

Things You Should Know About Irrigation System Selection

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Introduction

Choosing the right system to irrigate dairy farms in the drier parts of the South Island is vital for two main reasons. The first is that efficient irrigation is essential for a highly productive and profitable enterprise. The second is that to maximise pasture production and from that, milk production, you need a system that you can be sure will perform to the high level required.

It is important to realise that irrigation is an integral part of the farming business. It is not an insurance to be used when things get dry, so getting it right is crucial to success. Consideration must be given to the circumstances in which the system must operate in terms of the physical, business and community environment and how those factors relate to the advantages and disadvantages of the various system types.

What do you want out of your irrigation system?

There are a number of broad requirements that dairy farmers usually want from an irrigation system. They are:

- Low capital cost
- A system that grows the maximum amount of quality grass
- Highly efficient water application
- Low energy cost
- Low labour
- Idiot proof - easy to operate
- Reliable with low maintenance
- Environmentally friendly - acceptable to the public

In selecting an irrigation system, it would be great if a system could be designed that met all of the above requirements. However, there is no perfect irrigation system. The choice of system always requires compromise. For example, there is usually a trade-off between labour and capital. At one end of the spectrum, a sub-surface drip system meets all of the above requirements except low capital cost. At the other end, wild flooding has low capital cost and low energy cost but would struggle to meet the other requirements.

With spray irrigation, there is often a trade-off between operating pressure, which affects capital and running costs, and application efficiency, which is a function of factors such as

application rates and wind effects. Guns, for example, have high operating costs and are more affected by wind but have low application rates. Low pressure booms have lower operating costs but high application rates, which can cause surface ponding and lower application efficiency.

Types of irrigation

Surface irrigation

There are three basic types of surface irrigation systems used in New Zealand. They are:

- Border-strip irrigation
- Contour irrigation
- Wild flooding

Of these options, border-strip irrigation is really the only feasible option for intensive pasture irrigation. The other two options could be used but they are unlikely to be able to provide the intensive and efficient watering required to maximise pasture quality and quantity.

Spray irrigation

There are many types of spray irrigation systems available. Most of them fall into the following categories:

- Hard-hose gun
- Travelling gun (soft hose)
- Fixed centre-pivot
- Movable centre-pivot
- Linear move (also known as lateral move)
- Rotating boom
- Linear boom
- Long lateral
- K Line
- Solid set impact sprinklers
- Solid set guns

All of these methods could be used for intensive pastoral irrigation, but there are definite advantages and disadvantages of each system type. I have not included older system types such as hand move, end-tow and sideroll systems as they are rarely used for systems where cattle can graze, but they could be used for short-term irrigation.

Trickle irrigation

Subsurface dripline is the only physically feasible option as other options involve placing easily damaged materials on the ground surface, which makes them totally unsuitable for areas that are grazed.

Key factors to consider

This section describes the key factors that should be considered when selecting an irrigation system. This list is by no means exhaustive and experts should be consulted for an appraisal of all factors.

Physical factors

There are many physical factors that should be taken into account. The most significant factors are described below. It is important to find out how each of these factors relates to your specific situation.

Affect of wind The biggest problem with irrigating in windy conditions is that the uniformity of water application of spray irrigation systems is seriously affected. Some areas will get too much water, while others will get too little. Wind can also blow some water away from the area that is being irrigated. Evaporation is also higher in windy conditions, but evaporation overall is usually a small component of total losses.

Systems that discharge water under high pressure into the air such as big guns are usually most affected. Systems that discharge water under low pressure close to the ground such as booms, centre-pivots using drop tubes, long laterals, K Lines or micro sprinkler systems are usually least affected. However, these low pressure systems can also have high application rates and infiltration rate problems. Surface irrigation or drip systems are not generally affected by wind.

Animals Some systems may be operated while animals are in the paddock. Care must be taken to ensure that animals entering a paddock are not thirsty as the animals may try to drink from the sprinklers and break them. This can be an issue with K-Lines. It is unwise to have animals in paddocks where centre-pivots or lateral moves are operating because they could sleep in the wheel tracks and get run over.

Catchup ability This is important where water supply restrictions are likely, particularly on river-fed systems or on systems with limited system capacity. Systems on long rotations such as travelling irrigators or rostered border-strip systems usually have poor catchup ability because when water comes back on it takes the length of the rotation (or half that time if machines are shifted twice daily) to get water back onto all paddocks. Systems such as on-demand border-

strip, fixed centre-pivots or other permanent systems have good catchup ability because they can be set to apply water to the full area quickly.

