WESTVIC DAIRY IRRIGATION SCENARIO DECISION ASSISTANCE MODEL

MODEL

(WISDAM)

Manual for spreadsheets

SEPTEMBER 2003

Contents

Introduction

This manual provides details on how to use the WestVic Dairy Irrigation Scenario Decision Assistance Model (WISDAM). The model was developed to assist dairy farmers in south west Victoria in making decisions regarding investment in irrigation. It is important to be aware that the results generated by the model are intended to be a guide only. The model is used to predict the costs and incomes incurred in the future, and therefore is only as accurate as any estimates of future costs, prices and production.

Description of WISDAM terminology

WISDAM is essentially a discounted cash flow model used to assess the financial viability of various irrigation scenarios on a dairy farm.

A discounted cash flow model discounts the value of money to be received or spent in the future back to what it would be worth in current dollar terms. WISDAM models a period of twenty years, with year one being the year of initial investment.

The model assesses the financial viability of investment in irrigation by generating a range of measures including a net present value, a benefit:cost ratio, a pay-back period and a peak debt level. An explanation of these terms is provided.

The ***net present value (NPV)*** represents the present value of all the future dollar benefits of the investment minus the present value of all the future costs of the investment.

A discount rate is used to convert costs and income incurred some time in the future into current dollar terms. This rate represents the opportunity cost of the capital invested (ie. to reflect the annual returns from the next best investment alternative, such as a fixed term bank account, or the share market). If the NPV of an investment is greater than zero, then the investment is earning at a higher rate than the next best alternative investment option (as represented by the discount rate).

A ***benefit: cost ratio (B: C ratio)*** is the discounted present value of all future dollar benefits due to investment in irrigation, divided by the discounted present value of all future dollar costs of installing, running and maintaining the irrigation system. A benefit:cost ratio of greater than one indicates that the future benefits of the investment exceed the future costs. The greater the ratio, the greater the relative benefits of the investment.

While the NPV is a measure of the economic ***viability*** of an investment, it does not indicate how long it will take before the annual benefits associated with the project exceed the annual costs.
The ***pay back period*** indicates the number of years after the initial capital investment before positive annual cash flows are achieved. This measure provides an indication of the ***feasibility*** of the investment in terms of cash flow management.

WISDAM also provides the user with a ***peak debt level,*** which is a measure of the maximum farm debt load during the 20 year investment period. ***Peak debt level*** can assist with the assessment of the feasibility of the investment in terms of cash flow.

Input details

Irrigation scenarios

WISDAM allows for the comparison of a range of irrigation scenarios for any one farm. The model allows the user to choose from four different irrigation systems: travelling irrigator, fixed sprinkler, centre pivot and Van den Bosch. The user can assess just one system, or up to all four if desired.

The user chooses the area to be irrigated and the anticipated improvement in productivity on this area. For the purposes of assessing productivity improvement the four irrigation systems have been split into two groups: travelling irrigator/Van den Bosch and fixed sprinkler/centre pivot. The productivity improvements for the two systems within each group are likely to be similar.

The user can specify productivity improvements as increased production per head, increased cow numbers or reduced supplements fed. Changes in any one or more of these variables can be recorded for each farm.

A brief summary of each of the four irrigation systems used in the model is provided in Appendix 1.

Data entry

WISDAM consists of four spreadsheets in an Excel file. The titles and functions of each spreadsheet are described below.

- **Current Situation Feed Budget**. Calculates an annual feed budget for the current farm situation without irrigation.
- **Irrigation Feed Budget**. This spreadsheet contains two parts. The first covers travelling irrigators and Van den Bosch systems, whilst the second covers fixed sprinkler and centre pivot systems. This sheet requires the user to specify anticipated changes to the current feed budget with either a travelling irrigator / Van den Bosch irrigation system, or a fixed sprinkler / centre pivot irrigation system.
- **Investment Costs**. Requires the user to specify capital as well as annual running costs associated with investment in the irrigation system(s).
- **Analysis Results**. Presents the results of the investment analysis for each irrigation system under investigation.

WISDAM allows the user to investigate the viability of all four irrigation systems simultaneously to allow for comparisons between them.

WISDAM is not designed to allow for the assessment of utilising more than one system over different areas on any given farm.

The user need only fill out the sheet for the irrigation system they are interested in. If the client is interested in at least one system from options, then both parts of the sheet need to be completed.

In relation to the feed budget sheets (1 and 2), it is recommended that the client be provided with hard copies of the data input sheets to fill out. The user can then input the data from these sheets.

This program is protected so that the user is unable to accidentally type over set formulas.

