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The Sustainability of Carbon Mitigation in Dryland Farming Systems: The Oil Mallee Case Study

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) – updated March 2014. The proposed research study received human research ethics approval from the Curtin University Human Research Ethics Committee (EC00262), Approval Number HRE2018-0143.

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Abstract

There was early enthusiasm in Australia, and the world in general, for forestry to be a major contributor to carbon emissions mitigation. However, forestry incorporating neutral and negative emissions technologies, has not contributed as expected to mitigation, even when combined with bioenergy.

This thesis explores why Australia's natural advantage associated with forestry and agriculture was not exploited as expected. It focuses in particular on reforestation in agroforestry systems or carbon agroforestry, a form of bio-sequestration integrated into agriculture, which has the potential to contribute significantly to climate change mitigation and provide a range of sustainability and production co-benefits, including bioenergy.

Socio-Technical Transition theory, an approach to explaining barriers to technology change, is used to explain why carbon agroforestry has not played the major role anticipated for this form of abatement. The theory helps explain the complexity of motivating and supporting large numbers of stakeholders through a multi-level transition to an agricultural economy-wide adoption. While transition theory has been used in agricultural systems, this thesis extends its application to carbon agroforestry. In order to apply transition theory to agroforestry, it is necessary to identify additional influences on agricultural systems, such as international concerns surrounding land use change and definitions of sustainability in agroforestry. In addition, this thesis draws upon path dependency analysis to assist the explanation of the rate of change to integrated agroforestry. The expanded set of influences which constrain or encourage movement towards adoption, provides a more complete analysis which can be applied globally.

A case study drawn from the dryland farming areas of Western Australia identifies many national, local and regional influences on the expansion of carbon agroforestry. The Oil Mallee Project resulted in millions of short-stature eucalypts (Oil Mallees) being integrated into dryland cropping and grazing systems on around 1000 properties. Financial support from the Commonwealth and State Governments was provided to plant the trees to combat salinity and wind erosion. A key ambition of Oil Mallee Project was to extend the management of these plantations to include the production of eucalyptus oil and bioenergy, thereby creating new regional industries and further expanding agroforestry. However, the project did not expand beyond experimentation and the trialling of new multi-product technologies.

Socio Technical Transition theory provides a strong guide as to why transitions to higher levels of adoption and technology might not occur, particularly when combined with additional factors elaborated in the thesis. Using the Socio Technical Transition framework, suggestions are identified for a way forward for the achievement of a more successful upscaling process.

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Abbreviations

AAU	Assigned Amount Unit
ABARE	Australian Bureau of Resource Economics
ABC	Australian Broadcasting Corporation
ACCU	Australian Carbon Credit Unit
AD	Avoided Deforestation
AEP	Agricultural Environmental Policies
AGL	Australian Gas Light (Company) (formerly)
AGO	Australian Greenhouse Office
AIGN	Australian Industry Greenhouse Network
ALP	Australian Labor Party
ANAO	Australian National Audit Office
AR4	Fourth Assessment Report of the International Panel on Climate Change (IPCC)
ARB	Avon River Basin
ARENA	Australian Renewable Energy Agency
BECCS	Bioenergy with Carbon Capture and Storage
BECS	Bioenergy Carbon and Sequestration
BE	Bioenergy
BEFS	Bioenergy Food Security
BEFSCI	Bioenergy and Food Security Criteria and Indicators
CALM	Department of Conservation and Land Management
CCA	Climate Change Authority
CDM	Clean Development Mechanism
CEFC	Clean Energy Finance Corporation
CER	Certified Emissions Reduction
CFI	Carbon Farming Initiative
COAG	Council of Australian Governments
COP	Conference of the Parties
CPM	Carbon Pricing Mechanism
CPRS	Carbon Pollution Reduction Scheme
CRA	Carbon Rights Act (2003)
CRCFFI	Cooperative Research Centre of Future Farm Industries

CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Department of Agriculture, Fisheries and Forestry (Australia)
DCCEE	Department of Climate Change and Energy Efficiency (Australia)
DOE	Department of Energy (Australian)
DOIC	Domestic Offsets Integrity Committee
DPAW	Department of Parks and Wildlife (WA)
DPIRD	Department of Primary Industries and Regional Development (WA)
DTU	Technical University of Denmark
EITE	Energy Intensive Trade Exposed Industries
EPA	Environmental Protection Authority
ERAC	Emissions Reduction Assurance Committee
ERF	Emissions Reduction Fund
ERU	Emissions Reduction Unit
ESS	Energy Savings Scheme
ET	Emissions trading
ETS	Emissions Trading Scheme
FAO	Food and Agriculture Organisation
FAR	First Assessment Report
FETI	Fuels and Energy Technology Institute
GFC	Global Financial Crisis
GGAS	Greenhous Gas Abatement Scheme
GHG	Greenhouse Gas
gt	green tonnes
IEA	International Energy Agency
IET	International Emissions Trading
IIED	International Institute for Environment and Development
ILUC	Induced Land Use Change
IPART	Independent Regulatory and Pricing Tribunal (NSW)
IPCC	International Panel on Climate Change
ITMOs	International Transferred Mitigation Outcomes
IWP	Integrated Wood Processing
JI	Joint Implementation

LCA	Life Cycle Assessment page
LNG	Liquid Natural Gas
LUC	Land Use Change
LULUCF	Land Use, Land Use Change and Forestry
MAC	Management Abatement Curve
MIS	Managed Investment Scheme
MRET	Mandatory Renewable Energy Target
NAP	National Action Plan for Salinity and Water Quality
NCB	Non Carbon Benefits
NEG	National Energy Guarantee
NET	Neutral Energy Technology
NGER	National Greenhouse Energy Reporting
NGGI	National Greenhouse Gas Inventory
NGRS	National Greenhouse Response Strategy
NNET	Net Negative Energy Technology
NRM	Natural Resource Management
NSW	New South Wales (Australia)
OMA	Oil Mallee Association
OMC	Oil Mallee Company
OMCOP	Oil Mallee Code of Practice
PES	Payment for Ecosystem Services
PPACS	Permitted project average carbon stocks
R&D	Research and development
RSB	Roundtable on *Sustainable* Biomaterials
REDD	Reducing Emissions from Forest Deforestation and Forest Degeneration
REDD+	Reducing emissions from Forest Deforestation and Degeneration and enhancement of forest carbon stocks
RET	Renewable Energy Target
RFF	Resources for the Future
SAT	State Administrative Tribunal
SEI	Stockholm Environment Institute
SPP2.5	State Planning Policy 2.5 (Western Australian)
STRN	Sustainability Transitions Research Network
TEEB	The Economics of Ecosystems and Biodiversity

UK	United Kingdom
UN	United Nations
UNEP	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
URS	URS Forestry Ltd
USA	United States of America
WA	Western Australia
WIRES	Wiley Interdisciplinary Review of Climate Change
WTA	Willingness To Accept
WTP	Willingness To Pay

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Part 1 –
Introduction

Chapter One

1

Issues, Questions and Approaches

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> *"The fact is, that despite human imperfection, modern science on climate change has held up well under withering scrutiny. The vast majority of those who have spent their professional lives seeking to understand climate and the impacts of human activity on it have no doubt that average temperatures on earth are rising and that human-induced increases in greenhouse gases are making major contributions to these rises. They are supported in this by the learned academies of science in all of the countries of scientific accomplishment."*
>
> Garnaut, 2011, Page 1

> *The balance between energy arriving from the sun and energy escaping back into the atmosphere has been disturbed by human activity generating additional greenhouse gases. These greenhouse gases, such as carbon dioxide and methane, created the 'greenhouse effect' which kept the earth's surface and oceans warmer than they would otherwise be. "Now, mostly because of the burning of fossil fuels and changes in land use, the concentrations of greenhouse gases in the atmosphere are rising and causing surface temperatures to increase, leading to an 'enhanced' greenhouse effect."*
>
> (CSIRO, 2018) Website.

Widespread ecological restoration could play an important role in addressing climate change while also ensuring the provision of ecosystem services and the maintenance of biodiversity. By addressing the range of pressures caused by human activities that, in combination may push an ecosystem past a tipping point, we can help avoid or at least reduce the possibility of crossing a critical threshold. While climate change is a common driver of tipping point scenarios, in addition to reducing greenhouse gas (GHG) emissions, investing in actions to improve ecosystem management will be needed to strengthen the ability of ecosystems to absorb and recover from shocks and reduce the risk of reaching irreversible tipping points. (Garnaut, 2011).

The role of carbon forestry, particularly reafforestation programs to generate carbon credits as a potentially cost-effective form of offsetting GHG emissions, was identified in the early international negotiations through the United Nations Framework Convention on Climate Change (UNFCCC) and subsequent national climate change policy, particularly in Australia. Carbon forestry is also linked to ecological restoration. The term carbon agroforestry is used in this thesis to describe forestry programs that are integrated with agricultural production with an intention to create carbon credits and other products, such as biofuels. There is considerable concern and interest in how Australian agriculture is responding to climate change and this discussion incorporates an understanding of the threats to existing practices and research into new opportunities to adapt to new approaches (Barlow, 2011; George, 2019).

Carbon forestry, is incorporated in the United Nations Framework Convention on Climate Change (UNFCCC) processes under Land Use Change (LUC) and Land Use, Land Use Change and Forestry (LULUCF) and included in the protocols associated with the first landmark agreement under the UNFCCC - The Kyoto Protocol in 1998. Australia embraced the key principles of LUC and LULUCF after the announcement.

Despite the potential for LULUCF programs and activities to become an important part of GHG mitigation in Australia, a range of factors prevented the global and local processes working together, which meant carbon agroforestry did not meet this potential. This research endeavour was motivated by the need to investigate why and how a highly favoured approach to offsetting carbon emissions through forestry bio-sequestration, carbon forestry and carbon agroforestry, was not engaged to meet these early expectations.

This thesis uses the Socio-Technical Transition Theory to understand how multiple factors at different levels of socio-technical activity, can help provide a framework for understanding the difficulties faced in adoption of this key mitigation strategy, as well as contributing to finding a way forward (Geels, 2002, 2013). Identifying the potential paths of transition to widespread use of land-based approaches to address climate change remains highly significant but also highly complex (IPCC-LULUCF, 2000). It is argued that applying Socio-Technical Transition Theory (including through the use of a case study) can assist in understanding how to facilitate change in a time when governments, industry and community are all being urged into more rapid action (ABC News, 2019; Readfearn, 2019). Such urging of rapid action does not always anticipate the intricacies of socio-economic systems that are not simply or easily changed, despite the best of ideas and even evidence.

Geels (2013) proposes that there have been three analytical categories: (1) financial investment; (2) policy and governance; and (3) public opinion and civil society, that have stalled initiatives and innovation (Geels, 2013). He also suggests that the timing of some of these innovations, around 2010 – 2018, was encouraged by particular economic and social circumstances while the period following showed little progress due to the financial and economic crisis, the Global Financial Crisis (GFC). While acknowledging the three analytical categories listed by Geels (2013), and their impact on transition, this thesis provides some alternative causes for the stalling of initiatives. In addition to analysing the impact of issues including policy uncertainty, public attitudes and market failure, the discussion also considers the appropriateness of some international procedures for assessing the sustainability of LULUCF initiatives.

