback period of 15 years and an interest rate of 16,5%.
MS15j19,5 Financial feasibility, with subsidy, a payback period of 15 years and an interest rate of 19,5%.

A sensitivity analysis was also done for six alternatives to determine the effect of interest rates and payback periods on the financial feasibility of the floppies. The results for each of the alternatives are given in the appendices. A summary of the deficit years for the alternatives is shown in Table 5.9.

It can be seen that there are seven years with possible deficits. These defcit years include the first five years, as well as year 8 and 22. The highest probabilities for all the alternatives occur in years 1 and 8, and are more than 25%. If the farmers did not receive subsidy such as in case one, there would be two deficit years (year 1 and 8) according to the decision rule. Consequently, without subsidy, the floppy systems would not be financially feasible. However, all the other alternatives are financially feasible. It is also clear that initial subsidy is essential to ensure the financial feasibility of the floppies.

The probabilities vary a little within the same year for the alternatives with subsidy, but the variation is greater without subsidy. The conclusion is that the inclusion of subsidy has a greater effect on the financial feasibility of the floppies than changes in interest rate and payback period. However, the effect of interest rate and payback period is greater than their effects on the previous two irrigation systems. The reason may be the greater instalments which must be paid because the floppy system is the most expensive system.

5.3.2.6 Incorporating living expenses (Walda)

Table 5.10 contains for the baseline floppy system those years when there is a probability of not covering the living expenses. The corresponding minimum, maximum and average cash flow balances are also shown.

From the table it is clear that there is a probability of not being able to cover the annual living expenses of R24 000 in each of 29 years. In year 30 all the assets are liquidated and therefore it can be ignored.

The probabilities vary from 12% in year 11 and 24 to 98% in year 8. Applying the decision rule, there is a probability of 50% of not being able to cover living expenses in 3 years, namely year 1 (94%), year 8 (98%), and year 22 (61%). Farmers will have to cover their living expenses with off-farm income in those years.

Table 5.10: Probability of not covering living expenses of R24 000 per year, for a floppy-irrigation system, a payback period of 8 years and an interest rate of 16,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	94	-46,616	44,071	-3,362
2	45	-18,225	59,986	21,704
3	44	-15,675	61,335	22,122
4	42	-7,842	64,666	25,912
5	38	-6,494	66,362	25,847
6	30	-5,286	67,068	29,251
7	18	-4,205	68,595	31,681
8	98	-31,791	42,367	3,237
9	21	5,064	76,176	37,092
10	17	5,518	77,147	38,819
11	12	10,059	82,817	44,613
12	13	10,059	73,040	43,219
13	17	10,059	81,548	42,153
14	15	10,059	82,999	43,878
15	17	4,473	75,990	38,379
16	18	3,439	86,771	44,865
17	17	4,202	78,848	42,091

18	13	7,010	77,906	43,071
19	18	4,925	71,310	37,940
20	16	5,311	78,195	40,136
21	21	5,658	76,017	38,262
22	61	-18,534	57,186	16,279
23	17	4,929	71,634	39,033
24	12	8,863	81,622	43,565
25	14	10,059	82,385	45,105
26	18	10,059	82,901	42,379
27	13	10,059	79,024	42,748
28	17	10,059	82,985	43,758
29	15	10,059	82,259	41,772

The average cash flow balance is more than R24 000 in 25 years over the period. This means farmers can survive most of the time. There are, however, years when farmers have to make use of off-farm income. Good financial planning is necessary to bridge the poor years.

If the maximum cash flow balances are analysed, it can be seen that the farmers can generate enough cash to maintain a good standard of living under optimal conditions, with the lowest maximum balance of R42 367 (year 8) and highest of R86 771 (year 16). With good financial planning the farmers can therefore survive.

Finally, it can be concluded that dragline-, centre pivot- and floppy-irrigation systems are economically profitable and financially feasible. The size of the plot, the capital investment, and subsidy will determine the quality of the farmers' living standard.

5.4 CONCLUSIONS

All three irrigation systems are economically profitable, although the degree to which the main infrastructure is subsidized varies significantly. The degree of profitability of the irrigation systems vary mainly because of the difference in plot-sizes. The floppy system displays the greatest variation in profitability.

All three irrigation systems are also financially feasible, which means they generate enough cash to meet the relevant instalments. The purpose of financial feasibility analysis is to determine whether an investment can contribute to the long-term survival of the business. In the case of the three irrigation projects (Madadeni, Mbongozi, Walda) sugarcane is the only enterprise, which implies that the owners must also derive their living expense from sugarcane.

The research found that for all the systems there are deficit years in which the farmers have to support themselves with off-farm income. The amount that was available for living expenses varied among the systems. In this study it was assumed that a family could survive with

R2 000/month. However, the amount needed for maintaining a living standard depends on family size and other personal factors. From the viewpoint of small-scale farmers it is important that these projects can supply enough cash to support their families.

The sustainability of these irrigation projects will depend on the access of finance to replace expensive components of the irrigation systems. The two important factors that determine the size of the instalment are the interest rate and payback period. The financial feasibility of these investments was not significantly affected by changes in these two factors. The crucial factor was the initial subsidy of the irrigation systems.

An important success factor was the availability of a well established marketing process for sugarcane.

CHAPTER 6

WHOLE FARM ECONOMIC AND FINANCIAL ANALYSES OF LARGE-SCALE IRRIGATION FARMING IN THE ONDERBERG REGION TAKING RISK INTO CONSIDERATION

6.1 INTRODUCTION

The purpose of this chapter is to analyse different combinations of irrigation systems on whole farming level for large-scale case study farmers in the Onderberg region, taking risk into account.

6.2 METHODOLOGY

The methodologies used to analyse the economic profitability and financial feasibility, as well as the risk analyses, of the 32 typical case study farms were basically the same as the methodologies described in Chapter 5 where the same type of analyses were done for small-scale farmers. However, the scope of the analysis in this chapter was not only wider, but also more complex. The following factors complicated the analyses.

Where the analysis in Chapter 5 included only sugarcane, the 12 typical crop combinations incuded sugarcane, mangoes, grapefruit, valencias and bananas with not only different crop water requirements over their useful lifespan, but also different cost structures over their lifespan. A further complicating factor was the different irrigation system combinations for the different crops across the different farm sizes.

6.2.1 TYPICAL CASE STUDY FARMS

A survey was conducted on irrigation farmers in the Onderberg area. A total of 74 irrigation farmers were included in the survey. Information was gathered by means of a structured questionnaire. The main purpose of the questionnaire was to gather farming and financial data to construct representative farms. However, after examining the data it was decided to rather draw up a greater number of typical case study farms with which farmers can better identify themselves.

The area of the cultivated land forms the basis for classifying the farm sizes. With the data of the 74 farmers, three typical case study farm sizes were identified, namely 50, 150 and 250 ha of cultivated land. The distribution of farm sizes is summarized in Table 6.1. The middle values are used as the typical sizes, namely 50, 150 and 250 ha. These categories represent about 75% of the sample. For each farm size different crop combinations and irrigation system combinations are compiled.

Table 6.1: Distribution of farm sizes (cultivated land) of large-scale farmers (n=74) in the Onderberg area, 2000.

Intervals (ha)	Farm size (ha)	Number	Percent (%)
0 – 100	50	25	34
101 – 200	150	17	23
201 – 300	250	11	15
301 – 400	350	5	7
401 – 500	450	3	4
501 – 600	550	4	5
601 and larger		9	12
Total		**74**	**100**

Five crops are dominant in the area, namely sugarcane, mangoes, grapefruit, oranges (valencias) and bananas. These crops are grown in different combinations. For each farm size a typical crop combination was compiled. In total 12 crop combinations were identified. The crop combinations are summarized in Table 6.2.

Table 6.2: Crop combinations on commercial farms in the Onderberg area, 2000.

Crop combinations	Sugarcane (ha)	Mango (ha)	Grapefruit (ha)	Valencias (ha)	Bananas (ha)
CC 1	50				
CC 2	40	10			
CC 3	40		10		
CC 4	30	10	10		
CC 5	150				
CC 6	100				50
CC 7	100	10	20		20
CC 8	110		40		
CC 9	100	20	30		
CC 10	250				
CC 11	170		30	50	
CC 12	150	40	40	20	

Furthermore, each farm has its own unique irrigation system combination. The differences are due to the different crop combinations and cultivated land sizes. A total of 32 irrigation system combinations were identified. Data regarding the irrigation systems were obtained from the questionnaires, follow-up telephone conversations with the farmers and experts in the area.

The selected crop and irrigation system combinations for the 32 case study farms are summarized in Table 6.3. In the 50 ha farm size category there are 10 different irrigation systems with four different crop combinations. In the 150 ha category there are 12 different irrigation system combinations with five crop combinations. Finally, there are eight irrigation system combinations with three crop combinations in the 250 ha farm size category.

Table 6.3: Summary of the 32 case study farms by size, crop combination and irrigation system, in the Onderberg area, 2000.

Case Study	Crop combination	Farm size (ha)	Sugarcane (ha)			Mangoes (ha)		Grapefruit (ha)		Valencias (ha)		Bananas (ha)	
			Dragline	Centre pivot	Drip	Drip	Micro	Drip	Micro	Drip	Micro	Drip	Sprinkler
1	CC 1	50	50										
2		50			50								
3		50		30	20								
4		50	30		20								
5	CC 2	50	20		20		10						
6		50		30	10	10							
7		50	40			10							
8	CC 3	50		30	10			10					
9		50	40						10				
10	CC 4	50			30	10		10					
11	CC 5	150	70	80									
12		150	100		50								
13	CC 6	150		100								50	
14		150	100										50
15		150			100							50	
16	CC 7	150	20	80		10		20					20
17		150	100				10	20				20	
18		150	50		50	10		20				20	
19	CC 8	150	110					40					
20		150	30	80				40					
21		150	60	50				20	20				
22	CC 9	150	60		40	20		30					
23		150		100			20		30				
24		150	50	50			20	30					
25	CC 10	250	170	80									
26		250	100	50	100								
27		250	250										
28		250	100	150									
29	CC 11	250	170						30		50		
30	CC 12	250	150				40		40		20		
31		250			150		40	20	20		20		
32		250			150	20	20		40		20		

6.2.2 DESIGN OF TYPICAL IRRIGATION SYSTEMS

Because it was impossible to get on-farm records of the existing irrigation systems, it was decided to design the different irrigation systems. Mr Chris Stimie, now a consultant engineer, and a member of the steering committee of this research project, made it possible to get the co-operation of the Institute of Agricultural Engineering who assigned Mr Renald Radley to design the mechanized irrigation systems. An additional gain was that Mr Radley grew up in the Onderberg area and was therefore very familiar with irrigation conditions in the research area. Mr Chris Stimie, who was familiar with the flood irrigation methods in the research area, designed the appropriate furrow-irrigation system.

With Radley's model it was possible to design an optimal mainline system for each of the 32 irrigation system combinations (Radley, 2000). Mr Radley was consulted on a continuous basis when the designs were used for the irrigation system cost estimation.

6.2.3 IRRIGATION SYSTEM COST ESTIMATION

The procedures developed in Chapter 3 were used to estimate the fixed and variable irrigation costs of each system in different combinations with each other. The crop water requirements for the 5 crops were estimated by means of the SAPWAT-model (Van Heerden, 2002). The crop water requirements for mangoes were estimated for years 1-2, 3, 4 and 5-20. The crop water requirements for bananas were estimated for year 1, and 2-10. For grapefruit the crop water requirements for years 1-3, 4-6, and 7-12 were estimated. The crop water requirements for valencias were estimated for years 1-3, 4-10, and 11-20. The crop water requirements for sugarcane were the same over its useful lifetime.

The location of the different irrigation systems on the farm, as well as the mainline pipe system, affected the irrigation system costs of each system. Kilowatts were estimated for each irrigation system separately. These kilowatts were used as the basis to allocate the variable irrigation costs between the systems. The fixed irrigation costs were allocated according to the size of the system in hectares.

6.2.4 CROP ENTERPRISE COSTS

The Combud crop enterprise budgets were examined by experts for appropriateness and then updated. Crop enterprise budgets for mangoes were compiled for years 1, 2, 3, 4 and 5-20. For bananas budgets were compiled for year 1, and 2-10. The grapefruit budgets were for year 1, 2-3, 4-6, and 7-12. Enterprise budgets for valencias were compiled for year 1, 2-3, 4-10, and 11-20. For sugarcane there were budgets for year 1, and 2-6.

6.2.5 FARM MECHANISATION SYSTEMS

A mechanization system for each of the 32 case study farms was compiled. Expert opinions were used in a systematic process to put together the appropriate farm machinery taking into consideration the crop combinations, cultivated area, and timeliness of operations. These mixes of farm machinery and equipment for each case study farm were then checked with farmers for appropriateness. The relative amounts of variable crop enterprise costs were used as a criterion to allocate fixed mechanization cost between the various crops. It was assumed that each farm has an adequately financed mechanization system which was left out of the further analysis so as not to obscure the effect of the irrigation systems.

6.2.6 ECONOMIC AND FINANCIAL ANALYSIS

The same deterministic model described in Chapter 5 to estimate the economic profitability and financial feasibility of irrigation farming, was used to do the analyses for the 32 case study farms. The same financing options were also used, namely an interest rate of 19,5% on intermediate loans and 16,5% on long-term loans. The risk analyses were repeated for two lower interest rate levels (3% and 6%), namely 16,5% and 13,5% for intermediate and long-term loans respectively, and also 13,5% and 10,5% respectively. These results (figures) are given in Appendix 6.A. These interest rate levels had very little effect on the probability of failing to meet the financial obligations. Only the graphs of those farms with a negative cash flow are shown.

6.2.7 YIELD AND PRICE DISTRIBUTIONS

A crop expert was asked to characterize the variability of the crop yields by means of cumulative distribution functions for the different irrigation systems. Questionnaires were used. For instance, to quantify yield variability for sugarcane, the expert was requested to estimate both the minimum and maximum expected yields. Thereafter, he had to estimate three relatively low yield levels where the probability for a lower yield is 5%, 10% and 25%. Then he had to estimate three relatively medium yield levels where the probability for a lower yield is 40%, 50% and 60%. Finally the same was done for three relatively high yield levels where the probability for a lower yield is 75%, 90% and 95%.

For mangoes one yield distribution was elecited for all the irrigation systems. Yield distributions were elicited for bananas under drip-irrigation as well as under dragline-irrigation. For grapefruit there was one yield distribution for all the irrigation systems. For sugarcane yield distributions were elicited for drip-, dragline- and centre pivot-irrigation. Finally, for valencias one yield distribution was elicited for all the irrigation systems.

For the price distributions, experts for each of the crops were asked to decide which portion (export, local markets or processing) contributes most to the gross crop income, and to characterize the price variability of that portion by means of cumulative distribution functions. The expert had to estimate a pessimistic price where the probability for a lower price is 10%. Then he had to give an estimation of the most probable price, and lastly, an optimistic price where the probability for a lower price is 90%. Except for sugarcane, where it was argued that the farmers have a good idea of the expected price, price distributions were used for the other crops.

6.2.8 RISK ANALYSIS

Paragraph 5.2.2 described the procedures to simulate risk for sugarcane where the risk was characterized by an empirical distribution.

In this chapter the procedures are expanded to simulate the correlation between crop yield and product prices for multiple crops when the risk is characterised by empirical or triangular distributions.

When risk is characterised by the triangular distribution the following equation specifies the cumulative probability distribution, $F(x)$, which is defined completely in terms of the minimum (a), maximum (b) and the most probable value (mode) (m) (Hardaker, Huirne and Anderson, 1997):

$$\begin{aligned} F(x) &= (x-a)^2 / (b-a)(m-a), \ \ x \le m \\ F(x) &= 1-(b-x)^2 / (b-a)(b-m), \ \ x > m \end{aligned} \qquad (6.1)$$

To facilitate simulation of risk through the inverse transformation, the following equations are used for the triangular distribution:

$$\begin{aligned} x &= a + (u(b-a)(m-a))^{0.5}, 0 \le u \le (m-a)/(b-a) \\ x &= a - ((1-u)(b-a)(b-m))^{0.5}, (m-a)/(b-a) < u \le 1 \end{aligned} \qquad (6.2)$$

By substituting appropriately correlated uniform random values for u, it is possible to draw correlated random entities from the cumulative probability distributions characterizing risk. To generate correlated random uniform values independent standard normal deviates and the Cholesky matrix of the correlation matrix are needed. More specifically the following procedure is used to generate appropriately correlated uniformly distributed random values.

First independent standard normal deviates (ISND) are generated with Excel for each of the risk parameters. In the next step the ISNDs are correlated through the multiplication of the deviates with the Cholesky matrix of the correlation matrix. The following procedure is used to calculate the Cholesky matrix (Dagpunar, 1988:157):

$$
\begin{aligned}
c_{ii} &= \sqrt{(V'_{ii} - \sum_{m=1}^{i-1} c_{im}^{2}} \\
c_{ij} &= (V'_{ij} - \sum_{m=1}^{i-1} c_{im} c_{jm}) \Big/ c_{ii} \quad , j > i
\end{aligned}
\tag{6.3}
$$

Through integration the correlated standard normal deviates are transformed to correlated uniformly distributed values (CUD) using the NORMDIST function in Excel. CUD is then used in the inverse transform functions of the empirical and triangular distributions to simulate risk.

Richardson, Schumann and Feldman (2004) developed an add-in for Excel called SIMETAR (**Sim**ulation for **E**xcel **T**o **A**nalyze **R**isk) to facilitate the use of the procedure explained above. SIMETAR is used in this chapter to do all the risk simulations.

6.2.9 SPREADSHEETS

The analyses were done over a period of 30 years which is the same as for small-scale farmers (Chapter 5). However, the analysis was complicated by the many different lifespans of a greater number of crops and irrigation systems in the analyses. Different spreadsheets were developed for the mainline pipe system, irrigation systems for certain crops, and different crop water requirements over the lifetime of crops for each case study farm. A normative approach was followed to account for any cash flow streams beyond the planning horizon. With the normative approach, a terminal value is calculated for each activity as the present value of future net revenue discounted from infinity for a given replacement cycle, given the planning horizon, is exceeded (Rae, 1970).

6.3 RESULTS

In this section the profitability and financial feasibility analysis, incorporating risk, is reported.

6.3.1 ECONOMIC PROFITABILITY

The cumulative distribution functions of the net present value of the after tax net cash flow for case study farms 1-10 comprising of 50 ha cultivated land are displayed in Table 6.4. The interpretation of the results is the same as that for Table 5.1 (Chapter 5). The cumulative probabilities in the table indicate the probability to realize the corresponding NPV or less. The investment in irrigation systems is economically profitable if the NPV is positive. The minimum NPV for all 10 case study farms is positive ranging from R1 483 320 to R5 384 747.

Table 6.4: Cumulative distribution functions and statistical moments of the net present value of the after tax net cash flow for Onderberg case study farms comprising 50 ha cultivated land, 2000.

Case study farm	1	2	3	4	5	6	7	8	9	10
Mangoes					M_{10}	D_{10}	D_{10}			D_{10}
Grapefruit								D_{10}	M_{10}	M_{10}
Sugarcane	DI_{50}	D_{50}	$C_{30}D_{20}$	$DI_{30}D_{20}$	$DI_{20}D_{20}$	$C_{30}D_{10}$	DI_{40}	$C_{30}D_{10}$	DI_{40}	D_{30}
	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)
Minimum	1 483 320	3 765 504	3 263 872	2 395 858	4 395 469	4 939 024	3 592 239	3 361 780	1 952 991	5 384 747
5%	1 661 879	3 883 515	3 428 677	2 557 578	4 718 414	5 192 042	3 927 567	3 606 233	2 214 017	5 867 562
10%	1 799 013	3 982 768	3 493 932	2 667 051	4 802 377	5 347 507	4 010 607	3 659 799	2 329 144	6 074 506
25%	1 896 356	4 076 689	3 600 738	2 760 590	5 022 630	5 535 188	4 250 988	3 880 039	2 502 466	6 344 879
40%	1 961 849	4 135 967	3 665 513	2 819 485	5 156 223	5 689 259	4 361 032	3 987 596	2 668 530	6 648 105
50%	2 092 641	4 229 234	3 751 907	2 937 074	5 303 968	5 824 290	4 497 337	4 076 295	2 753 456	6 804 812
60%	2 142 223	4 270 962	3 792 813	2 985 923	5 399 079	5 941 046	4 597 857	4 161 438	2 842 134	6 996 702
75%	2 241 046	4 336 206	3 853 479	3 067 010	5 620 766	6 081 947	4 788 958	4 338 518	3 016 133	7 293 281
90%	2 349 497	4 406 851	3 951 956	3 166 310	5 829 613	6 347 454	5 040 344	4 512 519	3 139 277	7 694 911
95%	2 415 301	4 491 856	4 049 651	3 234 970	5 984 195	6 487 403	5 151 406	4 649 014	3 369 694	8 050 658
Maximum	2 639 929	4 688 630	4 231 798	3 450 337	6 325 604	6 887 921	5 567 516	4 854 964	3 572 792	8 339 902
Mean	2 072 505	4 208 691	3 733 615	2 919 860	5 313 583	5 836 660	4 523 488	4 108 145	2 763 168	6 859 576
Standard deviation	232 045	182 897	185 922	210 987	396 015	395 374	396 560	321 304	339 157	642 898
Coefficient of variation	11.20	4.35	4.98	7.23	7.45	6.77	8.77	7.82	12.27	9.37

C: Centre pivot
DI: Dragline
D: Drip
M: Micro

The first four farms in the 50 ha category are planted to sugarcane only, but with different irrigation systems. The mean NPV of farm 2 (50 ha sugarcane under drip-irrigation) is R4 208 691 (the highest of the four farms) and with the lowest coefficient of variation (4,35%).

Farms 5 to 10 represent different combinations of orchards with sugarcane. Farm 10 has a mean NPV of R6 859 576 (the highest), with also the greatest minimum NPV of R5 384 747, and a coefficient of variation of 9.37%.

The cumulative distribution functions and statistical moments of the net present value of the after tax net cash flow for the 14 medium-size (150 ha) case study farms are shown in Table 6.5. The minimum NPV for all 14 case study farms is positive ranging from R6 418 000 to R23 089 000. The investment in the different combination of irrigation systems for the case study farms is therefore economically profitable.

Farms 11 and 12 are sugarcane farms with centre pivot-, dragline- and drip-irrigation. The profitability of these farms compares well with farm 19 (40 ha grapefruit under micro-irrigation and 110 ha sugarcane under draglines), but in general the orchard farms are more profitable.

The same results for the 8 large-size (250 ha) farms are given in Table 6.6. The minimum NPV for all 8 case study farms is positive ranging from R7 551 000 to R24 927 000. The investment in the various irrigation system combinations for these 8 case study farms is therefore economically profitable.

The profitability of the farms differs. In general the profitability of the sugarcane farms (25-28), as well as farm 29 (170 ha sugarcane under draglines combined with oranges and grapefruit under micro-irrigation) is lower than the orchard farms (30, 31 and 32).

Table 6.5: Cumulative distribution functions and statistical moments of the net present value of the after tax net cash flow for Onderberg case study farms comprising 150 ha cultivated land, 2000.

Case study farm	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Bananas			D_{50}	DI_{50}	D_{50}	DI_{20}	D_{20}	D_{20}						
Mangoes						D_{10}	M_{10}	D_{10}				D_{20}	M_{20}	M_{20}
Grapefruit						D_{20}	D_{20}	D_{20}	M_{40}	D_{40}	$D_{20}M_{20}$	D_{30}	M_{30}	D_{30}
Sugarcane	$C_{80}DI_{70}$	$DI_{100}D_{50}$	C_{100}	DI_{100}	D_{100}	$C_{80}DI_{20}$	DI_{100}	$DI_{50}D_{50}$	DI_{110}	$C_{80}DI_{30}$	$C_{50}DI_{60}$	$DI_{60}D_{40}$	C_{100}	$C_{50}DI_{50}$
	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)
Minimum	6 846	6 771	21 472	11 819	23 089	12 995	13 465	15 633	6 418	9 240	8 260	12 613	13 177	12 014
5%	7 432	7 277	22 526	12 896	24 214	13 704	14 405	16 561	7 624	10 373	9 433	14 116	14 563	13 510
10%	7 695	7 606	23 135	13 555	24 765	14 434	15 067	17 195	7 983	10 695	9 768	14 364	14 904	13 774
25%	7 987	7 888	24 740	14 609	26 275	14 908	15 777	17 965	8 623	11 345	10 438	15 123	15 605	14 435
40%	8 179	8 066	25 606	15 399	27 248	15 620	16 396	18 560	9 045	11 725	10 821	15 799	16 407	15 231
50%	8 487	8 426	26 094	15 830	27 708	16 072	17 094	19 241	9 400	12 184	11 245	16 137	16 697	15 534
60%	8 635	8 583	26 899	16 601	28 605	16 580	17 483	19 631	9 717	12 398	11 530	16 513	17 055	15 929
75%	8 859	8 824	27 870	17 427	29 477	17 120	18 171	20 311	10 374	13 044	12 117	17 257	17 889	16 692
90%	9 136	9 133	30 008	19 342	31 591	18 327	19 475	21 658	11 142	14 010	13 046	18 424	18 981	17 854
95%	9 458	9 334	30 850	20 068	32 497	18 936	20 025	22 207	11 602	14 314	13 417	19 127	19 723	18 503
Maximum	10 042	9 985	32 049	21 955	33 800	19 783	21 061	23 106	12 384	15 136	14 243	19 858	20 321	19 265
Mean	8 438	8 376	26 475	16 194	28 096	16 200	17 137	19 287	9 526	12 239	11 331	16 304	16 833	15 707
Standard deviation	619	643	2 477	2 177	2 462	1 549	1 684	1 674	1 246	1 220	1 239	1 546	1 557	1 552
Coefficient of variation	7.34	7.68	9.36	13.44	8.76	9.56	9.83	8.68	13.08	9.97	10.93	9.48	9.25	9.88

C: Centre pivot
DI: Dragline
D: Drip
M: Micro

Table 6.6: Cumulative distribution functions and statistical moments of the net present value of the after tax net cash flow for Onderberg case study farms comprising 250 ha cultivated land, 2000.

Case study farm	25	26	27	28	29	30	31	32
Mangoes						M_{40}	M_{40}	$D_{20}M_{20}$
Oranges					M_{50}	M_{20}	D_{20}	M_{20}
Grapefruit					M_{30}	M_{40}	$D_{20}M_{20}$	M_{40}
Sugarcane	$C_{80}DI_{170}$	$C_{50}DI_{100}D_{100}$	DI_{250}	$C_{150}DI_{100}$	DI_{170}	DI_{150}	D_{150}	D_{150}
	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)	(R 000)
Minimum	9 854	13 639	7 551	12 039	8 771	17 374	24 927	24 781
5%	10 856	14 452	8 445	13 005	10 112	19 846	26 998	26 853
10%	11 337	14 942	9 133	13 411	10 697	20 668	27 886	27 739
25%	11 821	15 417	9 618	13 911	11 449	21 697	29 163	29 022
40%	12 147	15 719	9 946	14 236	12 057	23 260	30 605	30 466
50%	12 726	16 259	10 600	14 718	12 484	23 804	31 110	30 972
60%	12 967	16 505	10 849	14 993	13 040	24 320	31 831	31 707
75%	13 381	16 855	11 342	15 334	13 680	25 554	33 118	32 977
90%	13 842	17 282	11 882	15 814	14 676	27 402	35 072	34 921
95%	14 345	17 797	12 213	16 344	15 337	29 116	36 578	36 434
Maximum	15 371	18 760	13 336	17 297	16 324	30 380	37 970	37 854
Mean	12 634	16 165	10 499	14 648	12 647	23 965	31 360	31 220
Standard deviation	1 080	1 009	1 160	1 017	1 582	2 778	2 797	2 802
Coefficient of variation	8.55	6.24	11.05	6.94	12.52	11.59	8.92	8.98

C: Centre pivot
DI: Dragline
D: Drip
M: Micro

6.3.2 *FINANCIAL FEASIBILITY*

The financial feasibility of the case study farms can be interpreted from the graphs. The graphs depict the probability of failing to realize a positive real after tax net cash flow, and secondly the probability of failing to meet the financial obligations. Depending on the cash flow situation of the case study farm one or both graphs are displayed. If a farm can meet its financial obligations, this graph is logically not shown. With this information the decision-maker can decide whether the risk is acceptable, and how to bridge the negative cash flow.

Figures 6.1-6.6 depict the situation of the 10 small-size (50 ha) case study farms.

For example, there is about a 25% probability of failing to meet instalments in the first 5 years, and then again a probability of less than 10% of not meeting the financial obligations in years 15-19 and 21-25 for case study farm 1. This is a 50 ha sugarcane farm under dragline-irrigation. The reasons for the cash flow problems are the investments in sugarcane and the draglines in the beginning, and then the replacements of a large part of the mainline pipe system (year 20) and the dragline laterals (year 15).

In the case of farm 7 there is about a 10% probability of having a negative cash flow in the first 5 years, and about 40% of not meeting the financial obligations. The same happens in years 20-26. This is a 50 ha farm with mangoes (10 ha) under drip-irrigation and 40 ha under dragline-irrigation. Mangoes are replaced in year 20, as well as a part of the mainline pipe system.

The risky prospects for farm 9 stand out amongst the small-farm category. This is a farm with 10 ha of grapefruit under micro-irrigation and 40 ha of sugarcane under dragline-irrigation. There is a 50% probability of failing to cover the instalments in the first 5 years, and more than a 30% probability for this to occur again in years 12-16, and years 24-28. The cash flow problems in the beginning are due to the establishment costs of grapefruit and sugarcane as well as the draglines. At year 12 grapefruit are replaced and it coincides with the second cycle of sugarcane. The same happens in year 24.

The following 50 ha farms have no cash flow problems: farm 2 (50 ha sugarcane under drip-irrigation), farm 3 (30 ha sugarcane under centre pivot-irrigation, and 20 ha sugarcane under drip-irrigation), farm 4 (30 ha sugarcane under draglines and 20 ha sugarcane under drip-irrigation), and farm 6 (10 ha mangoes under drip-irrigation, 30 ha sugarcane under centre pivots and 10 ha under drip-irrigation).

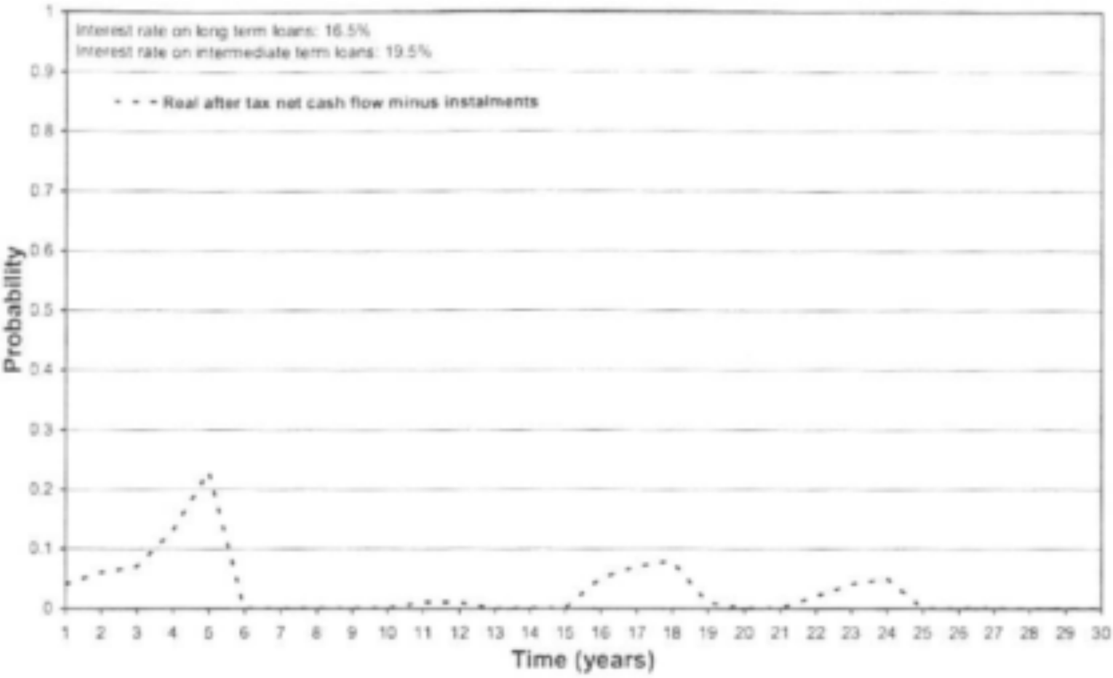

Figure 6.1: The probability of failing to meet instalments on Onderberg case study farm 1 planted to sugarcane (DI_{50}), 2000

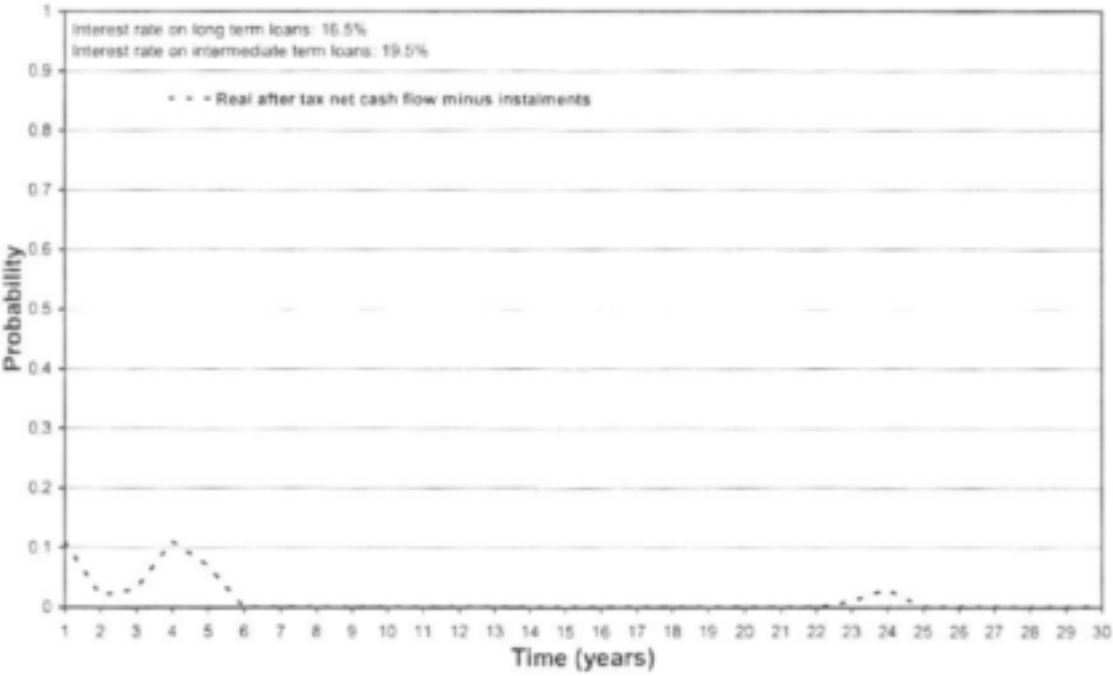

Figure 6.2: The probability of failing to meet instalments on Onderberg case study farm 5 planted to mangoes (M_{10}) and sugarcane ($DI_{20}D_{20}$), 2000

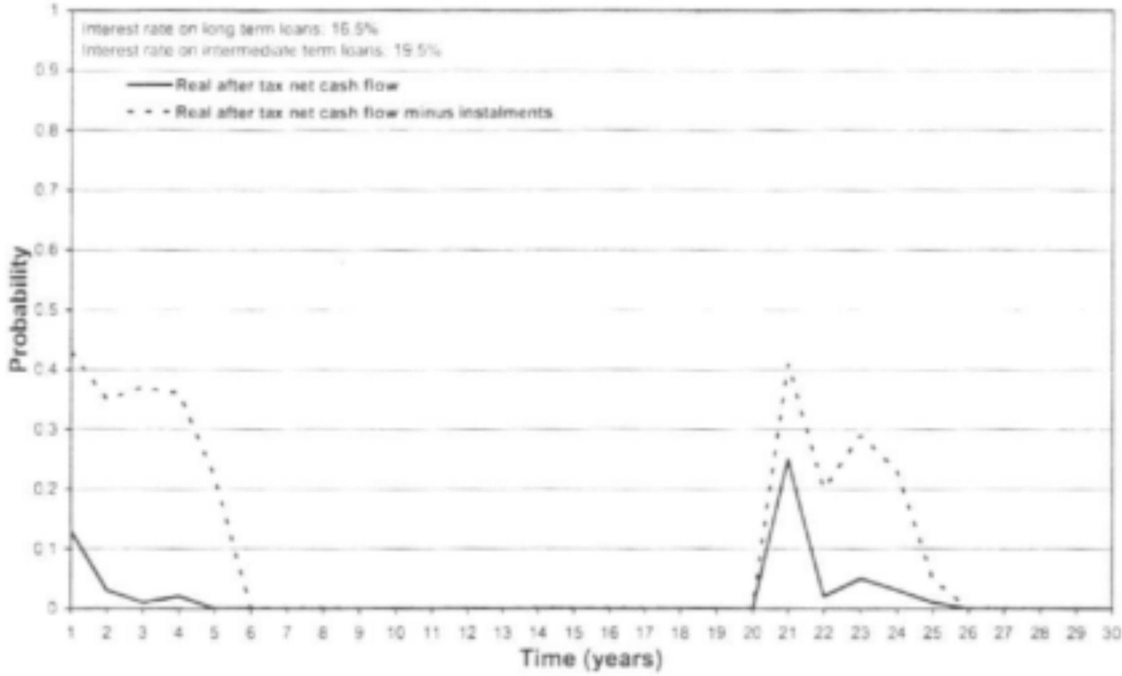

Figure 6.3: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments on Onderberg case study farm 7 planted to mangoes (D_{10}) and sugarcane (DI_{40}), 2000.

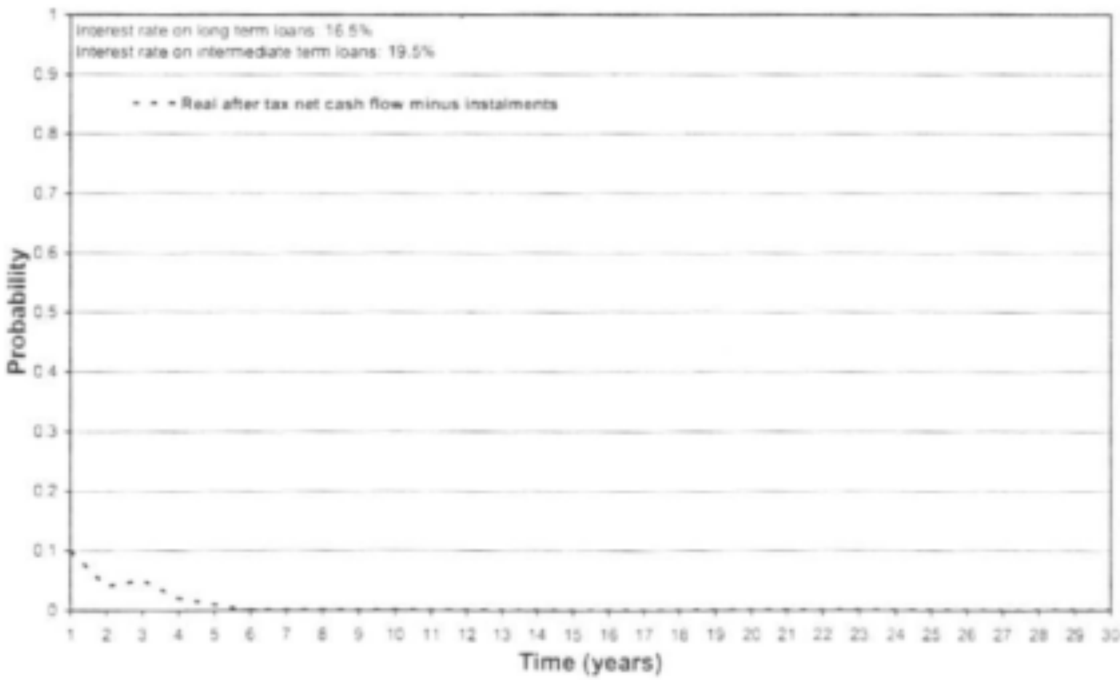

Figure 6.4: The probability of failing to meet instalments on Onderberg case study farm 8 planted to grapefruit (D_{10}) and sugarcane ($C_{30}D_{10}$), 2000

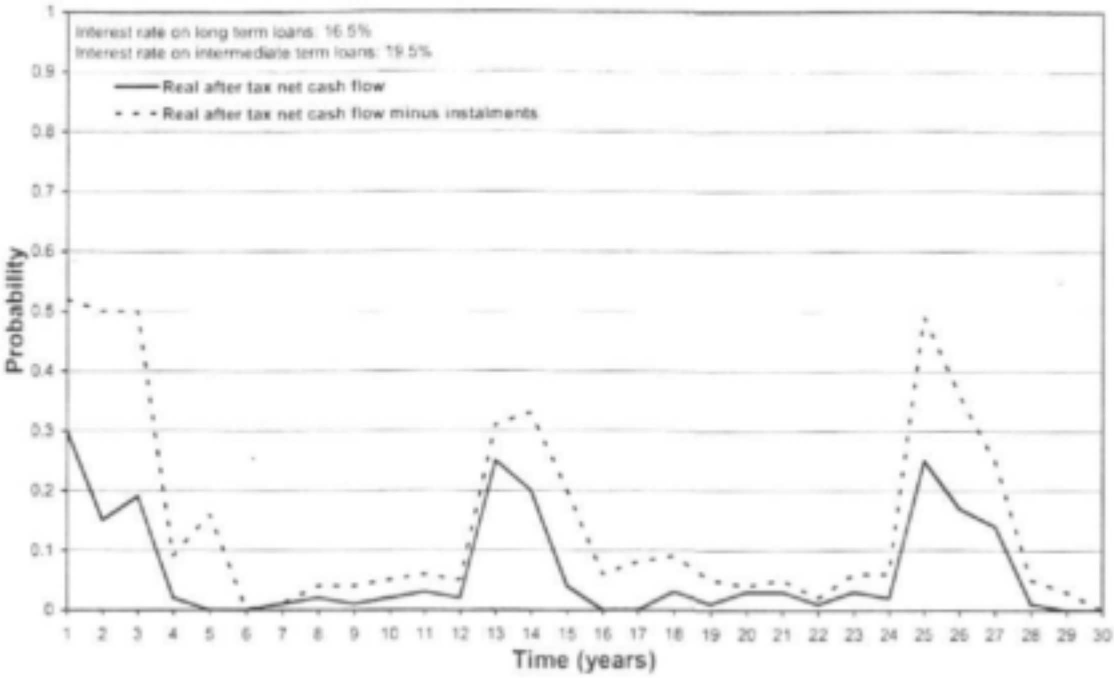

Figure 6.5: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments on Onderberg case study farm 9 planted to grapefruit (M_{10}) and sugarcane (DI_{40}), 2000.

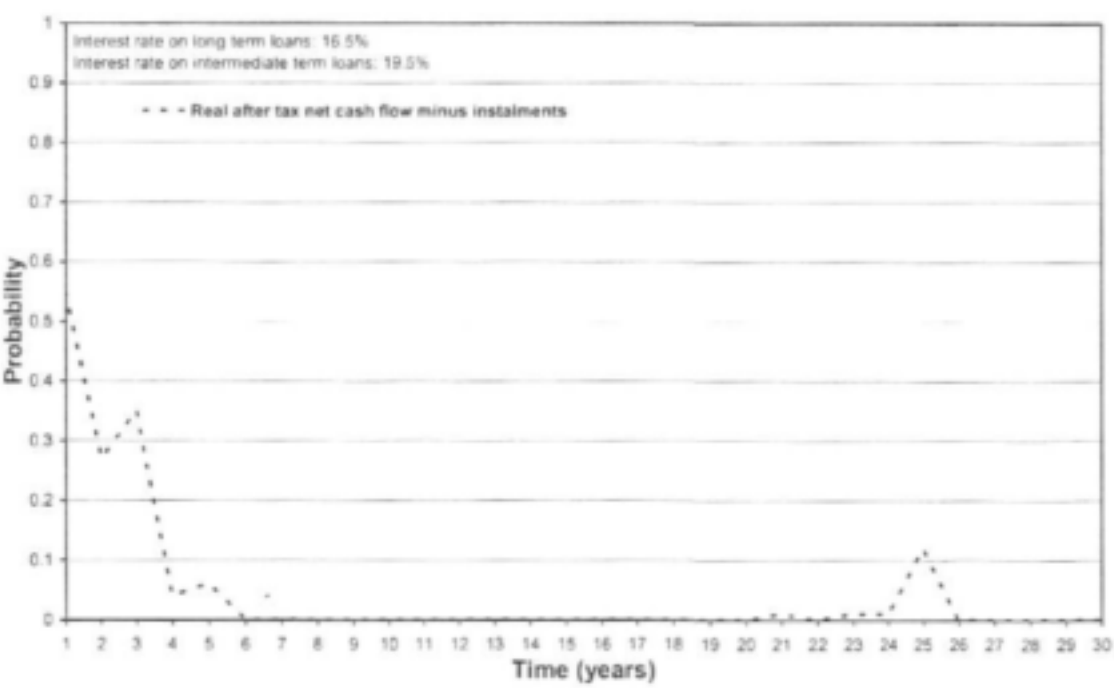

Figure 6.6: The probability of failing to meet instalments on Onderberg case study farm 10 planted to mangoes (D_{10}), grapefruit (M_{10}) and sugarcane (D_{30}), 2000

Figures 6.7-6.18 illustrate the situation of the 14 medium-size (150 ha) farms.

When examining Figures 6.7 to 6.18 (representative of the middle-size farms), one can analyse farms 14, 19 and 21 more closely (Figures 6.9, 6.13 and 6.15 respectively).

There is about a 40% probability of failing to meet financial obligations for case study farm 14 (50 ha bananas and 150 ha sugarcane under dragline-irrigation) during the first 3 years, and the situation is repeated during years 10-13, and years 20-23. In the beginning bananas and sugarcane have to be established under draglines. Then bananas are replaced in years 10 and 20. Also a large part of the mainline pipe system is replaced in year 20, as well as the laterals for bananas and sugarcane (year 20).

In the case of farm 19 (Figure 6.13) there is about a 60% probability of failing to meet financial obligations during the first 6 years, with more or less the same pattern during years 12-16, and 24-28. This is a 150 ha farm with 40 ha grapefruit under micro-irrigation and 110 ha sugarcane under draglines. In year 12 grapefruit are replaced and it concides with the second cycle of sugarcane establishment. The same happens in year 24.

For farm 21, Figure 6.15, (20 ha grapefruit under drip-irrigation, 20 ha grapefruit under micro-irrigation, 50 ha sugarcane under centre pivots and 60 ha sugarcane under draglines) there is about a 50% probability of failing to meet the financial obligations during the first 6 years, followed by a 30% probability of failure during years 12-15, and then again a 50% probability of failing to meet instalments during years 24-28. In the beginning grapefruit and sugarcane have to be established. Then in year 12 grapefruit have to be replaced, coinciding with the second cycle of sugarcane, with the same pattern repeating in year 24.

The following medium-sized farms have no cash flow problems: farm 11 (80 ha sugarcane under centre pivots and 70 ha sugarcane under draglines), farm 12 (100 ha sugarcane under draglines and 50 ha sugarcane under drip-irrigation), and farm 15 (50 ha bananas under drip-irrigation and 100 ha sugarcane under drip-irrigation).

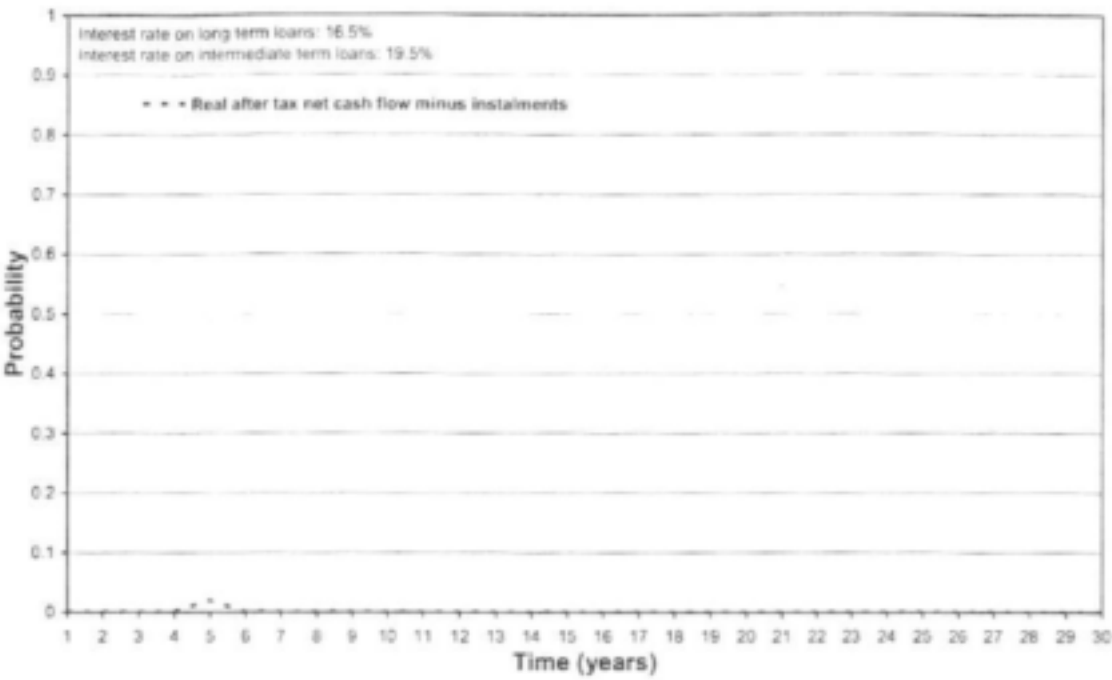

Figure 6.7: The probability of failing to meet instalments on Onderberg case study farm 11 planted to sugarcane ($C_{80}DI_{70}$), 2000

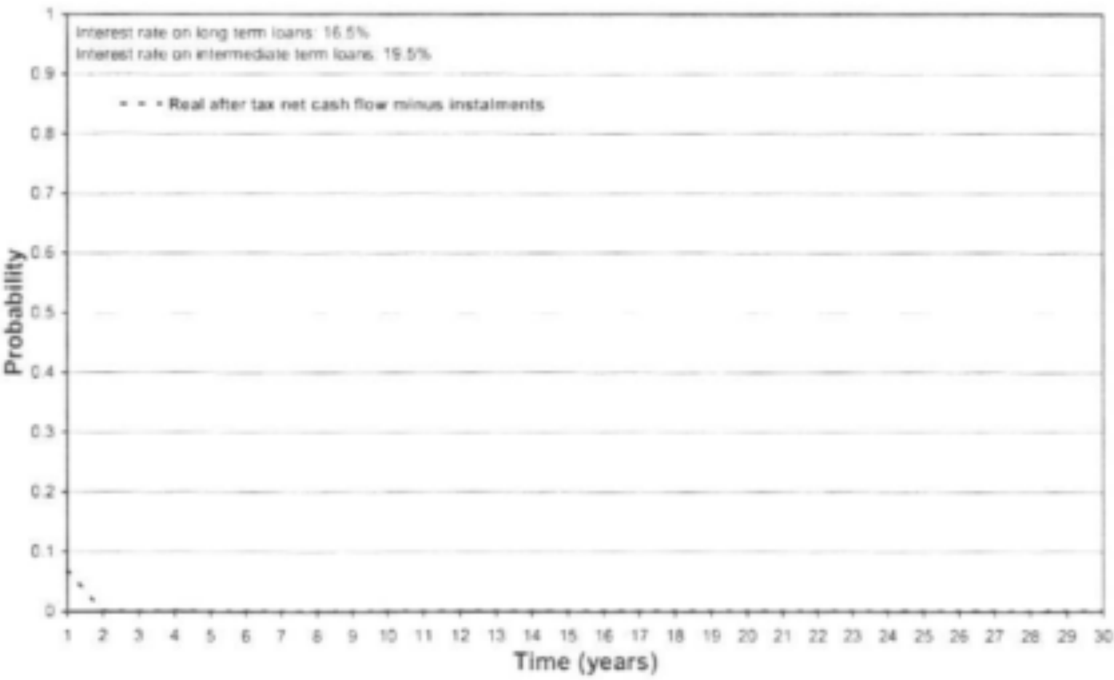

Figure 6.8: The probability of failing to meet instalments on Onderberg case study farm 13 planted to bananas (D_{50}) and sugarcane (C_{100}), 2000.

