Irrigation and Intensive Large-Scale Crop Management

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ABSTRACT

This paper considers the issues that have instigated changes in the management of intensive irrigated cropping systems, and discusses the relevant outcomes from these changes and the tools that are used by agronomic managers to facilitate these changes.

Systems that are discussed include, soil moisture monitoring, irrigation system developments and the use of GIS systems in planning and development.

KEYWORDS

Irrigation, change, centre pivot, micro-irrigation, GIS.

INTRODUCTION

The purpose of this paper and its associated presentation is to give some insight into some of the developments that have occurred in the implementation of practical intensive large-scale irrigated crop management in recent times.

In developing a structure for this paper it was decided to prepare a document which formed a background to the conference presentation rather than the presentation just summarising the document. It is important to note that this document is not intended to be a definitive paper outlining a number of trials and then reviewing the results, but sets out to be a narrative of how practitioners involved in commercial irrigated crop management are using new technologies in changing circumstances.

Some level of licence has been taken with regard to the title of the paper, in that areas such as intensive irrigated dairy production have been included. The focus of the paper is primarily towards irrigated enterprises.

THE DRIVERS OF CHANGE

Change in the agricultural sector is generally driven by two main factors

- Sustainability (Financial, Personal and Environmental)
- Regulation (local, national and international)

Irrigated crop management is no different, with the key areas of change being strongly driven by these factors.

The changes and their relevance to intensive irrigated cropping can be summarised as below.

Sustainability

Financial

This is the need for the business objectives of the farming operation to be met. This encompasses things such as suitable crops, land, location, available capital, management and operational systems to allow for satisfactory return on investment, growth etc. One of the most notable factors with respect to Irrigation development in particular has been the increasing willingness to expend capital at the commencement of a project to minimise the running costs during the life of the project, especially with respect to labour inputs.

Personal

This is the need for the business objectives to be met without being at the cost of personal objectives. The intense seasonal nature of irrigated cropping ventures ensures that this is one of the hardest areas to manage as a sustainable situation.

Environmental

This encompasses the two previous points to an extent in that most farming operations in setting their financial and personal objectives review environmental sustainability, however it does stand alone as a driver of change.

Regulation

Local/Regional

The changes in management of soil, water and human resources by local authorities are, on a daily basis affecting the decision made in the implementation and management of irrigated cropping operations. The prime examples being, the regulation of streams, management of soil erosion and “right to farm” issues.

National

In a very similar fashion national regulations are now affecting decision making processes. The key difference being that issues that may not be seen as relevant on a regional basis are now being enforced on a national basis, thus enforcing change in operation. This is particularly so with respect to Catchment Management issues with the COAG outcomes being a prime example.

International

International treaties, agreements and conventions now impact on the management of farming operations. Once again this seems prevalent when the issue of water resource management comes under consideration. The Conservation of wetlands, eg under the Ramsar Convention, is a prime example.

It should be noted that these issues are not being considered here as negatives, but simply the drivers of change, with in most cases the changes being warranted.

THE OUTCOMES OF CHANGE

One of the key outcomes has been the realisation of the need to manage the resources available to farming operations in a more suitable manner, with the intended result being improved profitability and sustainability.

In the consideration of intensive irrigated cropping operations, the relevant areas are as follows:

- Managing irrigation to maximise relevant crop water usage and minimise water losses through evaporation, run off and drainage.
- Managing irrigation to minimise problems with plant health brought on via water logging and poor soil condition.
- Managing soils to maintain soil structure and nutrition.
- Managing human resources to maintain/develop satisfactory and sustainable lifestyles.

Where to from here?

In the past few years technology has provided many systems for use by farming operations involved in irrigated cropping. Many of these have provided wonderful features but have been limited with regard to the benefits provided to the user. This situation has accelerated with the introduction of computer based systems.

With the increasing sophistication of systems being offered for use in agriculture it is becoming very difficult for those involved in the management of irrigated enterprises to have the time to adequately critique the relevance and practicality of what is on offer.

The next section of this paper attempts to consider some of the systems that are having increasing relevance in the management of intensive irrigated cropping enterprises.

THE TOOLS AVAILABLE

In simple terms the systems available for use can be broken down into 3 categories

- Management/Planning Systems
- Operational Systems
- Monitoring Systems

Within these there are some key areas that are providing practical benefits.

Management/Planning Systems

GIS (Geographic Information Systems)

GIS provides benefits in two particular areas as follows.

The development of accurate farm mapping systems using GPS (Global Positioning Systems) technology and Remote sensing data. This data may include Satellite imagery and EM surveys (electro-magnetic measures of conductivity). These farm maps are generally based around -rectified aerial photography and use a GIS management system such as ARC Info or Map Info as a platform. This allows anyone involved in the planning or development of a farming unit to consider all the relevant developments within an accurate spatial framework. A practical example is the set out of new vineyard and centre pivot Irrigation developments with respect to relevant soil types, topography, existing vegetation and areas of environmental significance. The input of all these relevant field assessed parameters into a GIS can allow much of the planning to be done in a desktop situation before final ground truthing. Such a process allows more accessible peer review, which should provide a more secure and sustainable outcome.

Farm management software, which interfaces with the farm maps to allow farm inputs, labour and machinery operations and environmental data to be recorded and historically analysed. These systems are becoming more readily available. The key issue with any such system is that the interface between an accurately generated farm map and the management software should be seamless and simple. Experience to date has shown that historical data matched to farm maps can provide excellent decision support systems where annual or rotational cropping systems are involved. These systems are also very valuable in managing perennial crops such as vineyards where yield/quality outcomes need to be referenced to different cultural practices and weather conditions.

