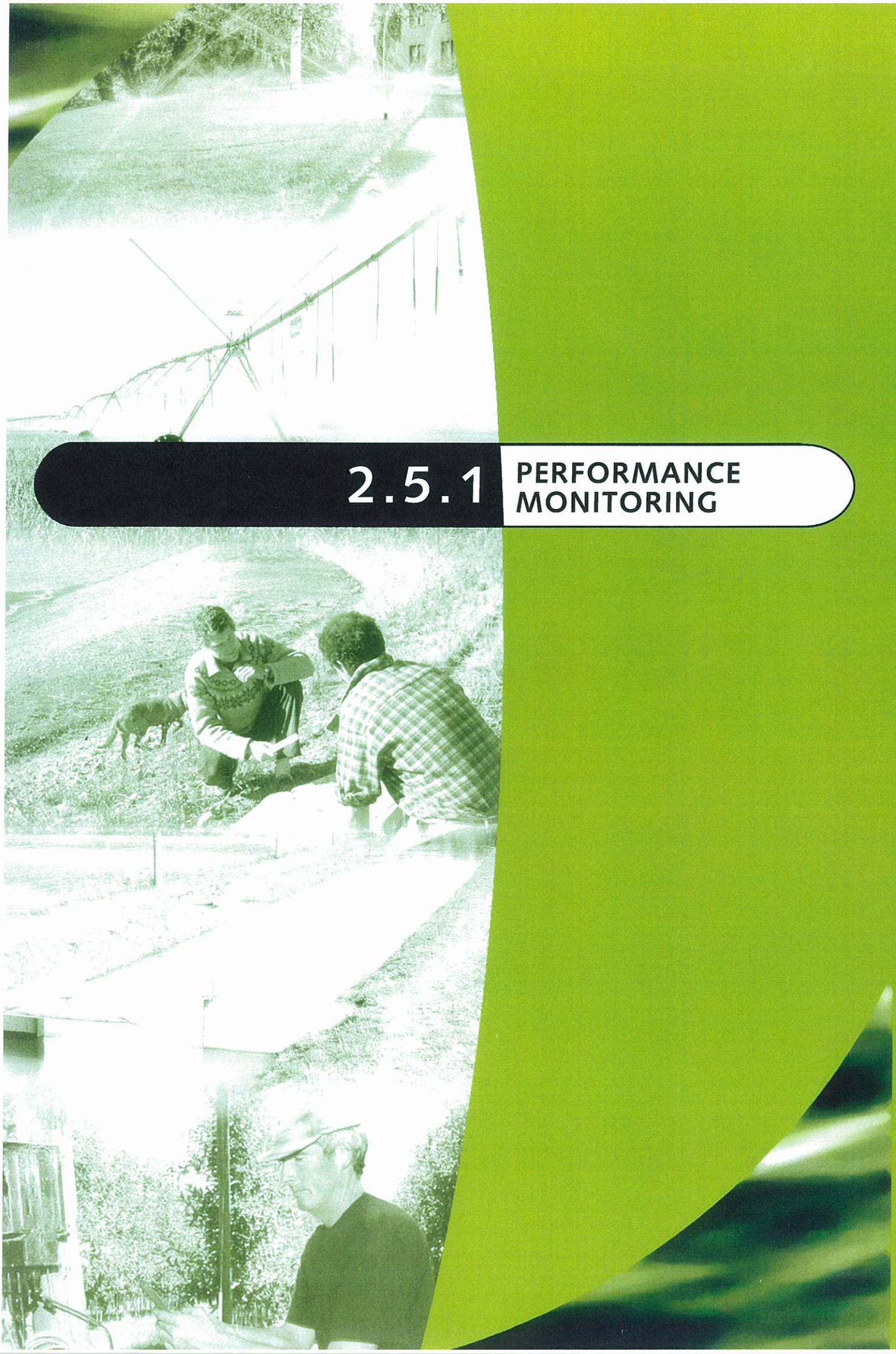

2.5.1 PERFORMANCE MONITORING

What are performance indicators?

To maintain the future viability of farming, farmers must be able to make a net profit over the long term. In addition, the natural resources that farmers depend on must be used sustainably. Irrigation is a farming activity that has the potential to increase farmers' profit and to enhance the conditions of some natural resources while minimising the impact on others. Indicators of irrigation performance, which can be used to measure and demonstrate the impacts of irrigation, help farmers to make informed management decisions to increase profit and to minimise environmental impacts.

What is an indicator?

An indicator is a measure of the state of a system that enables the evaluation of effects of specific actions on outcomes and allows actions to be adjusted to meet specific goals. Indicators are measurements that signal change and can be physical, chemical, biological or economic.

Some indicators are directly measurable, such as the amount of irrigation water entering a farm, or annual crop yields. These indicators are easy to measure and give direct feedback on the state of the system.