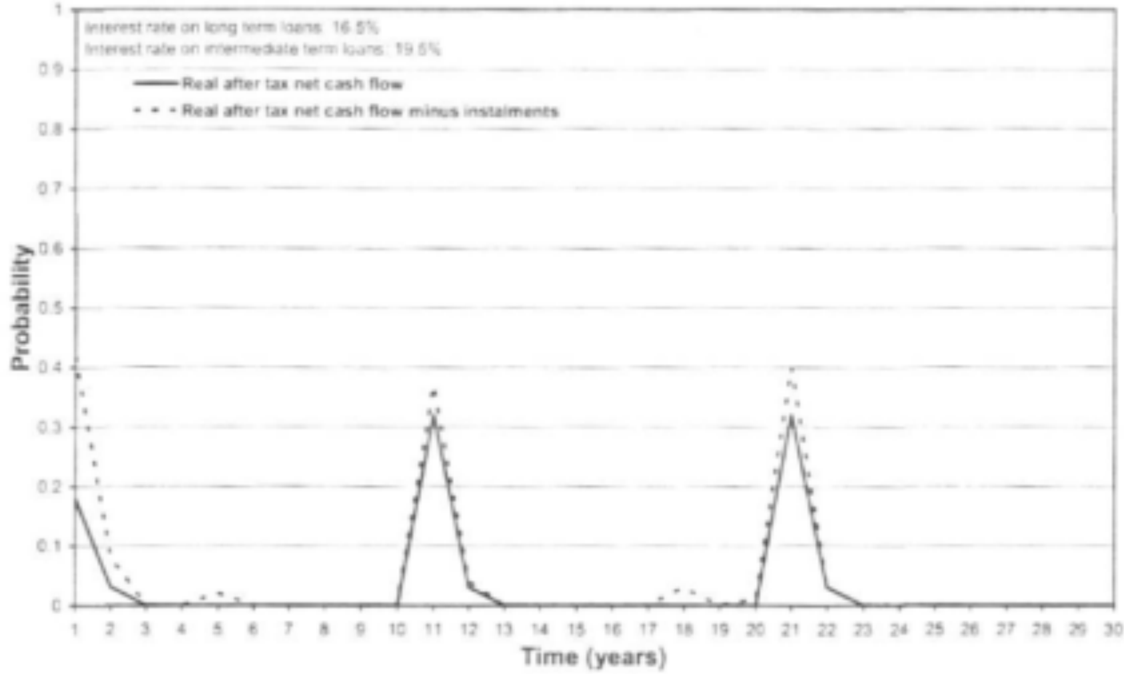

Figure 6.9: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments on Onderberg case study farm 14 planted to bananas (DI_{50}) and sugarcane (DI_{100}), 2000.

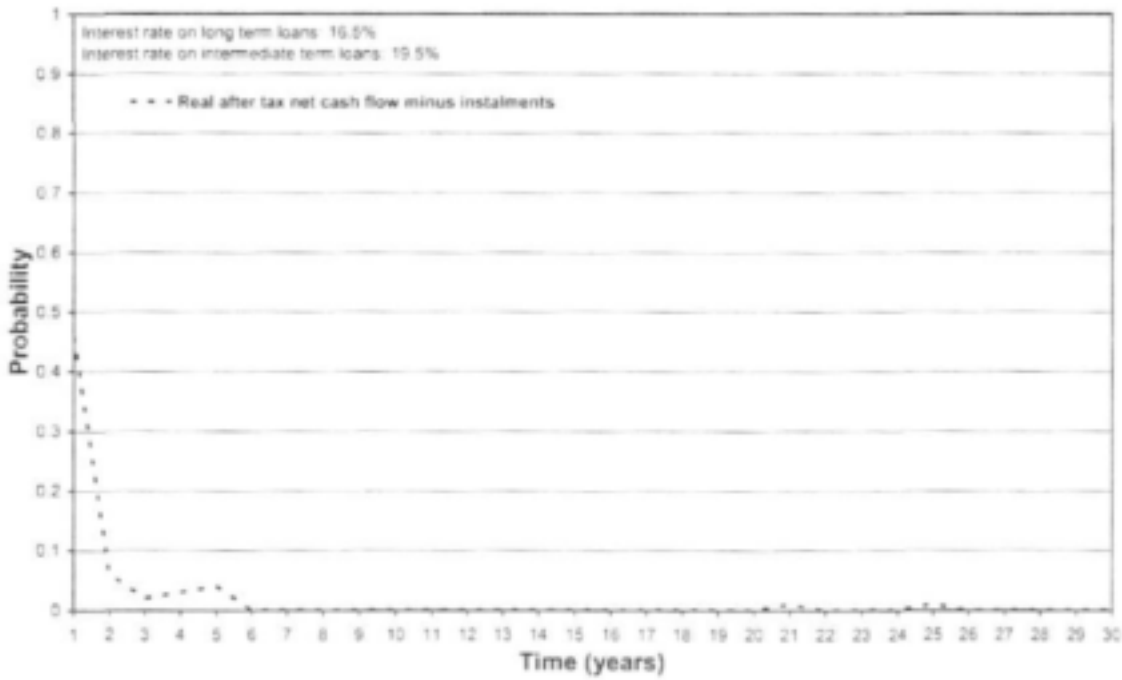

Figure 6.10: The probability of failing to meet instalments on Onderberg case study farm 16 planted to bananas (DI_{20}), mangoes (D_{10}), grapefruit (D_{20}) and sugarcane ($C_{80}DI_{20}$), 2000

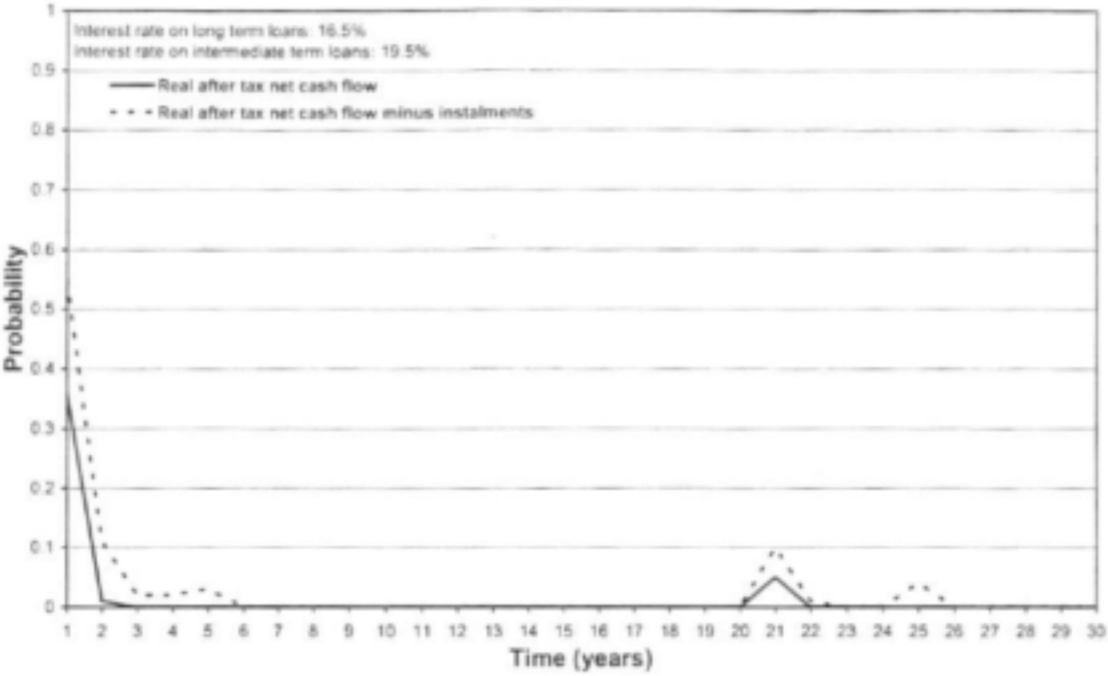

Figure 6.11: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments on Onderberg case study farm 17 planted to bananas (D_{20}), mangoes (M_{10}), grapefruit (D_{20}) and sugarcane (DI_{100}), 2000

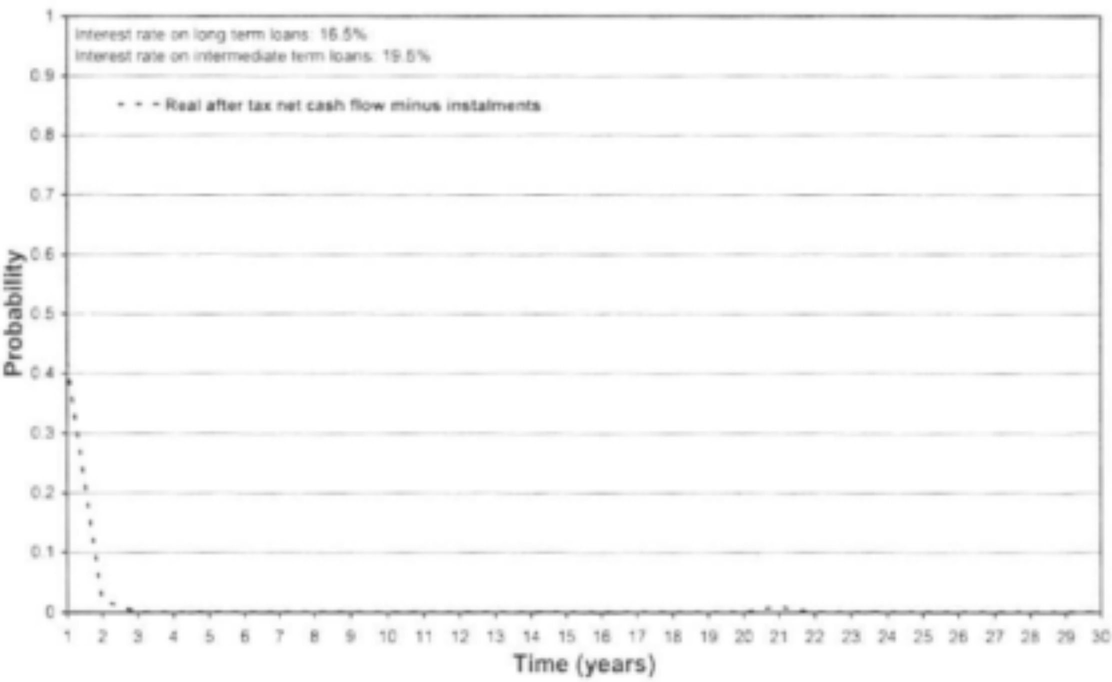

Figure 6.12: The probability of failing to meet instalments on Onderberg case study farm 18 planted to bananas (D_{20}), mangoes (D_{10}), grapefruit (D_{20}) and sugarcane ($DI_{50}D_{50}$), 2000.

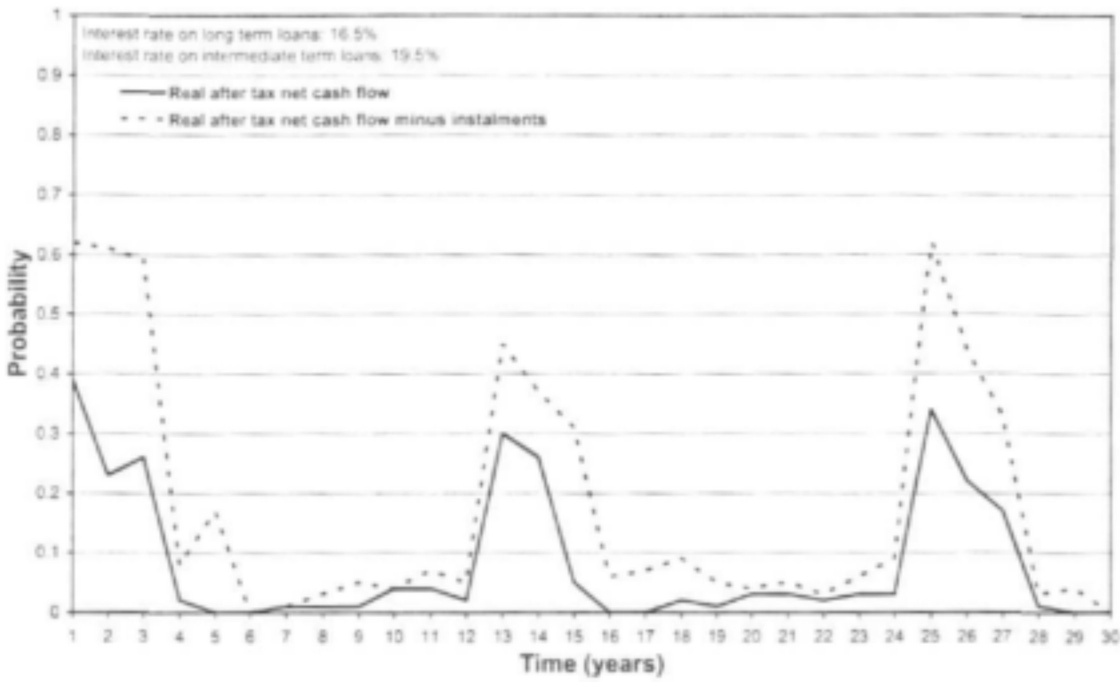

Figure 6.13: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments on Onderberg case study farm 19 planted to grapefruit (M_{40}) and sugarcane (DI_{110}), 2000

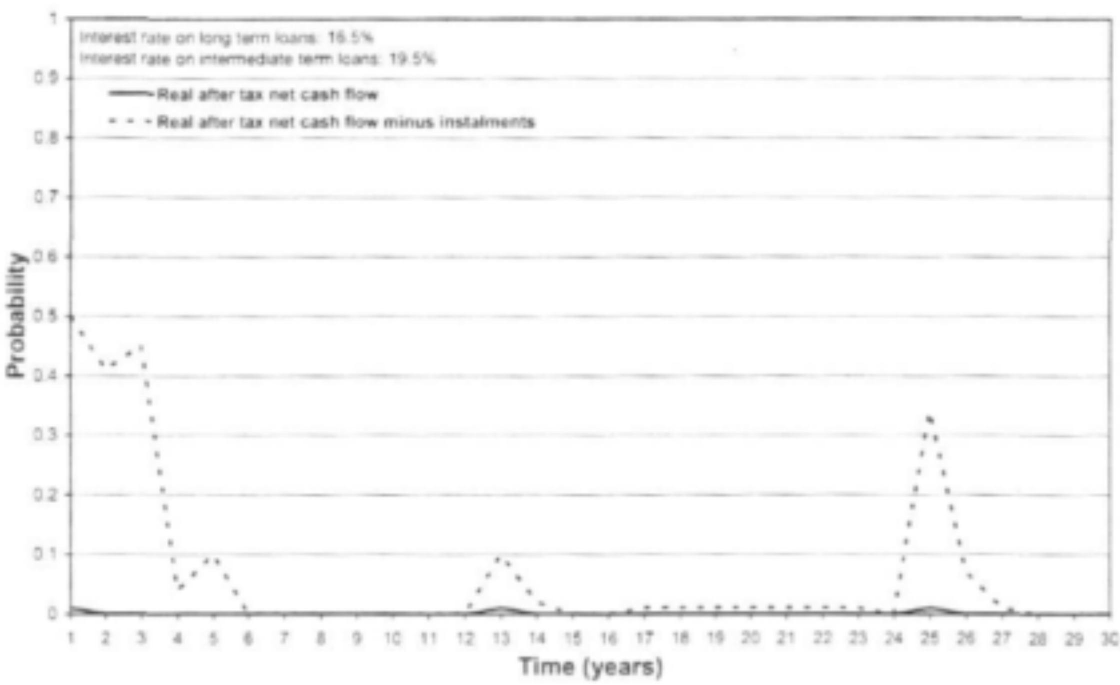

Figure 6.14: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments on Onderberg case study farm 20 planted to grapefruit (D_{40}) and sugarcane ($C_{80}DI_{30}$), 2000

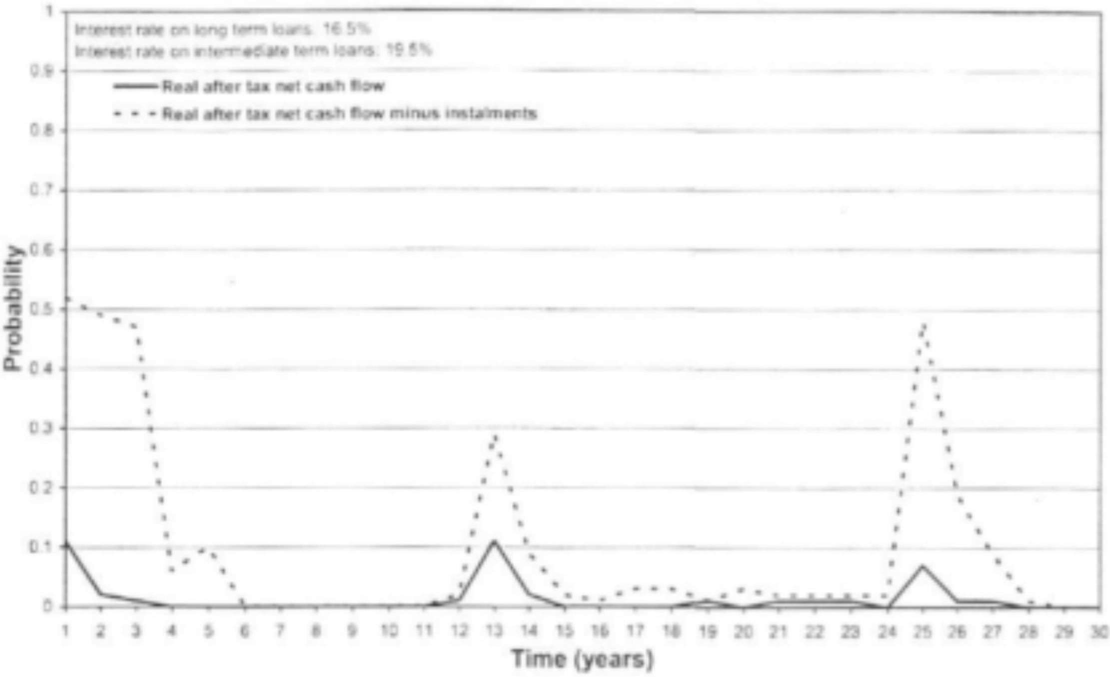

Figure 6.15 The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments on Onderberg case study farm 21 planted to grapefruit ($D_{20}M_{20}$) and sugarcane ($C_{50}DI_{60}$), 2000

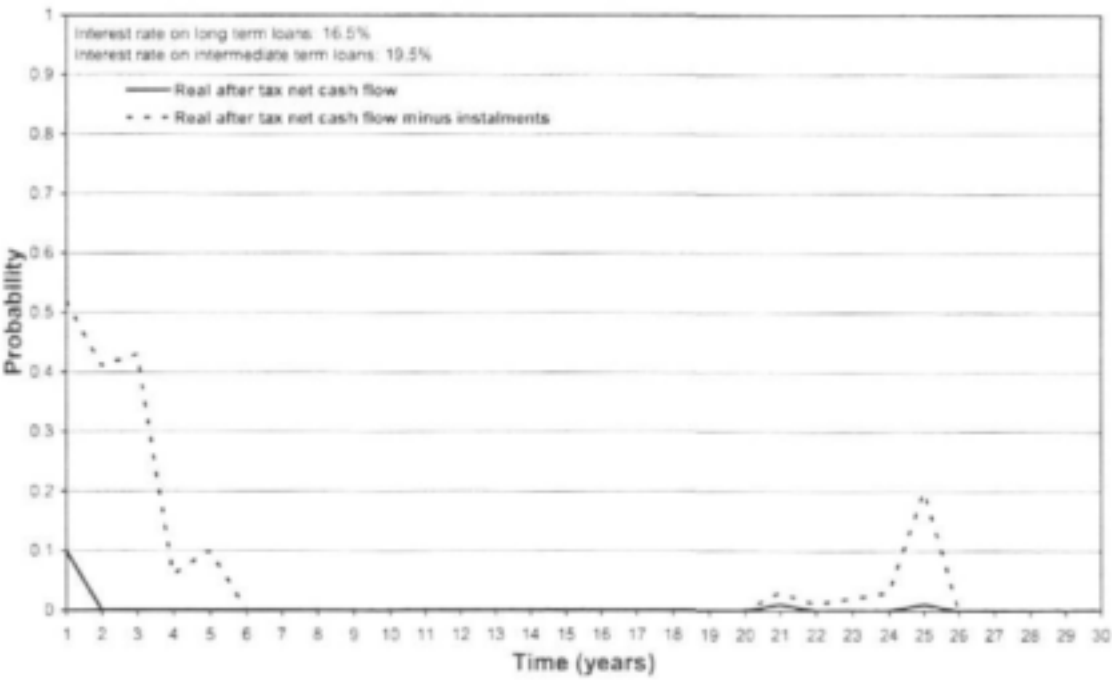

Figure 6.16: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments on Onderberg case study farm 22 planted to mangoes (D_{20}), grapefruit (D_{30}) and sugarcane ($DI_{60}D_{40}$), 2000

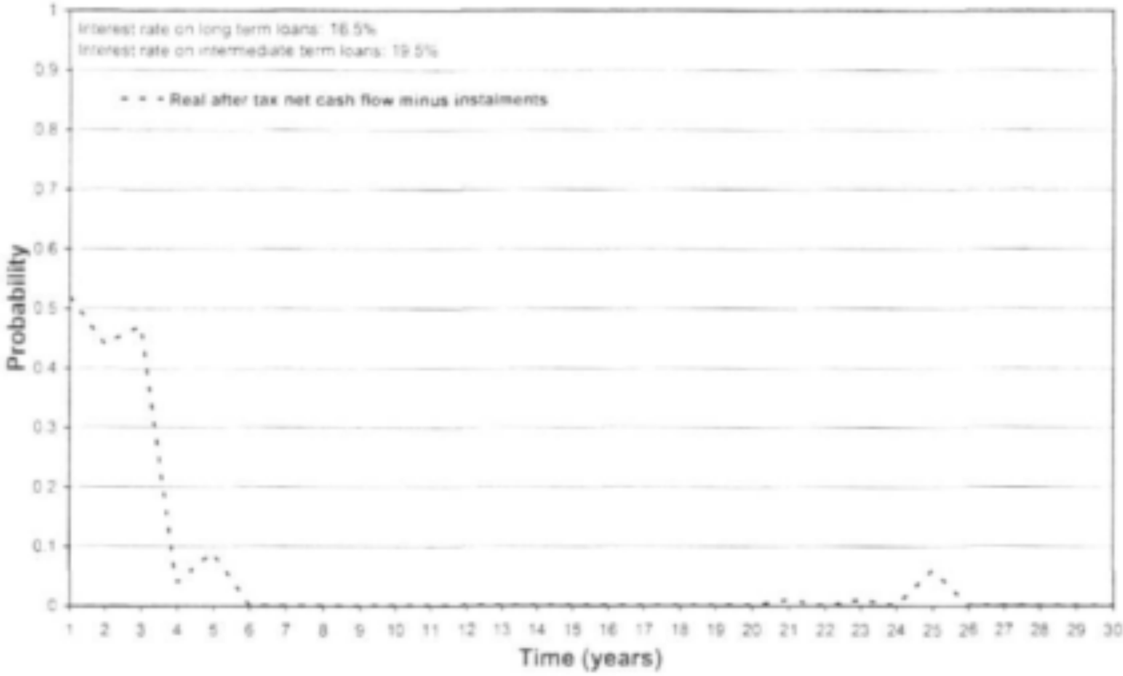

Figure 6.17: The probability of failing to meet instalments on Onderberg case study farm 23 planted to mangoes (M_{20}), grapefruit (M_{30}) and sugarcane (C_{100}), 2000

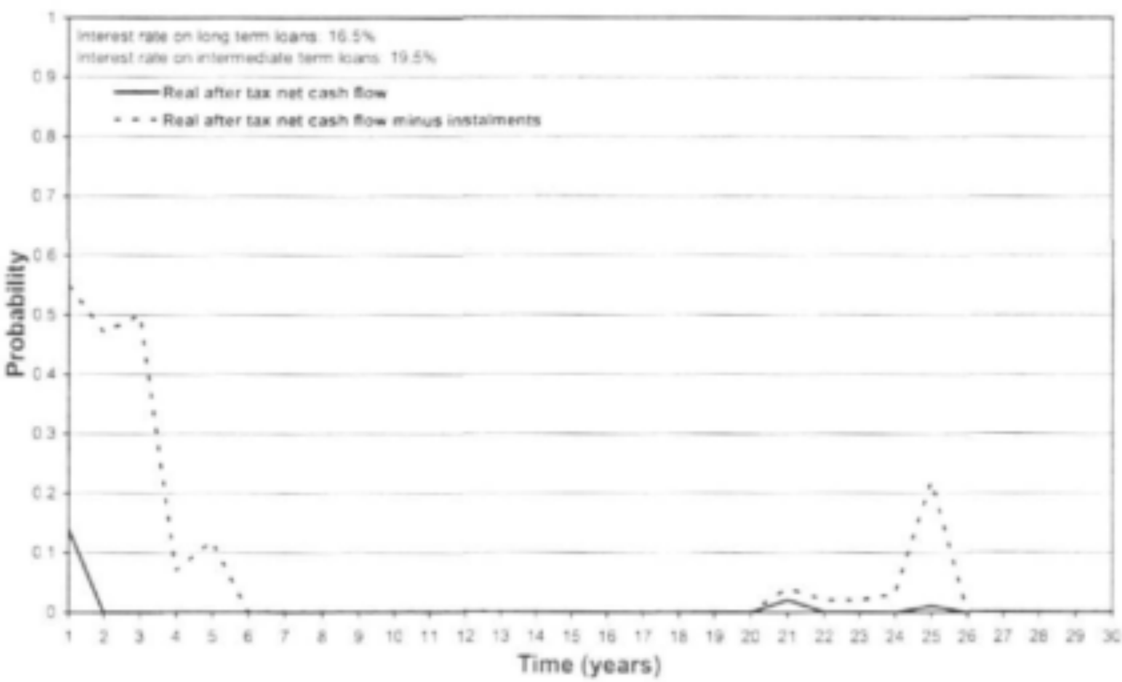

Figure 6.18: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments on Onderberg case study farm 24 planted to mangoes (M_{20}), grapefruit (D_{30}) and sugarcane ($C_{50}DI_{50}$), 2000

The financial feasibility of the eight large-size farms (250 ha under cultivation) is depicted in Figures 6.19-6.24.

If farm 29 (50 ha oranges under micro-irrigation, 30 ha grapefruit under micro-irrigation, and 170 ha sugarcane under draglines) is analysed (Figure 6.21), it can be seen that there is a 95% probability of not meeting financial obligations in the first 6 years, with a small peak during years 10-15, and then a 50% probability of financial failure during years 20-30. In the beginning all the irrigation systems and crops have to be financed. In year 12 grapefruit is replaced as well as sugarcane. Then in year 20 oranges are replaced, as well as a part of the mainline pipe system and dragline laterals. In year 22 infield micro-equipment is replaced. In year 24 grapefruit and sugarcane have to be re-established.

Figure 6.22 displays the cumulative probabilities of failing to meet financial obligations for farm 30 (40 ha mangoes, 20 ha oranges and 40 ha grapefruit under micro-irrigation, as well as 150 ha sugarcane under draglines). There is a 100% probability of not meeting the instalments in the first 6 years because of the capital layout on 100 ha of orchards under micro-irrigation, as well as 150 ha of sugarcane under draglines. In year 20 there is a 15% probability, and in years 24-28 a 40% probability of failing to meet the financial obligations. The reasons are that mangoes and oranges are replaced in year 20, as well as a part of the mainline pipe system. In addition, the infield micro-irrigation equipment has to be replaced, and grapefruit and sugarcane have to be re-established in year 24.

Figure 6.23 depicts the cash flow situation of farm 31 (40 ha mangoes under micro-irrigation, 20 ha oranges under drip-irrigation, 20 ha grapefruit under drip-irrigation, 20 ha grapefruit under micro-irrigation, and 150 ha sugarcane under draglines). In comparison with farms 29 and 30, farm 31 does not have a negative cash flow over the 30-year period, but there is a 50% probability over the first 6 years of failing to meet financial obligations and then again a 10% probability in years 24-26 of not covering the instalments. The outstanding reason for the better cash flow situation is the 150 ha sugarcane under drip-irrigation.

Figure 6.24 displays the cash flow situation of farm 32 (20 ha mangoes under drip-irrigation, 20 ha mangoes under micro-irrigation, 20 ha oranges under micro-irrigation, 40 ha grapefruit under micro-irrigation, and 150 ha sugarcane under drip-irrigation). The graph is almost similar to the graph of farm 31, because of 20 ha oranges under micro- instead of drip-irrigation, and instead of 40 ha mangoes under micro-irrigation, it is 20 ha mangoes under drip- and 20 ha mangoes under micro-irrigation.

The only large-sized farm with no cash flow problem is farm 26 (50 ha sugarcane under centre pivot-, 100 ha sugarcane under draglines and 100 ha sugarcane under drip-irrigation), and farm 25 (80 ha sugarcane under centre pivot-irrigation and 170 ha sugarcane under draglines).

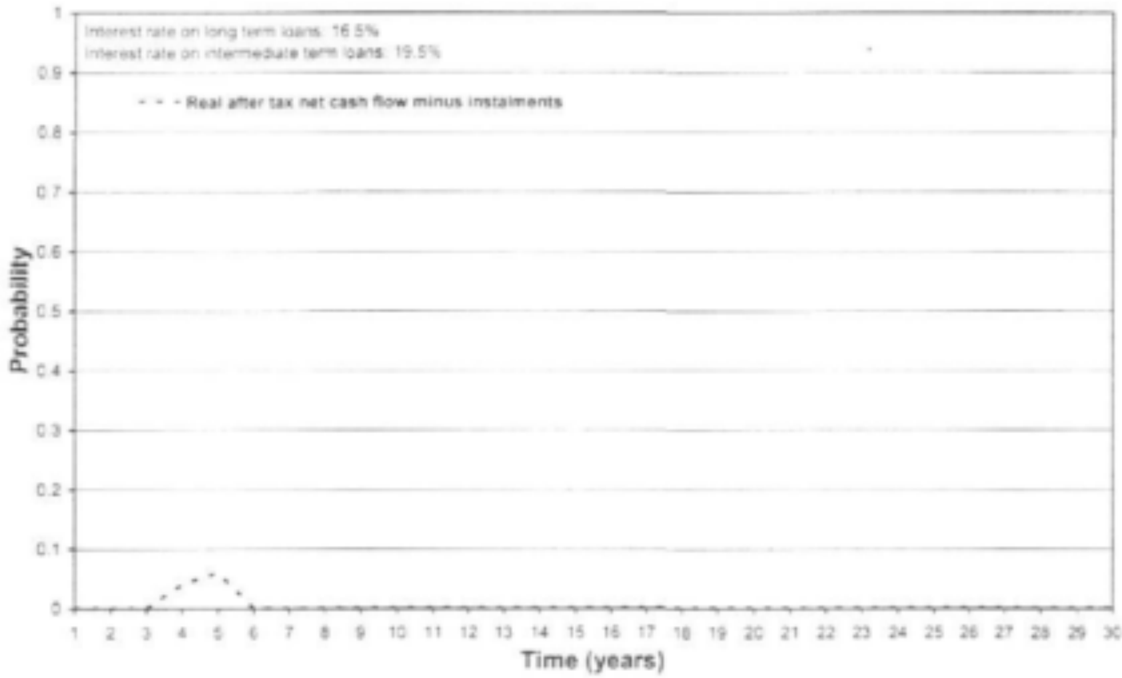

Figure 6.19: The probability of failing to meet instalments on Onderberg case study farm 25 planted to sugarcane ($C_{80}DI_{170}$), 2000

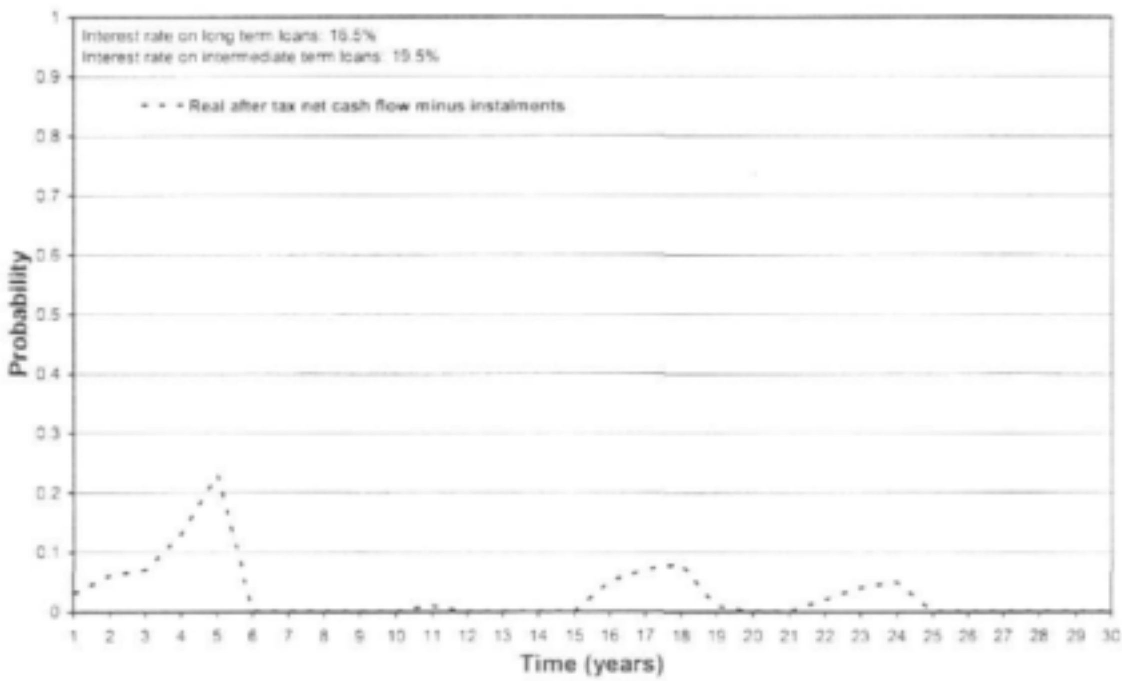

Figure 6.20: The probability of failing to meet instalments on Onderberg case study farm 27 planted to sugarcane (DI_{250}), 2000

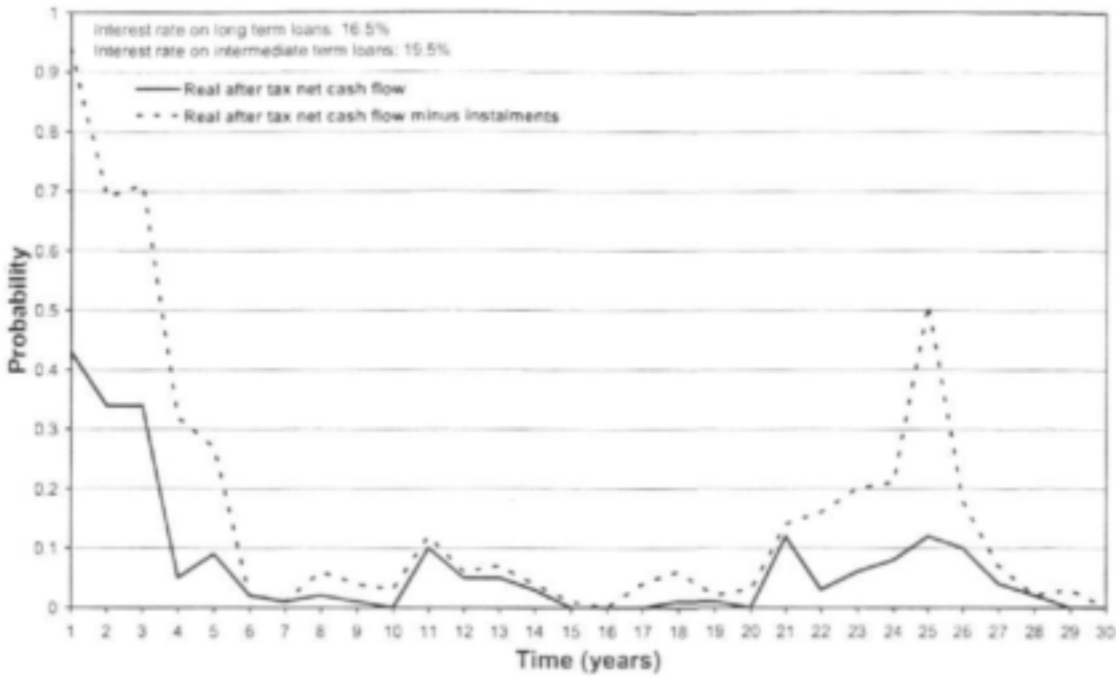

Figure 6.21: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments on Onderberg case study farm 29 planted to oranges (M_{80}), grapefruit (M_{30}) and sugarcane (DI_{170}), 2000

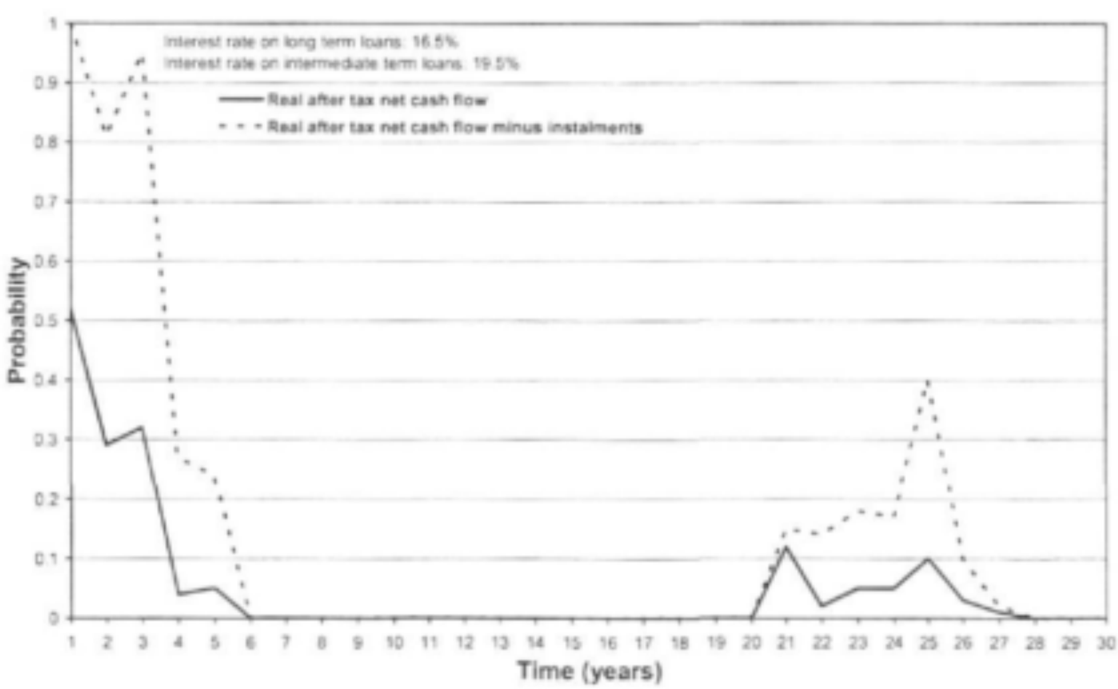

Figure 6.22: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments on Onderberg case study farm 30 planted to mangoes (M_{40}), oranges (M_{20}), grapefruit (M_{40}) and sugarcane (DI_{150}), 2000

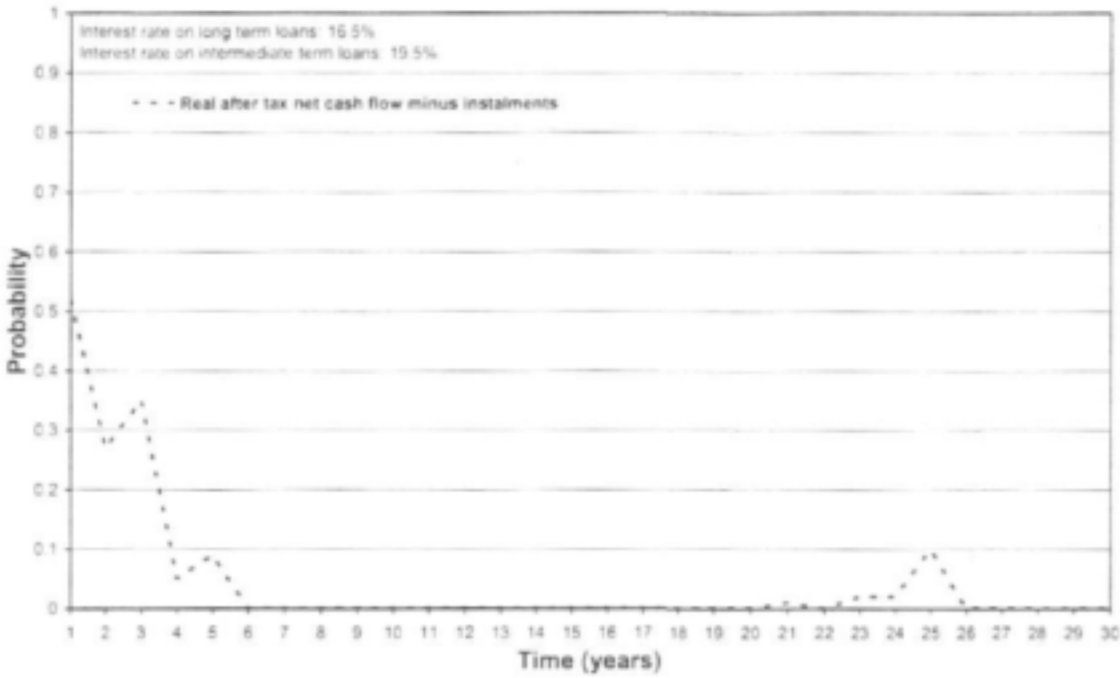

Figure 6.23: The probability of failing to meet instalments on Onderberg case study farm 31 planted to mangoes (M_{40}), oranges (D_{20}), grapefruit ($D_{20}M_{20}$) and sugarcane (D_{150}), 2000

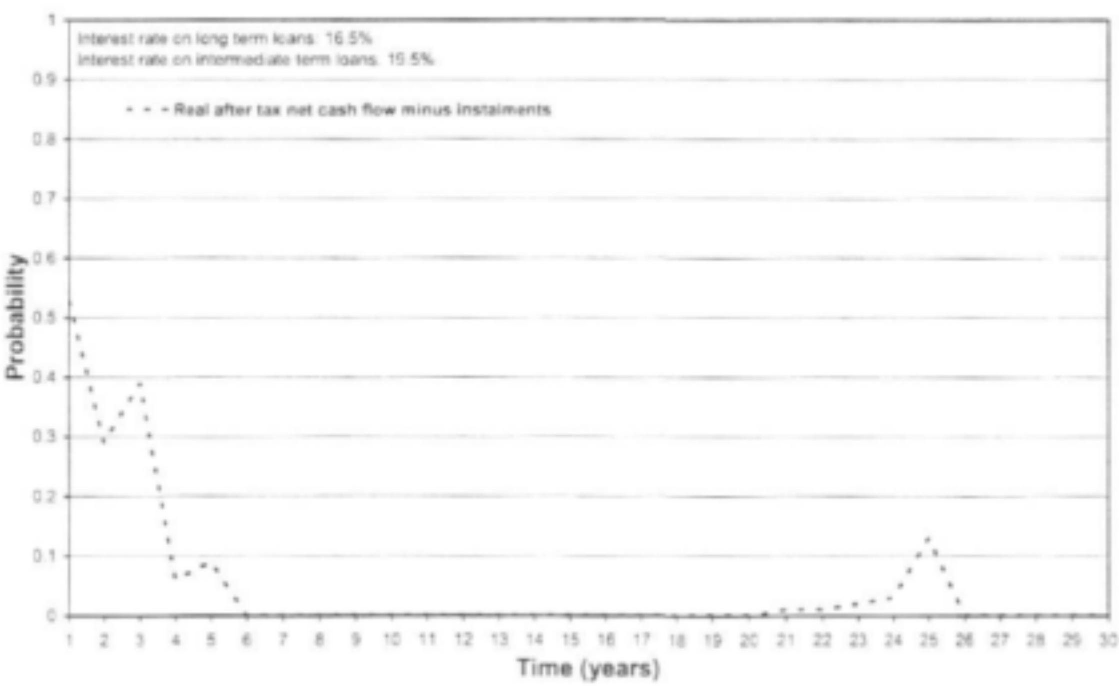

Figure 6.24: The probability of failing to meet instalments on Onderberg case study farm 32 planted to mangoes ($D_{20}M_{20}$), oranges (M_{20}), grapefruit (M_{40}) and sugarcane (D_{150}), 2000

6.4 CONCLUSION

All the irrigation system combinations on all the case study farms are economically profitable, taking risk into account. The mean NPV of the after tax net cash flow varies among farms in the same size category, but also varies between the three farm size categories. The NPV varies between R2 072 505 to R6 859 576 for the 50 ha farm group, for the medium-size (150 ha) category the NPV varies between R8 376 000 to R28 096 000, and for the large farms (250 ha) the NPV varies between R10 499 000 to R31 360 000. The reasons for these differences are the different crop and irrigation system combinations, and also because of economies of size.

The financial feasibility of all the farms differs. The simultaneous replacement of orchards and irrigation system components has a significant effect on the financial feasibility and riskiness of the case study farms. A farmer needs sufficient funding to capitalize on the better profitability of the different combinations of orchards under irrigation. In general, sugarcane serves as a cash source. Farmers with limited access to funding are forced to invest in lower cost irrigation systems due to the time value of money.

There are 9 case study farms among the 32 analysed with no cash flow problems. In the small-sized category, these are farms 2, 3, 4 and 6 with predominately sugarcane under drip-irrigation. Farm 11, 12 and 15 (medium-sized) also have positive cash flows, with predominately sugarcane under drip-irrigation. In the large-sized category (250 ha) farms 25 and 26 with sugarcane under centre pivot-, dragline- and drip-irrigation have no cash flow problems..

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 COST ESTIMATING PROCEDURES FOR MICRO-, DRIP- AND FURROW-IRRIGATION, AS WELL AS A COMBINATION OF IRRIGATION SYSTEMS

The proper estimation of irrigation costs is critical for irrigators to be able to evaluate efficient water use techniques. The cost estimating procedures which are developed for micro-, drip- and furrow-irrigation make it possible to estimate the annual fixed cost and variable cost of these systems as well as the marginal factor cost of applying water methodologically correctly. The use of these cost estimating procedures will also make it possible to estimate irrigaton costs for any mix of micro-, drip-, furrow-, dragline- and centre pivot-systems. The use of these cost estimating procedures will lead to better economic analyses of irrigation systems. The strength of the methods is that economic principles are applied in procedures which take into account the technical properties of each irrigation system. Since the marginal factor cost is also known, the optimal irrigation application can be estimated if the yield response and price of the product are also estimated.

The cost estimating procedures are based on the reliability of certain techno-economic coefficients of the irrigation systems. Fixed costs are affected by the useful lifespan and salvage value of the different system components. The variable costs, on the other hand, are affected by estimations of repairs and maintenance costs, labour, and the amount of water applied.

7.2 ECONOMIC EVALUATION OF INDEPENDENT SMALL-SCALE COMMERCIAL FARMING IN NKOMAZI AREA

The case study method with the help of the SAPFACT framework gave an in depth understanding of the individual cases' situation and practical experiences as lived and/or faced in a real-life context. Direct observation of farmers in their natural settings and access to subjective factors such as their thoughts and desires have helped to understand their situations.

It was found that there was a progressive agricultural learning and growth path. These independent farmers started their farming businesses with finance they got from working in different sectors or job opportunities, and through saving family income they acquired some of the production inputs. Some farmers started operations on small areas of land and expanded their operations little by little over time.

The success and survival of these independent small-scale farmers depend on their off-farm income. Part-time farming should therefore be promoted among small-scale farmers. Part-time farming is a worldwide phenomenon which should be facilitated. In comparison with other countries, the percentage of part-time farmers in South Africa is too low.

The following critical success factors were identified: business orientation, entrepreneurial spirit, hard work, dedication, diversification, and the ability to read and interpret economic changes and taking risk.

The farmers can improve their farms' financial survival by managing their cash flows more efficiently, and structuring their debts better.

The profitability of their farm businesses can improve if they manage their crops technically more efficiently. An analysis of their crop enterprises revealed that the crops only contributed marginally positively to their equity. In one case study three of the six crops contributed negatively to the farmer's own capital.

The sugarcane yields of around 50 tonnes/ha are far from satisfactory and can be improved significantly with more efficient production methods and extension.

