Using local expertise & experience for the National Water Initiative

Discussion about water, water access, water efficiency and water reform has been ongoing for a decade or more. Over time it is easy to lose sight of the objectives, the outcomes and the programs. The next three articles present an overview of the National Water Initiative, an example of how research organisations work alongside such programs, and how local projects can also fit into the "bigger picture".

Part 1 - An overview of the National Water Initiative

Part 2 - A project to assist implementation of National Water Initiative objectives

Part 3 - Application of the water use efficiency and productivity assessment framework to MIA

Part 1. An overview of the National Water Initiative

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IN A NUTSHELL

- A long-term action plan called the National Water Initiative was drawn up in 2004 by the Council of Australian Governments

Major steps are being taken to improve the way Australia manages its water resources. The most effective means of doing this is through programs that start with national level cooperation, and filter through state, regional, catchment and individual user levels, to achieve the best outcomes possible.

While states and territories individually remain the primary custodians of water resources, all levels of government are working cooperatively to deal with water as a national issue. This approach was formally adopted in 1994 when the state and territory governments, along with the Australian Government through the Council of Australian Governments (COAG) agreed to a new national framework to minimise unsustainable use of water resources. That framework addressed issues such as separating water access entitlements from land titles, separating the functions of water delivery from that of regulation, and making explicit provision for environmental water.

Much water reform progressed under the framework; however changes took place at very different rates across different states and territories.

The National Water Initiative

In 2004 COAG reaffirmed its commitment to water reform by drawing up a long-term action plan called the National Water Initiative (NWI). The NWI strives to:

- maintain the momentum for change
- further clarify water allocations and entitlements
- ensure the health of river and groundwater systems

The Australian Government and all states and territories, with the exception of Western Australia, have signed on to the National Water Initiative.

The objective of the NWI is to:

Achieve a nationally compatible market, regulatory and planning based system of managing surface and groundwater resources for rural and urban use that optimises economic, social and environmental outcomes

Just under half of the 70 or so actions of the NWI are national-scale or require state governments to work together. Ultimately, the NWI represents:

- a commitment to identify over-allocated water systems, and restoring those systems to sustainable levels
- the expansion of the trade in water resulting in more profitable use of water and more cost-effective and flexible recovery of water to achieve environmental outcomes
- more confidence for those investing in the water industry due to more secure water access entitlements, better registry arrangements, monitoring, reporting and accounting of water use, and improved public access to information
- more sophisticated, transparent and comprehensive water planning
- better and more efficient management of water in urban environments, for example through the increased use of recycled water and stormwater

What does this all mean?

The agreed National Water Initiative actions are based on eight elements.

1. *Water access entitlements and planning framework*

The consumptive use of water will generally require a water access entitlement, separate from land and described as a perpetual or open-ended share of the consumptive pool of a specified water resource. The water access entitlements will have characteristics to allow their free and open trade. The planning framework will be put in place to address over allocated water resource systems.

2. *Water markets and trading*

Arrangements will be made to facilitate intra- and inter-state trade in water. Temporary trade will be immediately freed up and institutional barriers to permanent trade out of irrigation areas will be progressively phased out by 2014. By creating an environment in which individual water users are able to trade water relatively quickly and easily, a far more dynamic water market will emerge, resulting in more productive and efficient use of water over time.

3. *Best practice water pricing*

There will be a continued movement towards a nationally consistent approach for full cost recovery of water storage and delivery for rural and regional systems. Nationally consistent benchmark reporting on the service quality and pricing of all water services is another priority.

Water pricing reform is currently a very active area for most state and territory governments. The overall intent is to ensure that prices set by mechanisms other than the market (ie by governments, public/private water service providers, and/or independent pricing bodies) do not lead to perverse outcomes either in secondary water markets, or for water-related investment activity. This is critical to facilitating market based instruments as more prominent mechanisms for managing water in Australia.