To best predict changes that may occur when irrigation is installed, it is important to first make a best fit for the existing system. In the 'Current Situation FB', one can type in what is currently happening and adjust growth rates figures to fit parameters such as milk output etc. It is advisable to print this sheet first and then use it as a basis to help fill in the proposed sections with irrigation.

Current situation feed budget spreadsheets

Farm area and pasture growth

Enter the area in hectares for irrigated and dryland.

Dryland area is split up into poor and good so that different growth rates can be used on these areas.

Type in growth rates for the different areas and a farm average is calculated.

The irrigation area will have a better growth rate during summer than the dryland area. Growth rates will depend on rainfall, temperature, pasture species, soil type and soil fertility. Table 1 provides a guideline for pasture growth rates in south west Victoria.

The 'high' figure would occur on pasture in good condition with a high proportion of improved species and high soil fertility. The 'low' figure would occur on old pastures with low soil fertility, or better pastures under dry or very wet conditions. The 'medium' figures are for conditions in between.

Table 1. Pasture growth rates (kg DM/ha per day) for ryegrass/ clover pastures in south west Victoria without nitrogen fertiliser (Ward *pers comm*)

	Pasture Rating		
Month	**High**	**Medium**	**Low**
Apr	20	10	4
May	20	14	7
Jun	16	12	8
Jul	15	10	5
Aug	20	10	8
Sep	50	35	20
Oct	80	60	40
Nov	80	60	40
Dec	40	25	10
Jan	10	5	0
Feb	10	5	0
Mar	10	6	1

It is important to note that these are 'natural' growth rates, that is growth without added nitrogen. When nitrogen fertiliser is applied growth rates will generally be increased, providing adequate moisture is available or pastures are not severely waterlogged.

Table 2. Effect of different irrigation practices on pasture growth rates (kg DM/ha per day) during the summer (late November – early April) in south west Victoria (Ward *pers comm*)

	Irrigation practices (summer)[1]		
	Optimum [2]	**Average**	**Poor**
Sandy Soil [3]			
Water applied (mm/week)	35	25	< 20
Irrigation interval (days)	3	6	8 +
Clay Loam Soil			
Water applied (mm/week)	35	25	< 20
Irrigation interval (days)	5	8	10 +
Pasture growth rates [4] (kg DM/ha per day)			
Summer (Jan, Feb)	55	35	25
Shoulder (Dec, Mar)	35	25	20

[1] The quoted irrigation practices refers to the summer irrigation period. Irrigation requirements will be less for the shoulder periods (spring and autumn). Actual figures vary from week to week depending on prevailing weather.
[2] Optimum practices require both sufficient water to be applied each week and at the required irrigation interval. Failure to do both will result in reduced pasture growth rates.
[3] On deep sandy soils water requirements may be greater due to drainage of water past the root zone.
[4] Pasture growth rates are typical for the region, but may vary from site to site and week to week.

Stock numbers

Enter the number of yearlings and bulls on the farm each month, if they are kept on the farm area that is included within this budget.

The feed budget begins from April 1st, therefore enter the number of cows and heifers present at that time.

For each 10 day period, enter the number of heifers and cows calving. Use AI records to assist in this process. Also enter when cows are dried off or sent away from the farm area by using the 'dry cows away' column.
As dry cows and heifers away are brought home to calve, enter them as a negative number.

Example:
Fifty heifers come home in the first week of May to calve, therefore enter ' – 50' in the 'Dry cows away' column, either in the same week, or 1 or 2 weeks before, depending on when they are brought home.

If one has cows coming and going in the same period, the 'Dry cows away' figure will be the balance.

Example:
In one period, 100 cows are brought home to calve, but at the same time 10 milkers are dried off and sent away. The difference is + 10 cows away – 100 cows brought back = - 90 on balance, so enter ' – 90' in the 'dry cows away' column.

As one progresses towards the end of the lactation, remember to dry cows off as expected. Also enter them in the 'Dry cows away' column if they are sent off the farm area.

The last 2 columns calculate total numbers of milkers and dry stock at home. Monitor this value and adjust these figures until they are correct.

For cull cows or deaths, one will need to write numbers off as cows that were dried off first and then culled.

Example:
If one has a total of 240 cows and heifers to calve, but plan to milk a maximum of 220, at some stage one will need to enter 20 cows in the 'dried' column and 20 in the 'culled' column. One may get rid of them all at once, or in two lots of 10, whatever is most likely. If milker numbers fall after the peak, remember to dry and cull them where needed.

Production targets and supplements

Enter an average weight of cows (kg) and average fat and protein test (%) for the season.