Energy source Although the energy source (electricity or diesel) is more of an economic issue, the location of an energy supply may influence the type of system used, if external energy is needed to drive a system. It may be better in some cases to choose a system that operates without additional energy requirements. If a gravity supply is available, system choice may be limited by the amount of pressure available.

Farm layout Farm layout is usually the biggest issue after price when selecting an irrigation system. Overall farm shape and fixed boundaries or obstacles such as power pylons can have a significant influence on system choice. Some irrigation systems cannot be used to efficiently water odd-shaped areas. It does not mean that these systems should not be used on irregularly shaped properties. They can be used to irrigate a large percentage of these properties and the areas left over irrigated with more flexible systems. However, it is usually better, if possible, to try to keep systems as simple as possible and only use multiple system types if absolutely necessary.

The golden rule for efficient irrigation is to design the farm around the irrigation system, not the other way around. This means if necessary taking out trees, shelter belts, fencing, moving buildings and so on, because you only do it once. Fast growing shelter trees can be replanted. Water races can be re-directed. Paddocks can be re-fenced and power lines can be moved.

Flood risk It is not unusual for areas prone to flooding to be irrigated. Where systems are mobile and can be moved to high ground, the danger of flooding is less of an issue. Where systems are fixed, they should be designed to be safe from flooding or be able to withstand short-term submergence.

Future flexibility Some irrigation systems such as subsurface drip, long laterals, solid set and K Line utilise mainlines that decrease in size as you move away from the water source because less water is carried to the ends of the system. This can reduce the cost of the mainline. Other systems such as travelling irrigators tend to carry the full flow to the extremes of the system and require larger mainlines. Be aware that if you have installed mainlines for systems such as long laterals or K Lines, it is a major reconstruction job to modify the system to suit travelling irrigators if you wish to change later.

Irrigation distribution uniformity Distribution uniformity, which is a measure of how uniformly water is applied to the soil by the irrigation system, affects the overall efficiency of the system. It depends on factors such as the type of sprinkler used, sprinkler height and spacing, operating pressure, application rate compared to the soil infiltration rate, prevailing wind and standard of maintenance.

Some systems have excellent uniformity in still conditions but are highly susceptible to wind effects. Often, irrigation systems with high uniformity also have high application rates, resulting in surface ponding. This leads to poor moisture distribution in the soil, and lower efficiency. Because of its complex nature, distribution uniformity is a topic best discussed with irrigation experts.

Shifting For a movable system, the ease of shifting, the time it takes to move and the skills needed to do it safely, are important issues. There is no point in buying an irrigation system if you are going to spend large parts of the day moving it. If the design of the system requires moving irrigators over long distances, serious thought needs to be given as to whether it is the best option. Moving irrigators over long distances is the biggest cause of damage and accidents.

Shelter Shelter belts are common on many farms to reduce evapotranspiration and to protect livestock from wind. They are usually very worthwhile for farms that use sprinkler irrigation systems because they help to reduce the effects of wind on sprinkler patterns maintaining better uniformity and reduced evaporation.

For fixed irrigation systems, shelter belts do not usually cause any problems. For movable systems, the way the irrigators cover an area often restricts where shelter can go. For example, on large centre-pivot systems, only low internal shelter or boundary shelter is possible. For boom irrigators, shelter must be in rectangular patterns because boom irrigators irrigate rectangular paddocks. Highly sheltered paddocks can make it very difficult to move large boom irrigators, movable centre-pivots or linear machines from one paddock to the next.

Soils

- ***Soil water holding capacity compared to application depth.***

The irrigation system should be able to apply water at depths that match the water holding capacity of the soil. Some irrigation systems can only apply a fixed depth of water, and if that depth exceeds typical available soil moisture deficits, inefficient irrigation will occur. Changing travel speeds or operating times is the usual way of changing application depths. In other cases, changing application depths may require changes such as replacing nozzles. If applying the correct amount requires significant effort such as shifting a movable irrigator twice daily, it will probably not be desirable because of labour demands.