4. *Integrated management of water for environmental and other public benefit outcomes*

Water that is provided by states and territories to meet agreed environmental and other public benefit outcomes will be given statutory recognition and at least the same degree of security as water for consumptive use. Achieving environmental outcomes will no longer be seen as an optional extra in water management.

5. *Water resource accounting*

Water accounting systems will be benchmarked and national standards introduced for accounting systems. Accounting for water use in a transparent and comparable manner across jurisdictions is fundamental to improving the hydrological models that underpin water allocation decisions, ensuring there is confidence in the water market and in the achievement of environmental and resource-use outcomes.

6. *Urban water reform*

A number of measures will be taken to improve water use efficiency in urban areas. These measures are designed to encourage greater re-use and recycling of wastewater (where cost effective) and to reduce household water use.

7. *Knowledge and capacity building*

There is a need to develop understanding of water at all levels so that it can be managed and used more sustainably. One of the ways to in which this will be done is through the "Australian Government Water Research Coalition". This group has been formed to coordinate mechanisms that enhance capacity and improve the efficiency and access to water research expertise and services.

8. *Community partnerships and adjustment*

The COAG recognises the importance of involving all stakeholders in the development and implementation of water plans. It agreed to providing understandable and up-to-date information on water and to addressing significant adjustment issues arising from reductions in water availability as a result of the implementation of the NWI Agreement.

The Murray-Darling Basin Water Agreement

At the same time that COAG signed the NWI, its members also signed a Murray-Darling Basin Water Agreement. The agreement sets out the arrangements for investing $500 million over five years, commencing in 2004–05, to reduce the level of water over-allocation and to achieve specific environmental outcomes in the Murray-Darling Basin.

The National Water Commission

To drive national water reform, the Australian Government created the National Water Commission in March 2005, to advise the Prime Minister and COAG on the progress of the water reform process. The Government nominated three members to the Commission and the National Water Initiative state and territory partners also nominated three members. The Prime Minister appointed the Chairman to make up the final seven-member Commission.

In the past 11 months the Commission has:

- run one round in the Water Smart Australia program (see below) and is currently assessing project proposals
- prepared guidelines for states and territories developing National Water Initiative implementation plans
- started undertaking the 2005 National Competition Policy assessment of state and territory progress in implementing water reforms
- begun developing a baseline assessment of Australia's water resource and governance arrangements

The key priorities for water reform in the next 12 months, as identified by the Commission, will be:

- interstate water trading
- clear specifications of water entitlements (for consumptive and environmental water)
- water resource accounting and measurement

The Australian Government Water Fund

The National Water Commission has an additional role in advising the Prime Minister on financial assistance to be provided from two programs under the Australian Government's $2 billion Water Fund – the $1.6 billion Water Smart Australia and $200 million Raising National Water Standards programs.

The Australian Government Water Fund is a program to invest in water infrastructure, improved water management, and better practices in the stewardship of Australia's scarce water resources.

The Water Smart Australia Program offers support for practical on-ground water projects that will contribute to improving water efficiency and environmental outcomes. As a general guide, the minimum level of funding available for a project is around $1 million. A call for proposals closed in June 2005, but a second call is expected in the first quarter of 2006.

The Raising National Water Standards Program aims to assist the development of the necessary tools for good water management in Australia. It will target investment to improve Australia's national capacity to measure, monitor and manage its water resources. The Raising National Water Standards Program is a strategic program that will invest in high priority activities that are *commissioned* from suitably qualified providers and organisations as well as in projects identified through a competitive grants process. A competitive grants round has yet to be run.

Both programs are managed to secure practical outcomes consistent with the National Water Initiative.

The second and third articles of this series describe how research is being designed and carried out to complement and assist NWI objectives.

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Sharon Phillips from the National Water Commission provided a valuable contribution to this article, redrafting it based on writing the National Water Commission has produced on a similar theme.

Further information

For more information on the National Water Initiative, the National Water Commission or funding programmes, visit www.nwc.gov.au or call 02 6102 6064.

