Wairarapa Farmer/Grower

Irrigation Decision Making

Booklet

A Beginners Guide To Irrigation

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Foreword

This document is designed to complement the ongoing work being done to create a regional irrigation system to provide access to water for a further 30,000 hectares of the Wairarapa valley.

While this scheme will deliver water to the farm gate, this is in many ways where the decision-making for individual farmers starts. The decision to irrigate or not is a major one that involves the consideration of many elements such as the financial implications and the changes in land-use management that are required to make it a profitable decision.

It is clear that water is rapidly becoming a scarce resource in this region and so it is important that everyone involved in making land-use decisions considers the irrigation option and the guidelines contained in this publication.

Bob Francis and Geoff Copps
Wairarapa Regional Irrigation Project

IS IRRIGATION AN OPTION FOR YOUR PROPERTY?
If water was to be delivered to your gate, would you be prepared to utilise it, what benefits would it add to your business and what capital cost would be involved.
This publication was prepared with funding from the MAF Sustainable Farming Fund to be used by Wairarapa farmers that are involved in the proposed Wairarapa Community Irrigation Schemes. Without land owner support, even if it could be very viable it will not get started. Investment in irrigation is a major decision and is unlikely to be profitable unless the farmer/grower is prepared to make the wide ranging changes to their business to make it a success.

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The Irrigation Guide – Prepared by Ian McIndoe, Lincoln Environmental, Dave Attewell, Attewell Irrigation Consultants Ltd and Bob Engelbrecht, Engelbrecht Evans and Co Ltd for the Farmers Irrigation Management Group

Irrigation Scheme Development – prepared by Chris Thomas, Bob Simpson and Cheryl Macaulay for the Farmers Irrigation Management Group

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For More indepth reading I can recommend

- The irrigation Guide
- Irrigation Scheme Development

Both published by the Farmers Irrigation Management Group PO Box 125, Timaru

- The New Zealand Irrigation Manual by Malvern Landcare Group

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WHY IRRIGATE?

There are a number of reasons why an individual farmer may wish to irrigate an existing property rather than to continue dry land farming. These include:

- Improving reliability of existing production systems;
- Opening up diversification or intensification options;
- Increasing profitability with an existing farming programme, both in total net income terms and as a return on investment in farming, and increasing the net asset value of the business;
- Producing a more constant income (cash flow) from one season to another;
- Wishing to change to a different farm production system that requires irrigation;
- Wishing to expand the viability of the farming business so other members of the farming family, or perhaps the next generation, may become involved in the farm business, as an alternative to purchasing additional land.

Rather than going through the irrigation development phase on an existing property, another option for an individual farmer is to sell an existing property and relocate to a more favourable production area, or to relocate to an already irrigated farm. One factor in considering this is that with a new conversion of a dry land farm to irrigation, the farmer is able to use the latest technology in planning and development, and has the advantages of a more modern system.

THE IMPORTANCE OF RELIABILITY OF PRODUCTION

There is no doubt that reliability of any particular production system will be significantly enhanced with the introduction of irrigation into the programme. Most of the world with which we trade today requires certainty of quantity, quality and delivery on time. Most of these characteristics are not possible in a low and unreliable rainfall environment without irrigation.

Under dry land farming conditions in Canterbury, historical records confirm that pasture production in an average growing season (with plenty of late spring/summer/autumn rainfall), on a particular soil type or farm, may be three times the production achieved under dry land conditions in low rainfall seasons, say: 4500 kg/ha dry matter compared with 1500 kg/ha dry matter

Irregularity is primarily due to rainfall variations.

The risks of farming in a dry climate are now much greater than they were 30 years ago. As the cost/price squeeze continually drives farmers to become more and more efficient to remain viable/economic, the higher stocking rates now run on many farms, perhaps most, and targeting of higher crop yields exposes the farming business to greater yield and financial risks than ever before.

Eliminating or minimising the climatic variations can substantially level out the otherwise extreme variability that would normally exist.

Records show that irrigated farms consistently have a much narrower range of production output, and consequently financial output, when compared with dry land farms.

Irrigation also provides the opportunity for dry land farmers, on the fringes of the irrigation area, to have a more reliable market for store lambs and store cattle than would otherwise be the case.

INCREASING PRODUCTION – INTENSIFICATION VERSUS DIVERSIFICATION

Farmers on existing properties have the choice of intensification or diversification to lift their production levels. When most farmers develop their existing properties, they will tend to intensify their farming systems rather than diversify.

Intensification means a higher stocking rate, greater production yields, more intensive cash cropping programmes, or a combination of all of these. In an irrigated farming programme, producing more of the same in greater quality as well as quantity will usually service the additional debt and provide a reasonable net profit.

On the other hand, diversification usually means a move away from the existing farm programme into other crop types or forms of livestock with which the farmer has not usually had previous experience. Farmers generally diversify into financial trouble, rather than out of it.

As a general rule, intensification is likely to work more effectively than diversification. There is less need for a farmer to up skill in a very wide range of new areas with the long "learning curve" that these moves often entail.
There have been many success stories where existing farmers have changed land use with irrigation. For example, a significant number of the recent dairy farms that have been converted from mixed cropping or dry land sheep farms have been completed by the original owners. Often, the owners will employ skilled staff to help them make the transition to the new enterprise.

CROP TYPES

The local farming economy has been based on five main crop and seed types:

- Wheat
- Barley
- Peas
- Ryegrass
- White clover seed

With the progressively declining product prices for the above crops and increasing input costs required, the profitability of conventional arable farming has trended downwards. Mixed cropping farming programmes, except where well irrigated on the most suitable soil types, have become less profitable than less intensive mixed livestock and cropping systems, particularly taking into account the high level of skills required to operate an intensive arable and small seeds programme.

Most farmers are generally better advised to intensify on a narrow range of relatively easily grown crops and seeds, rather than diversity into areas requiring much greater skills, attention to detail and demands on the farmer and staff. The extra demands usually outweigh the additional financial return.
Experience has shown that, unless an individual farmer has the necessary specialist skills and a favourable soil type and climatic environment in which to grow high risk crops, the fluctuations in income can be enormous from one season to the next. For the investment required, which often includes specialist planting equipment and high levels of seasonal finance, the return is frequently quite disappointing.

RETURNS PER HECTARE FROM NEW POLICIES WITH OR WITHOUT IRRIGATION. CROPS, VEGETABLES, ETC.

Irrigation provides the opportunity to intensify land uses on most soil types locally, providing increased yields, increased product quality and much more certainty in terms of product volumes grown, thus allowing farmers to more readily meet the terms of company contracts. As well, the move into process crops, including peas, potatoes, carrots, sweetcorn, etc is only possible with irrigation available. There is also the opportunity to grow specialist vegetable seeds and other specialist pharmaceutical-type crops, although these are usually only available in small areas per farm, can have high gross returns, but high risks and a high level of skill required.

Most farmers moving into irrigation will achieve the best financial performance from intensifying their existing farm programme, rather than diversifying into more complex crops and seeds.

ECONOMICS

Although irrigation has many benefits, whether to irrigate or not is primarily an economic decision. The benefits of irrigation must increase income enough to cover the costs of development and provide an acceptable return on the additional investment for it to be sustainable.
Irrigation development will usually be quite profitable for an individual farmer, if carried out carefully and thoroughly, with proper appraisals of the project, effective planning and installation, and a moderately reliable standard of farm business expertise.