- ***Soil infiltration rate compared to application rate***

Infiltration rate is the rate at which the soil can absorb water. Application rate is the rate (not to be confused with the depth) that the irrigation system applies water to the soil. Ideally, with sprinkler irrigation systems, water should not be applied to the soil at a rate that exceeds the soil infiltration rate. If it does, ponding of water on the surface will occur, causing water to move off the higher spots in a field into

the low spots. The low spots then end up with too much water and the high spots end up with too little water, leading to inefficient irrigation. Ponding on the surface also causes water to run down cracks and large pores in the soil and off sloping ground resulting in uneven watering.

- ***Impact damage***

The breakdown of soil particles at the soil surface is mainly relevant to high-volume sprinkler irrigation. This is caused by the impact of the irrigation water on the soil particles causing either movement of the particles or the breakdown of the soil into smaller particles. The heavier the crop cover, the less likely there will be a problem. High impact irrigation can cause soil sealing or wash material from cow races.

Topography Although most irrigated farms are on relatively flat ground, the ability to operate on sloping ground may be an issue. Factors to consider are the physical ability of the system to operate on sloping ground and the potential for runoff. Systems with low application rates or the ability to apply small depths of water are preferred. These tend to be permanent solid set systems, hard hose guns, centre-pivots or K Line. Travelling booms and winch-type guns operate better on more even grades.

Water supply The nature of the water supply affects system choice. The delivery schedule and quantity available may limit the type of system that can be used. Water supply reliability affects system capacity and the need for catchup ability. Water quality (chemical and/or suspended solids and sand) may also be significant, particularly for systems with small nozzles or drive or control systems containing small ports.

Economic factors

When selecting an irrigation system, the cost of the system is usually uppermost in farmers' minds. However, initial capital cost is only one of many economic factors to be considered. Some of these economic factors are described below.

Annualised costs This is the annual cost of paying for and operating the irrigation system. It should include the annualised cost of the initial investment and ongoing costs such as energy fixed and variable charges, maintenance, labour and any other item that is going to result in a cash outflow during the year. It is important that these costs are closely explored when comparing one system with another. Simply looking at up-front capital costs is not enough.

Capital investment This is the up-front cost of the system. It generally includes the cost of the water supply, wells, power reticulation, pumps, mainlines and irrigation equipment, including ancillary equipment such as tractors or motorbikes that may be needed as anchors or to move systems.

The initial capital cost of an irrigation system is usually substantial. Higher-cost systems tend to utilise modern technology to apply water more efficiently and also use automation to reduce the labour requirement. So, it is extremely important to consider both initial capital investment and on-going operating costs including the cost of energy, labour, repairs and maintenance before making a decision.

Efficiency Efficiency in terms of economic efficiency is primarily a function of the amount of production obtained versus the amount of water and energy used. Both water use and energy use depend primarily on how evenly water can be applied and how well the system is managed. Application efficiency, which is heavily influenced by distribution uniformity, is one of the key factors to consider. On systems with low application efficiency, you may have to apply significantly greater amounts of water to obtain a given level of production.

The most important aspect of irrigation efficiency is that systems that are poorly designed, with low application efficiency for example, will always be inefficient. Systems that are well designed at least have the potential to be operated efficiently.

Energy costs (fixed and variable) The energy input into irrigation systems in New Zealand normally refers to electricity required for pumping, although centre-pivot and lateral move irrigators also require an additional energy source for propulsion.

Be aware that fixed supply charges may be as much as the annual energy charges so there are advantages in minimising motor sizes to reduce both supply and energy charges.

Operating pressure can give you an indication of the cost of operation where pumping is involved. In general, the lower the operating pressure, the lower the energy cost. However, low pressure systems are not necessarily more efficient than other systems. Boom irrigators for example, or large centre-pivots can be fitted with low pressure spray nozzles but could then suffer from high application rates and lower application efficiency. It may be better to use sprinklers that operate at slightly higher pressure to obtain higher overall efficiency and trade that off against higher energy charges.

Gravity-fed systems - whether they are surface irrigation or spray irrigation systems - have zero energy requirements, but if water is applied inefficiently, the performance of the whole system will suffer.

Effective life Effective life of a system is partly related to reliability and partly to service availability. Irrigation systems usually last for many years. Low-cost systems generally do not last as long and may need replacement or major repairs after a few years, especially in harsh conditions.

Higher-cost systems may have a long life, but where they employ new technology, could become obsolete. This is particularly true for imported equipment, where spare parts may not be available after ten or fifteen years.