Better management of price and yield risks can improve their farms' financial survival. The effect of better marketing strategies on business survival can be significant. The marketing strategy commonly used by vegetable case study farmers was direct or spot market, whereby farmers sold to the local community and hawkers who came to buy from the farm gate. Contract selling was a recently adopted marketing strategy by one farmer who had a contract agreement with a retail shop in Malelane to supply it with vegetables. Alternative marketing strategies are spreading of sales, market information, vertical integration and value adding opportunities. Sugarcane farmers have a certain market as they deliver it to the sugarcane mills.

Only one farmer owns farming land and the other four utilize it on a RTO (right to occupy), which poses strategic risk to these farmers in that use of land held under such tenure is uncertain. Banks do not accept land held under a tribal land tenure system as collateral and tribal law does not allow sale of tribal land. These factors have negative effects on farm development and efficient use of land resources.

7.3 ECONOMIC AND FINANCIAL EVALUATION OF SMALL-SCALE FARMER IRRIGATION PROJECTS

The 7 ha draglines (Madadeni), 5 ha centre pivots (Mbongozi) and 10 ha floppies (Walda) are economically profitable, although the degree to which the main infrastructure is subsidized varies significantly. The degree of profitability of the irrigation systems vary mainly because of the difference in plot-sizes. The floppy system has the greatest variation in profitability.

All three irrigation systems are also financially feasible, which means they generate enough cash to pay the relevant instalments.

It was also found that for all three systems there are deficit years in which the farmers do not generate enough cash to cover their living expenses and therefore have to support their families with off-farm income. The amount which was available for living expenses varied among the irrigation systems. In this study it was assumed that a family could survive with R24 000 per year.

The sustainability of these irrigation projects depends on the access of finance to replace expensive components of the irrigation systems. The two important factors which determine the instalment amount are the interest rate and payback period. The financial feasibility of these investments was not significantly affected by changes in these two factors. However, the crucial factor for financial survival is the initial subsidy of the irrigation systems.

An important success factor was the availability of a well-established marketing process for sugarcane.

7.4 WHOLE FARM ECONOMIC AND FINANCIAL ANALYSES OF LARGE-SCALE IRRIGATION FARMING IN THE ONDERBERG REGION TAKING RISK INTO CONSIDERATION

All 32 irrigation system combinations on all the case study farms are profitable, taking risk into account. The net present value (NPV) amount differs between farms in the same size category, but also between farms in the three size groups, namely 50, 150 and 250 ha of cultivated land.The reasons for these differences are the different crop and irrigation system combinations, and also because of economies of size.

The financial feasibility of the 32 case study farms differs. The probabilities of failing to meet financial obligations are estimated over a period of 30 years. The simultaneous replacement of orchards and irrigation systems after their useful life has a significant effect on the financial feasibility and riskiness of these case study farms. A farmer needs sufficient funding to capitalize on the better profitability of the different combinations of orchards under irrigation. In general, sugarcane serves as a cash source. Farmers with limited access to funding are forced to invest in lower cost irrigation systems due to the time value of money.

7.5 RECOMMENDATIONS

7.5.1 ADVISORS AND FARMERS

- The cost estimating procedures for micro-, drip-, furrow-, dragline-, centre pivot-, and mainline pipe-irrigation systems should be included in the irrigation system design sheets of irrigation firms and other irrigation organizations because the procedures are economically and technically soundly grounded.

- The cost estimating procedures should be used to estimate the total fixed and operating costs of the major irrigation systems. These procedures are suitable for on-farm use by irrigators and advisors to decide over the long run which irrigation systems to buy and in the short run how to manage the operating costs which are directly linked to the decision of how much, how to and what to produce.

- The cost estimating procedures should also be used to consider changes in a current irrigation system or to evaluate the feasibility of switching to a more water-efficient system.

- The small-scale farmers should be encouraged to keep farm records and to use them in planning their farming operations.

- Farmers and advisors should be trained to compile crop enterprise budgets and how to use these budgets as building blocks in farm planning.

- Yield and price risks are two factors which significantly affect the financial feasibility of irrigation farming. Farmers and advisors should be trained to do viability analysis of irrigation farming taking risk into account.

- Advisors should have a broad business approach when giving extension advice to farmers. This implies that the advice should not only concentrate on production methods, but also include advice on financial issues and marketing strategies.

7.5.2 POLICY-MAKERS

- The unsatisfactory extension service as experienced by small-scale farmers revealed institutional failure, and this calls for urgent attention of policy-makers.

- Financial support is much needed as was learned through the growth path which was followed by the part-time farmers. Policy-makers should see to it that sound financial incentives are accessibly put in place to help part-time farmers and new entrants in farming business.

- Subsidies are necessary to finance the capital investment in mechanized irrigation systems. Insufficient cash flow is a general problem in agriculture and in the absence of subsidies profitable irrigation projects would not be feasible for small-scale farmers. The public sector therefore has a major role to play in establishing irrigation development projects by providing subsidy at the beginning.

- The absence of reliable crop enterprise budgets for small-scale irrigation farmers hampers the economic evaluation of these farmers. Data about labour and water use should be collected. It is recommended that the COMBUDS of the National Department of Agriculture be extended to include crop enterprise budgets for typical crops under irrigation.

- Business plans for small-scale farming should include the effect of production and price risks in the viability analysis.

- Plot-size and reliable product markets are two crucial factors in the financial survival of irrigation farming and therefore new project developments should take these factors into consideration.

- The national policy for small-scale irrigation should facilitate the critical success factors such as the provision of sufficient infrastructure, subsidies, and finance. It is important that the farmers and the communities are involved in the planning of these projects, and that the farmers take responsibility for their own financial survival.

- Policy-makers should urgently address the issue of land tenure, because the current tribal land tenure system hinders farm development. Farmers revealed their uncertainty regarding long-term occupancy of the farmland, since the land belongs to the community under the custody of the tribal chief. This uncertainty prohibits productive investments. A land lenure reform policy in tribal areas is needed with the aim of transferring ownership from the state to people living on the land. An efficient land market requires security of property rights and low transaction costs. As a starting point a farmland rental market should be promoted and facilitated for land in the former homelands, belonging to the state now, but managed by traditional leaders. To activate the rental market perceived risks will have to be reduced. This implies institutional change. Existing government institutions could assume responsibility for holding and enforcing land rental contracts, and should take a more active role in disseminating information about procedures. Tribal authorities could be encouraged to endorse rental contracts by allowing them to tax rentals. Institutional credit currently advanced for other inputs should be extended to include financing of land rental (Lyne, 1991).

- As the government has recognized the importance of the small-scale sector, there is a need for a countrywide economic evaluation of the small-scale commercial irrigation subsector, especially independent farmers. This would help in the development of policies that are specific to the subsector in the attempt to address the national agricultural economic problem. This could be extended to other countries in the SADC region so that effective policies could be jointly involved to address the agricultural economic problem as a regional challenge.

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APPENDIX **1.A**

LIST OF ABBREVIATIONS

TSB	Transvaal Sugar Board
FAF	Financial Aid Fund
RTO	Right to occupy
FARMS model	Firm-level Agricultural Management Simulator
IRRICOST	Irrigation cost
KV	Kilovolt
KVA	Kilovolt-ampère
KW	Kilowatt
KWh	Kilowatt-hour
mm.ha	Millimetre hectare
PVC	Polyvinyl chloride
RISKMAN	Risk Management
Spilkost	Centre pivot cost
WAS	Water Administration System
SWB	Soil Water Balance

APPENDIX 3.A

COST ESTIMATING PROCEDURES FOR CENTRE PIVOT IRRIGATION SYSTEMS

SECTION 1: GENERAL INFORMATION

1.	**MANAGEMENT OF THE CENTRE PIVOT**		
1.1	Hours labour required per 24 hours irrigated	: 0.61	hrs
1.2	Area annually cultivated	: 61	ha
2.	**WATER**		
2.1	Listed area irrigated with the centre pivot	: 31	ha
2.2	Planned water use	: 15 790	m^3/ha/yr
2.3	Water charges		

TARIFF		QUANTITY			CHARGE	
1	2.3.1.1	: 15 790	m^3/ha	2.3.1.2	: 13.98	c/m^3
2	2.3.2.1	: -	m^3/ha	2.3.2.2	: -	c/m^3
3	2.3.3.1	: -	m^3/ha	2.3.3.2	: -	c/m^3
4	2.3.4.1	: -	m^3/ha	2.3.4.2	: -	c/m^3
5	2.3.5.1	: -	m^3/ha	2.3.5.2	: -	c/m^3

3.	**INTEREST AND INFLATION RATE**		
3.1	Nominal interest rate	: 11.0	%
3.2	Annual inflation rate	: 5.7	%

4. INSURANCE

4.1	Type of insurance	4.1.1	: Centre pivot
		4.1.2	: -
		4.1.3	: -
4.2	Tariff for each type of insurance	4.2.1	: 1.9 %
		4.2.2	: - %
		4.2.3	: - %

5. OTHER COSTS

5.1	Labour costs	: R 2.56	/h
5.2	Repair and maintenance costs		
5.2.1	Electric motor	: 0.4	% of the purchase price/1 000hrs/yr
5.2.2	Distribution system	: 0.1	% of the purchase price/1 000hrs/yr
	OTHER		
5.2.3	-	: -	% of the purchase price/1 000hrs/yr
5.2.4	-	: -	% of the purchase price/1 000hrs/yr
5.2.5	-	: -	% of the purchase price/1 000hrs/yr

6. **PUMP RATE**

6.1 Design value : 106 m^3/h

SECTION 2: INITIAL INVESTMENT AND ANNUAL FIXED COSTS

7. **INTEREST AND DEPRECIATION**

7.1 Real interest rate = [(***3.1***/100+1)/(***3.2***/100+1)-1]×100

= 5.0 %

7.2 Details of the initial investment

ITEM NUMBER	COMPONENT	INVESTMENT COSTS (R) 1	SALVAGE VALUE (% OF ***COLUMN 1***) 2	EXPECTED LIFE (YR) 3
1.	Electric motor	11 300	20	15
2.	Distribution system	226 580	25	15
3.	-	-	-	-
4.	-	-	-	-
5.	-	-	-	-
	Total	237 880		

7.2.1 Total initial investment cost (total ***column 1***) : R 237 880

7.3 The calculation of interest and depreciation

ITEM NUMBER	SALVAGE VALUE (R) ***COLUMN 1***× ***COLUMN 2***/100 4	INTEREST ON THE SALVAGE VALUE (R) ***7.1***/100× ***COLUMN 4*** 5	DEPRECIABLE PORTION (R) ***COLUMN 1***- ***COLUMN 4*** 6	CAPITAL RECOVERY FACTOR[1] 7	CAPITAL RECOVERY[2] (R) ***COLUMN 6***× ***COLUMN 7*** 8
1.	2 260	113.00	9 040	0.096342	870.93
2.	56 645	2 832.25	169 935	0.096342	16 371.88
3.	-	-	-	-	-
4.	-	-	-	-	-
5.	-	-	-	-	-
Total	58 905	2 945.25	178 975		17 242.81

1. CRF = $i/100(i/100+1)^n/[(i/100+1)^n-1]$

where CRF = Capital recovery factor,

i = Interest rate and

n = life of the component.

2. Comprises interest and depreciation.

7.3.1 Annual interest and depreciation (total ***column 5*** + total ***column 8***) : R 20 188.06

8. Other fixed costs

8.1 Insurance

8.1.1 Centre pivot Annual costs = ***7.2.1×4.2.1***/100
= R 4 519.72

8.1.2 _____ - _____ Annual costs = ***7.2.1×4.2.2***/100
= R -

8.1.3 _____ - _____ Annual costs = ***7.2.1×4.2.3***/100
= R -

8.1.4 Total insurance cost = ***8.1.1+8.1.2+8.1.3***
= R 4 519.72

9. Annual ownership costs

9.1 Total annual fixed cost = ***7.3.1+8.1.4***
= R 24 707.78

SECTION 3: ANNUAL OPERATING COSTS OF A CENTRE PIVOT SYSTEM

10. Annual operation of the system

10.1 Water pumped (m^3) according to planning = ***2.1×2.2***
= 489 490 m^3/yr

10.2 Water pumped (mm.ha) according to planning = ***10.1***/10
= 48 949 mm.ha/yr

10.3 Hours pumped = ***10.1/6.1***
= 4 618 hrs

11. Water costs

11.1 Water purchases at tariff 1

11.1.1 Quantity

If ***2.2*** ≤ ***2.3.1.1*** = ***2.2×2.1***
= 489 490 m^3

If ***2.2*** > ***2.3.1.1*** = ***2.3.1.1×2.1***
= - m^3

11.1.2 Purchases at a higher tariff = ***2.2-2.3.1.1***
= 0 m^3

11.1.3	Water costs at tariff 1	= ***2.3.1.2***/100×***11.1.1***
		= R 68 431
11.2	Water purchases at tariff 2	
11.2.1	Quantity	
	If ***11.1.2*** ≤ ***2.3.2.1***	= ***11.1.2***×***2.1***
		= - m^3
	If ***11.1.2*** > ***2.3.2.1***	= ***2.3.2.1***×***2.1***
		= - m^3
11.2.2	Purchases at a higher tariff	= ***11.1.2-2.3.2.1***
		= - m^3
11.2.3	Water costs at tariff 2	= ***2.3.2.2***/100×***11.2.1***
		= R -
11.3	Water purchases at tariff 3	
11.3.1	Quantity	
	If ***11.2.2*** ≤ ***2.3.3.1***	= ***11.2.2***×***2.1***
		= - m^3
	If ***11.2.2*** > ***2.3.3.1***	= ***2.3.3.1***×***2.1***
		= - m^3
11.3.2	Purchases at a higher tariff	= ***11.2.2-2.3.3.1***
		= - m^3
11.3.3	Water costs at tariff 3	= ***2.3.3.2***/100×***11.3.1***
		= R -
11.4	Water purchases at tariff 4	
11.4.1	Quantity	
	If ***11.3.2*** ≤ ***2.3.4.1***	= ***11.3.2***×***2.1***
		= - m^3
	If ***11.3.2*** > ***2.3.4.1***	= ***2.3.4.1***×***2.1***
		= - m^3
11.4.2	Purchases at a higher tariff	= ***11.3.2-2.3.4.1***
		= - m^3
11.4.3	Water costs at tariff 4	= ***2.3.4.2***/100×***11.4.1***
		= R -

11.5 Water purchases at tariff 5

11.5.1 Quantity

If **11.4.2** ≤ **2.3.5.1** = ***11.4.2×2.1***

= ____-____ m^3

Otherwise maximum ***2.3.5.1*** = ***2.3.5.1×2.1***

= ____-____ m^3

11.5.2 Water costs at tariff 5 = ***2.3.5.2***/100×***11.5.1***

= R____-____

11.6 Total water cost = ***11.1.3+11.2.3+11.3.3+11.4.3+11.5.2***

= R 68 431

12. Labour costs

12.1 Labour hours required = ***10.3***/24hrs×***1.1***

= 117 hrs/yr

12.2 Total labour cost per year = ***5.1×12.1***

= R 300

12.3 Labour costs per m^3 of water pumped = ***12.2/10.1***

= R 0.0006

13. Repair and maintenance costs

13.1 Annual repair and maintenance costs of the electric motor

= (***7.2, column 1, item 1***)×***5.2.1***/100×***10.3***/1 000hrs

= R 208.73

13.2 Annual repair and maintenance costs of the distribution system

= (***7.2, column 1, item 2***)×***5.2.2***/100×***10.3***/1 000hrs

= R 1 046.35

13.3 Annual repair and maintenance costs of the ____-____

= (***7.2, column 1, item 3***)×***5.2.3***/100×***10.3***/1 000hrs

= R____-____

13.4 Annual repair and maintenance costs of the ____-____

= (***7.2, column 1, item 4***)×***5.2.4***/100×***10.3***/1 000hrs

= R____-____

13.5 Annual repair and maintenance costs of the ____-____

= (***7.2, column 1, item 5***)×***5.2.5***/100×***10.3***/1 000hrs

= R____-____

13.6 Total annual repairs and maintenance cost

= *13.1+13.2+13.3+13.4+13.5*

= R 1 255.08

13.7 Annual repair and maintenance costs per m^3 of water applied

= *13.6/10.1*

= R 0.0026

SECTION 4: SUMMARY OF COSTS

14. ANNUAL COSTS FOR PLANNED WATER APPLICATION

14.1	Fixed costs	
14.1.1	Total annual ownership cost	= ***9.1***
		= R 24 707.78
14.2	Variable costs	
14.2.1	Total water cost	= ***11.6***
		= R 68 431.00
14.2.2	Total labour cost	= ***12.2***
		= R 300.00
14.2.3	Total repairs and maintenance cost	= ***13.6***
		= R 1 255.08
14.3	Total cost per year	= ***14.1.1+14.2.1+14.2.2+14.2.3***
		= R 94 693.86

15. COST ALLOCATION

15.1	Fixed costs per hectare of crops grown	= ***9.1/1.2***
		= R 405.05
15.2	Labour costs per m^3 of water pumped	= ***12.3***
		= R 0.0006
15.3	Repair and maintenance costs per m^3 of water pumped	= ***13.7***
		= R 0.0026

15.4 Water costs

	TARIFF	M^3 OF WATER PUMPED		COSTS/M^3 OF WATER	
15.4.1	1	***11.1.1***	= 489 490 m^3	***2.3.1.2***/100	= R 0.1398
15.4.2	2	***11.2.1***	= - m^3	***2.3.2.2***/100	= R -
15.4.3	3	***11.3.1***	= - m^3	***2.3.3.2***/100	= R -
15.4.4	4	***11.4.1***	= - m^3	***2.3.4.2***/100	= R -
15.4.5	5	***11.5.1***	= - m^3	***2.3.5.2***/100	= R -

16. Marginal factor costs

Additional costs to apply an extra unit of water (m^3)

= ***15.2+15.3+*** [***15.4.1*** or ~~***15.4.2***~~ or ~~***15.4.3***~~ or ~~***15.4.4***~~ or ~~***15.4.5***~~][3]

= R 0.1430

3. Marginal water costs is the total amount for the last tariff increment at which water was purchased divided by quantity applied at this tariff.

APPENDIX 3.B

COST ESTIMATING PROCEDURES FOR DRAGLINE-IRRIGATION SYSTEMS

SECTION 1: GENERAL INFORMATION

1.	**MANAGEMENT OF THE DRAGLINES**		
1.1	Hours labour required per 24 hours irrigated	: 9	hrs
1.2	Area annually cultivated	: 19	ha
2.	**WATER**		
2.1	Listed area irrigated with the draglines	: 10	ha
2.2	Planned water use	: 17 900	m^3/ha/yr
2.3	Water charges		

	Tariff		Quantity			Charge	
2.3.1	1	2.3.1.1	: 17 900	m^3/ha	2.3.1.2	: 13.98	c/m^3
2.3.2	2	2.3.2.1	: -	m^3/ha	2.3.2.2	: -	c/m^3
2.3.3	3	2.3.3.1	: -	m^3/ha	2.3.3.2	: -	c/m^3
2.3.4	4	2.3.4.1	: -	m^3/ha	2.3.4.2	: -	c/m^3
2.3.5	5	2.3.5.1	: -	m^3/ha	2.3.5.2	: -	c/m^3

3.	**INTEREST AND INFLATION RATE**		
3.1	Nominal interest rate	: 11.0	%
3.2	Annual inflation rate	: 5.7	%

4.	**INSURANCE**		
4.1	Type of insurance	4.1.1	: -
		4.1.2	: -
		4.1.3	: -
4.2	Tariff for each type of insurance	4.2.1	: - %
		4.2.2	: - %
		4.2.3	: - %

5.	**OTHER COSTS**		
5.1	Labour costs	: R 2.56	/h

5.2	Repair and maintenance costs		
5.2.1	Lateral pipe	: 0.2	% of the purchase price/1 000hrs/yr
5.2.2	Dragline pipe	: 2.0	% of the purchase price/1 000hrs/yr
5.2.3	Sprinkler and stand	: 2.0	% of the purchase price/1 000hrs/yr
	OTHER		
5.2.4	-	: -	% of the purchase price/1 000hrs/yr
5.2.5	-	: -	% of the purchase price/1 000hrs/yr
5.2.6	-	: -	% of the purchase price/1 000hrs/yr

6. **PUMP RATE**

6.1 Design value : 27 m^3/h

SECTION 2: INITIAL INVESTMENT AND FIXED COSTS

7. **INTEREST AND DEPRECIATION**

7.1 Real interest rate = [(***3.1***/100+1)/(***3.2***/100+1)-1]×100

= 5.0 %

7.2 Details of the initial investment

ITEM NUMBER	COMPONENT	INVESTMENT COSTS (R) 1	SALVAGE VALUE (% OF ***COLUMN 1***) 2	EXPECTED LIFE (YR) 3
1	Lateral pipe	29 695.81	20	15
2	Dragline pipe	3 678.75	0	7
3	Sprinkler and stand	5 358.75	10	10
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-
	Total	38 733.31		

7.2.1 Total initial investment cost (total ***column 1***) = R 38 733.31

7.3 The calculation of interest and depreciation

ITEM NUMBER	SALVAGE VALUE (R) COLUMN 1× COLUMN 2/100 4	INTEREST ON THE SALVAGE VALUE (R) 7.1/100× COLUMN 4 5	DEPRECIABLE PORTION (R) COLUMN 1- COLUMN 4 6	CAPITAL RECOVERY FACTOR[1] 7	CAPITAL RECOVERY[2] (R) COLUMN 6× COLUMN 7 8
1	5 939.16	296.96	23 756.65	0.096342	2 288.76
2	0	0	3 678.75	0.172820	635.76
3	535.88	26.79	4 822.87	0.129505	624.59
4	-	-	-	-	-
5	-	-	-	-	-
6	-	-	-	-	-
Total	6 475.04	323.75	32 258.27		3 549.11

7.3.1 Annual interest and depreciation (total ***column 5*** + total ***column 8***) = R 3 872.86

8. **OTHER FIXED COSTS**

8.1 Insurance

8.1.1 - Annual costs = ***7.2.1×4.2.1***/100

= R -

8.1.2 - Annual costs = ***7.2.1×4.2.2***/100

= R -

8.1.3 - Annual costs = ***7.2.1×4.2.3***/100

= R -

8.1.4 Total insurance cost = ***8.1.1+8.1.2+8.1.3***

= R -

9. **ANNUAL OWNERSHIP COSTS**

9.1 Total annual fixed cost = ***7.3.1+8.1.4***

= R 3 872.86

1. $CRF = i/100(i/100+1)^n/[(i/100+1)^n-1]$

where CRF = Capital recovery factor,

i = Interest rate and

n = life of the component.

2. Comprises interest and depreciation.

SECTION 3: ANNUAL OPERATING COSTS OF A DRAGLINE SYSTEM

10.	**ANNUAL OPERATION OF THE SYSTEM**	
10.1	Water pumped (m^3) according to planning	= ***2.1×2.2***
		= 179 000 m^3/yr
10.2	Water pumped (mm.ha) according to planning	= ***10.1***/10
		= 17 900 mm.ha/yr
10.3	Hours pumped	= ***10.1/6.1***
		= 6 630 hrs

11.	**WATER COSTS**	
11.1	Water purchases at tariff 1	
11.1.1	Quantity	
	If ***2.2*** ≤ ***2.3.1.1***	= ***2.2×2.1***
		= 179 000 m^3
	If ***2.2*** > ***2.3.1.1***	= ***2.3.1.1×2.1***
		= - m^3
11.1.2	Purchases at a higher tariff	= ***2.2-2.3.1.1***
		= 0 m^3
11.1.3	Water costs at tariff 1	= ***2.3.1.2***/100×***11.1.1***
		= R 25 024
11.2	Water purchases at tariff 2	
11.2.1	Quantity	
	If ***11.1.2*** ≤ ***2.3.2.1***	= ***11.1.2×2.1***
		= - m^3
	If ***11.1.2*** > ***2.3.2.1***	= ***2.3.2.1×2.1***
		= - m^3
11.2.2	Purchases at a higher tariff	= ***11.1.2-2.3.2.1***
		= - m^3
11.2.3	Water costs at tariff 2	= ***2.3.2.2***/100×***11.2.1***
		= R -
11.3	Water purchases at tariff 3	
11.3.1	Quantity	
	If ***11.2.2*** ≤ ***2.3.3.1***	= ***11.2.2×2.1***
		= - m^3
	If ***11.2.2*** > ***2.3.3.1***	= ***2.3.3.1×2.1***
		= - m^3

11.3.2 Purchases at a higher tariff = ***11.2.2-2.3.3.1***

= ___-___ m^3

11.3.3 Water costs at tariff 3 = ***2.3.3.2***/100×***11.3.1***

= R___-___

11.4 Water purchases at tariff 4

11.4.1 Quantity

If ***11.3.2*** ≤ ***2.3.4.1*** = ***11.3.2***×***2.1***

= ___-___ m^3

If ***11.3.2*** > ***2.3.4.1*** = ***2.3.4.1***×***2.1***

= ___-___ m^3

11.4.2 Purchases at a higher tariff = ***11.3.2-2.3.4.1***

= ___-___ m^3

11.4.3 Water costs at tariff 4 = ***2.3.4.2***/100×***11.4.1***

= R___-___

11.5 Water purchases at tariff 5

11.5.1 Quantity

If ***11.4.2*** ≤ ***2.3.5.1*** = ***11.4.2***×***2.1***

= ___-___ m^3

Otherwise maximum ***2.3.5.1*** = ***2.3.5.1***×***2.1***

= ___-___ m^3

11.5.2 Water costs at tariff 5 = ***2.3.5.2***/100×***11.5.1***

= R___-___

11.6 Total water cost = ***11.1.3+11.2.3+11.3.3+11.4.3+11.5.2***

= R 25 024

12. Labour costs

12.1 Labour hours required = ***10.3***/24hrs×***1.1***

= 2 486 hrs/yr

12.2 Total labour cost per year = ***5.1***×***12.1***

= R 6 364.16

12.3 Labour costs per m^3 of water pumped = ***12.2***/***10.1***

= R 0.0356 /m^3

13. Repair and maintenance costs

13.1 Annual repair and maintenance costs of the lateral pipe

= (***7.2, column 1, item 1***)×***5.2.1***/100×***10.3***/1 000hrs

= R 393.77

13.2 Annual repair and maintenance costs of the dragline pipe

= (***7.2, column 1, item 2***)×***5.2.2***/100×***10.3***/1 000hrs

= R 487.80

13.3 Annual repair and maintenance costs of the sprinkler and stand

= (***7.2, column 1, item 3***)×***5.2.3***/100×***10.3***/1 000hrs

= R 710.57

13.4 Annual repair and maintenance costs of the -

= (***7.2, column 1, item 4***)×***5.2.4***/100×***10.3***/1 000hrs

= R -

13.5 Annual repair and maintenance costs of the -

= (***7.2, column 1, item 5***)×***5.2.5***/100×***10.3***/1 000hrs

= R -

13.6 Annual repair and maintenance costs of the -

= (***7.2, column 1, item 6***)×***5.2.6***/100×***10.3***/1 000hrs

= R -

13.7 Total annual repairs and maintenance cost

= ***13.1+13.2+13.3+13.4+13.5+13.6***

= R 1 592.14

13.8 Annual repair and maintenance costs per m^3 of water applied

= ***13.7/10.1***

= R 0.0089

SECTION 4: SUMMARY OF COSTS

14. ANNUAL COSTS FOR PLANNED WATER APPLICATION

14.1 Fixed costs

14.1.1 Total annual ownership cost = ***9.1***

= R 3 872.86

14.2 Variable costs

14.2.1 Total water cost = ***11.6***

= R 25 024.00

14.2.2 Total labour cost = ***12.2***

= R 6 364.16

14.2.3 Total repairs and maintenance cost = ***13.7***

= R 1 592.14

14.3 Total cost per year = ***14.1.1+14.2.1+14.2.2+14.2.3***

= R 36 853.16

15. COST ALLOCATION

15.1 Fixed costs per hectare of crops grown = ***9.1/1.2***

= R 203.83 /ha

15.2 Labour costs per m^3 of water pumped = ***12.3***

= R 0.0356 $/m^3$

15.3 Repair and maintenance costs per m^3 of water pumped = ***13.8***

= R 0.0089 $/m^3$

15.4 Water costs

	TARIFF	WATER PUMPED			COSTS	
15.4.1	1	***11.1.1***	= 179 000 m^3	***2.3.1.2***/100	= R 0.1398	$/m^3$
15.4.2	2	***11.2.1***	= - m^3	***2.3.2.2***/100	= R -	$/m^3$
15.4.3	3	***11.3.1***	= - m^3	***2.3.3.2***/100	= R -	$/m^3$
15.4.4	4	***11.4.1***	= - m^3	***2.3.4.2***/100	= R -	$/m^3$
15.4.5	5	***11.5.1***	= - m^3	***2.3.5.2***/100	= R -	$/m^3$

16. MARGINAL FACTOR COSTS

Additional costs to apply an extra unit of water (m^3)

= ***15.2+15.3+*** [***15.4.1*** or ***15.4.2*** or ***15.4.3*** or ***15.4.4*** or ***15.4.5***][3]

= R 0.1843

3. Marginal water costs is the total amount for the last tariff increment at which water was purchased divided by quantity applied at this tariff.

APPENDIX 4.A

QUESTIONNAIRE CHECKLIST BASED ON THE SAPFACT FRAMEWORK

LAND

1. Would you give your brief history as a farmer: how and when you acquired land and started farming.
2. What is the total area of your land? Is this what you started with or you have had to increase it over time?
3. Do you own the land you farm on?
4. Do you have any plans of expanding your operation?
5. Including the cultivated area, how much land do farmers hold in hectares?
6. What are the farmers' plans for expansion? Do they want to expand or not? What are the constraints if they want to expand?

IRRIGATION SYSTEM

7. What irrigation system(s) do you use?
8. What area of land is under irrigation?
9. When did you purchase/install the irrigation system(s)? What was the system price then?
10. Where do you get your irrigation water and how do you bring the water to the field for irrigating?
11. Do you pay for irrigation water? If so what is the cost per hectare?
12. Do you pay for irrigation water monthly or annually?
13. Where do you get finance to run your irrigation farming?
14. What problems do you experience in your irrigation farming?
15. Do you schedule your irrigation or do you only irrigate when you feel it is necessary to do so?
16. Are farmers getting technological advice, that is, are irrigation specialists advising farmers on irrigation matters and giving recommendations for system changes e.g. from flood to sprinkler or drip? Do farmers receive irrigation training?
17. Do flood irrigation farmers maintain the furrows' slopes to ensure good pressure so that irrigation is effective? What type of furrow is used? Permanent (concrete) or temporary (earth)?
18. What are electricity charges for farmer 3, monthly and standing charges? What is the estimation of his irrigation system (electric motor, pipes and sprinklers)? How many motors does he use?
19. How much can farmer 3 estimate to be the initial cost of the sprinkler irrigation system he is using, so that we can determine the system's purchase price?
20. Do farmers have water use rights? Are they allocated a stipulated amount of water per year or are they not? Do they belong to water users committees or not?

C. MECHANIZATION

21. What machinery do you own?
22. When was it purchased and at what price?
23. Do you pay insurance for your machinery? How much?
24. What is your license fee per year?
25. What problems do you experience with your machinery?
26. Do you have access to machinery parts and machinery service?
27. What are your annual machinery repairs cost?
28. Does farmer 3 keep stock of diesel or buys only when he needs it, what is his monthly diesel usage?
29. Do farmers keep farming records including purchases records, production records, financial records? Will they be willing to pay for services of a bookkeeper or accountant to draw up their business books so that they will be in a position to know how their business is doing?
30. In the case of vegetable farmers, will they be willing to join farmers' group/association, which will jointly sell their vegetables? That is, something like a cooperative?

D. LABOUR

31. Do you work full time on your farming enterprise?
32. Do you employ labour (permanent and/or temporary) or do you use family labour?
33. How big is your household?
34. Do all the family members work on the farm or are some on off-farm employment?
35. When do you experience peak labour demand and what activities are involved during the peak labour demand?
36. If you employ labour, what is the average salary per month in the case of permanent workers and daily/hourly rate for casual labourers?
37. How many workers do you have on your farm?
38. What do your workers do, i.e. job description for permanent and casual workers?
39. Are workers trained by the farmer, external agencies or not trained (got experience from working over the years)?
40. What is the attitude of the farmers on the government set minimum wage for farm workers?

E. CROP ENTERPRISE

41. What crop(s) do you grow?
42. What area (ha) does each crop occupy?
43. What area of crop is on irrigation?
44. What irrigation system do you use on each crop?
45. Do you consider the irrigation system you are using suitable for your crops?
46. If not, can you tell which irrigation system you prefer and why?
47. During drought periods, do you experience water shortage for irrigating your crops?

48. Do you have a reliable supply of seeds for the crops you grow?
49. If not, what makes it difficult for you to obtain the type of seeds you want?
50. Do you have access to the following:
    (a) fertilizers
    (b) pesticides
    (c) equipment parts and
    (d) maintenance
51. If not explain why it is not possible to get them and what you think could be done to avail them?
52. Do you have access to extension service or technical advice?
53. If yes, is it a paid consultant or a government extension officer?
54. If no, do you think there is need for technical advice?
55. What is your average production per hectare in tons?
56. Do you apply pests, disease, and insect control measures to prevent your crop(s) from being harmfully affected or damaged?
57. Do you apply fertilizers to your crop s)?
58. Why do you grow crops, in other words, what is your motivation for growing crops?
59. Comparing yourself with other small-scale farmers, are you satisfied with the yield you are producing?
60. Do you keep records of your farming enterprise?
61. If yes, what type of records do you keep?
62. What marketing channel(s) do you use to market your product or produce?
63. How much profit do you make from your farming enterprise per year?
64. What is your production cycle plan like, i.e. when do you start your production for the year and what activities do you go through from preparation to harvesting to marketing?
65. Besides your farming business, what other sources of income do you have e.g shop, bottle store, rented house/hostel or any commercial properties?
66. If you do not own land, what is it that you should do to acquire land from the chief?
67. What other production costs do you incur? Do you pay royalties to the chief? How often and how much?
68. Would you give a list of all the assets you have?
69. Do you have loans with banks? How much do you pay per month and what was the loan used for?
70. During peak labour demands where do you get workers/labourers?
71. How much water is available for irrigation say per hectare for a production year?
72. How much do you spend on family expenses per year? (e.g. food, clothing, school fees, etc.)
73. What is the source of information for farmers? E.g. on what do vegetable farmers' base their product prices.
74. Generally what are the objectives of farmers, why do they farm?

75. What packaging materials do vegetable farmers use and how much and where do they buy them? E.g. 80kg empty bag (sack), plastic bags for packaging vegetables.
76. What operations and implements are used by farmers in farming e.g ploughing, planting etc.

F. *FINANCING*

77. Is there awareness of the effect of the loan system of the commercial banks on farmers?
78. Is there awareness that for farmers not making profit could fill in a tax return form to recover some of the income tax?
79. Are farmers VAT registered so that they could claim back the VAT charges from buying agricultural inputs?
80. What are the loan (FAF) balances for farmer 1 and 2? This is vital to help determine their fixed obligations in developing their financial statements using the FARMS model.
81. Does farmer 3 have a retention account with FAF and whether he is able to use it
82. Do vegetable farmers have bank accounts with commercial banks, do they borrow money from banks for running their farming businesses?
83. Do farmers have access to banking facilities and services near them? If farmers have access to banking services, are the loan arrangements favorable given the situation of farmers, that is, is there flexibility in loan repayment arrangement?

G. *OTHERS*

84. What community development or activities do farmers engage in?
85. What are the distances of Barbeton, Mzinti, Mtata, Vlakbult and Magudu from Nelspruit or Malelane and Malelane-Nelspruit? What are the transport charges if farmers have to travel to buy their farming inputs?
86. What are the ages of farmers and are their children interested in farming to take over when the fathers retire?
87. What forums do farmers belong to that help them in their farming e.g. farmers' groups, advisory classes, etc?
88. Do farmers receive information and training, for example through arrangements like farmers days, workshops, field demonstrations, farmers' shows etc

APPENDIX **4.B**

DESCRIPTION OF THE OTHER FOUR CASE STUDY FARM BUSINESSES

4B.1 FARMER 2

4B.1.1 General management

The farmer is about 65 years of age and has not completed primary education. He has a wife and eight children; only two are at home and others are employed in different sectors. The farmer acquired farming land from the chief in 1962 and started farming cotton and maize. The farmer started with 6 ha on which he planted maize and cotton on 4 ha. In 1997 the farmer changed to sugarcane because the extension officers advised him that there were better profits in sugarcane. Cotton was not doing well then because prices for it were relatively low. The farmer has 10 ha planted to sugarcane and on the other 10 ha he wants to plant seed cane under drip-irrigation.

The reasons the farmer gave for engaging in farming included better family living standards and a profitable farming business. The farmer does not keep farming records that could be helpful in planning, decision-making and for control purposes. He is conservative in his management style and does not disclose information easily. The farmer has taken steps to expand the farming operation and plans to install drip-irrigation in the expansion area. Extension service is available from both government extension officers and from TSB and he finds it helpful. He is a full-time farmer.

4B.1.2 Land tenure

The farmer acquired the 20 ha farming land from the chief in 1962 and he uses it on RTO basis. The farmer said he hand-cleared it piece by piece over the years until the whole 20 ha were cleared of trees. He found it a difficult exercise but had to do it.

4B.1.3 Irrigation management

The farmer uses flood-irrigation on his 10 ha, but would like to install drip-irrigation on the other 10 ha to save water. The farmer currently uses a diesel pump to pump water from Komati River to the field. The farmer pays R65/ha per year for water. The farmer got the initial finances to start his farming from family savings as he used to work in the mines. He also received an FAF loan from TSB under the small grower division.

The following were stated to be problems experienced in irrigation farming: finance to pay the labourers; he finds diesel pump expensive to run e.g., the farmer uses about 2 500 ℓ of diesel/year; transport to run the business, i.e. to go and buy inputs and run other business chores. He wants to install electricity, but has to pay around R80 000, which he does not have.

The farmer does not schedule his irrigation activity, but uses judgement/observation to determine the next irrigation. Since irrigation water is not rationed for the farmer, it was not possible for the farmer to say how much irrigation water is available per hectare in a production year. The farmer noted that rivers sometimes run dry and this poses water shortages for irrigation.

The farmer has the following machinery and implements: Fiat 650 bought second-hand in 1984; Deutz diesel pump, 3-cylinder and pipes also bought in 1984 (estimated cost was said to be around R11 500). Disc plough, mouldboard plough, harrow, cultivator as well as a planter were bought second-hand in 1998 at an estimated cost of R11 000 all inclusive; Borges tractor; an old Ford van which he bought in 1998 and which he estimates to be worth R5 000. The farmer has not insured his mechanization and hence does not pay any insurance premium. The farmer pays no license fee. The farmer indicated that he experiences problems with machinery in that he has to pay large sums of money to the Deutz garage in Hectorspruit for repairs. This is where he also gets the engine parts. He estimated the repair costs for the year to be around R12 000 for the engine, R2 500 for the tractor and R800 for the pump.

4B.1.4 Labour Management

The farmer employs both permanent and temporary labourers. He stated that his children do not want to work on the farm. Of his 8 children only two are at home and the others are employed in different sectors (two are teachers, one is an engineer, one is a pilot in Swaziland and another works in Johannesburg), and one is still at school. The farmer experiences peak labour demands when he has to weed, fertilize, and cut sugarcane. A total of four permanent workers are employed and they concentrate on irrigation, spot weeding and planting, while one of the permanent workers is a tractor driver. Temporary workers are paid R8.50/day and permanent workers R12.50/day. The farmer's wife is also paid R12.50/month for working at the farm. During peak labour demands, temporary labour is available from the village (Magudu).

4B.1.5 Crop enterprise analyses

(a) Crop management practices

The farmer grows sugarcane on 10 ha and on the other 10 ha he wants to grow seed cane. The farmer has access to fertilizers, pesticides, and equipment parts. However, the farmer says he services his mechanization himself. No pesticides are applied to sugar, but instead prevention measures are taken by insuring that thorough weeding is done and the pieces of straw are picked and/or burnt to prevent insects from hiding in them and become a problem to the next crop. However, herbicides are sometimes administered after harvesting to prevent germination of weeds. Application of fertilizer is highly dependent on the recommendations of the soil analyst. The farmer takes soil samples every year to be analyzed and pays R50 for soil sample processing or analysis.

A loan for buying drip-irrigation pipes was taken from ABSA bank in 1999 and it amounted to R80 000. FAF however provided the initial finances for the establishment of sugarcane. No other sources of income are available to the farmer besides pension money. For family expenses the farmer quoted R800 every month. The crop enterprise budget for the farmer is presented below.

(b) Crop enterprise budget

A crop enterprise budget was developed for case study farmer 2 and is presented in Table 4.3. An analysis of the crop budget is also presented to show sugarcane profitability.

Sugarcane

The crop enterprise analysis showed that sugarcane was profitable, yielding a gross margin of R2 722/ha and income above specified costs of R2 618/ha. The cost of production for sugarcane was R101.25/ha, and since this was less than the selling price of R121.75/ton, it means the farmer made a profit. The breakeven yield was 107.55 tons/ha and the breakeven price was R101.45/ton. When the farmer's production was compared with the industry average, it was found that the farmer produces 129.07 tons/ha, which is above the industry level of 100 tons/ha. However, there is still room for improvement, especially on the quality of the crop (sucrose level), since the farmer is still at a learning stage in sugarcane production. The sucrose percentage of the farmer's cane was 11.35% while the industry average was 13%. The farmer can increase his income by increasing the quality of his sugarcane. He also has to increase the fertiliser applications to increase crop productivity and quality. The sugarcane is in the 2-7 years production stage.

The establishment costs for sugarcane ranged from R9 938 to R13 184/ha and the income above specified costs in the first year ranged from –R123 to R2 703 for small-scale commercial irrigation farmers who are on schemes. The income above specified costs for these farmers in the 2-7 years production stage ranged from R1 893 to R5 356/ha (Pretorius, 2000). When this farmer is compared with farmers on schemes it was realised that he compared well with them with income of R2 618.24 above specified costs. However, there is still room for improvement as far as crop management practices are concerned.

Table B.1: Crop enterprise budget for case farmer 2: Sugarcane, 10 ha, Year 2-7, Flood-irrigation, 2001.

Gross income	**Unit**	**R/unit**	**Quantity**	**R/ha**	**Total Value (R)**
Sugarcane	Ton	121.75	129.07	15 714.27	157 130.00
Gross Income					
Variable costs					
Soil sample	sample	50.00	1.00	0.2	50.00
Fertilisers : 2:3:2 (22)	Kg	1.43	40.00	57.00	572.00
5:1:5 (46)	Kg	1.57	200.00	314.00	3 140.00
Harvesting	R	6.50	129.07	839.00	8 390.00
Transport	R	37.53	129.07	4 844.00	48 440.00
Levies and charges	R	2.02	129.07	261.00	2 607.00
Labour	R/h	1.47	358.00	522.48	5 264.80
Interest	R		1.00	597.39	5 973.85
Irrigation cost:					
Repairs	R			1 270.00	11 270.00
Diesel	R			3655.60	36 556.00
Lubrication	R			731.12	7 311.20
Labour	R/h			33.80	338.00
Total variable costs:				12 991.27	129 912.65
Gross margin				2721.70	27 217.00
Fixed costs					
Irrigation	R			103.50	1 035.00
Total specified costs	R			13 094.77	130 947.65
Income above specified costs				2 618.24	26 182.35

1. Crop water requirement per season = 1 300 mm
2. Recoverable Value (RV) = 11.35%

The crop budget analysis has shown that the farmer operated a profitable sugarcane enterprise as shown by income above specified costs of R2 618.24. This income can be increased by improving the quality of the sugarcane (sucrose content) since the yield level is above industry level at 129 tons/ha.

4B.2 FARMER 3

4B.2.1 General management

The farmer is about 54 years of age, was a secondary schoolteacher and is active in politics. He has a wife and four children, the three daughters are married away and the son is a privately practising clinical psychologist. His farming objectives included affording a comfortable lifestyle and to run a profitable farming business. The farmer believes farming can be profitable as he saw it when he grew up, as his parents worked on the farms.

The farmer started by running a filling station at Kanyamadzani in 1989. In 1993 the farm he is farming on was available for sale and he used the savings from the filling station as contribution to buying the farm. He got a loan from PAM, a buildings bank then, which is now the Peoples' Bank, to buy the initial 80 ha at R330 000. The following year another 42 ha was available for sale including the farmhouse, and he bought it for R400 000. The farmer serviced the loan from the savings he made from the filling station. The savings were estimated to be about R5 000 per month. Currently the farmer has a quota for 40 ha with TSB to grow sugarcane, but could only supply 35 ha worth of sugarcane last year. Having started from 4 ha of sugarcane the farmer made sure that each year he used part of the cane as seed cane to expand on the production area. The farmer has plans to expand the area planted with sugarcane each year and wants to negotiate for a larger quota with TSB. He keeps expenses records. These could be used together with other farming records to draw up accounts to aid decision-making as well as for control purposes. The farmer is a part-time farmer since he operates other businesses apart from farming.

4B.2.2 Land tenure

The farmer owns the farm he is farming on. He took loans from the bank to buy it as it became available. The farmer has a title deed to the farming land and can use it as collateral to source external finance.

4B.2.3 Irrigation management

Sprinkler-irrigation is used to irrigate sugarcane, which covers 35 ha, and the farmer finds the system suitable for irrigating his crop. No water shortages are experienced during drought seasons. When the farm was bought the irrigation system was in place and it is still working perfectly to date. Irrigation water is from Dekaap River and an annual fee of R200/ha is paid for water. The farmer runs the farming business from a FNB (First National Bank) overdraft, which is currently to the tune of R20 000 per year. So far the farmer has not experienced problems in his irrigation farming. Irrigation is scheduled from 06:00 to 18:00 except when it rains.

The farmer owns a tractor, Massey Ferguson 165 worth R40 000; a disc plough worth R10 000; and a ripper worth R5 000. The farmer pays R1 500/month for whole farm insurance, but no license fee is paid. The most prevalent problem with machinery is breakdowns. Machinery parts are available at Ericon where the farmer also services his machinery. The farmer was not able to tell the annual service costs. The farmer paid R500 every month for electricity he uses for irrigating his crop. There was no rationing of water so the farmer did not know how much irrigation water was available for irrigation per hectare on annual basis.

4B.2.4 Labour management

A paid manager is employed to manage the farming operations and is paid R10 000 per year. The manager is also a brother of the farmer, and has on-farm housing provided. Four permanent labourers are employed at a rate of R15/day, and the driver is paid R20/day. Temporary labour on the other hand is paid R10/day plus a weekly supply of 7.5 kg of maize meal. On average eight temporary workers are employed. No family labour works on the farm. Permanent workers take care of the irrigation and do spot weeding, and temporary workers are needed in summer when weeding and fertilization has to be done and when new sugarcane has to be planted. Around June-July temporary labour is needed for cutting cane (harvesting). During peak labour demands, labourers are sourced from Barberton and there were some Mozambiquans who walk up and down the road looking for someone to pick them up for a piece job who also provide temporary labour.

4B.2.5 Crop enterprise analyses

(a) Crop management practices

The main crop grown was sugarcane and it occupies 35 ha. The other 45 ha is not used. The farmer explained that before he could expand his operation he has to get a quota increase from the TSB, otherwise if he just expands he will not be able to sell his cane. The farmer also raised concerns that quota increases were not easy to get. Seed cane is taken from the farm so there is no supply problem for it. Fertilizers, pesticides, and herbicides are available from the cooperative in Barberton. Equipment parts and servicing are available from Ericon Garage.

Extension service is available from TSB and government extension officers. The farmer finds advice by extension officers very helpful. The production for the farmer was around 55 tons/ha. The extension officer considered this low and the reason for such low yields could be fertilization and weed control, which the farmer also admitted, could be true. The farmer said he applied fertilizers and had plans to put in some herbicides, but was prevented by weather conditions. Although there was room for improvement the farmer said he was satisfied with the yield he is getting if he compares himself with other farmers around him. A bookkeeper was employed to keep farming records and was paid a fee of R500. Expenditure and purchases records were superficially kept. The sugarcane production cycle is from June to June. Besides the farming business, other sources of income include filling station and housing rent.

The farmer had the following assets: two on-farmhouses, one leased and the other occupied by the farm manager, a Raider van, 1996 model, a Mercedes Benz car and a house he is living in. The farmer has a loan with FNB (overdraft) for which he pays a monthly amount of R1 500. He also has a loan with The Peoples' Bank. The farmer outlined the following to be his annual family expenses: R24 000 for food; R5 000 to R6 000/year for his own clothes; R10 000/year for the wife's expenses. The crop enterprise budget for the farmer is given below. The author compiled it from personal visits to the farmer and discussions with advisors.

(b) Crop enterprise budget

A sugarcane enterprise budget was developed for farmer 3 and is presented in Table 4.4. An analysis of the sugarcane enterprise budget was done to determine crop profitability and is also presented.

Sugarcane

The analysis of the crop enterprise budget showed that the sugarcane enterprise was profitable. It yielded gross margin of R1 707/ha and income above specified costs of R1 155.57/ha. The cost of production was R102.70/ton. The selling price for the farmer's sugarcane was R121.75/ton. Since this is higher than the production cost, the farmer made a profit. The breakeven yield was 46.05 tons/ha and the breakeven price was R102.70/ton. When the farmer's production was compared with the industry average it was found that the farmer was producing 55.28 tons/ha, which is below the industry average of 100 tons/ha. However, there is still room for improvement since the farmer is fairly new in sugarcane production. This also suggests that the farmer can increase his income by increasing his yield levels because the crop quality is good at 13.85% and he should maintain or even increase it. The sugarcane is in the 2-7 years production stage. The establishment costs for sugarcane ranged from R9 938 to R13 184/ha and income above specified costs in the first year of production ranged from -R123 to R2 703/ha for small-scale commercial irrigation farmers who are on schemes. The income above specified costs of these farmers in the 2-7 years production stage ranged from R1 893 to R5 356/ha (Pretorius, 2000). When this farmer is compared with this category of farmers it was realised that the farmer is realising lower income above specified costs at R1 155.57/ha. The reason could be that the farmer applied low fertiliser levels and obtained low yields, which translated into low income.

Table B.2: Crop enterprise budget for case farmer 3: Sugarcane, 35 ha, Year 2-7, Sprinkler-irrigation, 2001.