Designing and installing the irrigation system is one part of the project. Operating it effectively and profitably is another. Do not underestimate the changes you may need to make to your work and lifestyle. Most of the changes are positive, but some are ones that you may not wish to take at your time of life.

What is particularly important is that the margin between gross profit and farm working expenditure is great enough to service the additional debt. This includes the cost of:

- The irrigation development;
- Additional investment in plant, vehicles and equipment;
- Additional structural improvements on the farm (such as buildings, grain storage, etc);
- Seasonal finance (often very substantial);

After meeting these requirements, there should be a reasonable return for the additional level of skills, risk and commitment required from those involved.

Occasionally it may be necessary to have a major change in farm management programme to enable the ongoing cost of an irrigation development project to be profitable. Perhaps the best example of this is irrigation development of a traditional sheep and beef farm, where a major lift in gross margin (gross income less farm working expenses) will be necessary to make the venture profitable.
A change in livestock programme to, rearing of replacement dairy heifers, intensive bull beef farming business, or even conversion to dairy farming, may be necessary. It is usually quite rare for intensification of a sheep and beef farming system alone to be able to service the additional costs and debt of irrigation development, unless the development area is only part of the total farm business.
For example, store lambs may be transferred from the existing farm business or purchased from other farmers in the surrounding area to the irrigated part of the farm to finish them to very high carcass weights at premium prices. This finishing process may not have been previously possible on store hill country or lower fertility dry land farms.

In New Zealand, irrigation is supplemental to rainfall, and the higher the rainfall, the lower the marginal return for irrigation. Although reducing the risk of low yields is one of the main benefits of irrigation, economic risk, however, does not necessarily decrease with irrigation. Economic risk may be increased in the long term by the decision to irrigate. Irrigated farms are subject to higher cost, and the investment in irrigation may expose the farm to higher financial risks through higher debt. In addition, legislation may change affecting the cost of capital, access to water may change, and increases in energy costs may exceed the increase in product prices.
Each case must be considered on its merits. Qualified farm and financial advisors should be consulted to determine the economic feasibility of irrigation development.
Farmers should be enthusiastic about irrigation, it they are to achieve optimum results through irrigation.

The greatest difficulty being faced at present financially, is that funding is assessed on the basis of one generation of farmers paying all of these costs, when the benefits of the scheme on their farm will continue for perhaps 50 years or longer, and the benefits to the local districts and regions are very significant.

GLOBAL WARMING
If the scientist that supported global warming are right then the need for irrigation on the East Coast of the North Island will increase.

With water and the warmer temperatures the crops that can be grown in the region will change. Without water the dryland options will become more limited.

IRRIGATION BENEFITS TO A REGION

The whole region benefits from irrigation, not just the farmer/grower who use it because of the spin off from the extra production being achieved. There is benefits to many sectors of the community. A number of new businesses will be established and many others expanded. Farm servicing industry such as transport, fertiliser, irrigation servicing and new ventures will expand and the greater profits and higher population will impact on most businesses.

Frequently (and particularly in the early stages of development) the benefits of irrigation development will be greater for the local community (through the flow on effects of the additional goods and services traded and the increased production achieved), than to the individual farmers who needs to consider the long term benefits. Irrigation, nowadays, is not a "get rich quick" scheme.

Development that may be good for the district, may not in fact be good for the individual irrigation farmer.

For example

The Ashburton District (Plains only) – with some irrigation

- 25,500 people (10,750 rural and 14,750 urban)
- 250,000 ha
- 1,000 farm units
- 135,000 ha irrigated with a Gross Farm Income/ha $3,550
- 115,000 ha not irrigated wit a Gross Farm Income/ha $1,150

- 135,000 @ $3,550 GFI/ha	= 479,250,000
- 115,000 @ $1,150 GFI/ha	= 132,250,000
	= 612,500,000

Gain from irrigated land of 135,000 ha at $2,400 extra income per ha = 324 million more business activity.

Ashburton District without irrigation – There would be no dairy farms. There would be much reduced manufacturing base in Ashburton. Most manufacturing companies are based on agriculture or agriculture servicing and other manufacturing work has tended to develop from that. There would be no Five Star Beef Lot, no Canterbury Meat Packers processing works, no Talleys process vegetable factory, no South Pacific Seeds Company.

Likely to be only 425 farms grossing $333,000 per farm or $150 million for the district.

12,500 people, urban 8,500, rural 4,000

WHAT OPTIONS ARE OPEN TO YOU?

If you are convinced that the benefits of irrigation may be worthwhile, you should carefully consider the options available to you. Realistic options will be governed to a large extent by the following factors:

- Present financial position;
- Family circumstances;
- Present position in economic life cycle;
- Farm location
- Farm size
- Amount of water available (quantity and reliability);
- Soil types;
- Proximity to markets and services;
- Willingness to take risks;
- Whether progressive development is possible.

WAIRARAPA RAINFALL / IRRIGATION REQUIREMENT – ANNUAL NEED

	Average Daily soil moisture loss PET mm	Average daily rainfall mm	Average monthly soil moisture loss PET mm	Average monthly rainfall mm	Monthly surplus/ deficit rainfall mm –PET
Oct	2.2	2.5	68	77	+9
Nov	3.3	2	99	60	-39
Dec	3.7	1.5	115	49	-66
Jan	4	1.5	124	46	-78
Feb	3.4	1.7	95	48	-47
Mar	2.5	2.1	75	64	-11
April	1.2	1.6	37	50	+13
Total deficit until autumn rains – amount of effective irrigation water required					**232mm**

	Dry Year		Wet Year	
	Monthly rainfall mm	**Monthly deficit**	**Monthly rainfall mm**	**Monthly surplus/ deficit**
Oct	30	-47	90	+22
Nov	30	-69	80	-19
Dec	20	-95	65	-50
Jan	20	-104	75	-49
Feb	10	-85	75	-20
Mar	25	-50	80	+5
April	30	-7	100	+63
		457mm		**119mm**

Therefore in an average year to achieve potential pasture production you would need 232mm of water per hectare over the November to March period at 75% irrigation efficiency the total amount applied would be 309mm. In a dry 457mm would be required so 609mm would need to be applied. In a wet year 119mm would be required so 159mm would need to be applied.

With the different amount required between years (depending on rainfall and ET) it will alter the variable running costs per year. The water required in a wet year is just over 50% of an average year but is just and 200% above in a dry year. The variable costs are based on a daily charge for labour and electricity. Irrigated dairy farms generally require more water, more regularly and over a longer season.

