A Producer's Propensity to Conserve Framework: Application to a US and Australian Conservation Program

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Introduction

The increasing recognition of the environmental impact of agriculture has led to increasing public activity to mitigate or correct negative externalities from such activities around the world. We find there exist important differences in approaches to public investment in conservation between countries as well as different courses for innovation and improvement. The contrast presented here is between the US Governments national program and the Victorian Government (Australia) program currently operating at the state level. Initially, US programs were heavily payment dependent, which created a sense of entitlement, later focusing on compensating producer costs of participation and opportunity cost, and strove for mass participation. Recently Australian programs have emerged less concerned with producer expectations but focusing more on meeting public resource concerns and cost effectiveness.

The following section describes the concept of a *producer's propensity to conserve* and how policy implementation may be influenced by it. It can be used as a framework to understand why (not) producers participate and what their expectations may be from a conservation program. The framework is also used to describe the potential returns to a producer from conservation, in the form of government grants/incentives and from improvements in on farm productivity (less water borne diseases, better pasture management etc). The framework provides a useful starting point when considering what type of conservation program to run and program cost effectiveness.

An Australian and US conservation program are compared and contrasted to demonstrate the use of the framework.

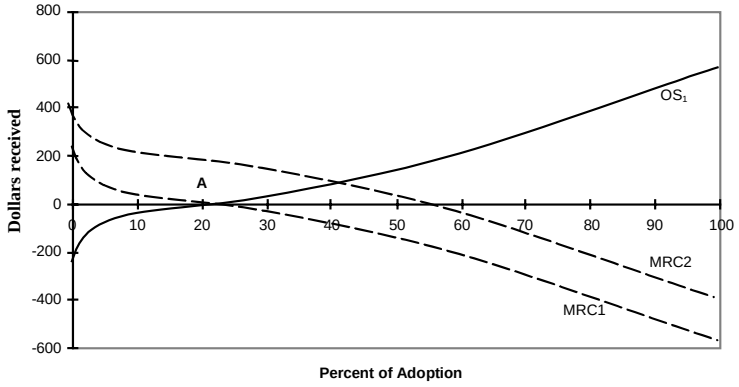
Producers Propensity to Conserve Framework

A producer's conservation propensity function (CPF) can be described as follows:

CPF=f (Net Benefits / Individual Characteristics; Physical Conditions; Financial Conditions (including initial costs); Policy Variables; etc.)

Policy implementation can then focus on this function for program success which is often dependent upon high levels of participation based on producer's perceptions and individual program benefits. These perceptions are based on their individual farming enterprises, not on the broader set of environmental amenities that might be created from participation. This can be illustrated by Figure 1 below. On the x-axis are the producers that can provide environmental goods and services and on the y-axis is the dollar benefit to the landholder from undertaking conservation activities (without a subsidy or grant). Figure 1 focuses on the financial conditions of the producers to demonstrate how propensity to conserve may vary.

Figure 1. Perceived Marginal Return to Conservation



MRC_1 shows the hypothetical marginal return to conservation curve is illustrated here starting from a point where a perceived direct benefit from this conservation program is $200. Many producers might undertake conservation of their own accord, given the private benefit. However, they may not be aware of the specific activities to achieve both the conservation outcomes and the financial return. Extension and eduction programs may be useful in providing this type of information if the government desires more environmental outcomes.

As one moves to the right on the x-axis, incentives need to be applied to enlist a producer. Consider the offsetting cost function, OS1 in Figure 1, as the payment necessary to make a producer neutral to the conservation activity. To the right of *A* producers require financial compensation in order to offset their opportunity cost of undertaking conservation activities.

One could shift the perceived MRC_1 upwards through a change in producer's attitudes towards conservation to lessen the offsetting cost required such that subsidy payments would only be

necessary for the last 45% of adopters. This assumes that the attitudinal changes provide producers with sufficient benefit (utility) to offset the financial costs.

A conservation program could be judged cost effective if it paid only the amount a producer needed (the opportunity cost) to undertake the conservation activities. In addition, the program would need to ensure it is only providing financial assistance to those that can provide environmental goods and services – the program can assess the environmental goods and services it is producing.

Case studies

What follows are two short program descriptions that are then contrasted to illustrate the difference in both programs and possible future directions between the US and Victoria conservation programs.

