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Mixed-species plantations: Prospects and challenges

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Abstract

About 2% of English-language literature on plantations deals with mixed-species plantations, but only a tiny proportion (<0.1%) of industrial plantations are polycultures. Small landholders are more innovative, with 12% of Australia's farm forestry plantations under mixed-species plantings, and 80% of Queensland's farm forestry as polycultures. We examine reasons for this discrepancy, and explore the history, silviculture and economics of polycultures. Financial analyses suggest that a yield stimulus of 10%, depending on product and rotation length, may be sufficient to offset increased costs associated with planting and managing a mixed-species plantation, a stimulus that has been demonstrated in many field trials. We conclude that the main obstacle to commercial uptake of polycultures in industrial plantations may be the lack of operational-scale demonstrations coupled with reliable financial analyses.

Keywords: Monoculture; Polyculture; Uptake; Adoption; Financial analysis

1. Introduction

There is wealth of research espousing the benefits of mixed-species plantings (e.g., Wormald, 1992; Ball et al., 1995; Dupuy, 1995; Hartley, 2002; Kelty, 2006; Erskine et al., 2006; Forrester et al., 2005), but a paucity of industrial polyculture plantations demonstrating commercial success. In this paper, we examine and seek to explain this discrepancy. We consider the impetus for mixed plantings, the benefits and costs, and explore the current status of commercial uptake of mixed-species plantings.

2. Calls for mixed plantings

Within the community of mixed-species researchers, it is easy to gain the impression that there is widespread support and demand for mixed-species plantations, but this is not generally so in the case of commercial plantations for timber production. There is little doubt that mixed-species plantings are preferable to monocultures for restoration activities (Lamb, 1998; Hooper et al., 2005), but the case is not so clear with commercial plantations for timber production. Table 1 demonstrates the results of a series of searches for information relating to ''plantation and timber'', contrasted with equivalent searches for ''plantation and timber and mixed-species'', to illustrate the relative level of interest in mixed-species enterprises for timber production. Table 1 shows that within a range of well-known databases, mixed-species plantations occupy only about 2% of the entries. The summary in Table 1 surveys only English-language material, and is influenced by the chosen search terms (cf. lumber versus timber; polyculture versus mixed species). The use of the north-American term ''lumber'' and the European phrase ''close to nature silviculture'' as alternatives did not noticeably influence the percentages reported in Table 1. Thus, Table 1 should offer a reasonable indication of the level of interest in mixed species production.

The great disparity between the number of entries in these databases is noteworthy. CAB Direct, publisher of *Forestry Abstracts*, can be expected to have more entries than the more generic Institute for Scientific Information (ISI), but the disparity between CAB Direct and Google Scholar (GS, available at scholar.google.com, an internet search engine confined to scholarly literature) is surprising. This reveals that much of the mixed-species literature is on the fringe of academia, considered noteworthy by GS, but not by CAB. Of the 879 references returned by GS, 360 contained 'Australia' as an author address, or in the subject material. Similarly, of the 37,700 references returned by Google, 989 have an Australian domain (.au; cf. 391 from .ca [Canada], and 321 from .us [mainly the US federal government]). This indicates that Australia is a major player in mixed-species research and debate, and offers an interesting case study. Table 2 examines

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Table 1
Relative frequency of mixed-species entries in popular databases (based on searches for ''plantation and timber and mixed-species'' on 10 March 2006)

Database and search terms	Plantation and timber	Plantation and timber and mixed species	Percentage
Google.com	2370000	37700	2
Scholar.google.com	19200	879	5
CAB direct	1277	11	1
ISI web of knowledge	267	6	2

internet domains that display material relating to mixed-species plantations, both globally and within Australia.

Domains containing .com (or national variants, including .com.au and .co.uk) have the greatest number of mixed-species documents, but relatively few (525) occur at the top-level domain of .com; most occur in national sites (e.g., .com.au). The number of hits in this category is misleading, because the count is contaminated by, e.g., repeated counts of the same scientific paper displayed by different service providers (CSA, Ingenta, JSTOR, ScienceDirect, etc.). However, Table 2 does reveal that Australia has a relatively large proportion of the global mixed-species activity, and that government agencies (those with .gov domains) are major players in promoting the mixed-species message on the internet.

Despite the high score attained by government agencies in Table 2, it appears that in Australia, they do not ''walk the talk''. Table 3, a summary of the National Plantation Inventory (Parsons and Gavran, 2005), indicates that Australia has only 359 ha of mixed-species plantations, of which 305 ha (85%) is privately owned, and planted since 1995. It is not possible to compare this with other nations, because the FAO Forest Resource Assessment does not discriminate between mixed and monoculture plantations. Australian State Governments own about half the plantations in Australia, but only 4 ha of mixed-species plantings (Parsons and Gavran, 2005). However, Table 3 is misleading, because it focuses on industrial plantations and omits farm forestry which contributes the bulk of the mixed-species plantings in Australia (Table 4, Stephens et al., 2003).

The National Farm Forest Inventory (Table 4, Stephens et al., 2003) illustrates that farmers counter the industrial trend towards monocultures, and plant a substantial proportion of mixed plantings (12% nationally). The trend varies by state: in Western Australia, 92% of farm forestry plantings are hardwood monocultures; in South Australia and Victoria 55% are softwood (*Pinus radiata*) monocultures, whereas in Queensland 81% are mixed-species plantings. The largest area of mixed plantings is in New South Wales, with 2700 ha of mixed-species plantings on private farms.

Another insight into current plantation activity can be gained from Product Rulings issued by the Australian Taxation Office. Plantation companies seeking private investment may seek a Product Ruling to clarify the tax position for investors, and these are public documents. The Australian Tax Office currently has 93 such Rulings relating to timber plantation (Table 5); of these, all but three relate to monocultures (or in the case of sandalwood, a host plant plus the intended crop). The three polyculture Rulings involve two species planted in alternate rows by BioEnergy Australia (Table 2). Table 5 overstates the real position of mixed plantings, because it does not take areas into consideration, and Rulings relating to monocultures tend to refer to larger areas than those relating to mixed plantings. Clearly, investors and industry currently do not see great advantages in species mixtures. Why is it that there is so much mixed-species literature (Tables 1 and 2), but so little activity on the ground (Tables 3 and 5)?

Several Australian non-government organisations (NGOs) have called for greater emphasis on mixed-species plantations.

Table 2
Sources of internet-based material on mixed-species plantings (based on searches for ''mixed-species and plantation and timber'' on 10 March 2006)

Domain	Hits	Example	Typical themes	Common contaminants
Global				
com., co	13965	SunWood Group (a Thai teak plantation), Panama Teak Forestry	Investment prospectus	Scientific papers hosted by commercial publishers
.gov	9420	ACIAR; Forest Research, UK	Development assistance projects	Timber sales announcements and price data
.org	883	Forest Stewardship Council, Friends of the Earth Europe	Lobbying for mixed plantings	Scientific publications (e.g., http://www.doi.org)
.edu., ac	525	Harvard Forest, University of Wales	Education, research, demonstration	Consultancy services, natural mixed species forests
Australia				
.com.au	143	BioEnergy Australia, EcoForest Limited	Investment prospectus	Timber sales announcements
.gov.au	591	Rural Industries R&D Corporation, Dept Primary Industries Queensland	Farm forestry manuals	Natural mixed species forests
.org.au	137	Australian Conservation Foundation, The Greens (Political Party)	Policy statements	Restoration plantings, not timber plantations
.edu.au	116	Southern Cross University, University of Melbourne	Education, research and publications	Natural mixed species forests