Financing and delivery How big of an issue this is depends on each individual's financial situation and development plans. Some people may have funds available but it is more common to borrow funds to finance the development. Perhaps the development can be spread over several years. Some systems can accommodate this approach, while others require the majority of capital investment in the first year. Perhaps the supply company can offer attractive financing or payment terms. Guarantees are another factor to consider. These may influence your decision.

Also important to consider is the time of delivery. You may be working to tight deadlines and one company may be able to offer better delivery arrangements than another.

Labour costs The labour required to operate irrigation systems varies enormously. Fully automated systems can reduce the labour required for daily operation of the system to a few minutes per day. However, automatically controlled systems cost more, and depending on the system, can have a significant labour requirement for maintenance. The capital cost of automation should be weighed against the labour cost including maintenance to obtain a comparative cost.

Remember to allow for the cost of supervision and management in your labour calculations.

Land value and availability Some systems are able to irrigate all of the land in a property, while others may not be able to do so. For example, hard hose guns can usually irrigate irregular areas while centre-pivots cannot. Hard-hose guns usually cost more to operate than centre-pivots and can be less efficient in windy areas. However, watering the corners of a centre-pivot area may require the installation of a much higher cost system. The additional production gained by watering these corners should be traded off against the cost of watering them. In some cases, it may not be economic to water these corner areas. Often, the decision is made on the basis of land value and availability.

Reliability and service All systems require repairs and maintenance, with some requiring more than others. As systems age, the money and time spent on repairs and maintenance increases, and may become a significant part of the total running costs of the system. In addition, breakdowns can result in serious loss of production, particularly if they occur at the peak of the season.

Before purchasing an irrigation system, find out how reliable the system is, how much maintenance is required, and how many years service can be expected from the system. Talk to existing users of equipment to find out about its reliability and whether service is available. Find out how much of the maintenance can be carried out by farm staff, without the need for trained service technicians.

Poor water quality due to sand, organic materials, precipitation of solids, and iron in the water can have a significant effect on system life and reliability. It is important that you choose system components appropriate to the quality of water.

Avoid irrigation companies that cannot commit to servicing systems within a few hours, or in more serious cases, a few days. Also, avoid companies that are not likely to be in the business for the long-term.

Social factors

Social factors are often ignored when selecting an irrigation system. However, they can have a significant impact on the success or failure of irrigation. Some of the social factors that should be taken into account when selecting an irrigation system are listed below.

General acceptance Some irrigation methods are not “politically” acceptable in some areas. It is prudent to find out what is acceptable and what is not. For example, border-strip irrigation is viewed by some water managers as inefficient even though when it is designed correctly, can achieve very good efficiencies. Public perception can be a strong influence, particularly in water-short areas. This can become an issue when applying for resource consents.

Health and safety issues . Although irrigation systems utilising clean water are not usually seen as a health issue, safety is extremely important. Some systems are large, and used incorrectly by untrained staff can pose a risk to operators or others. A common danger is the movement of large boom irrigators under power lines and extreme care must be taken to prevent irrigators touching lines. A potential problem also exists where irrigators with large jets spray water onto roadways or where wipeoff water from border-strip systems flood roadways. If these problems are likely to occur, it may be better to choose a different method of irrigation.

Labour skills When selecting an irrigation system, you should find out how much time and what skills will be needed to safely operate the system, and how much maintenance is likely to be needed.

Systems that need a high degree of skill to operate correctly should be viewed with caution, as getting reliable people to do the job can be difficult. If one skilled person is dedicated to operating the system, it may be acceptable. If general farm staff is required to do the shifting, it may not be such a good idea. You should find out whether suitable and reliable labour is available. In some areas of intensive irrigation, it is now possible to contract professional irrigation system operators to operate and maintain irrigation systems.

If reliable skilled labour is likely to be difficult to obtain, it may be worthwhile considering systems that can be automated to remove the labour requirement. A word of caution however. Highly automated systems are inherently more complex to maintain and you must make sure that suitable service and support is available.

Personal preference Even after you have done your homework, there may be insufficient difference between two systems or quotes to make it obvious about which system to choose. It may come down to personal preference, which companies or people you feel most comfortable dealing with or just plain gut feeling. Regardless of how advice is obtained, the final decision is yours and how you decide to make the final choice is your decision. But don't do what has happened in the past - buy a particular system just because you like the colour.

Potential for vandalism Vandals can create havoc with irrigation systems. Where vandalism may be a problem, it is wise to use vandal-proof technology and lockable control systems.