The U.S. Example: Conservation Reserve Enhancement Program (CREP)

The CREP is a 1996 extension of the 1985 Conservation Reserve Program (CRP). These are voluntary programs, however, national water quality regulations are beginning to provide an incentive for farmers to be involved in CREP. In the CRP, producers bid for program participation to set land aside in conserving uses for a decade. Bidders are ranked on the conservation value of their land and the level of their bid. Those accepted receive annual payments from the federal department of agriculture (USDA). CREP is also a land set aside program but specific to certain conservation practices required of the farmer in addition to a land set-aside.

In these programs, the productivity of the farm and extent of change to achieve conservation are critical to participation. For example, in the Shenandoah Valley of Virginia, dairy and cow-calf operators farm pastures with some of the highest carrying capacities in the US. However, stock can cause a severe physical toll on waterways, adding to problems of fecal coli contamination and stream bank soil erosion leading to increased sediment loads, detrimental impacts on wildlife habitat, and other downstream concerns.

One of the goals of CREP in the Valley is to provide incentives to producers to guard against cattle's damage to stream beds and water quality. In this case CREP provides a 50% cost share on stream fencing, alternative watering facilities, and stream bank stabilization. The US Natural

Resources Conservation Service (NRCS) provides technical assistance to farmers for such actions through its local offices. Farmers draw up a conservation plan for management practices and infrastructure investment with technical assistance from NRCS. This is the basis for entry into the program, so the locally available technical assistance is critical.

The institutional structure and a history of incentive driven participation in this voluntary program makes the producer's focus on his/her perceived benefits and costs critical to participation. The federal agency's goal to increase participation encourages making the program more attractive to a producer's bottom line. Because bidding into this program is only quasi competitive, the incentive level tends to increase, moving to the right in Figure 1, offsetting higher perceived costs to increase participation. Producer costs and benefits from streambed exclusion become paramount. One can envision a series of these individual costs and benefits across all producers in the Valley which, in theory, could predict the likely rate of adoption of streambed exclusion. Such analysis is an important part of the analysis for US programs (NRCS 2005). Table 1 is a template for such a cost consideration for a Shenandoah operation with 100 head (50 cows and 50 calves). This illustrates what a producer may consider in his/her decision.

Table 1. Producer Level Potential Costs (in $US)

Item	Potential Loss or Compensatory Action	Perceived Probability	Monetary Value	Annualized Cost
Loss of Convenience				
Well/trough maintenance	2 hours work/week	100	$10/hour	$1,000
Loss of Pasture Land	1.2 Ha	100	$173	$210
Loss of Easy Access	Build stream pass-through	100	$5,000	$550
Loss of Shade for Cattle	Construct shade sheds	100	$2,000	$50
Pasture Management				
Additional Management	Rotational management	100	$25/occurance	$750
			TOTAL	$2,500

In this case it would be in the producer's interest to undertake the conservation activities without compensation. The producer is at the left axis of Figure 1. A similar account for the benefits side is presented in Table 2 below.

Table 2. Maximum Producer Direct Potential Annual Benefits – No Subsidy (in $US)

Item	Potential Gain or Averted Loss	Perceived Probability	Monetary Value	Annualized Cost
Herd Health				
Reduced foot problems	6 Vet visits	100	$200	$1,200
Less water borne diseases	5 calves/year	100	$100	$500
Generally less calf loss	2 calves/year	100	$100	$400
Increased daily gain				
Pasture Management				
Better forage utilization and grazing distribution	+2 animal units	$100	$300	$600
Reduced soil erosion				not applicable
Reduced downstream impact				not applicable
Better water quality				not applicable
Improved wildlife habitat				not applicable
			TOTAL	$2,700

To improve participation both the level of the subsidy and the possibility of changing perception of farmers about conservation should be important in the US. What exists is a focus on the cost to producers (both direct and opportunity cost) as a basis to incentives for participation. The introduction of producer cost based program tends to create a program based offsetting cost curve that is often above the mirror image of most producer's perceived cost curves in order to expand participation. Setting what might be a high reserve price for participation over and above the true opportunity cost. Raising the producer's perceived marginal return to conservation curve – reducing the offsetting cost required is practiced less.

Under the U.S. programs, less may be achieved than desired unless more specific environmental benefits can be calculated and ascribed to specific individual producers. The 1966 Environmental Quality Incentive Program (EQIP) in the US included a high degree of targeting based on cost effectiveness that could be placed in the context of potential environmental benefits from a producer or a limited geographical area. However, this form of targeting does not ensure cost effectiveness, the program could improve by measuring the environmental benefit for each farm and providing funds to low cost producers, were cost is determined per unit environment benefit obtained.