There are several internationally developed methods for judging the sustainability of forestry (including carbon agroforestry and bioenergy) on farming land that are based largely on agricultural and forestry practices in European and American situations (IEA Bioenergy, 2009). The assumptions on which judgements on sustainability are formed, do not always apply in Australia, and the rules generated have limited flexibility to adapt to the Australian ecosystem. For example, the early definition adopted by the UNFCCC of what constitutes the minimum size of trees contained in a forest excluded the smaller species of trees in dryland areas of Australia. Until Australia successfully advocated for inclusion of smaller more sparse forms of forest, this threatened to limit the business opportunities for carbon sequestration in the Australian inland and dryland farming areas. However the revised definition has come under some criticism, particularly in relation to the density required and the height (Gilbert, 2009).

Socio-Technical Transition theory enables the research in this thesis to extend the work developed on carbon sequestration beyond the costs and benefits of carbon agroforestry to include the implementation and delivery of such projects. This approach has also assisted evaluating the benefits associated with certain types of carbon agroforestry and could assist with the socio economic transition to more sustainable practices of mitigation.

The thesis is therefore framed around consideration of these broad issues and how their interaction could reveal the potential for greater use of carbon agroforestry for carbon sequestration and bioenergy, particularly in dryland agriculture, incorporating the co-benefits from incentivised carbon and commercial programs.

1.1 Background history to land-based carbon sequestration

1.1.1 International climate change mitigation policy mechanisms

The development of a comprehensive global climate change agreement was seen by participating countries as an essential step in enabling the abatement of greenhouse gases (GHGs) to mitigate climate change (Garnaut, 2008a). Beginning in 1988, many years of negotiations led to the development of the UNFCCC, which came into force in 1994.

While there were no binding GHG emissions limits in the Convention, the Parties (States) to the Convention initially agreed to mitigate climate change by returning anthropogenic emissions of carbon dioxide and other GHGs to 1990 levels by 2020 (UNFCCC, 1994).

Under the UNFCCC, nation states are encouraged to establish protocols to enhance effective implementation of the Convention through the Conference of the Parties (COP). The first of these was the Kyoto Protocol which incorporated the quantifiable obligations of countries to reduce their GHG emissions. Once the Kyoto Protocol came into force in 2005, 177 countries ratified, acceded to, approved or accepted the Protocol (Hodgkinson, 2008; UNFCCC, 1994). This foundation Protocol set the stage for other agreements in subsequent years, most notably the Paris Agreement in 2016, when developing countries also became engaged in the implementation of measures to mitigate climate change.

A key achievement of the Kyoto Protocol was the defining of market mechanisms (referred to as flexibility mechanisms) which provided an opportunity to lower the cost of achieving emissions targets. These flexibility mechanisms comprised the Clean Development Mechanism (CDM), Joint Implementation (JI) and International Emissions Trading (IET). These mechanisms enabled trade in carbon units, including emission (ERUs), certified emission reductions (CERs) for JI activities and assigned amount units (AAUs) for IET activities (Garnaut, 2008). The mechanisms stimulated trade in units between individual project entities in developed and less-developed countries while accounting was finalised at the national level. For example, credits acquired by a developed country could count towards the quantified emission limits established through the Protocol. At the time of developing these mechanisms, developing countries did not have targets enabling them to 'sell' carbon credits created in their country (Hodgkinson, 2008).

The Kyoto Protocol, through Article 3.3, also introduced human-induced afforestation and reforestation as ways of meeting emission reduction commitments. The land-based activities under the heading of land use, land use change and forestry (LULUCF) included forest management, cropland management, grazing land management and revegetation. The prominence given to LULUCF activities reflected the expectation at that time that carbon sequestration might play a key role in reducing the cost of emissions mitigation (Schlamadinger et al., 2007). Technically, carbon agroforestry certainly offered this potential, but not everything that is technically attractive can in practice be implemented. Socio-Technical Transition Theory suggests that such changes are inevitably more complex and difficult than non land based activities (Geels, 2018).

1.1.2 The role of forestry and international agreements

The enabling of carbon sequestration as a means of reducing a nation's registry of emissions was negotiated after the Kyoto Protocol was signed by the Parties to it (Hodgkinson, 2008). This provided the Parties the opportunity to avoid the need to limit all emissions at source and allowed for offsets through carbon sequestration. Forests and agriculture are included in the emissions inventories of all industrial countries, although they are not covered by a legally binding framework (European Commission, 2018). This option to offset emissions was not immediately adopted by all of the Parties. European nations, operating under the umbrella of the European Union (EU), as a Party to the UNFCCC, originally found limited scope for the use of forestry for carbon sequestration (Nijnik & Bizikova, 2008) and chose not to include land use and forestry in their mitigation efforts. Instead, they assumed an approach where losses in this sector were balanced by other activities. In addition, limitations were placed on the use of forestry in mitigation efforts during the first commitment period of the Kyoto Protocol and more global estimates were used in the second commitment period. Following the UN Paris Agreement on climate change in 2016, EU member States will include land use and forestry in their efforts from 2020 to contribute to meeting their EU target of 40% reduction compared to 1990 levels by 2030 (European Commission, 2018).

The use of forestry biomass for bioenergy can produce an even greater impact on emissions reduction than carbon sequestration on its own (Garnaut, 2008a). In definitional terms, carbon agroforestry includes both carbon sequestration (CS) and the potential for bioenergy (BE) from forestry. When bio-energy is combined with carbon capture (including sequestration) and geological storage, it is referred to as Bioenergy with Carbon Capture and Storage (BECCS) (Erbach, 2015; IEA, 2011). These terms have become increasingly part of the language of IPCC and UNFCCC since the Paris Agreement in 2016.

The two most recent special IPCC Reports in 2018 and 2019 have placed a special importance on the land sector to remove carbon from the atmosphere (IPCC [Masson-Delmotte, 2018; IPCC-LULUCF, 2000). The 2018 report highlights the challenges and impacts of a 1.5 to 2. degree increase in global temperature and the significantly different impact of each increase. In addition the proposed pathways to mitigation also represent challenges.

> "Such large transitions pose profound challenges for sustainable management of the various demands on land for human settlements, food, livestock feed, fibre, bioenergy, carbon storage, biodiversity and other ecosystem services *(high confidence)*. "(IPCC [Masson-Delmotte, 2018).

The IPCC-LULUCF of 2000 specifies the range of possible program, the project level activities and some of the mechanisms available to engage in land based activities.

> "Consideration would need to be given to synergies and tradeoffs related to LULUCF activities under the UNFCCC and its Kyoto Protocol in the context of sustainable development including a broad range of environmental, social, and economic impacts, such as: (i) biodiversity; (ii) the quantity and quality of forests, grazing lands, soils, fisheries, and water resources; (iii) the ability to provide food, fiber, fuel, and shelter; and (iv) employment, human health, poverty, and equity"(IPCC-LULUCF, 2000).

1.1.3 The Australian context

Australia's use of forestry to meet Kyoto targets

In contrast to the EU, Australia incorporated land use and forestry in its accounts from the beginning of the Kyoto Protocol as there were significant 'early wins' identified from changing land use practices in rural Australia. The expectation was that this sector would deliver large gains in Australia's carbon mitigation effort (Garnaut, 2011; Harper et al., 2007).

Carbon sequestration through forestry has remained as a component of Australia's proposed response to climate change, although its degree of success has varied over time. It was originally believed that carbon sequestration through forestry would contribute significantly to the national effort to reduce emissions of carbon dioxide as part of its strategy to mitigate GHGs (Garnaut, 2008). For example, Australia opted to include changes in tree cover as part of the measurement of national inventory. It also opted for a definition of a forest under article 3.3 of the Kyoto Protocol (1997) that ensured the smaller tree species found throughout Australia could be included in the national inventory. Article 3.3 includes emissions reductions through carbon sequestration from reforestation, afforestation or avoidance of deforestation. While it is possible that a key ambition in having smaller tree species included was to enable protection of woodlands and enable avoided deforestation approaches, this definition also paved the way for smaller species, such as mallees, to be incorporated into afforestation and reafforestation approaches to mitigation. Indeed LULUCF played a significant role in Australia meeting the Kyoto Protocol targets and the woodlands became a valuable contribution as 'avoided deforestation'.

However, in the first commitment period of the Kyoto Protocol, Australia did not include any activities under Article 3.4, which includes forest management, cropland management, grazing land management, and revegetation (Parliamentary Library, 2009). In the second commitment period, Article 3.4 activities are included (DOE, 2016). This structured framework for national engagement in climate change reflected the anticipation that carbon sequestration would play a crucial role in the abatement challenge. Abatement technologies utilising carbon sequestration include establishment of permanent forest “sinks”, bioenergy utilising forestry biomass and activities embracing both technologies. In the first commitment period it was a particularly wet year and growth of the trees and shrubs was very strong, therefore presenting a risk that growth would be slower in the future and present as emissions rather than removals.

1.1.4 Australia’s use of Joint Implementation and the Clean Development Mechanism

The position taken by Australia regarding the Kyoto Convention’s Clean Development Mechanism (CDM) and The Joint Implementation (JI) programs changed over time as the policies related to emissions trading were developed and then dismantled (DCCEE, 2008; Kachi, 2014). At an early stage the Australian Government indicated its enthusiasm to utilize the CDM in its mitigation programs (Hodgkinson, 2008). The CDM has been considered an important transitional mechanism and CERs were recognized as useful for compliance purposes.

In 2008 the Government restricted the use of international credits in meeting industry targets and in particular the CDM credits achieved through forestry (Kachi, 2014) because of the creation of temporary units (tCERs) and the problem of subsequently converting these to permanent units for use within Australia. In 2012, the Labor Government further reduced the use of international credits from 50% of allowable offsets to 12.5%, although it allowed EU credits to be used. Plans were set in place to allow more freely the use of international credits by 2015 (Climate Change Authority, 2014; Parliamentary Library, 2012).

The international community continues to consider a range of proposals to reform the CDM in an effort to ensure that it remains an effective mechanism in any future agreement. In the meantime, however, carbon forestry, a potential area of CDM activity, has been left languishing. Indeed issues related to carbon credit creation definition of permanence have been an issue in forestry activities, particularly in the creation and exchange of international credits.

1.1.5 Land use and land use change and forestry (LULUCF) as a component of Australia's UNFCCC negotiations

The carefully constructed engagement in climate change negotiations ensured that forestry and avoidance of land clearing, would constitute an important part of the abatement effort for Australia. It was clear in 1997 that the scale of land clearing had been reducing since 1990 due to market pressure and other reasons related to climatic conditions (Macintosh, 2012). Although Australia would not reach a series of national agreements on forest use and protection for many years, it was also clear that other protections would be put in place over time (Buizer & Lawrence, 2014). The Australian Government negotiated an agreement that all developed (Annex 1) nations would be able to include emissions from land use change and forestry in their 1990 baseline, which provided an immediate boost to its ability to meet its agreed target of 108% of 1990 emissions (Christoff, 2010). This component of the Kyoto Protocol - Article 3.7 - became known as the 'Australia Clause' (Parliamentary Library, 2015).

