"Water Use Efficiency: A water Balance Approach"

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Introduction

- Agricultural water use sector is the largest of all water use sectors in the world
  - using an estimated 70% of surface and groundwater yields annually
- Competition for our scarce resource
  - Increasing pressure from government that water must be re-allocated to other water use sectors
- Great expectations existed that an increase in efficiency will lead to reduced consumption by agricultural users and thereby "release" some of the annual water yield for use by other sectors

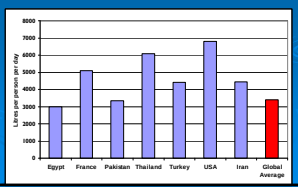
The importance of water:

- **Water is the key to food security**
  - **without water, crops simply cannot grow.**
- **Water is not just for primary production**
  - **it plays a vital role at all stages along the agricultural value chain**
- **Water for agriculture connects us all together**
  - **In times of scarcity we all have a responsibility to use water wisely, efficiently and productively.**

We need to be more 'water smart'.

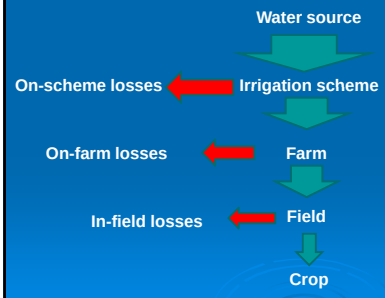
Two significant international research developments have taken place since 2005 which have changed the way the irrigation (and water in general) community look at water use efficiency.

Firstly, the concepts of water footprints and virtual water became more widely recognised (Hoekstra & Hung, 2002), and secondly there was a move away from efficiency indicators towards a water balance approach (Perry, 2007).



Irrigation Efficiency

- A new approach to defining efficient use of irrigation water:



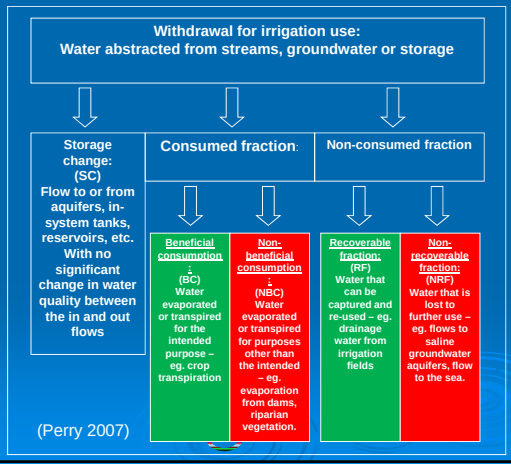
Ensuring that most of the water taken from the source reach the intended target – the crop – by minimising losses along the way.

A water balance approach

Water use efficiency

- The water balance approach is more flexible than calculating ratios
- It takes into account:
  - the intended destination of water taken from a resource, and
  - how the water is used along the way.
- It encourages a better understanding of water management at all levels
- Based on the water use efficiency framework recommended by the ICID as published in an article by Chris Perry in 2007

Water balance framework



(Perry 2007)

Four levels of water management infrastructure

Water management level	Infrastructure system component		
Water Source	Dam/Reservoir		Aquifer
Bulk conveyance system	River	Canal	
Irrigation scheme	On-scheme dam		
	On-scheme canal		
	On-scheme pipe		
Irrigation farm	On-farm dam		
	On-farm pipe / canal		
	In-field irrigation system		

(Reinders, et al,2010)