Enter an estimate of milk price (cents/litre) each month. One may need to seek assistance from a field officer, as this figure will depend on ones expected monthly milk production, fat and protein test and the factory's price structure. Changing cow numbers and calving pattern can also change average milk price each month.

Enter target yield each month as litres/cow per day.

Total dry matter intakes per cow per day are calculated based on target production and cow size. This is an approximation based on average milk fat and protein test, not monthly tests.

Enter the two months before the start of calving as a '2' for the month that is two months before calving, and a '1' in the month before calving. This allows for extra feed required for the latter stages of pregnancy and weight gain for cows in late lactation.

Enter the expected amounts of supplements fed to milkers (kg/cow per day) each month. For silage and crops enter on a dry matter basis, whilst for all other supplements enter on an as fed basis.

For fodder crops, estimate how much total dry matter is available and the number of days over which it will be fed out to provide an estimate of kg DM required per cow each day.

Example:
For a 10ha crop with an expected yield of 4 tonnes DM/ha, the total crop available is 40 tonnes. If this is fed to 200 cows over 90 days: 40,000 kg ÷ 200 cows ÷ 90 days = 2.2 kg DM/cow per day on average. However, one might feed 3 - 4 kg DM/cow per day initially, and less in the last month. Check that the total amount of crop at the end of the feed out period adds up to what has been calculated.

To work out the yield of a fodder crop make a square grid 1 x 1 m (4m of wire bent into a square). Throw the grid into the crop 5 to 10 times – each time pick the turnips or cut the rape within the grid and record the weight. Add the weights together and divide the total by the number of measurements. Multiply this number by 10,000 to estimate the wet weight of the crop per hectare. When estimating the dry matter content a good guide to use is: turnips 10%, pasja 10 –15% and rape 15 – 20%. To estimate the yield, multiply the wet weight per ha by the dry matter percentage of the crop. Ensure that crop plus grain is not more than half the cow's intake or animals may suffer a fibre deficiency, which can affect milk composition.

Enter the total kg of nitrogen fertiliser applied in each month.

Example:
If 4 tonnes of urea was applied in May, this equals 4 tonnes x 460 kg N per tonne of urea = 1840 kg of nitrogen (urea is 46% N).
For other nitrogen fertilisers , use the appropriate figure

Type in expected response to nitrogen applied. The response is the kilograms dry matter of grass grown per kg of nitrogen applied (kg DM/kg N). Responses will be greatest under warm, moist conditions and on fertile paddocks that are predominantly ryegrass based. Table 3 provides a guide to likely responses:

Table 3. Pasture response to applied nitrogen fertiliser (kg DM/kg N) in different seasons (McKenzie *pers comm*)

Season	Response
Autumn	8 – 14
Winter	2 – 10
Spring	15 – 25

Response to applied nitrogen can be zero if pastures are waterlogged and soil temperature are low (below 5^{o}C). If conditions are too dry (ie. limited soil moisture) then responses may also be low.

For further information on responses to nitrogen fertilisers read "Using Nitrogen Confidently" by Dr Frank McKenzie.

Feed budget

The feed budget provides a separate total dry matter (DM) required each month for milkers and other stock. A feed supply figure is then provided for each month for each feed type. Remember that pasture, silage and crop totals are on a DM basis (t DM), whilst grain and hay are given as tonnes as fed.

The 'Nitrogen' column shows the extra tonnes of pasture DM grown from using nitrogen. The extra growth is assumed to occur in the month after application. The value provided for extra growth is calculated as the total kg of nitrogen applied by the response rate.

The column 'Milkers DM difference' is calculated as the feed that the milking herd requires minus pasture grown and supplements fed (after all feeds have been converted to a DM basis). This figure does not include the other stock. The requirements of other stock will have to be met from conserved fodder or a separate grazing area. If they are given access to the milking herd's pasture, a sufficient surplus will have to be generated by using more supplements.

The 'Milkers DM Difference' should run as a positive figure each month. If one has negative numbers, supplements need to be increased, (or target production reduced) until one gets a positive result.

Ideally a surplus of 20 t DM or more should occur in months where a feed wedge is being built up, such as after the autumn break. The model assumes that 70% of the spring surplus is conserved. This figure is provided so one can compare total fodder required against what the farm may supply.

Enter cow numbers for the season in the shaded box under the feed budget table. This will calculate production per cow, so a check can be made to see if the results are realistic. This is particularly useful when entering past figures. The same applies for the pasture utilised figure. If the figures are wrong, make adjustments and checks to figures such as pasture growth, cow numbers each month, target milk yields or supplements fed.