Gross income	Unit	R/unit	Quantity	R/ha	Total Value (R)
Sugarcane	Ton	123.28	55.28	68 32.81	239 148.00
Gross Income					239 148.00
Variable costs					
Soil sample	sample		1.00		50.00
Fertilisers : 2:3:2 (22)	Kg	1.94	40.00	78.00	2 716.00
5:1:5 (46)	Kg	1.57	500.00	785.00	27 475.00
Harvesting	Ton	7.98	55.28	441.00	15 440.00
Transport	Ton	45.54	55.28	2 517.00	88 111.00
Levies and charges	Ton	1.79	55.28	98.97	3 464.00
Labour	R/h	1.66	165.71	275.71	9 650.00
Interest	R		1.00	191.80	671.08
Irrigation cost:					
Repairs	R			332.63	11 642.00
Electricity	R			500.00	17 501.00
Lubrication	R			50.00	1 750.00
Labour	R/h			27.00	933.00
Total variable costs:					179 403.08
Gross margin				1 707.00	59 745.00
Fixed costs					
Irrigation	R			551.43	19 300.00
Total specified costs	R			5 677.23	198 703.00
Income above specified costs				1 155.57	40 445.00

1. Crop water requirement per season = 1 200 mm
2. Recoverable Value = 13.85%

The crop enterprise analysis showed that case study farmer 3 operated a profitable sugarcane enterprise. However, there is still room for improvement. His yield level was far below the industry average at 55.28 tons/ha, and the reason could be that he applied low levels of fertilisers and is still on the learning curve. The farmer also needs to improve on his crop management practices especially weeding, because the researcher observed weeds in the sugarcane field during her visits to the farm.

4B.3 FARMER 4

4B.3.1 General management

The farmer is about 50 years of age and has completed primary education. He has a wife, four children and two grandchildren. He stays with his elderly mother and sister. No family member except him works on the farm. The farmer is a part-time farmer since he also works as a manager at another farm. The farmer started his farming operations in 1977 on half a hectare piece of land, and was producing melons for sale. To date the farmer operates on a 7 ha piece of tribal land for which he holds a RTO. He farms maize, cabbage, mangoes, peppers and tomatoes. The objectives of the farmer included a better family living standard, and to run a profitable farming business. The farmer is experienced in vegetable production, although he sometimes changes the crops grown as their market demand also changed. The farmer does not keep farming records that could be helpful in planning, decision-making and for control purposes.

4B.3.2 Land tenure

The land farmed is communal, that is, it is under the jurisdiction of the chief who may give permission to new operations or expansion of existing ones by issuing a RTO. The farmer expressed his desire to expand the cultivated area, but is uncertain whether the chief would allow him. The farmer holds a RTO to the currently cultivated land. The farmer does not pay any royalties to the chief.

4B.3.3 Irrigation management

Furrow-irrigation is used to irrigate the whole 7 ha field. The farmer used a diesel engine pump to pump irrigation water from the Mlomati River. The farmer could not remember how much he bought the engine for, and even worse the engine was taken away by floods in the 1999/2000 growing season and his crops were rain fed. No payment is made for irrigation water. The main problem that the farmer said he experienced was lack of funds to buy an engine to pump water so that he could irrigate his crops. The good news, however, is that the farmer managed to buy another diesel engine in early 2001 for R17 675. The farmer used the money he gets from working as a farm manager at another farm to run his own farming operations. He also explained that he encounters problems of high running costs, for example high diesel cost. The farmer does not schedule his irrigation, but uses subjective judgement to determine the next irrigation and how much to irrigate.

4B.3.4 Labour management

The farmer is a part-time farmer, since he has to spend some time at another farm where he supervises and oversees the farming operations. Both permanent and temporary workers are employed. Three permanent workers are employed and around seven temporary workers are employed when there is much to be done. Each worker is paid an amount of R6.00 per day because they work for only half a day. No family members work on the farm. Peak labour demand is around June to July including August when weeding, planting, fertilization and harvesting has to be done, especially for winter crops. Permanent workers do the routine work of weeding, putting in fertilizers and planting.

4B.3.5 Crop enterprise analyses

(a) Crop management practices

The farmer farms maize on 2 ha, cabbage on 1 ha, mangoes on 0.5 ha, peppers on 1 ha and tomatoes on 1 ha. Winter and summer crops are rotated and production is throughout the year. The farmer does not own machinery, but contracts machinery for soil preparation and planting maize at a rate of R540/ha. The only machinery he has is the small Borge tractor, which was provided through external donations for the purpose of cultivating cotton, which he never cultivated. Since the farmer does not own machinery, he does not have to pay for any insurance, license fee, repairs nor machinery parts. There is a reliable supply of seeds for the crops the farmer grows from Hygro-Tech in Nelspruit. The farmer also has access to fertilizers and pesticides from the same cooperative in Nelspruit. The farmer has access to government technical advice, and he finds it helpful. However, the farmer raised concerns that the extension service was inadequate. The researcher observed signs of poor management of mango trees. The trees were not pruned and after harvest the stalks to which fruits were attached were not nipped off as management practice to encourage more fruition in the next season. The farmer did not apply fertilizers to mango trees, but only to vegetables.

The farmer did not know his production in tons for his crop, but could estimate profit for some of the crops he grew, for example, he estimated that he is able to get about R4 000/ha for green maize, and about R20 000 for tomatoes which he sells in crates. He said he was able to sell 40 crates per day and a crate of tomatoes is R25.00. The farmer sells to hawkers and the local market. He was negotiating a contract to produce green beans and patty-pans which he would start in the next season. If he is successful with the contract the farmer applies pesticides, and insecticides to prevent his crop from being harmfully affected. Fertilizers are also applied e.g. 2:3:2(22) and 2:3:4 for poor soils and a follow up application with 1:0:1(36). If he compares himself with other farmers locally the farmer thinks he is satisfied with the yield he is getting, but he wishes to do better than he is currently doing.

The farmer's production cycle is that for winter vegetables are grown, and in summer maize and tomatoes are the rotation crops. Besides his salary of R1 500 per month as a manager, the farmer says he does not have other sources of income. He used to run a cooperative, but it is no longer in operation. For a list of assets the farmer gave the following; a Borge tractor and disc plough. The farmer does not have loans with banks. For peak labour needs workers are available locally. There is no water rationing so the farmer did not know how much water is available per hectare in a year. The farmer's expenses for the year were R9 600. The farmer's capital investment included 7 ha of farming land, which is utilised on RTO basis and was valued at R2 500/ha, since it is a production asset.

The farmer faces flood risk, and he installed his diesel engine just at the verge of the river and sends a short pipe into the river for pumping water. When the river is in flood the engine might get carried away in water. The farmer has to be watchful for the likelihood of heavy rains and be there when it starts raining to remove the engine so that it would not drown. He had his engine swamped in the 1999 floods and had to buy another engine as a result of the catastrophe.

(b) Crop enterprise budgets

The crop enterprise budgets for maize, cabbage, mangoes, peppers and tomatoes were developed for case study farmer 4. These crop enterprise budgets are presented in Tables B.3, B.4, B.5, B.6 and B.7 respectively. The analysis of the crop enterprise budgets is also presented to determine the profitability of each crop enterprise.

Maize

The analysis of the maize enterprise showed that it was profitable, yielding a gross margin of R6 910/ha and income above specified costs of R6 601.67/ha. The cost of production was R0.27/cob. Since this was less than the selling price of R0.70/cob, the farmer made a profit. The breakeven yield was 5 193 cobs/ha and the breakeven price was R0.27/cob. The farmer fared better than farmer 5 in maize production, but compared badly with farmer 1.

Table B.3: Crop enterprise budget for case farmer 4: Maize, 3 ha, Year 2-7, Flood-irrigation, 2001.

Gross income	Unit	R/unit	Quantity	R/ha	Total Value (R)
Maize	Cob	0.70	15 200.00	10 640.00	31 920.00
Gross Income					31 920.00
Variable costs					
Fertilisers 2:3:4 (33)	Kg	2.34	300.00	702.00	2 106.00
Seed	Kg	8.30	10.00	83.00	249.00
Soil preparation	Ha	540.00	1.00	540.00	1 620.00
Labour	Hr	1.25	88.00	110.00	330.00
Irrigation cost:					
Repairs	R			1 336.00	4 009.00
Diesel	R			484.79	1 454.36
Lubrication	R			96.96	290.87
Labour	R/h			377.00	1 131.00
Total variable costs:				3 730.00	11 190.00
Gross margin				6 910.00	20 730.00
Fixed costs					
Irrigation	R			308.36	925.07
Total specified costs	R			4 038.67	12 116.00
Income above specified costs				6 601.67	19 805.00

1. Crop water requirement per season = 300 mm

Cabbage

The analysis of the cabbage enterprise showed that it was profitable, yielding a gross margin of R7 769/ha and income above specified costs of R7 461/ha. The cost of production was R0.51/head. Since this was less than the selling price of R1.50/head, the farmer made a profit. The breakeven yield was 2 274 heads/ha and the breakeven price was R0.51/head. The farmer compared badly with farmer 5 in cabbage production considering the income above specified costs.

Table B.4: Crop enterprise budget for case farmer 4: Cabbage, 1 ha, Flood-irrigation, 2001.

Gross income	**Unit**	**R/unit**	**Quantity**	**R/ha**	**Total Value (R)**
Cabbage	Head	1.50	7 500.00	11 250.00	11 250.00
Gross Income					11 250.00
Variable costs					
Fertilisers 2:3:4 (33)	Kg	2.34	150.00	351.00	351.00
Seed	G	0.15	500.00	75.00	75.00
Malasol	Ml	0.17	250.00	43.00	43.00
Soil preparation	Ha	540.00	1.00	540.00	540.00
Labour	Hr	1.25	141.00	176.25	176.25
Irrigation cost:					
Repairs	R			1 336.00	1 336.00
Diesel	R			484.79	484.79
Lubrication	R			96.96	96.96
Labour	R/h			377.00	377.00
Total variable costs:				3 481.00	3 481.00
Gross margin				7 769.00	7 769.00
Fixed costs					
Irrigation	R			308.36	308.36
Total specified costs	R			3 789.36	3 789.36
Income above specified costs				7 461.00	7 461.00

1. Crop water requirement per season = 400 mm

Mangoes

The analysis of the mango enterprise showed that it was profitable, yielding a gross margin of R7 623 and income above specified costs of R7 469. The cost of production was R4.25/crate. Since this was less than the selling price of R25/crate, the farmer made a profit. The breakeven yield was 123 crates and the breakeven price was R4.25/crate.

Table B.5: Crop enterprise budget for case farmer 4: Mangoes, 0.5 ha, Flood-irrigation, 2001.

Gross income	Unit	R/unit	Quantity	R/ha	Total Value (R)
Mangoes	crate	25.00	720.00	18 000.00	9 000.00
Gross Income					9 000.00
Variable costs					
Labour	Hr	1.25	380.00	456.00	228.00
Irrigation cost:					
Repairs	R			1 336.00	668.00
Diesel	R			484.79	242.5
Lubrication	R			96.96	49.00
Labour	R/h			377.00	189.00
Total variable costs:				2 754.00	1 377.00
Gross margin				15 246.00	7 623.00
Fixed costs					
Irrigation	R			308.36	154.00
Total specified costs	R			3 062.00	1 531.00
Income above specified costs				14 938.00	7 469.00

1. Crop water requirement per season = 450 mm

Peppers

The analysis of the pepper enterprise showed that it was profitable, yielding a gross margin of R1 865/ha and income above specified costs of R1 556.64/ha. The cost of production was R2.46/kg. Since this was less than the selling price of R3.50/kg, the farmer made a profit. The breakeven yield was 1 055 kg/ha and the breakeven price was R2.46/kg. The farmer compared better with farmer 5 in the production of pepper considering the income above specified costs.

Table B.6: Crop enterprise budget for case farmer 4: Peppers, 1 ha, Flood-irrigation, 2001.

Gross income	Unit	R/unit	Quantity	R/ha	Total Value (R)
Peppers	Kg	3.50	1 500.00	5 250.00	5 250.00
Gross Income					5 250.00
Variable costs					
Fertilisers: 1:0:1 (36)	Kg	2.34	100.00	234.00	234.00
2:3:2 (22)	Kg	1.43	100.00	143.00	143.00
Soil preparation	Ha	540.00	1.00	540.00	540.00
Seeds	G	0.19	250.00	48.00	48.00
Labour	Hr	1.25	100.00	125.00	125.00
Irrigation cost:					
Repairs	R			1 336.00	1 336.00
Diesel	R			484.79	484.79
Lubrication	R			96.96	96.96
Labour	R/h			377.00	377.00
Total variable costs:				3 385.00	3 385.00
Gross margin				1 865.00	1 865.00
Fixed costs					
Irrigation	R			308.36	308.36
Total specified costs	R			3 693.36	3 693.36
Income above specified costs				1 556.64	1 556.64

1. Crop water requirement per season = 450 mm

Tomatoes

The analysis of the tomato enterprise showed that it was profitable, yielding a gross margin of R9 927/ha and income above specified costs of R9 618.64/ha. The cost of production was R17.06/kg. Since this was less than the selling price of R25/crate, the farmer made a profit. The breakeven yield was 409.41 crates/ha and the breakeven price was R17.06/crate. The farmer compared better with farmer 5 in the production of tomatoes considering the income above specified costs.

Table B.7: Crop enterprise budget for case farmer 4: Tomatoes, 1 ha, Flood-irrigation, 2001.

Gross income	**Unit**	**R/unit**	**Quantity**	**R/ha**	**Total Value (R)**
Tomatoes	Crate	25.00	600.00	15 000.00	15 000.00
Gross income					15 000.00
Variable costs					
Fertilisers: 2:3:4 (33)	Kg	1.94	100.00	194.00	1 552.00
LAN	Kg	0.99	100.00	99.00	99.00
Red miller	G	1.00	75.00	75.00	75.00
Seed	Kg	0.56	500.00	280.00	280.00
Soil preparation	Ha	540.00	1.00	540.00	540.00
Labour	Hour	1.25	185.00	232.00	232.00
					2 778.00
Irrigation cost:					
Repairs	R			1 336.00	1 336.00
Diesel	R			484.79	484.79
Lubrication	R			96.96	96.96
Labour	R/h			377.00	377.00
Total variable costs				5 073.00	5 073.00
Gross margin				9 927.00	9 927.00
Fixed costs					
Irrigation	R			308.36	308.36
Total specified costs	R			10 235.36	10 235.36
Income above specified costs				9 618.64	9 618.64

1. Crop water requirement per season = 500 mm

The analysis of the crop enterprise budgets for maize, cabbage, mangoes, peppers and tomatoes showed that case study farmer 4 operated profitable crop enterprises. They realised income above specified costs of R6 601.67, R7 461, R7 469, R1 556.64 and R9 618.64 respectively. The problem that he sometimes faces is markets for his produce, because the local market cannot buy all his vegetables and the hawkers are an unreliable market. The farmer is experienced in his vegetable production and changes the crops grown as their market demand also changes. He has a business mind and knows what he is doing.

4B.4 FARMER 5

4B.4.1 General management

The farmer is about 87 years of age and has not completed primary education. He has a wife and eleven children, but only a 38-year old son and his wife work on the farm. The farmer went blind recently and the son has taken over as the farm manager. He acquired farming land from the chief in 1942. The initial 3 ha land was hand-cleared piece by piece over the years. Maize was the only crop grown then, most of which was sold and the other portion used for home consumption. In 1972 the land area was increased to 4 ha and vegetables were also produced for selling. Farming land is not owned by the farmer, it is tribal land and is utilized on RTO basis, that is, the right to occupy land and/or utilize it, is given by the chief. The farmer desires to expand his farming area, but is unsure whether he will get permission from the chief.

The objectives of the farmer included better living standard for the family and to run a profitable farming business. The farmer is experienced in his flood-irrigated vegetable production. He does not keep any farming records to help him plan, make informed decisions and employ appropriate control measures. The farmer produces maize, cabbage, sugar beans, beetroot, pepper and tomatoes. He uses his own capital to run his farming operations.

4B.4.2 Land tenure

The farmer acquired farming land from the chief in 1942. He holds a RTO for it, a document giving him permission to utilise the land and not to own it. The farmer further noted that no individual can own land in a communal area, but only a right to occupy a piece of land may be given by the chief.

4B.4.3 Irrigation management

Furrow-irrigation is used to irrigate the 4 ha field on which is grown maize, tomatoes, cabbage, beetroot, potatoes, sugar beans and chillies. The farmer uses a diesel engine to pump water from Nkomazi River for irrigation. He estimates the engine price to have been R800.00 in 1964 when he bought it. The farmer does not pay for irrigation water. Since there is no rationing of water, the farmer could not tell how much irrigation water is available per hectare in a production year. Profit from the farm is used to run the irrigation operation.

The greatest problem that the farmer experience is markets for his produce. He says the local market does not buy all of his produce and the vegetables spoil because they are highly perishable. The farmer does not have problems with maize, because he also uses it for family food needs. No irrigation scheduling is followed, and the farmer uses his judgement to determine the next irrigation.

The farmer owns a Massey Ferguson 135 tractor bought second-hand in 1978 for R12 000, a trailer bought for R7 200, and a disc plough bought for R8 000. Machinery is not insured, hence there is no insurance premium paid. The farmer pays no license fee. He also indicated that he did not experience any machinery problems.

Machinery parts and spares are bought from a Toyota garage in Malelane and the farmer services his machinery himself. He estimated the annual repair costs to be around R7 000.

4B.4.4 Labour management

The farmer, now a son who has taken over, is full time in the farming business, and employs both permanent and temporary labourers. Peak labour demands are experienced in July to October when planting, ploughing, fertilizer application, weeding, and harvesting has to be done. One permanent worker is employed and is paid at a rate of R10.00/day. About 6 to 7 temporary workers are employed and are paid at a rate of R5.00/day and do work for half a day. The permanent worker takes care of irrigation, while temporary workers the fertilizer application, weeding and harvesting. During peak labour demands labour is available locally.

4B.4.5 Crop enterprise analyses

(a) Crop management practices

The farmer grows maize on 2 ha of the field, tomatoes on 1 ha, cabbage on 1 ha, beetroot on 0,5 ha and sugar beans on 1 ha. Maize and sugar beans are summer crops and are rotated with vegetables, most of which are winter crops. The whole 4 ha field is on furrow-irrigation and the farmer finds the irrigation system he uses suitable. No water problems are experienced during drought periods. LTK cooperative in Malelane provides a sure supply of seeds for the crops grown. Inputs such as fertilizers, pesticides, and insecticides are also available from the same co-operative. The main problem is transporting the inputs from Malelane to Mzinti, and the farmer has to contract someone to bring the inputs to the farm.

The farmer expressed his dissatisfaction about the service of the government extension service. The farmer was not able to tell his production in tons per hectare and no farming records are kept. The farmer applies insecticides, pesticides, and fertilizers e.g. Malasol - an insecticide, Coperavate – a pesticide, as well as the following fertilizers: 2:3:2(22) and 1:0:1(36) to his crops to prevent them from being harmfully affected and to get high yields. He considered himself not doing badly when he compared himself with other farmers in the neighbourhood.

Crop production takes place all the year round. Besides the farming business the only other source of income is pension. Other production costs incurred included transporting inputs from where they are bought to the farm. The farmer does not have loans with banks. The farmer's family expenses for the year were R12 960.

The crop enterprise budgets for the farmer are given below. The author compiled them from personal visits to the farmer and discussions with advisors.

(b) Crop enterprise budgets

The crop enterprise budgets for maize, cabbage, sugar beans, beetroot, peppers and tomatoes were developed for case study farmer 5. These crop enterprise budgets are presented in Tables B.8, B.9, B.10, B.11, B.12 and B.13 respectively. The analysis of each crop enterprise budget was done to determine its profitability and the results are presented for each crop enterprise.

Maize

Crop enterprise analysis showed that maize was profitable, yielding a gross margin of R3 917.80/ha and income above specified costs of R3 112.13/ha. The cost of production was R0.40/cob, and since the production cost was less than the selling price of R0.70/cob the farmer made a profit. The breakeven yield was 5 954 cobs/ha and the breakeven price R0.40/cob. When compared with case farmers who produced maize it was found that he compared unfavourably with farmers I and 4 in terms of income above specified costs.

Table B.8: Crop enterprise budget for case farmer 5: Maize, 2 ha, Flood-irrigation, 2001.

Gross income	Unit	R/unit	Quantity	R/ha	Total Value (R)
Maize	Cob	0.70	10 400.99	7 280.00	14 560.00
Gross Income					14 560.00
Variable costs					
Fertilisers 2:3:2 (22)	Kg	1.94	100.99	194.00	388.00
Seed	Kg	6.00	10.99	60.00	120.00
Lubrication	R			6.84	13.68
Diesel	R	3.80	9.99	34.20	34.20
Repairs	R			30.00	60.00
Malasol	Ml	0.17	250.99	43.00	86.00
Labour	Hr	1.63	55.99	89.70	179.40
Irrigation cost:					
Repairs	R			1 252.50	2 505.00
Diesel	R			844.00	1 688.00
Lubrication	R			169.00	338.00
Labour	R/h			710.00	1 420.00
Total variable costs:				3 362.2.0	6 724.40
Gross margin				3 917.80	7 835.60
Fixed costs					
Mechanisation	R			509.25	1 018.50
Irrigation	R			296.63	593.25
Total fixed costs	R			805.88	1 611.75
Total specified costs	R			4 167.88	8 335.76
Income above specified costs				3 112.13	6 224.25

1. Crop water requirement per season = 300 mm

Cabbage

Crop enterprise analysis showed that cabbage was profitable, yielding a gross margin of R11 576.29/ha and income above specified costs of R10 769.75 /ha. The cost of production was R0.42/head, and since the production cost was less than the selling price of R1.50/head the farmer made a profit. The breakeven yield was 2 820 heads/ha and the breakeven price

R0.42/head. When compared with case farmer 4 who also produced cabbage it was found that farmer 5 was better in terms of income above specified costs.

Table B.9: Crop enterprise budget for case farmer 5: Cabbage, 1 ha, Flood-irrigation, 2001.

Gross income	Unit	R/unit	Quantity	R/ha	Total Value (R)
Cabbage	Head	1.50	10 000.00	15 000.00	15 000.00
Gross Income					15 000.00
Variable costs					
Fertilisers 2:3:2 (22)	Kg	1.43	100.00	143.00	143.00
Lubrication	R			6.84	6.84
Diesel	R	3.80	9.00	34.20	34.20
Repairs	R			30.00	30.00
Seed	G	0.18	500.00	90.00	90.00
Malasol	Ml	0.17	250.00	43.00	43.00
Labour	Hr	1.32	130.00	172.21	172.21
Irrigation cost:					
Repairs	R			1 252.50	1 252.50
Diesel	R			844.00	844.00
Lubrication	R			169.00	169.00
Labour	R/h			710.00	710.00
Total variable costs:				3 423.71	3 423.71
Gross margin				11 576.29	11 576.29
Fixed costs					
Mechanisation	R			509.25	509.25
Irrigation	R			296.63	296.63
Total fixed costs:	R			806.25	806.25
Total specified costs	R			4 230.25	4 230.25
Income above specified costs				10 769.75	10 769.75

1. Crop water requirement per season = 400 mm

Sugar beans

Crop enterprise analysis showed that sugar beans were not profitable, yielding a gross margin of -R182/ha and losses above specified costs of R987.88/ha. The cost of production was

R10.90/kg, and since the production cost was less than the selling price of R8.00/kg the farmer made losses. The breakeven yield was 436kg/ha and the breakeven price R10.90/kg.

Table B.10: Crop enterprise budget for case farmer 5: Sugar beans, 1 ha, Flood-irrigation, 2001.

Gross income	**Unit**	**R/unit**	**Quantity**	**R/ha**	**Total Value (R)**
Sugar beans	Kg	8.00	320.00	2 500.00	2 500.00
Gross Income					2 500.00
Variable costs					
Seed	Kg	6.20	15.00	93.00	93.00
Lubrication	R			6.84	6.84
Diesel	R	3.80	9.00	34.20	34.20
Repairs	R			30.00	30.00
Packaging material	sack	5.00	4.00	20.00	20.00
Labour	Hr	1.68	120.00	202.00	202.00
Irrigation cost:					
Repairs	R			1 336.00	1 336.00
Diesel	R			484.79	484.79
Lubrication	R			96.96	96.96
Labour	R/h			377.00	377.00
Total variable costs:				2 682.00	2 682.00
Gross margin				-182.00	-182.00
Fixed costs					
Mechanisation	R			509.25	509.25
Irrigation	R			296.63	296.63
Total fixed costs:	R			805.88	805.88
Total specified costs	R			3 487.88	3 487.88
Income above specified costs				-987.88	-987.88

1. Crop water requirement per season = 450 mm

Beetroot

Crop enterprise analysis showed that beetroot was profitable, yielding a gross margin of R5 660/ha and income above specified costs of R4 996.20/ha. The cost of production was

R1.64/packet, and since the production cost was less than the selling price of R3.50/packet the farmer made profit. The breakeven yield was R1 217.68 packets/ha and the breakeven price R1.64/packet.

Table B.11: Crop enterprise budget for case farmer 5: Beetroot, 0.5 ha, Flood-irrigation, 2001.

Gross income	Unit	R/unit	Quantity	R/ha	Total Value (R)
Beetroot	Packet	3.50	2 600.00	9 258.00	4 629.00
Gross Income					4 629.00
Variable costs					
Fertilisers: 2:3:2 (22)	Kg	1.43	100.00	143.00	72.00
Seed	Kg	0.15	500.00	75.00	38.00
Lubrication	R			6.84	3.42
Diesel	R	3.80	9.00	34.20	17.10
Repairs	R			30.00	15.00
Packaging material	Bag	0.66	867.00	579.00	289.00
Labour	Hr	1.39	210.00	293.00	146.00
Irrigation cost:					
Repairs	R			1 336.00	668.00
Diesel	R			484.79	242.50
Lubrication	R			96.96	48.48
Labour	R/h			377.00	188.50
Total variable costs:				3 455.92	1 727.96
Gross margin				5 660.00	2 830.00
Fixed costs					
Mechanisation	R			509.25	254.63
Total fixed costs:	R			805.88	402.94
Total specified costs	R			4 261.80	2 130.90
Irrigation	R			296.63	1 483.15
Income above specified costs				4 996.20	2 498.00

1. Crop water requirement per season = 350 mm

Peppers

The analysis of the pepper enterprise showed that it was not profitable, yielding a gross margin of -R135.59/ha and losses above specified costs of R538.53/ha. The cost of production was R41.49/crate. Since this was more than the selling price of R35.00/crate, the farmer made losses. The breakeven yield was 98.39 crates/ha and the breakeven price was R41.49/crate. *The farmer compared badly with farmer 5 in the production of pepper considering the income* above specified costs.

Table B.12: Crop enterprise budget for case farmer 5: Peppers, 1 ha, Flood-irrigation, 2001.

Gross income	Unit	R/unit	Quantity	R/ha	Total Value (R)
Peppers	Crate	35.00	83.00	2 905.00	2 905.00
Gross Income					2 905.00
Variable costs					
Fertilisers: 1:0:1 (36)	Kg	2.34	200.00	468.00	468.00
Seed	G	0.16	500.00	80.00	80.00
Lubrication	R			6.84	6.84
Diesel	R	3.80	9.00	34.20	34.20
Repairs	R			30.00	30.00
Labour	Hr	1.39	113.00	157.00	157.00
Irrigation cost:					
Repairs	R			1 336.00	1 336.00
Diesel	R			484.79	484.79
Lubrication	R			96.96	96.96
Labour	R/h			377.00	377.00
Total variable costs:				3 040.59	3 040.59
Gross margin				-135.59	-135.59
Fixed costs					
Mechanisation	R			509.25	254.63
Irrigation	R			296.63	1 483.15
Total fixed costs:	R			805.88	402.94
Total specified costs	R			3 443.53	3 443.53
Income above specified costs				-538.53	-538.53

1. Crop water requirement per season = 350 mm

Tomatoes

The analysis of the tomato enterprise showed that it was not that profitable, yielding a gross margin of R801.21/ha and losses above specified costs of R4.67/ha. The cost of production was R35.04/crate. Since this was more than the selling price of R30.00/crate, the farmer made losses. The breakeven yield was 138.99 crates/ha and the breakeven price was R35.04/crate. The farmer compared badly with farmer 4 in the production of tomatoes considering the income above specified costs.

Table B.13: Crop enterprise budget for case farmer 5: Tomatoes, 1 ha, Flood-irrigation, 2001.

Gross income	Unit	R/unit	Quantity	R/ha	Total Value (R)
Tomatoes	Crate	30.00	119.00	4 165.00	4 165.00
Gross income					4 165.00
Variable costs					
Fertilisers: 2:3:4 (33)	Kg	2.34	150.00	351.00	351.00
Coperavate	G	0.12	250.00	30.00	30.00
Red miller	G	1.00	75.00	75.00	75.00
Seed	Kg	0.62	500.00	310.00	310.00
Lubrication	R			6.84	6.84
Diesel	R	3.80	9.00	34.20	34.20
Repairs	R			30.00	30.00
Labour	Hour	1.25	185.00	232.00	232.00
					1 069.04
Irrigation cost:					
Repairs	R			1 336.00	1 336.00
Diesel	R			484.79	484.79
Lubrication	R			96.96	96.96
Labour	R/h			377.00	377.00
Total variable costs				3 363.79	3 363.79
Gross margin				801.21	801.21
Fixed Costs					
Mechanization	R			509.25	509.25
Irrigation	R			296.63	296.63
Total fixed irrigation costs	R			805.88	805.88
Total specified costs	R			4 169.67	4 169.67
Income above specified costs				-4.67	-4.67

1. Crop water requirement = 500 mm

The analysis of the crop enterprise budgets for maize, cabbage and beetroot showed that they were profitable crop enterprises while sugar beans, peppers and tomatoes were not profitable. The profitable enterprises realised income above specified costs of R3 112.13, R10 769.75 and R4 996 respectively. The problem that the farmer faces sometimes is markets for his produce, because the local market cannot buy all his vegetables and the hawkers are unreliable because sometimes they do not come to buy the vegetables. Some hawkers are dishonest when buying vegetables. The farmer is experienced in his vegetable production and changes the crops grown as their market demand also changes. He has a business mind, after taking over from his father who went blind, and he managed to negotiate and agree on contract selling to Spar in Malelane.

APPENDIX 4.C

BALANCE SHEET, INCOME STATEMENT AND CASH FLOW STATEMENT FOR THE OTHER FOUR CASE STUDY FARM BUSINESSES

4C.1 FARMER 2

BC.1.1 The Balance Sheet

Table C.1 below shows the balance sheet for case farmer 2 for the year ending on the 30th September 2000. The debt to asset ratio was determined from the balance sheet to see the asset structure or solvency position of the farmer.

Table C.1: Balance sheet for case farmer 2 for the year ending on 30 September 2000

Assets	R	Liabilities	R
Current assets		**Current liabilities**	
Bank account	-2 558.00	Production loan	90 298.00
Medium-term assets			
Machinery	4 410.00		
Irrigation system	1 992.00		
Pipes	80 000.00		
Subtotal	83 846.00		
Fixed assets		**Medium term liabilities**	
Land	60 000.00	Loans: FAF	22 036.00
		ABSA	38 534.00
		Total liabilities	150 868.00
		Net worth	-7 022.00
Total assets	143 846.00	**Total liabilities + net worth**	143 846.00

1. Dry land R1 000 – R1 500, Irrigated land R3 000 – R4 000, R2 500 for flood-irrigated land.
2. Medium-term assets were valued at market price.

The debt to asset ratio of the farmer was 1.05 indicating that the farmer was insolvent. It meant that the farmer's total assets could not pay for all the farm liabilities. It is believed that high financial commitment contributed to this financial status. The farmer had a FAF loan to start producing sugarcane, and he also took another loan from ABSA bank to buy pipes in preparation for the irrigation expansion. It is also believed that the scale of operation (10 ha) is relatively small given the financial commitment the farmer has made currently.

The farmer's capital investment includes tribal land, which is used on a RTO basis and was valued at a market rate for flood-irrigated land (R2 500) since it is a production asset.

4C.1.2 The Income statement

Table C.2 below shows the summary of the farmer's income statement for the period starting from 1 October 1999 ending on 30 September 2000.The returns to total capital and returns to own capital/equity were determined for farmer 2 and are presented below.

Table C.2: Summary of Income Statement for case farmer 2.

Period Covered: 1 October 1999 to 30 September 2000

Farm Operating Receipts	**(R)**	**Farm Operating Expenses**		**(R)**
Sugarcane sales	157 130.00	Expenses:	Sugarcane	129 912.65
Interest received	2 371.00		Other	200.00
			Interest paid	36 391.00
Total:	161 872.00	**Total:**		166 503.65
Net cash operating income				-4 631.65
Non-cash adjustment:				
Depreciation				1 035.00
Farm loss				-5 666.65
Pension				6 840.00
Less: Living expenses				8 400.00
Income tax				13 036.00
Withdrawal from own capital				-20 262.65

The farmer realised negative returns to total capital of -3.22% indicating that the farming business was not profitable. The returns to equity were -80.70%, which indicates the rate of return the farmer earned on his farming investment. The profitability on own capital was far less than the profitability on total capital indicating unprofitable employment of borrowed capital (financing).

4C.1.3 The Cash Flow Statement

Table C.3 below shows a summary of the cash flow statement for farmer 1 for the year starting from October and ending on 30 September.

Table C.3: A summary of a cash flow statement for case farmer 2: 1 October 1999 – 30 September 2000.

	Oct	Nov	Dec	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Total
Beginning cash balance	36500												36500
Cash inflow	570	570	570	570	570	570	570	570	570	570	570	157700	163970
Cash outflow	77551	19059	5323	5895	5323	5323	8463	5323	5323	5662	5323	95960	210055
Cash difference	-40481	-18489	-4753	-5325	-4753	-4753	-7893	-4753	-4753	-5092	-4753	66740	-46085
Loan amortisation:													
Principal	53904												
Interest	36394												
Ending cash balance	-3981	-22470	-27223	-32548	-37301	-42054	-49947	-54700	-59453	-64545	-69298	-2558	-2558
Loan balance end of period	Balance end of last year												
Intermediate loans:													
FAF	51018	22036											
ABSA	63456	38534											

An examination of the cash flow statement of the case study farmer revealed that in eleven of the twelve months of the analysis period, the farmer experienced cash deficits. Cash surplus was realised when the farmer received income from the sale of sugarcane. The farmer was in a bad financial status as shown by his cash outflow exceeding his cash inflow. The balance sheet as well as the income statement portrays the same bad financial picture of the farming business.

Analysing the financial statements of the farmer in general, it was found that in the short run farmer 2 was in a bad financial position, hence not in a position to take financial risk. However it was uncertain how risk analysis would influence the farmer's net cash flow position.

4C.1.4 Marketing

The farmer experiences no marketing problems since the sugarcane is delivered by contracted transport straight to the mill, and there is a sure market for sugarcane. The farmer's sugarcane production cycle is from August to August.

4C.2 FARMER 3

4C.2.1 The Balance Sheet

Table C.4 below shows the Balance Sheet for case farmer 3, for the year ending on 31 July 2001. The debt to asset ratio was determined for the farmer to find out his solvency position.

Table C.4: Balance sheet for case farmer 3 for the year ending on 31 July 2001.

Assets	R	Liabilities		R
Current assets		**Current liabilities**		
Bank account	174 970.00	Overdraft:	Principal	20 000.00
Medium-term assets			Interest	2 700.00
Bakkie	41 625.00	Production loan:	Principal	12 052.00
Machinery	10 438.00		Interest	129 924.00
Irrigation system	37 389.00			
Subtotal	89 452.00			
Fixed assets		**Long-term liabilities**		
Land	320 000.00	Loans:		671 735.00
Buildings	300 000.00			
Total fixed costs	62 000.00			
		Total liabilities		836 411.00
		Net worth		48 011.00
Total assets	884 422.00	**Total liabilities + net worth**		884 422.00

1. Dry land R1 000 – R1 500, Irrigated R3 000 – R4 000, Min R2 500
2. Medium-term assets were valued at market price

The debt to asset ratio of the farmer was 0.95 indicating that the farmer is solvent. It showed that the farmer could pay for total farm liabilities with his total farm assets. However, he cannot borrow more money because his debt/asset ration is high, for every Rand that he has, 95c is borrowed. The farmer owns the farm and the farming land was valued at a market rate for irrigated land at R4 000/ha. This puts the farmer in a better position because he can use the land as collateral.

4C.2.2 The Income Statement

Table C.5 below shows the income statement for farmer 3, for the period starting from August and ending on 31 July 2001. The returns to total capital and returns to own equity or net worth were determined to find out farm profitability.

Table C.5: Summary of Income Statement for case farmer 3.

Period Covered: 1 August 2000 to 31 July 2001				
Farm Operating Receipts	**(R)**	**Farm Operating Expenses**		**(R)**
Sugarcane sales	239 148.00	Expenses:	Sugarcane	179 403.00
Interest received	3 482.00		Other	560.00
			Interest paid	2 700.00
Total:	242 630.00	**Total:**		182 663.00
Net cash operating income				59 967.00
Non-cash adjustment:				
Creditors				20 000.00
Depreciation				15 186.00
Farm profit				24 781.00
Rent received				36 000.00
Off-farm income				60 000.00
Less: Living expenses				39 600.00
Income tax				30 751.00
Addition to own capital				50 430.00

The farm profitability was 6.78% indicating that the farm business was profitable. Returns to own capital was 51.62%, which indicated the rate of return the farmer earned on his farming investment. The farmer's profitability on own capital was greater than the profitability on total capital employed (farm profitability), which indicated that the farmer employed his borrowed capital profitably. It also shows positive financial leverage.

4C.2.3 *The Cash Flow Statement*

Table C.6 below shows a summary of the cash-flow statement for farmer 3, for the year starting on 1 August and ending on 31 July.

Table C.6: A summary of a cash flow statement for case farmer 3: 1 August 2000 – 31 July 2001

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Total
Beginning cash balance	20000												20000
Cash inflow	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	127574	127574	351148
Cash outflow	10451	10011	8511	8511	8511	8511	8511	8511	8024	7537	37802	30850	155738
Cash difference	-2451	-2011	-511	-511	-511	-511	-511	-511	-24463	465	89772	96724	195410
Loan amortisation:													
Principal	12052												
Interest	129924												
Ending cash balance	17549	15538	15027	14516	14005	13494	12983	12472	-11991	-11526	78246	174970	174970
Loan balance end of period	Balance end of last year												
Long-term loans:	683787	671735											

An examination of the cash-flow statement of the case farmer revealed that in nine of the twelve months of the analysis period, the farmer experienced deficits. Surplus cash flow was realised when the farmer received income from the sale of sugarcane. The farmer uses an overdraft to finance his seasonal financial requirements, but he could instead use a retention account. The farmer also appears to have an expensive lifestyle as reflected by a relatively high living expense amount of R3 300/month. The other factor that could be contributing to the cash-flow problem is long-term and short-term obligations that the farmer has. He took the initial loan from the bank to buy his farm, and production is only on 35 ha out of the 80 ha that he bought. This is because he has production quota for 35 ha only. However, the farmer's total cash inflow exceeds total cash outflow.

It is recommended that the farmer be careful not to over-borrow money and expose himself to the risk of losing what he has. He should strive to increase his crop productivity so that he can be able to secure a bigger sugarcane quota and put the rest of his land (45 ha) to productive use. Generally he is a role model to other small-scale commercial irrigation farmers.

Analysing the financial statements of the farmer in general, it was found that in the short run farmer three was not in an acceptable financial position. This was shown by his very high debt to asset ratio of 0.95. He may therefore not take financial risk, but it was uncertain how risk would influence the farmer's cash flow position.

4C.2.4 Marketing

Cargo Transport Company is contracted to transport sugarcane to the mill. There was no marketing problem since TSB provides a ready market for sugarcane. The only problem that is sometimes experienced is with transport contractors who may not come on time to pick up the sugarcane, which has negative effects on the sucrose content of the cane.

4C.3 FARMER 4

4C.3.1 The Balance Sheet

Table C.7 below shows the balance sheet for case farmer 4, for the year ending on 31 December 2000. The debt to asset ratio was determined to find out the farmer's solvency position.

Table C.7: Balance sheet for case farmer 4 for the year ending on 31 December 2000.

Assets	R	Liabilities	R
Current assets		**Current liabilities**	
Bank account	67 162.00	Other	2 000.00
Medium-term assets			
Irrigation system	14 994.00		
Subtotal	82 156.00		
Fixed assets			
Land	17 500.00		
		Total liabilities	2 000.00
		Net worth	99 156.00
Total assets	99 656.00	**Total liabilities + net worth**	97 656.00

1. Dry land R1 000 – R1 500, Irrigated R3 000 – R4 000, Min R2 500 for flood-irrigated land
2. Medium-term assets were valued at market price

The debt to asset ratio of the farmer was 0.02, indicating that the farmer was highly solvent. The farmer used his own capital to run his farming business. Included in his capital are 7 ha flood-irrigated farming land utilised on an RTO basis which was valued at a market rate for flood-irrigated land at R2 500/ha, since it is a production asset.

4C.3.2 The Income Statement

Table C.8 below shows the farmer's income statement for the period starting from 1 January to 31 December 2000. The returns to total capital and the returns to own equity or net worth were determined from the income statement to find out farm profitability.

Table C.8: Summary of Income Statement for case farmer 4.

Period Covered: 1 Jan 2000 to 31 Dec 2000				
Farm Operating Receipts	(R)	**Farm Operating Expenses**		(R)
Maize sales	31 920.00	Expenses:	Maize sales	11 190.00
Cabbage sales	7 461.00		Cabbage sales	3 481.00
Mangoes	9 000.00		Mangoes	1 377.00
Peppers	1 557.00		Peppers	3 385.00
Tomatoes	9 619.00		Tomatoes	10 236.00
Interest received	1 382.00		Other	200.00
Total:	60 939.00	**Total:**		29 869.00
Net cash operating income				31 070.00
Non-cash adjustment:				
Depreciation				4 241.00
Farm profit				26 829.00
Off-farm income				18 000.00
Less: Living expenses				9 600.00
Addition to own capital				35 229.00

The farm profitability (Net farm income/Total capital) was 31.17% indicating that the farm business was profitable. Returns to own capital or equity (Farm profit/own capital) was 27.06% which indicates the rate of return the farmer earns on his farming investment. The profitability on own capital was less than the profitability on total capital indicating that the farmer was not employing his borrowed capital profitably. It is worth noting that the farmer uses his own equity and does not borrow external funds to run his farming business. He seems to be doing well in his business.

4C.3.3 *The Cash Flow Statement*

Table C.9 below shows a summary of the cash flow statement for farmer 4 for the year starting on 1 January and ending on 31 December 2000.

Table C.9: A summary of a cash flow statement for case farmer 4: 1 January 2000 – 31 December 2000.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Beginning cash balance	2000												2000
Cash inflow	1500	1500	17100	17100	1500	18750	15750	1500	1500	1500	6000	6000	89700
Cash outflow	4370	3621	2208	2291	1947	1689	1371	1299	1299	1295	1272	1875	29870
Cash difference	-870	-2121	14892	14809	-447	17061	14379	201	201	205	4728	4125	59830
Ending cash balance	-870	-2991	11901	26710	26263	43324	57702	57903	58104	58309	63037	67162	67162

1. Farmer did not have a loan

An examination of the cash-flow statement of the case farmer revealed that in only three of the twelve months of the analysis period, the farmer experienced cash deficits. In most of the months the farmer realised cash surpluses from the sale of vegetables. This is because vegetable production is throughout the year, ensuring almost a constant cash inflow to the farmer. Vegetables also take a short time to grow, about three to four months to be ready for sale, unlike sugarcane which is harvested only once a year, bringing cash inflow only then. The farmer is in a good financial position as shown by his net worth, addition to own capital and his total cash inflow exceeding total cash outflow.

The farmer does not need to expand his production area currently, but needs to improve on his crop management practices, especially on the mango trees. Extension service is still needed and training is essential for better crop management practices. The farmer should also try to find contracts to sell his vegetables to reduce price risk that he faces with selling to hawkers.

A general analysis of the farmer's financial statements in the short run indicated that farmer 4 was in a very good financial position, therefore he may take financial risk if he wanted to. However, it was uncertain how risk would influence his cash flow position.

4C.3.4 Marketing

The farmer highlighted that he faced problems in marketing his crops. He sells to the local market and to hawkers who come to buy from the farm gate, but sometimes do not come to buy the vegetables. Since vegetables are highly perishable, they get spoilt if he does not manage to sell them at a give-away price.

4C.4 FARMER 5

4C.4.1 The Balance Sheet

Table C.10 below shows the balance sheet for case farmer 5, for the year ending on 31 December 2000. The debt to asset ratio was determined for the farmer to find out his solvency position.

Table C.10: Balance sheet for case farmer 5 for the year ending on 31 December 2000.

Assets	**R**	**Liabilities**	**R**
Current assets		**Current liabilities**	
Bank account	14 459.00	Other	500.00
Medium-term assets			
Machinery	882.00		
Irrigation system	721.00		
Subtotal	1 603.00		
Fixed assets			
Land	10 000.00		
		Total liabilities	500.00
		Net worth	25 562.00
Total assets	26 062.00	**Total liabilities + net worth**	26 062.00

1. Dry land R1 000 – R1 500, Irrigated R3 000 – R4 000, Min R2 500
2. Medium-term assets were valued at market price

The debt to asset ratio of the farmer was 0.019, indicating that the farmer was solvent. The farmer did not borrow capital, but used own equity to run his farming business. The farmer's capital investment included 4 ha flood-irrigated farming land, which is utilised on a RTO basis and was valued at R2 500/ha, since it is a production asset for the farmer.

4C.4.2 The Income Statement

Table C.11 below shows the farmer's income statement for the period starting from 1 January and ending on 31 December 2000. The returns to total capital and returns to own equity or net worth were determined to find out business profitability.

Table C.11: Summary of Income Statement for case farmer 5.

Period Covered: 1 Jan 2000 to 31 Dec 2000

Farm Operating Receipts	**(R)**	**Farm Operating Expenses**		**(R)**
Maize sales	14 560.00	Expenses:	Maize	6 724.40
Cabbage sales	15 000.00		Cabbage	3 423.71
Sugar beans	2 500.00		Sugar beans	2 682.00
Beetroot	4 629.00		Beetroot	1 727.96
Peppers	2 905.00		Peppers	3 040.59
Tomatoes	4 165.00		Tomatoes	3 363.79
			Other	300.00
Total:	43 759.00	**Total:**		21 262.00
Net cash operating income				22 497.00
Non-cash adjustment:				
Depreciation				3 224.00
Farm profit				19 273.00
Pension				6 840.00
Less: Living expenses				12 960.00
Addition to own capital				13 153.00

The farm profitability was 86.32% indicating that the farm business was very profitable. The return to own capital or equity was 75.40%, which indicates the rate of return the farmer earns on his farming investment. The profitability on own capital was, however, less than the profitability on total capital. It is also worth noting here that the farmer did not have a loan with any financial institution, as he used his own capital to run his farming business.

4C.4.3 The Cash Flow Statement

Table C.12 below shows a summary of the cash flow statement for farmer 5 for the year starting on 1 January and ending on 31 December 2000.

Table C.12: A summary of a cash flow statement for case farmer 5: 1 January 2000 – 31 December 2000.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Beginning cash balance	5000												5000
Cash inflow	2526	570	1298	11113	16451	570	570	3130	2471	570	570	570	40559
Cash outflow	4071	5094	4109	4756	2230	2249	2204	4312	1470	2204	2419	2189	37306
Cash difference	-1545	-4524	-2811	6357	20578	-1679	-1634	-1182	1001	-1634	-1849	-1619	3293
Ending cash balance	3455	-1069	-3880	2477	23055	21376	19742	18560	19561	17927	16078	14459	14459

1. Farmer did not have a loan (vegetable farmer)

An examination of the cash-flow statement of case study farmer 5 revealed that the farmer experienced cash flow problems. Contrary to what would be expected of vegetable production, the farmer realised cash deficits in nine months of the twelve months of the analysis period. The cash flow revealed what was also found in the analysis of the crop budgets wherein of the six crop enterprises grown by the farmer, only three earned income for the farmer and the other three (peppers, sugar beans and tomatoes) contributed losses to the farmer.

The farmer does not need to expand his production area at the moment, instead he has to rearrange his enterprises, concentrating on the winners especially the crops for which he contracted to sell to Spar and to move away from the losers. This will help improve his cash flow position. Generally the farmer seems to be doing well in his farming business. His net worth and addition to own capital support this observation.

A general analysis of farmer five's financial statements in the short run, indicated that he was in a good financial position, therefore he may take financial risk if he wanted to. However, it was uncertain how risk would influence his cash flow position.

4C.4.4 Marketing

The farmer sells his produce to the local market and hawkers who come to buy from the farm gate. He raised concerns about some hawkers who are sometimes unreliable and cheat when they buy vegetables, and that the local market is not able to buy all his produce. However, the farmer negotiated a contract to sell to Spar in Malelane. This will help reduce the effect of price risk he faces in selling to hawkers and the local market.

APPENDIX 4.D

RISK ANALYSIS FOR THE OTHER FOUR CASE STUDY FARM BUSINESSES

4D. RISK ANALYSIS

4D.1 FARMER 2

4D.1.1 The effect of production risk on net cash flow

The input specification for sugarcane production risk was 100 tons/ha as a pessimistic yield level, 129.07 tons/ha as most likely and 130 tons/ha as the optimistic yield level.

Considering production risk for sugarcane and holding price risk constant (because price is certain from the TSB mill at the beginning of the production season), there was no probability that the farmer would realise a negative cash flow. The variability of the net cash flow was not very high; it ranged from R55 781 to R87 625. This is shown in Figure D.1 below.

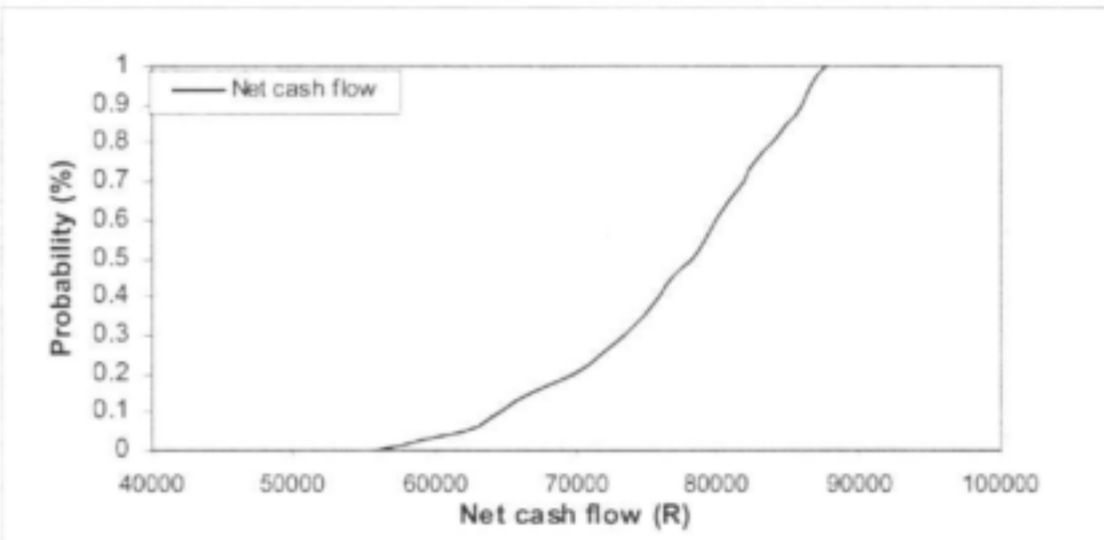

Figure D.1: Cumulative probability distribution function of net cash flow for farmer 2, taking into consideration production risk on sugarcane, 2001.

