



Research article

Weed hygiene practices in rural industries and public land management: Variable knowledge, patchy implementation, inconsistent coordination



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ABSTRACT

Weed management science and practice largely focuses on eradicating, containing and reducing existing weed populations; the focus is on plants in situ. More recently, the redefinition of biosecurity to include weeds has seen greater attention paid to preventing the introduction of weeds to previously uninfested areas within countries. Thus weed hygiene has come to the fore, with a growing number of publications recommending a diverse range of practices to minimise the spread of weeds across farm, regional and state boundaries. Yet little is known about the uptake of weed hygiene practices. The aim of this paper is to evaluate the extent to which best practice weed hygiene is being implemented on, across and along private and public lands. Telephone interviews were conducted with 54 private and public land managers, weed contractors, and agricultural transport operators in New South Wales, Australia. Vehicle hygiene was commonly undertaken across all stakeholder groups when it was consistent with other goals, requirements or norms. Other practices, such as sequencing harvesting from least to most weedy paddocks or including weed hygiene clauses in contracts were often known, but rarely practiced because of the onerous labour and financial costs or concerns about social etiquette. Individual commitment to weed hygiene efforts were also undermined by intra and inter-organisational coordination challenges. Public debate and assessment are needed on the benefits and costs to society of weed hygiene compared to in situ weed control to determine where best to invest limited time and resources.

1. Introduction

Globally, minimising the spread of invasive plants by regulating and working with a wide range of individual and company landholders and land users, plant industries, and agencies is undertaken by all levels of government. This investment represents a significant part of land and natural resource management governance and expenditure. Landholders are, for example, often required to manage their land to mitigate the spread of designated invasive plants. More generally, a key element of biosecurity policy and management internationally is prevention of the entry and subsequent spread of invasive organisms (Food and Agriculture Organisation, 2007). Accordingly, prevention is a central plank of invasive plant policy and management (e.g. Great Britain Invasive Non-Native Species Strategy, the USA 2016–2018 National Invasive Species Council Management Plan, and the National Invasive Species Strategy and Action Plans of Jamaica, Mauritius, Tonga, Vanuatu, among others). Prevention can be enacted in numerous ways. Perhaps best known is border control and quarantine at

ports and airports. However, both within countries and within and across boundaries at other scales – states, regions, individual properties, and public landholdings – what are generally known as ‘weed hygiene’ practices can play an important role in preventing and/or minimizing the further spread of invasive plants. These practices aim to reduce the spread of invasive plants and include cleaning vehicles, machinery and equipment, and taking precautions in fodder and animal transport. Yet, in Australia and elsewhere, this aspect of invasive plant (hereafter referred to as weeds) management appears to have attracted little research outside of that focussed on distribution vectors.

Among Australian weed managers, weed hygiene is regarded as an important part of weed management and this importance is reflected in the plethora of policies and guidelines on weed hygiene practices (Table 1). Despite the presence of such research and guidelines, the 2013 National Landcare Survey (de Hayr, 2013) indicated that very few resources were being expended on weed hygiene; only 11% of agricultural businesses surveyed incurred weed hygiene costs. More generally, there has been limited research into the extent to which weed

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Table 1
Recommended weed hygiene practices and responsibility in research and management sources.

