

# Aligning policy with the real world: using experimental economics to design a diffuse source salinity credit trading policy

John Ward<sup>1</sup>, John Tisdell<sup>2</sup> and Jeff Connor<sup>1</sup>  
<sup>1</sup>CSIRO Land and Water PERU  
<sup>2</sup>Griffith University



## OUTLINE

www.csiro.au

1. Brief description of the biophysical and economic characteristics and the nature of the recharge problem
2. Evaluation of impediments to an effective market in recharge credits
3. Design and testing of potential policy instruments and solutions
4. Implementation and key features of the trial contract



## RECHARGE TRIAL OBJECTIVES

www.csiro.au

Identify, design and test market based policy instruments, that:

- Substantially reduce groundwater recharge and river salinity in an Australian catchment by engaging the farming community in land use management changes;
- Design and deploy a tender process, (in lieu of property rights) to contract farmers to commit to recharge obligations;
- Establish contract obligations that can be fulfilled by either land use change or trading in recharge credits.



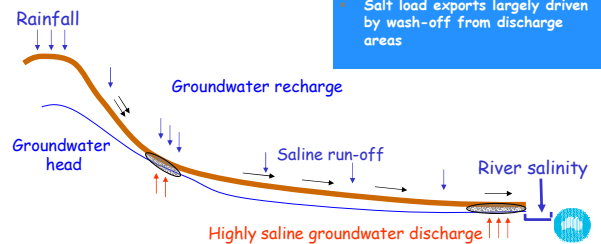
## Re-vegetation action by farmers reduces groundwater head and river salinity

www.csiro.au



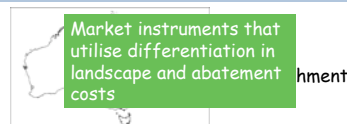
Bet Bet catchment

- ~9000 ha, 130 farmers
- Variable geology and salt loads
- Upper Bet Bet Creek sub-catchment:
  - 2300 ML recharge/year
  - 2600 tonnes salt/year
- Salt load exports largely driven by wash-off from discharge areas



## Re-vegetation action by farmers reduces groundwater head and river salinity

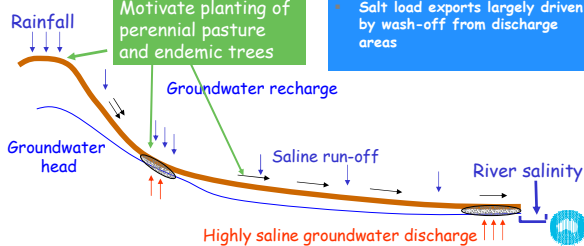
www.csiro.au



Market instruments that utilise differentiation in landscape and abatement costs

Motivate planting of perennial pasture and endemic trees

- ~9000 ha, 130 farmers
- Variable geology and salt loads
- Upper Bet Bet Creek sub-catchment:
  - 2300 ML recharge/year
  - 2600 tonnes salt/year
- Salt load exports largely driven by wash-off from discharge areas



## Key Issues

www.csiro.au

1. As this is an on-ground trial, several potential market impediments were evaluated.
2. The region is a highly targeted area with a potential for substantial salinity reduction: strong emphasis on gaining the participation of those farms with low cost abatement potential.
3. In lieu of enforceable property rights, a proposed competitive tendering process enables a low-risk, easy entry into the scheme.
4. Payment to participating farmers is performance based.



## Methods to design and test policy instruments

www.csiro.au

1. Identified and evaluated potential impediments to a successful on ground trial:
  - Economic (farm budgeting) modelling;
  - Development of a catchment recharge accounting and audit tool by integrated biophysical and economic modelling;
  - Extensive community consultation and experimental trials in the field;
  - Survey of attitudes to change, environmental responsibility and current farming behaviour.
2. Laboratory tested potential policy instruments and solutions using experimental techniques (*wind tunnel for water management policy*)



## Impediments identified in initial scoping

www.csiro.au

- A lack of fully articulated and enforceable property rights arrangements;
- A lack of a performance based incentive to manage and reduce recharge;
- Capital/cash-flow/time preference constraints;
- High transaction costs of information;
- The likely presence of thin markets;
- Non-market motivations.



