Global Environmental Change 24 (2014) 306–320

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

Assessing the likelihood of widespread landholder adoption of afforestation and reforestation projects☆

Jacki Schirmer [a,b,c,*], Lyndall Bull [a,b]

[a] Fenner School of Environment and Society, Building 48, Australian National University, ACT 0200, Australia
[b] Cooperative Research Centre for Forestry, Private Bag 12, Hobart, TAS 7001, Australia
[c] Centre for Research and Action in Public Health, Building 22, University of Canberra, 0200, Australia

ARTICLE INFO

Article history:
Received 28 November 2011
Received in revised form 2 November 2013
Accepted 6 November 2013

Keywords:
Adoption
Afforestation
Reforestation
Carbon sequestration
Mitigation

ABSTRACT

Tree planting for carbon sequestration is a commonly proposed climate change mitigation strategy, with afforestation projects forming part of voluntary and mandatory carbon offset trading schemes. Afforestation is often promoted as a new economic opportunity for private landholders. While multiple studies have identified physical and economic opportunities for afforestation, few have examined the willingness of private landholders to adopt afforestation, and the factors that influence this willingness. We examine this using data from a survey of Australian landholders. The willingness of landholders to adopt afforestation for carbon sequestration varies substantially depending on how this afforestation is designed and implemented: landholders prefer small plantings on less productive land, which minimise the disturbance afforestation presents to land management, and to landholder values about appropriate uses of agricultural land. Landholders are less willing to consider afforestation if it involves planting the large areas required by many current carbon afforestation schemes. Willingness to adopt afforestation is influenced in particular by landholder's perceptions of its potential to provide a diversified income stream, and its impacts on flexibility of land management. More broadly, it is influenced by their views about the social acceptability of afforestation, particularly whether the landholder believes trees should be planted on agricultural land, and how they believe others in the community view afforestation. Our results suggest that widespread adoption requires designing afforestation so it (i) provides a range of socio-economic benefits that go beyond provision of income; (ii) minimises disruption to land management flexibility; and (iii) is compatible with landholder beliefs about appropriate use of agricultural land.

1. Introduction

The planting of trees to sequester carbon is a commonly advocated climate change mitigation strategy. It is included in the Clean Development Mechanism (CDM) of the United Nations Framework Convention on Climate Change (UNFCC), and afforestation and reforestation projects form part of several voluntary and mandatory carbon offset trading schemes worldwide (Diaz et al., 2011). Afforestation refers to planting trees on land not afforested in recent history (usually at least 50 years), while reforestation refers to the replanting of trees on more recently deforested land (Hamilton et al., 2010). Land must have been cleared prior to 1989 to be eligible under the CDM (Hamilton et al., 2010).

Despite widespread promotion in recent years, afforestation and reforestation projects have not gained the traction hoped for by their advocates. By September 2011 they made up only 0.75% of registered CDM projects, with approximately 403,000 hectares of trees planted by 241 afforestation and reforestation projects servicing mandatory and voluntary markets worldwide (Diaz et al., 2011). Even assuming this is an underestimate, the figure is low compared to the 264 million hectares (MHa) of planted forests globally (FAO, 2010), and the varied estimates of a need for plantings in the order of tens to hundreds MHa if afforestation and reforestation are to make a meaningful contribution to addressing human-induced climate change (e.g. Cannell, 2003; Zomer et al., 2008). The relatively small contribution of afforestation and reforestation to carbon markets may result from many factors, including market barriers, high upfront costs, and the long time before trees sequester large amounts of carbon (Thomas et al., 2010; Diaz et al., 2011). However, these projects are growing in their contribution to traded carbon as

* Corresponding author at: Centre for Research and Action in Public Health, Building 22, University of Canberra, 0200, Australia.
Tel.: +61 2 6201 2785/428 254 948; fax: +61 2 6125 0746.
E-mail addresses: Jacki.schirmer@canberra.edu.au (J. Schirmer), Lyndall.bull@anu.edu.au (L. Bull).

0959-3780/$ – see front matter © 2013 The Authors. Published by Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.gloenvcha.2013.11.009

early plantings reach an age at which they sequester significant levels of carbon: afforestation- and reforestation-grown carbon constituted 10% of transactions in voluntary carbon markets in 2011 (Peters-Stanley and Hamilton, 2012).

From this point on, we use the term 'afforestation' in this paper to refer to afforestation and reforestation for carbon sequestration; the content of the paper should be assumed to apply to both unless otherwise specified. When referring to the planting of trees for purposes other than carbon sequestration, we do not use the term 'afforestation', to avoid confusion.

Afforestation is an often controversial aspect component of the CDM. Critics argue that it may divert attention from the need to reduce greenhouse gas emissions and consumption, exploit developing countries, have negative environmental impacts, or be ineffective at mitigating carbon (Ciscell, 2010). Proponents argue that afforestation has the potential not only to achieve significant mitigation, but to provide livelihood benefits for landholders in both developing and developed countries. Irrespective of perceptions of costs and benefits, the reality is that afforestation is a part of climate mitigation policy, and likely to remain so into the future (Corbera and Brown, 2010). Given this, it is important to consider how to ensure afforestation has benefits for landholders, both to ensure that they are not adversely affected by afforestation, and to increase the likelihood that they will adopt afforestation and thus increase its contribution to climate mitigation.