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Further reading

The programs and initiatives described in this article are explained in more detail, in documents that can be accessed via the internet

- *www.coag.gov.au/meetings/250604/iga_national_water_initiative.pdf*
- *www.nwc.gov.au/NWI/index.cfm#overview*
- *National Water Initiative - The Economics of Water Management in Australia -An Overview, by M.Thompson, 2005, NWC*

Part 2. New R&D assists National Water Initiative

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IN A NUTSHELL

- CSIRO Land & Water has developed an analytical process for determining the efficiency and productivity of water use, that will help future determinations of the sustainability of irrigation regions

Irrigation is a major user of the total water resources in Australia. Increasing the efficiency of use and productivity of irrigation water, at different scales – farm, system, catchment – could provide major contributions to the National Water Initiative (NWI) objectives, not to mention practical benefits at each scale.

Research and community organisations across Australia are working on projects that help achieve the objectives of the NWI. One project, which includes scientists from CSIRO Land and Water at Griffith, is developing a methodology, or an *analytical framework*, that will enable water resource planners and decision makers to analyse and assess the performance of irrigation areas and their future sustainability, and to identify opportunities that will make these areas more efficient and productive.

Analysing water use efficiency & productivity

The new analytical framework was developed as part of the CSIRO contribution to the CRC for Irrigation Future's "Irrigation Sustainability Challenge Project".

The project aims to develop a framework to analyse the efficiency and productivity of irrigation water use, from hereon called the WUEP framework. The WUEP framework will be used to carry out comprehensive biophysical, economic, environmental and social assessment of the current performance of irrigation areas, and their future sustainability and potential for improvements to meet NWI objectives.

This WUEP framework is based on recent international research efforts to integrate methods of water use analysis across scales, from farms to whole systems, along the entire pathway of water transport from storage to farmers' fields, and the transformation of water into plant products. The international work also proposed modifications to the resulting integrated framework to allow practical application at the field scale. It is the modifications to the framework that the CSIRO scientists are developing. The result being an analytical framework that will better suit the irrigation regions of NSW/Australia, allow the application of data from field research, rather than theoretical data, and provide analysts and decision makers with the best possible information to formulate future water policy and reform.

The components of water efficiency & productivity

The WUEP framework takes some established analytical systems for determining water use efficiency and productivity, and modifies them to better reflect the field conditions of irrigation systems in New South Wales (Figure 1).

In the classical approach to water efficiency and water productivity, the WUEP parameter ***Irrigation Efficiency*** combines conveyance, farm and field efficiencies. This is a measure of how efficiently water is delivered to the root zone for potential plant use.

Similarly, ***Rainfall Efficiency*** is the fraction of rain that infiltrates into the soil and is stored in the root zone for subsequent uptake by crops. Factors such as the irrigation systems, crop type, soil type and agronomic management affect the system's ability to store water. Certain practices can reduce or increase losses through deep percolation and excess runoff.

Not all water that is stored in the soil root zone is transpired by the crop. Some of the water stored is lost by direct soil evaporation, not providing a production benefit. The fraction of water stored in the root zone that is used for crop transpiration is termed ***Crop Water Efficiency***.

Water Use Efficiency is determined by combining the irrigation, rainfall and crop water efficiencies.

Crops transpire (use water) at all stages of growth, converting the water to carbohydrates and crop biomass, and ultimately saleable yield, eg grain, cotton or fruit. The ratio of saleable yield to transpiration is called ***Crop Water Productivity***. This is influenced by factors such as the crop type, water and fertiliser management, crop health, climatic conditions and soil type.

Water Productivity is the combined product of *Water Use Efficiency* and *Crop Water Productivity*.

Field applications

In field applications, it is often not possible to accurately analyse ***Irrigation Efficiency*** and ***Rainfall Efficiency*** separately, from available field data. Therefore, in the WUEP framework these two terms were combined into ***Irrigation+Rainfall Efficiency***. However, this is not a disadvantage as making better use of rainfall is important for irrigation.