Resource Management Act (RMA) issues Usually, RMA issues are associated with obtaining a water supply. However, a requirement under the Act is that water is used efficiently and through its abstraction and use does not have unacceptable adverse effects on the environment.

Application efficiency, therefore, must be considered. As it can vary from one system to another, an understanding of its implications on obtaining consents is necessary. Other issues that may have to be taken into account now include the effect of irrigation on nitrates and bugs in groundwater. Experts should be consulted.

Comment on irrigation types more suited to dairy farming

Border-strip irrigation

Border-strip irrigation was the traditional method used on the majority of community irrigation schemes in New Zealand. Today, the number of new systems being installed is very low, partly because inadequate water supplies are available and partly because the cost of construction on uneven soils is costly.

Although the method is often considered to be an inefficient method of irrigation from a water-use perspective, with good design on suitable soils it can be as efficient as spray irrigation systems. The use of laser levelling has improved the efficiency of the newer systems and has been used with considerable success. Its low labour requirement, long life and simplicity make border-strip an attractive method of irrigation where pasture is grown and where an adequate gravity-fed water supply is available.

On the right farms, border-strip can be a low-medium cost method of irrigation.

Hard hose reel and gun

One of the biggest advantages of hard-hose reel type machines is the ease of shifting, which takes typically 15-30 minutes unless they have to be shifted long distances. They are also highly suitable for irrigating irregular areas. Because they apply water over a large circular area, average application rates tend to be low, which is an advantage. Pasture damage tends to be small and is mainly caused by towing out the gun carriage.

The biggest disadvantages are the poor distribution uniformity in windy conditions and the high operating costs because of the need to provide relatively high pressure. The poor uniformity in windy areas can be overcome to some extent by designing the system to operate at closer lane spacing than is usually recommended, and using low angle or adjustable angle guns. Intensive shelter can also help. Because they water a circular pattern, some areas may not be able to be watered unless adjacent areas are watered.

Care must be taken when operating the larger machines on soft wet ground, as they can become bogged and difficult to move. Large tractors may be required.

A more recent innovation with these machines is to replace the gun with a collapsible boom, which can be folded up during transportation. The boom can be operated at lower

pressures, is less affected by wind and can irrigate into corners. However, it removes some of the flexibility when irrigating irregular paddocks and takes a bit longer to move and set up.

Overall costs of setting up these systems tends to be medium-high.

Soft hose travelling gun

These types of machines have been widely used for many years. The two main drive systems are piston drive and turbine drive. Where pressure is at a premium, a piston drive machine is better because it requires less pressure to operate. These machines take longer to shift than the hard hose real machines because of the need to purge and roll up a hose, but because they are relatively small they are easy to manoeuvre. They also need an anchor for the wire rope.

As with all guns, they suffer from poor distribution in windy conditions, but tend to have low application rates. They should be operated as much as possible in calm or low-wind conditions and at appropriate lane spacing for the conditions. Often, the biggest problems with these irrigators are that they are operated on lane spacings that are too wide or at gun pressures that are too low.

Cost tends to be medium-high.

Fixed boom, soft hose

Fixed boom travelling irrigators are common throughout New Zealand, particularly on larger properties. These machines are usually driven by high-speed turbines, low-speed pelton wheels, or pistons. The independent drive systems provide more flexibility in terms of the range of depths that can be applied and the range of application devices that can be used.

Older systems were fitted with either low pressure spray nozzles, which suffered though excessive application rates, or medium pressure impact sprinklers, which required higher pressures to operate.

Generally, low pressure systems have the advantage of low operating costs, high uniformity and less effect by wind, but can experience problems with ponding and surface redistribution. Using higher pressure outlets such as impact sprinklers increases operating costs, decreases uniformity a little and increases the wind effects but because of the greater wetted footprint significantly decreases ponding and surface runoff. For this reason, Rotators and impact sprinklers are commonly seen on booms today as a compromise between performance and operating cost.

Travelling booms are ideal for irrigating rectangular paddocks because they can irrigate into the corners. They are best suited to areas that are not constrained by shelter belts or other obstructions. As with all soft hose machines, they require a winch anchor.

Costs tend to be middle of the range.

Rotary boom, soft hose

Rotary boom irrigators are currently the most widely used machines for irrigating pasture on dairy farms. They are simple in construction, generally very reliable with good performance, and are extremely well accepted.