Costs and returns

The income on total milk produced is calculated, however any calf milk used will need to be subtracted. The cost of supplements is calculated on the price of supplements entered, with total grain cost being based on amount of grain used.

For fodder costs one may choose to enter a figure for all fodder used, or alternately just the cost of expected purchased fodder.

Example:
The feed budget may indicate that 200 tonnes of fodder is required for the year, but the farm will only harvest 150 tonnes, therefore the other 50 tonnes is purchased fodder.

The model will not calculate the cost of nitrogen fertiliser used as this depends on the fertiliser types/ blends used.

Travelling irrigator – Van den Bosch and Fixed sprinkler – Centre pivot feed budget spreadsheets

Both the Travelling irrigator–Van den Bosch and Fixed sprinkler-Centre pivot feed budget sheets require information for the same categories as in the Current situation feed budget spreadsheet. The difference being that the user is required to make estimates of how the current situation would change with irrigation.

The user must first specify the area to be potentially irrigated.

The program will then adjust annual farm DM production accordingly.

The user can then specify how this extra DM production would be used on the farm.

The options are to increase cow numbers, increase milk production per cow or reduce amount of supplements fed.

The user can specify anticipated changes to any one or combination of these variables for one or both irrigation system groups.

Investment costs spreadsheet

Capital and annual irrigation costs

Both the current situation and the irrigation feed budget spreadsheets represent annual steady state feed demand and supply schedules. These budgets take no account of the capital or annual running costs associated with investment in an irrigation system.

The investment costs spreadsheet is where the user inputs costs for whichever irrigation system(s) they wish to investigate.

Capital costs are specified under the following headings:

Dam/bore construction (including all materials and labour)
Permits
Purchase of water right
Irrigation equipment (including all materials and labour)
Electricity connection
Pasture renovation (including all inputs and labour)
Other

The investment is assessed in terms of costs and benefits over a twenty-year period. It is assumed that all capital costs associated with installing the irrigation system are incurred in year 1 of the investment period. The user is then required to input an estimated life span of the irrigation system before it would need replacing. The user must choose an expected life span of between 5 and 30 years in multiples of five (see Appendix 2).

In addition to capital costs, the annual costs of running and maintaining each system must also be provided. These costs include the cost of water per megalitre, annual licence fee, electricity/diesel cost per megalitre, repairs and maintenance and labour.

Additional non-irrigation specific, annual costs may include pasture costs such as fertiliser, chemicals and oversowing or pasture topping.

In the scenario where cow numbers are increased as a result of installing the irrigation system, the cost of additional cows will need to be provided, along with annual variable costs associated with running those extra cows. Table 4 provides average variable costs per cow from the Target 10 Dairy Farm Analysis (2000) as a guide. The user is also required to specify the anticipated number of years required to reach maximum cow numbers.

Table 4: Average variable costs per cow according to the Target 10 Dairy Farm Analysis (2000)

Variable cost category	$ per cow
Artificial insemination	27
Selling costs & freight	10
Herd testing	15
Animal health	42
Calf rearing	29
Shed costs	14
Dairy supplies	18
Agistment	10

Water use

WISDAM allows the user to identify the frequency of dry, average and wet years for their area. For each of these season types, the user is required to specify the megalitres of water used per hectare (ML/ha), the number of weeks irrigated and the number of years in ten that each season type would be expected to occur (the total must add to ten). As a guide, Southern Rural Water use 6 megalitres per hectare as the standard water requirement for irrigated pasture.

Taxation, interest and inflation

It is important when entering data to ensure that all costs and incomes include the Goods and Services Tax (GST). In addition to the GST, annual income tax is calculated according to the 2002/2003 Australian Taxation Office Rules.

It has been assumed in WISDAM that capital expenditure on an irrigation system can be written off over the first three years in accordance with the three-year deduction for expenditure on water facilities. One should however, discuss ones eligibility for this deduction with an accountant.

One can specify ones own overdraft interest rate on any borrowed money, and the credit interest rate at which cumulative cash surpluses earn.

One can specify ones estimates of the average cost and income inflation rates over the next twenty years.

One can specify the average discount rate for the investment over the next twenty years. The discount rate represents the earning rate of the next best alternative investment option for the capital in question.

Table 5 provides suggested values for real discount rate, and income and cost inflation rates.

Table 5: Suggested values for real discount rate, income inflation rate and cost inflation rate

Variable	Suggested value
Real discount rate	12%
Income inflation rate	2%
Cost inflation rate	4%

Model outputs

The model outputs are presented (Table 6) showing the ***net present value (NPV), benefit cost ratio (B: C ratio), pay back period, peak debt level***, maximum cows milked, average butterfat production per cow, and average protein production per cow for each irrigation system examined.