Water balance framework system component (based on infrastructure)	Inflow of water into system component	Possible water destinations within the system component	Framework classification	Desired Range, % of inflow
Dam / reservoir	Total amount of water released from storage	Increase flow in bulk conveyance system (river or canal)	SC	
		Operational losses at the point of release	NRF	<5
River bulk conveyance system (from on-river dam to scheme / farm edge) (if applicable)	Total amount of water entering the river	On-scheme surface storage	BC	
		On-scheme distribution system	BC	
		Farm edge (on-farm surface storage, distribution system or irrigation system)	BC	
		Evaporation from water surface	NBC	<5
		Seepage in river bed	NRF	<10
		Transpiration by riparian vegetation	NBC	<5
		Unlawful abstractions	NBC	0
		Operational losses (unavoidable)	NRF	<10
Canal bulk conveyance system (from on-river dam to scheme / farm edge) (if applicable)	Total amount of water entering the main canal	On-scheme surface storage	BC	
		On-scheme distribution system	BC	
		Farm edge (on-farm surface storage, distribution system or irrigation system)	BC	
		Evaporation from canal	NBC	<1
		Seepage in canal	NRF	<5
		Unlawful abstractions	NRF	0
		Operational losses (unavoidable, eg filling canal, tailends)	RF	<10
		Operational losses (inaccurate releases, spills, breaks etc.)	NRF	0

Water balance framework system component (based on infrastructure)	Inflow of water into system component	Possible water destinations within the system component	Framework classification	Desired Range, % of inflow
On-scheme surface storage	Total amount of water entering a scheme dam	Increase volume of water stored	SC	
		On-scheme distribution system (release from dam)	BC	
		Farm edge (on-farm surface storage, distribution system or irrigation system)	BC	
		Evaporation from dam	NBC	<1
		Seepage from dam	NRF	<1
		Operational losses (spills)	NRF	<1
Shared (scheme-level) groundwater aquifer compartment	Total aquifer recharge	Increase groundwater storage	SC	
		Farm edge (on-farm surface storage, distribution system or irrigation system)	BC	

Water balance framework system component (based on infrastructure)	Inflow of water into system component	Possible water destinations within the system component	Framework classification	Desired Range, % of inflow
On-scheme canal distribution system (if applicable)	Total amount of water entering the on-scheme canal distribution system	Farm edge (on-farm surface storage, distribution system or irrigation system)	BC	
		Evaporation from canal	NBC	<1
		Seepage in canal	NRF	<5
		Unlawful abstractions	NRF	0
		Operational losses (unavoidable, eg. filling canal, tailends)	RF	<10
		Operational losses (inaccurate releases, spills, breaks,etc.)	NRF	0

Water balance framework system component (based on infrastructure)	Inflow of water into system component	Possible water destinations within the system component	Framework classification	Desired Range, % of inflow
On-farm distribution system	Total amount of water entering the on-farm pipelines or canals	Irrigation system	BC	
		On-farm distribution system leaks	NRF	0
		Operational losses (unavoidable)	NRF	<5
In-field system (from field edge to root zone) *Intended destination of the water released.*	Total amount of water entering the irrigation system (Gross Irrigation Requirement (GIR) plus precipitation)	Increase soil water content	SC	
		Transpiration by crop	BC	
		In-field evaporation (beneficial)	BC	
		Frost protection irrigation water	BC	
		Leaching (intended, beneficial but non-recoverable)	BC	
		Interception (unavoidable)	NBC	<1
		In-field evaporation (non-beneficial, excessive)	NBC	0
		In-field deep percolation (non-intended, non-recoverable)	NRF	0
		In-field run-off (uncontrolled)	NRF	0
		Drainage water (surface & subsurface, recoverable)	RF	
		Operational losses (unavoidable)	NRF	<5

Gamtoos Irrigation Scheme is South Africa

Water balance – Gamtoos Irrigation Scheme

System component	Inflow		Destination		
	Component	Units of water	Component		Units of water
On-scheme conveyance system	Water released from storage dam into canal	167	Evaporation from canal	NBC	2
			Seepage in canal	NRF	10
			Leakages in pipes	NBC	25
			Unlawful abstractions	NBC	16
			Operational losses (unutilised)	NRF	8
			Return flows (unutilised)	RF	4
On-farm conveyance system (from farm edge to field edge)	Water delivered at the farm edge	102	On-farm system leaks	NRF	2
In-field application system (from field edge to root zone) – Centre pivot	Water applied on the field	100	In-field evaporation	BC/NBC	53
			Transpiration by crop	BC	47
			In-field deep percolation	NRF	3
			Interception	NRF	3
			Run-off	RF	0
			Change in soil water content	SC	-6