4D.1.2 The effect of borrowed capital on cash flow

If the farmer wants to install a drip irrigation system in the 10 ha expansion area, he will need an extra capital investment of R104 650 (pump R5 035, electric motor 7.5 kW R3 010, main line pipes R27 080, filter station R14 001 and pipes for 9.99 ha R55 524). Since the farmer has already taken a loan of R80 000 to buy pipes for the irrigation system, he will only need about R25 000 more to install his drip irrigation system, which he can borrow from FAF. Taking the new loan into consideration in the financial risk analysis, it was found that it had no effect on the farmer's financial risk as shown by the almost constant net cash flow which ranged from

R55 287 to R87 618. However, with an increase in the production area to 20 ha the cash flow improved as shown by total cash inflow now exceeding total cash outflow. The financial position of the farmer improved significantly and the net cash flow ranged from R111 503 to R175 232 with expansion in the production area. This is shown in Figure D.2 below.

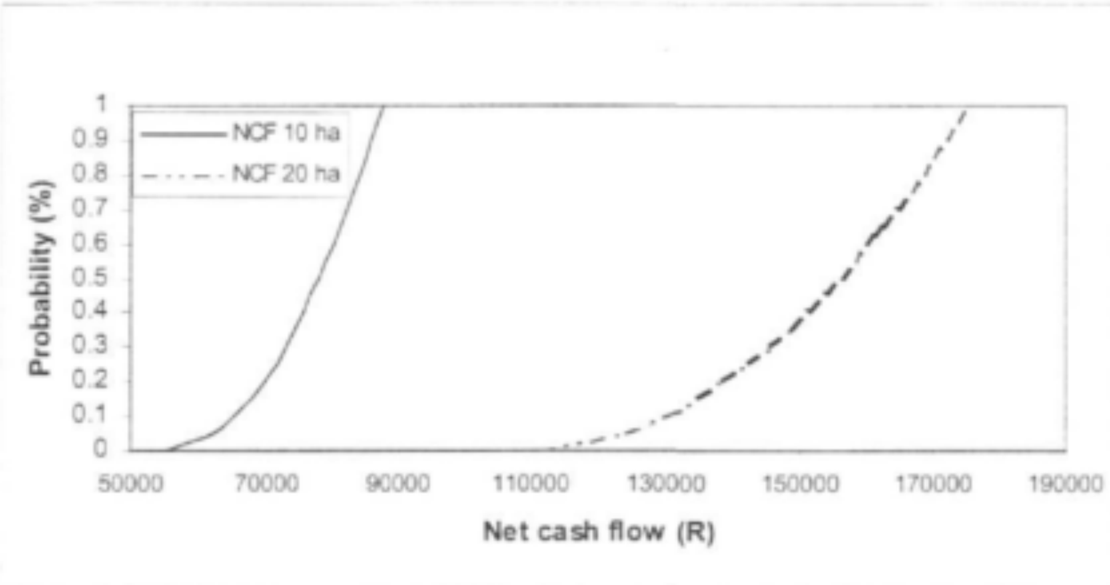

Figure D.2: Cumulative probability distribution functions of net cash flow for farmer 2, taking into consideration financial risk on the farmer's cash flow as a result of the decision to expand the production area, 2001.

It is recommended that the farmer ask for a R25 000 establishment loan from FAF to install his drip irrigation in the next 10 ha. This is because the decision does not expose the farmer to drastic financial risk and the decision has a significant positive effect on the net cash flow of the farmer as shown in Figure D.2 above. However, the farmer faces strategic risk of not owning the land he farms on. The other risk is that the farmer is a full-time farmer, hence relying totally on farming for his livelihood, and he therefore has to ensure that his farming business is profitable for him to survive. This suggests that the farmer has to follow production risk management strategies to maintain sustainability of his farming business.

4D.2 FARMER 3

4D.2.1 The effect of production risk on net cash flow

The input specification for sugarcane production risk for farmer 3 was 54 tons/ha as a pessimistic yield level, 55.31 tons/ha as most likely and 100 tons/ha as the optimistic yield level. Considering production risk for sugarcane and holding price risk constant for the farmer, there was a 100% probability that the farmer would realise a negative net cash flow. The net cash flow ranged from -R281 368 to -R133 673 as shown in Figure D.3 below. The farmer has to follow production risk management strategies.

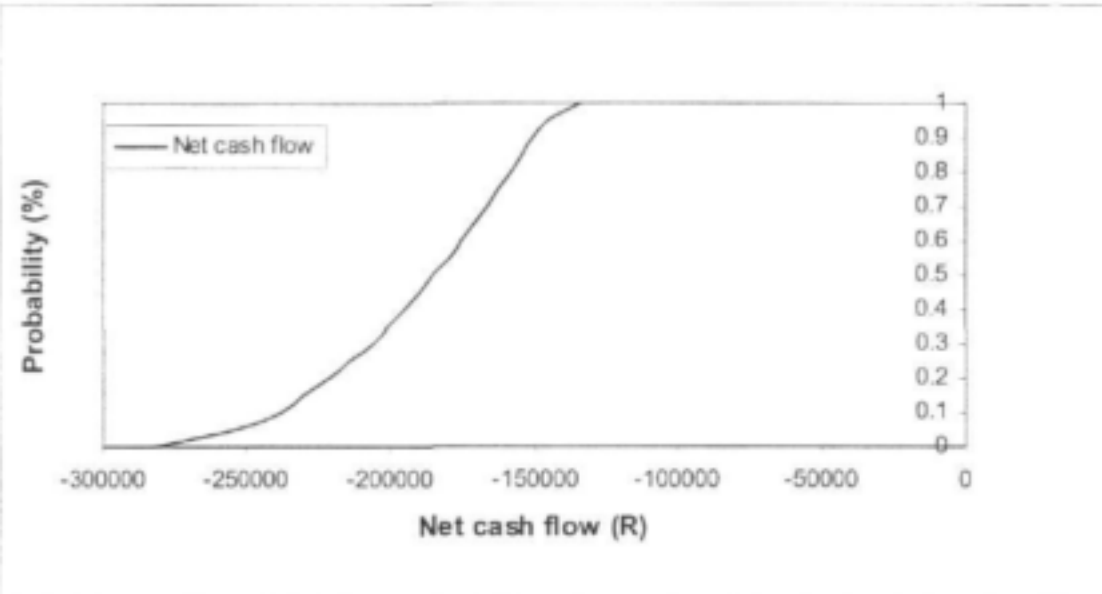

Figure D.3: Cumulative probability distribution function of net cash flow for farmer 3, taking into consideration production risk on sugarcane, 2001.

The farmer has to follow financial risk management strategies. He therefore needs to support the production loan with his off-farm income to stay liquid in adverse economic times. He will also have to use his off-farm income to meet the short-term financial obligations of the long-term loan. Furthermore it is recommended that the farmer be cautious of over-borrowing because it might result in him losing his farm. On the other hand, the farmer owns his farm and the strategic risk of RTO is insignificant for him. As a part-time farmer, he holds other businesses in his portfolio which helps him spread the risk thereby reducing its effect. A wider view of the farmer's business orientation suggests that the farmer is operating a sustainable business.

4D.3 Farmer 4

4D.3.1 The effect of production and price risk on net cash flow

The farmer was asked to estimate his pessimistic and optimistic production and price levels for all his vegetables, for most likely values the realised yield levels on the existing crop production strategy, and the farmer's selling prices for vegetables were used as input variables for risk simulation purposes.

Considering both production and price risk on the existing crop rotation, there was no probability that the farmer would realise a negative cash flow. The net cash flow ranged from R38 911 to R80 556. When price risk on vegetables was considered and holding yield risk constant on the existing crop rotation there was also no probability that the farmer would realise negative net cash flow. The net cash flow ranged from R44 239 to R74 097. When considering yield risk and holding price risk constant on the existing crop rotation, there was also no probability that the farmer would realise a negative net cash flow and net cash flow ranged from R43 509 to R64 805. Price risk had more effect on net cash flow than yield risk; however, both production and price risk (all risk) had a bigger effect on net cash flow than when taken separately. This is shown in Figure D.4 below.

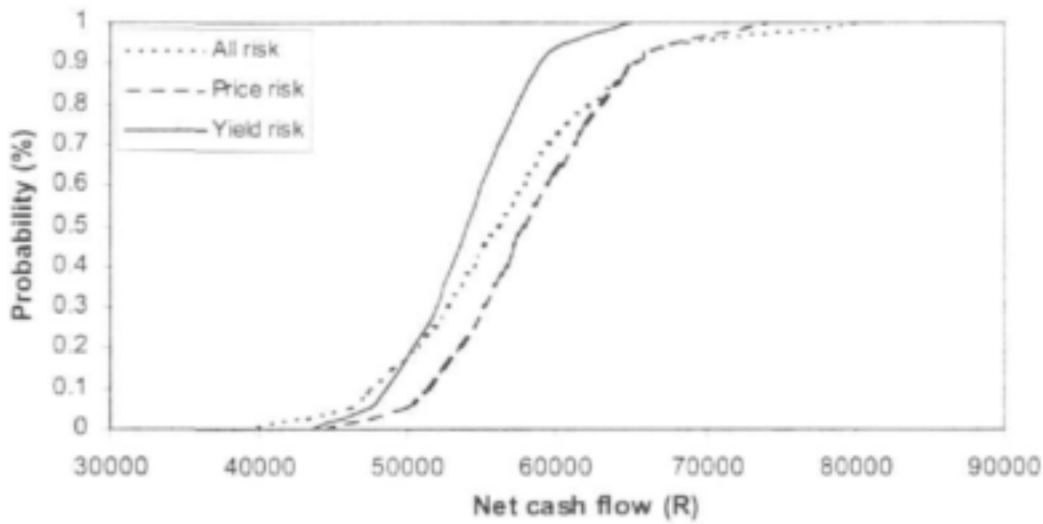

Figure D.4: Cumulative probability distribution functions on net cash flow for farmer 4, taking into consideration production and price risk on vegetables, 2001.

4D.3.3 Considering three crop rotations to determine the risk efficient crop rotation

RISKMAN was used to measure risk associated with production and price risk, the effect of diversification through crop rotation, and a crop management strategy especially for vegetables was incorporated. The assumptions made for evaluation purposes are that the farmer is risk averse, and that he maintained his production technology and levels of some of the production resources such as land and labour. Prices and marketing strategies were assumed constant for each production strategy (crop rotation). Subjective crop rotations were determined for farmer 4 taking into consideration the land constraint (7 ha) and the summer and winter cropping seasons. Table D.1 below shows the three crop rotation options that farmer 4 may consider.

Table D.1: Crop rotations for farmer 4

Crop	Rotation 1	Rotation 2	Rotation 3
Cabbage	1 ha (w)	1 ha (w)	2 ha (w)
Maize	3 ha (s)	4 ha (s)	2 ha (s)
Mangoes	0.5 ha (both)	0.5 ha (both)	0.5 ha (both)
Peppers/Chillies	2 ha (both)	2.5 ha (both)	2 ha (both)
Tomatoes	1 ha (w)	2 ha (w)	1.5 ha (w)

Ha = hectare

(w) = winter season

(s) = summer season

(both) = both winter and summer seasons

The cumulative probability distribution functions of net cash flow obtained from the three crop rotations are shown in Figure D.5 below. The figure shows the net cash flow and its associated risk. Probability or likelihood of occurrence measures the chance associated with attaining a level of net cash flow from each rotation. The range between the lowest and the maximum net cash flow (variability) measures the risk associated with the net cash flow distribution. High variability value means high risk and low variability value means low risk associated with each net cash flow distribution.

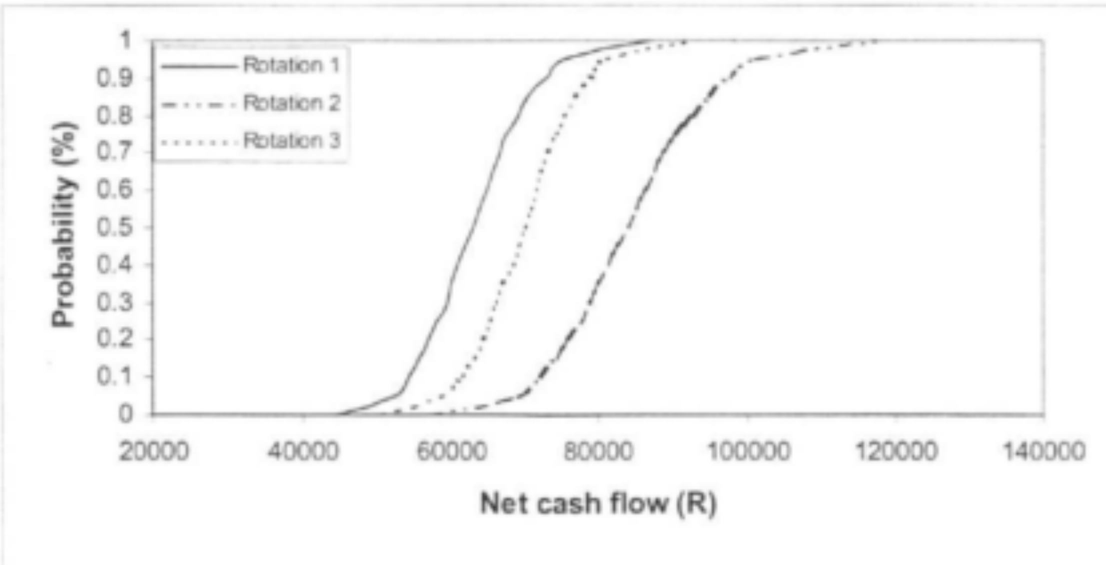

Figure D.5: Cumulative probability distribution functions on net cash flow for farmer 4, taking into consideration production and price risk on vegetables and determining a risk efficient crop management strategy, 2001.

Considering both production and price risk on the three crop production strategies, there was no probability that the farmer would realise a negative cash flow from any of the three crop production strategies or crop rotations. There was no probability that crop rotation 2 would realise less net cash flow than the other two crop rotations as seen from Figure B.5 above. The net cash flow ranged from R44 654 to R87 179 for crop rotation 1, from R56 906 to R117 500 for crop rotation 2 and from R50 850 to R92 880 for crop rotation 3. Crop rotation 2 dominated rotations 1 and 3 by first order stochastic dominance. The crop rotation with the net cash flow distribution function lying to the far right dominates all others and brings the highest net cash flow to the farmer, and it is a risk efficient crop management strategy. This suggests that the farmer should consider crop rotation 2, because for any probability level crop rotation 2 realised a higher net cash flow than 1 and 3. The general observation suggests that the farmer operated a sustainable business.

4D.4 FARMER 5

4D.4.1 The effect of production and price risk on net cash flow

The farmer was asked to estimate his pessimistic and optimistic production and price levels for all his vegetables, for most likely values the realised yield levels on the existing crop production strategy, and the farmer's selling prices for vegetables were used as input variables for risk simulation purposes.

Hawker's prices

Considering both production and price risk on the existing crop rotation, there was no probability that the farmer would realise a negative cash flow. The net cash ranged from R28 961 to R52 909. When price risk was considered, holding yield risk constant on the existing crop rotation, there was no probability that the farmer would realise a negative cash flow. Net cash flow ranged from R32 549 to R55 038. When considering yield risk and holding prices constant on the existing crop rotation, there was no probability that the farmer would realise a negative net cash flow. Net cash flow ranged from R32 804 to R37 472. Price risk had more effect on net cash flow than yield risk. However, combined production and price risk had less effect on net cash flow than price risk taken separately. This is shown in Figure D.6 below.

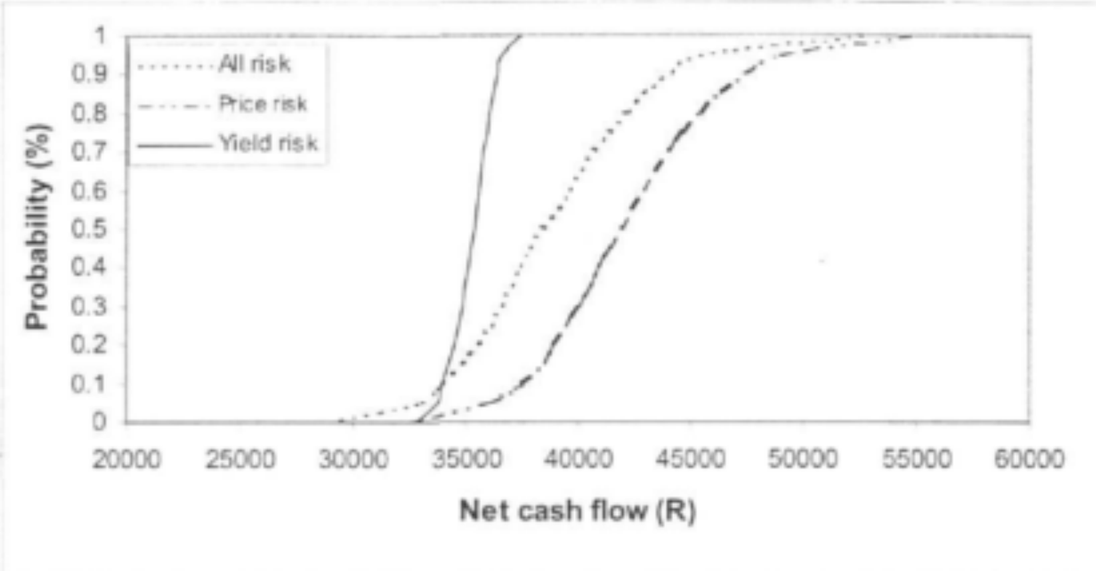

Figure D.6: Cumulative probability distribution functions on net cash flow for farmer 5, taking into consideration production and price risk on vegetables with existing production and marketing strategies, 2001.

4D.4.2 Considering three rotations to determine the risk efficient crop rotation

RISKMAN was used to measure risk associated with production and price risk, the effect of diversification through crop rotation, and a crop management strategy especially for vegetables was incorporated. The assumptions made for evaluation purposes are that the farmer is risk averse, that he maintained his production technology and levels of some of the production resources such as land and labour. Prices and marketing strategies were assumed constant for each production strategy (crop rotation). Subjective crop rotations were determined for farmer 5 taking into consideration the land constraint (4 ha) and the summer and winter cropping seasons. Table D.2 below shows the three crop rotation options that farmer 5 may consider.

Table D.2: Crop rotations for farmer 5

Crop	Rotation 1	Rotation 2	Rotation 3
Beetroot	1 ha (w)	0.5 ha (w)	0.5 ha (w)
Cabbage	1 ha (w)	1 ha (w)	0.5 ha (w)
Maize	2 ha (s)	3 ha (s)	3 ha (s)
Peppers/Chilies	1 ha (both)	0.5 ha (both)	1 ha (w)
Sugar beans	1 ha (s)	0.5 ha (s)	1 ha (s)
Tomatoes	1 ha (w)	2 ha (w)	2 ha (w)

Ha = hectare

(w) = winter season

(s) = summer season

(both) = both winter and summer seasons

The cumulative probability distribution functions of net cash flow obtained from the three crop rotations are shown in Figure D.7 below. The figure shows the net cash flow and its associated risk. Probability or likelihood of occurrence measures the chance associated with attaining a level of net cash flow from each rotation. The range between the lowest and the maximum net cash flow (variability) measures the risk associated with the net cash flow distribution. High variability value means high risk and low variability value means low risk associated with each net cash flow distribution.

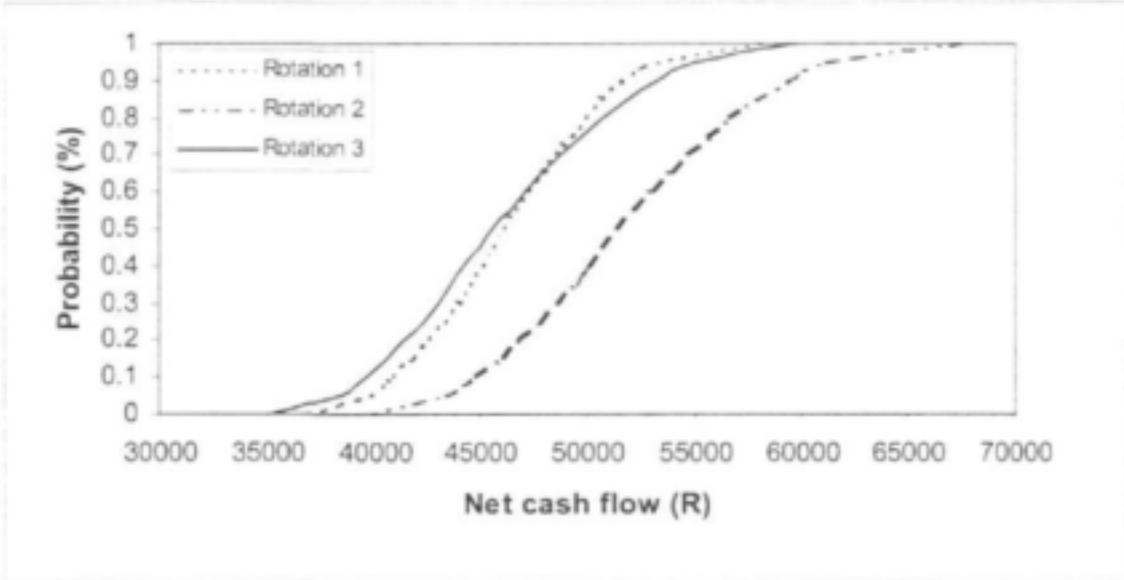

Figure D.7: Cumulative probability distribution functions on net cash flow for farmer 5, taking into consideration production and price risk on vegetables, and determining a risk efficient crop management strategy, 2001.

Considering both production and price risk on the three crop production strategies, there was no probability that the farmer would realise a negative cash flow from any of the three crop production strategies. There was also no probability that crop rotation 2 would realise less cash flow than crop rotations 1 and 3. Therefore crop rotation 2 dominated crop rotations 1 and 3 by first order stochastic dominance, bringing a higher net cash flow to the farmer than the other two crop rotations. Net cash flow for rotation 2 ranged from R39 564 to R67 554. Net cash flow for rotation 1 ranged from R36 886 to R58 196 and for rotation 3 it ranged from R35 115 to R59 777.

If for any reason the farmer had to consider production strategies 1 and 3 it was found that for probabilities below approximately 60 % crop rotation 1 always realised higher cash flow than crop rotation 3. For higher probabilities crop rotation 3 always realised higher cash flow than crop rotation 1. However, crop rotation 1 dominated crop rotation 3 by generalised stochastic dominance, as it had a larger area under the curve than it was under crop rotation 3.

Contract prices

When both production and price risk were considered on the risk efficient rotation using contract prices, there was no probability that the farmer would realise a negative net cash flow. Net cash flow ranged from R37 221 to R67 481. Considering price risk and holding production risk constant, there was no probability of realising negative cash flow. Net cash flow ranged from R44 648 to R74 537. When considering production risk, holding prices constant, there was no probability of realising negative cash flow and net cash flow ranged from R44 577 to R49 795. This is shown in Figure D.8 below.

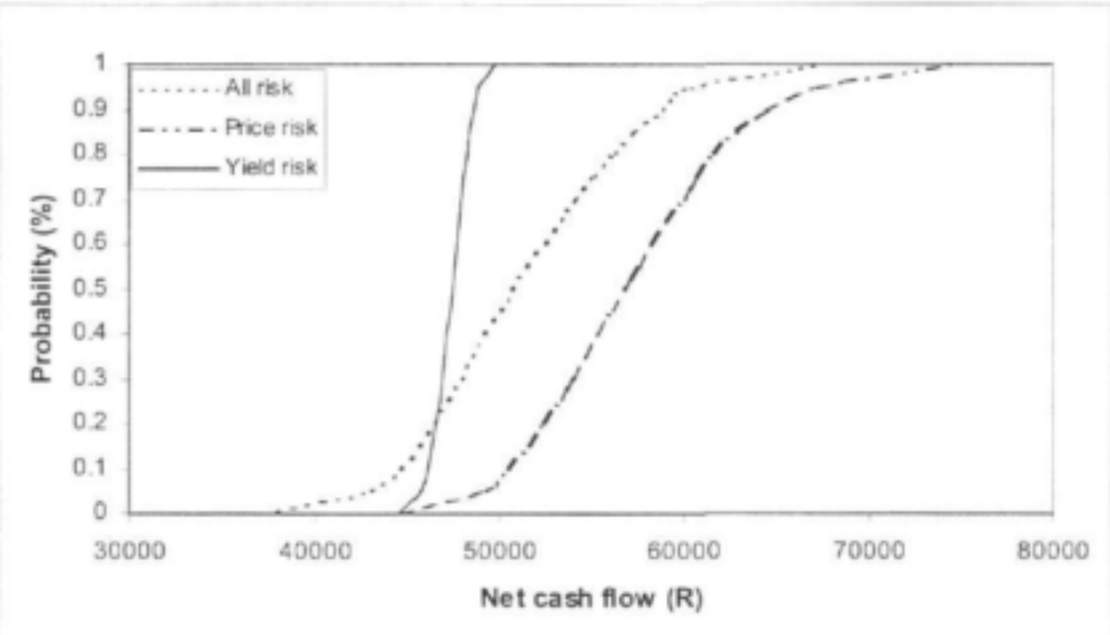

Figure D.8: Cumulative probability distribution functions on net cash flow for farmer 5, taking into consideration production and price risk on vegetables, risk efficient production and contract marketing strategy, 2001.

Price risk had more effect on net cash flow than yield risk, but the combined effect was less on net cash flow than price risk considered separately. However, the effect of price risk on contract selling was less than when selling to hawkers and the local market, because contract prices are certain, which suggests that contract marketing is a risk efficient marketing strategy that vegetable farmers should consider. With the newly adopted marketing strategy, sustainability of the business is ensured. Alternative marketing strategies that vegetable farmers may consider are discussed below.

4D.5 MARKETING STRATEGIES

Marketing strategies can be used to reduce the effects of price variability. It was found that the most common marketing strategy that vegetable farmers used was spot or direct marketing to the local community and hawkers who come to buy farm produce at the farm gate. Contract selling was a newly adopted marketing strategy by farmer 5 to reduce price risk. With this strategy the farmer made a sale contract with Spar in Malelane to supply it with vegetables at an agreed price and time. Sugarcane farmers have a ready market for their produce or a monopolistic buyer, the TSB mill. A ten-year contract is signed between the farmer and the mill for the farmer to deliver cane to the mill. At the end of ten years, the farmer may renew or withdraw from the contract. The farmer is required by contract to meet the agreed quota allocation. Marketing strategies that the small–scale commercial irrigation farmers did not exploit included spreading of sales, market information, vertical integration and value adding. If considered, these marketing strategies could improve crop profitability.

Spreading of sales rather than selling the whole crop at maturity can help to avoid selling at a time when prices are low, hence reducing risk significantly. The remarkable advantage of spreading sales is the marketing flexibility it offers and the farmer is not put under pressure to sell his crop at once. In irrigated farming this flexibility is achieved by varying the planting dates, especially for vegetables and where possible using cold storage to extend the shelf life of the vegetables, then selling them when prices are higher. Spreading of sales also ensures a relatively constant cash inflow and this can be carefully planned so as to help improve cash flow on monthly basis. It is difficult to spread sales for sugarcane production unless one has staggered quotas, a decision that is beyond the control of the farmer. It is also difficult to change planting dates once establishment is done (initial planting of the seed cane). This is because sugarcane is a long-term crop, planted once in eight years.

Market information is another marketing strategy that farmers have not exploited in the area to mitigate price risk. If farmers had access to market information it would aid them in marketing decisions. Blackie and Dent (1977) confirmed this in their argument that information only attains economic value in the context of decision-making, meaning that the value of market information is realised only if it can aid in marketing decision. The importance of market information was also emphasised by Patrick (1984), in his study when he reported that over 90 percent of the producers indicated that they used marketing information in making management decisions.

It was evident from the interviews with farmers that there were relatively less external sources of information to assist vegetable farmers with marketing and financial decisions. This condition increases the risk of farming. It was found that small-scale commercial farmers relied much on extension service. They did not make use of specialist sources of information such as marketing consultants and accountants. This is probably due to the cost associated with professional service, or lack of awareness of the importance of such information. Unlike the sugarcane farmers who have regular and specialised extension service from the TSB, vegetable producers do not belong to any forum, such as marketing boards. They also raised concerns about inefficiency regarding government extension services. It was also found that farmers marketed their produce individually, exposing their vulnerability to dishonest hawkers (strategic risk). Farmers also disclosed that they sold to the local market mainly because they do not have transport to take their produce to the nearest town where prices are favourable. This is confirmed by Madikizela and Groenewald (1998) in their study in which they concluded that unavailability of transport infrastructure, lack of information and dishonesty of some traders were major problems faced by Eastern Cape farmers.

Vertical integration is another marketing strategy that small-scale commercial farmers have not exploited and could benefit from it if they considered it. Besides the local market and the hawkers who may not be reliable customers, farmers could sell their produce through marketing agents or supermarkets as well as greengrocers. The farmers may also group themselves and open a vegetable stall in a strategic place to market their produce (direct marketing). In this way they can share marketing costs and enhance their income. This marketing strategy worked well in the United States, especially for small–scale commercial farmers (Parliament, 2001). Festing (1997) also reported that direct marketing was recommended to the United Kingdom small-scale farmers where it was less popular.

Value adding is another possibility that farmers have not considered, for example, the farmer sells a cob of maize for R1 and the next trader buys it, boils or roasts it and sells it for R2.50. If the farmer could boil the maize he would more than double his returns. The farmer does not have to leave his daily farming chores to be a retailer, the wife or children or even an employee could do it on his behalf. In another case, the marketing strategy adopted was that the farmer would harvest the dry maize and process it to loose grains; the farmer then gets the grain in 80 kg bags and delivers it to the mill. However, the farmer does not sell it for immediate cash, but exchanges it for 80 kg maize meal, which he takes one by one according to family needs until the delivered number of grain bags are all withdrawn. The price of 80 kg maize meal was R89.00, and the farmer benefited here in that it takes more than 80 kg of grain to produce an 80 kg bag of maize meal. This could be considered as hedging against increases in maize meal price on the side of the farmer. If he sold the maize grain for immediate cash, he would have to face the increases in maize meal prices later on. The farmer saves on storage costs and avoids the possibility of spoil either by weevils, rats or rain. The miller benefits from getting the primary input without having to pay immediate cash. It is believed that the farmer is the overall beneficiary in this case. Whether the miller really benefits from this exercise will have to be investigated.

4D.6 CONCLUSION

The analysis of the case study farmers' financial statements revealed that farmer 1 was in an acceptable financial position, but should be cautious not to over-borrow. Farmer 2 was not in a good financial position, and as a result was not able to take financial risk. Farmer 3 was highly indebted because of the loans he took to buy his farm, which meant that he was not able to take more financial risk. Farmers 4 and 5, who are vegetable farmers, were in good financial position and could take financial risk if they wanted to. In all the cases, however, it was uncertain how risk would affect their net cash flow position.

The study revealed that case study farmers faced production and price risk, in other instances financial risk was also experienced. The risk analysis on the net cash flows of the farmers, considering production and price as the risk variables, revealed that for farmer 1, considering both production and price risk on sugarcane and maize, there was approximately 95% that he would realise negative net cash flow. Price risk had more effect than yield risk on net cash flow. Considering financial risk on net cash flow it was realised that it increased the risk of the farmer. Therefore it was recommended that he should use his off-farm income to finance the change from flood-irrigation to sprinkler-irrigation system. Risk analysis revealed that there was no probability that farmer 2 would realise negative net cash flow and the decision to expand his irrigation area would significantly improve his net cash flow position. It was recommended that he expand his irrigated area. Risk analysis for farmer 3 revealed that there was no probability that he would realise positive net cash flow and it was recommended that he be careful not to over-borrow and that he should augment his production loan and short-term financial obligations with his off-farm income. For farmer 4 there was no probability that he would realise negative net cash flow. Both production and price risk had a greater effect on net cash flow than when taken separately. A risk efficient production strategy was identified and recommended to the farmer. There was no probability that farmer 5 would realise negative cash flow. Price risk had more effect than production and price risk taken together, and yield risk was the lowest for the farmer. A risk efficient crop production strategy was identified and recommended to the farmer. Farmers 1, 2, 4 and 5 faced strategic risk of uncertain land tenure as they did not own farming land but used it on a RTO basis. Farmer 5 also faced strategic risk of dishonest hawkers.

The study found that sugarcane farmers 1, 2 and 3 had a sure market for their sugarcane, as they just delivered it at the TSB sugarcane mill. Vegetable farmers 4 and 5 used spot or direct marketing strategy to sell their produce to the local community and to hawkers who came to buy from the farm gate. Contract marketing was a newly adopted marketing strategy by farmer 5 who had a selling contract with Spar retail shop. Other marketing strategies including spreading of sales, market information, vertical integration and value adding were suggested for vegetable farmers and maize farmers to exploit.

APPENDIX 5.A

ENTERPRISE BUDGETS FOR SUGARCANE UNDER DRAGLINE-, CENTRE PIVOT-, AND FLOPPY-IRRIGATION

Table A.1: Enterprise budget for sugarcane under dragline-irrigation in the establishment year, 2000.

Enterprise: Sugarcane
Project: Madadeni – Draglines
Size of plot: 7 ha
Year: 1 (15 months)

	Unit	Price/Unit	Quantity	Value/Cost /ha
GROSS income				
Sugarcane	Tonne	0.1472	110	
Price (Sucrose 14.72%)	Tonne	854.2	16.192	R 13,831
TOTAL GROSS INCOME				R 13,831
BUSINESS EXPENSES				
AREA DEPENDENT COSTS				
Seedbed preparation	Ha	550.00	1	R 550
Seed	Tonne	180.00	10	R 1,800
Soil analysis	Sample	62.00	1	R 62
Fertilizer	kg	2.45	590	R 1,446
Weedicides	l	135.20	2.5	R 338
Administrative costs	Ha	26.00	1	R 26
Pumping operator	Ha	37.00	1	R 37
Repairs and maintenance	Ha	1	428	R 428
TOTAL AREA DEPENDENT COSTS				R 4,687
YIELD DEPENDENT COSTS				
Harvesting costs	Tonne	6.50	110	R 715
Transport	Tonne	32.00	110	R 3,520
Levies: Small Growers' Development Trust (SGDT)	Tonne	0.30	110	R 33
Mill Group Board	Tonne	0.26	110	R 29
Local Growers' Board	Tonne	0.09	110	R 10
Sugarcane Committee	Tonne	0.20	110	R 22
Pest and Disease Control	Tonne	0.20	110	R 22
Sugarcane Research Service	Tonne	0.78	110	R 86
TOTAL YIELD VARIABLE COSTS				R 4,436
OTHER EXPENSES				
Irrigation costs	mm.ha	1.06	1000	R 1,060
Labour	Hour	1.25	1165	R 1,456
Interest	R	1	76	R 76
TOTAL COST				R 11,715
GROSS MARGIN				R 2,116
ALLOCATIVE OWNERSHIP COSTS				
Irrigation cost	R	1	480	R 480
TOTAL SPECIFIED COST				R 480
INCOME ABOVE SPECIFIED COST				R 1,636

Table A.2: Enterprise budget for years 2 to 7 for sugarcane under dragline-irrigation, 2000.

	Unit	Price/ Unit	Quanity	Value/Cost /Ha
Enterprise: Sugarcane				
Project: Madadeni – Draglines				
Size of plot: 7 ha				
Year: 2-7 (12 months)				
GROSS INCOME				
Sugarcane	Tonne	0.1472	110	
Price (Sucrose 14,72%)	Tonne	854.2	16.192	R 13,831
TOTAL GROSS INCOME				R 13,831
BUSINESS EXPENSES				
AREA DEPENDENT COSTS				
Soil analysis	Sample	62.00	1	R 62
Fertilizer	kg	2.45	590	R 1,446
Weedicides	l	135.20	2.5	R 338
Administrative costs	Ha	21.00	1	R 21
Pumping operator	Ha	30.00	1	R 30
Repairs and maintenance	Ha	1	428	R 428
TOTAL AREA DEPENDENT COSTS				R 2,325
YIELD DEPENDENT COSTS				
Harvesting costs	Tonne	6.50	110	R 715
Transport	Tonne	32.00	110	R 3,520
Levies: Small Growers' Development Trust (SGDT)	Tonne	0.30	110	R 33
Mill Group Board	Tonne	0.26	110	R 29
Local Growers' Board	Tonne	0.09	110	R 10
Sugarcane Committee	Tonne	0.20	110	R 22
Pest and Disease Control	Tonne	0.20	110	R 22
Sugarcane Research Service	Tonne	0.78	110	R 86
TOTAL YIELD VARIABLE COSTS				R 4,436
OTHER EXPENSES				
Irrigation costs	mm.ha	1.06	1000	R 1,060
Labour	Hour	1.25	960	R 1,200
Interest	R	1	60	R 60
TOTAL COST				R 9,081
GROSS MARGIN				R 4,750
ALLOCATIVE OWNERSHIP COSTS				
Irrigation cost	R	1	384	R 384
TOTAL SPECIFIED COST				R 384
INCOME ABOVE SPECIFIED COST				R 4,366

Table A.3: Enterprise budget for sugarcane under centre pivot-irrigation in the establishment year, 2000.

Enterprise: Sugarcane
Project: Mbongozi – Centre Pivot
Size of Plot: 5 ha
Year: 1 (15 months)

	Unit	Price/Unit	Quantity	Value/Cost/ Ha
GROSS INCOME				
Sugarcane	Tonne	0.1455	131	
Price (Sucrose 14,55%)	Tonne	854.2	19.06	R 16.281
TOTAL GROSS INCOME				R 16.281
BUSINESS EXPENSES				
AREA DEPENDENT COSTS				
Seedbed preparation	Ha	550.00	1	R 550
Seed	Tonne	180.00	10	R 1.800
Soil analysis	Sample	62.00	1	R 62
Fertilizer	kg	1.64	670	R 1.099
Weedicides	l	135.20	2.5	R 338
Administrative costs	Ha	53.00	1	R 53
Pumping operator	Ha	30.00	1	R 30
Repairs and maintenance	Ha	1	600	R 600
TOTAL AREA DEPENDENT COSTS				R 4.532
YIELD DEPENDENT COSTS				
Harvesting costs	Tonne	6.50	131	R 852
Transport	Tonne	33.74	131	R 4.420
Levies: Small Growers' Development Trust (SGDT)	Tonne	0.50	131	R 66
Mill Group Board	Tonne	0.18	131	R 24
Local Growers' Board	Tonne	0.32	131	R 42
Sugarcane Committee	Tonne	0.10	131	R 13
Pest and Disease Control	Tonne	0.20	131	R 26
Sugarcane Research Service	Tonne	0.79	131	R 103
Fire insurance	Tonne	0.12	131	R 16
TOTAL YIELD VARIABLE COSTS				R 5.561
OTHER EXPENSES				
Irrigation costs	mm.ha	0.94	1000	R 937
Labour	Hour	1.25	1248	R 1,560
Interest	R	1	247	R 247
TOTAL COST				R 12,836
GROSS MARGIN				R 3,445
ALLOCATIVE OWNERSHIP COSTS				
Irrigation costs	R	1	226	R 226
TOTAL SPECIFIED COST				R 226
INCOME ABOVE SPECIFIED COST				R 3,219

Table A.4: Enterprise budget for years 2 to 7 for sugarcane under centre pivot-irrigation, 2000.

Enterprise: Sugarcane

Project: Mbongozi – Centre pivot

Size of plot: 5 ha

Year: 2-7 (12 months)

	Unit	Price/Unit	Quantity	Value/Cost/ Ha
GROSS INCOME				
Sugarcane	Tonne	0.1455	131	
Price (Sucrose 14,55%)	Tonne	854.2	19.06	R 16,281
TOTAL GROSS INCOME				R 16,281
BUSINESS EXPENSES				
AREA DEPENDENT COSTS				
Soil analysis	Sample	62.00	1	R 62
Fertilizer	kg	1.64	670	R 1,099
Weedicides	l	135.20	2.5	R 338
Administrative costs	Ha	42.00	1	R 42
Pumping operator	Ha	24.00	1	R 24
Repairs and maintenance	Ha	1	600	R 600
TOTAL AREA DEPENDENT COSTS				R 2,165
YIELD DEPENDENT COSTS				
Harvesting costs	Tonne	6.50	131	R 852
Transport	Tonne	33.74	131	R 4,420
Levies: Small Growers' Development Trust (SGDT)	Tonne	0.50	131	R 66
Mill Group Board	Tonne	0.18	131	R 24
Local Growers' Board	Tonne	0.32	131	R 42
Sugarcane Committee	Tonne	0.10	131	R 13
Pest and Disease Control	Tonne	0.20	131	R 26
Sugarcane Research Service	Tonne	0.79	131	R 103
Fire insurance	Tonne	0.12	131	R 16
TOTAL YIELD VARIABLE COSTS				R 5,561
OTHER EXPENSES				
Irrigation costs	mm.ha	0.94	1000	R 937
Labour	Hour	1.25	1056	R 1,320
Interest	R	1	198	R 198
TOTAL COST				R 10,180
GROSS MARGIN				R 6,101
ALLOCATIVE OWNERSHIP COSTS				
Irrigation costs	R	1	180	R 180
TOTAL SPECIFIED COST				R 180
INCOME ABOVE SPECIFIED COST				R 5,921

Table A.5: Enterprise budget for sugarcane under floppy-irrigation in the establishment year, 2000.

Enterprise: Sugarcane
Project: Walda - Floppy
Size of plot:10 ha
Year: 1 (15 months)

	Unit	Price/Unit	Quantity	Value/Cost/ Ha
GROSS INCOME				
Sugarcane	Tonne	0.1375	107	
Price (Sucrose 13,75%)	Tonne	854.2	14.71	R 12,567
TOTAL GROSS INCOME				R 12,567
BUSINESS EXPENSES				
AREA DEPENDENT COSTS				
Seedbed preparation	Ha	550.00	1	R 550
Seed	Tonne	180.00	10	R 1,800
Soil analysis	Sample	62.00	1	R 62
Fertilizer	kg	2.09	1043	R 2,180
Weedicides	l	135.20	2.5	R 338
Rent of tractor	Ha	39.00	1	R 39
Administrative costs	Ha	13.00	1	R 13
Pumping operator	Ha	43.00	1	R 43
Repairs and maintenance	Ha	1.00	368	R 368
TOTAL AREA DEPENDENT COSTS				R 5,393
YIELD DEPENDENT COSTS				
Harvesting costs	Tonne	6.50	107	R 696
Transport	Tonne	23.68	107	R 2,534
Levies: Small Growers' Development Trust (SGDT)	Tonne	0.30	107	R 32
Mill Group Board	Tonne	0.26	107	R 28
Local Growers' Board	Tonne	0.09	107	R 10
Sugarcane Committee	Tonne	0.20	107	R 21
Pest and Disease Control	Tonne	0.20	107	R 21
Sugarcane Research Service	Tonne	0.78	107	R 83
TOTAL YIELD VARIABLE COSTS				R 3,425
OTHER EXPENSES				
Irrigation costs	mm.ha	0.67	1000	R 667
Labour	Hour	1.25	624	R 780
Interest	R	1	136	R 136
TOTAL COST				R 10,401
GROSS MARGIN				R 2,166
ALLOCATIVE OWNERSHIP COSTS				
Irrigation costs	R	1	1273	R 1,273
TOTAL SPECIFIED COSTS				R 1,273
INCOME ABOVE SPECIFIED COSTS				R 893

Table A.6: Enterprise budget for years 2 to 7 for sugarcane under floppy-irrigation, 2000.