Further negotiations across the LULUCF related articles in the first period of the climate change agreement (up to 2012) ensured that windfall gains from natural (i.e. non-human induced) activity could be incorporated into a country's accounts and offset other emissions. However, these arrangements also made some countries vulnerable to natural shocks and changes in LULUCF areas (Macintosh, 2012). Some attempts to change the rules governing LULUCF activities were made but many aspects of confusion and opportunism remained, with the Article 3.7 beneficial arrangements remaining along with the opportunity to choose and exclude sources and sink activity through the optional nature of Article 3.4 activities (Schlamadinger et al., 2007).

Australia's emphasis on obtaining the best arrangement possible from LULUCF for the nation was evidenced by its tactical approach to negotiations, the availability of reports from the Australian Bureau of Resource Economics (ABARE) and the Australian Greenhouse Office (including the three discussion papers on National emissions Trading) (Macintosh, 2012). Negotiations for advantageous LULUCF activities in the carbon accounting framework took place before a national emissions trading system (ETS) was even contemplated. However, it is noteworthy that what transpired was regulatory complexity and underperformance in LULUCF initiatives even while the rules for an ETS were being designed. Thus, a local systemic problem emerged in this transition, in addition to the global issues.

1.1.6 Mitigation through carbon offsets and bioenergy

Carbon agroforestry and the value of offsets

Noticeably different Australian Governments[1] have embraced the idea of using offsets from carbon sequestration and carbon sinks as an alternative to achieving actual reductions at the source of emissions. Indeed, the inclusion of carbon offsets in climate change policies enables greater flexibility and enables reductions to be achieved at a lower cost than some other emission reduction technologies. Offsets created in the land sector involve capturing carbon in plant material and ensuring the preservation of that living plant for a considerable period of time (Polglase et al., 2013a; van Kooten, 2018). However, this approach of using offsets in mitigation policies has sometimes been questioned as a legitimate form of mitigation (Hodgkinson, 2008). The merits of the use of offsets in mitigation is discussed in Chapter 4.

The early support for the use of carbon offsets in the land sector (referred to as carbon sinks) in Australia was also motivated by the opportunity to supplement or replace direct government support for tree planting and assist the efforts to reduce land degradation, salinity, biodiversity loss and mine site repair, while providing an additional source of income for farmers and other land owners (Hodgkinson, 2008). While these environmental co-benefits of carbon agroforestry might have been incidentally realised in early carbon plantings (Smith, 2009), they were not specifically incorporated into the design of national emissions trading and auction systems.

Bioenergy and carbon neutrality

The use of bioenergy can significantly increase mitigation from carbon agroforestry activities and has the potential to achieve carbon neutrality in the energy sector. Therefore, its inclusion in international climate change policy is potentially very important. However, concerns about claims of the carbon neutrality of bioenergy have been articulated in a report by Chatham House in 2009 and more recently, following Paris meeting of UNFCCC in 2016, where bioenergy featured prominently. The real issue highlighted by both Brack and Searchinger is that the maintenance of carbon in forests is a prime concern. It is more correct to note that bioenergy is carbon neutral in the energy

[1] The terms ‘Australian Government’, ‘Federal Government’ and ‘Commonwealth Government’ are used interchangeably in this thesis.

sector (Brack, 2017a; Searchinger et al., 2009). However the IEA Bioenergy and IPCC (especially in relation to SR1.5) have demonstrated potential mitigation value of bioenergy. A key statement appears in the Fourth Assessment Report of the IPCC : "in the long term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit' (Nabuurs, 2007).

Debate over the carbon mitigation value of bioenergy continues to occur and is largely based on how the emissions from bioenergy are assigned. Concerns articulated in a report by Chatham House in 2009 centred on the impact on bioenergy on forest carbon as a whole and emerged again following the meeting of the UNFCCC in 2016. IEA Bioenergy analysis shows that biofuels based on perennial lignocellulosic (woody) feedstocks generally show more promise, both in terms of net greenhouse benefit and other environmental and socio-economic impacts, than many first-generation options based on starch and oilseed crops (IEA, 2018). The systems with the greatest benefit are those that utilise residues as feedstock, and employ efficient energy conversion technologies such as combustion or pyrolysis for heat or co-generation of heat and power (Bartle J., 2010,; Gallasch, Bird, & Cowie, 2010). The history of land-based carbon sequestration and bioenergy reveals an interplay of global and local systems that are complex and difficult overall to accommodate as a complete package. This issue of the climate effect of bioenergy is a complex mix of technologies, wood products, socio economic factors, sequestration rates and energy emissions.

The role of bioenergy and its significance in the mix of land based technologies used to mitigate climate change could possibly be enhanced with better understanding of how more popular technologies (in regional Australia) such as solar PV could be mixed with bioenergy, and optimise the benefits of both technologies. Then baseload characteristic of bioenergy could be used to remove the intermittent nature of solar PV and retain the notional carbon neutrality of the blended system at large scale applications (Leirpoll et al., 2021).

1.2 New perspectives on the role of land use and forestry in climate mitigation

1.2.1 Negative emissions technologies

Most recent scenarios from integrated assessment modelling suggest that considerable attention needs to be turned to negative emission technologies (NETs) (Smith et al., 2016). These technologies are designed to achieve net removal of GHGs from the atmosphere through a combination of carbon sequestration, displacement of fossil fuels and capture of bioenergy emissions. While there are many options for NETs, there are acknowledged physical and biophysical limitations to their adoption (Smith et al., 2016). In addition, land use considerations are a key concern, particularly in relation to competition with food production and the possibility of land clearing (Moe, 2018).

There is a generalized assumption in the literature that less productive land is suitable for agroforestry and bioenergy (Miyake, Renouf, Peterson, McAlpine, & Smith, 2012; Pannell et al., 2012; Paul et al., 2016; Spangenberg, 2009). This generalised assumption is not necessarily valid, as explained later in this thesis (see Chapter 7) but it does indicate a desire to make carbon agroforestry into a significant mechanism for how transformational ecological land use can accompany significant quantities of greenhouse gases being removed from the atmosphere.

1.2.2 The Paris Agreement and BECCS

The growth in understanding and commitment to forms of carbon forestry for carbon mitigation continued to grow during the early part of the 2010 - 2020 decade until it reached a culmination in the Paris Agreement in 2016. The international agreement at the Paris meeting of the Conference of Parties to the UNFCCC in 2016 stipulated a numerical target limit of the rise in temperature caused by anthropogenic activity. This gave legal effect to the ambition embedded in the UNFCCC that temperature rise be limited to 2 degrees above that in pre-industrial levels. While the Paris Agreement did not specify the exact means by which this would be achieved, it did refer to reaching a balance between emissions and removals by sinks in the second half of the century, a common interpretation was that carbon neutral and carbon negative technologies would be employed (Smith et al., 2016).

In Paris, agreement was reached to adopt country-specific emission reduction targets, with an overall aim to avoid 3 degrees warming, and to reach the position recommended by the UNFCCC to limit warming to an increase of 2 degrees in the agreed timeframe

(UNFCCC) It was also decided to investigate possible means of achieving a 1.5 degrees target (Gao, Gao, & Zhang, 2017). In terms of achieving this target, the Intergovernmental Panel on Climate Change (IPCC, 2014) has stated that scenarios restricting global warming to two degrees Celsius relative to pre-industrial levels need to include large increases in the use of renewables, including bioenergy (Salisbury et al., 2014b). The IPCC has therefore highlighted the need for carbon neutral and carbon negative emissions technologies. Carbon neutral technologies, such as bioenergy, do create emissions in the process of energy generation, however the regrowth of feedstock consumes an amount of atmospheric carbon equivalent to the emissions from energy generation, notwithstanding the time factor between emission and recapture (Cowie, Berndes, Junginger, & Ximenes, 2017). If the direct emissions from bioenergy are secured and stored through carbon capture and storage (CCS), the technology is termed “negative emissions technology” (NET) or “net negative energy technology” (NNET).

When bioenergy is combined with carbon capture and geological storage of emissions, this combination of technologies is referred to as Bioenergy with Carbon Capture and Storage (BECCS).

1.2.3 The renewed need for carbon agroforestry

Adoption of these BECCS technologies suggested that carbon agroforestry could become an important contributor to emissions reduction (Nijnik & Bizikova, 2008; Polglase et al., 2013b). Carbon credits or offsets can also be generated in forestry activity by creating permanent forests and carbon pools from wood products. Growth formulas are used to calculate the net level of carbon sequestration and allowance is made for the residues associated with harvesting. When substituting wood for other building materials, such as concrete or steel, it is possible to calculate the level of emissions offset depending on the emissions factors for these materials. Furthermore, CO_2 emissions from bioenergy are not counted in the energy sector to avoid double counting in the land sector, which reports stock change associated with the harvest of biomass for energy (and other purposes). Substitution of wood for other building materials is reflected as a reduction in emissions in other sectors (e.g. fossil fuel used in manufacturing building products). Any reforestation stimulated in response to demand for BECCS, or forest C stock resulting from increased harvest, will be counted in national inventories but will not reflect any impact on land use, such as the displacement of food crops. The way forestry is treated in climate change terms tends to be political and dependent on the country specific issues faced at the time (van Kooten, 2018).

1.2.4 Carbon forestry is still underperforming

The international rules governing the role of forestry are interpreted by governments at the national level to reflect policies adopted to meet national targets. In addition, carbon forestry in those countries where it has been awarded an important potential role in emissions reductions, generally has to be conducted within a commercial framework that rewards participants (Höhne, Wartmann, Herold, & Freibauer, 2007; Lawson K, Burn K, Low K, E., & H, (2008) ; Mitchell, Harper, & Keenan, 2012). There are many ecological or ecosystem service benefits attributed to forestry related to soil health, water management, biodiversity and other issues. However, many of these benefits, that accrue to the community and the environment, are not sufficiently factored into the level of payments to the forest grower. This and many other factors will be considered in the thesis as the story of how complex the socio-technical transition to implementing this promising set of carbon agroforestry technologies has become. This will include the question of whether market failure exists across a number of areas (discussed in Chapter 4), and the question of whether this market failure results in a less than ideal uptake of carbon agroforestry programs in Australia (Polglase et al., 2011)

In Australia, it is anticipated that even more forestry for carbon sequestration will be undertaken after 2050, provided that incentives and disincentives that recognise ecosystem service delivery are put in place (Bryan BA, 2015; Lindenmayer, 2012; Stephens, 2014b). The conditional nature of this assumption reveals the multiple complexities that now beset this industry.

1.2.5 Sustainability and carbon farming

New carbon agroforestry projects, whether primarily for carbon sequestration or bioenergy, are often carried out on agricultural land that can be used for other productive purposes. In this context, and in the absence of common international rules, there is significant debate about whether such activity should take place or in what form. In particular, when a bioenergy crop is initiated on agricultural land, issues of land use competition with food production are commonly raised (Berndes, 2013). A core principle guiding the analysis of sustainability of bioenergy, therefore, is land use and assurance that energy crops do not unduly displace food production and also do not cause negative spill-over effects. Integrated carbon agroforestry is advanced in this thesis as a possible means of limiting the displacement of agricultural land.