Because they water a large circular area, average application rates are low, with very little ponding occurring. Uniformity is reasonably good in calm conditions provided that machines are nozzled correctly and operated at recommended pressures. Because water is carried to the ends of the boom, the water distribution pattern is much less affected by wind than with guns.

The rotation speed of the boom and therefore the travel speed can slow down in strong winds resulting in more water being applied than perhaps needed and also causing the system not reaching the end of the run when expected. Independent drives can be fitted to these machines to eliminate this problem, but that increases complexity, cost and required hydrant pressure.

Although there is some scope for changing application depths by changing travel speeds, they are less flexible than machines with independent drives because they will not operate at low flows and are generally not used where small depths of water are required. They do not water into corners unless overshoot into adjacent areas is allowed and the impact of the end jets on the ground can cause minor problems if spraying onto races.

These machines take longer to shift than guns because of the need to purge and roll up a hose, and the need to manoeuvre a large boom. They also need an anchor for the wire rope.

Cost is usually slightly lower than the fixed booms with soft hose.

Linear move (lateral move), end fed, soft hose

The biggest advantage of these machines is their high distribution uniformity and their ability to apply a wide range of depths. Although application rate can be a problem if applying large depths of water, ponding and surface redistribution can be minimised by applying small depths of water more often.

A wide range of sprinkler types can be fitted to them ranging from LEPA (low energy precision applicators), low pressure spray jets through to large impact sprinklers. However, the preferred choice of sprinklers currently are low pressure plastic sprinklers or medium pressure impact sprinklers.

Because sprinklers tend to be quite closely spaced, linear systems are not greatly affected by wind.

Farm shape must suit these machines to make them effective, with long rectangular areas without obstacles being best. They are not suitable for small irregular areas. Shifting only requires moving the hose except where end-towing or rotation is needed to move to another block. Drive systems are usually independent, with diesel motors mounted on the machines being most common.

Despite all their advantages, they are rarely used on dairy farms because of the frequent need to run cows over the hose and because of the difficulty in maintaining alignment or guidance systems. Recent developments could alleviate or eliminate guidance system problems.

Fixed centre-pivot

As with lateral move irrigators, the greater emphasis being placed on irrigation uniformity and the need to apply variable applications has increased the popularity of centre-pivots, particularly on dairy farms. Fixed centre-pivots also have one other major attraction and that is a very low labour requirement. Most of the operational time is spent on routine maintenance, as operation is very simple.

Generally, centre-pivots have very high application uniformity and the ability to apply a wide range of depths. Application rates are very low at the centre of the pivot, and increase with distance from the centre. On very long systems, sprinkler flow rates and therefore application rates at the ends can be very high because of the large area watered by the end span. This can create problems with ponding and surface redistribution, which can be minimised by applying small depths of water more often. The control systems of centre-pivots allow enormous flexibility such as changing application depths over the full circle or in different sectors simply by programming in requirements.

A wide range of sprinkler types can be fitted to them ranging from LEPA systems, low pressure spray jets through to large impact sprinklers. However, the preferred choice of sprinkler is now Rotators or similar low pressure plastic sprinklers, which have excellent uniformity and reliability with an acceptable application rate.

Because sprinklers tend to be quite closely spaced, these systems are not greatly affected by wind.

Farm shape must suit these machines to obtain good overall coverage. Square or circular areas with no obstacles are best. They can be used on flat or rolling country at slopes that most other irrigation systems cannot operate on, but they are not suitable for small irregular areas. Although corners are not watered, sector operated end-guns or controllable corner towers can be used to cover most of the corners. Generally, they are fed directly from the centre, so damage to crops is limited to wheel tracks every 50 metres or so. Drive systems are usually independent, with underground electric cable or diesel motors being most common.

On larger systems, the cost per hectare irrigated is low, making them extremely cost-effective. On small systems however, fixed centre-pivots can be costly.

Towable centre-pivot

These systems have most of the advantages and disadvantages of fixed centre-pivots.

They are often more cost-effective than fixed centre-pivots because the same machine is used to cover a number of positions. Because they are moved, they tend to be smaller than fixed units. Generally, hydrants are placed at centre positions, so very short flexible hoses are used. Moving is achieved by jacking up and rotating the wheels to allow end-towing.

Because they are smaller, farm shape is less critical than with fixed pivots, but again square or circular areas with no obstacles are best. Sector operated end-guns are used to extend watering into the corners. Drive systems are usually independent, with diesel motors being most common. Some systems have permanently installed underground electric cable, which is the most convenient.