To give an example, a NPV of $250,000 indicates that given the assumed discount and interest rates, the dairy farmer would earn the equivalent of $250,000 in current dollars over the 20 year investment period. Say the dairy farmer spent $200,000 in current dollar terms on the irrigation system over a twenty year period, then the B:C Ratio of the investment would be 1.25 ($250,000 divided by $200,000). This means that for every $1 invested, $1.25 is earned.

While the NPV and the B: C Ratio are indicators of the viability of an investment over a given time, they tell nothing about the feasibility of the investment. For example, if it takes 18 years before the initial investment costs are paid off, then it may not be a feasible investment in terms of cash flow. However if it only takes 10 years before positive cumulative cash flows occur, then this may be a manageable debt scenario.

Table 6. Output data from model

	Travelling irrigator	**Fixed sprinkler**	**Centre pivot**	**Van den Bosch**
Net present value				
Benefit/cost ratio				
Pay-back period				
Peak debt level				

Sensitivity analysis

In any type of investment analysis it is important to test the sensitivity of the results to variations in the major input values before making any final decisions. WISDAM allows the user to alter the key variables of milk price, cost of supplements, frequency of dry seasons, water price, and interest rates to assess the impact on both the viability (NPV and B: C Ratio) and the feasibility (pay back period and peak debt level) of the investment.

The sensitivity analysis allows the user to explore 'what happens if' scenarios. For example, will the investment still be profitable if long - term milk prices drop by 5 % and the price of water rises by 10 %?

It is suggested that the user considers the worst case scenario, and if the investment is still viable, the risk of failure is low.

Summary

In summary, it is important to remember that with this type of model, the outputs are only as accurate as the values inputed. Whilst many values entered will be estimates, some careful consideration should be given to all values entered. Therefore, to get the most benefit from WISDAM it is suggested that appropriate time be given to providing accurate input data. Quotes for the installation of particular irrigation systems can be sought from a reputable irrigation company. These companies should also be able to provide farmers with estimates of annual maintenance costs for the various systems, and also advise farmers on the appropriateness of each system for their particular enterprise. A list of local suppliers of irrigation equipment is provided in Appendix 3.

Appendix 1

Water availability

Sources of irrigation water in south west Victoria are either from surface diversions (generally pumping from rivers) or ground water from bores. To obtain water from these sources an appropriate license is required from Southern Rural Water. Virtually all water from surface diversions is already committed and in most areas the same would apply to ground water sources. In future, water licenses will be purchased by private trading. For further information it is advisable to contact Southern Rural Water at Warrnambool or Colac.

Water quality

It is advisable to check water sources for irrigation suitability purposes, in particular the salinity of the water source and a number of other minerals (eg. calcium (Ca), magnesium (Mg), sodium (Na), chloride (Cl)). Testing of potential irrigation water supplies can be undertaken by the water quality laboratory at Deakin University, Warrnambool or Department of Primary Industries, Ellinbank.

Irrigation systems

1. Centre pivot

In a centre pivot system the sprayline, anchored at one end to a central pivot structure, forms the radius of a circular irrigated area. Water is pumped into the line at the pivot structure. The sprayline rotates around the centre pivot, powered by hydraulic or electric drive on each tower. Sprinklers operating at medium pressure (200-350 kPa) or drop tubes and sprays at low pressure (75-140 kPa) are spaced along the sprayline. This spacing becomes closer towards the outside of the circle to allow for the increasing speed of travel of the sprayline and the greater area being irrigated.

The centre pivot system has high distribution uniformity and application efficiency and so has reduced water demand and reduced water losses through deep percolation. However, there may be difficulties with large machines because of the heavy application rates that occur at the outer spans, causing run off and uneven watering if the soil is not highly permeable. Operating pressure should be as low as possible to minimise running costs, but high enough for satisfactory sprinkler or spray performance. The centre pivot system has lower energy use and hence lower power costs than with most other systems.

A major advantage of centre pivots is their virtually automatic operation and therefore low labour costs. To sustain this advantage, however, regular inspections and maintenance are necessary.

The major practical consideration for the centre pivot system is that it requires a large continuous area free of obstructions. The economics of the centre pivot system are very dependent on the pivot size that can be accommodated, since each additional span added waters a much larger area than the previous one, thus spreading the capital cost over a larger area. It is possible to operate a centre pivot system over only a portion of a circle, but this does not maximise the capital investment.

