An assessment of the impacts of environmental certification on vegetation management in New Zealand plantation forestry

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Summary The dependency of the New Zealand forestry sector on herbicides for cost-effective vegetation management does not align with environmental principles endorsed by the Forest Stewardship Council (FSC). Hexazinone and terbuthylazine, two of the most commonly used herbicides in New Zealand forestry, have been ranked by FSC as hazardous and must not be used in certified forests without special dispensation. A 5 year interim approval has been obtained for the continued use of these herbicides in certified forests. To extend an approval a certificate holder must show a need for using hazardous herbicides. Such an assessment requires an estimate of the likely cost of alternative vegetation control methods. Using discounted cashflow analysis, the economic implications of alternative vegetation control methods that: (1) use FSC compliant herbicides; (2) reduce overall herbicide use; and (3) avoid herbicides altogether, were examined. Results indicate removal of terbuthylazine and hexazinone from the forester's vegetation management toolbox in FSC certified forests could reduce profitability of the New Zealand forestry sector.

Keywords Derogation, FSC, cost analysis, weeds, herbicides, environmental impacts.

INTRODUCTION

The New Zealand plantation forestry sector, comprising approximately 1.8 million ha of planted forests, returns over $3.0 billion per year in export forest products (10% of 2007 total exports) (NZFOA 2007/2008). Although more difficult to quantify, plantation forests also make major positive contributions to environmental and social issues (Ford-Robertson 1996, Palma 2005, Brockerhoff *et al*. 2008). These economic, environmental and social benefits from plantation forestry can only be realised if a variety of biotic and abiotic factors are effectively managed, most importantly, in the case of *Pinus radiata* forests, competition from weeds. Management of the competing vegetation during the establishment of plantation trees is the single most important silvicultural practice used to maximise timber yield (Wagner *et al.* 2006). The short-term benefits include increased early survival and growth (Squire 1977, Watt *et al*. 2003), and the long-term benefits, an overall gain in volume (m^3 ha^{-1}) of 1–4 years on many sites in New Zealand (Wagner *et al*. 2006). Management of the competing vegetation can be achieved though a variety of methods (manual, mechanical, chemical or biological), the principal determinant being cost effectiveness. Currently, the most cost effective vegetation management strategies in New Zealand involve the use of herbicides, both in pre-plant site preparation treatments and for release during the first, and sometimes second, year after planting.

The dependency on herbicides for vegetation management creates problems for the sector. Public demand for products from sustainably managed resources has led to the development of independent forest certification schemes aimed at ensuring (plantation) forests are managed in an environmentally appropriate, socially beneficial and economically viable manner. The Forest Stewardship Council (FSC) is the dominant certification body for the New Zealand plantation forestry sector, with 42% of New Zealand's plantations currently FSC certified. While there are a number of criteria against which a forest company is assessed for FSC certification (and for which the sector is generally compliant), the policy on pesticide use has been one associated with much conflict (Hock and Hay 2003). The pesticide policy requires the phasing out of chemicals designated as highly hazardous with an ultimate move away from pesticide use (FSC 2007). Hexazinone and terbuthylazine, two of the four most commonly used herbicides in New Zealand plantation forestry, have been ranked by FSC as hazardous and cannot be used without special dispensation (derogation) (FSC 2007). The key attributes of hexazinone and terbuthylazine that underpin their value to the sector are their selectivity to *P. radiata*, as well as their persistence that enables herbicide applications to control weeds for up to 1 year. This is particularly relevant for the control of aggressive weeds such as buddleia, gorse, broom and grasses during the first year or two after planting.

A temporary derogation has been obtained for restricted use of hexazinone and terbuthylazine on certified land, subject to continued research to test

Table 1. Details, including cost, of the chemical and non-chemical vegetation management alternatives used as examples in the cost-analysis. A pre-plant aerial application of glyphosate (2–4 kg ha^{-1}), metsulfuron (0.12 kg ha^{-1}) and organosilicone surfactant was included in the cost of both chemical alternatives.