Irrigation Control Systems

The systems have undergone immense development in recent years and now allow the simple and accurate timing of irrigation events. The level of control includes the ability to “pulse” irrigation events to meet the needs of soils that have less than desirable infiltration rates, thus minimising run off. It is however impossible to adequately program such a system without sufficient input information. The control system requires information developed within the initial GIS and information gained from the relevant monitoring systems. Essentially given the right level of planning and implementation, it is now possible to control all pressurised and most surface irrigation systems to a level that allows the maximum uptake of irrigation water. These systems now utilise areas such as telemetry for signal transmission and can therefore be retro-fitted with minimal field disturbance. There have been attempts to utilise fully automated systems where a level of intelligence is applied to the control system such that changes in irrigation timing are made by the control system. It is the very strong view of the author that the determination of the irrigation schedule should be made via human intervention such that all the agronomic and relevant environmental issues can be considered.

Operational Systems

Irrigation Supply Systems

The most notable Developments in Irrigation systems have occurred in the following areas.

Drip Irrigation Emitters

This has been a key area of development in that the industry (in Australia) now has an extensive range of reliable and effective drip emitters available at costs which are a fraction of those experienced 10 years ago. This has been brought about by the developments in plastic extrusion technology and the corresponding increase in Australian based manufacturing facilities. The particular improvement has been in the development of cost effective in-line drip tube, which is becoming more widely used in row cropping, in the form of temporary and permanent sub surface drip irrigation systems.

Micro-sprinkler Technology

In a similar fashion to drip emitters, micro-sprinkler technology has provided some excellent quality sprinklers with high reliability, low cost and excellent distribution uniformity. Much of the work involved in this development has been based around centre pivot systems and the need to develop sprinklers/sprays to manage relatively high instantaneous application rates. Retrieval management systems to allow simple and practical use of micro-sprinkler systems for annual crops are becoming more readily available, which will see an increase in the use of these systems for high value row crops.

Filtration Systems

When drip/trickle systems were first introduced, filtration systems tended to be one of the most troublesome areas of operation. It is safe now to say that it is a very reasonable expectation for the filtration system installed with any drip irrigation system to provide reliable and adequate filtration, regardless of the type of system being used, *ie*. media (sand/gravel), screen or disk.

Centre Pivot Irrigation Systems

These systems have significantly increased in numbers over the past 5 years. A good example is Tasmania where 7 years ago there was not a single centre pivot irrigation system in the state. There are now over 150 systems with a further 20 to 30 expected to be installed in the next 9 months. The structural nature of these systems have not changed very much in recent years, and whilst there have been developments in computer management systems there are concerns that mechanised systems such as these which are essentially broad acre low cost irrigation systems, should be based around simplicity and reliability. The main area of development has been the application technology. The sprinkler and spray systems developed in recent years have allowed low pressure (70 to 100kpa emitter pressure) to be used whilst dealing with the relatively high instantaneous application rates that occur towards the outside of the radius of the machines. One of the key improvements has been the development of low cost pressure regulation. This ensures that uniform application occurs throughout the system even (in most cases) in the event of operator error.

System Design

There is no doubt that the work done in Australia by the IAA (irrigation Association of Australia) in the development of the Certified Irrigation Designers program (CID) has lead to a general improvement in the adoption of suitable irrigation system design. Developers of new systems should be insisting that system designers have a CID certification as a minimum requirement.

Monitoring Systems

Environmental Monitoring

Weather

The use of farm weather stations has become far more prevalent, particularly as the systems have become more user friendly and sustainable in their operation. It is now possible to have systems linked by telemetry network throughout the country with the information continuously collected and available on an effective real time basis. These systems now incorporate models for things such as reference evapotranspiration, powdery and downy mildew infection periods and light brown apple moth flights.

Soil Moisture Monitoring

This is a very strong area of development in Australia with many products produced in this country being world leading technology.

The most widely used systems tend to be neutron probe, capacitance based systems and gypsum block systems.

Much of the new development has occurred in the use of capacitance based systems which measure the soil and water dielectric. The main types of systems offer continuous monitoring with remote communication and downloading being available via telemetry networks.

The inherent nature of the systems allows a soil moisture profile through the root zone to be viewed, with discrete sections of 100mm being monitored by the sensors, via a 50mm access tube carefully inserted into the profile.

Water level, flow and quality

The development of farm based weather stations has simplified the collection of further relevant parameters such as water levels in streams and dams along with flow in streams and pipes. Quality issues such as dissolved oxygen and turbidity can also be monitored via the systems.

Plant Nutrition/Health Monitoring

One of the fundamental processes in managing intensive large-scale irrigated enterprises is the maintenance of suitable nutritional levels. An issue with this process in general has been the time lag in obtaining the test results necessary to make decisions that can have some relevance.

Complete sap analysis (wet analysis) has been used for some time in vegetable production (particularly in potatoes) as a tool to support agronomic decision making. In most cases the results for these tests can be provided from the testing laboratory within a maximum of 48hrs after sampling. This process is gaining increasing favour for perennial crops such as vines, as it provides the managing agronomist with a quick result to support other agronomic observations. Proponents of sap testing processes emphasise that the system is one tool in the overall agronomic assessment process and should not be seen as a stand alone diagnostic tool.

Yield Monitoring

Yield monitoring has been around for some time. Methods for monitoring are now becoming more readily available and usable for a number of crops. The important development is the increasing use of farm management software which can be interfaced with the yield management hardware such that simple retrieval and management of data can be achieved. In the past this process could be quite cumbersome with the outcome being that most yield monitoring systems installed in the middle part of the 90’s were rarely utilised in practice.