Because they are moved, maintenance tends to be higher. Purchasers of these systems must ensure that they are designed for regular towing.

K Line, small impact sprinklers

K Line systems are a relatively new development in irrigation in New Zealand, and their use has expanded rapidly over the last two years. Their biggest advantage is their low cost compared to other systems. This allows farmers to get into irrigation at relatively low cost. In addition, they are simple and can be installed and maintained by farmers.

Because small sprinklers are used, application rates tend to be very low, with ponding and surface redistribution being almost non-existent. Provided appropriate pressure control is employed, this low application rate makes them suitable for operation on most soils and on rolling country at slopes exceeding that acceptable for most other irrigation system types (provided that they can still be moved).

One of the objectives of K Line systems is to have them operate 24 hours per day if required and move them once daily. Under this situation, they apply 50 – 80 mm of water or more, so soils must be able to accommodate these depths. This also means that rotation times tend to be longer than other systems reducing their catchup ability. To keep application rates and depths as low as possible, sprinkler spacing are generally wider than standard manufacturers' recommendations, resulting in average to low uniformity. However, the low uniformity is counterbalanced by good absorption of water into the soil.

They are best used for irrigating pasture, and can be moved with a large four wheeled motor bike but are labour intensive. Shifting time is significant and depends on the number of K Lines on the property.

The performance of these systems over the long term is unknown, although generally, good results have been obtained in most areas over the last year or two. Small sprinkler nozzles make them more susceptible to blockages, and small plastic sprinklers running continuously increase maintenance requirements.

Long lateral, impact sprinklers

Although long lateral systems have had a major upsurge in use in some areas over recent years, similar systems have been used for several decades. Recent refinements include sprinklers on movable skids and flexible polythene hose.

They are a medium cost system and are quite widely used as the only means of irrigation on many dairy farms in the North Island. They are less common in the South Island because of the large number of sprinklers that would be needed on the larger farms and tend to be used to fill in odd-shaped areas and corners on farms that are not easily irrigated by other means.

Because sprinklers are operated in isolation, application rates are low and ponding or surface redistribution tends to be small. This makes them suitable for a wide range of soil types.

To obtain good uniformity, sprinklers should be moved in a regular pattern. Performance is directly affected by where sprinklers are moved, and unfortunately, complacency in this respect is common. Shifting time is one of the biggest disadvantages of this system, with the larger systems taking several hours to move.

Many long lateral systems have been designed to operate for only 8-10 hours per day. This is partly for convenience, partly to meet design requirements, partly to utilise night rate electricity, and sometimes related to available water supply. This approach is not recommended for South Island irrigation of dairy farms because it requires much bigger system components, pumps, pipes, and higher cost etc than would be needed for a system that operates for 20-24 hours per day.

Conclusions

It should be evident from the issues described in this paper that the choice of an irrigation system is not a simple matter. There are a few key messages that you need to keep in mind:

- There is no perfect irrigation system - all have advantages and disadvantages
- Many factors (physical, economic and social) need to be considered when choosing a system

- There is not necessarily a “best” choice for a particular property
- Choice depends on individual farm circumstances
- Compromise is always needed
- Consider all costs, not just up-front capital costs
- Do your homework
- Consult an independent expert if you need help

Workshop summary

When considering irrigation systems, it always involves compromise. Design the farm around the irrigation system.

Consider capital cost versus operating cost. Also consider that fixed costs have a huge bearing on annual costs.

In terms of interval of application, little and often is the key. Three days is too short due to loss of oxygen in the soil. Six days is ideal.

Irrigation type	Advantages	Disadvantages
Border dyke	Low labour Medium cost Low maintenance	Efficiency low Return interval up to 24 days
Centre pivot (fixed)	Low labour \$1200/ha for large, defined as 800m+ long Up to \$2000/ha for medium - 400-500m long Uniform application Not affected by wind	Problems with high application rates at pivot's end More complicated to maintain because of costly electronics
Towable centre point Hard hose gun	Higher water application Low labour Easy to use	More labour High pressure Affected badly by wind
K Line	Low initial capital cost <\$1000/ha (for system and main lines) Easy maintenance Good on slopes Gentle irrigation Good for heavy soils	Not necessarily low maintenance Higher labour (50ha/hr)
Rotary Boom	Lower labour (120ha/hr) Medium application efficiency Medium cost	Low pressure Slow down in the wind - may not reach the end of the run