When this program was greatly expanded with the 2002 Farm Act, many of the targeting aspects of the program were excluded under the new authority to more broadly spread participation. One unanswered question is whether targeting to improve environmental benefits can be accomplished increasingly through the alternative of changing producer's perceptions to better perceive individual and common advantages where benefits are high. This would mitigate the requirement for a high level of program benefits as offsetting costs.

The Victorian Example: EcoTender

The institutional structure of the Commonwealth Australian government and it States allow the states to act independently of the commonwealth. They have their own environmental budgets and there is pressure on them to perform well. What follows is a description of an innovative Australian program that lowers cost of procuring environmental outcomes through structured competitive bidding and specifically incorporates multiple amenity values.

In 2001-03 Victoria implemented a program called BushTender (Stoneham et al 2003), which was loosely based on the US CRP program. BushTender used an auction system to distribute environmental funds to landholders in return for providing terrestrial biodiversity outcomes on their properties. The implementation of BushTender led to approximately 5000 hectares of native vegetation on private land being secured under management agreements. In economic terms, it created the supply side of a market for nature conservation, and generated significant cost savings when compared with typical grant-based systems for distributing conservation funds to landholders.

Victoria explicitly recognised that farmers are willing and able to make informed businesses decisions. They will put aside land and or manage their land and water resources if they can generate a return equal to or in excess of current activities. Therefore the Victorian Government set about allocating land management contracts that provide benefits to terrestrial biodiversity, BushTender.

The Bush Tender program focused on the right hand side of Figure 1, to the right of the intercept at 20% adoption. It was assumed farmers would have undertaken actions to left given they would provide positive economic returns to the farmer. Alternatively, if there are positive returns to

producers they would bid lower and government would get their desired environmental outcomes at a lower cost.

EcoTender is based on the highly successful BushTender trial that took place in Victoria during 2001-2003. The $500,000 EcoTender pilot is an initiative of the Victorian Department of Primary Industries (DPI), funded by the National Action Plan (NAP) for Salinity and Water Quality Market Based Instruments Program (MBI).

EcoTender is the next advance in the application of market-based instruments to solve environmental problems on private land. Whereas BushTender focused on a single environmental outcome (increasing terrestrial biodiversity), EcoTender aims to achieve multiple environmental benefits including reductions in the amount of saline land and improvements in in-stream water quality.

Key to the success of the *tender* process is the gathering of previously 'missing information' linking landholder actions on farm with environmental objectives. If relevant information *is* gathered and shared between buyers (government) and sellers (landholders) of environmental goods and services, new markets can be created for these products.

The EcoTender process ensures that the government has the information it needs to be able to directly link environmental outcomes with actions on private land. Rather than use site data (eg erosion on site) to select intervention locations environmental programs need to focus where the impact is occurring, which generally is off site. Accurate spatial resolution and location information are critical to the process.

EcoTender as with BushTender focuses on the outcomes of the program. For instance, the action of replacing pasture with indigenous trees results in a measurable output such as a reduction in erosion at the site. EcoTender is interested in the outcomes that would result from the restoration and maintenance of remnant vegetation including a reduction in erosion – thus the importance of connectivity within the landscape. For example we are interested in whether a reduction in erosion will contribute to improving stream health.

For instance, a reduction in erosion can be described in the following steps. 1. Fall in erosion, 2. Fall in erosion to stream, and 3, Reduced impact on riverine flora and fauna. This is followed by an assessment of the significance of the flora and fauna within the context of local and regional

stream networks. The final outcome could be an aggregate of the service provided to riverine flora and fauna, adjusted for river significance. The outcome used to assess the bids is limited by available scientific information.

This program design recognizes a correlation between the production of environmental outcomes. That is for one action a number of environmental outcomes may be reduced. For instance revegetation with native species provides benefits to terrestrial biodiversity as well as water quality benefits (reduced nutrient runoff), less erosion to stream and carbon sequestration (need to be careful with carbon because there is a market now, may not be considered a public good any longer). Also reduces groundwater accessions thus reducing saline land.

Further, a number of studies have suggested that conservation programs using a range of mechanisms (grants, taxes) have been inefficient because they have focused on on-site information rather than environmental outcomes (Ribaudo 1986, Wu and Bogess 1999, Wu and Skelton-Groth 2002). For example some US conservation programs have focused on on-site physical criteria, such as soil erosion and recharge, rather than the benefit to the environment of a reduction in erosion or recharge. There is a growing recognition that environmental outcomes are correlated – benefits are jointly produced by the same action. For instance, revegetation may jointly produce carbon, improvements to water quality and wildlife benefits. Wu and Bogess (1999) refer to this as an ecosystem-based approach that recognises the interaction between alternative environmental benefits. They show that an efficient fund allocation must account for both physical production relationships between environmental outcomes and the value (to the environment) of those outcomes.