In the WUEP framework soil evaporation and crop transpiration were also combined, which is much easier to measure or estimate as total crop evapotranspiration in the field. The combined value is used in defining the modified WUEP parameter ***Crop Water Efficiency+Productivity***.

Any water escaping beyond the crop root zone contributes to deep drainage flows into groundwaters, which could then flow laterally out of the farm paddock areas. Such lateral water flows moving into other farming areas with shallow groundwater could directly contribute to crop uptake by capillary "groundwater inflow". Groundwater pumping from deep watertables can also contribute to "inflow irrigation", by supplementing surface irrigation supplies.

The next article of this series describes the application of this WUEP framework to paddock-scale information collected in farm surveys carried out by NSW DPI staff in the rice cropping and non-rice broadacre cropping enterprises of the Murrumbidgee Irrigation Area.

Further information

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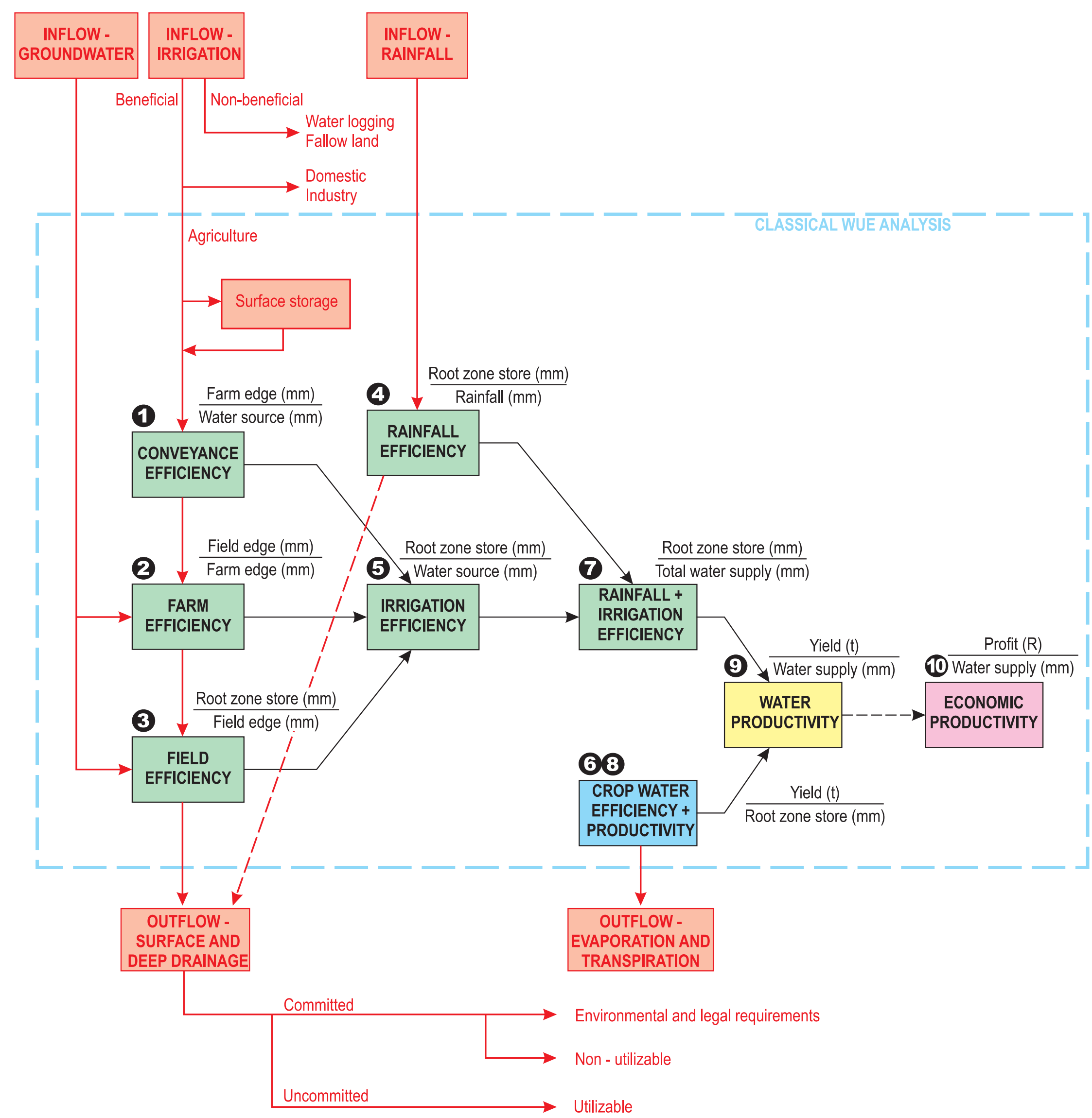