To be successful as a mitigation strategy, afforestation projects must achieve net sequestration after taking into account issues such as carbon outcomes under previous land uses and leakage. Considerable attention has been given to these issues (e.g. Murray et al., 2004; Sathaye and Andrasko, 2007; van Minnen et al., 2008), as well as to identifying the total area of land physically suitable for afforestation projects (e.g. Zomer et al., 2008), and the area of land likely to achieve a positive economic return for landholders under different carbon prices (Benitez et al., 2007; Winsten et al., 2011; Palmer and Silber, 2012; Yemshanov et al., 2012; Paul et al., 2013; Polglase et al., 2013). Several studies have examined whether afforestation is a cost effective mitigation strategy compared to other options climate mitigation options (Richards and Stokes, 2004; van Kooten et al., 2004), particularly compared to use of bioenergy (Rootzen et al., 2010; Kallio et al., in press).

Less attention has been given to the social and economic challenges of achieving large scale adoption of afforestation. A small number of studies have identified social, economic, and institutional factors that may limit the success of afforestation projects, focusing on the potential social, economic and environmental impacts of afforestation, transaction costs, land tenure issues, and competition for use of land (Nilsson and Schopfhauser, 1995; Cannell, 2003; Jindal et al., 2008; Thomas et al., 2010). These have built some understanding of the broader economic and social ramifications of afforestation, but Jindal et al. (2012) identified that there remains a need to examine the benefits and costs of afforestation beyond simple provision of economic return to landholders.

We argue that there is an additional need: to better understand what the various social and economic costs and benefits of afforestation mean for the likelihood of widespread adoption of afforestation by landholders (Bozmoski and Hultman, 2010). Theoretical estimates of afforestation potential, based on biophysical and economic viability, have limited usefulness unless accompanied by an understanding of whether and when landholders are willing to consider afforestation. In many countries, afforestation can only occur on a large scale via tree planting on privately owned land. This means afforestation will only be successful if private landholders are convinced to participate in afforestation projects, and to maintain their participation over long periods. The factors influencing landholder adoption of afforestation are not well understood, representing a significant gap in current knowledge regarding afforestation's likely success as a mitigation strategy (Bull and Thompson, 2011). The few studies undertaken have typically assumed adoption will depend on the economic returns landholders achieve from afforestation, or on sociodemographic characteristics of landholders (van Kooten et al., 2002; Shaikh et al., 2007; Cacho et al., 2008; Torres et al., 2010), but have not formally tested these assumptions.

Meanwhile, an extensive literature on landholder adoption of new technologies and conservation practices has studied the agricultural landscapes where afforestation projects need to gain traction. This literature shows that landholder decisions are not driven solely by economic considerations, but rather depend on a wide range of factors, including the relative advantage of the new activity (e.g. its perceived costs and benefits), individual and social learning processes, extension efforts, sociodemographic and farm characteristics, influence of social networks, the supportiveness of institutional frameworks, and access to the physical, natural and financial resources needed for adoption, amongst other factors (Pannell et al., 2006; Prokopy et al., 2008; Ommani et al., 2009; Bull and Thompson, 2011). This suggests a need to examine the likely success of afforestation from an adoption perspective. Questions such as the following need to be asked to complement existing assessments of biophysical and economic feasibility of afforestation: how likely is it that landholders will be willing to adopt afforestation? Under what circumstances? What factors are most important in affecting willingness to adopt? How can afforestation be designed to achieve the goal of sequestering carbon while also being attractive to landholders?

In this paper, we examine the likelihood of widespread adoption of afforestation, and the factors that influence the willingness of landholders to adopt, using the results of a survey of landholders in Australia. First, we review existing studies on afforestation, and on tree planting and landholder adoption of new practices on agricultural land more broadly, to identify factors likely to influence adoption. We then describe the methods used to survey landholders. Our results analyse the likelihood of widespread adoption of afforestation, and how landholder's willingness to adopt varies depending on the design of afforestation. We then identify the factors that have the greatest influence on willingness to adopt. Our discussion focuses on the implications of our findings for those seeking to encourage adoption of afforestation on private land. By examining the role of landholder perceptions and beliefs, we contribute a new perspective that is critical to understanding whether afforestation is likely to be adopted at scales that enable it to make a meaningful contribution to offsetting greenhouse gas emissions.

2. Factors likely to influence landholder adoption of afforestation

An extensive literature has examined when and why landholders are willing to adopt new land management practices in general, and can be used to inform studies of willingness to adopt afforestation. Rather than reviewing the highly diverse literature on landholder adoption of new practices in its entirety, we identified factors likely to be relevant to landholder adoption of afforestation by drawing on three types of literature.

First, we examined recent meta-studies of factors influencing landholder adoption of new land management activities, focused on Australian (Pannell et al., 2006), American (Prokopy et al., 2008; Baumgart-Getz et al., 2012), and international studies (Knowler and Bradshaw, 2007). Second, we reviewed previous studies that have proposed factors likely to influence landholder adoption of afforestation (e.g. Bull and Thompson, 2011), or reviewed socio-economic costs and benefits to landholders of afforestation (e.g. Jindal et al., 2012). Third, we reviewed studies that have examined