Enterprise: Sugarcane

Project: Walda - Floppy

Size of plot: 10 ha

Year: 2-7 (12 months)

	Unit	Price/ Unit	Quanity	Value/Cost/ Ha
GROSS INCOME				
Sugarcane	Tonne	0.1375	107	
Price (Sucrose 13.75%)	Tonne	854.2	14.71	R 12,567
TOTAL GROSS INCOME				R 12,567
BUSINESS EXPENSES				
AREA DEPENDENT COSTS				
Soil analysis	Sample	62.00	1	R 62
Fertilizer	kg	2.09	1043	R 2,180
Weedicides	l	135.20	2.5	R 338
Rent of tractor	Ha	39.00	1	R 39
Administrative costs	Ha	10	1	R 10
Pumping operator	Ha	34.00	1	R 34
Repairs and maintenance	Ha	1.00	294	R 294
TOTAL AREA DEPENDENT COSTS				R 2,957
YIELD DEPENDENT COSTS				
Harvesting costs	Tonne	6.50	107	R 696
Transport	Tonne	23.68	107	R 2,534
Levies: Small Growers Development Trust (SGDT)	Tonne	0.30	107	R 32
Mill Group Board	Tonne	0.26	107	R 28
Local Growers Board	Tonne	0.09	107	R 10
Sugarcane Committee	Tonne	0.20	107	R 21
Pest and Disease Control	Tonne	0.20	107	R 21
Sugarcane Research Service	Tonne	0.78	107	R 83
TOTAL YIELD VARIABLE COSTS				R 3,425
OTHER EXPENSES				
Irrigation costs	mm.ha	0.67	1000	R 667
Labour	Hour	1.25	528	R 660
Interest	R	1	136	R 136
TOTAL COST				R 7,845
GROSS MARGIN				R 4,722
ALLOCATIVE OWNERSHIP COSTS				
Irrigation costs	R	1	1018	R 1,018
TOTAL SPECIFIED COSTS				R 1,018
INCOME ABOVE SPECIFIED COSTS				R 3,704

APPENDIX **5.B**

FINANCIAL FEASIBILITY AND LIVING EXPENSES FOR DRAGLINE-IRRIGATION SYSTEMS (MADADENI)

Table B.1: Financial feasibility for a dragline-irrigation system, without subsidy, a payback period of 8 years at an interest rate of 16,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	32	-21,949	46,237	5,846	74.94
2	7	-1,758	54,335	21,021	52.00
3	4	-763	57,900	21,143	50.87
8	30	-16,137	44,124	6,537	68.33
15	8	-5,104	53,814	17,220	55.80
22	18	-11,408	51,212	11,419	62.96

Table B.2: Probability of not covering living expenses of R24 000 per year, for a dragline-irrigation system, without subsidy, a payback period of 8 years and an interest rate of 16,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	94	-21,949	46,237	5,846
2	48	-1,758	54,335	21,021
3	47	-763	57,900	21,143
4	43	3,809	63,465	25,816
5	43	4,112	64,230	25,090
6	35	4,384	63,837	26,843
7	33	4,627	64,671	27,741
8	98	-16,137	44,124	6,537
9	41	4,341	62,152	25,074
10	39	5,049	63,543	26,512
11	30	7,947	67,936	30,201
12	30	7,783	54,835	28,703
13	38	7,713	66,022	28,455
14	32	7,542	67,771	29,527
15	81	-5,104	53,814	17,220
16	31	6,201	66,693	28,893
17	36	6,479	61,448	27,625
18	31	7,595	61,217	28,953
19	35	6,627	58,182	27,877
20	29	7,108	67,263	29,538
21	34	7,142	63,956	28,263
22	96	-11,408	51,212	11,419
23	33	6,089	58,069	27,973
24	32	6,887	66,875	29,253
25	30	7,732	67,149	30,381
26	37	7,740	67,839	28,455
27	35	7,747	62,716	28,556
28	37	7,753	67,963	29,893
29	35	7,838	67,088	28,372
30	8	18,901	78,686	41,365

Table B.3: Financial feasibility for a dragline-irrigation system, with subsidy, a payback period of 8 years at an interest rate of 13,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	31	-21,539	46,647	6,256	74.47
2	7	-1,380	54,712	21,398	51.57
3	4	-414	58,249	21,493	50.47
8	29	-15,868	44,393	6,806	68.03
15	8	-5,081	53,836	17,242	55.77
22	18	-11,314	51,306	11,513	62.85

Table B.4: Probability of not covering living expenses of R24 000 per year, for a dragline-irrigation system, with subsidy, a payback period of 8 years and an interest rate of 13.5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	94	-21,539	46,647	6,256
2	47	-1,380	54,712	21,398
3	46	-414	58,249	21,493
4	42	4,134	63,791	26,142
5	41	4,418	64,536	25,396
6	34	4,674	64,127	27,133
7	32	4,905	64,949	28,018
8	98	-15,868	44,393	6,806
9	41	4,341	62,152	25,074
10	39	5,049	63,543	26,512
11	30	7,977	67,966	30,231
12	30	7,810	54,863	28,731
13	38	7,738	66,047	28,481
14	32	7,566	67,795	29,551
15	80	-5,081	53,836	17,242
16	31	6,345	66,838	29,038
17	36	6,613	61,582	27,759
18	30	7,719	61,341	29,078
19	35	6,725	58,280	27,975
20	28	7,200	67,355	29,630
21	34	7,241	64,055	28,361
22	96	-11,314	51,306	11,513
23	33	6,180	58,159	28,064
24	32	6,896	66,884	29,263
25	30	7,741	67,157	30,390
26	37	7,748	67,847	28,463
27	35	7,755	62,724	28,564
28	27	7,761	67,971	29,900
29	35	7,838	67,088	28,372
30	8	18,901	78,686	41,365

Table B.5: Financial feasibility for a dragline-irrigation system, with subsidy, a payback period of 8 years at an interest rate of 19,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	32	-22,380	45,806	5,415	75.43
2	7	-2,152	53,940	20,626	52.45
3	4	-1,127	57,536	20,780	51.28
8	30	-16,414	43,847	6,260	68.65
15	8	-5,127	53,791	17,197	55.82
22	19	-11,505	51,115	11,322	63.07

Table B.6: Probability of not covering living expenses of R24 000 per year, for a dragline-irrigation system, with subsidy, a payback period of 8 years and an interest rate of 19,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	94	-22,380	45,806	5,415
2	49	-2,152	53,940	20,626
3	47	-1,127	57,536	20,780
4	43	3,472	63,128	25,479
5	44	3,797	63,914	24,775
6	36	4,086	63,539	26,545
7	34	4,342	64,386	27,455
8	98	-16,414	43,847	6,260
9	41	4,341	62,152	25,074
10	39	5,049	63,543	26,512
11	30	7,916	67,904	30,170
12	31	7,754	54,806	28,674
13	38	7,686	65,995	28,428
14	32	7,518	67,746	29,502
15	82	-5,127	53,791	17,197
16	31	6,049	66,542	28,742
17	37	6,340	61,309	27,485
18	31	7,465	61,087	28,824
19	36	6,526	58,081	27,775
20	29	7,014	67,168	29,443
21	35	7,040	63,855	28,161
22	96	-11,505	51,115	11,322
23	33	5,996	57,975	27,880
24	32	6,877	66,866	29,244
25	30	7,723	67,140	30,372
26	37	7,732	67,831	28,447
27	35	7,739	62,708	28,548
28	27	7,745	67,955	29,885
29	35	7,838	67,088	28,372
30	8	18,901	78,686	41,365

Table B.7: Financial feasibility for a dragline-irrigation system, with subsidy, a payback period of 10 years at an interest rate of 13,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	30	-20,173	48,013	7,621	72.92
2	6	-106	55,987	22,673	50.12
8	27	-14,968	45,293	7,707	67.01
15	8	-6,094	52,824	16,230	56.92
22	16	-11,014	51,606	11,813	62.51

Table B.8: Probability of not covering living expenses of R24 000 per year, for a dragline-irrigation system, with subsidy, a payback period of 10 years and an interest rate of 13,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	94	-20,173	48,013	7,621
2	44	-106	55,987	22,673
3	44	779	59,443	22,686
4	39	5,255	64,911	27,262
5	39	5,473	65,591	26,452
6	32	5,671	65,125	28,131
7	30	5,851	65,895	28,964
8	98	-14,968	45,293	7,707
9	44	2,664	60,475	23,397
10	43	3,505	61,999	24,968
11	32	6,599	66,588	28,853
12	36	6,538	53,590	27,458
13	41	6,562	64,871	27,304
14	35	6,476	66,704	28,461
15	91	-6,094	52,824	16,230
16	30	6,788	67,281	29,481
17	35	7,027	61,996	28,173
18	29	8,108	61,729	29,466
19	35	6,904	58,459	28,154
20	28	7,371	67,526	29,800
21	32	7,558	64,372	28,678
22	96	-11,014	51,606	11,813
23	33	6,465	58,445	28,349
24	33	6,406	66,395	28,773
25	31	7,291	66,707	29,940
26	37	7,333	67,433	28,049
27	36	7,372	62,341	28,181
28	28	7,407	67,617	29,547
29	36	7,438	66,689	27,973
30	8	18,530	78,315	40,994

Table B.9: Financial feasibility for a dragline-irrigation system, with subsidy, a payback period of 10 years at an interest rate of 16,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	30	-20,656	47,530	7,138	73.47
2	7	-544	55,549	22,234	50.62
8	28	-15,220	45,041	7,454	67.29
15	9	-6,274	52,643	16,050	57.13
22	17	-11,108	51,513	11,720	62.62

Table B.10: Probability of not covering living expenses of R24 000 per year, for a dragline-irrigation system, with subsidy, a payback period of 10 years and an interest rate of 16.5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	94	-20,656	47,530	7,138
2	44	-544	55,549	22,234
3	44	381	59,045	22,288
4	39	4,893	64,549	26,900
5	39	5,144	65,261	26,122
6	33	5,371	64,824	27,830
7	31	5,576	65,620	28,689
8	98	-15,220	45,041	7,454
9	44	2,432	60,243	23,165
10	43	3,291	61,785	24,754
11	32	6,369	66,357	28,623
12	36	6,324	53,376	27,244
13	41	6,361	64,670	27,103
14	35	6,286	66,515	28,271
15	92	-6,274	52,643	16,050
16	30	6,622	67,115	29,315
17	35	6,876	61,845	28,022
18	29	7,969	61,591	29,328
19	35	6,778	58,333	28,027
20	28	7,255	67,410	29,684
21	33	7,455	64,270	28,576
22	96	-11,108	51,513	11,720
23	33	6,380	58,359	28,263
24	33	6,327	66,316	28,694
25	31	7,218	66,634	29,867
26	37	7,265	67,365	27,981
27	37	7,309	62,278	28,117
28	28	7,347	67,557	29,487
29	36	7,382	66,632	27,916
30	9	18,476	78,261	40,940

Table B.11: Financial feasibility for a dragline-irrigation system, with subsidy, a payback period of 10 years at an interest rate of 19,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	30	-20,656	47,530	7,138	73.47
2	7	-544	55,549	22,234	50.62
8	28	-15,220	45,041	7,454	67.29
15	9	-6,274	52,643	16,050	57.13
22	17	-11,108	51,513	11,720	62.62

Table B.12: Probability of not covering living expenses of R24 000 per year, for a dragline-irrigation system, with subsidy, a payback period of 10 years and an interest rate of 19,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	94	-20,656	47,530	7,138
2	44	-544	55,549	22,234
3	44	381	59,045	22,288
4	39	4,893	64,549	26,900
5	39	5,144	65,261	26,122
6	33	5,371	64,824	27,830
7	31	5,576	65,620	28,689
8	98	-15,220	45,041	7,454
9	44	2,432	60,243	23,165
10	43	3,291	61,785	24,754
11	32	6,369	66,357	28,623
12	36	6,324	53,376	27,244
13	41	6,361	64,670	27,103
14	35	6,286	66,515	28,271
15	92	-6,274	52,643	16,050
16	30	6,622	67,115	29,315
17	35	6,876	61,845	28,022
18	29	7,969	61,591	29,328
19	35	6,778	58,333	28,027
20	28	7,255	67,410	29,684
21	33	7,455	64,270	28,576
22	96	-11,108	51,513	11,720
23	33	6,380	58,359	28,263
24	33	6,327	66,316	28,694
25	31	7,218	66,634	29,867
26	37	7,265	67,365	27,981
27	37	7,309	62,278	28,117
28	28	7,347	67,557	29,487
29	36	7,382	66,632	27,916
30	9	18,476	78,261	40,940

APPENDIX 5.C

FINANCIAL FEASIBILITY AND LIVING EXPENSES FOR CENTRE PIVOT-IRRIGATION SYSTEMS (MBONGOZI)

Table C.1: Financial feasibility for a centre pivot-irrigation system, without subsidy, a payback period of 8 years at an interest rate of 16,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	44	-28,057	26,985	-2,350	95.15
2	21	-12,480	33,239	9,636	70.08
3	20	-10,903	35,648	10,335	67.55
4	13	-6,805	39,016	13,310	60.95
5	13	-5,887	40,216	13,442	59.47
6	9	-5,064	40,632	15,548	58.15
7	6	-4,328	41,731	17,157	56.96
8	33	-18,901	27,569	1,822	80.42
22	19	-9,743	37,993	10,854	65.68

Table C.2: Probability of not covering living expenses of R24 000 per year, for a centre pivot-irrigation system, without subsidy, a payback period of 8 years and an interest rate of 16,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	99	-28,057	26,985	-2,350
2	96	-12,480	33,239	9,636
3	97	-10,903	35,648	10,335
4	92	-6,805	39,016	13,310
5	96	-5,887	40,216	13,442
6	94	-5,064	40,632	15,548
7	96	-4,328	41,731	17,157
8	100	-18,901	27,569	1,822
9	42	2,894	47,584	22,027
10	43	3,121	48,230	23,020
11	32	5,392	51,416	25,949
12	37	5,392	43,489	24,991
13	41	5,392	50,387	24,373
14	35	5,392	51,563	25,580
15	37	4,364	49,382	24,510
16	31	2,361	53,012	26,333
17	37	2,727	48,191	24,525
18	35	4,117	47,468	25,105
19	39	2,972	43,828	22,618
20	35	3,154	49,280	23,905
21	42	3,317	47,397	22,787
22	97	-9,743	37,993	10,854
23	37	2,936	44,052	23,137
24	36	4,794	50,818	25,489
25	34	5,392	51,065	26,138
26	39	5,392	51,484	24,540
27	40	5,392	48,340	24,740
28	31	5,392	51,552	25,669
29	38	5,392	50,964	24,357
30	10	19,172	65,072	39,738

Table C.3: Financial feasibility for a centre pivot-irrigation system, with subsidy, a payback period of 8 years at an interest rate of 13,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	30	-21,587	33,455	4,120	84.74
2	12	-6,531	39,188	15,585	60.51
3	10	-5,421	41,130	15,817	58.72
4	8	-1,741	44,080	18,375	52.80
5	7	-1,195	44,909	18,135	51.92
6	3	-702	44,995	19,910	51.13
7	2	-257	45,801	21,228	50.41
8	28	-15,087	31,383	5,636	74.28
22	18	-9,577	38,160	11,020	65.41

Table C.4: Probability of not covering living expenses of R24 000 per year, for a centre pivot-irrigation system, with subsidy, a payback period of 8 years and an interest rate of 13,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	97	-21,587	33,455	4,120
2	94	-6,531	39,188	15,585
3	97	-5,421	41,130	15,817
4	65	-1,741	44,080	18,375
5	64	-1,195	44,909	18,135
6	53	-702	44,995	19,910
7	53	-257	45,801	21,228
8	98	-15,087	31,383	5,636
9	42	2,894	47,584	22,027
10	43	3,121	48,230	23,020
11	32	5,392	51,416	25,949
12	37	5,392	43,489	24,991
13	41	5,392	50,387	24,373
14	35	5,392	51,563	25,580
15	37	4,364	49,382	24,510
16	31	2,607	53,258	26,579
17	37	2,953	48,417	24,752
18	34	4,327	47,677	25,315
19	39	3,167	44,024	22,813
20	35	3,337	49,464	24,089
21	42	3,491	47,571	22,961
22	97	-9,577	38,160	11,020
23	36	3,097	44,214	23,298
24	36	4,794	50,818	25,489
25	34	5,392	51,065	26,138
26	39	5,392	51,484	24,540
27	40	5,392	48,340	24,740
28	31	5,392	51,552	25,669
29	38	5,392	50,964	24,357
30	10	19,172	65,072	39,738

Table C.5: Financial feasibility for a centre pivot-irrigation system, with subsidy, a payback period of 8 years at an interest rate of 19,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	32	-23,206	27,320	2,304	87.34
2	14	-8,019	34,047	13,973	62.90
3	13	-6,795	35,507	14,360	60.93
4	9	-3,017	38,296	16,861	54.86
5	7	-2,392	39,134	16,815	53.85
6	5	-1,835	39,385	18,638	52.95
7	3	-1,341	40,150	20,033	52.16
8	30	-16,138	26,017	4,509	75.97
22	19	-9,915	33,190	10,562	65.95

Table C.6: Probability of not covering living expenses of R24 000 per year, for a centre pivot-irrigation system, with subsidy, a payback period of 8 years and an interest rate of 19,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	98	-23,206	27,320	2,304
2	95	-8,019	34,047	13,973
3	97	-6,795	35,507	14,360
4	87	-3,017	38,296	16,861
5	80	-2,392	39,134	16,815
6	63	-1,835	39,385	18,638
7	58	-1,341	40,150	20,033
8	100	-16,138	26,017	4,509
9	42	2,894	43,359	21,922
10	43	3,121	43,900	22,901
11	32	5,392	46,858	25,830
12	37	5,392	40,912	24,954
13	41	5,392	46,086	24,211
14	35	5,392	46,968	25,381
15	37	4,364	45,076	24,350
16	31	2,102	48,311	25,961
17	37	2,490	44,164	24,194
18	35	3,899	43,666	24,815
19	39	2,769	40,359	22,327
20	35	2,964	44,507	23,608
21	43	3,138	43,145	22,462
22	97	-9,915	33,190	10,562
23	38	2,770	40,555	22,872
24	36	4,794	46,260	25,340
25	34	5,392	46,595	25,975
26	39	5,392	46,909	24,431
27	40	5,392	44,551	24,632
28	31	5,392	46,959	25,509
29	38	5,392	46,518	24,238
30	10	19,172	60,545	39,530

Table C.7: Financial feasibility for a centre pivot-irrigation system, with subsidy, a payback period of 15 years at an interest rate of 13,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	27	-18,957	31,569	6,554	80.51
2	9	-4,076	37,989	17,915	56.56
3	8	-3,123	39,179	18,032	55.03
8	25	-13,352	28,803	7,294	71.49
9	8	-336	40,129	18,692	50.54
22	16	-9,008	34,097	11,469	64.50

Table C.8: Probability of not covering living expenses of R24 000 per year, for a centre pivot-irrigation system, with subsidy, a payback period of 15 years and an interest rate of 13,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	97	-18,957	31,569	6,554
2	59	-4,076	37,989	17,915
3	62	-3,123	39,179	18,032
4	54	418	41,731	20,296
5	54	838	42,364	20,045
6	45	1,219	42,440	21,692
7	42	1,565	43,057	22,940
8	98	-13,352	28,803	7,294
9	61	-336	40,129	18,692
10	54	148	40,927	19,928
11	40	2,650	44,116	23,089
12	44	2,860	38,381	22,422
13	45	3,050	43,744	21,869
14	38	3,221	44,797	23,210
15	46	2,347	43,059	22,333
16	30	3,427	49,636	27,287
17	35	3,719	45,394	25,424
18	33	5,044	44,811	25,960
19	38	3,840	41,430	23,398
20	35	3,972	45,514	24,615
21	41	4,090	44,098	23,415
22	97	-9,008	34,097	11,469
23	35	3,638	41,423	23,740
24	38	3,786	45,252	24,333
25	35	4,464	45,667	25,048
26	39	4,537	46,054	23,577
27	44	4,602	43,761	23,843
28	32	4,661	46,229	24,779
29	40	4,715	45,841	23,561
30	11	18,543	59,916	38,901

Table C.9: Financial feasibility for a centre pivot-irrigation system, with subsidy, a payback period of 15 years at an interest rate of 16,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	28	-19,887	30,639	5,624	82.00
2	11	-4,920	37,145	17,071	57.92
3	8	-3,890	38,412	17,265	56.26
4	7	-280	41,034	19,599	50.45
8	26	-13,838	28,317	6,809	72.27
9	8	-783	39,683	18,245	51.26
10	6	-265	40,514	19,515	50.43
22	17	-9,173	33,931	11,303	64.76

Table C.10: Probability of not covering living expenses of R24 000 per year, for a centre pivot-irrigation system, with subsidy, a payback period of 15 years and an interest rate of 16,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	97	-19,887	30,639	5,624
2	66	-4,920	37,145	17,071
3	74	-3,890	38,412	17,265
4	58	-280	41,034	19,599
5	59	203	41,729	19,410
6	48	640	41,860	21,113
7	44	1,035	42,527	22,410
8	98	-13,838	28,317	6,809
9	63	-783	39,683	18,245
10	57	-265	40,514	19,515
11	40	2,267	43,733	22,706
12	47	2,502	38,023	22,064
13	46	2,713	43,408	21,533
14	40	2,902	44,478	22,892
15	46	2,043	42,754	22,029
16	30	3,137	49,346	26,997
17	36	3,456	45,130	25,161
18	33	4,805	44,572	25,721
19	38	3,623	41,213	23,181
20	35	3,773	45,316	24,417
21	41	3,910	43,917	23,234
22	97	-9,173	33,931	11,303
23	35	3,487	41,272	23,589
24	38	3,647	45,113	24,194
25	35	4,336	45,539	24,919
26	40	4,417	45,934	23,457
27	44	4,491	43,650	23,731
28	32	4,556	46,124	24,674
29	40	4,615	45,742	23,462
30	11	18,448	59,821	38,806

Table C.11: Financial feasibility for a centre pivot-irrigation system, with subsidy, a payback period of 15 years at an interest rate of 19,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	30	-20,871	29,656	4,640	83.58
2	12	-5,812	36,253	16,179	59.35
3	9	-4,699	37,602	16,456	57.56
4	8	-1,014	40,299	18,864	51.63
5	6	-465	41,061	18,742	50.75
8	27	-14,344	27,811	6,302	73.08
9	9	-1,247	39,218	17,781	52.01
10	8	-693	40,086	19,087	51.12
22	18	-9,346	33,759	11,131	65.04

Table C.12: Probability of not covering living expenses of R24 000 per year, for a centre pivot-irrigation system, with subsidy, a payback period of 15 years and an interest rate of 19,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	97	-20,871	29,656	4,640
2	80	-5,812	36,253	16,179
3	92	-4,699	37,602	16,456
4	60	-1,014	40,299	18,864
5	61	-465	41,061	18,742
6	51	32	41,253	20,505
7	48	481	41,973	21,856
8	99	-14,344	27,811	6,302
9	65	-1,247	39,218	17,781
10	58	-693	40,086	19,087
11	41	1,871	43,337	22,309
12	50	2,133	37,653	21,695
13	47	2,366	43,060	21,185
14	42	2,573	44,149	22,562
15	47	1,727	42,438	21,713
16	31	2,830	49,039	26,690
17	37	3,178	44,852	24,883
18	34	4,552	44,320	25,468
19	39	3,394	40,984	22,952
20	35	3,565	45,108	24,209
21	41	3,720	43,728	23,045
22	97	-9,346	33,759	11,131
23	35	3,329	41,114	23,431
24	38	3,502	44,968	24,049
25	35	4,202	45,405	24,785
26	41	4,294	45,811	23,333
27	44	4,375	43,534	23,616
28	32	4,448	46,016	24,566
29	40	4,512	45,639	23,359
30	11	18,350	59,722	38,707

APPENDIX 5.D

FINANCIAL FEASIBILITY AND LIVING EXPENSES FOR FLOPPY-IRRIGATION SYSTEMS (WALDA)

Table D.1: Financial feasibility for a floppy-irrigation system, without subsidy, a payback period of 8 years at an interest rate of 16,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	93	-65,334	25,353	-22,080	105.63
2	32	-35,434	42,776	4,495	80.17
3	23	-31,524	45,486	6,273	76.84
4	21	-22,466	50,042	11,288	69.13
5	21	-20,018	52,838	12,324	67.04
6	16	-17,823	54,531	16,715	65.17
7	8	-15,859	56,941	20,028	63.50
8	59	-42,657	31,501	-7,629	86.32
22	18	-18,534	57,186	16,279	65.78

Table D.2: Probability of not covering living expenses of R24 000 per year, for a floppy-irrigation system, without subsidy, a payback period of 8 years and an interest rate of 16,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	99	-65,334	25,353	-22,080
2	95	-35,434	42,776	4,495
3	97	-31,524	45,486	6,273
4	87	-22,466	50,042	11,288
5	81	-20,018	52,838	12,324
6	62	-17,823	54,531	16,715
7	56	-15,859	56,941	20,028
8	98	-42,657	31,501	-7,629
9	21	5,064	76,176	37,092
10	17	5,518	77,147	38,819
11	12	10,059	82,817	44,613
12	13	10,059	73,040	43,219
13	17	10,059	81,548	42,153
14	15	10,059	82,999	43,878
15	17	4,473	75,990	38,379
16	18	3,439	86,771	44,865
17	17	4,202	78,848	42,091
18	13	7,010	77,906	43,071
19	18	4,925	71,310	37,940
20	16	5,311	78,195	40,136
21	21	5,658	76,017	38,262
22	61	-18,534	57,186	16,279
23	17	4,929	71,634	39,033
24	12	8,863	81,622	43,565
25	14	10,059	82,385	45,105
26	18	10,059	82,901	42,379
27	13	10,059	79,024	42,748
28	17	10,059	82,985	43,758
29	15	10,059	82,259	41,772

Table D.3: Financial feasibility for a floppy-irrigation system, with subsidy, a payback period of 8 years at an interest rate of 13,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	46	-44,794	45,893	-1,540	88.14
2	15	-16,548	61,662	23,381	64.09
3	13	-14,123	62,887	23,674	62.02
4	9	-6,396	66,112	27,358	55.45
5	7	-5,136	67,720	27,205	54.37
6	6	-3,999	68,355	30,538	53.40
7	3	-2,973	69,827	32,914	52.53
8	30	-30,598	43,560	4,430	76.05
22	18	-18,181	57,539	16,633	65.48

Table D.4: Probability of not covering living expenses of R24 000 per year, for a floppy-irrigation system, without subsidy, a payback period of 8 years and an interest rate of 13.5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	94	-44,794	45,893	-1,540
2	44	-16,548	61,662	23,381
3	42	-14,123	62,887	23,674
4	36	-6,396	66,112	27,358
5	34	-5,136	67,720	27,205
6	24	-3,999	68,355	30,538
7	15	-2,973	69,827	32,914
8	97	-30,598	43,560	4,430
9	21	5,064	76,176	37,092
10	17	5,518	77,147	38,819
11	12	10,059	82,817	44,613
12	13	10,059	73,040	43,219
13	17	10,059	81,548	42,153
14	15	10,059	82,999	43,878
15	17	4,473	75,990	38,379
16	18	3,962	87,294	45,388
17	17	4,683	79,329	42,572
18	12	7,455	78,351	43,516
19	17	5,340	71,724	38,355
20	16	5,701	78,585	40,526
21	20	6,027	76,387	38,631
22	60	-18,181	57,539	16,633
23	17	5,271	71,977	39,375
24	12	8,863	81,622	43,565
25	14	10,059	82,385	45,105
26	18	10,059	82,901	42,379
27	13	10,059	79,024	42,748
28	17	10,059	82,985	43,758
29	15	10,059	82,259	41,772

Table D.5: Financial feasibility for a floppy-irrigation system, with subsidy, a payback period of 8 years at an interest rate of 19,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	49	-48,530	42,156	-5,277	91.32
2	17	-19,979	58,231	19,950	67.01
3	16	-17,291	59,719	20,506	64.72
4	10	-9,341	63,167	24,413	57.95
5	8	-7,897	64,959	24,445	56.72
6	8	-6,612	65,742	27,925	55.63
7	5	-5,474	67,326	30,412	54.66
8	35	-33,022	41,136	2,006	78.12
22	19	-18,898	56,822	15,916	66.09

Table D.6: Probability of not covering living expenses of R24 000 per year, for a floppy-irrigation system, without subsidy, a payback period of 8 years and an interest rate of 19,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	95	-48,530	42,156	-5,277
2	49	-19,979	58,231	19,950
3	48	-17,291	59,719	20,506
4	46	-9,341	63,167	24,413
5	44	-7,897	64,959	24,445
6	32	-6,612	65,742	27,925
7	23	-5,474	67,326	30,412
8	98	-33,022	41,136	2,006
9	21	5,064	76,176	37,092
10	17	5,518	77,147	38,819
11	12	10,059	82,817	44,613
12	13	10,059	73,040	43,219
13	17	10,059	81,548	42,153
14	15	10,059	82,999	43,878
15	17	4,473	75,990	38,379
16	18	2,890	86,222	44,316
17	17	3,699	78,345	41,588
18	13	6,546	77,442	42,607
19	18	4,495	70,880	37,510
20	17	4,909	77,793	39,734
21	21	5,278	75,637	37,881
22	61	-18,898	56,822	15,916
23	17	4,576	71,281	38,680
24	12	8,863	81,622	43,565
25	14	10,059	82,385	45,105
26	18	10,059	82,901	42,379
27	13	10,059	79,024	42,748
28	17	10,059	82,985	43,758
29	15	10,059	82,259	41,772

Table D.7: Financial feasibility for a floppy-irrigation system, with subsidy, a payback period of 15 years at an interest rate of 13,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	34	-38,727	51,960	4,527	82.97
2	12	-10,884	67,327	29,045	59.27
3	8	-8,820	68,190	28,977	57.51
4	8	-1,416	71,091	32,337	51.21
5	6	-446	72,410	31,896	50.38
8	25	-26,597	47,561	8,432	72.64
9	9	-2,388	68,725	29,640	52.03
10	8	-1,342	70,287	31,959	51.14
15	5	-180	71,337	33,726	50.15
22	15	-16,975	58,745	17,839	64.45

Table D.8: Probability of not covering living expenses of R24 000 per year, for a floppy-irrigation system, without subsidy, a payback period of 15 years and an interest rate of 13,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	92	-38,727	51,960	4,527
2	28	-10,884	67,327	29,045
3	23	-8,820	68,190	28,977
4	23	-1,416	71,091	32,337
5	25	-446	72,410	31,896
6	21	434	72,788	34,971
7	12	1,231	74,031	37,118
8	96	-26,597	47,561	8,432
9	25	-2,388	68,725	29,640
10	23	-1,342	70,287	31,959
11	17	3,735	76,493	38,288
12	19	4,219	67,200	37,379
13	22	4,656	76,145	36,750
14	17	5,050	77,990	38,869
15	22	-180	71,337	33,726
16	17	5,702	89,034	47,128
17	16	6,308	80,953	44,196
18	12	8,976	79,872	45,037
19	16	6,768	73,152	39,783
20	14	7,046	79,930	41,871
21	19	7,298	77,658	39,902
22	57	-16,975	58,745	17,839
23	17	6,419	73,124	40,523
24	14	6,726	79,484	41,428
25	15	8,092	80,418	43,137
26	18	8,245	81,087	40,565
27	15	8,384	77,349	41,073
28	18	8,509	81,435	42,209
29	16	8,622	80,823	40,335

Table D.9: Financial feasibility for a floppy-irrigation system, with subsidy, a payback period of 15 years at an interest rate of 16,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	39	-40,872	49,814	2,381	84.80
2	12	-12,832	65,379	27,097	60.93
3	10	-10,589	66,421	27,208	59.02
4	8	-3,025	69,482	30,728	52.58
5	7	-1,911	70,945	30,431	51.63
6	3	-903	71,451	33,635	50.77
8	27	-27,717	46,441	7,312	73.60
9	10	-3,418	67,694	28,610	52.91
10	8	-2,294	69,335	31,007	51.95
15	5	-883	70,634	33,024	50.75

Table D.10: Probability of not covering living expenses of R24 000 per year, for a floppy-irrigation system, without subsidy, a payback period of 15 years and an interest rate of 16,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	93	-40,872	49,814	2,381
2	37	-12,832	65,379	27,097
3	28	-10,589	66,421	27,208
4	24	-3,025	69,482	30,728
5	26	-1,911	70,945	30,431
6	22	-903	71,451	33,635
7	13	9	72,809	35,896
8	97	-27,717	46,441	7,312
9	26	-3,418	67,694	28,610
10	23	-2,294	69,335	31,007
11	17	2,851	75,609	37,405
12	20	3,393	66,375	36,554
13	23	3,880	75,369	35,974
14	18	4,315	77,255	38,134
15	23	-883	70,634	33,024
16	17	5,087	88,418	46,512
17	16	5,749	80,395	43,638
18	12	8,469	79,364	44,530
19	17	6,307	72,691	39,322
20	16	6,626	79,510	41,451
21	19	6,915	77,275	39,519
22	58	-17,325	58,395	17,488
23	17	6,098	72,803	40,202
24	14	6,431	79,189	41,132
25	15	7,819	80,145	42,864
26	18	7,992	80,834	40,311
27	15	8,147	77,112	40,836
28	18	8,287	81,213	41,986
29	17	8,412	80,612	40,125

Table D.11: Financial feasibility for a floppy-irrigation system, with subsidy, a payback period of 15 years at an interest rate of 19,5%, 2000.

Year	Probability not to be able to pay the instalment %	Minimum Balance R	Maximum Balance R	Average Balance R	Break-even Yield Tonne/ha
1	43	-43,141	47,545	112	86.73
2	13	-14,889	63,321	25,040	62.68
3	12	-12,456	64,554	25,341	60.61
4	9	-4,720	67,787	29,033	54.02
5	7	-3,451	69,405	28,890	52.94
6	3	-2,305	70,049	32,233	51.96
7	2	-1,269	71,531	34,617	51.08
8	27	-28,886	45,273	6,143	74.59
9	10	-4,490	66,622	27,538	53.82
10	9	-3,281	68,347	30,020	52.79
15	6	-1,611	69,906	32,295	51.37
22	16	-17,692	58,028	17,122	65.06

Table D.12: Probability of not covering living expenses of R24 000 per year, for a floppy-irrigation system, without subsidy, a payback period of 15 years and an interest rate of 19,5%, 2000.

Year	Probability of not covering living expenses of R24 000 per year %	Minimum Balance R	Maximum Balance R	Average Balance R
1	94	-43,141	47,545	112
2	41	-14,889	63,321	25,040
3	36	-12,456	64,554	25,341
4	32	-4,720	67,787	29,033
5	26	-3,451	69,405	28,890
6	23	-2,305	70,049	32,233
7	14	-1,269	71,531	34,617
8	97	-28,886	45,273	6,143
9	30	-4,490	66,622	27,538
10	24	-3,281	68,347	30,020
11	18	1,937	74,695	36,490
12	21	2,541	65,522	35,701
13	24	3,079	74,568	35,173
14	18	3,555	76,495	37,374
15	24	-1,611	69,906	32,295
16	18	4,436	87,768	45,861
17	16	5,159	79,805	43,048
18	12	7,933	78,829	43,994
19	17	5,820	72,205	38,835
20	16	6,184	79,068	41,009
21	20	6,513	76,873	39,117
22	58	-17,692	58,028	17,122
23	17	5,762	72,468	39,867
24	14	6,123	78,881	40,825
25	16	7,535	79,861	42,581
26	19	7,729	80,571	40,049
27	15	7,903	76,868	40,592
28	18	8,057	80,983	41,756
29	17	8,194	80,394	39,907

APPENDIX 6.A

PROBABILITY OF FAILING TO MEET INSTALMENTS ON ONDERBERG CASE STUDY FARMS FOR TWO DIFFERENT INTEREST RATE LEVELS: 16,5% AND 13,5% (INTERMEDIATE LOANS) AND 13,5% AND 10,5% (LONG-TERM LOANS)

Only the graphs of those case study farms with a negative cash flow are depicted, namely case study farms 1, 5, 7, 8, 9, 10, 13, 14, 16, 17, 13, 19, 20, 21, 22, 23, 24, 25, 27, 29, 30, 31 and 32.

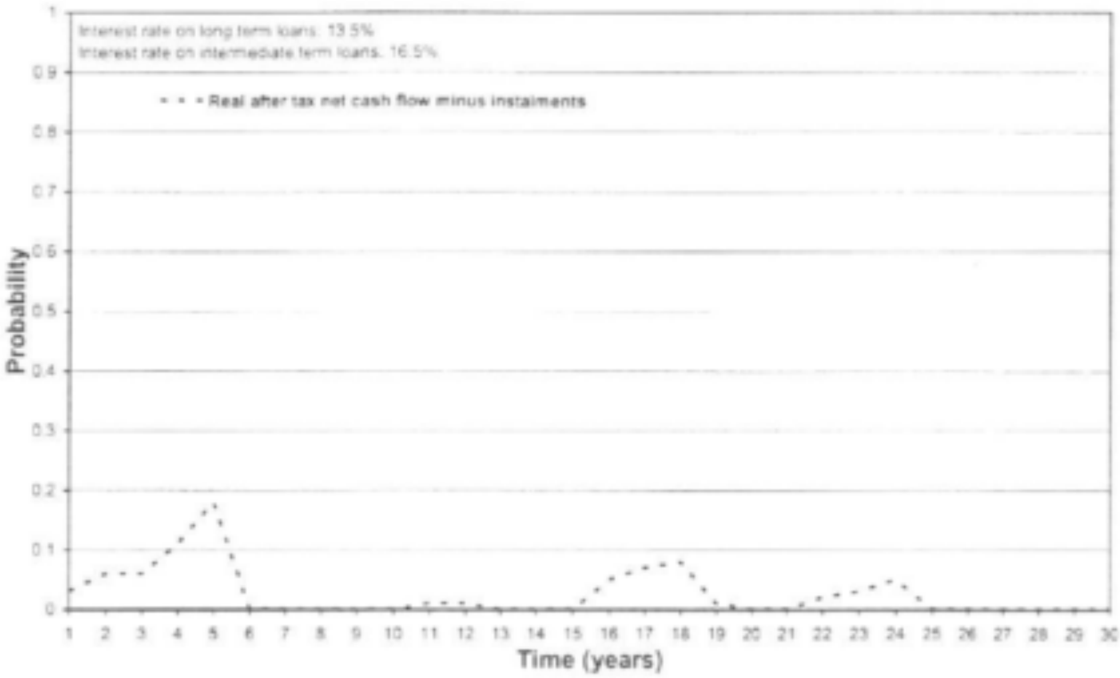

Figure A.1: The probability of failing to meet instalments (13,5%/16,5%) on Onderberg case study farm 1 planted to sugarcane (DI_{50}), 2000

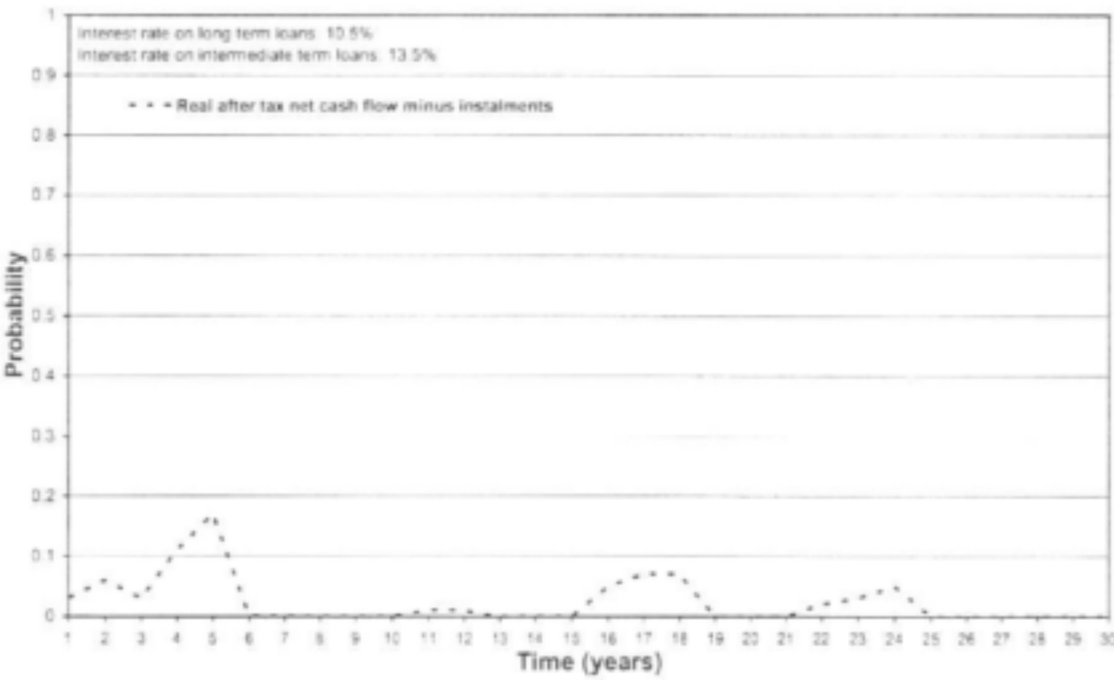

Figure A.2: The probability of failing to meet instalments (10,5%/13,5%) on Onderberg case study farm 1 planted to sugarcane (DI_{50}), 2000

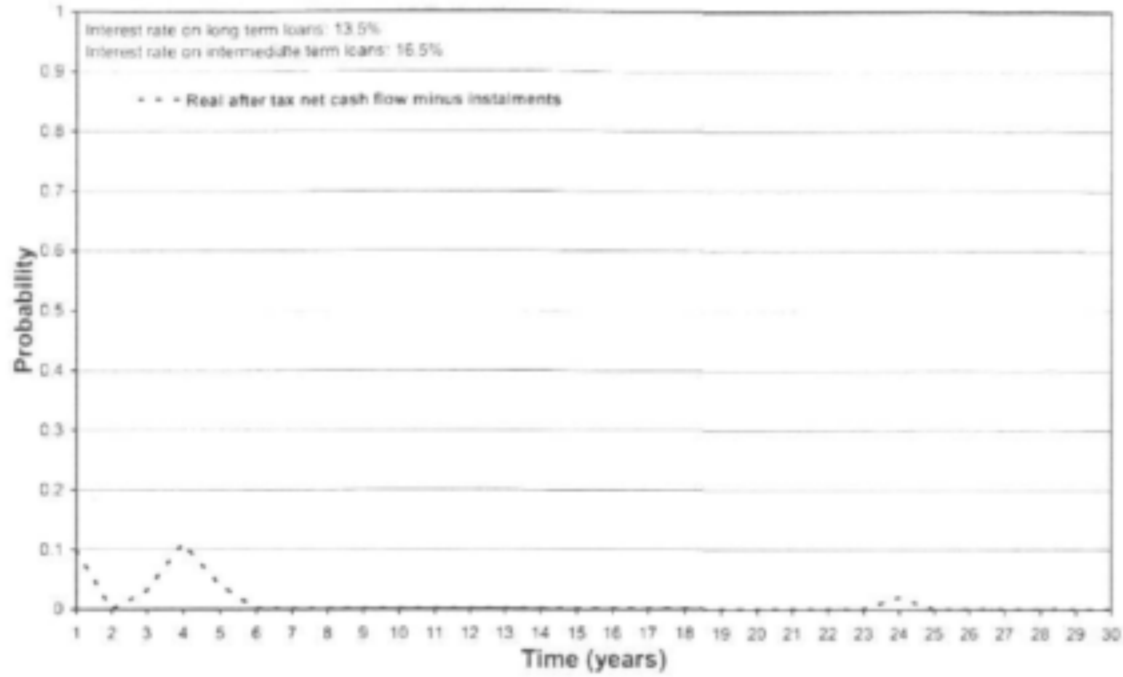

Figure A.3: The probability of failing to meet instalments (13,5%/16,5%) on Onderberg case study farm 5 planted to mangoes (M_{10}) and sugarcane ($DI_{20}D_{20}$), 2000

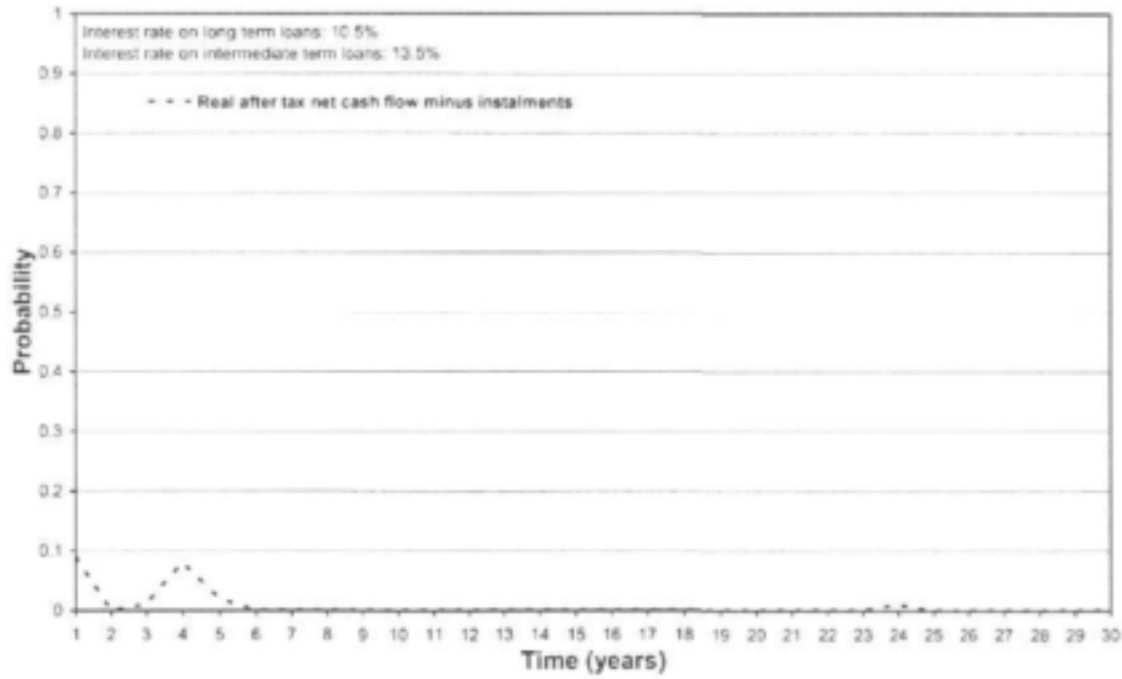

Figure A.4: The probability of failing to meet instalments (10,5%/13,5%) on Onderberg case study farm 5 planted to mangoes (M_{10}) and sugarcane ($DI_{20}D_{20}$), 2000

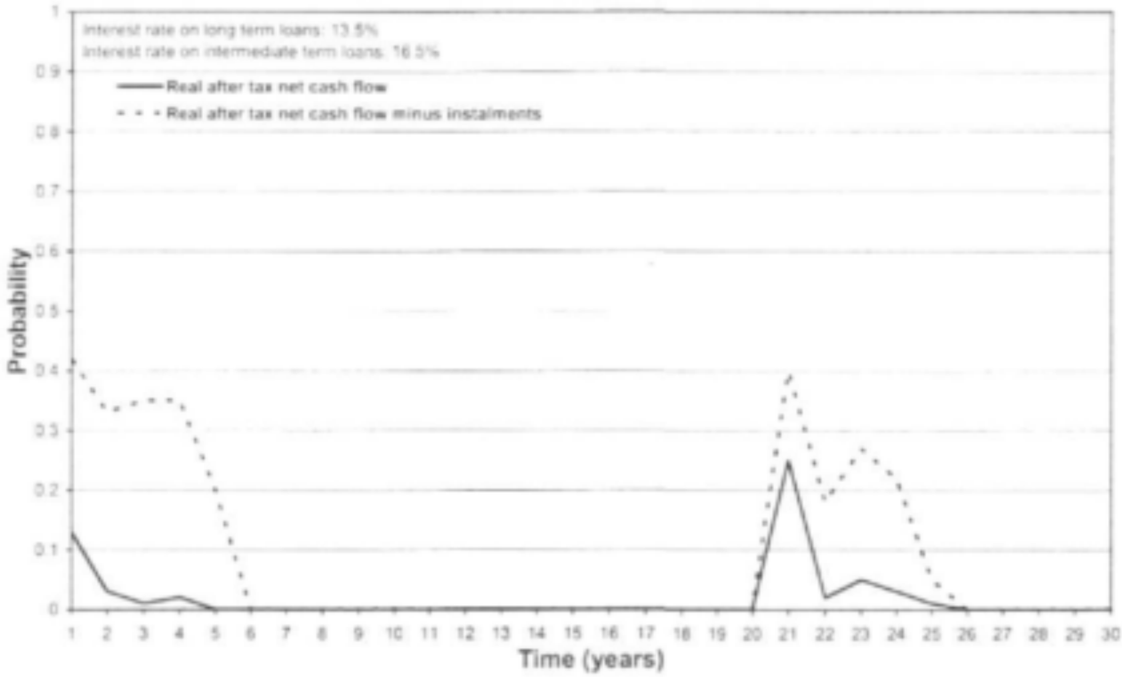

Figure A.5: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments on Onderberg case study farm 7 planted to mangoes (D_{10}) and sugarcane (DI_{40}), 2000

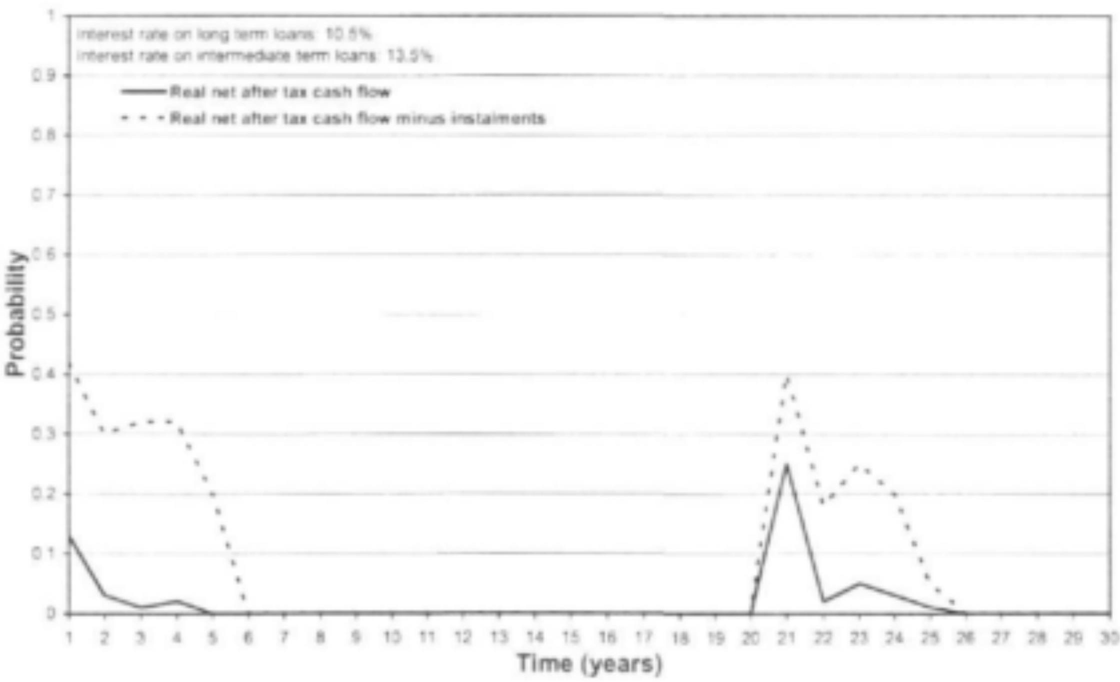

Figure A.6: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments on Onderberg case study farm 7 planted to mangoes (D_{10}) and sugarcane (DI_{40}), 2000

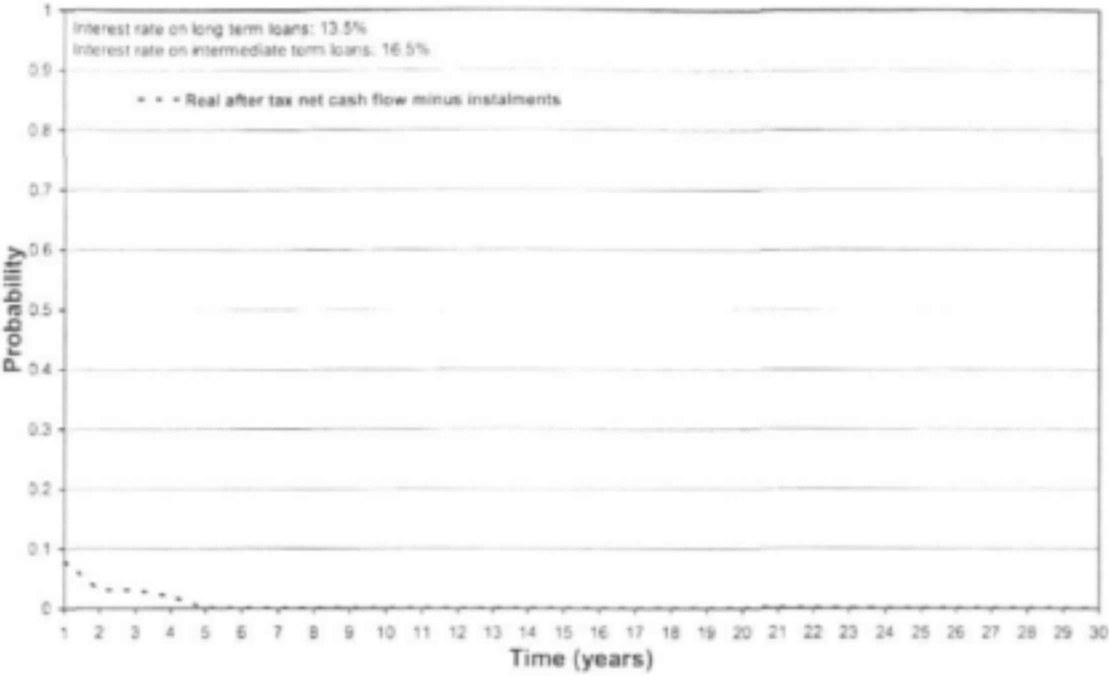

Figure A.7: The probability of failing to meet instalments (13,5%/16,5%) on Onderberg case study farm 8 planted to grapefruit (D_{10}) and sugarcane ($C_{30}D_{10}$), 2000

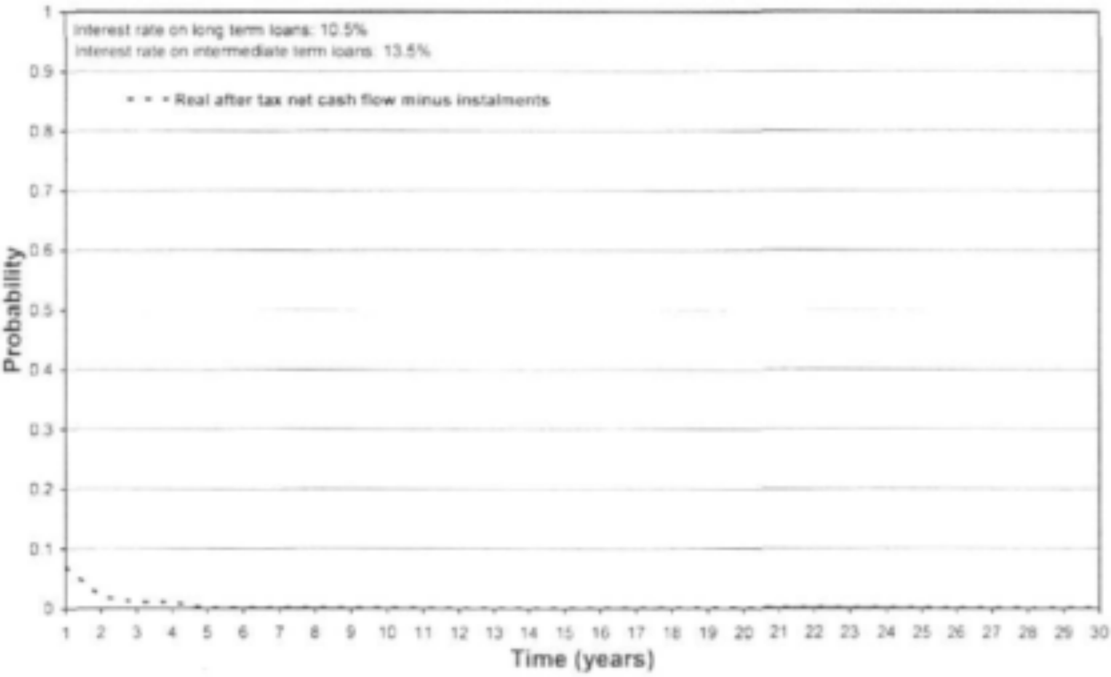

Figure A.8: The probability of failing to meet instalments (10,5%/13,5%) on Onderberg case study farm 8 planted to grapefruit (D_{10}) and sugarcane ($C_{30}D_{10}$), 2000