In addition to this direct land use change issue (LUC), there are assumed to be possible "knock on" effects or indirect land use change (iLUC) which suggests that additional land for agriculture will be made available by the clearing of forests, thereby also creating additional emissions. To the extent that carbon sequestration activities can bring around iLUC, this thesis maintains that similar assurances required of by bioenergy need to be applied to carbon sequestration when considering the sustainability of that activity.

1.2.6 Carbon, co-benefits and ecosystem services

The valuing of co-benefits and ecosystem services as both private and public goods is a crucial step in addressing the need to protect, repair and improve agricultural landscapes. Purposeful creation of carbon credits, along with valued co-benefits, are effective tools to incentivise agroforestry, including production of bioenergy, as long as protected measures are included to avoid negative land use change and misallocation problems. The measures proscribed in international sustainability protocols are often overly prescriptive when both local planning and land care legislation are in place. An alternative to the use of international protocols is the adoption of codes of practice which can incorporate elements of both international and local considerations.

The importance of international sustainability assessment systems to the potential future of bioenergy is discussed later in this thesis (see Chapter 8). A common requirement of these assessment systems is that bioenergy needs to demonstrate significantly better performance in terms of reduced emissions than existing forms of fossil fuel based energy (FOA, 2011). However, it is claimed that these assessments do not adequately recognise the capacity for bioenergy to replace fossil fuels which can lead to a further reduction in emissions, often referred to as the 'climate effect' of bioenergy (Cintas et al., 2016; Cowie et al., 2017). In addition to the land use questions around bioenergy, there is debate over the required or acceptable payback period in order for bioenergy to make a useful contribution to climate change mitigation, i.e. the period necessary for carbon sequestration to replace the carbon emitted from bioenergy (Brack, 2017b; Cowie et al., 2017; Searchinger et al., 2008). However, the guidelines for GHG industries specify that bioenergy emissions are reported in the land sector rather than the energy sector. This results in bioenergy being considered "carbon neutral in the energy sector" and tends to lead to confusion. Nevertheless bioenergy must be linked to issues such as the cyclical sourcing of feedstock (harvest and regrowth) and eventual absorption of carbon emissions. (Cintas et al., 2016; Cowie et al., 2017).

The plethora of sustainability indicators and assessment systems (see Table 8.2) also create a barrier to the ready adoption and expansion of carbon agroforestry in all its forms. These assessment systems incorporate standards that are comprehensive and incorporate impacts across most agricultural landscapes. Ideally projects need to be assessed on the particular regional circumstances rather than a generalised set of assumptions (Cowie et al., 2017). In particular, these sustainability standards need to acknowledge the situations where planting trees on agricultural land can have beneficial environmental and socio technical benefits.

The importance of co-benefits to sustainability is now well recognized globally (IPCC, 2018) and the term ‘climate resilient development’ has been coined by the IPCC to show how the full set of Sustainable Development Goals can be used to help deliver climate mitigation and adaptation. Local sustainability assessment can help with local goals and the two can overlap and be complementary – in principle (Beatley, 2017).

There is a need for a framework (such as the land degradation neutrality framework) to bring all these factors together to guide sustainability in land-based activities. While taking action on climate change remains divisive, the solutions in some areas are now rapidly disrupting some sectors such as power and transport (IPCC, 2018). However, the land sector and particularly carbon agroforestry, is lagging behind these sectors and needs to be pushed through the barriers that have prevented its application and the delivery of multiple benefits. The positive way forward that first drove the incorporation of carbon agroforestry in climate mitigation, has now begun to dissipate into disputation on certain aspects of the pathway to carbon neutrality. As a result, carbon agroforestry is failing to deliver what was hoped for it. New perspectives on the way ahead are needed.

1.2.7 Market failure and climate change

A key contemporary framework for analysis of the impact of climate change is to attribute the damage caused by climate change as a consequence of market failure. Indeed climate change is seen as perhaps the most significant example of market failure in human history (Stern, 2005). This framework claims that, to the extent that GHGs and other bi-products of industrial production systems have not been accounted for, then neither has the damage they cause people and economies external to that production (Andrew, 2008). A number of paradigms, including the Coase Theorem (Hahn 2013), have been proposed to account for the negative externalities of anthropogenic climate change.[2] The fundamentals of the Coase Theorem and the negative externality problem are not discussed in detail in this thesis but it is important to acknowledge the economic principles that have emerged to underpin the pricing or valuation of a problem in order to manage the inequitable burden of pollution and in particular the international impact of climate change.

The fact that some agricultural systems do not ensure the maintenance or repair of ecosystem services is seen as another form of market failure. Facilitating the delivery of ecosystem services is considered a possible associated component of carbon sequestration and bioenergy. Payments for carbon sequestration and bioenergy could be considered 'Coasian' payments to landowners to ensure delivery of these important services (Hackl, Halla, & Pruckner, 2005). Discussion of the valuation of negative and positive externalities form a part of this thesis. Adopting this framework of market failure provides an opportunity to discuss how market failure might be identified in the future and what measures could be proposed to address the occurrence and/or resulting negative externalities.

1.2.8 Public attitudes and climate change action

The volatility of public attitudes to action on climate change has been a crucial background to the way policies have been developed in Australia. Chapter 3 analyses the possible reasons for these fluctuations and the way that politics has influenced attitudes and not always in the way anticipated. Indeed the way in which climate change policies are introduced is seen as a crucial determinant of success and subsequent discussion centres on how to incorporate carbon sequestration, bioenergy and sustainability into an integrated policy. The manner in which policies are adopted also impacts on the effectiveness of these policies in transitioning the economy to a lower carbon future. As discussed above in 1.2.7, market failure related to climate change exists. This needs to be acknowledged by the public as payments are needed to make good the negative externalities. It is essential that in relation to supporting payments for ecosystem services, that public opinion is supportive of the anthropogenic nature of climate change.

[2] The Coase Theorem (Hahn, 2013) proposes that the problem these negative externalities cause can be resolved if property rights - in this case ownership of the environment - can be assigned and the market is able to negotiate ownership. If necessary the state can place a price on these property rights creating a hybrid market and a government solution to the problem (Schweizer, 1988). The USA cap and trade system to manage acid rain was based on this approach, and a solution was found without the government placing a tax on the pollution.

1.3 Socio-Technical Transition Theory

A framework used in technological change and especially related to climate change, is Socio-Technical Transition Theory, developed by Frank Geels (Geels et al, 2017) and others who have followed him in this applied analysis (Bilali, 2018; Darnhofer, 2015). Geels et al (2017) has proposed a framework and tools for enabling technological change such as that required for effective climate change strategies (Geels, 2017).

However, the challenge is that climate change is a ‘wicked problem’ (Chapter 3) where considerable uncertainty prevents easy solutions and a framework is needed to enable understanding of how socio-economic change is best achieved. A related quandary is that complexity necessitates combining evidence-based decision-making with experiential knowledge to ensure solutions are forward-looking as well as context-appropriate.

Geels (2017) and others proposing socio-technical transition approaches have suggested there are three levels at which change needs to occur and which are set out in Figure 1.1:

- **Micro level** where there are technological niches requiring demonstrations on a small scale with tools relevant to research and development in organisations and communities.
- **Meso level** where there is a patchwork of socio-technical regimes at various levels of government and industry scale, that influence markets and pricing and the tools are needed to show how the system can change for the better.
- **Macro level** where the whole landscape or governance system needs to be transformed mainly involving public authorities resetting the regulations and recreating appropriate institutions.

Geels also adds the influences against which innovations need to battle to achieve acceptance and adoption at the landscape level. These are set out in Figure 1.2.

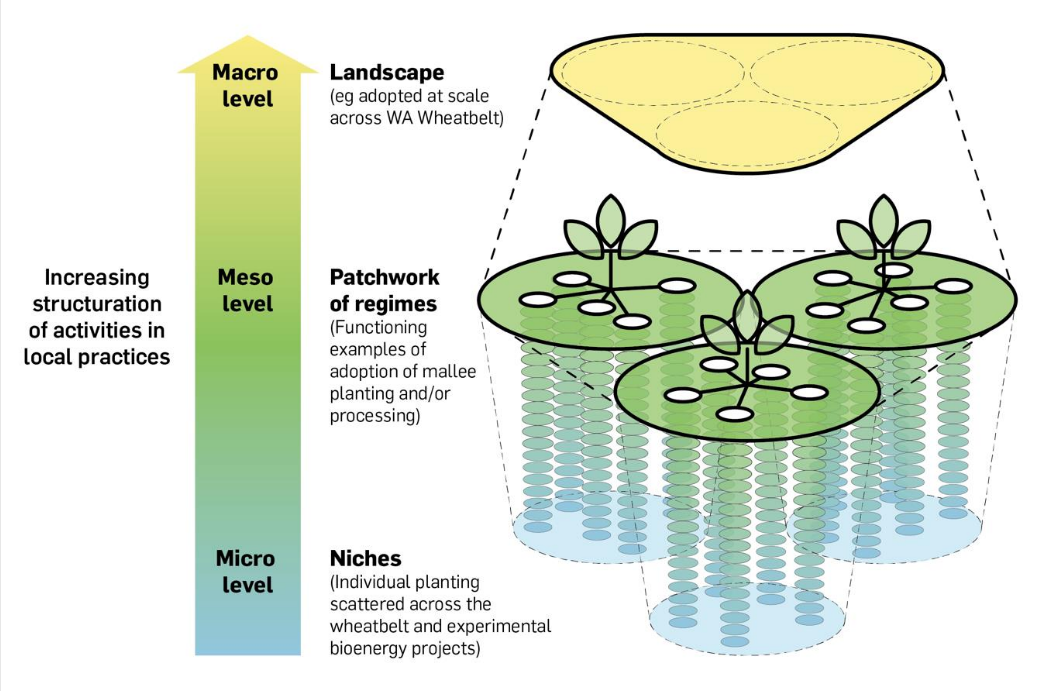

Figure 1.1 Levels where change is required
Adapted from Geels et al (2017)

