An Economic Approach to Plant Introduction Decisions: The case of plant-based solutions to salinity

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Certification

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

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Abstract

Invasive plants and dryland salinity both impose considerable costs on the Australian environment and agriculture. Expectations are for these costs to increase still further because both result from dynamic, and sometimes lengthy, processes. A range of exotic pasture plant species has been identified as having the potential to reduce dryland salinity if introduced to Australian farming systems. With this opportunity however comes the potential for these new plants to become invasive (i.e. weeds) and thus add to the already high annual costs of introduced plants. How do we decide whether to introduce the new pasture plants or not?

Current decision processes employ a precautionary approach that favours the exclusion of new plants from Australia through consideration of potential costs but not benefits. As the potential gains and costs from the new pasture plants may both be high, an alternative decision framework is needed. This thesis presents an economic approach where introductions are allowed when they offer positive contributions to society's welfare. The approach has been applied to the decision to introduce new varieties of birdsfoot trefoil (*Lotus corniculatus* L.) to the Kings Plain Subcatchment within the Border Rivers Catchment of northern New South Wales.

The analysis for this study rests on the development of a bioeconomic model within a guiding benefit-cost framework. The bioeconomic model comprises two sub-models. The first uses a numerical, deterministic, dynamic programming technique to estimate the benefits of reduced salinity as a result of introducing birdsfoot trefoil as a pasture option in the Kings Plain Subcatchment. The second uses a deterministic, and then stochastic, simulation technique to estimate the costs of birdsfoot trefoil's spread in agricultural and natural areas of the surrounding Border Rivers catchment. The difference between these benefits and costs is the net contribution to welfare.

The results of this study show the range of conditions under which the introduction of birdsfoot trefoil and new pastures in general, would offer net benefits and therefore should be permitted. The benefits were found to vary with initial depth of the watertable and result from the combined impact of delaying rising watertables *and* allowing landholders to more profitably operate when watertables are closer to the

surface. Benefits were estimated to be highest for an initial watertable depth of 3.5 m and for the Kings Plain Subcatchment were estimated to be $8.8 million over 50 years discounted at 7 percent. The costs were found to vary with the number of seeds transferred into the surrounding Border Rivers Catchment. For the case where 10,000 seeds per hectare are dispersed annually, costs were estimated in stochastic analysis to have a mean of $0.50 m in agricultural areas and less than $10,000 in natural areas. The number of seeds dispersed from the subcatchment was demonstrated to be the key uncertainty on which the overall decision to introduce rests. The net benefits were found to be positive where the number of seeds dispersed into the surrounding catchment is less than 2 – 3 percent of those produced in pasture in the subcatchment.

If a decision to introduce is made on the basis of an expected increase in welfare, some groups may be made worse off by the decision so that there is a role for government to minimise the costs to these groups. This could include the imposition of liability, on those who introduce the plant, accompanied by performance bonds for introductions where collective action is possible or direct regulation where it is not. However, research and development to minimise the uncertainty of plant dispersal and inform policy is considered likely to accompany any decision to introduce such new plants. In the case of a problem of salinity and invasive plants, there is potentially a role for government to both encourage the adoption of plants such as birdsfoot trefoil and also minimise the external impacts of invasiveness.

The study offers a balanced and improved means of determining if new plants should be introduced and policy approaches to this decision, when costs and benefits, including externalities, result from dynamic and uncertain natural processes.

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Acronyms used in this study

ABARE	Australian Bureau of Agriculture & Resource Economics	KPS	Kings Plain Subcatchment
ABS	Australian Bureau of Statistics	LWA	Land and Water Australia
APHIS	American Animal and Plant Health Inspection Service	MDBC	Murray-Darling Basin Commission
BA	Biosecurity Australia	NAP	National Action Plan for Salinity & Water Quality
BFT	Birdsfoot trefoil	NDSP	National Dryland Salinity Program
BRC	Border Rivers Catchment	NHT	Natural Heritage Trust
BSMS	Basin Salinity Management Strategy	NLP	National Landcare Program
CMA	Catchment Management Authority	NLWRA	National Land & Water Resources Audit
CRC	Cooperative Research Centre	NRM	Natural Resource Management
CRC PBMDS	CRC for Plant-Based Management of Dryland Salinity	PMSEIC	Prime Minister's Science, Engineering and Innovation Council
CSIRO	Commonwealth Scientific & Industrial Resource Organisation	R&D	Research & Development
DAFF	Department of Agriculture, Fisheries & Forestry	RDC	Research and Development Corporation
EC	electro conductivity	UN	United Nations
FAO	Food and Agriculture Organisation	USDA	United States Department of Agriculture
GIS	Geographic Information System	Weeds CRC	CRC for Australian Weed Management
GM	Genetically Modified	WONS	Weeds of National Significance
GRDC	Grains Research & Development Corporation	WRA	Weed Risk Assessment (system)