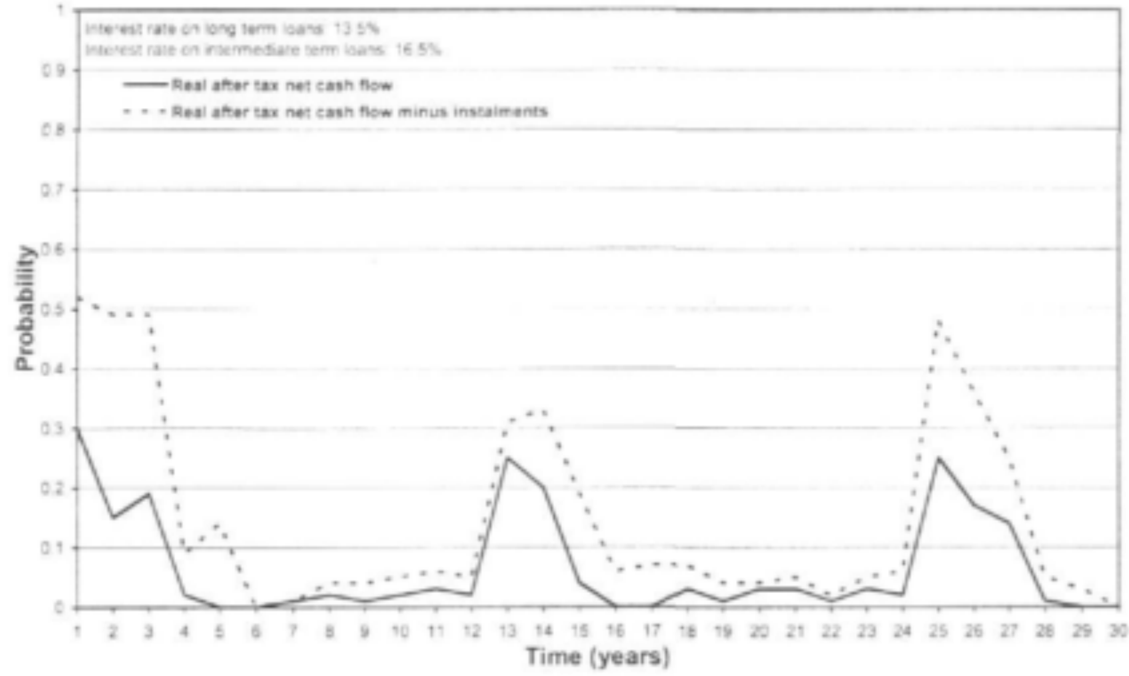

Figure A.9: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (13,5%/16,5%) on Onderberg case study farm 9 planted to grapefruit (M_{10}) and sugarcane (DI_{40}), 2000

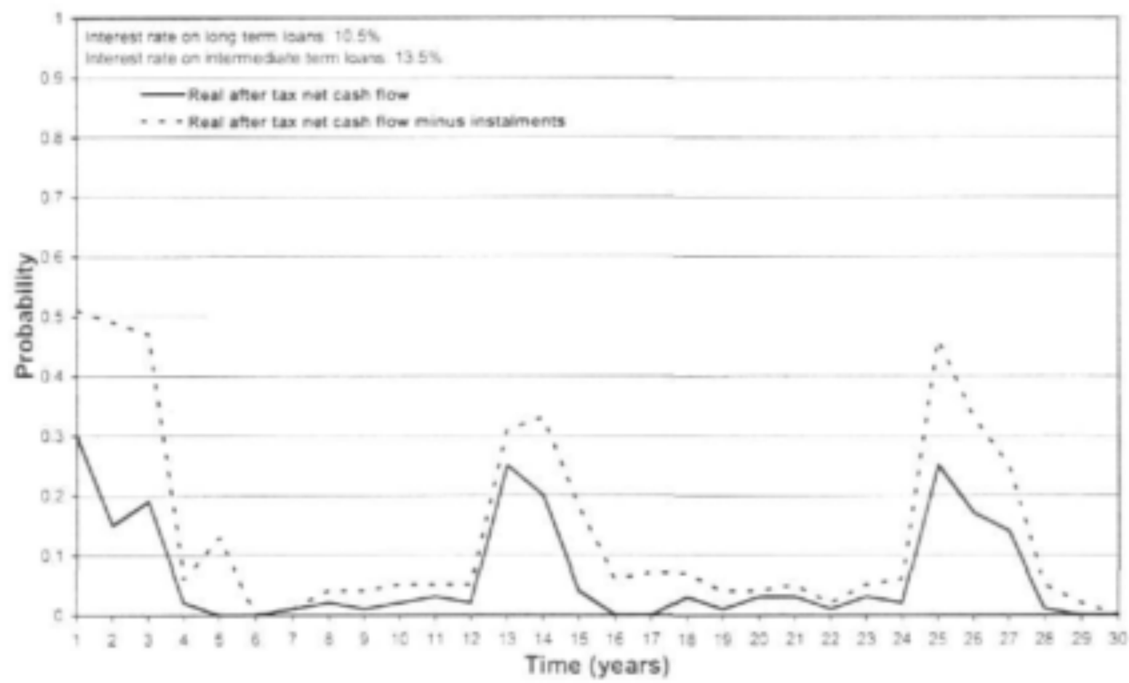

Figure A.10: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (10,5%/13,5%) on Onderberg case study farm 9 planted to grapefruit (M_{10}) and sugarcane (DI_{40}), 2000

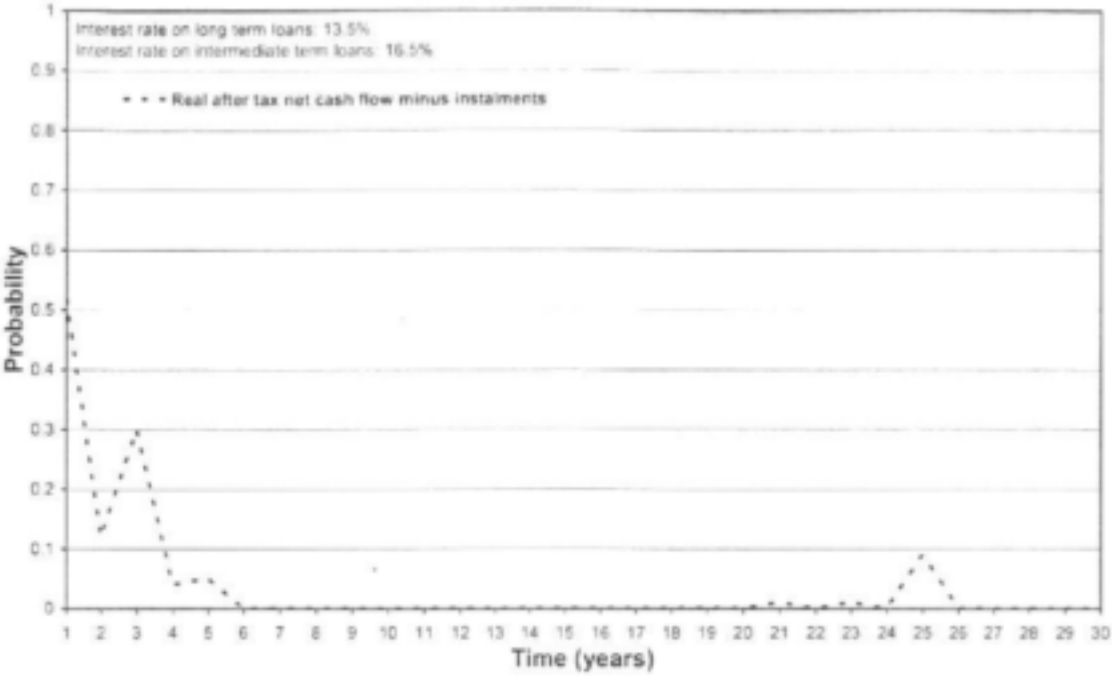

Figure A.11: The probability of failing to meet instalments (13,5%/16,5%) on Onderberg case study farm 10 planted to mangoes (D_{10}), grapefruit (M_{15}) and sugarcane (D_{30}), 2000

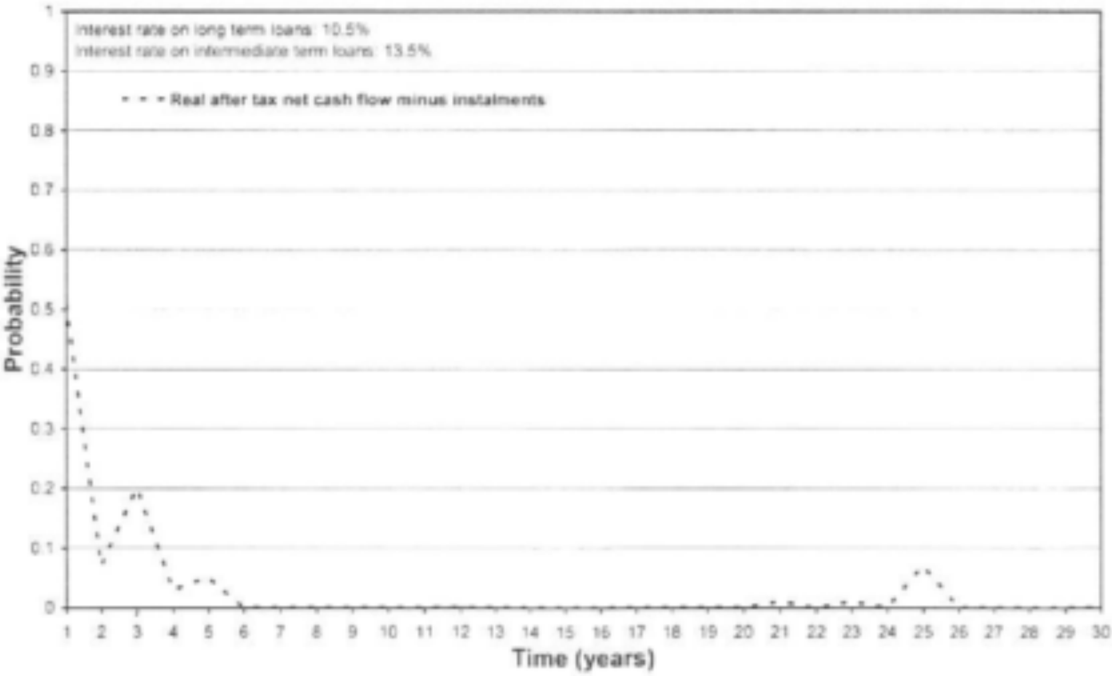

Figure A.12: The probability of failing to meet instalments (10,5%/13,5%) on Onderberg case study farm 10 planted to mangoes (D_{15}), grapefruit (M_{15}) and sugarcane (D_{33}), 2000

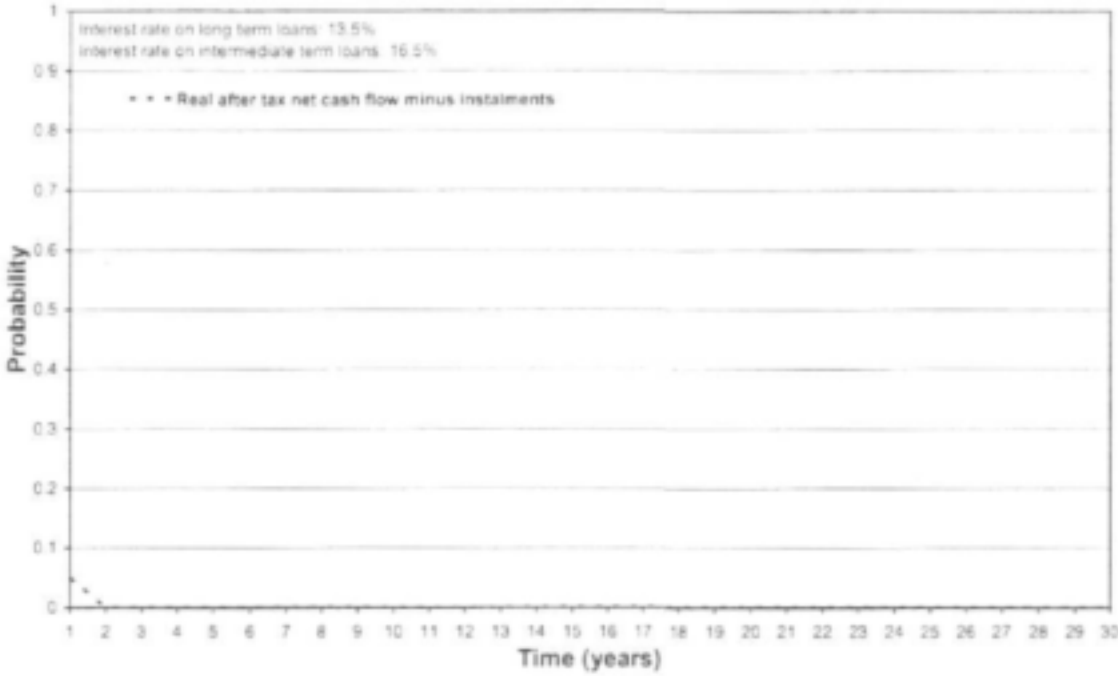

Figure A.13: The probability of failing to meet instalments (13,5%/16,5%) on Onderberg case study farm 13 planted to bananas (D_{50}) and sugarcane (C_{100}), 2000

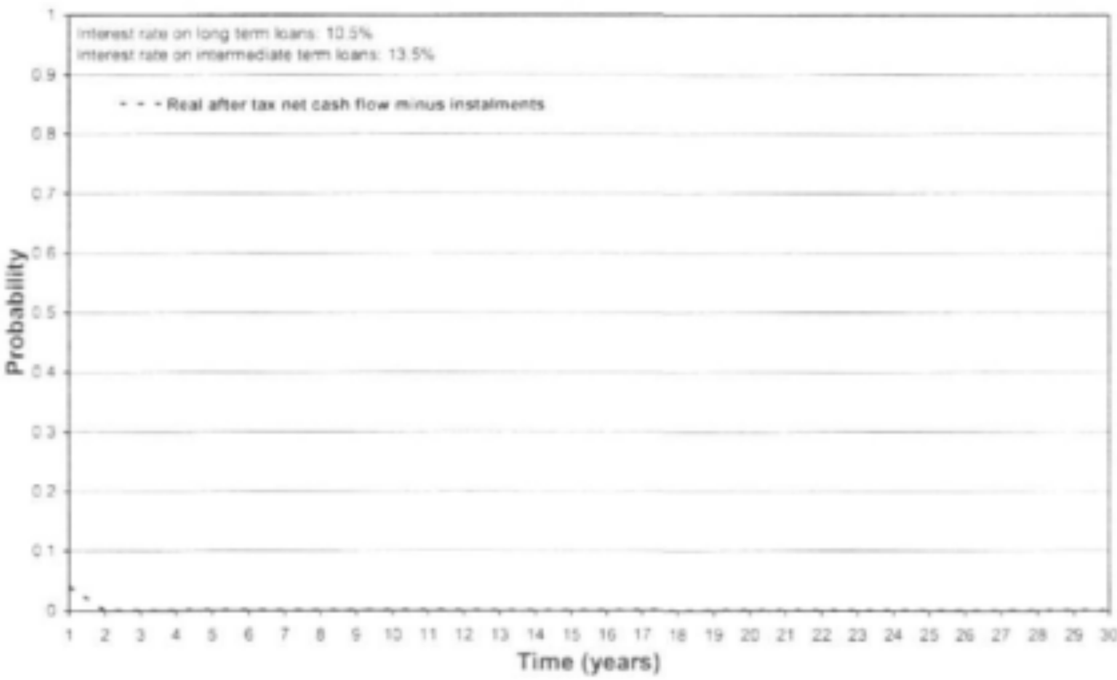

Figure A.14: The probability of failing to meet instalments (10,5%/13,5%) on Onderberg case study farm 13 planted to bananas (D_{50}) and sugarcane (C_{100}), 2000

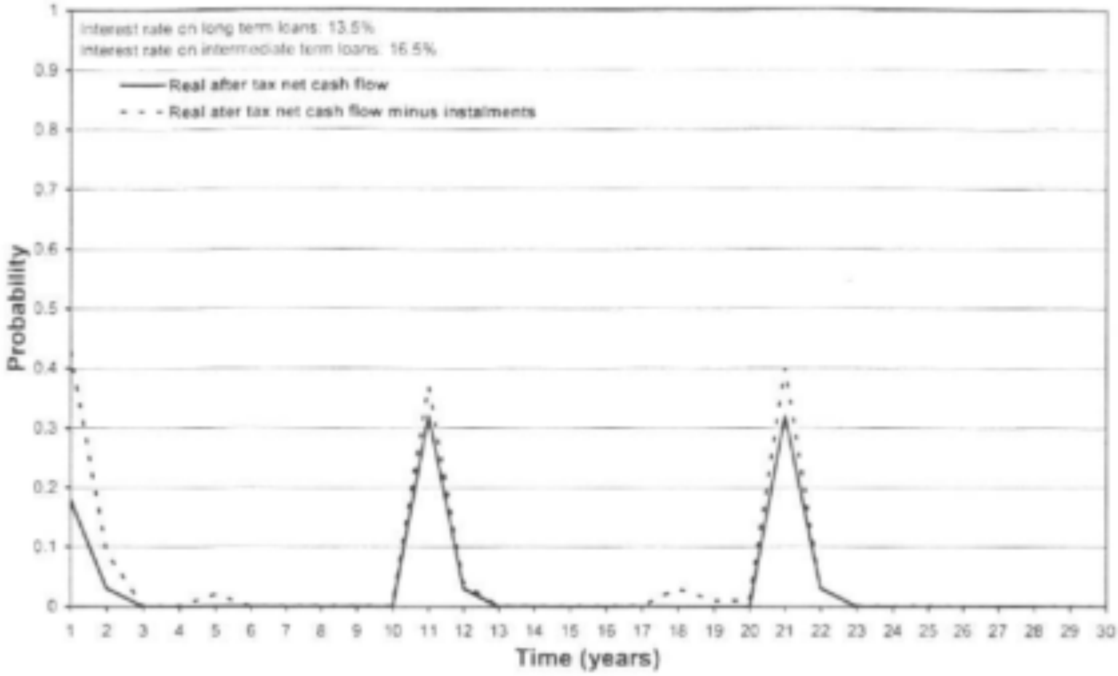

Figure A.15: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (13,5%/16,5%) on Onderberg case study farm 14 planted to bananas (DI_{50}) and sugarcane (DI_{100}), 2000

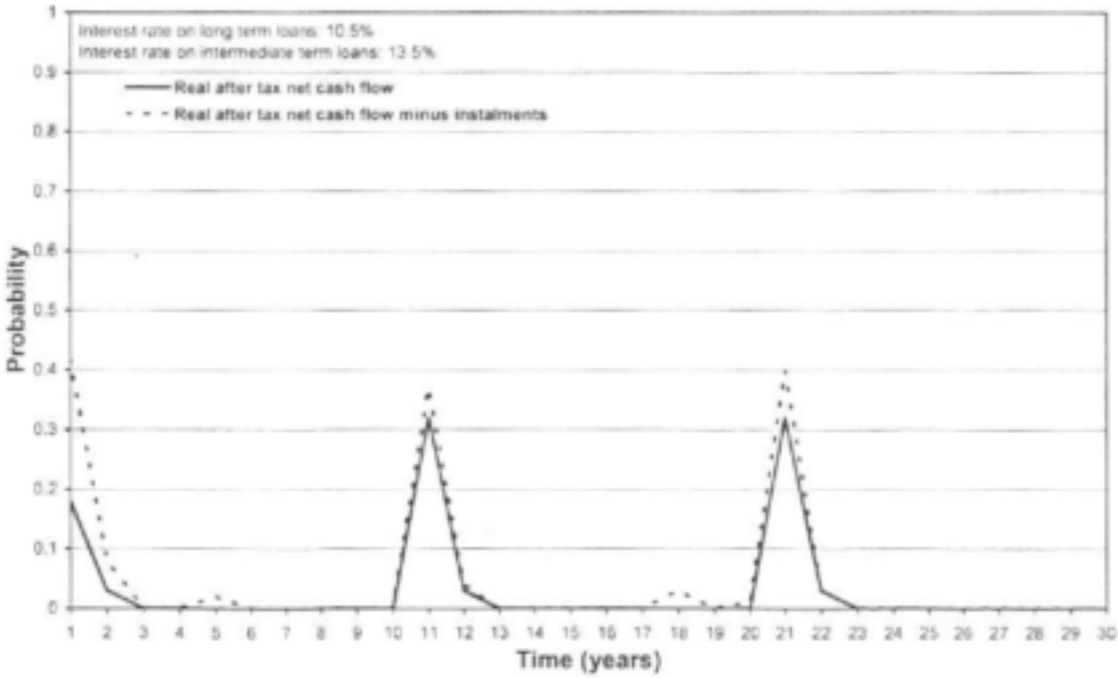

Figure A.16: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (10,5%/13,5%) on Onderberg case study farm 14 planted to bananas (DI_{50}) and sugarcane (DI_{100}), 2000

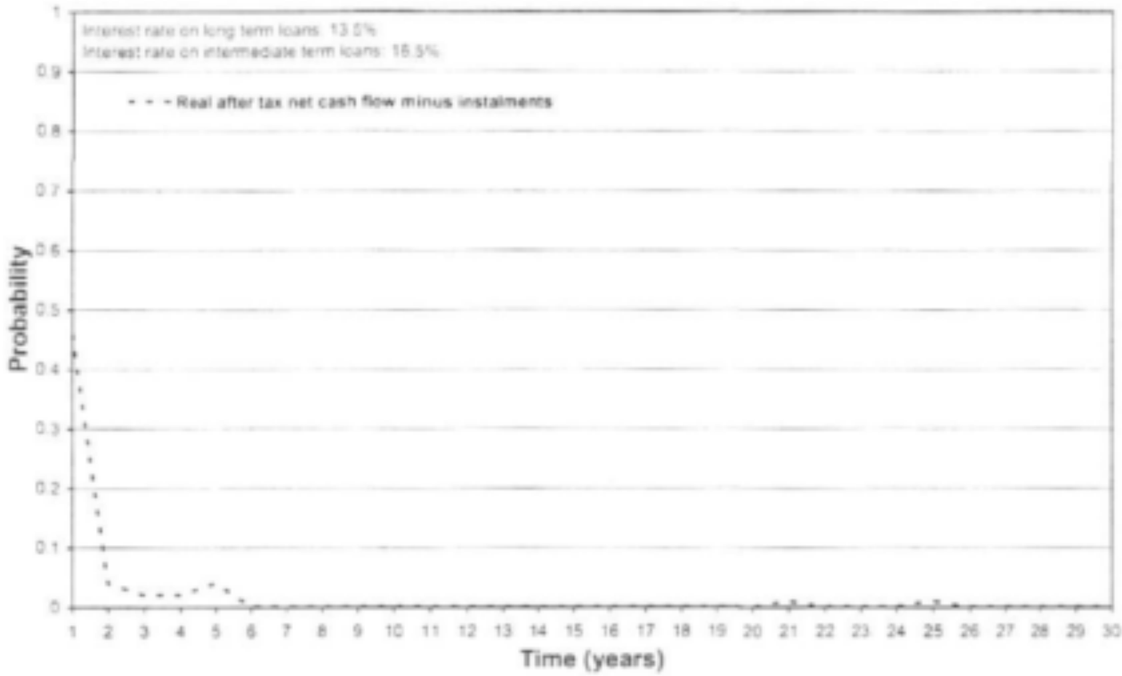

Figure A.17: The probability of failing to meet instalments (13,5%/16,5%) on Onderberg case study farm 16 planted to bananas (DI_{20}), mangoes (D_{10}), grapefruit (D_{20}) and sugarcane ($C_{80}DI_{20}$), 2000

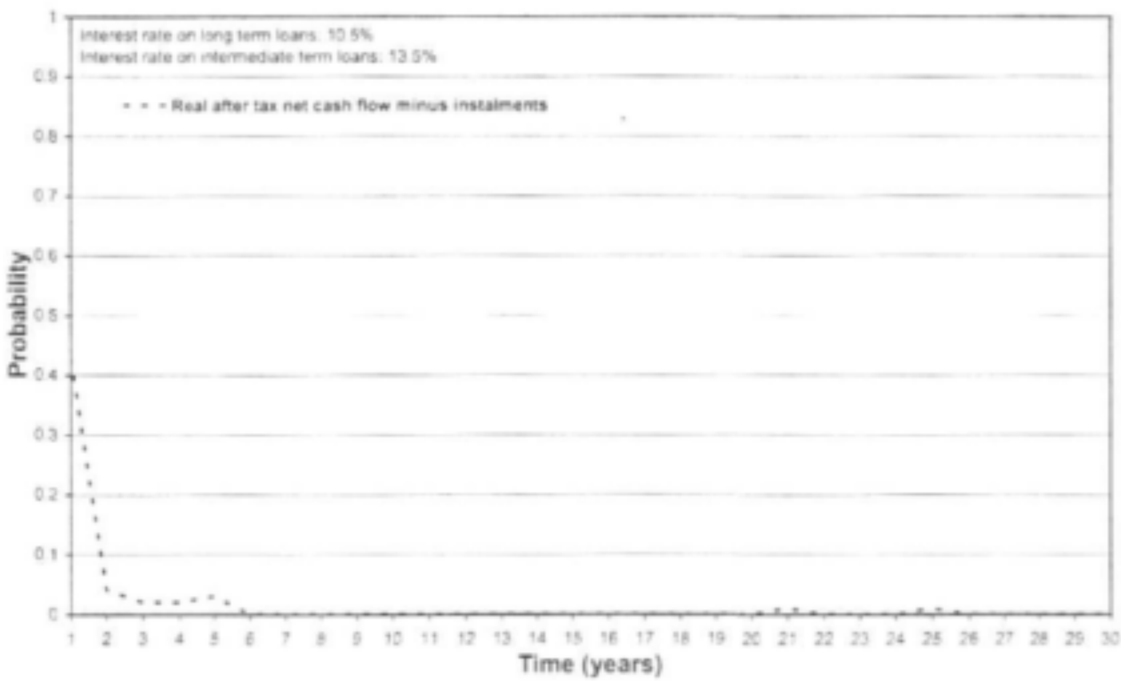

Figure A.18: The probability of failing to meet instalments (10,5%/13,5%) on Onderberg case study farm 16 planted to bananas (DI_{20}), mangoes (D_{10}), grapefruit (D_{20}) and sugarcane ($C_{80}DI_{20}$), 2000

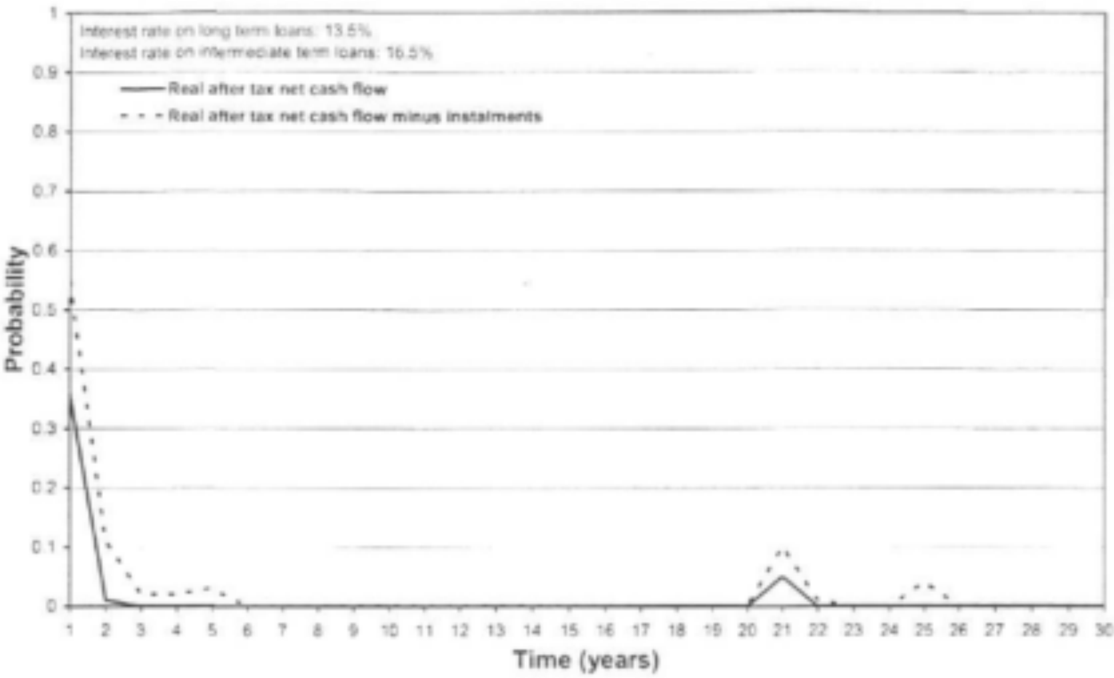

Figure A.19: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (13,5%/16,5%) on Onderberg case study farm 17 planted to bananas (D_{20}), mangoes (M_{10}), grapefruit (D_{20}) and sugarcane (DI_{100}), 2000

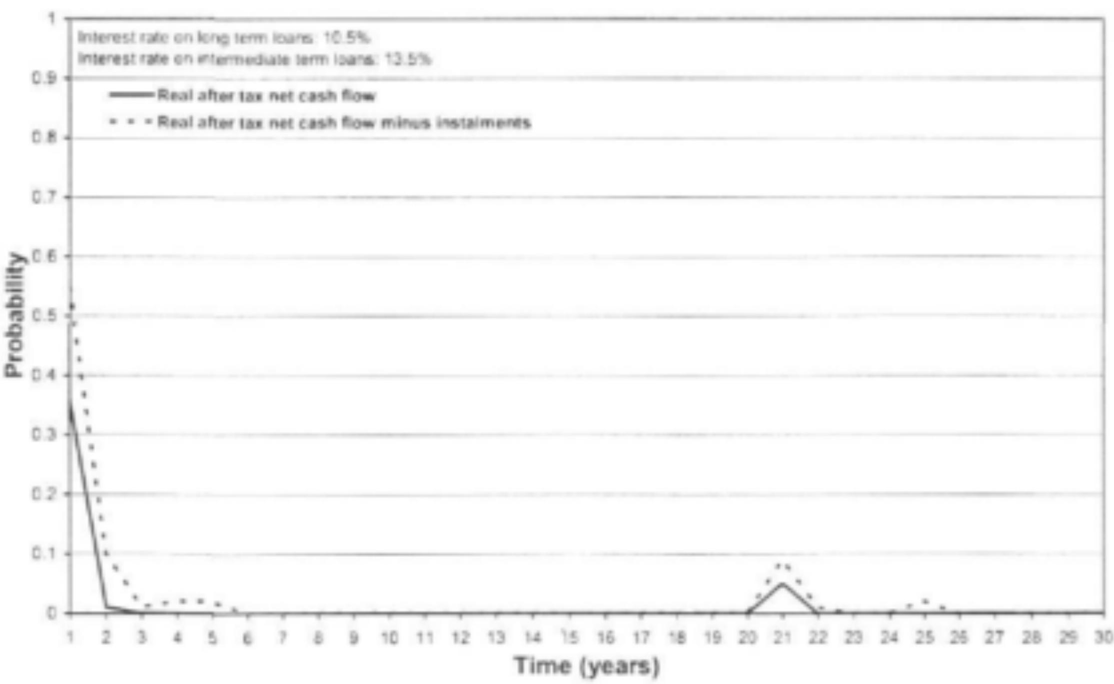

Figure A.20: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (10,5%/13,5%) on Onderberg case study farm 17 planted to bananas (D_{20}), mangoes (M_{15}), grapefruit (D_{20}) and sugarcane (DI_{100}), 2000

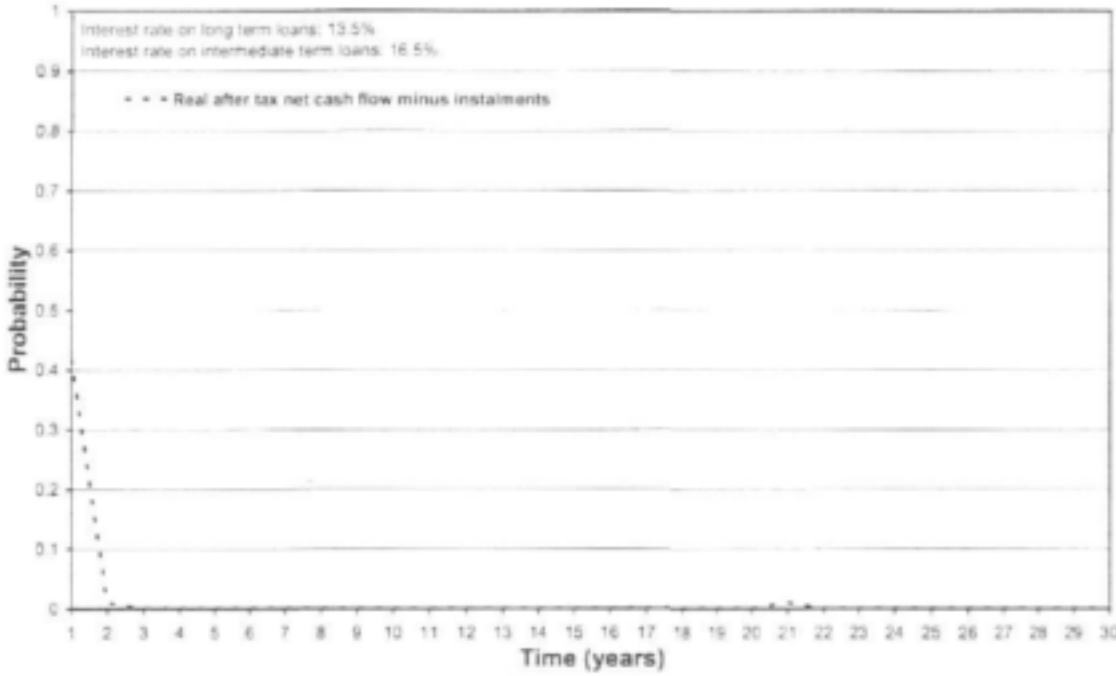

Figure A.21: The probability of failing to meet instalments (13,5%/16,5%) on Onderberg case study farm 18 planted to bananas (D_{20}), mangoes (D_{12}), grapefruit (D_{20}) and sugarcane ($DI_{50}D_{50}$), 2000

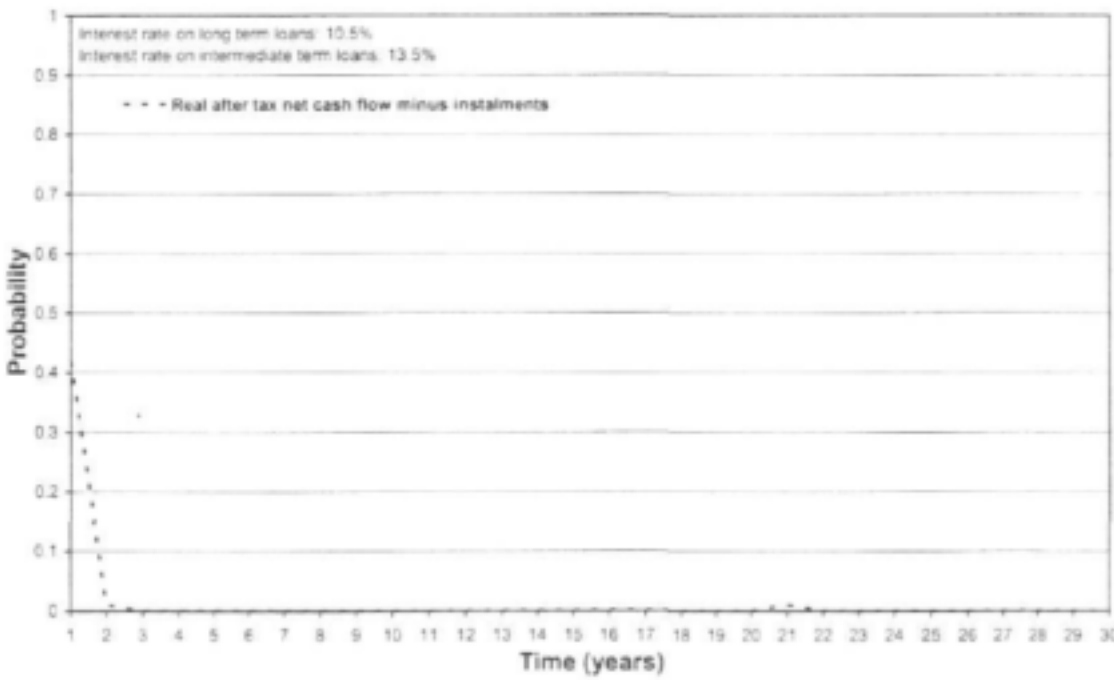

Figure A.22: The probability of failing to meet instalments (10,5%/13,5%) on Onderberg case study farm 18 planted to bananas (D_{20}), mangoes (D_{12}), grapefruit (D_{20}) and sugarcane ($DI_{50}D_{50}$), 2000

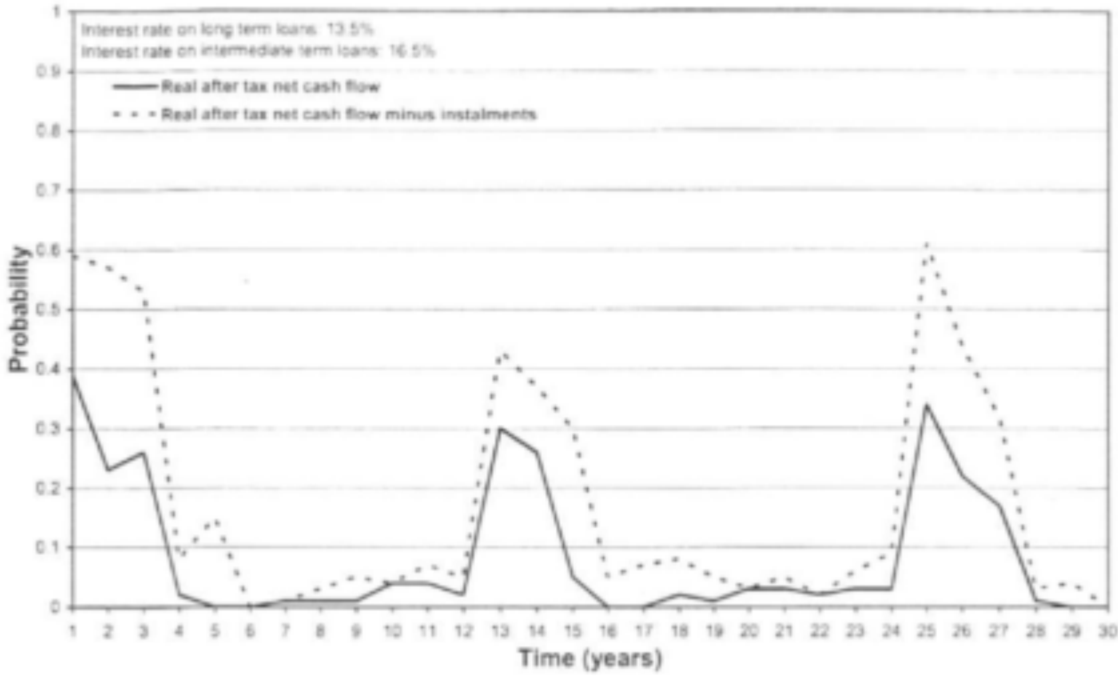

Figure A.23: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (13,5%/16,5%) on Onderberg case study farm 19 planted to grapefruit (M_{4C}) and sugarcane (DI_{110}), 2000

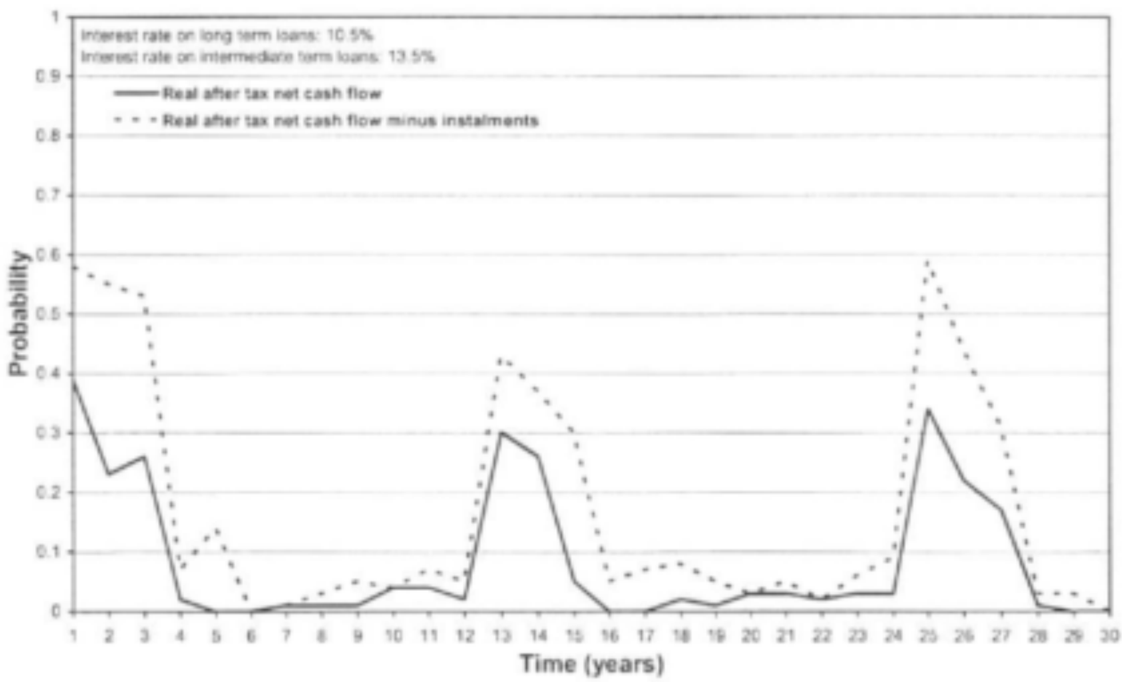

Figure A.24: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (10,5%/13,5%) on Onderberg case study farm 19 planted to grapefruit (M_{4C}) and sugarcane (DI_{110}), 2000

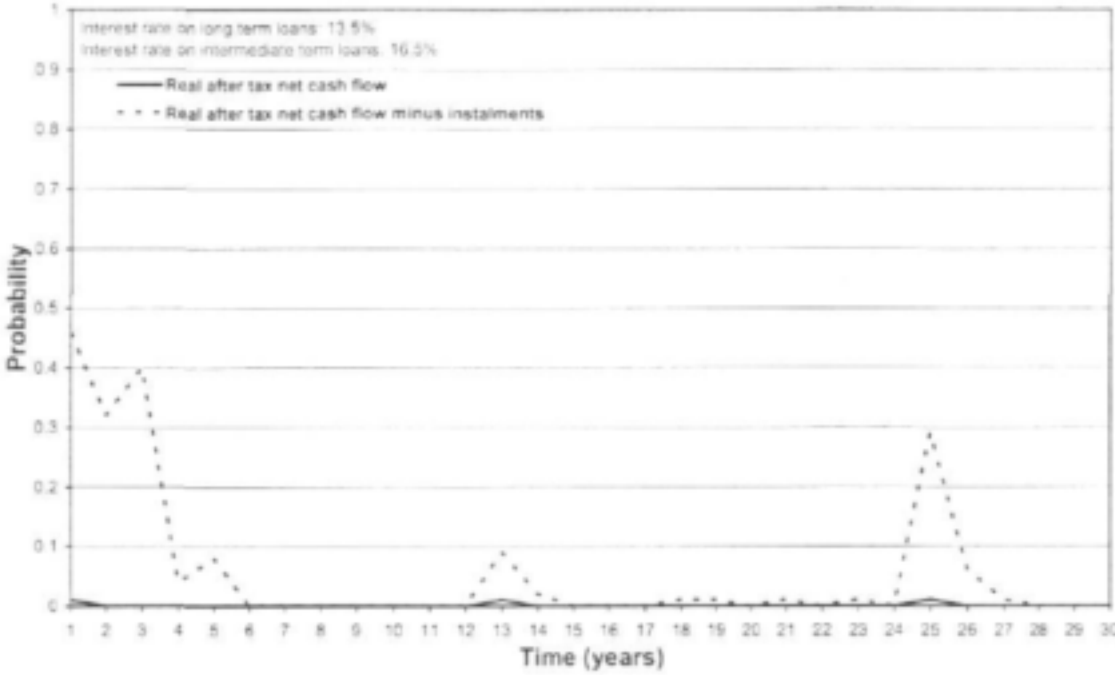

Figure A.25: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (13,5%/16,5%) on Onderberg case study farm 20 planted to grapefruit (D_{4C}) and sugarcane ($C_{8C}DI_{3C}$), 2000

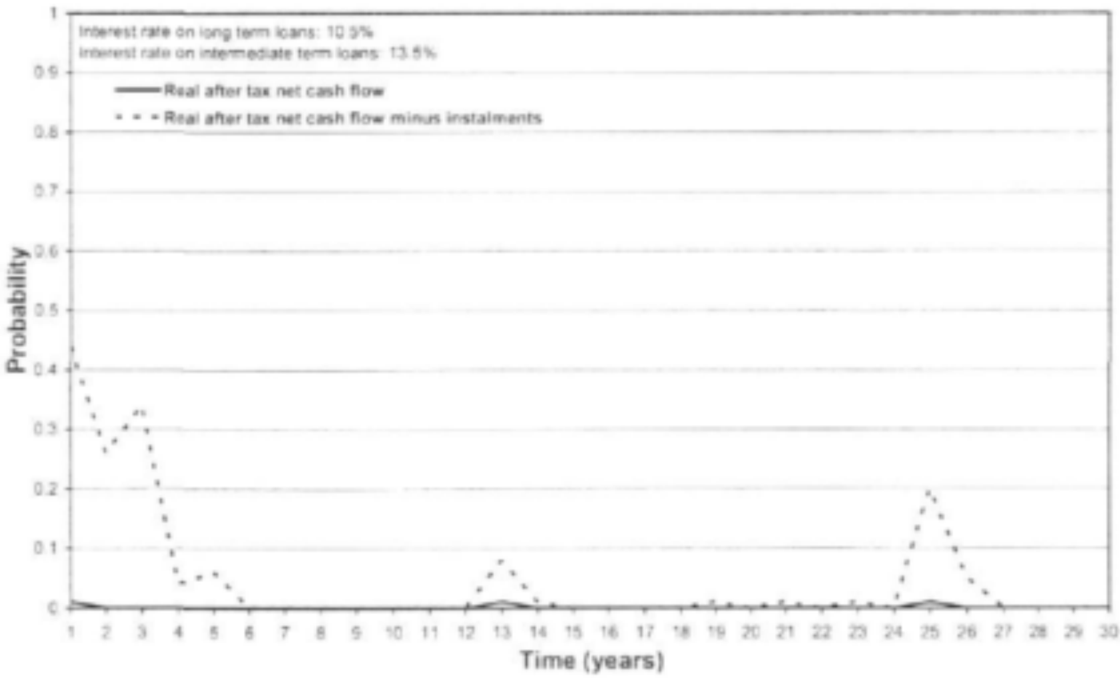

Figure A.26: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (10,5%/13,5%) on Onderberg case study farm 20 planted to grapefruit (D_{4C}) and sugarcane ($C_{8C}DI_{3C}$), 2000

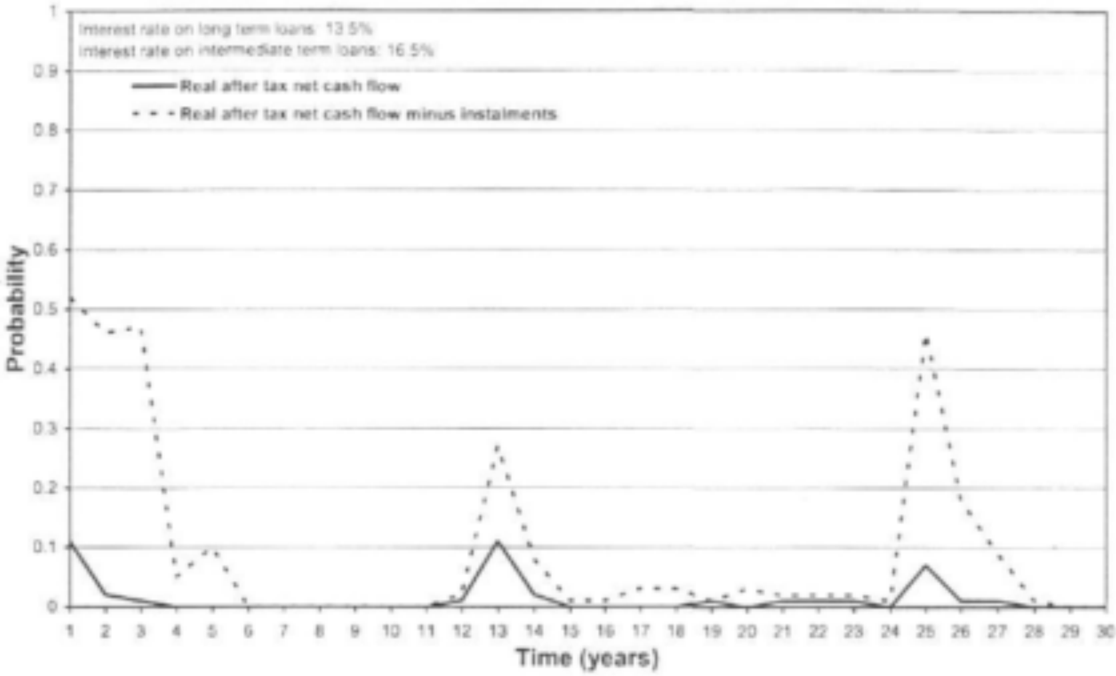

Figure A.27: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (13,5%/16.5%) on Onderberg case study farm 21 planted to grapefruit ($D_{20}M_{20}$) and sugarcane ($C_{50}DI_{60}$), 2000