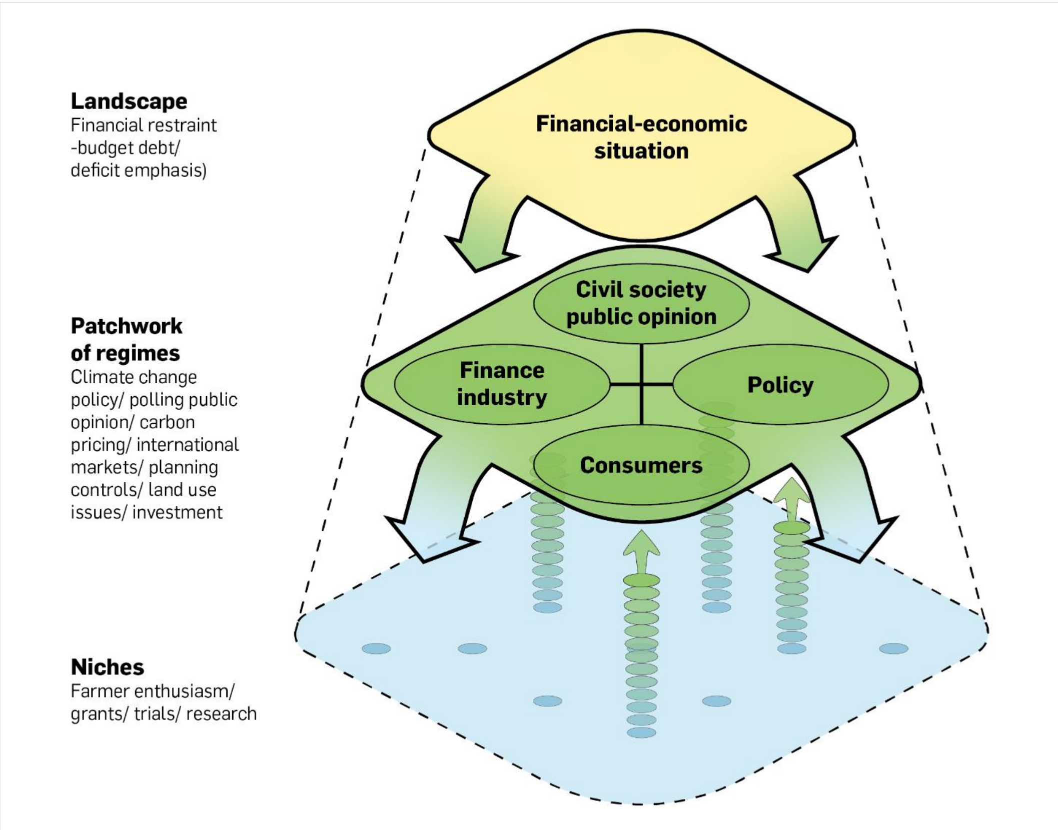

Figure 1.2 Influences against which innovations need to battle
Adapted from Geels et al (2017)

While Geels (2017) and the other authors above have used socio-technical transition theory to describe transitions in agriculture, the multi-level perspective can be applied to carbon agroforestry and more particularly, as a means of analysing the case study in this thesis. The niche and innovation level can readily be associated with the individual farms with Oil Mallee plantings supported initially by both Commonwealth and State Government funding and investment from the carbon market with support from farmers groups and innovators such as the Oil Mallee Association. The meso level step analysis can be applied to the regimes of modern broad acre practices which dominate the Western Australian Wheatbelt and the hesitation to adopt agroforestry without guaranteed financial reward. The landscape level is where governance by financial institutions and governments maintains a steady and consistent influence across the agricultural system. For the innovations to succeed, transition across these levels needs to be promoted in some way to elevate good practice towards adoption across the landscape level.

Socio-technical transitions are long-term processes that can take decades or even generations to complete. In relation to sustainability they are often structured around visions of a sustainable future (Nevens et al, 2013). These transitions often involve combining an innovative solution with networking, collaboration, and alliance building to spark new ideas, practices, expectations, and forms of social relations. The experiments are important because they provide a vehicle to translate long-term aspirational visions into short-term concrete actions (Karvonen & Van Heur, 2014). The transition processes work through at least three diffusion paths through which they bring about larger changes:

- **Embedding -** a process of combining and adapting technologies, integrating them into existing structures, as well as giving these technologies meaning (Von Wirth, et al, 2018).
- **Translation -** the horizontal diffusion where there is replication and reproduction elsewhere.
- **Scaling -** the internal development and growth of niche experiments (Liedtke, et al, 2015).

The thesis will examine a range of socio-technical factors found to be associated with implementing carbon agroforestry and will apply the Geels framework to shed some light on the way ahead. Management of societal transition to sustainability or more explicitly transition in cropping agriculture to adoption of integrated agroforestry is destined to be slow and possibly generational (Kemp, 2003). At each level of the multilevel perspective it is thought that a different series of actors are involved and influence the transition pathway from one level to the next (Rotmans, Kemp, & van Asselt, 2001). At the landscape level the government plays a significant role while at the meso level market economics determines the distribution of technologies and rewards. At the micro level society and individuals experiment and succeed or fail but the transition towards new levels of sustainability benefit from this approach to change, as opposed to attempts at fast change with disruptive consequences and possible creation of opposition (Rotmans et al., 2001).

The Sustainability Transitions Research Network (STRN 2017) argues that sustainability transition is a broad and interdisciplinary research field. In fact, sustainability transitions have several features that make them a special topic in sustainability scholarship:

- multi-dimensionality and co-evolution (transitions are co-evolutionary processes, involving changes in different dimensions of socio-technical systems);
- multi-actor process (transitions are enacted by a range of stakeholders/actors);
- stability and change (dialectic relationship between stability and change is central in sustainability transition research);
- long-term process (transitions may take decades to unfold);
- open-endedness and uncertainty (sustainability journeys are open-ended as there are multiple transition pathways, which implies uncertainty);
- values, contestation, disagreement (sustainability notion is highly contested, so different actors tend to disagree about sustainability transitions pathways and participants are impacted in different ways);
- public policy (public policy plays a central role in shaping transitions towards sustainability) (Bilali, 2018)

Furthermore, there is a phasing of this movement or progression from niche to landscape level and this is captured in Figure 1.3 which highlights many of the aspects addressed in the discussion in this thesis of how carbon agroforestry made significant steps towards widespread adoption but ultimately failed to become embedded at a landscape level. The interplay between early movers and media interest, public opinion and legislative interest is discussed in successive chapters. In the final chapter these pressures and influences are integrated into a concluding diagram, taking as a starting point the Geels (2017) multilevel transition process.

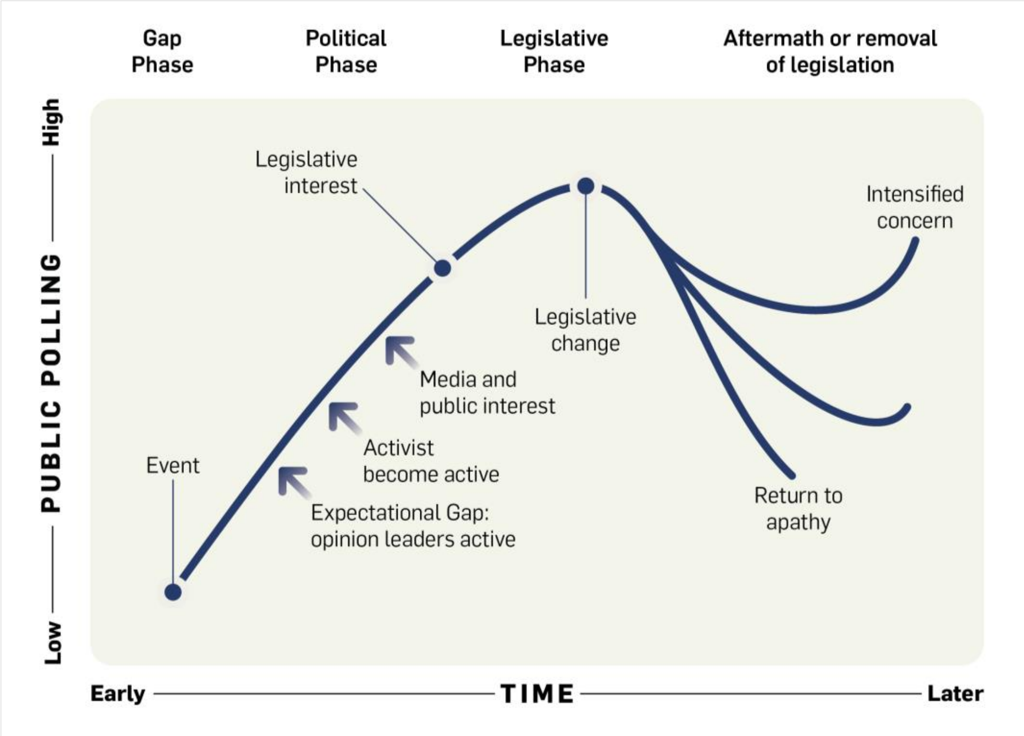

Figure 1.3 Temporal dynamics of issue lifecycles in terms of public awareness and political change

Adapted from Rivoli and Waddock (2011)[3] in Geels (2017)

While the Geels transition framework has been applied to biofuel crops competing with food, it is probably the first time that carbon agroforestry, has been analysed using a Socio-Technical Transition Theory framework (Bilali, 2019b). The use of this transition theory to such a potential conflict of interest is not well defined around energy and biofuels in particular (Raman & Mohr, 2014). The debate on food versus fuel has evolved from the global debate around food security, including other crops such as cotton, sugar, livestock and coffee. In addition advocacy for north south equity and fairness in international trade have most likely hidden the potential for sustainability assessment to incorporate these wider issues and indeed more localised situations. (Raman & Mohr, 2014).

This study builds on the developing application of Socio Technical Transition Theory to agroforestry, carbon and potentially sustainable biofuel production and analyses this particular new agricultural industry against this transition framework. The study uses sustainability assessment to provide more specificity to the generic and global assumptions that pervade the food versus fuel debate (Bilali, 2019a; Bilali, 2018, 2019b; Raman & Mohr, 2014).

[3] Link: https://www.sciencedirect.com/science/article/pii/S221042241200069X?via%3Dihub#bib0240

A key part of Socio-Technical Transition Theory is how public awareness shapes many of the steps needed to move the practitioners to greater levels of adoption of new technological systems. In Figure 1.3 details the process of how public awareness rises and falls, either achieving political change or falling back into apathy. An important aspect reflected in this diagram is the importance of public support for an idea like carbon agroforestry and how this can motivate governments into action (Geels, 2011). Likewise, policy changes can generate shifts in public opinion (Hilgartner, 1988) but the timing of public interest and government engagement in projects such as agroforestry may not happen synchronistically or across communities of interest, including regional communities and farmers. Indeed, even if public attitudes become supportive, public interest may wane before government action is taken (Downs, 1972). This link between public opinion and government action is discussed in this thesis and reasons are proposed as to why the fluctuations in opinion take place. It is also important to note that encouraging change to greater sustainability can create unlikely opposition, just as public opinion can react negatively to poor expression of a problem.

Although not translated to the particular field of carbon agroforestry it is also relevant to note the process of energy technological development and the three domains described by (Grubb, 2015) which highlight the need to acknowledge the stages through which innovation needs to pass. These three stages, satisficing, optimising and transforming when combined with socio technical transition considerations provide an added perspective on the readiness of new technologies (Grubb, 2015). This thesis however will focus on the socio technical transition process.

1.4 Case study – the Oil Mallee Project

The Case Study in this thesis is the Oil Mallee Project, which was initiated with the promotion of carbon agroforestry at its core. It highlighted that co-benefits can facilitate the meeting of climate resilient development goals and raised the importance of a regionally endorsed sustainability assessment process through an Oil Mallee Code of Practice. The case study is set in the Western Australian Wheatbelt and involved the adoption of integrated carbon agroforestry by a large number of farmers. The Oil Mallee Association (OMA) is an organisation that was created to advance the growing of trees on farms.

Box 1.1 Description of the Oil Mallee Association

The Oil Mallee Association (OMA) is an industry body sustained through the efforts of its members and supported by grants and collaborations. OMA promotes the use of Oil Mallees (genetically improved native eucalypts) for integrated agroforestry and sustainable land management practices.