EXPECTED PASTURE RESPONSE TO IRRIGATION – KG DM/HA/DAY

Old Trial results

	Winchmore – Canterbury *(25 year average, 1960-1985)*		**Rukahia -** Waikato	
	Per Day	**Per Month**	**Per Day**	**Per Month**
October	56	1736	6	186
November	53	1590	-8	-240
December	48	1488	19	589
January	45	1395	41	1271
February	39	1092	41	1148
March	37	1147	18	558
April	24	720	14	420
TOTAL Pasture Grown – October to April		**9168**		**3932**

WAIRARAPA PASTURE PRODUCTION FIGURES

	Taratahi Production Average			**Estimated Lost Production In a drought**	
	Per day	**Per month**	**SE**	**Kg DM Per day**	**Per month**
October	70	2170		-30	930
November	51	1740	10	-20	600
December	30	961	24	-21	650
January	15	465	18	-15	450
February	12	280	18	-11	300
March	21	690	24	-22	690
April	26	620	18	-19	560
Total Pasture Grown – Oct to April		**6934**			**-4480**

ESTIMATE WAIRARAPA IRRIGATION RESPONSE FOR STOCKPOL MODELLING

	Kg DM/ha/day	**Kg DM/ha/month**
November	14	420
December	30	930
January	35	1085
February	35	980
March	20	600
April	10	310
Irrigation Response – Oct to April		**4325**

PASTURE RESPONSE TO DIFFERENT IRRIGATION SYSTEMS –
Observations by Chris Lewis, Consultant, Baker and Associates

- Southern Cross/Gun system 30-35 kg DM/ha
- Rotorainer 35-45 kg DM/ha
- K line/long lateral 35-45 kg DM/ha
- Centre Pivot 45-60 kg DM/ha
- Unirrigated 0-25 kg DM/ha

CAPITAL REQUIRED FOR IRRIGATION

Irrigation involves a very high financial commitment, even when the water is readily available. Therefore before any form of irrigation is undertaken the land owner needs to ensure that they are prepared to fund the scheme and have access to the money needed.

Generally it will be important that the production increases achieved with irrigation are able to fund the set up and running costs of the scheme. Certainly of production /piece of mind can be very important to the farmer/grower but can be hard to put an economic figure on it.

Capital is required for

(a) Getting water to irrigation
1. well or pump from river/dam
2. community water scheme capital or annual charge of say $250-$300/ha

(b) On farm irrigation – depends on system used say $800 – $2500 per hectare capital cost

(c) Capital costs associated with changes to farming/horticulture policies eg. Stock (livestock or plants) plant and equipment, cashflow requirement

For example starting with a 180 hectare sheep and beef property

(a) Capital cost to convert to dairying

Conversion Costs – shed, fences etc	$1,011,600
Change in stock capital	$410,000
Irrigation	$225,000
Total capital required	$1,646,600
Or capital required per hectare	$9,147
Plus costs of dairy company shares $1150 kg MS @ $4.90 = $1,014,300	$5,635
Total capital cost per hectare	$12,771

(b) Sheep and beef property

	Extra sheep	**Extra Cattle**
Irrigation	$225,000	$225,000
Extra stock to fund lambs	$160,000	
Extra stock to fund cattle		$450,000
Capital cost with lambs	$385,000	
Capital cost with cattle		$675,000
Or capital required per hectare	$2,138	$3,750

Cropping

- May need capital input for specialist plant if needed, an irrigation system which will be in the medium to higher price range.

Horticulture/Viticulture

- Generally on much smaller block
- Can be very high capital costs to establish and considerable time delay before income comes in.
- Irrigation cost maybe much lower than other establishment costs.

LAND OWNERSHIP CONSIDERATION
Owners age, what children and level of current net income is likely to be a key factor in the desire to change farming systems or not. The owners vision for the future will be another important factor to be considered. Is the next generation likely to farm the property (or have a manager on) or will it be sold. How important is the need to be able to increase profitability in the future?

Future uses –
Without irrigation there is limited diversification available, ability to sub divide into lifestyle units.
With irrigation
- intensification of existing policies
- specialised livestock enterprise
- stock finishing
- dairying
- horticulture/viticulture crops
- production of feed for other farmers

Is there the desire to change farming system and undertake the necessary upskilling to run a profitable operation under irrigation. Is there scope to hire the necessary skills as happens with most diary conversions.

Would you be happy to sell the land once the irrigation water is available – get the capital gain from the extra land use options. Long term experience in east coast South Island, in group irrigation schemes, is that up to 70% of land owners (usually older farmers), will sell to farmers more interested in irrigation development, rather than involve themselves in more debt, more work and more demanding farm programme.

Taxable income – is there a desire to increase taxable income
Level of debt – can the property fund and service the capital required for irrigation
Years to retirement/semi retirement – is there motivation to work harder/smarter to make more profit.

IMPACT ON LAND VALUE – resale potential
Dairy land producing 400-500 more kgs of milk solids per ha would be expected to sell for $7600 more per ha (400 kg ms/ha x $19/kg ms)
A farm with irrigation is almost always higher (often quite considerable) than the original value of the farm plus the cost of irrigation and ancillary developments provided the project has been done properly.
Other irrigation schemes have had significant impact on the land values.
For viticulture in Martinborough the land values with a water source have gone up markedly – say $10,000 per hectare.
South Canterbury – maybe $3,000 per hectare with irrigation but this maybe similar to capital cost of irrigation.

LIFESTYLE BLOCKS – is irrigation an option for them?
Usually, lifestylers are less concerned about irrigation, particularly if it involves significant financial and time commitment.
- ➢ Unlikely to be intensifying into some livestock policies – would not pay unless very good at it.
- ➢ Is doing some horticulture/viticulture crop an option
- ➢ Can the block be leased out – livestock - cash crops/horticulture

Would expect the bulk of small block owners not to be interested in irrigation.
Most would need to upgrade equipment/facilities on the block to be able to efficiently utilise it.
Time required to irrigate and manage the block more intensively is unlikely to be compatible with lifestyle/other occupation, reason for owning block in the first place.
Potential economic uses for small blocks depend on what the soils are suitable for
- better soils intensive horticulture
- poorer soils grapes/olives/tree crops?

COST OF A DROUGHT

In the Wairarapa you can expect a very dry summer, say every five to ten years, which will have a big impact on the financial returns. This impact can be felt for at least two years but often more. The year of the drought and the following year when stock performance is likely to be well down and generally the stock wintered is likely to be 10 – 20% down the winter following and usually does not get back to the pre drought level until the third winter.

Example – 180ha – Sheep and Beef property, some Cropping

Static Situation

1371 ewes	111%	Lambing	$60 lamb price
555 hoggets	4.8kg	Wool @ $2.90	
20 rams	$900	2yr bull sales	
44 R2 bulls	$350	Weaner price	
45 R1 bulls	400	Lambs traded	
	$8,000	Net cropping income	
2174 stock units			
12.1 stock units per hectare			

Gross Income	$136,600
Farm expenses	$68,400
Cash farm surplus	**$68,200**

Drought Year

Gross income	$139,000	Lower lamb price	($- 3.40)
Farm expenses	$73,000	Lower cattle sale	($-50)
Cash farm surplus	**$66,000**	No lamb trading	
But includes $16,000 stock capital			

True cash farm surplus = $50,000. **Available for drawing / tax – assume debt free**

Year After Drought

Gross income	$101,000	Lambing % - 11%
Farm expenses	$71,000	Lower cattle weights
Cash farm surplus	**$30,000**	
But gone up $16,000 in capital stock		

True cash farm surplus = $46,000**. Available for drawing / tax – assume debt free**

Therefore the cost of the drought per farm

Year of drought	$18,200	($68,200 - $50,000)
Year after	$22,200	($68,200 - $46,000)
Cost of Drought	**$40,400**	

Average cost per year – 1 year to recover

Frequency	Amount	Cost/ha
5 year frequency	$8,080	$45
8 year frequency	$5,050	$28
10 year frequency	$4,040	$22

Normally farmers would take longer than the next winter to get back up to pre drought stocking rates.