Location	Responsibility	Practice	Source
On-farm	Farmers	Sow weed-free seed: check Seed Analysis Certificate for bought seeds (or request a Weed Hygiene Declaration); demarcate seed paddocks and ensure weed numbers are very low	(Storrie, 2014; PHA, 2012)
		Set aside containment areas if hand-feeding stock with imported feed; empty out stock before returning to pasture	(Storrie, 2014; Sindel and Coleman, 2010, 2012)
	Farmers, contractors	Harvest paddocks from least weedy to most weedy; clean farm machinery before relocation	(Storrie, 2014)
		Train farm personnel in biosecurity and farm hygiene practices; supply personnel hygiene supplies where appropriate	(PHA, 2011, 2012)
On and off-farm	Farmers, agricultural transport companies	Secure loads (grain, fodder) if suspected of containing weed seeds	(Biosecurity Queensland, 2014)
		Avoid vehicle and machinery movements when road conditions are wet and muddy; do not drive through infested paddocks; visiting consultants to use vehicle supplied by farmer	(ACCRC, 2000; Biosecurity Queensland, 2014)
	Farmers, contractors	Enforce machinery cleaning standards with all harvest, baling, windrowing and grain transporting contractors	(Storrie, 2014; PHA, 2012)
		Quarantine livestock exposed to plants for 5–8 days prior to transport to a new destination; use dedicated weed-free holding paddocks	(DNRME, 2004; Storrie, 2014)
Roadside/construction sites	Contractors, field workers	Vehicle/machinery wash-down and decontamination	(ACCRC, 2000; Anderson, 2011; Biosecurity Queensland, 2014; DoE, 2015; DPIPW&E, 2015; Rudman et al., 2004)
		There are specific procedures for cars, trucks, 4WDs; compactors; cotton pickers; dump trucks; excavators; headers and harvesters; mini tractors; PTO rotary hoes; track-type dozers; wheeled loaders; wheeled tractors	
	Field workers	Personal and small tool wash-down using portable wash baths	(Rudman et al., 2004)
Waterways, wetlands, riparian zones and boggy areas	Field workers, contractors	Ensure all materials taken onto a site (seedlings, mulch, soil, gravel, rock and sand) are certified free of weeds (AS3743-2003, AS4454-2012)	(DPIPW&E, 2015)
		Conduct site assessment to determine if noxious weeds or plant disease are present; chemically treat or manually remove weeds before commencing work; plan disposal method to be used	(CCF, 2011)
		Minimise movement of machinery and avoid slashing during peak seed production times	(Baldyga, 2006; Biosecurity Queensland, 2014; CCF, 2011)
		Undertake works in clean areas then gradually work toward infested areas	(Baldyga, 2006)
		Incorporate machinery hygiene into contracts	(Baldyga, 2006)
		Ensure roadside material, such as soil and gravel, is seed-free (vendor declaration); locate stockpiles in weed-free areas and regularly inspect	(Baldyga, 2006; CCF, 2011)
Waterways, wetlands, riparian zones and boggy areas	Field workers, contractors	Locate staging grounds (work depots) in weed-free areas; undertake regular inspections and control works	(Baldyga, 2006)
		Nominate areas for clean-down procedures and roadside slashing, and establish wash-bay for long-term projects; include on site plan; avoid sensitive vegetation and wildlife; ensure run-off will not enter any watercourse (30 m buffer)	(Baldyga, 2006; CCF, 2011; DPIPW&E, 2015)
		Avoid scalping and tyre rutting	(Baldyga, 2006)
		Avoid use of felt-soled boots, waders	(Allen and Gartenstein, 2010)
Waterways, wetlands, riparian zones and boggy areas	Field workers, contractors	Check all equipment is free of debris and dry	
		Check all machinery (tractors, mowers, slashers, bulldozers, graders, excavators), vehicles, boats, trailers are clean and dry	
		Disinfect (with Phytoclean or F10) footwear, equipment, vehicles and machinery between sites; wait 48 h before using equipment in another waterway	

hygiene is being undertaken by landholders and other groups with land and weed management roles, and particularly into the reasons behind implementation, or lack thereof. Thus, the aim of this paper is to explore the extent to which private landholders, public land managers, weed contractors and agricultural transport operators know about and implement weed hygiene best practices. It also examines the reasons why they do or do not implement certain practices. It is based on research in New South Wales (NSW), located in south-eastern Australia.

2. Weed hygiene in policy and research

Pimentel et al. (2005) estimated that invasive species caused \$US120 billion in damage and losses in the United States. High figures are similarly reported for other countries such as China (Pejchar and Mooney, 2009). In Australia, a conservative estimate is that weeds cost the NSW economy over \$AUS1.8 billion each year through control

costs, productivity losses, public agency expenditure, and value lost due to price responses in agricultural markets (Natural Resources Commission, 2014). This does not include impacts on biodiversity or costs of control by private landholders on non-agricultural land. More generally in Australia, the recent draft Australian Weeds Strategy 2017 to 2027 (Invasive Plants and Animals Committee, 2016) noted that weeds cost the grains industry \$AUS3.27 billion annually in control measures and lost production. Hoffmann and Broadhurst (2016) calculated that the total costs of invasive species in Australia in 2011–12 were \$AUS13.6 billion and noted that this is a conservative estimate, especially for environmental costs.

In this context, there is emphasis in policy in prevention of weed spread at various scales. For this paper, the focus is on prevention of spread within national borders. In Australia, the scope of appropriate strategies and management tools is largely governed by the extent to which a weed is widespread. Once a weed is widespread and abundant

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