The OMA is custodian of the Oil Mallee database which contains details of plantings across all Oil Mallee regions, complete with details of growers, species planted and other issues of interest.

The OMA is constantly improving the manner in which the information is kept and managed and respects the need to maintain confidentiality of growers identity, location and details of the resource. This important information reflects the most valuable asset of the OMA; the knowledge and commitment of the growers themselves. OMA, 2019

With the advent of the National Action Plan for Salinity and Water Quality in 2000 (ANAO, 2004), the OMA coordinated the distribution of seedlings made available through State and Commonwealth funding. Each allocation of seedlings to a particular farmer was accompanied by a contract which included a reference to the potential for the trees to become a recognised carbon sequestration project. Over this time the OMA promoted bioenergy as a suitable way of exploiting the plantations of trees by regularly coppicing the trees.

The OMA also successfully championed the establishment of a trial bioenergy project using Mallee biomass at Narrogin, a town in the south west of Western Australia. The industry as a whole was set back by a failure of this project to be maintained as a working example of bioenergy from biomass grown on farms. The OMA has maintained its advocacy for integrated agroforestry while at the same time attempting to develop strategies to manage the Mallee estate across the WA wheatbelt and assist individual projects such as the Kalannie Distillers, who produce Eucalyptus Oil, The OMA successfully secured support from two Regional Development Commissions for the purchase of a large boiler. The OMA also supported the Rainbow BeeEater project, which has successfully produced biogas and biochar (OMA Website).

With the advent of the National Action Plan for Salinity and Water Quality in 2000 (ANAO, 2004), the OMA coordinated the distribution of seedlings made available through State and Commonwealth funding. Each allocation of seedlings to a particular farmer was accompanied by a contract which included a reference to the potential for the trees to become a recognised carbon sequestration project. Over this time the OMA promoted bioenergy as a suitable way of exploiting the plantations of trees by regularly coppicing

the trees. The OMA also successfully championed the establishment of a trial bioenergy project using mallee biomass at Narrogin, a town in the South West of WA.

The Narrogin Trial Bioenergy plant was completed in 2005 and operated for a year to demonstrate the integration of eucalyptus oil extraction, bioenergy and production of activated carbon. It closed in mid 2006 after successful demonstration of these elements but with no further funding to continue.

The industry as a whole was set back by a failure of this project to be maintained as a working example of bioenergy from biomass grown on farms for reasons outlined in Chapter 6. The OMA maintained its advocacy for integrated agroforestry while at the same time developing strategies to manage the Oil Mallee estate across the WA Wheatbelt and assist individual projects such as the Kalannie Distillers (now Kochii Eucalyptus Oil), which produces Eucalyptus Oil and the Rainbow BeeEater Project, producing biogas and biochar (OMA Website).

There were several parallel objectives from the OMA's program. Environmental benefits were anticipated as a result of re-afforestation of over-cleared land and financial rewards would accrue to the landowner from carbon sequestration and bioenergy. Analysis of the Oil Mallee Project provides insights into the suitability of international climate change governance to the Project as well as insights into local sustainability assessment systems for bioenergy and carbon sequestration established on agricultural land. Improving insights into the applicability of climate change governance and sustainability to carbon agroforestry can be seen to be part of the socio-technical transition pathway for carbon agroforestry.

1.5 Research question and objectives

It has been stated earlier that carbon sequestration through agroforestry programs has played a much less significant role in climate change mitigation policy in Australia than initially anticipated. Particularly after Kyoto in 1998 it had been widely predicted in Australia that growing trees across the landscape would provide an early low-cost practice to achieve reductions in emissions. This disparity between expectation and result has prompted the key research question for this study.

1.5.1 Research question

Why has carbon agroforestry failed to meet the expectation for carbon mitigation in Australia and what can be done to change this?

1.5.2 Objectives

- To discover if the period of volatile global and local climate policy created uncertainty and also had an impact on public support for action on mitigation of emissions particularly carbon agroforestry.
- To identify key technical and governance issues confronting carbon agroforestry in Australia.
- To explain the role played by multiple and standardised sustainability assessments in the acceptability of carbon agroforestry and bioenergy projects, despite the variation in local context.
- To use the activities and programs of the OMA as a case study to highlight the challenges and potential benefits of carbon agroforestry and bioenergy as part of a local socio-technical transition.
- To outline the extent and importance of environmental co-benefits to carbon agroforestry and identify mechanisms that value these co-benefits and ecosystem services;
- To explore whether a socio-technical transition framework can help to understand the factors that have limited carbon agroforestry's growth and the critical factors that need to be addressed to advance the growth of agroforestry, both locally. and globally.

1.6 Approach

1.6.1 Outline

The approach used is primarily qualitative, involving a literature review and a case study incorporating interviews and observations. Inductive reasoning (Hayes et al, 2010) was used to develop conclusions and recommendations after examining existing carbon farming policy and attendant outcomes. Inductive reasoning is appropriate in this approach to research since quantitative analysis is not possible when speculating about how regulatory and policy hurdles might be overcome to achieve a sustainable outcome for carbon agroforestry (Hayes, Heit, & Swendsen, 2010). In other words, a diverse range of literature is used to explore arguments that might provide a resolution of potentially conflicting issues that impact on the adoption of a beneficial climate change mitigation strategy. A key source of observations comes from the personal involvement of the author in the processes that are being examined, as set out in Box 1.2.

Box 1.2 Author's involvement in the Oil Mallee Case Study – A Personal Statement

The author / researcher has employed elements of autoethnographic research approaches in undertaking this research by reflecting on past actions, attitudes and experiences (Adams, 2015). He has been aware of the necessity of drawing on his own perceptions and insights and also the benefits that this long experience has brought to the work. However, the research process stops short of containing autobiographical material but rather draws on a work history and engagement that needs to be acknowledged (Dwyer, 2017; Ellis, 2011; Pensoneau-Conway, Adams, Bolen, Ellis, & Bochner, 2017; Throne, 2019)

For over eight years the author held the position of General Manager of the Oil Mallee Association of Australia (OMA) and for several years during this period, the Managing Director of the Oil Mallee Company Ltd (OMC), a joint venture between the OMA and CO2 Australia Ltd. CO2 Australia undertook its own carbon forestry projects, including a large contract for Woodside Petroleum which was intended to run for ten years and partially offset the fugitive emissions from gas facilities in the North West of Western Australia. The shareholding of OMC included many farmers and a 29% holding by CO2 Australia.

During this time the author also secured funding for the formulation of the Oil Mallee Code of Practice, a document he created with significant research and industry participation. The Code of Practice is featured in Section 3 of the thesis as a practical region-specific alternative or contributor to sustainability assessment processes.

Prior to taking this particular role with the Company and association the author held senior policy roles in the WA State Government and actively engaged and provided leadership in relation to climate change policy. This involved participating in COAG (Council of Australian Governments) climate change meetings, including as the WA representative in the creation by the Australian Greenhouse Office of the Four Discussion Papers on Emissions Trading.

During this period the author also attended three UNFCCC meetings COP6 in 2000 (The Hague), COP 8 in India (2002) as part of the Australian Delegation, and COP 13 in Bali (2007).

The author adopted the role of an investigator in the research for this Oil Mallee Project case study in order to explore industry applicable strategies that might lead to the adoption of carbon agroforestry. This role included observing patterns and correlations between policy and outcomes and attending many conferences and forums on carbon farming.

In addition, the author draws on knowledge of and experience in the Oil Mallee industry over many years, as a form of retrospective action research. The practical experience involves analysis of barriers and opportunities, problem-solving and implementation of solutions to promote carbon farming with Mallee species in Western Australia. This has provided a detailed understanding of the substance and application of relevant international and national legislation and policies, carbon farming research and stakeholder perspectives.

1.6.2 Literature approach

This thesis takes as its starting point the global determination to address anthropogenic climate change supported by the burgeoning field of scientific and policy writings over the last 30 years. In particular, the thesis focuses on literature that has emerged since the first international agreement on climate change, the Kyoto Protocol, in 1998. Key readings have been used to analyse the agreements reached by the international community and the policy responses by individual countries or groups of countries, but particularly Australia. Two economists contributed significantly to setting the policy framework once the International agreements became clear, Sir (now Lord) Nicholas Stern (Stern, 2005) from the UK and Professor Ross Garnaut (Garnaut, 2008a) in Australia.

Notwithstanding the strong theoretical support for carbon forestry in the literature, there is a combination of socio-technical transition factors that needs to be incorporated into consideration of the viability, feasibility and implementation of carbon agroforestry programs. This thesis uses research and the Oil Mallee Project case study to identify four issues that have inhibited carbon agroforestry and need to be addressed if carbon agroforestry is to be more widely adopted:

- *Governance*: the importance of regional context, its planning controls and policies;
- *Integration*: the benefits of integrating forestry and agriculture;
- *Environmental impact*: the value of ecosystem services and other co-benefits;
- *Policy certainty*: the presence of supportive attitudes to enable policies to be implemented.

These issues are reviewed in the final chapter (Chapter 12) through the socio-technical transition approach.

1.6.3 Case Study

The Oil Mallee Project is used as a case study to highlight an integrated approach to carbon sequestration and biomass production. The use of a case study in this research about agricultural practice and farmers has enabled a method of viewing the response of individuals and groups to challenges and opportunities raised on a theoretical level by the UNFCCC agreements and adopted or indeed challenged by governments. One particular challenge discussed later in this thesis was raised by the Australian Government and related to what qualifies as a tree when incorporated in the definition of a forest. The standard definition had been based on European forest species, whereas the Australian Government argued for low statured eucalypts, such as mallee species, to qualify in the definition of a forest. Indeed, the meeting to discuss this issue was held in Perth WA in 2000 thus highlighting the existing investment by the Australian Government and farmers in mallee plantings and their prospective value in carbon agroforestry. (More detail in Chapter 4, 4.2.)

There is strong support for the use of case studies in areas where a theory can be developed around a particular circumstance and group which would be very difficult to establish through other more quantitative data capture and analysis (Gillham, 2000). The use of a case study in this thesis provides valuable qualitative information.

1.6.4 Qualitative research

The quantitative research component of this thesis is a survey of farmers who have undertaken agroforestry using various species of mallee eucalypts. The study obtained information and opinions from farmers who had contracted with the Kansai Electric Company of Japan to create the '1000 hectare' project with a view to exporting the carbon credits to Japan. These farmers were located in approximately one region of the WA Wheatbelt and had used the same design of planting. They were invited to participate in semi-structured interviews and their responses are analysed to extract a range of attitudes about their involvement in integrated agroforestry. They provided insight into the attitude of particular landowners to carbon agroforestry undertaken on their land.

Of those approached 10 farmers completed the questionnaire and signed off on the written record of interview. This relatively small sample represents a common approach to planting, payment structure and scale and provides valuable information on attitudes to the trees and their continuing presence on the farm. While results and findings of the interviews may not necessarily be representative of all mallee growers (over 1000 farmers planted trees across their properties under the supervision of the OMA) the study does provide rich and important insights into the issues highlighted and points towards some potential solutions.