Portable centre pivot systems are also available which can be towed between multiple sites on a property, thus spreading the capital cost over a larger area. In order to cover a larger area, either the irrigation interval, the application rate and travel speed or the operating hours must be increased.

It is not necessary to remove all fencing from within the area of the pivot. Methods are available to enable the pivot to cross fences. The pivot can also cross farm roads providing there is a relatively level path for the wheels to follow. Centre pivot systems can operate on gentle slopes and with slight undulations.

2. Fixed sprinkler

A fixed sprinkler system involves the permanent instillation of a grid of sprinklers to provide complete coverage of the irrigated area without any need to move the sprinklers. The block is divided into a number of units or 'grids' with a valve controlling flow to each unit. The number and size of the units and the size of the supply system is designed to achieve the required application and irrigation interval. Fixed sprinkler systems normally use impact sprinklers. These can be mounted on risers and fixed to a supporting post, or alternatively there are special pop-up sprinkler heads, which retract into casing at ground level when not in use. Operating pressures are in the range of 250 to 400 kPa.

The fixed sprinkler system has a reasonably high distribution uniformity and application efficiency compared to other systems. As a result they have a moderate water demand and relatively low water losses through deep percolation. If correctly designed and operated they should not generate run off or cause erosion. Pumping energy required, and therefore power costs are moderate.

The major practical advantage of fixed sprinkler systems is the simplicity of operation and minimum labour requirement. With an automated control system the only labour requirement is to check the control panel. They are also very flexible and can easily be operated to give different applications and intervals. In theory it would also be possible to customise a fixed sprinkler system to apply different amounts of water to different areas of a farm, to take account of different soil types or microclimates, although this would introduce a higher degree of complexity into the design.

Fixed sprinkler systems can readily be designed for any paddock shape, and can be designed to avoid watering wet spots or high-traffic areas such as gateways and water troughs. They can be used on undulating or sloping land.

The major practical disadvantage of fixed sprinklers is the inconvenience associated with having a grid of fixed posts within the paddock. This makes all paddock operations more difficult, especially cultivation, slashing, topping and forage conservation. Some of these issues can be avoided by using pop-up sprinklers. The mainlines are buried below tillage depth and therefore do not pose a problem.

3. Travelling irrigators

The most common type of travelling irrigator used in Victoria is the soft hose type consisting of a single giant sprinkler (rain gun) mounted on a self-propelled trailer and operated at high pressure (400 to 620 kPa). Water is supplied through a flexible, lay flat nylon reinforced rubber hose, which is dragged behind the trailer during irrigation. Self-propulsion of the trailer is effected by a cable and winch driven by an hydraulic cylinder in piston-drive or bellows-drive models, or by a water turbine.

A rectangular strip is irrigated at each run. The strip may be from 50 to 100 metres wide, depending on the size of the rain gun, and from 200 to 600 metres long according to the length of the hose. Up to 50 mm of water can be applied in a 23 hour run. Travel speed can be varied to enable the irrigator to complete runs in times varying from 5 hours to 48 hours.

Soft hose travelling irrigators operate quite effectively on topography varying from flat to steep and irregular aspects. Obstacles such as trees or farm buildings do not restrict their operation.

Travelling irrigators typically have a poorer distribution uniformity than the other systems due to the large spacing between sprinklers. The pattern of water distribution of a high pressure rain gun can be distorted under windy conditions resulting in an uneven watering and increased water losses.

Travelling irrigators require high operating pressures to give wide coverage and to produce adequate break-up of the stream of water. As a results they have high energy and running costs. Constant travel speed, which is necessary for uniform water application can be affected by the amount of hose drag and the extent of build-up of cable on the cable drum. Both of these effects are minimal at the start of the irrigation run and maximal at its completion.

As a result of the relatively poor distribution uniformity they have a higher water losses through deep percolation loss and a higher loss due to wind and evaporation due to the high trajectory of the gun sprinkler. Labour requirements and costs are higher than some other systems due to the time required to move and set up the machine for each run.

4. Van den Bosch

The Van den Bosch or Long Lateral system is a semi-permanent system with a widely spaced network of underground piping with quick-coupling hydrants at the surface. The system comprises of a medium pressure sprinkler on a light portable stand. This is attached to a 70 metre length of 25 mm flexible polythene hose, each of which is connected to a hydrant and serves an area of about 0.5 - 0.8 hectare in 8 or more moves. The sprinklers may be moved by hand, but are designed with a skid base and can be readily moved by one person while riding a motorbike. Sprinkler spacing can be readily varied to suit the prevailing wind conditions.