Other indicators cannot be easily described by simple measurement. For example, the amount of nitrogen leaching from a farm into groundwater can be measured at specific points using lysimeters. However, it is not a simple calculation to extrapolate these values to represent an overall farm. Specific methods that have been developed to take into account factors such as rainfall, irrigation, soils types, crop type and farm enterprise type must be used.

Where it is impossible or impractical to measure an effect, derived indicators can be used. For example, soil productivity is expensive and time-consuming to measure as it is described by a large list of physical, chemical and biological characteristics. Instead, earthworm population can be used to indicate soil productivity because soil health influences earthworm population.

Why use indicators?

To find out if progress is being made to achieving goals, it is necessary to measure, monitor and report inputs and outputs. There are several reasons why indicators should be used:

- Indicators are a structured way of monitoring progress.
- They provide feedback to continually improve performance.
- They provide information to demonstrate the sustainability of farming practices to regulatory authorities and to national and international markets.
- With continual use, they help farmers to set realistic targets.
- They can provide information to show that imposed conditions (eg with resource consents) are justified or unjustified.
- They can support a case for change.

Farmers routinely use indicators now. Tractor fuel use in litres per hour is an indicator of tractor performance and operator skills. Minimising fuel use is a goal that can be targeted by monitoring fuel consumption.

Irrigated agriculture goals

Because indicators are used to monitor performance and to change actions to meet specific goals, it is necessary to consider what those goals might be. Sustainability goals for irrigated agriculture were developed as part of a MAF Policy project (MAF 1997). These goals are summarised in the following table (see over).

Overall goal	Maximise net profit over the long term
Economic goals	Optimise farm productivity Maintain a contribution to the wider community
Environmental goals	Hold and comply with resource consents Improve soil health Minimise adverse effects on water sources and receiving waters Minimise adverse effects on air Maintain or enhance biodiversity, habitats and landscape Pursue effective waste management Minimise use of non-renewable energy resources
Social goals	Ensure acceptability of farming practices to the wider community Demonstrate good environmental management in the market place

Although the above goals can be used as a starting point, farmers should develop their own set of goals.

It needs to be recognised that goals can be conflicting. For example, applying fertiliser helps farm productivity but may cause adverse effects on groundwater. Maximising long-term profit is the overall goal for farmers but that cannot be achieved with the exclusion of other economic, environmental and social goals. There is a need to obtain a balance between conflicting goals.

Indicator selection criteria

Before selecting irrigation indicators, it is necessary to identify the rationale that is used to select the indicators and to identify desirable characteristics. Although the criteria used to select indicators is generic (i.e. applies to all indicators), the importance of each criteria depends on which goal is being targeted.

The following criteria have been identified in the MAF Policy project (MAF 1997):

- **Influence of irrigation system design and management**

  Indicators must describe characteristics of a farming system that can be altered by changing irrigation system design or management. The relationship between a farmer's irrigation decisions and the indicator should be clear and well understood.

- **Able to be controlled by farmers**

  Indicators must describe inputs or outputs that farmers have some control over. Often, indicators will also be influenced by factors beyond a farmer's control, eg rainfall or product prices, but at least part of the indicator should be controllable.

- **Readily measurable**

  Monitoring and recording indicators should be quick and easy and not need significant capital investment in equipment, be costly to measure or require specialist technical skills. Indicators should where possible use information that farmers routinely gather as part of normal farm management practices.

- **Scientifically valid and repeatable**

  Indicators should be measurable with a well-documented and accepted technique to ensure repeatability and consistency within farms and across farms. The use of scientifically valid methods will also assist in providing input into future research.

- **Will measure progress towards goals on a reasonable time scale**

  Indicators must be measurable at an appropriate frequency to assess performance against goals. For most of the goals summarised above, indicators will only need to be measured annually and the year-to-year trends assessed. Water indicators may need to be measured more frequently. For example, the annual amount of water abstracted from a river is not as important to the river as the maximum daily abstraction. However, annual water use may form parts of indicators that affect other outputs.

- **Can be aggregated for groups of farms**

  It should be possible to combine the selected indicators to provide composite indicators for an irrigation scheme, community or region. This type of overview will help determine the cumulative benefits and the effects of a scheme or region.

Recommended indicators

A set of recommended indicators and the rationale for selecting them is given in Sheet 2 in Section 2.5.1.

Which performance indicators should I use?

Indicators of sustainable irrigated agriculture were developed as part of a MAF Policy project (MAF 1997) and followed on from the goals listed in Section 2.5.1 Sheet 1.

The indicators have been divided into three groups covering economic, environmental and social aspects. It must be stressed that the list of indicators given below is not comprehensive. Other indicators may be used to meet the requirements of particular individuals.