1.7 Overview of the thesis

1.7.1 Thesis structure

Table 1.1 Thesis parts, themes and chapters

Part	Theme	Chapter
1. Introduction	Issues, questions and approaches	1
2. Literature and policy	Climate policy	2
	Australian attitudes	3
	International policy	4
	Policy design	5
3. Case study	History of OMA	6
	Farmers opinion of Oil Mallee plantings	7
4. Lessons learned	Sustainability assessments	8
	Valuing of co-benefits and ecosystem services	9
5. Conclusions and transitions	Questions reviewed	
	Transitions highlighted	10
	Further work and new approaches	

1.7.2 Summary of chapters

Chapter 2 – Climate policy in Australia

In this chapter the historical background to the climate change negotiations are outlined including the importance placed by Australia on certain accounting practices and land use baselines to secure the best outcome for the nation. The early emphasis on the land sector and forestry increased expectations that carbon agroforestry would be a very important component of the national mitigation strategy over many years.

An historical review of climate policy in Australia is followed by a discussion of the relationship between the way policies have been presented and the eventual demise of a market-based approach to mitigation, despite early enthusiasm for strong action on climate change. An analysis of this trend via path dependence is followed by examination of the potential for progressive incrementalism to be a better way to ensure policies are developed, implemented and retained.

Chapter 3 – Attitudes to action on climate change

The fluctuations in public support for action on climate change are observed through the lens of three Australian polls and a collection of international surveys of opinion. The similarity in the fluctuations is noted and some common reasons proposed. Overtly hyperbolic and politically motivated expressions of concern for action on climate change do not manage to deal with the 'wicked' nature of the problem and appear to create and harden the division of opinion. It is suggested that this approach does not set up the right circumstances for steady and consistent policy approaches to climate change mitigation, including market-based approaches which require industry and community confidence.

Chapter 4 – International Climate Change Policies

The rationale for action on climate change rests in market failure at the international and national levels, requiring intervention by governments. The international agenda provides significant scope for carbon agroforestry to occupy a significant position in national policies. This chapter highlights the importance of the international climate change framework and the national response to the potential contribution of carbon agroforestry in meeting national targets.

The inability of policies around carbon agroforestry to respond to the leadership of the international framework can be called policy failure and this is explored in Chapter 5.

Despite the UNFCCC awarding significant importance to bioenergy as a carbon neutral and potentially a negative emissions process (BECCS) at the Paris Climate Change Conference, the contribution of bioenergy to climate change mitigation is contested, which contrasts with the key role for bioenergy anticipated by the IPCC, as expressed in SR1.5. The barriers to the adoption of bioenergy are discussed along with some forward-looking opportunities for expansion.

Chapter 5 – Policy design issues

In this chapter analysis of the unique importance placed by Australia on carbon agroforestry is juxtaposed against the relatively poor performance of this sector in achieving emission reductions. The reasons for this lack of success are explored, including the commencement and cessation of carbon trading, and the role of regulatory and change confusion in creating uncertainty. This uncertainty created a brake on the use of new carbon agroforestry as a means of creating offsets. The regime of changing legislation and regulation included imposing limiting conditions on CFI methodologies related to agroforestry.

At the same time, there is a need for recognition of the level of biodiversity associated with carbon agroforestry. If this link is secured through additional payments more carbon plantings would be possible.

If a source of payments for ecosystem services were to exist in Australia, it may also help support the preservation of extensive tree plantings which were undertaken as 'early action' and intended for formal carbon sequestration before consolidated national policy was achieved. These plantings include many thousands of hectares of mallee eucalypt in Western Australia.

Chapter 6 – The History of the Oil Mallee Project in Western Australia

The history of the Oil Mallee Project is outlined, particularly its engagement in carbon sequestration and promotion of bioenergy. The role of significant research and investment in these areas in response to issues such as land use and carbon policy is considered.

Chapter 7 – Farmer opinion of Mallee plantings

A group of farmers who have established Mallee plantings on their properties in the WA Wheatbelt were interviewed to explore their current attitudes towards and satisfaction with integrated carbon agroforestry and their views of the potential of agroforestry. This chapter outlines and analyses the farmers' perspectives.

Chapter 8 – Role of sustainability assessment frameworks

Several sustainability assessment frameworks for bioenergy are identified and analysed as to their suitability for classifying integrated agroforestry. The circumstances where the use of farmland for forestry falls outside the criteria in the assessment frameworks are discussed. This discussion then asserts that when certain local conditions and governance arrangements are considered, it would be possible for bioenergy programs to avoid generic land use change compliance. The potential for codes of practice to be adapted for use as sustainability tools is raised.

The Oil Mallee Code of Practice (OMCOP) is outlined and described as an iterative and regionally specific set of guidelines which carries many of the conditions required of a more broadly applicable sustainability framework.

Chapter 9 – Valuing co-benefits

The many ways in which ecosystem services can be measured are discussed in Chapter 9. Examples where pricing systems are used are analysed to gain insight into how co-benefits and ecosystem services associated with integrated agroforestry could be valued. The valuing of these services would possibly enable a better alignment with how agroforestry is perceived by farmers and land owners who assign productive land to this purpose.

Chapter 10 - Conclusions and further research

The findings of the research are summarised through the framework of Socio-Technical Transition Theory in this final chapter. Several attributes of proposed good practice and policy are identified that could arguably ensure a significant role for carbon agroforestry in all its forms into the future.

Table 1.2 Actions and chapters by research objective/sub-question

Objective/Sub-question	Thesis action	Chapter
Overall Research Question: Why has carbon agroforestry failed to meet the expectation for carbon mitigation in Australia and what can be done to change this?		
Impact of volatility uncertainty on public attitudes on policy	Analysis of the polling of public attitudes to climate change action over time	2
Key technical and governance issues confronting carbon agroforestry in Australia	Historical survey of land use issues in dryland broad acre agriculture and history of carbon sequestration	3
Sustainability assessments and the acceptability of carbon agroforestry and bioenergy projects	Analysis of sustainability assessment frameworks and comparison to Oil Mallee code of Practice	4
The extent and importance of environmental co-benefits to carbon agroforestry	Survey of literature on the links between co benefits and carbon sequestration	5
The activities and programs of the Oil Mallee Association of Australia Inc	Case study	6
Mechanisms that value these co-benefits and ecosystem services.	Review of literature on valuing co benefits and payment for ecosystem services	7
A socio-technical transition framework to understand the factors that have limited carbon agroforestry's growth	Application of Transition Theory to carbon agroforestry to identify pathways to successful carbon agroforestry	8

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PART 2 –

CARBON AGROFORESTRY LITERATURE AND POLICY

Chapter Two

2

Climate Policy in Australia

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2.21 Polling of public attitudes to energy 51
2.22 The Safeguard Mechanism is designed 52
2.23 Summary 53

2.1 Introduction: A short history of climate policy

This chapter analyses the development of Australian climate change policy from its emergence soon after the first report of the United Nations' Intergovernmental Panel on Climate Change (IPCC) in 1990 to the present. A range of policy approaches that have been developed to address this wicked problem are examined to highlight the complex nature of climate change policy.

This historical review of climate policy in Australia is followed by a discussion of a possible link between the way policies have been presented and the eventual demise of a market-based approach to mitigation. Despite public support for strong action on climate change, particularly following a succession of UN reports, this support faded just as such action was taken. An analysis of this trend via path dependence theory is followed by a discussion of the need for alternative pathways to achieve more lasting policy.

2.2 The Intergovernmental Panel on Climate Change (IPCC)

The IPCC was convened by the United Nations in 1988 and published its first assessment report in 1990. In that year, the Australian Government proposed a 20% reduction in Australian GHG emissions by 2005, which was endorsed by the Australian Parliament. At the first UN Conference of the Parties[4] (COP1) in Kyoto, Japan in 1997, Australia negotiated a relatively soft emission reduction target of +108%. The negotiation to allow an actual increase in national emissions was based on the argument that Australia's export-oriented economy needed special protection in comparison to other nations. A concession was incorporated in the country's existing forestry and land use practices. The Australian delegation argued that emissions from land clearing be included in the target, knowing that reducing land clearing from a very high point would be easier that reducing emissions from industrial or fossil fuel industries. (Hamilton, C., The Conversation 16/7/15). This measure was called the Australia Clause and slowing down the rate of clearing enabled a significant increase in emissions from other sources. Although agreeing to the target in principle, it took a change in government a decade later in 2007 for Australia to officially ratify the Kyoto Protocol, committing publicly to pursuing this goal for carbon emissions reduction.

[4] The COP is the supreme decision-making body of the Convention. All States that are Parties to the Convention are represented at the COP, at which they review the implementation of the Convention and any other legal instruments that the COP adopts and take decisions necessary to promote the effective implementation of the Convention, including institutional and administrative arrangements.
(See https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop for more information).

Nevertheless, in the decade between 1997 and 2007, various climate change related activities took place and several policies and regulations were implemented both at the federal and state levels. Of note was the establishment of the Australian Greenhouse Office (AGO). The AGO released a series of discussion papers in 1999 on the topic of national GHG emissions trading - in other words the establishment of a market for carbon. In 2002, the Australian state of New South Wales (NSW) introduced the world's first emissions trading scheme, known as the Greenhouse Gas Abatement Scheme (GGAS), which functioned as a baseline and credit scheme[5] (Blazey & Connors, 2008).

In the space of three years, several noteworthy reports on climate change were produced, adding awareness to the options for policy response to climate change. In 2006, the UK Government released the Stern Review on the Economics of Climate Change (Stern, 2005). In 2007, the Intergovernmental Panel on Climate Change (IPCC) released its Fourth Assessment Report (AR4), which confirmed with 90% certainty that climate change was occurring, largely due to the impact of humans (IPCC, 2014).

In 2007, Australia also held a federal election which was fought predominantly on climate change. After a decade of Liberal Government leadership, the Labor Opposition made climate change an important part of their successful bid for office. In 2008, the new Australian Government released its own version of the UK's Stern Report, written by economist Professor Ross Garnaut – The Garnaut Climate Change Review (Garnaut, 2008a).

In 2009 the UN Conference of the Parties to the UNFCC (COP15) met in Copenhagen. COP15 remains one of the largest environmental conferences in history. Despite the momentum building for climate action, the next few years in Australia were fraught with political turbulence as the Federal Government attempted unsuccessfully to implement the Carbon Pollution Reduction Scheme (CPRS), a national emissions trading scheme. In 2010, then Labor Prime Minister Kevin Rudd was replaced by Julia Gillard, who commenced negotiations with the Australian Greens to design another form of Emissions Trading Scheme (ETS). In 2011, the Carbon Pricing Mechanism (CPM) was

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[5] Baseline and credit schemes identify, measure and provide incentives for activities that reduce emissions. Australia has implemented a range of baseline and credit schemes at the state and national level, including the Renewable Energy Target (RET), the New South Wales Greenhouse Gas Reduction Scheme (GGAS) and the New South Wales Energy Savings Scheme (ESS). The CFI is a baseline and credit scheme, as is the government's ERF. Baseline and credit schemes can be designed in a variety of ways to suit a range of different policy objectives, including promoting energy efficiency and meeting emissions reduction targets. A baseline is established against which performance can be measured. If actual emissions are below the baseline, the difference between the two represents emissions reductions, and is eligible for credits (CCA, 2014b).

presented to Parliament and entered into force in 2012. Several other climate policies and Acts were created, including the Clean Energy Finance Corporation (CEFC) Act 2012 under which the CEFC was established to invest, directly or indirectly, in ‘clean energy technologies that could reasonably be expected to control, reduce or prevent anthropogenic emissions of greenhouse gases’, and the Carbon Farming Initiative (CFI), which encouraged carbon abatement from the land sector ("Clean Energy Finance Corporation Act 2012," 2012).