The Van den Bosch system typically has poorer distribution uniformity but similar application efficiency compared to the fixed sprinkler system. As a result the Van den Bosch system has slightly higher water demand and water losses through deep percolation than the fixed sprinkler system. Both systems operate at medium pump pressures giving them similar pumping energy requirements.

The main disadvantage of the Van den Bosch system is the high labour requirement. It is estimated to take at least one minute to move each sprinkler so one hundred sprinklers require over one and a half hours to move. The system also requires considerable operator judgement and care to place the sprinklers accurately at each shift. This can also be considered an advantage, in that the operator can adjust the placement of sprinklers to avoid wet spots.

Van den Bosch systems can readily be designed for any paddock shape, and are able to be used on sloping and undulating land.

Summary of irrigation systems

Below (Table 7) is a summary of the relative performance of each irrigation system discussed above for a range of variables.

Table 7. Performance of the four irrigation systems for a range of variables

	Fixed sprinkler	**Centre pivot**	**Trav. irrigator**	**Van den Bosch**
Distribution uniformity	Mod-Excellent	Excellent	Low	Mod-Low
Application efficiency	Mod-Excellent	Excellent	Low	Mod-Low
Labour requirements	Low	Low	High	High
System rotation time	Excellent	Excellent	Mod-Low	Moderate
Operating pressure	Medium	Low	High	Medium
Running costs	Medium	Low	High	Medium
Maintenance	Low-Medium	Low-Medium	High	Low-Medium
Flexibility - Crops	Excellent	Excellent	Excellent	Fair
- Other areas	Poor	Poor	Excellent	Poor
Capital cost per hectare*	$5000-$8500	$2000-$4000	$1800-$3500	$1800-$3000

*Includes irrigation system and pump

A range for capital cost per hectare has been provided for each system. This range provides a general guide only. Prices vary depending upon land topography, location of water supply, size of area to be irrigated, and farm layout. The availability of water will also have a considerable bearing on whether or not investment in any irrigation system is viable.

Appendix 2

Feed budget data input sheets

1. Current situation feed budget input sheet

1. Pasture Information

	Irrigation	Dry-good	Dry-poor	Total
Area (ha)				

Pasture growth (not including nitrogen)

Month	excellent	Good	poor	farm average
April				
May				
June				
July				
Aug				
Sept				
Oct				
Nov				
Dec				
Jan				
Feb				
Mar				

2. Yearlings and bulls grazing at home

MONTH	No. Yearlings	No. Bulls
April		
May		
June		
July		
August		
September		
October		
November		
December		
January		
February		
March		

3. Stock numbers on April 1st

Dry cows	Stale cows	Fresh cows	Heifers to calve

4. Number of cows calving, dried off and sold (dry cows brought home are written as a negative figure in column 'Dry cows away')

Month	Dates	Cows & heifers calving	Cows dried	Cows culled	Dry cows away
April	1-10 11-20 21-30				
May	1-10 11-20 21-31				
June	1-10 11-20 21-30				
July	1-10 11-20 21-31				
August	1-10 11-20 21-31				
September	1-10 11-20 21-30				
October	1-10 11-20 21-31				
November	1-10 11-20 21-30				
December	1-10 11-20 21-31				
January	1-10 11-20 21-31				
February	1-10 11-20 21-29				
March	1-10 11-20 21-31				

5. Milk Production Targets & Supplements

Month	Milk Price c/L	Target Prod'n L/cow/d	Supplements Fed (kg/cow/d)				Nitrogen	
			Grain	Silage	Hay	Crop	kg N	Response* (kg DM)
April								
May								
June								
July								
August								
September								
October								
November								
December								
January								
February								
March								

* Pasture response to N one month after application.

Average Cow Weight	
Average Milk Fat %	
Average Milk Protein %	

6. Value of Supplements

	Grain	Silage	Hay	Crop
$ per Tonne				

2. Irrigation feed budget input sheet

1. Pasture Information

	Irrigation	Dry-good	Dry-poor	Total
Area (ha)				

2.1 Yearlings & Bulls grazing at home

Month	Trav irrigator - Van den Bosch Yearlings Bulls	Fixed sprinkler - Centre pivot Yearlings Bulls
April		
May		
June		
July		
Aug		
Sept		
Oct		
Nov		
Dec		
Jan		
Feb		
Mar		

2. Stock numbers on April 1st

Travelling irrigator-Van den Bosch				Fixed sprinkler-Centre pivot			
Dry	Milkers Stale	Fresh	Heifers to calve	Dry	Milkers Stale	Fresh	Heifers to calve

3. Number of cows calving, dried off and sold (dry cows brought home are written as a negative figure in column 'Dry cows away'). Table presented as two tables, whereas in the spreadsheet it is presented as one. The last two columns are calculated by the model.