Figure 1 *A modified intergrated framework for analysis of water use efficiency and productivity*

Part 3. New R&D shows improved efficiency & productivity in MIA

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IN A NUTSHELL

- The WUEP framework (see previous article) has been applied to paddock-scale measurements in rice and non-rice cropping enterprises in the MIA
- Analysis of rice water use by the framework shows marked increases in water use efficiency and productivity, since programs to move rice cropping to less permeable soils have been introduced
- *Water Productivity* in rice has increased from 4.2 kg/mm to 6.0 kg/mm, due to the combined effects of increases in *Rainfall+Irrigation Efficiency* and *Crop Water Efficiency+Productivity*
- There were no distinct trends in the measuring period from 1997 to 2003 for non-rice crops, which possibly reflects a lack of water saving initiatives for these crops in the MIA during this period
- The yields and associated water productivity parameters showed a tendency to decrease with increase in the growing season rainfall, possibly due to the potential for increased waterlogging on slowly permeable clay soils during high rainfall years
- Water productivity parameters for non-rice crops are less than the maximum values observed for specific crops in other field studies, indicating a potential for increase through improved on-farm agronomic and irrigation management

A new analytical framework, developed by international researchers and modified by Australian scientists, including some based at Griffith, has shown that the Rice Water Use Target policy has had a positive effect on water use efficiency and water productivity in rice growing enterprises in the Murrumbidgee Irrigation Area.

In 1998, IREC and Murrumbidgee Irrigation introduced the Water Use Efficiency Improvement Scheme (WUEIS). The aim of this project was to benchmark and monitor the water use efficiency of different crops across the Murrumbidgee Irrigation Area (MIA). A lot of on-farm data was collected by Sigrid Tijs during the five years of the project and individual feedback was provided to the participants.

Recently, CSIRO Land & Water scientists Nihal Jayawardane and Evan Christen developed an integrated Water Use Efficiency and Productivity (WUEP) framework that can be used to identify areas and strategies for potential improvements in water use efficiency and to monitor the effects of implementing water saving strategies. The WUEP framework is explained in part 2.

Studying MIA data with the new framework

The WUEP framework was used to analyse data collected by the Water Use Efficiency Improvement Scheme and other programs. The framework identified improvements in water efficiency and productivity for rice cropping enterprises, which can be attributed to specific programs. It also identified that water efficiency and productivity in non-rice crops could be improved through changed agronomic practices.

Rice crops

Analysis by the WUEP framework was able to show the impact, in the MIA, of the rice irrigation water use target policy implemented in 1985, which was aimed at moving ponded rice-growing areas onto lands with lower percolation losses. The policy has led to increased ***Rainfall+Irrigation Efficiency*** from around 0.83 to 0.92 (Table 1).

The potential for further increase in ***Rainfall+Irrigation Efficiency*** appears to be small, except possibly a more gradual increase by the continued implementation of the water use target policy, with further tightening of rice water use targets.