The environmental outcomes were chosen in EcoTender because they were considered to be public goods. That is the market would not provide these goods as there is no monetary incentives for farmers to change their landuse practices. Also the outcomes have public value and the public needs to make decisions about what they want and how much money to spend.

In EcoTender it was not possible to determine what the single most important outcome is. This relies upon either having scientific information relating to the threat to flora and fauna for prioritization. Alternatively you could prioritize based on preferences which would require information about what society prefers. This is generally not available, so best judgment has to be used. Suggested methods for eliciting this information are CV, CM, past budget allocations, the

Minister etc. The first two require imparting a lot of scientific information to members of the public and asking them to make a decision about preferences. However, it is widely recognised that this method is very costly if done well and is fraught with many other problems.

The following table summarizes the outcomes used in the pilot.

Table 3. Summary of outcomes, service and significance

Attribute	Change in level of service	Desirable change	Significance
Terrestrial Biodiversity	Δ habitat score (habitat maintained or improved per ha)	Increase	Biodiversity conservation significance , threatened species conservation status, habitat quality, landscape preference
Aquatic function	Δ water "quality" (tonnes of soil / ha to stream)	Decrease	(not in pilot)
	Δ water quantity (mm of water / ha to stream)		
Saline land area	Δ saline land (ha with groundwater < 2m)	Decrease	can discriminate - but equal weighting in pilot
Carbon sequestration	Δ carbon sequestered (tonnes / ha)	Increase	n/a

The pre-1750 environmental conditions benchmark was also used to calculate the final aggregate score. For each of the environmental outcomes the pre-1750 and current stock of each outcome was calculated under steady state conditions (see 4 below).

Table 4. Pre-1750 and current environment outcome stocks

Environmental outcome	Pre-1750 stock	Current stock	Difference
Habitat hectare[1]	418,140	19,081	399,059
Saline land area (<2m)	83,702	127,153	43,451
Aquatic function	27,070	94,320	67,250

1) Applied to both remnant management and re-vegetation

For each site assessed in the auction equation (1) was applied to determine the aggregate score.

$$Total\ Score = \left(\frac{A_i}{D_A} + \frac{S_i}{D_S} + \frac{B_i}{D_B} \right) * 100 \qquad \text{(i)}$$

where:

A_i, S_i and B_i are the aquatic, saline and biodiversity outcomes for site i

D_A, D_S and D_B are the aquatic, saline and biodiversity differences from Table above

In effect the above equation calculates the total percentage movement towards pre-1750 conditions for each of the environmental outcomes.

Carbon is dealt with as a market good and landholders are paid separately for each unit produced. The selection of bids is based only on the Total Score and the cost of the bid, farmers adjust their bid given the knowledge they will receive carbon payments if their bid is accepted.

One of the key motivations EcoTender was the hypothesis that environmental outcomes are jointly produced and this feature might improve the cost effectiveness of funds allocated to the environment. In order to determine if outcomes are jointly produced a random sample of sites were assessed for saline land, carbon, terrestrial biodiversity and aquatic function. These sites were then sorted to determine whether they were producing more than one outcome – for the single action revegetation. Analysis of the simulation results derived for all sites with the pilot suggest that 73% generate two or more environmental goods supporting the hypothesis that environmental outcomes are jointly produced from a single landuse change.

Further, if outcomes are jointly produced there may be scope to reduce total costs if outcomes are correlated. For instance the use of one outcome as a proxy for others may reduce the level of model reporting and complexity. This may save time and reduce the transaction costs associated with estimating outcomes. In order to test if outcomes can be used as proxies for one another the outcomes are tested for spatial correlation.

The table below shows the correlation matrix between the metrics for aquatic function, saline land, carbon and the significance indices for terrestrial biodiversity, for the whole catchment.