Travelling Irrigator-Van den Bosch

Month	Dates	Cows & heifers calving	Cows dried	Cows culled	Dry cows away	Total milkers	Total drys & spring heifers
April	1-10 11-20 21-30						
May	1-10 11-20 21-31						
June	1-10 11-20 21-30						
July	1-10 11-20 21-31						
August	1-10 11-20 21-31						
September	1-10 11-20 21-30						
October	1-10 11-20 21-31						
November	1-10 11-20 21-30						
December	1-10 11-20 21-31						
January	1-10 11-20 21-31						
February	1-10 11-20 21-29						
March	1-10 11-20 21-31						

Fixed Sprinkler-Centre Pivot

Month	Dates	Cows & heifers calving	Cows dried	Cows culled	Dry cows away	Total milkers	Total drys & spring heifers
April	1-10 11-20 21-30						
May	1-10 11-20 21-31						
June	1-10 11-20 21-30						
July	1-10 11-20 21-31						
August	1-10 11-20 21-31						
September	1-10 11-20 21-30						
October	1-10 11-20 21-31						
November	1-10 11-20 21-30						
December	1-10 11-20 21-31						
January	1-10 11-20 21-31						
February	1-10 11-20 21-29						
March	1-10 11-20 21-31						

4. Milk Production Targets & Supplements

Travelling Irrigator-Van den Bosch

Month	Target Prod'n	Supplements Fed (kg/cow/d)	Nitrogen

	L/cow/d	Grain	Silage	Hay	Crop	kg N	Response* (kg DM)
April							
May							
June							
July							
August							
September							
October							
November							
December							
January							
February							
March							

* Pasture response to N one month after application.

Fixed Sprinkler-Centre Pivot

Month	Target Prod'n L/cow/d	Supplements Fed (kg/cow/d)				Nitrogen	
		Grain	Silage	Hay	Crop	kg N	Response* (kg DM)
April							
May							
June							
July							
August							
September							
October							
November							
December							
January							
February							
March							

Average Cow Weight	
Average Milk Fat %	
Average Milk Protein %	

7. Value of Supplements

	Grain	Silage	Hay	Crop
$ per Tonne				

4. Investment costs input sheet

* All income and costs provided should include the GST.

Irrigation system

1. Travelling irrigator
2. Fixed sprinkler
3. Centre pivot
4. Van den Bosch

CAPITAL COSTS	1	2	3	4
Dam/Bore construction				
Permits				
Purchase of water right				
Irrigation equipment				
Electricity connection				
Pasture renovation				
Other				
Expected life of system (5,10,15,20,25 or 30 Years)				

ANNUAL COSTS	1	2	3	4
Water cost per ML				
Annual licence fee				
Energy (elec/diesel) per ML				
Repairs & maintenance to Irr. Equip. Year 1				
Repairs & maintenance to Irr. Equip. Year 30				
Irrigation labour (hrs per week)				
Value of labour ($/hr)				

ADDITIONAL NON-IRRIGATION COSTS	$
Additional pasture costs per hectare	
- Fertiliser	
- Chemicals	
- Oversowing/pasture topping	
Additional cow costs	
- Extra cows ($/hd)	
Value of additional bobby calves	
- Bobby calf sale value ($/hd)	
Variable costs per cow	
- Artificial insemination	
- Stock selling costs & freight	
- Herd testing	
- Animal health	
- Calf rearing	
- Shed costs	
- Dairy supplies	
- Agistment	
TOTAL	

WATER USE	Dry	Average	Wet
ML Water used per hectare			
Weeks irrigated			
Frequency of occurrence (Years in 10)			

Number of years required to reach max cow numbers ____ **Years**

FINANCIAL VARIABLES	Percent
Real discount rate	
O/D interest rate	

Credit interest rate	
Income inflation rate	
Cost inflation rate	

Appendix 3

Irrigation equipment suppliers

1. Laurie Spokes Windmill & Irrigation Pty Ltd
Princes Hwy Colac
Ph: (03) 5231 5432

2. Davison Drilling & Irrigation
233 Millicent Rd Mt Gambier
Ph: (08) 8723 0344

3. Bosch Irrigation
1061 Raglan Pde Warrnambool
Ph: (03) 5561 5200

4. Owens of Warrnambool Pty Ltd
159 Lava St Warrnambool
Ph: (03) 5562 3833

5. Warrnambool Co Operative Society
259 Timor St Warrnambool
Ph: (03) 5561 9500