Economic indicators

Maintaining an economically viable farm is the main motivating factor for most farmers. Because of the importance of long-term viability, economic indicators must be able to measure the ability of a business to maintain long-term financial health. Because the emphasis here is on irrigation, there is a need to measure how effectively water is used and whether farmers are obtaining as much profit as possible from the water used. Energy, as one of the major input costs of pressurised irrigation systems, should also be included.

The recommended economic indicators are:

1. Annual net operating profit after tax ($).
2. Quantity of crop or product produced per unit of water used (kg/m^3). This is also known as water use efficiency.
3. Profit per unit of water used ($/m^3).
4. Quantity of crop or product produced per ha (kg/ha or tonnes/ha).
5. Quality of produce (% of each crop reaching specific grading levels).
6. Annual energy used to operate the irrigation system (kWh).
7. Energy used per unit of water pumped (kWh/m^3). This is also known as power rating.
8. Labour units per irrigated hectare.

Environmental indicators

The sustainability goal for irrigation is to minimise any adverse effects on the water source and on any resources that receive irrigation water through wind-drift, surface runoff or drainage to groundwater.

In most cases, individual farmers cannot determine the direct effects of irrigation on other water bodies, particularly groundwater systems. Regulatory bodies usually deal with these effects when applications are made for resource consents. But what farmers should do is operate irrigation systems to minimise these effects.

Soil health indicators are often complex and expensive to obtain. However, by evaluating soil water holding capacity, which is a function of physical, chemical and biological soil properties, an indication of whether soil health is improving or not can be obtained.

The amount of water used efficiently, i.e. used beneficially, is a clear indicator of performance. This can relate to production and effects on the environment. Accurately measuring application efficiency or nitrate losses to groundwater is difficult, but other indicators such as the amount of ponding or surface runoff can be used to give guidance for improving application efficiency.

The recommended environmental indicators are:

1. Resource consents obtained and complied with.
2. Soil water holding capacity (mm/m or mm held in root zone).
3. Volume of water used for each crop (m^3/ha).
4. Percentage of water flowing onto farm that is stored in crop root zone (%). This is also known as application efficiency.
5. Daily visual assessment of the amount of ponding or surface runoff.
6. Maximum daily water abstraction rate over season (m^3/day). This is also known as peak rate of take.
7. Lysimeter-based measurement of nitrogen leaching below the root zone (g/m^3).
8. Agrichemicals or fertilizers used per quantity of crop produced (kg/ha).

Social indicators

Social acceptability is difficult to measure but is very important. Although complaints and media attention could be used as an indicator of social acceptability, they are often not the attitude of the wider community.

By using resource consents and abatement notices as indicators of social acceptability, farmers can monitor and keep records to demonstrate continual compliance with consent conditions. Irrigation practices may need to be altered to cater for consent conditions, but farmers can be reasonably certain that the community s interests have been taken into account.

The recommended social indicator is:

1. Record of any abatement notices.

How to use the indicators

To make best use of indicators, it is necessary to have clear objectives with measurable performance criteria. The aim is to be clear about what you are trying to achieve and how you know if you are going in the right direction. The following process can be used to do this.

1. Write down a set of goals or objectives. As a starting point, use the goals given in Section 2.5.1 Sheet 1.
2. Write down a set of indicators that you can use as performance measures for these objectives. These should help you make informed and defensible irrigation management decisions. Use some of the indicators given above as a starting point.
3. Set targets or directions for improvement for each of the indicators. This may be difficult initially as the necessary information may not be measured, but make an estimate and refine the values over time.
4. Take the necessary steps to control inputs so that the target values can be obtained and improved.
5. Calculate and record indicator values at relevant time intervals.
6. Use feedback from the indicators to continually improve farming practices and to demonstrate the sustainability of those practices to regulatory authorities.

Example

A dairy farmer has a goal of maximising production and profit while minimising irrigation water use, i.e. maximising water use efficiency.

1. One suitable indicator to use is volume of water used per kg of milk solids produced over a season (m^3/kg MS).
2. The target value in the first season is 8 m^3/kg MS (obtained from average records for the district), which should be reduced over time. This can be achieved by increasing production or decreasing water use, or both.
3. Carry out irrigation using best techniques available at the time.
4. Calculate the indicator at the end of the season. For example, it may have been 9 m^3/kg MS.
5. Find out why the target value was exceeded. If it was likely to have been from inefficient water use, take measures and put in place plans to improve in the next season. Improvements to the irrigation system to improve uniformity or implementation of soil moisture monitoring are examples of actions that can be taken.
6. Repeat the process in the next season.

Precautions

Although regional values give some guidance on how particular farms rate against others, there are many factors that influence indicator values. They are of most benefit to individual farms as tools to improve performance on those farms. If used to compare performance regionally, caution is advised.