If the recovery of stock numbers takes 2 years the cost of the drought is

Year of drought	$ 18,200
1st year after drought	$ 17,600
2nd year after drought	$ 9,800
Cost of drought	**$47,600**

Average cost per year – 2 years to recover

Frequency	Amount	Cost/ha/year
5 year frequency	$9,520	$53
8 year frequency	$5,950	$33
10 year frequency	$4,760	$26

IRRIGATION DEVELOPMENT – THE FIRST STEPS

Irrigation is not an insurance against drought. It is a change in farming practice that needs to be planned thoroughly, set up competently, and managed effectively and efficiently.

Before embarking on an irrigation development project, detailed budgets and cashflows should be prepared for the current "status quo" situation, the development period, and the fully developed farm, **but based on accurate input data, not guess work**.

This will involve an analysis of past financial performance on your current dryland property, and an accurate assessment of the likely benefits from the transition to irrigation farming.

This pre-development planning is extremely important because, if you get it wrong, proceeding with the project may undermine your farming future.

If, after carrying out a thorough assessment of the proposals, and having time to mull over the specific proposal and any other practical alternatives, you do not fell comfortable with the proposition, then **don't** proceed.

Check out the standard ratios, such as:

- debt/equity ratio
- farm working expenses as percentage of gross profit (FWE/GP)
- debt servicing as a percentage of gross profit
- debt servicing per stock unit
- debt servicing per kg milkfat

for both your past financial performance and your budget proposals.

These standard checks are quite well known nowadays, but should not be set in concrete – they are guidelines. One ratio on it's own does not usually provide the answer, but a series of standards can provide a strong lead to the prospects of success for your project.

Past financial performance analysis, and the characteristics that make up its components, are generally a better guide to future financial performance than are budgeted estimates.
Do a SWOT analysis on your current business.

Irrigation farming will not

1. Mean less work
2. Provide a low cost farming operation
3. Mean less pressure on good financial management

Irrigation farming will

1. Increase reliability of farm profits
2. Allow more intensive (and more profitable) farming activities
3. Provide more predicability and improved profitability, in the long term
4. Enhance farm values
5. Provide more satisfaction from farming
6. Provide advantages for extensive farming areas surrounding irrigation farms (through the demand for surplus livestock, source of feed, etc) and
7. Ensure the survival and further development of service industries in the district, by making farm production more reliable and constant, both on the input and output sides.

For the community as a whole, irrigation development will

1. Increase wealth – for everyone
2. Increase job opportunities
3. Productively use the renewable natural resources of the district, that is, water and electricity
4. Productively utilise the competitive advantages of the district
5. Ensure the growth of service industries and
6. Provide opportunities for conservation and enhancement of local resources.

Carried out, carefully, thoroughly, and efficiently, irrigation development will generally achieve better results than expected and for the farmer with enthusiasm and commitment, will probably out perform any other on-farm investment choices he may have.

SWOT ANALYSIS – Strengths, Weakness, Opportunities, Threats
Things to consider are:

Size of property	
Your lifestyle	- age - health - personal income and expenses
Your family	- leisure time - hobbies - time with family - education - holidays

Your objectives and goals

Soils - Fertility
- drainage
- suitability to current use
- fertilisers

Pasture production/pasture species

Contour - suitability for irrigation, what sort
- suitability for intensification

Climate - rainfall/reliability
- wind
- evapotranspiration
- temperature/sunshine

Improvements - buildings
- water
- sub division

Plant and equipment - do things yourself
- use contractors

Stock policies - production levels – per head – per hectare
- stocking rate
- breeding
- buying and selling
- lambing/calving percentage
- animal growth rate
- average carcass weight

Cropping policies - do it yourself versus contractors
- importance of it
- cropping options

Financial performance/accounts analysis - sheep and cattle income per stock unit
- cropping returns

Direction business is going, come from – sheep and cattle income per stock unit
- sheep and cattle income per effective hectare

Equity, borrowing, return on capital

Ownership structure
Off farm savings/investments

Look at each factor and consider it in light of its strengths, weakness, threats and opportunities to the overall business and personal/family life. (MRDC publication available to help you do this)
Do a SWOT analysis on your Proposed Irrigation Business.
With this information you are then in a position to make a more informed decision on whether or not you should proceed down the irrigation path.

ESTIMATED COST OF WATER

Although water is often considered to be "free" in New Zealand, there is always a cost involved in delivering water to a farm. This cost will reflect the financial value of the capital investment that has been made to obtain the water, the energy charges associated with delivering the water and the cost of maintaining supply.

Annual operating costs should be considered along with capital costs. Annual water charges on the recent private schemes range from around $50 per hectare up to $300 per hectare. These charges are usually a combination of debt servicing and charges for ongoing operation and maintenance. The proposed capital cost for the 3 areas being proposed in the Wairarapa have a capital cost around $5,250 to $7,600 per ha for the Opaki and Greytown/Carterton scheme and around $5,200 to $7,600 for the Martinborough scheme. The cost of servicing this capital would be say $600 per ha.

ESTIMATED COSTS OF THE ON FARM COMPONENT OF THE SYSTEM

The cost of the on-farm component of irrigation, not including the cost of obtaining a water supply, varies according to the size of property, the capacity of the irrigation system in terms of flow rates, irrigation return intervals, and the application method used. Generally there is a trade-off between the initial capital cost of a system and the annual operating costs, especially labour costs. Higher capital schemes tend to have low labour input and be more versatile, while lower capital schemes will be higher in labour demand and less flexible in their capabilities.

It is difficult to provide specific guidelines on system costs because the factors that determine costs vary so much. As a guide, capital costs can range from $800-1000 per hectare for systems such as K Line, which is relatively labour intensive, through to $10,000 per hectare for a fully automated subsurface drip system. Typically, travelling boom irrigator systems such as Roto-Rainers range from $1100-$1500 per hectare and centre pivots from $1300-$2500 per hectare. Irrigating small areas can push the capital investment for on-farm irrigation up to $3000 per hectare.

ANNUAL COST OF IRRIGATION

A. Water source (Community Scheme or Deep Well) per ha.

   Community Scheme – capital cost of say $6,000 per ha giving an interest and principal cost of $604 per ha (480 interest and 124 principal).
   Plus an annual running cost of community scheme say $125/ha

B. Irrigation system – on farm

   Say $1300 per hectare giving an interest and principal cost of $140 per ha (105 interest and 35 principal).

c. Annual running costs – on farm

   Is dependant on number of days irrigated, electricity used and labour requirement.

COST BENEFITS

Farmers must operate as businessmen, planning for a financial return on their total investment, rather than consider their business to have a premium in terms of lifestyle.
They should aim for a return on the total investment, rather than a capital gain in the value of their investment.

DAIRY CONVERSION – EXAMPLE

180 hectare sheep and beef property converted to dairying and irrigated.