MEASURE

MODEL

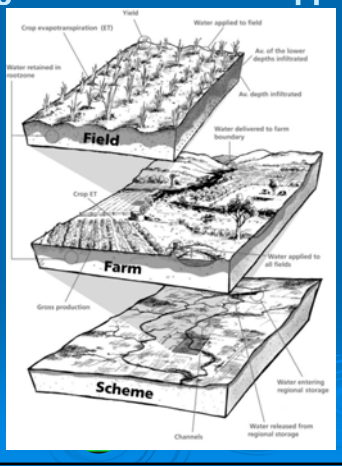
EFFICIENCY GUIDELINES

Optimising water use

- We have to find ways of reducing the non-beneficial consumptive and non-recoverable fractions of water use within the areas that we control
- How?

Implementing the water balance approach

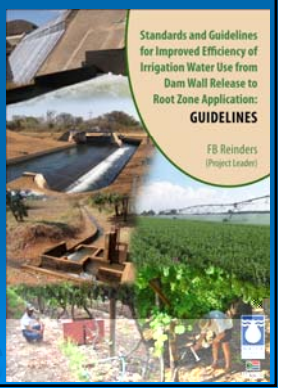
- **Applied at different levels**
- **During design AND management**



Australian water use efficiency framework (Purcell and Currey, 2003)

Guidelines - Module 1

- Fundamental concepts:
  - Lawful water use
  - Water and energy demand management
  - Systems approach
  - Water balance
  - Appropriate technologies



Guidelines - Module 2

- Efficient in-field irrigation systems are:
  - Planned with available resources and the water user in mind,
  - Designed to apply water uniformly and with low energy requirements,
  - Consists of quality irrigation equipment,
  - Operated according to specifications,
  - Maintained according to recommendations, and
  - Regularly evaluated for early problem detection

Guidelines - Module 3

- Efficient on-farm conveyance systems are:
  - Planned with capital and operating costs in mind,
  - Designed to provide the most economical solution,
  - Consists of quality irrigation equipment with high energy efficiencies,
  - Operated according to design specifications,
  - Maintained according to recommendations, and
  - Regularly evaluated for early problem detection

Guidelines - Module 4

- Efficient irrigation schemes are ones where:
  - All stakeholders have access to information regarding water availability and quality,
  - Water use is properly planned not to exceed availability,
  - Accurate and reliable measuring devices are installed,
  - O&M takes place according to specifications,
  - A regularly updated WMP is in place supported by an effective water use charging policy, and
  - Regular evaluations for early problem detection take place.

Benefits – through better understanding:

- In-field:
  - More accurate scheduling
  - Improved soil health
  - Awareness of salt / nutrient movement
- On-farm:
  - Earlier detection of irrigation maintenance needs
  - Optimised on-farm water use
- On-scheme:
  - Prioritisation of repairs and improvements to infrastructure
  - Improved scheme operation
  - More fair and equitable water allocation

Present design norms and the new default system efficiency values

Irrigation system	Losses				Default system efficiency (net to gross ratio) (%)
	Non-beneficial spray evaporation and wind drift (%)	In-field conveyance losses (%)	Filter and minor losses (%)	Total Losses (%)	
Drip (surface and subsurface)	0	0	5	5	95
Microspray	10	0	5	15	85
Centre Pivot, Linear move	8	0	2	10	90
Centre Pivot LEPA	3	0	2	5	95
Flood: Piped supply	0	3	2	5	95
Flood: Lined canal supplied	0	5	2	7	93
Flood: Earth canal supplied	0	12	2	14	86
Sprinkler permanent	8	0	2	10	90
Sprinkler movable	10	5	2	17	83
Traveling gun	15	5	2	22	78

Conclusion

Implementation of the water balance approach requires reliable data, which in turn will require:

- Standardised measurements
- Accurate record keeping
- Practical models
- Effective implementation plans
- Skilled persons

Thank you