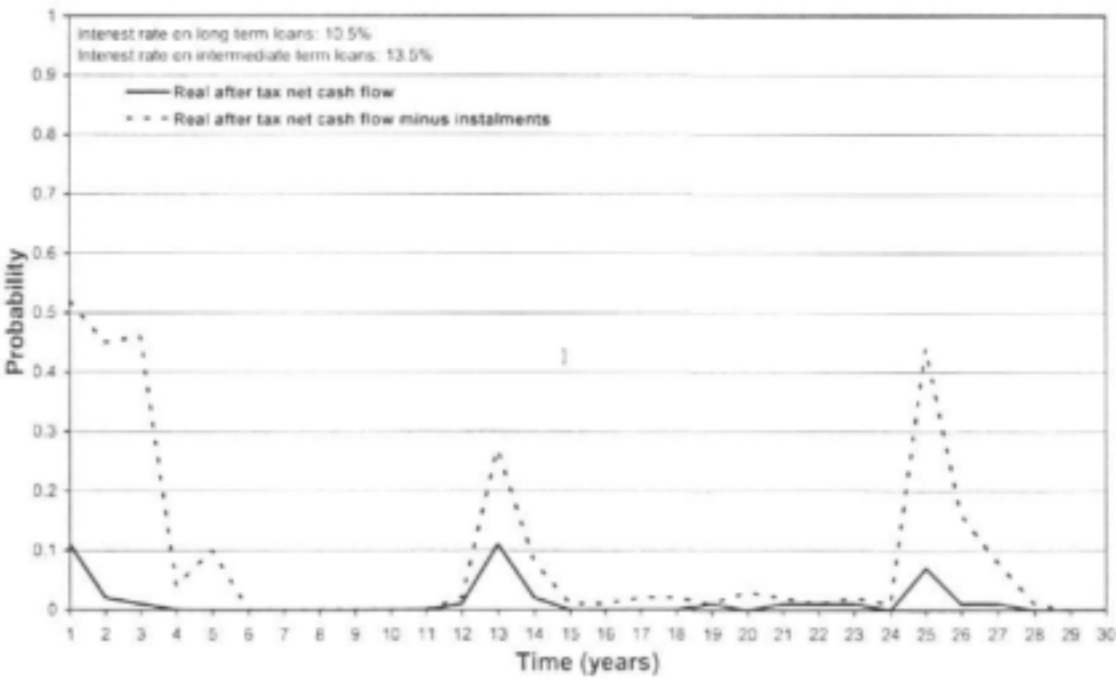

Figure A.28: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (10,5%/13,5%) on Onderberg case study farm 21 planted to grapefruit ($D_{20}M_{20}$) and sugarcane ($C_{50}DI_{60}$), 2000

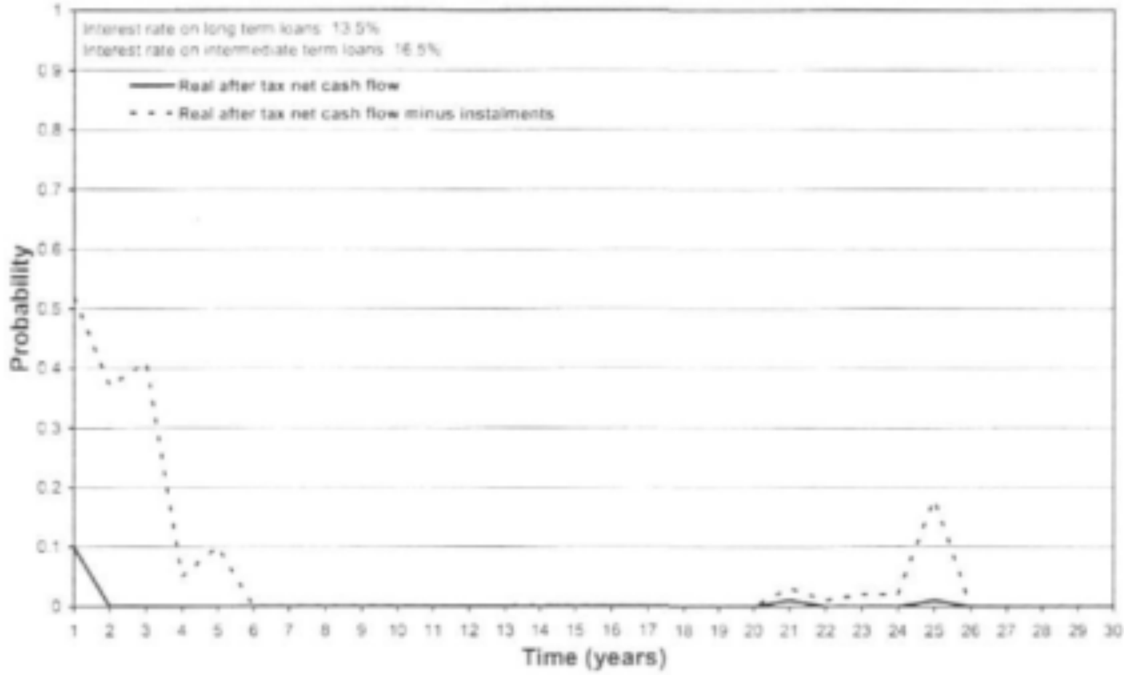

Figure A.29: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (13,5%/16,5%) on Onderberg case study farm 22 planted to mangoes (D_{2C}), grapefruit (D_{3C}) and sugarcane ($DI_{6C}D_{4C}$), 2000

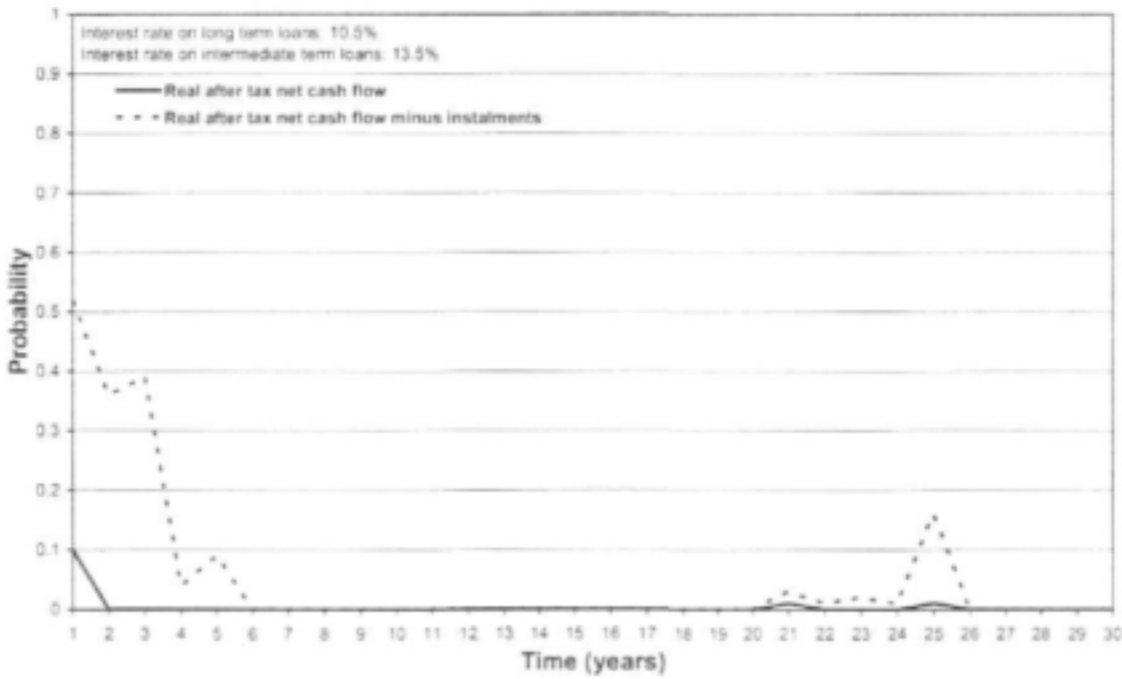

Figure A.30: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (10,5%/13,5%) on Onderberg case study farm 22 planted to mangoes (D_{22}), grapefruit (D_{3C}) and sugarcane ($DI_{6C}D_{4C}$), 2000

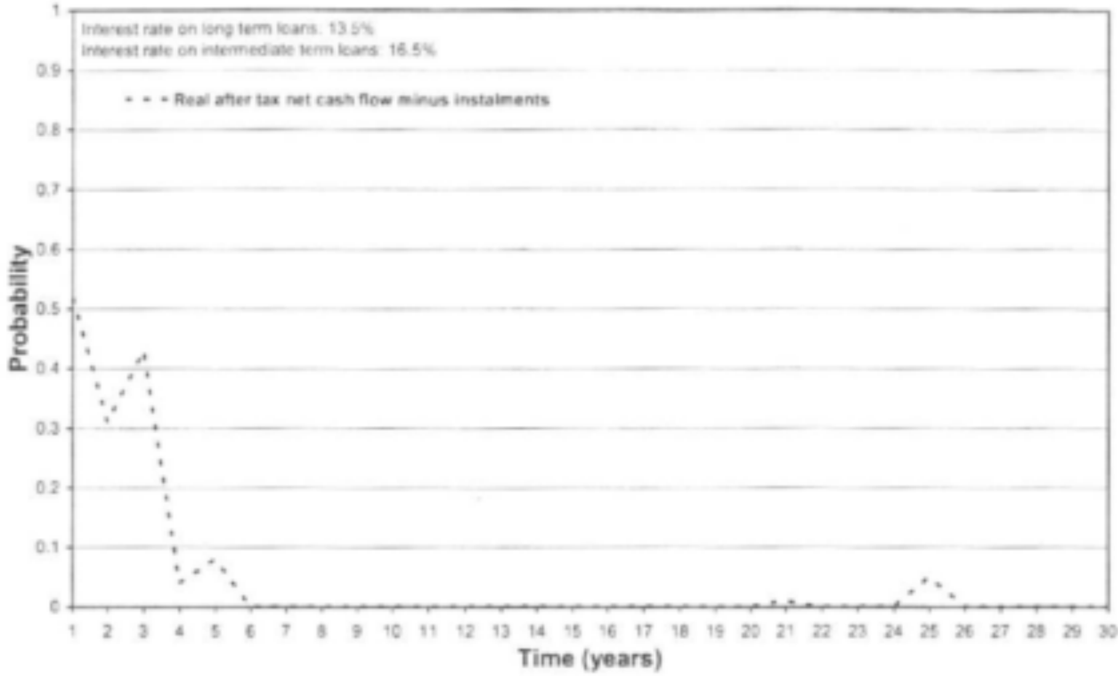

Figure A.31: The probability of failing to meet instalments (13,5%/16,5%) on Onderberg case study farm 23 planted to mangoes (M_{20}), grapefruit (M_{30}) and sugarcane (C_{100}), 2000

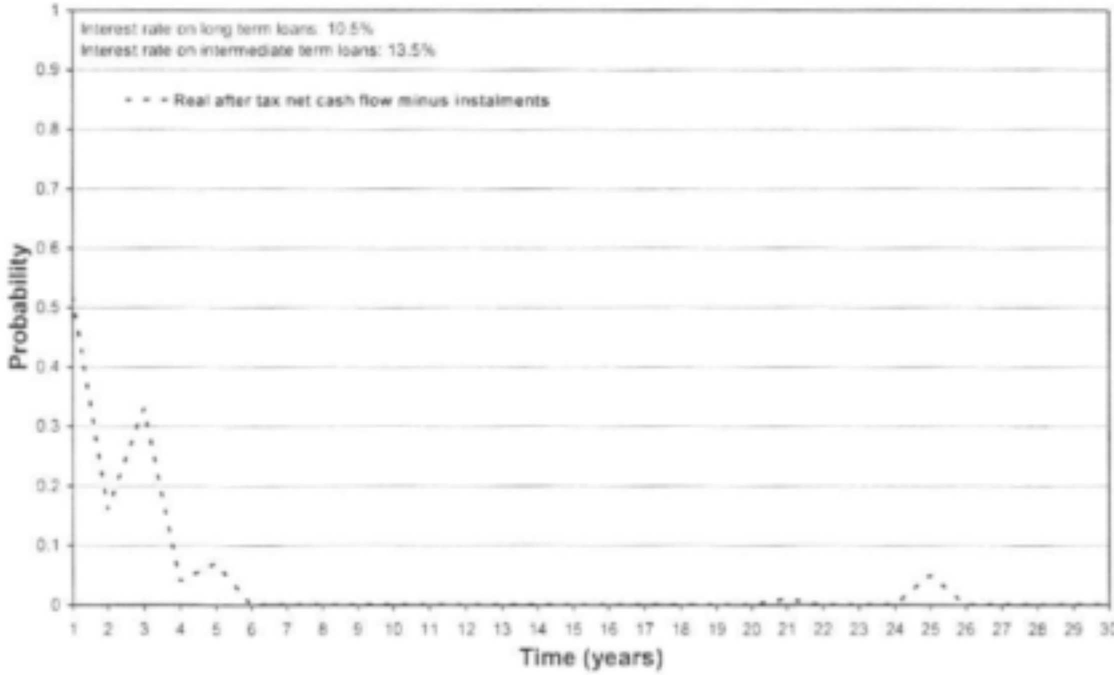

Figure A.32: The probability of failing to meet instalments (10,5%/13,5%) on Onderberg case study farm 23 planted to mangoes (M_{20}), grapefruit (M_{30}) and sugarcane (C_{100}), 2000

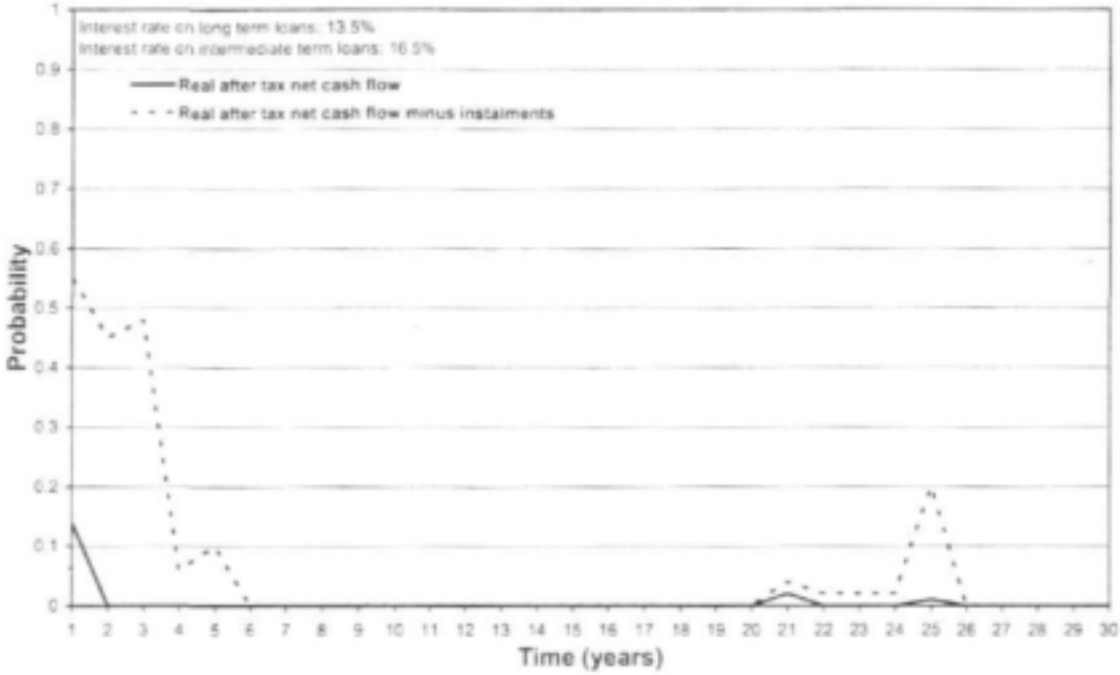

Figure A.33: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (13,5%/16,5%) on Onderberg case study farm 24 planted to mangoes (M_{25}), grapefruit (D_{30}) and sugarcane ($C_{50}DI_{50}$), 2000

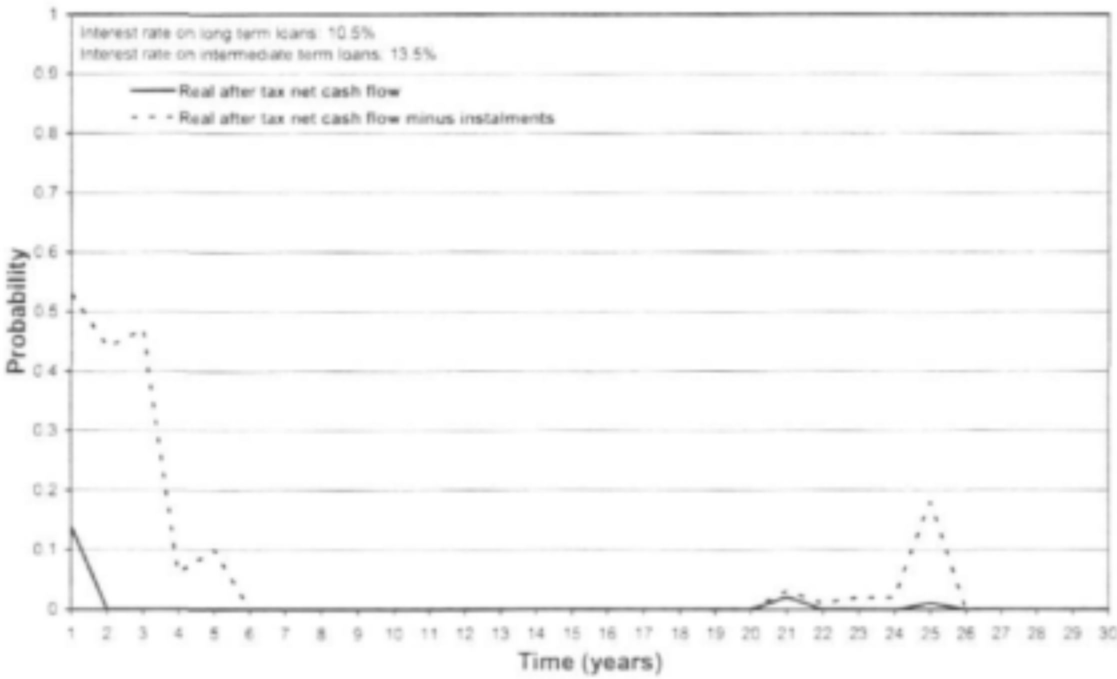

Figure A.34: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (10,5%/13,5%) on Onderberg case study farm 24 planted to mangoes (M_{25}), grapefruit (D_{30}) and sugarcane ($C_{50}DI_{50}$), 2000

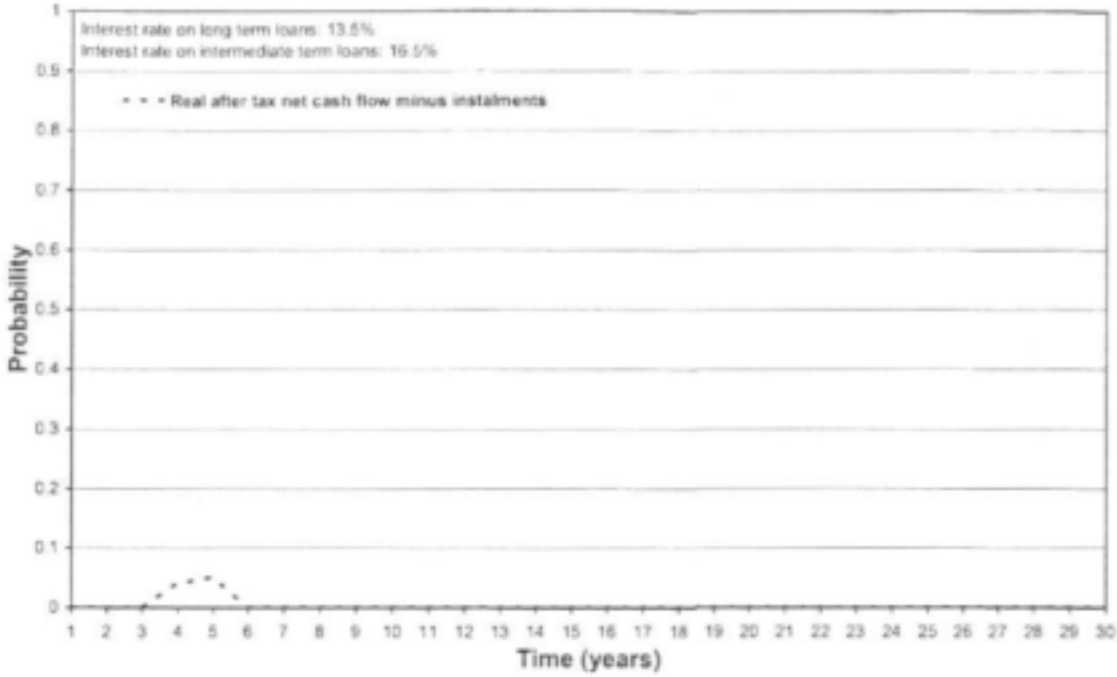

Figure A.35: The probability of failing to meet instalments (13,5%/16,5%) on Onderberg case study farm 25 planted to sugarcane ($C_{80}DI_{170}$), 2000

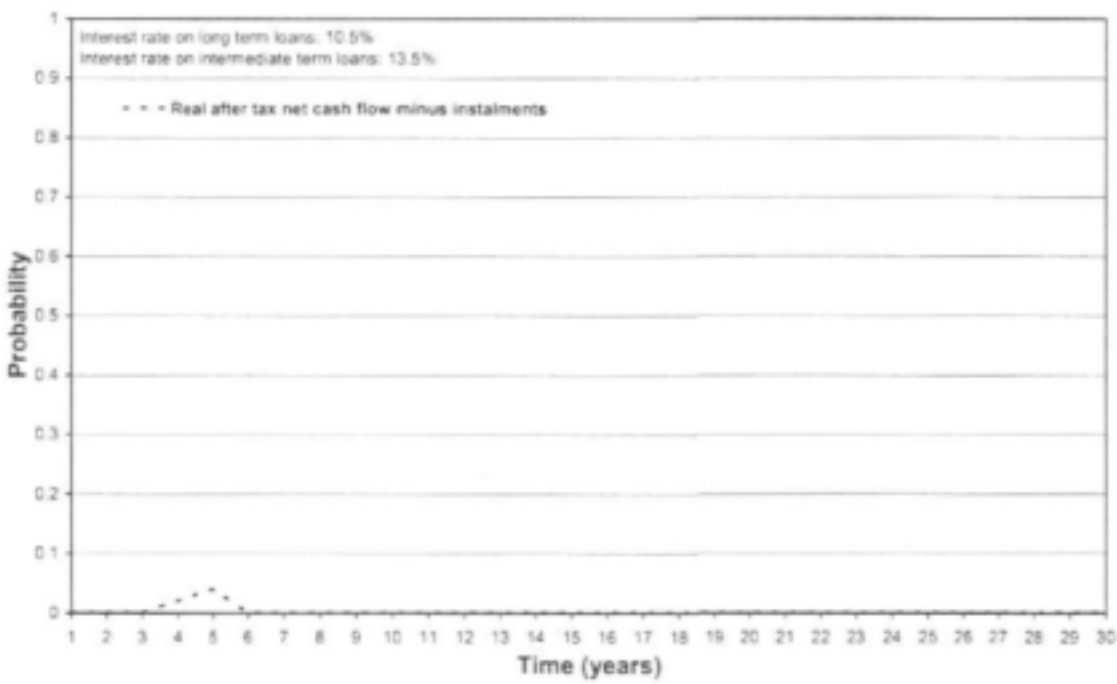

Figure A.36: The probability of failing to meet instalments (10,5%/13,5%) on Onderberg case study farm 25 planted to sugarcane ($C_{80}DI_{170}$), 2000

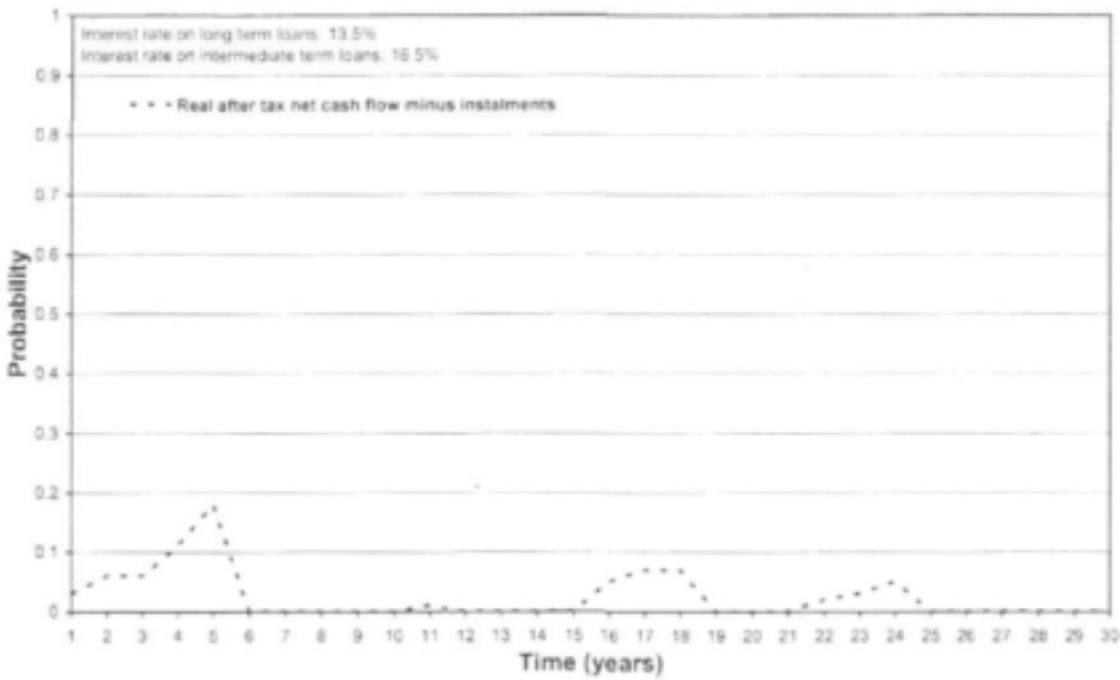

Figure A.37: The probability of failing to meet instalments (13,5%/16,5%) on Onderberg case study farm 27 planted to sugarcane (DI_{250}), 2000

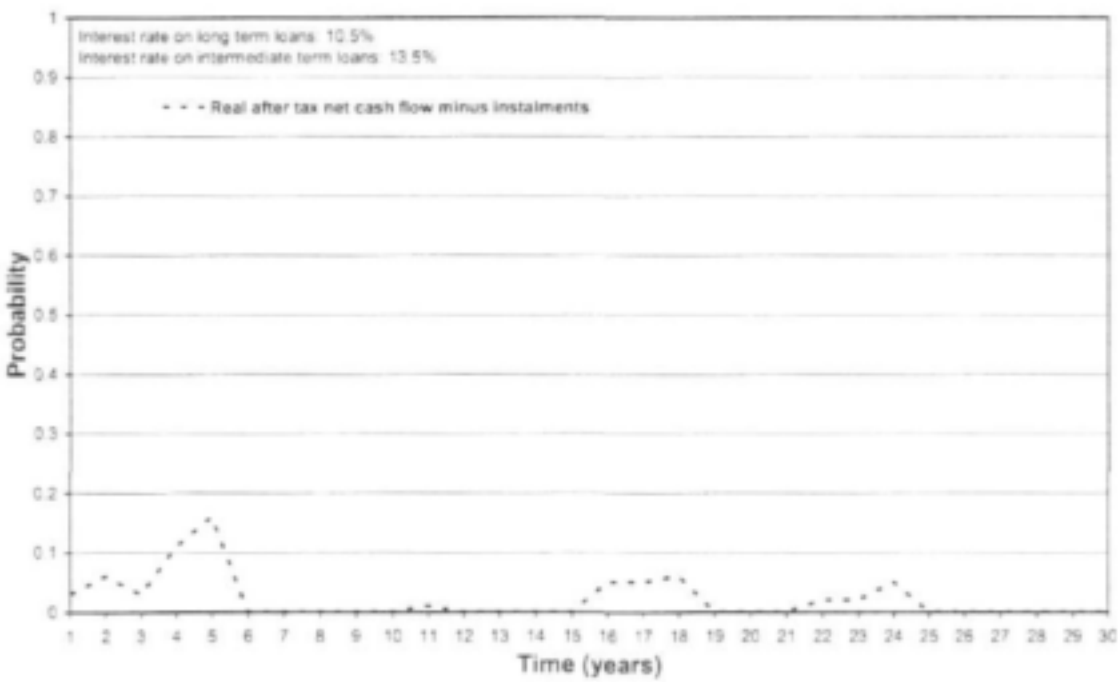

Figure A.38: The probability of failing to meet instalments (10,5%/13,5%) on Onderberg case study farm 27 planted to sugarcane (DI_{250}), 2000

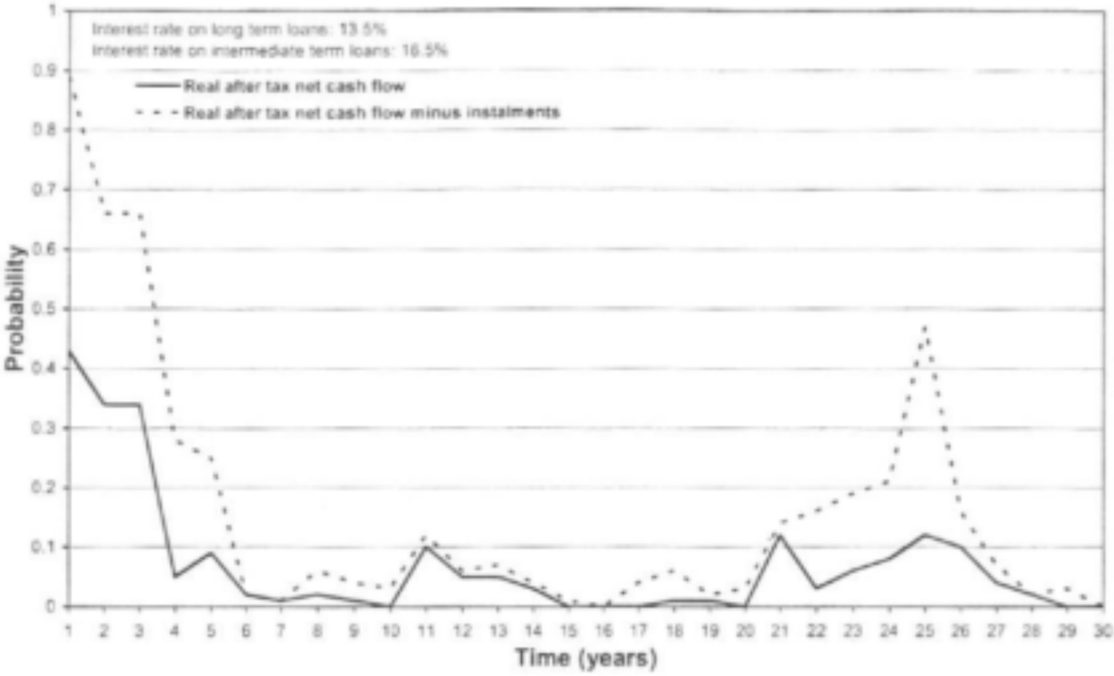

Figure A.39: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (13,5%/16,5%) on Onderberg case study farm 29 planted to oranges (M_{5c}), grapefruit (M_{3c}) and sugarcane (DI_{17c}), 2000

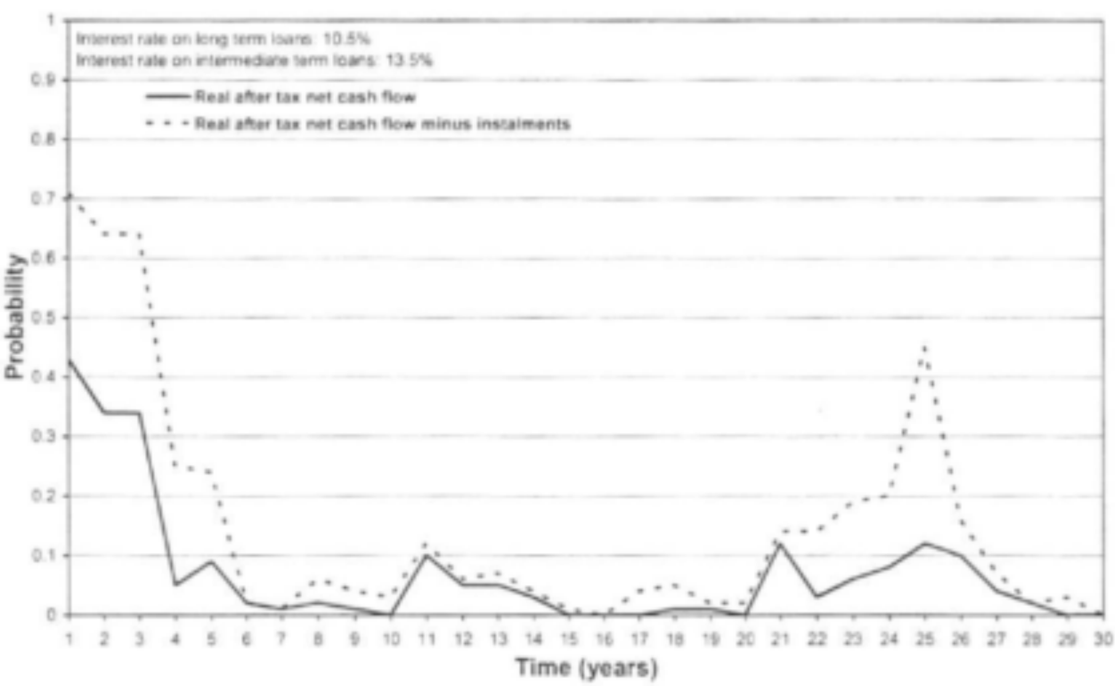

Figure A.40: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (10,5%/13,5%) on Onderberg case study farm 29 planted to oranges (M_{5c}), grapefruit (M_{3c}) and sugarcane (DI_{17c}), 2000

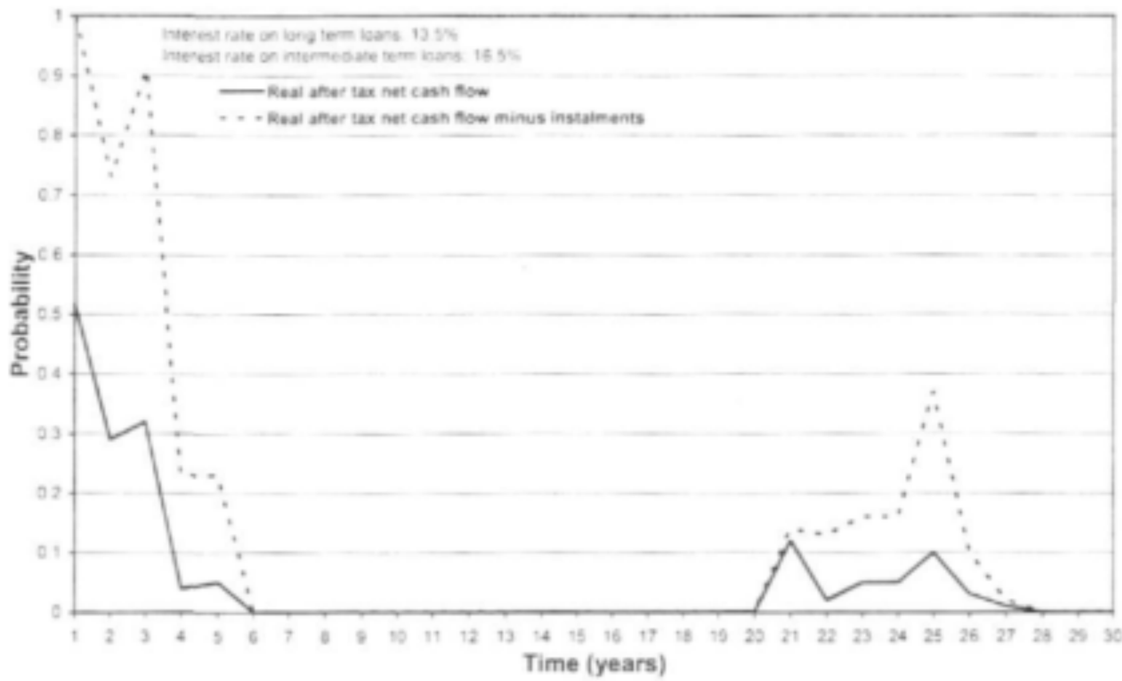

Figure A.41: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (13,5%/16,5%) on Onderberg case study farm 30 planted to mangoes (M_{4C}), oranges (M_{2C}), grapefruit (M_{4C}) and sugarcane (DI_{15C}), 2000

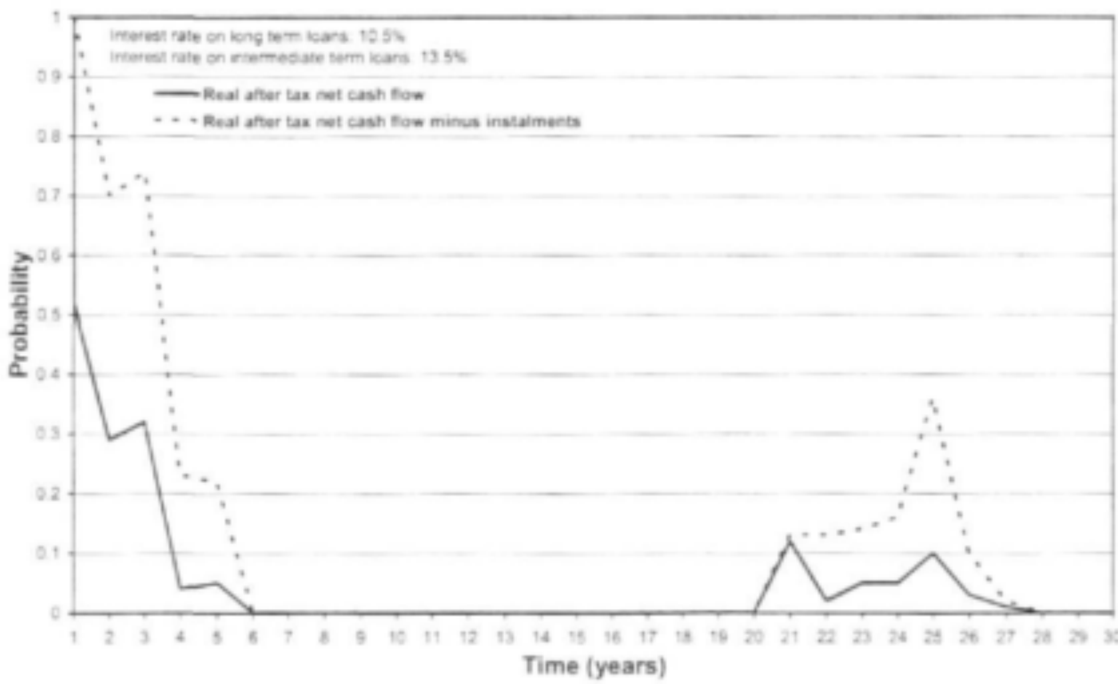

Figure A.42: The probability of failing to realise a positive real after tax net cash flow and furthermore meeting instalments (10,5%/13,5%) on Onderberg case study farm 30 planted to mangoes (M_{4C}), oranges (M_{2C}), grapefruit (M_{4C}) and sugarcane (DI_{15C}), 2000

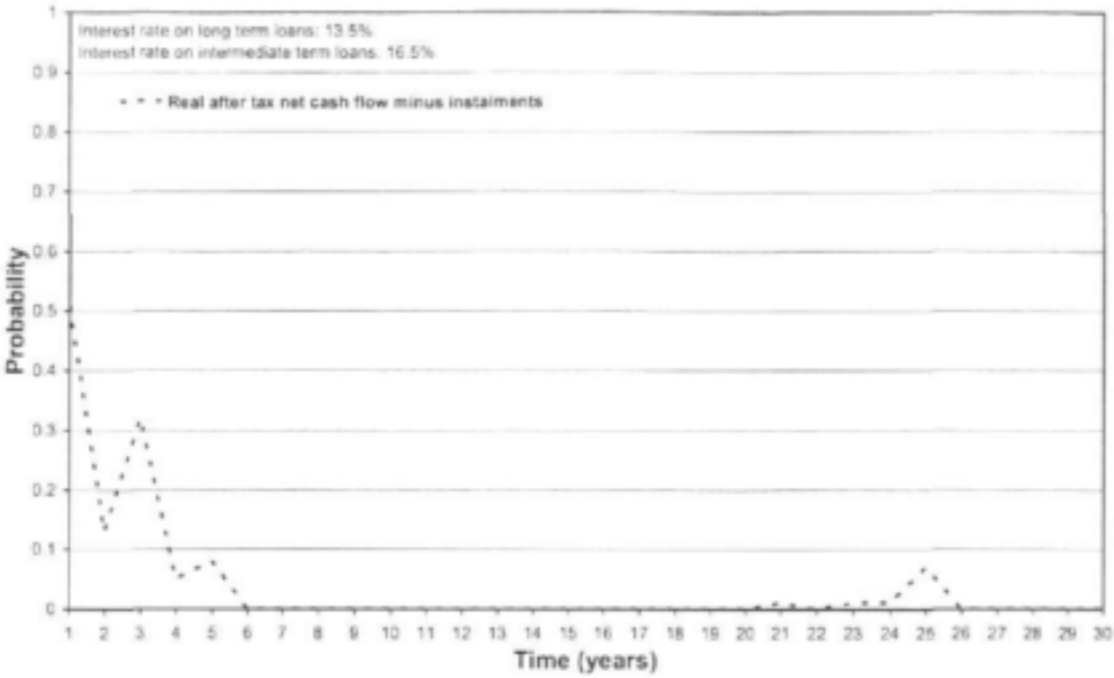

Figure A.43: The probability of failing to meet instalments (13,5%/16,5%) on Onderberg case study farm 31 planted to mangoes (M_{40}), oranges (D_{20}), grapefruit ($D_{20}M_{20}$) and sugarcane (D_{150}), 2000

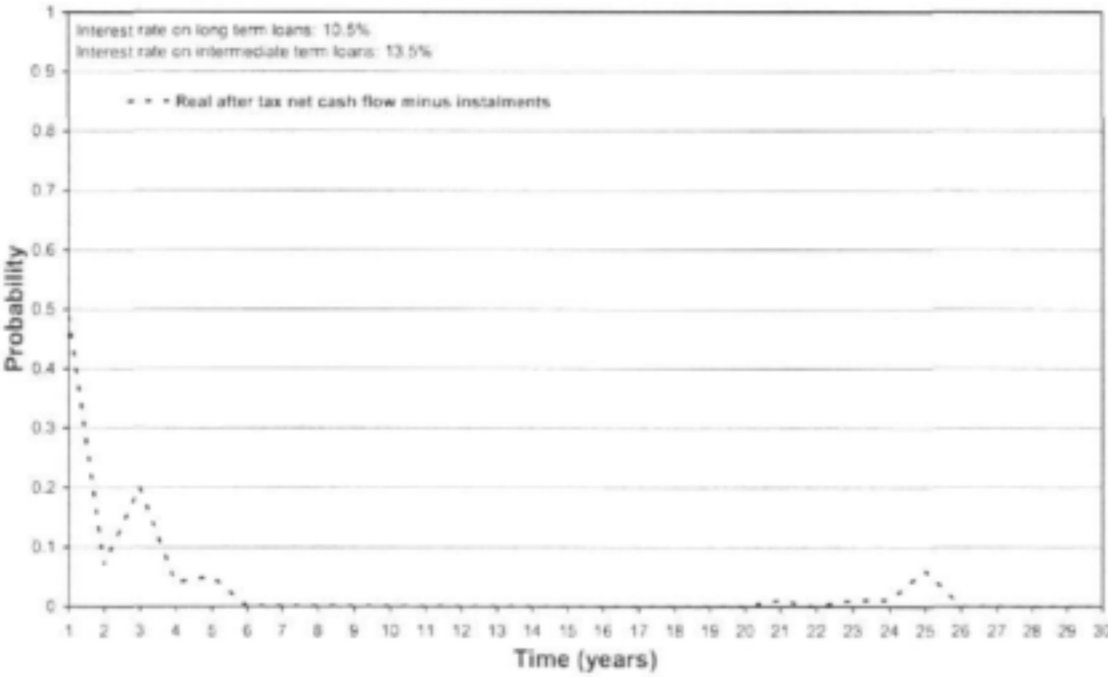

Figure A.44: The probability of failing to meet instalments (10,5%/13,5%) on Onderberg case study farm 31 planted to mangoes (M_{40}), oranges (D_{20}), grapefruit ($D_{20}M_{20}$) and sugarcane (D_{150}), 2000

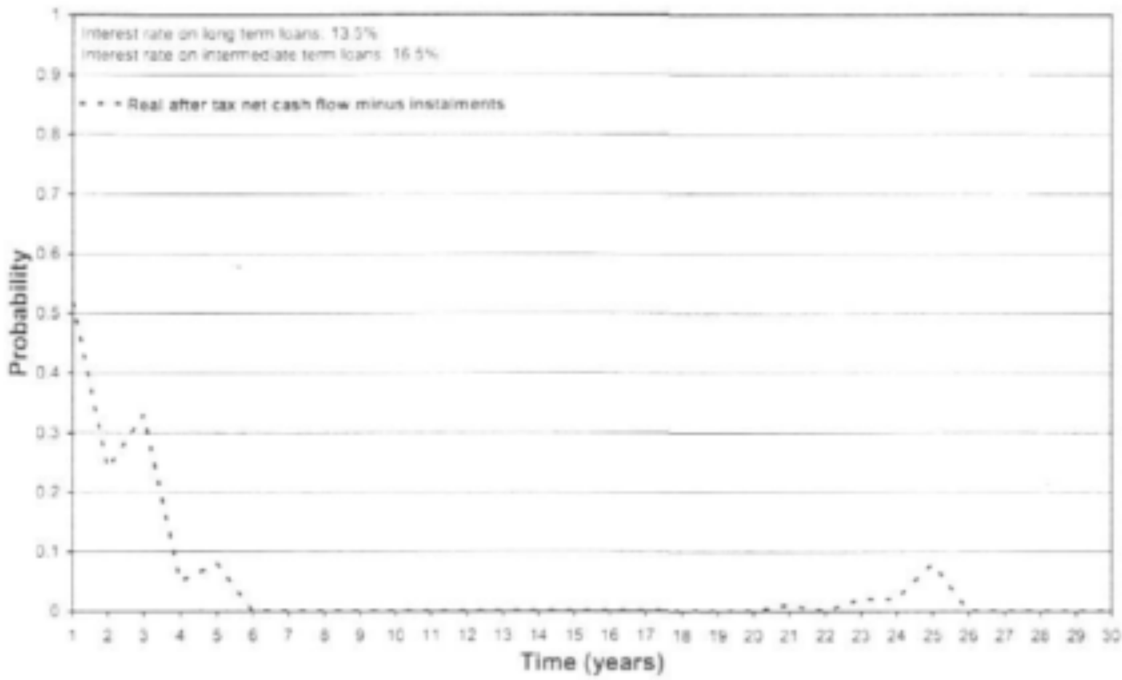

Figure A.45: The probability of failing to meet instalments (13,5%/16,5%) on Onderberg case study farm 32 planted to mangoes ($D_{20}M_{20}$), oranges (M_{20}), grapefruit (M_{40}) and sugarcane (D_{15c}), 2000

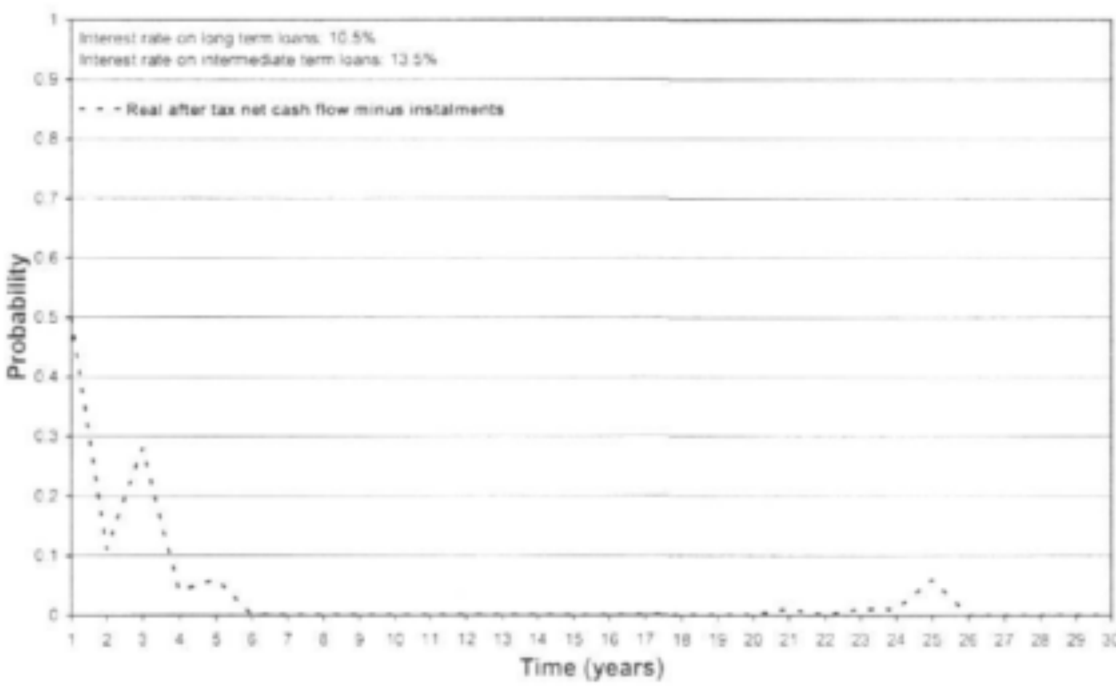

Figure A.46: The probability of failing to meet instalments (10,5%/13,5%) on Onderberg case study farm 32 planted to mangoes ($D_{20}M_{20}$), oranges (M_{20}), grapefruit (M_{40}) and sugarcane (D_{15c}), 2000

Other related WRC reports available:

Guidelines for irrigation water measurement in practice

I vd Stoep; N Benadé; HS Smal; FB Reinders

The Water Research Commission initiated a research project in 2000 in order to review the current situation and needs in the field of irrigation water measurement in South Africa. The main objective of the project was to develop guidelines for the correct choice, installation and management of water measuring devices by Water User Associations (WUA) for canal, pipeline and river distribution systems.

A series of field visits to important irrigation areas in South Africa as well as visits to a number of measurement equipment manufacturers and the relevant government departments were undertaken. A comprehensive literature study of flow measurement in irrigation was also conducted. A considerable amount of time was spent on the activities for the installation of various flow measurement devices at irrigation schemes. Different types of flow meters as well as water level sensors were installed at a number of WUA's, and monitored for extended periods of time. Shorter evaluations were conducted under laboratory conditions. Surveys were conducted amongst water users from 6 different WUA's with different water distribution systems, irrigation systems and farming conditions.

It was found that suitable measuring devices are available, but in order for them to be used successfully, they need to be installed correctly, well maintained, and read accurately. In other words, a WUA's water measuring system has to be managed.

The guidelines that were compiled are aimed at implementing water measurement successfully in practice, and give a detail description of the actions that need to be taken. There is currently no policy to guide WUA's in this and it is hoped that this report will provide some guidance to policy makers with regard to the issues that have to be addressed.

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