Farm debt free
Market value $10,000 to $18,000 per hectare
180ha x $12,500 per ha = $2,250,000
Once converted production per cow = 360kg MS / cow
3.2 cows per ha
1150 kg MS / ha

Dairy Conversion Cost

	Per hectare	Per kg MS
Clean up farm	$50	$0.04
Cowshed / power / effluent	$2,770	$2.41
Houses (2)	$830	$0.72
Support building	$70	$0.06
Fencing	$75	$0.06
Tracks	$500	$0.43
Stock water	150	$0.13
Fertiliser	$250	$0.22
Seed & Cultivation	$170	$0.15
Supplement	$220	$0.19
Wages/Travel	$35	$0.03
Miscellaneous	$500	$0.44
TOTAL	**$5,620**	**$4.88**

Summary

180 hectares x $5,620 = $ 1,011,600
plus stock – 600 cows = $ 540,000

150 heifers = $ 70,000
less original stock = $ 200,000
Irrigation = $ 225,000
Sub total **= $1,646,600 or $9,147 per ha**
Dairy company shares = $1,014,300 or $5,635 per ha
Total borrowing required = $2,660,900 or $14,782 per ha

There are dairy company shares to buy – based on the production that is achieved. This could cost another 1150kg ms/ha x $4.90 = $5,635 /ha x 180 ha = $1,014,300

The shares would be required progressively as the production is achieved so the full amount maybe spread over say 3 years.

Market value once the property is doing 1150 kg ms/ha is around $22,425 per ha ($19.50 per kg ms)

$22,425/ha x 180ha	= 4,036,500	@16/kgms	= 3,312,000
plus dairy shares	1,014,300		1,014,300
Plus stock	610,000		610,000
	5,660,800		4,936,300
Minus debt	2,660,900		2,660,900
Net worth once farm Producing to expectation	**$2,999,900**		**$2,275,400**

Net worth before converting:

Freehold property 180 ha @ $12,500/ha	= 2,250,000
Stock	200,000

Net worth before converting $2,450,000

Dairy Income – on converted property – 180 ha

1150 kg ms / ha at + say 73,000 stock income $3.70 / kg ms

Income per hectare = $ 4,660

Expenses per hectare

Farm Working (55% income)	= $	2,560
Irrigation off farm		600
	= $	500
Total farm expense	= $	3,160
Surplus	= $	1,500

Surplus before borrowing tax and personal = $1500
For development and Shares

Loan to convert + shares		= $1487/ha	
@ $14,782 ha		= $1182	Interest (8%)
	plus	= $ 305	Principal (20 year loan)

STOCKPOL MODELLING

CURRENT PROFITABILITY – NON IRRIGATION – SHEEP, BEEF, CROPPING

The current gross farm income (GFI) for sheep and beef and cropping properties are likely to be in the range $720 to $1,200 per hectare net of replacement stock.

A MODEL FARM FOR THE WAIRARAPA PLAINS – This farm is likely to be running a mix of breeding ewes and cows and trading lambs and cattle. The trading stock will make up over 50% of stock units wintered. Winter stock units at 12 su/ha. Around 20% of the property will go into cash crops – barley and peas, and there is silage/baleage and hay made for sale. Some within year lamb trading is done.
This traditional farming system property will have the current GFI in the $720 to $900 range.
Farms with a much higher ratio of trading stock (over 80%) generally will have a much higher GFI and will range $1,000 to $1,300 per ha.

SHEEP, BEEF AND CROPPING FARM BUDGET – TRADITIONAL POLICY

Property size 250ha effective

Stock Wintered

Ewes	**890**	**120% lambing**	
Ewe hoggets	245	$62 lamb price	
Rams	12	$23 trading margin for winter hoggets	
Trading Hoggets	957		
Sheep Stock Units	1740	4.93kg wool/ssu at $3.00	
Breeding Cows	45	R1-R2 Bull trading margin	400
R1 Heifers	15		
R1 Steers	21	R1-R3 Bull trading margin	275
R1 Bulls	109	R3 Steer price 900	
R2 Steers	21		
R2 Bulls	59	Net Cropping income before regrassing $30,000	
Breeding Bulls	2		
Cattle Stock Units	1260		
Total SU	= 3000		
SU/eff ha	= 12		
Income	$200,000	($800/ha)	
Farm expenses	$88,000	Animal health	$10,000
		Fertiliser	$19,000
		Regrassing/green feed	$10,000
Cash Farm surplus	$113,000		

Debt servicing $19,000 Interest and Principal (on say 100,000 loan)

Capital Expenditure $5,000

Profit $88,000 available for personal drawings, tax, extra Principal and capital items

Gross income per Ha	**= $800/ha**
Farm expenses	**= $352/ha**
Profit before Personal drawings, tax and debt servicing And capital expenditure	**= $448/ha**

CURRENT PROFITABILITY- WITH IRRIGATION

For farms running the traditional policy but doing more stock trading within the year and more feed conservation for sale the GFI with irrigation increases to around **$1,300 per ha. This gives $300 to $580 increase in income from irrigation.**

Those farms running a high ratio of trading cattle plus cropping and conserving feed achieve GFI in the range $1,500 to $1,730 with irrigation. This is a $430 to $500 per hectare increase in gross income.

PROCESS CROPS – VEGETABLES

With irrigation there maybe scope to get a processor to set up a plant in the Wairarapa. They are likely to need at least 1000 plus hectares of crops to make it a viable option.

Current process crop margins – Rangitikei, Hawkes Bay/Heretaunga Plains

Green Beans	$400 - $1500/hectare
Sweetcorn	$600 - $1100/hectare
Peas	$350 - $850/hectare

Plus an annual ryegrass crop with lamb finishing earning another $400 - $500 per hectare.

Therefore total income per hectare ranging from $800 - $2000.

Specialist Seed Production

This can produce very high income per hectare (say $2000 plus) but at this stage there is only a very limited amount done in the Wairarapa by specialist growers. This maybe an industry that could expand with a community water scheme.

COMPARATIVE GROSS RETURNS PER HECTARE – ASHBURTON DISTRICT – CANTERBURY – DATA SUPPLIED BY BOB ENGELBRECHT

As a general guide, gross returns per hectare from irrigated land throughout Ashburton District is approximately three times that from the equivalent dry land. On individual farms, simply intensifying on an existing land use, gross returns per hectare are approximately times two. The difference comes from farms that have a major change in land use, say from dry land sheep to intensive dairying, where gross returns may increase perhaps up to times twenty.

DRYLAND

1. Dryland shallow soils sheep $ 450 to $ 600/ha
2. Dryland medium soils livestock/crop $1,000 to $2,500/ha

IRRIGATED

1. Irrigated shallow soils livestock/crop $1,200 to $9,000/ha
2. Irrigated shallow soils dairying $5,000 to $9,000/ha
3. Irrigated medium soils livestock/crop $1,500 to $4,000/ha
4. Irrigated medium soils dairying $5,000 to $10,000/ha
5. Maize silage $2,000 to $3,000/ha
6. Process peas $1,500 to $3,000/ha
7. Process potatoes $10,000to $12,000/ha
8. Berryfruits (blackcurrants) up to $12,000/ha
9. Vegetables up to $20,000/ha

UTILISING EXTRA DRY MATTER GROWN BY IRRIGATION WITH LAMBS – SAY AVERAGING 30KG LIVEWEIGHT

	Extra Kg DM available per day	**No lambs extra weight gain at 100gms/day**	**Liveweight gain/ha per day**	**Liveweight gain per ha per month**	**$ gain per ha per month @ $1.50/kg**
Nov	14	28	2.8	84	$126
Dec	30	60	6.0	184	$279
Jan	35	70	7.0	217	$325
Feb	35	70	7.0	196	$294
Mar	20	40	4	124	$186
				805kg LWG/ha	**$1210/ha**