CHEMICAL ALTERNATIVES			
Aerial application of FSC approved herbicides (Aerial FSC)[1]: \$877 ha^{-1}			
Release Yr 0	Clopyralid (1.13 kg ha^{-1}), triclopyr (0.11 kg ha^{-1}), picloram (0.038 kg ha^{-1}), haloxyfop (0.125 kg ha^{-1}), surfactant		
Release Yr 1	Clopyralid (1.5 kg ha^{-1}), triclopyr (0.15 kg ha^{-1}), picloram (0.050 kg ha^{-1}), haloxyfop (0.25 kg ha^{-1}), surfactant		
Spot control (assumed 1.8 m diameter spot and initial stocking of 800 stems ha^{-1}): \$456 ha^{-1}			
Release Yr 0	Terbuthylazine (2.20 kg ha^{-1}) and hexazinone (0.38 kg ha^{-1})		
Release Yr 1	Clopyralid (0.388 kg ha^{-1}), triclopyr (0.038 kg ha^{-1}), picloram (0.013 kg ha^{-1}), surfactant		
NON-CHEMICAL ALTERNATIVES			
	Manual[2]: \$2385 ha^{-1}	Mechanical: \$3307 ha^{-1}	Weed mats[3]: \$3473 ha^{-1}
Preplant Yr 1	–	Crush (gravity roller)	–
Yr 0	Manual cut	Burn and disc	Manual cut and place mats
Release Yr 0	Manual cut ×2	Disc release	–
Yr 1	Manual cut ×2	Disc release 25%	Manual cut ×2

[1] This treatment is illustrative only and not based on results of research or field trials.
[2] This is manual clearing of vegetation within the tree line. Assumed 0.6 ha per man-day using axes, slashers or brushcutters.
[3] Costed for 0.6 m × 0.6 m jute mats placed and secured with steel pins.

alternative herbicides and control methods. To extend a derogation a certificate holder must demonstrate a need to use designated hazardous herbicides. Such an assessment requires an estimate of the likely cost of alternative vegetation control methods. This information would also be useful to certified forest industry members as a benchmark against which to assess the potential effect of certification on profitability. The impact of alternative control methods on internal rates of return (IRR) was estimated using current operational practice as a baseline for comparison. Specifically, the cost of methods that (1) use aerially applied FSC compliant herbicides; (2) reduce overall herbicide use, and (3) avoid herbicides altogether, were examined.

MATERIALS AND METHODS

The cost of two chemical (using aerially applied FSC approved herbicides or spot application) and three non-chemical (manual, cultural and mechanical) alternatives to current practice were evaluated, typically for sites dominated by broom (Table 1). These were compared to a benchmark current practice treatment costed at \$740 ha^{-1}. The current operational treatment was based on results from industry surveys and consisted of a preplant aerial application of glyphosate (2–4 kg ha^{-1}) and metsulfuron (0.12 kg ha^{-1}), an aerial application of terbuthylazine (8.5 kg ha^{-1}) and hexazinone (1.5 kg ha^{-1}) in the spring following planting, and an aerial application of clopyralid (1.5 kg ha^{-1}), triclopyr (0.15 kg ha^{-1}), picloram (0.05 kg ha^{-1}) and Pulse (0.5 L ha^{-1}) in the second year after planting (Potter and Kriticos 2007). Costs (for chemical and non-chemical control) were sourced either from three forest companies with FSC accreditation during the 2009/2010 financial period or from the literature (Table 1, Maclaren 1993). Costs obtained from literature were adjusted for inflation (to 2010) using the CPI index, calculated from: http://rbnz.govt.nz/statistics. IRR was calculated to reflect the situation for an intensively managed, pruned *P. radiata* log regime located on low, medium and high yield (and cost) sites (Neilson and Buckleigh 2004). All calculations assumed no effect on final timber yield when using alternative regimes.

RESULTS AND DISCUSSION

The analysis of the chemical and application costs (excluding the potential effects on tree growth) indicated that a switch to the more expensive FSC approved herbicides (Aerial FSC; Table 1) would result in minimal impacts to the IRR when compared to the operational standard (Figure 1). On average the IRR was reduced by 0.1% and little variation in this reduction was noted between the productivity classes. The minimal changes in IRR reported here for aerially applied FSC compliant chemicals, however, may be optimistic as they do not incorporate any tree growth effects. Two field trials have been implemented to test clopyralid, triclopyr and picloram as possible alternative herbicides for vegetation control on sites dominated by broom (M. Watt, unpublished data). Both triclopyr and picloram are phytotoxic to pines and field trial losses at 1.5 years range from a tree volume reduction of 25% (wet site) to 37% (dryland site) when compared to current practice.