## Recharge and farm income accounting and audit tool

www.csiro.au



Landscape position	Decision	Crop type	Management	Farm	\$GM	Recharge
Ridge & upper slope	1	Annual pasture	low intensity set stocking	1	3868	91
	2	Phalaris pasture	set stocking		3280	73
	3	Phalaris pasture	rotational grazing		2948	62
	4	Native vegetation	<10 years old		2210	22
	5	Farm forestry	<10 years old - low rainfall species		1399	0
Ridge & upper slope	1	Annual pasture	low intensity set stocking	2	5525	81
	2	Phalaris pasture	set stocking		5095	65
	3	Phalaris pasture	rotational grazing		4763	55
	4	Native vegetation	<10 years old		2763	20
	5	Farm forestry	<10 years old - low rainfall species		2023	0
Mid slope & break of slope	1	Annual pasture	low intensity set stocking	5	8840	59
	2	Phalaris pasture	set stocking		4897	29
	3	Phalaris pasture	rotational grazing		4043	15
	4	Native vegetation	<10 years old		3315	11
	5	Farm forestry	<10 years old - low rainfall species		1060	0
Lower slope & alluvial plain	1	Annual crop	good establishment and growth	9	8840	44
	2	Phalaris pasture	set stocking		6982	22
	3	Phalaris pasture	rotational grazing		6560	7
	4	Lucerne	managed but declining		5952	6
	5	Farm forestry	<10 years old - low rainfall species		3022	0

## Recharge and farm income accounting and audit tool

www.csiro.au

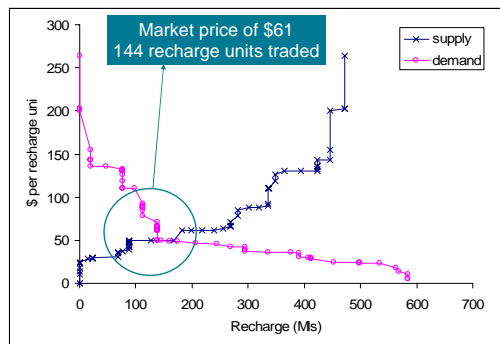
Landscape position	Decision	Crop type	Management	Farm	\$ GM	Recharge (units)
Ridge	1	Annual pasture	low intensity	1	3868	91
	2	Phalaris pasture	set stocking		3280	73
	3	Phalaris pasture	rotational		2948	62
	4	Native vegetation	<10 years old		2210	22
	5	Farm forestry	<10 years old		1399	0

### Experimental simulation comprises 12 players:

- 12 heterogeneous farms: 4 farms in 3 landscape positions each with 5 management decisions;
- Characterised by variable recharge rates, farm income and marginal values of recharge units.
- Net farm income is the sum of the farm decision income plus trading income (converted to player income).

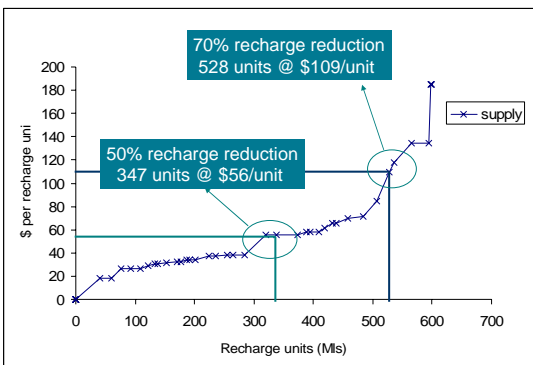
## Estimated Market with a CAP and Trade instrument: allocations at 50% reduction of maximum recharge

www.csiro.au



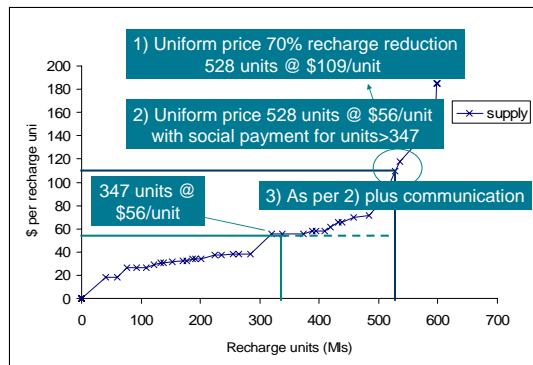
## Estimated cost of supply with a Tender based instrument

www.csiro.au



## Tender based instrument with a social payment for additional reduction

www.csiro.au



## Experimental protocols and setting

www.csiro.au

- Analogue of the catchment decision environment
- Player recruitment and assignment
- Experimental sessions
- Player payments
- Instruction sets and quiz
- Communication



## Experimental metrics: Market price: ( $M_p$ ) Recharge units traded: ( $R_o$ ) or recharge reduction Aggregate income for farms 1-12: ( $Y$ )

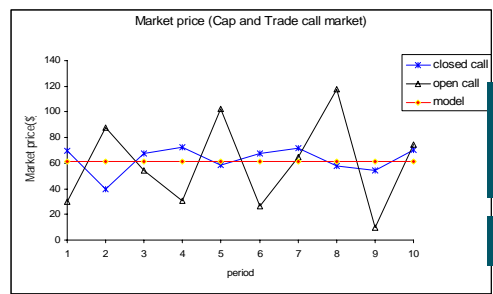
www.csiro.au

- Hypothesis 1:**  
 $H_0$ : Open call (publicly disclosed bidding information) = closed call (individual bidding information)
- Hypothesis 2:**  
 $H_0$ : Uniform price tender = Discriminate price tender
- Hypothesis 3:**  
 $H_0$ : Uniform price tender = Threshold (with a social payment) = Threshold + communication