UTILISING EXTRA FEED WITH EXTRA LAMBS (25kg) GROWING AT 200gms /DAY

	Extra kg DM available per ha/day	No extra lambs per ha 1.6kg DM demand per day	LWG per ha/day	LWG per ha/per month	$ gain per ha per month @ $1.50/kg LWG	$ gain per ha per month @ 1.25/kg LWG	LWG per head
Nov	14	8.75	1.75	52.5	79	66	6
Dec	30	18.75	3.75	116.25	174	145	6.2
Jan	35	21.87	4.37	135.6	203	169	6.2
Feb	35	21.87	4.37	122.5	184	153	5.6
Mar	20	12.5	2.5	77.5	116	97	6.2
				504kg	$756	$630	30kg/hd

If the 25kg lamb worth $1.85/kg	= $46.25
Holding cost = interest @ 40 cents / month x 2.0 months	= $ 0.8
Annual health	= $ 0.50
Total	= $ 1.30

Assumes very high utilisation of extra dry matter grown

Number of lambs on per ha – Taking them from 25 to 40kg liveweight

	Nov	Dec	Jan	Feb	Mar
Buy 1st month	8.75	10	11.87	10	2.5
Sell mid month			8.75	10	11.87
On end month	8.75	18.75	21.87	21.87	12.5

Using 100 ha for lambs – Stock, capital and variable costs per month

	Nov	Dec	Jan	Feb	Mar
No lambs	875	1875	2187	2187	1250
Total	$40,468	$86,718	$101,148	$101,148	$57,812

Costs – interest	320	680	800	800	450
Fertiliser	600	600	600	600	600
Animal Health	200	470	410	530	350
Losses 0.3%/month	150	340	390	390	220
TOTAL	1270	2090	2310	2320	1620

TOTAL Costs = $9,600

INCOME

100ha	X	$756	=	$75,600	Less costs	$9,600	=	$72,000
100ha	X	$630	=	$63,000	Less costs	$9,600	=	$59,300

Assumes very high utilisation of extra dry matter grown

The meat company or supplier contracts the grazier to carry the lamb. The more weight they put on them the more money they make. Unless they are on top quality feed the lamb growth rates can be quite disappointing at 150 grams/day.

CONVENTIONAL LAMB TRADING – NOVEMBER/DECEMBER
Purchase through November/December for an autumn kill can be quite risky and is often more dependent on the feed situation that the export market realisation. When there is feed there will be good premiums operating to attract stock into the works, and when feed is short there is a back-log of sellers wanting to get stock killed so a much lower need for any premiums to be paid by the works. Many traders have had lambs on for 2-6 months and only made a dollar a head or less. In other years there can be a $20.00 margin for the same period. More specialised finishers are now finishing for a fixed price per kg live weight gain. They are getting paid for how well they do them.

GROWING CALVES AT AN EXTRA O.5 KG LIVE WEIGHT GAIN (LWG) PER DAY REQUIRE
= 0.8 kg DM / head / day at 100 kg liveweight
= 0.9 kg DM / head / day at 150 kg liveweight
= 1.3 kg DM /head / day at 200 kg liveweight

Demand for 0.5kg LWG is 2.6 Kg DM at 100kg liveweight
Demand for 0.5kg LWG is 3.4 Kg DM at 150kg liveweight
Demand for 0.5kg LWG is 4.4 Kg DM at 200kg liveweight

	Extra kg DM available per ha per day	**No calves growing faster**	**Original no calves in irrigated situation**	**Grow faster 0.5 to 1.0 kg/day**	**Additional calves @ 1.0kg**	**Total on per ha**	**Extra kg LWG per ha per month**
Nov	14	17.5	22	17.5		22	262
Dec	30	35.0	12		8.8	20.8	273
Jan	35	39	5		7.8	12.6	242
Feb	35	27	3		6.1	9.1	172
Mar	20	15	7		3.5	10.5	109
							1058kg LWG/ha

1058 kg LWG @ $1.50 = $1,587 before costs

Assumes very high utilisation of extra dry matter grown

Often the price of weaner bulls does not increase much between a 100kg calf in early November and a 160kg calf in March. $30 to $50 for an extra 60kg in liveweight. Therefore LWG maybe only worth 75c per kg on them.

Utilising with 18 month bulls – 320kg liveweight 1st November doing 1kg/day

	Extra feed	Original No of bulls non irrigated	Carrying extra bulls @ 1kg/day LWG	Growing 0.25kg faster	Extra LWG per ha per month
Nov	14	7.2		7.2	54
Dec	30	3.9	3.3	4	133
Jan	35	2	4.4		136
Feb	35	1.3	4		112
Mar	20	2.7	2.4		74
					509kg extra LWG /ha

509 kg LWG @ $1.50 /kg = $ 763/ha
509 kg LWG @ $2.00 /kg = $1,018/ha

COST OF HOLDING ONTO CATTLE FOR LONGER

- Interest at $4.60 per head per month $ 80/ha
- Animal health $10 per head $ 40/ha

$120/ha

NET RETURNS
@ $1.50 per kg LWG = $763 - $120 = **$643/ha net**
@ $2.00 per kg LWG = $1,018 - $120 = **$898/ha net**

Assumes very high utilisation of extra dry matter grown

CATTLE TRADING
18 month cattle generally still have a good drive to grow over the November to April period, they can still achieve up to 1.25kg live weight per day depending on whether they are heifers, steers or bulls. Even cleaning up country they can be doing 0.5 to 1kg live weight per day over this period.
Calves and 2.5 year older cattle are a different story. The calf if not fed quality feed will perform quite badly – say 0.3kg live weight per day or less. The older cattle will often put very little weight on in late January to early March unless it was held tighter in the spring and was on top quality feed. It is easy to put 2kg per day on in the spring but much harder to put on 1kg per day in the summer.

WHAT IS THE WATER HOLDING CAPACITY OF THE SOIL?
Water holding capacity, also known as available soil moisture, is the amount of water stored in a soil that is available for plant use. It is the difference between field capacity (the maximum amount of water held by the soil against gravity) and permanent wilting point (the water held when the plant dies). For ease of making calculations, water holding capacity is usually expressed in millimetres rather than percentage soil moisture. It depends on soil type , percentage of stones, organic matter and crop root depth. Normally, this information may be obtained from soil maps or soils specialists. In the absence of more detailed information, use this table.

	Water Available (millimetres per 100mm of soil depth)	
Soil Class	Down to 300 mm	Below 300 mm
Sand	15	5
Loamy sand	18	11
Sandy loam	23	15
Fine sandy loam	22	15
Silt loam	22	15
Clay loam	18	11
Clay	17.5	11
Peat	20-25	>20-25

The depth of soil should be matched to the expected crop rooting depth at the time of maximum evapotranspiration.
So, if the soil type is a silt loam and the crop is pasture with a rooting depth of 500mm, the water holding capacity is:

$$\frac{300}{100} \times 22 + \frac{200}{100} \times 15 = 66\text{mm} + 30\text{mm} = 96\text{mm}$$

If a soil contains stones, the percentage of stones by volume should be estimated or measured and the water holding capacities reduced by that percentage. So if the above soil has 50% stones in the bottom 300mm, the water holding capacity in that zone is:

30mm x 50% = 15mm

The total water holding capacity then becomes:

66mm + 15mm = 81mm

HOW FAR CAN THE SOIL DRY OUT BEFORE THE CROP UNDERGOES STRESS?