Agronomic measures to increase rice yields combined with strategies limiting rice to suitable soils, has increased ***Crop Water Efficiency+Productivity*** from about 5.1 kg/mm (ie kilograms of yield per mm of rainfall+irrigation water) in the early to mid 1980s, to an average of about 6.5 kg/mm in subsequent years.

In the same period, ***Water Productivity*** increased from 4.2 kg/mm to 6.0 kg/mm, due to the combined effects of increases in Rainfall+Irrigation Efficiency and ***Crop Water Efficiency+Productivity***.

There is potential to further increase rice ***Crop Water Efficiency+Productivity*** and the associated *Water Productivity* by improved agronomic management practices that increase rice yields.

In the WUEIS on-farm surveys of rice cropping, carried out in the period 1997–2003 (Table 4 and 5), the WUEP parameters for rice are higher than the values recorded in the pre-1985 district-scale measurements (Table 1).

Non-rice broadacre crops

Analysis by the WUEP framework showed no distinct time-trends in wheat crop yields, in contrast to the time-trends observed in rice farms, which is possibly due to lack of water saving initiatives for non-rice crops during this period. Table 2 and 3 show the wheat crop yields, irrigation water use and the calculated WUEP parameters from the WUEIS data.

The higher wheat yields appear to occur in the moderate rainfall years, with a tendency towards decreased yields with an increase in the growing season rainfall. This may be associated with the potential for increased waterlogging stress in the slowly permeable clay soils of the MIA during high rainfall years, as also observed in other agronomic field studies.

Water productivity parameters based on crop yield also showed a similar trend, ie lower yield in high rainfall seasons, for wheat and barley crops.

Table 1

Differences in MIA rice water use efficiencies and productivities prior to introduction of rice water targets scheme in 1986 and in the subsequent period. The values are an average annual figure for the reporting period.

WUEP parameters, and inputs/outputs used in calculating these parameters	1980–1985	1986–2003
Rain *(mm)*	131	169
Irrigation *(ML)*	41.29	13.00
Yields *(t/ha)*	6.59	8.72
Calculated ETcrop *(mm)*	1302	1358
Calculated drainage rate *(mm/day)*	1.72	0.74
Rainfall+irrigation efficiency	0.83	0.92
Crop water efficiency+productivity *(kg/mm)*	5.09	6.52
Water productivity *(kg/mm)*	4.22	5.98

Table 2

Wheat crop yields and water use in WUEIS surveys of MIA farms

Year	Number of paddocks	Irrigation ML/ha	Rainfall ML/ha	ET crop ML/ha	Yield (t/ha)	Yield (t/ML of irrigation)
1997	71	2.34	2.47	3.65	4.59	2.58
1998	86	2.05	2.94	4.24	4.59	2.86
1999	83	2.01	3.26	3.46	4.09	2.78
2000	42	1.68	2.37	3.43	4.60	3.59
2001	61	2.34	1.72	3.54	5.14	2.57
2002	31	2.95	0.79	3.47	4.76	1.75
Mean		*2.17*	*2.48*	*3.89*	*4.58*	*2.73*

Table 3

Water use efficiencies and productivities in wheat paddocks calculated from the WUEIS survey data

Year	Rainfall + Irrigation Efficiency	Crop Water Efficiency + Productivity (kg/mm)	Water Productivity (kg/mm)	Crop Water Productivity (kg/mm)
1997	0.64	13.09	8.18	11.89
1998	0.70	11.33	7.93	11.17
1999	0.70	9.59	6.66	9.13
2000	0.68	14.16	9.50	14.00
2001	0.70	14.98	10.49	16.40
2002	0.73	13.93	10.25	17.79
Mean	*0.69*	*12.41*	*8.48*	*12.57*

In contrast the ***Rainfall+Irrigation Efficiency*** parameter for wheat crops (Table 3) does not appear to be related to rainfall. This may be due to the use of survey data from different farm paddocks with varied landforming operations, in the different years. Further analysis of the data is needed to account for such differences in farm paddocks.