Spot control provides an opportunity to reduce the amount of terbuthylazine and hexazinone applied on a per hectare basis, a requirement for FSC compliance. This cost analysis indicates spot control is a cheaper alternative to the current aerial application standard (Table 1) and IRR increases for this treatment by 0.1% to 0.3%, for sites with high and low yield (Figure 1). However, spot control is only effective on sites dominated by herbaceous weeds, with a requirement for oversowing with grasses on sites dominated by brushweeds (West and Dean 1992). Field trial losses at 1.5 years for (wet and dry land) sites dominated by broom are about 20% for spot weed control (1.5 m diameter) when compared to current practice (M. Watt unpublished data). If such growth losses are carried through the rotation, adoption of spot control may incur financial losses that are not indicated in this cost analysis.

Another factor limiting large scale deployment of spot weed control is the availability and cost of the substantial part-time labour requirement (Table 2). Maintaining a large workforce is uneconomic when weather plays a large part in task allocation and alternative work is required on unsuitable spraying days. A switch to FSC compliant herbicides from current herbicides used for spot application could also be problematic as the window of opportunity to apply these alternatives is narrow in comparison to that of terbuthylazine and hexazinone.

The examples of non-chemical vegetation control regimes are all more expensive than current operational methods (Table 1). All have negative effects on the IRR, especially for the more marginal sites (Figure 1). For example, compared to the standard operational treatment, the use of weed mats reduces IRR by 1.9 to 0.6%, respectively, on low and high productivity sites (Figure 1). Non-chemical control methods could also result in up to 20% loss in yield (Balneaves

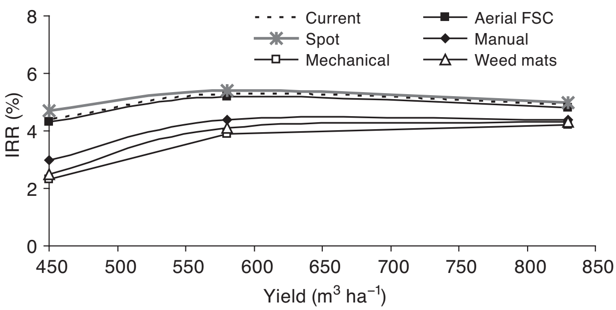

Figure 1. The effect of alternative vegetation control regimes on the internal rate of return calculated for a low to high yield range assuming no change in final yield between alternative and current practices.

Table 2. The number of man-days (estimate) to complete a vegetation management regime (pre-plant and release in Year 0 and Year 1) for 1000 ha for the different chemical and non-chemical regimes (Table 1). The number of times an operation is applied is shown in brackets.

Regime	Aerial application[1]	Spot application[2] (team of 20)	Fire[3]	Mechanical[4]	Manual[5] (team of 20)	Total
CHEMICAL ALTERNATIVES						
(a) FSC aerial	11 (×3)					33
(b) Spot control	11 (×1)	18 (×2)				47
NON-CHEMICAL ALTERNATIVES						
(a) Manual					80 (×5)	400
(b) Mechanical			20	130		150
(c) Weed mats					80 (×3) + 100[6]	340

[1] Assume rate of 30 ha h^{-1} and 3 spraying h day^{-1}.
[2] Assume 800 stems ha^{-1} and 2.75 ha $person^{-1}$ day^{-1} and spot size of 3.24 m^2.
[3] Assume 50 ha burned day^{-1}.
[4] Assume two operating machines.
[5] Assume each person using axes or brushcutters can complete weeding approximately 0.6 ha day^{-1}.
[6] Estimated 0.5 ha man day^{-1} to place and pin mats.

and McCord 1990), with increases in tending costs of up to 50% on sites dominated by gorse, broom or pampas (Zabkiewicz and Richardson 1990). If so, economic losses could therefore be even greater than that estimated for this analysis. Equally significant is the estimated increase in time required to manage vegetation using non-chemical methods (Table 2), with 150 to 400 days (as compared to less than 50 with chemical control) required to complete the management of 1000 ha. Efficient control of vegetation would therefore be difficult and potentially require labour teams of 40 to 60 people.

This analysis is an estimate of the possible effects of herbicide use restrictions on the profitability of the New Zealand forest industry. While all calculations have assumed no effect of alternative treatments on crop yield, results from current field trials and published research indicate that growth reductions relative to current yields will occur, with associated negative implications for IRR.

The negative impacts on productivity of alternative methods, together with increased vegetation management costs, could therefore have severe consequences for the economic viability of the New Zealand forest industry. Regardless of the method of vegetation management adopted, a critical consideration for any management alternative is the long-term impact of minimal weed control on the quality of the existing forest landbase as well as adjacent agricultural and conservation lands.

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