Although the example above refers to one indicator, several indicators should be used to evaluate overall performance.

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What records should I keep?

Indicators of irrigation performance, which can be used to measure and demonstrate the impacts of irrigation and help farmers to make informed management decisions to increase profit and to minimise environmental impacts, have been described in Sheets 1 & 2 in this section.

To enable these indicators to be determined and to compare the results with performance targets, recording of information specific to each indicator must be completed. This sheet describes some of the measurements or information recording that should take place based on the indicators described previously. If farmers wish to use other indicators, the appropriate information should be recorded.

Economic indicators

Indicator	Task	Equipment/information needed
Annual net operating profit after tax ($).	Record profit from financial records.	Financial records/accounting system
Profit per unit of water used ($/m^3).	Record profit and total seasonal water use.	Total water use records and financial records.
Quantity of crop or product produced per unit of water used (kg/m^3).	Record production of each crop and water applied to each crop in the season.	Daily water use records & seasonal production records.
Quantity of crop or product produced per ha (kg/ha or tonnes/ha).	Record production of each crop.	Production records.
Quality of produce (% of each crop reaching specific grading levels).	Record the different grades of crops produced.	Grading record sheets.
Annual energy used to operate irrigation system (kWh).	Record energy being used from irrigation electricity meters.	Electricity meter readings for irrigation pumps.
Energy used per unit of water pumped (kWh/m^3).	Record and add up annual energy use and total seasonal water use.	Electricity meter readings and water use records.
Labour units per irrigated hectare.	Record time spent on irrigation activities	Daily record sheets.

Farmers already routinely record some of the items described above, so some of the indicators are or can probably be determined for previous years.

Flow measurements to determine water use are vitally important and if not currently measured will require appropriate equipment to be installed to allow that to occur. See Section 2.4.3 or Section 2.4.4 for details on how to measure flow. Flow records and electricity use are best measured daily, but weekly or at the very least monthly records can be used.

If more that one irrigator is being used, flow will need to be apportioned to each crop based on the irrigation time for each crop.

Environmental indicators

Indicator	Task	Equipment/Information needed
Resource consents obtained and complied with.	Record consent application details and outcomes.	None.
Soil water holding capacity (mm/m or mm held in root zone).	Measure amount of water held in root zone.	Soil moisture measurement equipment or gravimetric method.
Volume of water used for each crop (m^3/ha).	Read water meters and irrigation times and locations daily.	Log of irrigation hours. Water measurement equipment. Areas of crops.
Percentage of water flowing onto farm that is stored in crop root zone (%).	Record daily rainfall, irrigation applied, soil moisture and calculate expected drainage.	Rain gauge. Soil moisture measurement system.
Depth of water applied/ (Evapotranspiration — Rainfall).	Record daily rainfall and irrigation applied. Obtain daily ET records from nearest climate station.	Rain gauge. Access to daily ET records.
Daily visual assessment of the amount of ponding or surface runoff.	Record location, time, soil and crop condition, depth of water applied and assessment of amount of ponding.	Daily records.
Maximum water abstraction rate over season (m^3/day).	Record daily peak flow rates and note maximum at end of season.	Daily flow records.
Lysimeter-based measurement of nitrogen leaching below the root zone. (g/m^3).	Collect drainage water from lysimeters on regular basis, label and have analysed.	Lysimeter. Sample bottles. Record sheets.
Agrichemicals or fertilizers used per quantity of crop produced (kg/ha).	Record time, location, amount and description of applications.	Seasonal records.

Soil moisture measurement

The most important decisions relating to daily irrigation decisions require soil moisture to be measured in each paddock or in enough paddocks to be able to assess soil moisture in non-measured paddocks. See Section 2.4.1 on how to measure soil moisture.

Calculation of the percentage of water flowing onto the farm that is stored in the root zone is best carried out using daily soil moisture records and a simple water balance. A soil moisture measurement method that records continuous readings is ideal for this.

Lysimeters

Although rarely used in the past by farmers, the need to monitor the effects of irrigated agriculture on the environment will see increasing use of these devices.

Samples taken for water quality analysis need to be collected carefully to eliminate the chance of contamination by other sources. Water quality laboratories or soils experts can advise.

Social indicators

Indicator	Task	Equipment/Information needed
Abatement notices	Retain abatement notices and record time, date and place of incident.	Record book.

Hopefully, abatement notices will never be issued, but if they are, full details of what occurred, when and what was done to resolve the issue, should be recorded.

Precautions

A significant commitment to planning, implementation, monitoring and reviewing will be required to make best use of the information and to progress towards more profitable and sustainable irrigated agriculture.

Regardless of which indicators are used, water use measurement and soil moisture measurement are vitally important and should be given highest priority.

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