## Laboratory Experiments: Hypothesis 1 gains from trade: open = closed call

www.csiro.au



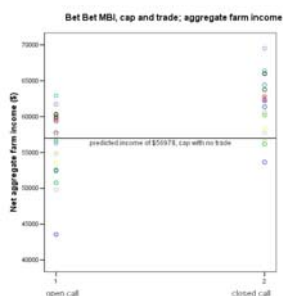
In this context, the more informationally complex open call is less stable

closed call more stable



### Laboratory Experiments: Hypothesis 1 gains from trade: open = closed call

www.csiro.au



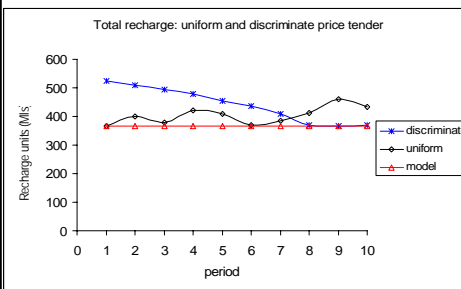
Reject Ho:  
 $F_{(2,47)} = 11.47 (p < 0.05)$   
 • Closed call gains from trade significantly greater ( $p < 0.05$ ) than open call and control  
 Accept closed call as the market structure

All statistical tests using ANOVA with heterogeneous variance, Dunnett's T3 post hoc test ( $\alpha = 0.05$ )



### Laboratory Experiments: Hypothesis 2 Total recharge: discriminate = uniform price

www.csiro.au

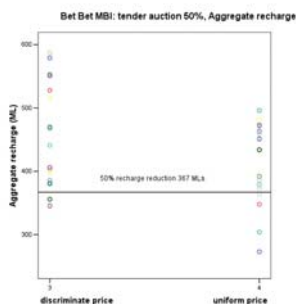


In periods 1-5, total recharge observed in the uniform price tender is less than discriminate price:  
 Is more incentive compatible



### Laboratory Experiments: Hypothesis 2 Total recharge: discriminate = uniform price

www.csiro.au



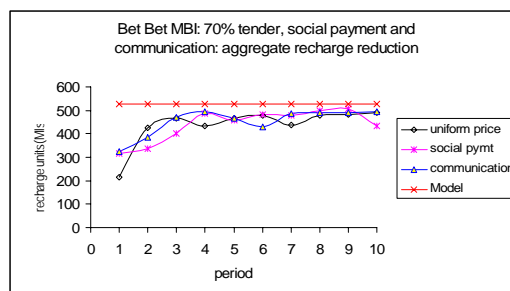
Reject Ho:  
 $F_{(2,22)} = 6.549 (p < 0.05)$   
 • Uniform price not significantly different ( $p \geq 0.05$ ) than control  
 • Discriminate significantly greater ( $p < 0.05$ ) than uniform and the control

Accept uniform price tender auction



### Laboratory Experiments: Hypothesis 3 tender = social payment = communication

www.csiro.au



### Laboratory Experiments: Hypothesis 3 tender = social payment = communication

www.csiro.au



Accept Ho:  
 $F_{(3,66)} = 4.231 (p = 0.008)$   
 • All treatments are significantly less ( $p < 0.05$ ) than the control  
 • No significant difference ( $p \geq 0.05$ ) between treatments

Accept social payment as bonus mechanism



### Impediments and design solutions

www.csiro.au

Impediments →	Property rights	Lack of performance incentive	Capital & time preferences/risk constraints	Thin market / rent seeking	Information costs	Non-market motivations
<b>Design features</b>						
Payments to establish obligations	x					
Performance based payment		x				
Multiple year agreement with establishment and annual performance payments		x	x			
Higher payment for more permanent change		x				
Uniform price auction				x	x	
Group performance component of payment to establish initial obligations				x		x
Group incentive payment for reconciliation of credit/debit positions					x	x
Extension including policy and economics demonstration software					x	

Impediments and design solutions www.csiro.au

Impediments →	Property rights	Lack of performance incentive	Capital & time preference/risk constraints	Thin market / rent seeking	Information costs	Non-market modifications
Design features ↓						
Payments to establish obligations	x					
<b>Application of experimental results to contract design</b> Trial uses a <b>uniform price tender</b> system, a <b>closed call market exchange</b> and provides a bonus <b>social payment</b> for exceeding the collective obligation.						
of credit/debit positions						
Extension including policy and economics demonstration software					x	

Main contract features www.csiro.au

- Negotiation of landholder contracts (uniform price tender)
  - Trial period of 12 months of land management change
    - Land management and recharge audit (individual payment according to recharge management performance)
    - Trading among landholders if required (closed call clearance market)
    - Social bonus paid to a local farmer organization if the collective obligation is exceeded