As a pasture/crop uses water, the soil moisture will reduce to the point where the soil becomes dry enough to slow down growth. At this point, known as the stress point or critical deficit, the readily available soil moisture is used up and the crop goes into stress. Stress points change with the stage of growth and evapotranspiration. The hotter the day, the higher the soil moisture needs to be to prevent stress. Salinity also affects stress points. If local information is unavailable, use 50% of water holding capacity as the stress point.
So for the above stony silt loam, the stress point is 81mm x 50% = 40mm.
The critical deficit is 81mm – 40mm = 41mm
If production is less critical, higher stress points may be used. For example, where pasture is being irrigated on a beef farm, the soil could be allowed to dry out to 30% of available soil moisture, with the understanding that some production loss will occur.
The stress point then becomes 81mm x 30% = 24mm
The critical deficit is 81mm – 24mm = 57mm

HOW DOES EFFICIENCY CHANGE THE DEPTH OF WATER APPLIED?

For full production, it is insufficient to apply a net depth of water because irrigation systems are not 100% efficient, and some losses always occur.

The gross depth that should be applied = $\frac{\text{Net Depth} \times 100}{\text{Efficiency (\%)}}$ (mm)

The greatest difficulty with this calculation is knowing what efficiency to use. Rough figures to use are land shift and sideroll 75%, travelling gun 65% and centre pivot 80%.
For example, if centre pivots are being used, the above table suggests that the application efficiency is about 75-90%, say 80%.

So, the gross depth of water to apply in the example for the 50% stress point is:

$$\text{Gross depth} = \frac{41\text{mm} \times 100}{80} = 51\text{mm}$$

HOW MUCH WATER DOES THE CROP NEED DAILY WHEN DEMAND IS HIGHEST?

The best way to determine maximum daily crop water needs is to carry out a soil-water balance that takes daily rainfall, evapotranspiration and water holding capacity of the soil into account. This is usually computer modelled and is available for many regions in New Zealand from irrigation specialists or perhaps regional councils.

In the absence of this information, the 7 day average values of potential evapotranspiration that are exceeded not more than 20% of the time can be used. If high value crops are being irrigated, 10% should be used. To obtain the daily crop water demand, the potential ET should be multiplied by the crop factor.

Daily crop water demand = Average maximum daily ET x crop factor (usually 1.0)

Crop factors for some crops may be found in the following table.

Crop	Crop Factor
Pasture/seeds	1.0
Lucerne	1.2
Oats	1.0
Barley	1.0
Potatoes	1.0
Vegetables	1.0
Deciduous orchard	0.85
Citrus orchard	0.75

For example, the crop is pasture and has a crop factor of:

1. The average maximum daily ET is 4.5mm/d, obtained from local experts. So, the daily crop water demand is: = 4.5 mm/d x 1 = 4.5 mm/d

Note that rainfall has not been included in this calculation because in most areas, the probability of getting no rainfall for one return interval during peak demand months is very high.

WHAT SHOULD THE IRRIGATION RETURN INTERVAL (ROTATION LENGTH) BE?

This is how often a particular paddock or crop should be irrigated.

$$\text{Return interval} = \frac{\text{net depth applied}}{\text{Daily crop water demand}}$$

$$\text{Return interval} = \frac{39\text{ mm}}{4.5\text{mm/d}} = 9\text{ days}$$

Note that the return interval calculation is based on the net depth of water applied, not the gross depth.

In the example, the calculations have shown that about 50mm of water should be applied every 9 days.

WHAT SHOULD THE IRRIGATION SYSTEM CAPACITY BE?

Irrigation system capacity is a very useful measure that may be used to compare irrigation capacity between farms and between different regions. High rates indicate excess capacity and possibly unnecessary capital expense. Low rates indicated that crop production losses will probably occur.

$$\text{Irrigation system capacity} = \frac{\text{Average maximum daily demand} \times 11.6}{\text{Efficiency (\%)}} = \text{l/s/ha}$$

For example if you wish to apply 4.5mm/d, and are using a centre pivot irrigator with and estimated efficiency of 80% your irrigation system capacity is:

$$\underline{4.5\text{ mm/d} \times 11.6} = 0.65\text{ l/s/ha}$$

WHAT CROPS ARE TO BE GROWN?

This needs to be decided early in the process to determine when maximum water demand is likely to occur and to consider factors such as rooting depths.

For pastoral farms, maximum water demand usually occurs in January, and calculations for January will be sufficient. If a range of crops is being grown, it is necessary to carry out these steps for each crop for the months of maximum water use. This may occur in December or January, depending on crop rotations.

HOW MUCH WATER DO YOU NEED?

KEY FACTORS TO CONSIDER

The following factors should be taken into account when determining gross irrigation requirement:

- **CLIMATE**

Peak irrigation demand is primarily driven by the difference between effective rainfall and evapotranspiration (ET). ET depends on potential evapotranspiration (PET), crop type and soil moisture content. PET is the rate at which a crop will use water, assuming that it is not water limited (i.e. not under stress). If a soil dries out to the extent that the crop is under stress, actual ET becomes less than PET. The drier the soil, the lower the actual ET will be.

- **CROP TYPE(S)**

Crop type has a significant effect on peak and seasonal irrigation demand. Peak irrigation demand varies between crops.

Length of growing season, rainfall and ET are the primary determinants of the total volume of water required over a season. Pasture, for example, tends to have the highest seasonal water use because it has a long growing season. The mix of age and maturity of crops on a property has an effect on overall water demand.

- **SOIL PROPERTIES**

The main soil properties include water holding capacity, crop root depth, drainage characteristics and upward capillary flux from water tables below the root zone. The soil acts as a buffer in the system. Soils with high water holding capacities in the root zone can store and use more winter and seasonal rainfall, can go for longer periods between irrigation, and have the potential to store irrigation water more efficiently. In contrast, soils with low water holding capacities in the root zone require more frequent irrigation, and use irrigation and rainfall less efficiently. They use more irrigation water over a season, and typically require slightly higher peak rates because of the lower efficiency.

Differences in effective water holding capacity (essentially soil type) can cause large differences in irrigation demand in any region.

- **IRRIGATION METHOD**

The type of irrigation system dictates the potential for achieving a given level of water use efficiency. The choice of irrigation method is largely determined on cost and suitability to a particular farming situation.

- **IRRIGATION MANAGEMENT**

Irrigation management has a major effect on application efficiency, which changes with every irrigation application. Application efficiency is a measure of how much applied water is stored in the soil for crop use, and it depends on the design of the irrigation system and condition occurring at the time of irrigation.

Generally, irrigating when soil moisture deficits are as low as possible and not refilling the soil profile to field capacity (i.e. a little and often) results in higher application efficiency.

- **RISK**

In terms of risk, irrigation broadly falls into two categories.

The first category is supplemental irrigation, where irrigation is used as a form of insurance to cover the times when there is insufficient rain to maintain production at desired levels. In most years, some irrigation is beneficial; but in general, irrigation is not essential for a farm to be economically viable. Many of the irrigated dairy farms in the North Island fall into this category.

The second category includes farms where irrigation is essential to maintaining an economic unit. Without irrigation, the farming enterprises would not survive in their current form. Irrigation is no longer treated as insurance. It is a vital input to the farming system. Rainfall, when it occurs, is treated as a bonus, but the majority of the crop water demand is met from irrigation.