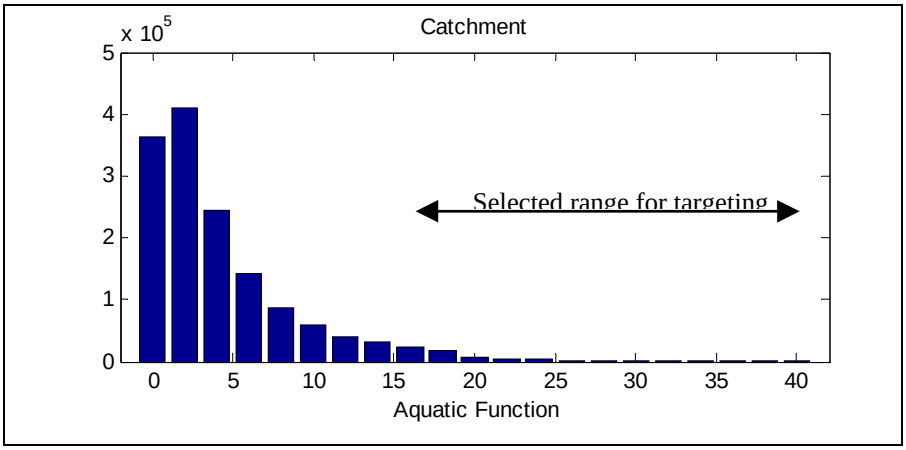
Table 5. Whole of catchment spatial correlation matrix

	Aquatic Function	**Carbon**	**Saline Land**	**BLP**	**LC**
Aquatic Function	1				
Carbon	0.17	1			
Saline Land	0.16	0.06	1		
BLB	0.03	-0.07	-0.09	1	
LC	0.09	-0.06	-0.17	0.64	1

Results presented in Table 5 suggest that there is a very low correlation at the catchment scale between outcomes, and as such we would expect a lot of variability in the *total score* (sum of outcomes) reflecting landscape variability. These results support the need to estimate the outcomes for each site during the auction because no assumptions can be made about the level or ratio of outcomes. The catchment modeling framework used in EcoTender can provide *ex ante* data on expected outcomes. There is a temptation to use this data to target areas with the aim of reducing the number of site/farm visits thereby saving time (reducing costs) or achieving greater outcomes (areas with *ex ante* high outcome scores).

The following is an example of targeting areas of the catchment based on high outcome scores. 4 below shows the histogram for aquatic function outcomes for each site within the catchment (approximately 1.4 million units each of 50*50 metre resolution). Using tools built into the CMF specific areas of the histogram can be remapped by selecting a range.

Figure 4. Catchment - Aquatic Function Histogram



For this example land areas that scored aquatic function greater than 15 were mapped to show their location within the catchment. This showed there was a concentration of land in the south east of the catchment scoring high for aquatic function. It may be possible to target these areas for land use change reducing the costs by not visiting other areas of the catchment, were aquatic function the primary outcome of interest. However, it was shown above that there is a very low correlation between outcomes, so targeting this area may reduce the overall quantum of outcomes.

While it may be tempting to target high impact areas the cost of undertaking actions in these areas may be high. It may be possible to target areas with lower aquatic impact at a lower cost, thus reducing the cost per unit outcome. The overall cost for a given level of aquatic function would be lower. The auction approach adopted in the pilot makes the most of both the heterogenous nature of the outcomes and costs. It may be possible to identify other areas with a lower aquatic function score but increase the scores of one or more of the other outcomes, generating greater outcomes in aggregate, assuming the purchaser is indifferent between outcomes.

Conclusions

- The methodology applied in EcoTender links landuse and management with biophysical crop growth and environmental processes on a site-specific basis with the capacity to assess the off-site impacts at both the farm and sub-catchment scales. This approach accounts for spatial variability and connectivity within the landscape in a way that is not yet in practice in the U.S. The scientific framework of EcoTender has shown that using site based measures alone are not suitable metrics for the allocation of environmental funds for the prevention of catchment (water shed) scale environmental problems.
- EcoTender demonstrates the value of adopting a holistic catchment modelling framework to inform a market-based auction process.
- Further the EcoTender has shown that targeting a single outcome is not sufficient to capture the heterogeneity of landscape change at the farm scale. Combining this information with auctions for landuse change provides the opportunity to purchase environmental outcomes more cost effectively than current grant based approaches.
- The U.S. approach is really and incentive program as compared to Victorian approach.

- The U.S. approach provides landholders with an incentive to seek money, however it provides little incentive for producers to implement measures on behalf of the government cost effectively.
- The structured auction approach introduces competition so farmers recognise they need to be able to provide the outcomes on a cost effective basis to be competitive. Associated high subsidies may create a culture of expectation, “I deserve to have money given to me because it has been done in the past.” “I have the right to farm.” etc.
- An alternative view may be society (through the creation of laws etc) has given farmers the right to own land and water. One method of compensating landholders is to treat the environmental outcomes they produce/depleting as market goods and pay them for providing them (reducing the depletion rates).
- The U.S. approach generally adopt on-site criteria to allocate funds, this is not the most cost effective way to go as shown in EcoTender.

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