Table 4 shows that the summer cereal grain yields are around twice as high as the winter cereals, as is the evapotranspiration of summer crops. However, the irrigation water requirement of summer crops is around four times the water use of winter crops, resulting in a decrease in cereal grain yield production per ML of irrigation water by a factor of 2 to 3. During years of low allocations to the irrigation areas, farm returns could be maximised by growing crops that have the greatest financial returns per ML of irrigation, which are generally the winter crops.

The calculated crop water productivity parameters of crops grown in the MIA (Table 5) vary according to crop type. They also show values which are less than the maximum values observed for the same crops in other field studies, indicating a potential for increase through improved on-farm agronomic and irrigation management.

The ***Rainfall+Irrigation Efficiency*** of all non-rice broadacre crops shows a narrow range of 0.65 to 0.75, with a mean value of 0.69.

Various researchers have suggested that potentially, the use of improved irrigation layout design and irrigation management could be expected to increase the value of irrigation efficiency in contour systems from around 0.5 to more than 0.8, while in border check and permanent bed farming systems it could be increased from around 0.7 to

Table 4
Mean crop yields and water use in specific crops from WUEIS surveys of MIA farms during the period 1997 to 2003

Crops	Irrigation (ML/ha)	Rain (ML/ha)	ET crop (ML/ha)	Yield (t/ha)	Yield (t/ML of irrigation)
Summer crops					
Rice	11.97	1.96	11.76	9.51	0.82
Maize	8.51	1.68	8.46	7.71	0.93
Corn	8.16	1.92	7.74	8.68	1.08
Corn silage	7.25	1.44	6.71	3.72	0.50
Soybean	7.81	1.77	7.34	2.55	0.36
Mean	*8.74*	*1.75*	*8.40*	*6.43*	*0.74*
Winter crops					
Wheat	2.17	2.48	3.89	4.58	2.73
Oats	1.99	2.17	3.70	3.23	2.52
Barley	1.76	2.40	3.60	4.23	3.41
Canola	2.43	2.66	4.29	1.92	1.07
Faba bean	3.18	2.12	4.11	3.45	1.34
Mean	*2.31*	*2.37*	*3.92*	*3.48*	*2.22*
Perennial crops					
Lucerne	6.22	4.24	8.84	13.67	2.34

Table 5
Mean water use efficiencies and productivities for specific crops calculated from the WUEIS survey data during the period 1997 to 2003

Crops	Rainfall + Irrigation Efficiency (kg/mm)	Crop Water Efficiency + Productivity (kg/mm)	Water Productivity (kg/mm)	Crop Water Productivity (kg/mm)
Summer crops				
Rice	0.86	8.12	6.99	8.86
Maize	0.75	8.98	6.84	10.07
Corn	0.70	12.04	7.87	11.61
Corn silage	0.69	5.31	3.67	5.54
Soybean	0.70	3.65	2.50	3.74
Mean	*0.74*	*7.62*	*5.58*	*7.97*
Winter crops				
Wheat	0.69	12.41	8.48	12.57
Oats	0.72	8.87	6.39	9.79
Barley	0.70	12.46	8.61	13.08
Canola	0.70	4.67	3.28	4.71
Faba bean	0.65	8.76	5.72	8.56
Mean	*0.69*	*9.43*	*6.50*	*9.74*
Perennial crops				
Lucerne	0.77	16.71	12.69	17.53

more than 0.9. The potential for whole-of-system water savings by farmers adopting improved irrigation layout and management could be quantified by combining detailed farm surveys information on currently existing irrigation systems and practices, with assessments of current on-farm irrigation and rainfall efficiencies.

Future use of the framework

Recently introduced MIA water saving initiatives such as the EnviroWise and FarmWise programs have seen many farmers improve their farm layout and install drainage recirculation systems. WUEP analysis could be used to quantify the benefits of these initiatives.

Further information

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