It is unrealistic and generally uneconomic to design and install irrigation systems that meet the absolute maximum demand for water. The exception is for very high value crops. Farmers normally compromise by having sufficient capacity to meet full demand most of the time, but accept that some of the time crops may be stressed. Farmers using irrigation as an insurance may well accept a higher risk of loss than those where irrigation is an integral part of the farming operation.

- **WATER SUPPLY RESTRICTIONS**

Water supply restrictions add to the risk. The important factor for farmers to know is how frequently and to what extent they could be restricted. They should be made aware of this before a system is designed and water allocated, or at the start of an irrigation season.

ESTIMATING WATER REQUIREMENTS

WATER QUANTITY

An approximation of how much water is needed can be calculated as follows:

$$\text{Flow rate (in m /h)} = \frac{10 \times A \times d}{H}$$

Where A = area irrigated in hectares
d = gross daily depth of water required in millimetres
H = number of hours of irrigation per day
M /h = cubic metres per hour

For example, a 100ha property may need a supply, based on 5mm per day, to meet ET requirements. If pumping will occur for an average of 23 hours per day, the flow rate required is:

$$\text{Flow rate} = \frac{10 \times 100 \times 5}{23}$$

= 217 m3/h (or 60 l/s, or 0.6 l/sha)

Any water requirements for frost protection, temperature control or leaching, if appropriate, must also be taken into account. Generally, frost protection requires much higher peak flow rates than irrigation.

WATER QUALITY

Water quality is important in evaluating a water supply. The two issues that need to be considered are, firstly, whether it is acceptable for specific methods of irrigation.

In general, water quality (particularly groundwater) in New Zealand is very good, but in some areas there are problems.

Whether water is acceptable for a specific irrigation method depends generally on the size of orifices that the water is required to pass through and the operating pressures in the system.

HOW MUCH WATER SHOULD BE APPLIED?

The net depth that should be applied = Field capacity – stress point (mm)

For the two examples above, the net depths are 41mm and 57mm respectively. Note that these values are equal to the critical deficit.

HOW MUCH WATER SHOULD YOU APPLY FOR?

Because of the way irrigation takes are defined, you should apply for the peak amount of water that you will need now or in the near future, but you need to justify the amount. The amount depends primarily on the area that you plan to irrigate and what you are going to use the water for.

WHAT PROPORTION OF THE PROPERTY TO IRRIGATE – ALL, 50%, 25%

When large scale individual farm development of irrigation commenced 30 to 35 years ago (excluding the Rangitata [RDR] Schemes), most farmers intended to irrigate perhaps 50% of their irrigateable area, gaining the complementary benefits to the balance of the farm. With very odd exceptions, once farmers recognised the gains they could achieve from irrigating the first half of the farm, they could not wait to irrigated the balance, as soon as they could manage that, financially.

Nowadays, most farm irrigation development programmes are based on total farm irrigation, even if this is undertaken in several stages. Therefore you should be planning to irrigate the whole farm area that can be irrigated.

LIKELY ANNUAL NEED FOR IRRIGATION – 1 OUT OF 5 YEARS, 3 OUT OF 5 YEARS, 5 OUT OF 5 YEARS?

For all of Ashburton District, irrigation would be used every season, the variation being in the number of hours of irrigation undertaken. Last season had a higher rainfall than average, particularly through the late spring/summer months (also associated with very overcast weather conditions), so many schemes operated for less than 1,000 hours of pumping.

In a very low rainfall irrigation season, some irrigators may pump for perhaps 3,500 hours, or even up to 4,500 hours. The average is probably between 2,000 to 2,500 hours, depending on soil type, rainfall, location and land use.

Irrigated dairy farms generally require more water, more regularly, and over a longer season.

Annual irrigation use, covering all farming types, may vary from less than 200mm in a low demand season to perhaps 650 or 700 mm in a very dry year.

SOIL TYPES AND NEED FOR RISK WITH IRRIGATION

In Ashburton District, there is approximately 5,000 hectares each year being developed, privately, mostly from underground water resources.

As the pressure on farmers to produce more and perform at a higher level, the rainfall/soil type under which irrigation development is worthwhile has moved progressively further and further up the Canterbury plains towards the foothills. Many farmers, with experience in irrigation, now see irrigation development as a preferred option to additional land purchasing, in order to reduce the risks of their business. It is difficult to see that this situation will change in the immediate future.

HOW MUCH WATER SHOULD YOUR SYSTEM BE ABLE TO APPLY AND HOW OFTEN?

To irrigate efficiently and sustainably, the irrigation system must be designed to be physically capable of meeting the needs that are identified. If a decision requires application of a given depth of water, the irrigation system must be physically capable of applying that depth. Likewise for efficient irrigation, applying a given depth of water requires that the crop can use most of the applied water.

The three main questions that need to be answered when designing an irrigation system are:

- What depth of water should the system be capable of applying?
- How often should this depth be able to be applied?
- At what rate can the water be applied?

The key requirements are to design a system that has the ability to match application depths to soil moisture deficits, to ensure that application rates do not exceed soil infiltration rates, and to apply water as uniformly as possible. These requirements have a significant effect on the capacity, on the efficiency of the system, productivity and its economic viability.

Alternatively, you may be eligible for a water allocation from a scheme at a specific rate based on the area irrigated.

SOIL AND CROP PARAMETERS

If you are going to determine system capacity based on soil and crop parameters, the general process is to:

- Decide on what crops are going to be irrigated;
- Determine the water holding capacity of the soil;
- Determine stress points;
- Calculate the net depth of water to be applied;
- Calculate the gross depth of water to be applied to account for losses;
- Calculate the maximum daily crop water demand;
- Calculate the return interval (rotation length);

IRRIGATION EFFICIENCY

Encompasses a number of factors such as:
Water use
Labour
Energy
Capital

Ideal is daily shifting rather than 12 hours. Irrigator not necessarily on for 24 hours.

Ensure soil can hold water for period of application. No point in putting more water on that just gets wasted above field capacity.

Don’t under design – designed on price rather than to do the job.

IRRIGATION TERMINOLOGY

Evapotranspiration (ET) - The total water lost by a cropped surface through the conversion of liquid water to water vapour. It includes water evaporated from the soil surface and the water transpired by crops.

Critical Deficit - The amount of water depleted from a soil at the point when crop growth slows due to moisture stress. The critical deficit depends on crop type, stage of growth and ET levels. The higher the ET levels on a particular day, the lower the allowable deficit.

Field Capacity (FC) - The amount of water held in a soil after it has been fully wet up and allowed to drain to the point where drainage becomes negligible. It is the upper limit of water available to plants.

Permanent Wilting Point (PWP) - The amount of moisture left in a soil when it has dried out to the extent that plants permanently wilt and die. It is normally defined as the water content at a soil water suction of 1500 kPa and indicates the lower limit of water available to plants.

Readily Available Water (RAW) - The amount of water held in a soil between Field Capacity and the Stress Point. It is the amount of water plants can use without undergoing stress or restricted growth.

Soil Moisture Holding Capacity (SMHC) - The same as water holding capacity.

Water Holding Capacity (WHC) - The amount of water held in a soil between Field Capacity and Permanent Wilting Point. It is the amount of water available for plant use.

Stress Point - The amount of water remaining in a soil at the point when crop growth slows due to moisture stress. The stress point depends on crop type, stage of growth and ET levels. The higher the ET levels on a particular day, the higher the stress point.