For the second time, in 2013, a federal election was fought on climate change. After significant campaigning by the Federal Opposition, including highlighting the potential impact of the carbon price on the cost of living, a Coalition Government[6] was elected. A number of factors related to action on climate change were highlighted by the Opposition during the election, including the future price on carbon. There was a change of Government, but polling did not indicate a major change in public attitudes to action on climate change. This is discussed in the Chapter 3.

2.3 Kyoto and the Australia Clause

The framework for the inclusion of forestry in Australia as part of an emissions reduction program was established at an early stage on international negotiations. Ten years after the meeting of the IPCC in 1988 a landmark agreement was reached at the third UNFCCC Conference of the Parties in Kyoto in late 1997 – the Kyoto Protocol. In the two years leading up to the Kyoto Protocol Agreement, the Howard Government was able to negotiate the inclusion of land use change and forestry into the calculation of the net emissions of the 1990 baseline. This became known as the Australia Clause, as Australia was the only country to utilise land use change and forestry calculations in this way.

2.4 The no regrets attitude of the Howard Coalition Government

A defining aspect of the approach adopted by the Commonwealth over the period of almost twenty years, from 1988 to 2007, was that of ‘no regrets’. This approach requires that any measure taken to reduce GHG emissions was to have no impact on the domestic economy or Australia’s international trade competitiveness. Therefore, having negotiated beneficial conditions to enable the use of forestry and land use to address the emissions reduction target, the adoption of ‘no regrets’ delayed the implementation of other

[6] The “Coalition” refers to a Liberal–National Coalition, which is an alliance of centre-right political parties that forms one of the two major parties in Australian politics.

mitigation strategies and introduced a significant potential role for carbon agroforestry as a major intervention.

The Howard Government established the Australian Greenhouse Office (AGO) in 1998, the first dedicated national climate change agency. The AGO advised the Government on how to reduce emissions and on the international requirement of developed nations to measure and monitor emissions. Legislation was enacted requiring large companies to record their emissions on an annual basis and this led to the establishment of the National Greenhouse Gas Inventory (NGGI).

2.5 The four discussion papers

In addition to creating a reporting and monitoring framework for emissions management, the Howard Government also examined the role of the market in reducing national emissions. Starting in early 1999, the AGO issued four Discussion Papers addressing the design and functioning of a possible national emissions trading scheme (AGO, 1999). The discussion papers were drafted with the involvement of the States and defined the principles of trading GHGs, the allocation of permits, how carbon sinks might be included and how the reporting and monitoring might be designed. These four Discussion Papers were not acted upon by the Coalition Government but provided a balanced assessment of the issues to be considered if a national trading scheme was to be designed.

2.6 Meeting Australia's Kyoto Commitments

The 'Australia Clause' was a significant aid in enabling Australia to meet its commitments under the Kyoto Protocol. In a real sense, the ability to include emissions from land clearing (which was already in decline) enabled Australia's emissions from all other sources to increase and be offset by reductions in the rate of clearing in this sector. As stated earlier, further breathing space had been provided when Australia negotiated an emissions target of 108% of its 1990 baseline emissions, while every other industrialised country (except Iceland) committed to a reduction (Hamilton, 2015 ; Mazengarb, 2017 ; Oberthür, 1999; Tiffen, 24 October 2009).

2.7 State Government activity

While successive Federal Governments failed to settle on a cohesive approach to climate change policy, some Australian states enacted legislation to encourage mitigation of GHG emissions within their borders. In 2003 the New South Wales Government introduced the Greenhouse Gas Reduction Scheme (GGAS), a baseline and credit trading scheme – the first emissions trading scheme in the world (IPART, 2013; Taberner, 2014). The scheme closed in 2012 when it was clear that the Gillard Government would implement a national emissions trading scheme and was not reinstated despite the subsequent repeal of the national emissions trading scheme.

Other states also took steps to mitigate climate change:

- The Queensland Government legislated to increase the proportion of gas in the energy market in 2007, along with a number of initiatives in renewable energy and adaptation.
- The Victorian Government introduced various measures in 2007 including an agreement with California to investigate an emissions trading scheme between the two states.
- The South Australian and Tasmanian Governments legislated for measures to improve efficiency and strategies to reduce emissions through energy switching and incentives but did not introduce certificates or trading of emissions (Parliamentary Library).
- In Western Australia, the Government enacted the Carbon Rights Act 2003 (described below).

In 2002, the Council of Australian Governments (COAG) recommended that the schemes emerging in the States be replaced by a national scheme. In 2004, the National Emissions Trading Task Force, comprising the states and territories (but not the Commonwealth) was formed. The Task Force issued a report in 2007 outlining a framework for a national emissions trading scheme (Taberner, 2014). The Commonwealth did not actively engage in these policy dialogues until 2007, a few months before the scheduled federal election.

2.8 Western Australian Carbon Rights Act 2003

The Western Australian Carbon Rights Act 2003 (CRA) was proclaimed in 2004. It provided opportunities to place covenants on properties to protect the carbon rights attached, but separate, to the land. In the view of some the CRA had a broader role than dealing with carbon agroforestry.

> "The development of the CRA was a government initiative to promote the development of the forest plantation industry to expand regional economic opportunities, provide domestic wood products, support woodchip exports, replace logging of old growth forest, and gain the broader environmental benefits of revegetation, by reducing transaction costs and increasing certainty associated with establishing and trading carbon sequestration rights" (Eckhart, 2008) p. 2.

According to Eckhart (2008) this broader mandate was a result of many commercial forestry interests including carbon rights in their agreements and contracts well in advance of any operational means of securing them. Most other states had legislation that incorporated the possibility of carbon being tradeable at some stage.

> "Yet, because Australia's national government until recently refused to ratify the Kyoto Protocol and has not established domestic sectoral or other emission limits or taxes, there exists no basis for either international or domestic commercial trading of carbon sequestration or any other emission reduction units" (Eckhart, 2008) p. 32.

Notwithstanding the improbability of this broader mandate, the Act was certainly oriented towards land use activities as a means of securing carbon credits by utilising WA's vast land mass, with no limits placed on how much carbon sequestration could take place. Eckhart (2008) also suggests that very few formal carbon covenants were placed on forests up to 2008. Notwithstanding his assertion, there were by that time a high number of contractual agreements between organisations including the OMA and landowners referencing the CRA. The Kansai Electric Company of Japan had registered agreements with 24 farmers participating in their 1000 hectare carbon sequestration project in the northern wheatbelt (Oil Mallee Association, 2012; OMA, 2015; URS Forestry, 2009)

2.9 The WA Environmental Protection Authority and Carbon Rights Act 2003

Prior to the introduction of national ETS legislation, the Western Australian Environmental Protection Authority (EPA) used the relevant Commonwealth and State climate change legislation and strategies to limit GHG emissions on major gas developments in the State (EPA, 2008). When companies were required to offset their emissions, some chose to do so by undertaking carbon sequestration in WA. They secured the carbon rights under the Carbon Rights Act 2003 and were required by the EPA to comply with planning and other regulations. Woodside Petroleum allocated up to 100 million dollars to the planting of mallees in the WA Wheatbelt to offset a proportion of emissions from processing Liquefied Natural Gas (LNG). The contract was awarded to CO2 Australia Limited (Hudson, 2007).

2.10 A carbon industry emerges

From around the year 2000, several companies were formed in WA specialising in forestry carbon sequestration and were contracted to undertake extensive plantings of suitable trees, particularly in the dryland farming regions of the WA Wheatbelt.[7] The Oil Mallee Association encouraged integrated belts of local or compatible dryland Mallee Eucalypts across cropping and grazing programs. One such planting program was that commissioned by the Japanese energy company Kansai Electric. Kansai was endeavouring to create tradeable carbon credits which could be transferred back to Japan under the Joint Implementation (JI) program, one of the international emissions trading mechanisms foreshadowed in the Kyoto Protocol, the Kyoto mechanisms.[8]

A significant positive influence that resulted in increased, potentially compliant, carbon planting was the targeted support from the Commonwealth Government through the National Action Plan for Salinity (NAP). Projects in WA received a high proportion of the funding and the OMA, through its affiliated groups, was responsible for allocating several million seedlings to farmers (additional detail of this program is provided in Chapter 6 of this thesis).

Some of these plantings were also undertaken in anticipation of a prospective bioenergy industry based at Narrogin. A trial bioenergy plant was commissioned by the State Government with the sole feedstock to be mallees grown within about 50 kilometres of the plant. The Narrogin plant was commissioned in 2005 and, in addition to electricity, the plant produced eucalyptus oil and biochar (URS Forestry, 2009).

At the time of commissioning of the plant, there was Commonwealth legislation in place which restricted the use of forestry for bioenergy. Only biomass generated as a by-product of other processes was eligible (Renewable Energy (Electricity) Act 2001). This

[7] Companies included: CO2 Australia Ltd, Carbon Conscious Ltd, Select Carbon Ltd, Carbon Neutral Inc, Elementree Ltd, Oil Mallee Company Ltd.

[8] The Kyoto mechanisms are the Clean Development Mechanism (CDM), Joint Implementation (JI) and Emissions Trading (ET). CDM and JI are the two project-based mechanisms which feed the carbon market. The CDM involves investment in emission reduction or removal enhancement projects in developing countries that contribute to their sustainable development, while JI enables developed countries to carry out emission reduction or removal enhancement projects in other developed countries.

constraint on the eligibility of biomass for renewable energy led to the adoption of the multiple products to be produced at the Narrogin facility, bioenergy being a by-product of biochar and eucalyptus oil production. In 2006 this was amended through changes to the Act (Australian Government, 2019). This Act was amended several times over the following decade and now contains constraints specifically aimed at the native forest industry (Energy, 2019).

However, industry concerns about changes to the eligibility of biomass were reflected in submissions to the Forest Industry Inquiry of 2011 and the test for using forestry biomass still causes confusion (DAFF, 2011; Dawkins, 2011b; Parliament of Australia, 2011b). The Forest Industry Inquiry revealed that the eligibility requirements for forestry biomass did not adequately encompass the potential for bioenergy to contribute to the mitigation of climate change (Parliament of Australia, 2011b).

2.11 The IPCC and definition of a forest

The Food and Agriculture Organization (FAO) defines a forest as having a tree crown cover (or equivalent stocking level) of more than 10% and area of more than 0.5 ha. Trees should be able to reach at least 5 metres at maturity. The IPCC specified a range of values for crown cover and potential height, within which national definitions had to fit. As defined in the Marrakech Accords, forests are land with a minimum area of 0.05–1.0 ha, with tree crown cover (or equivalent stocking level) of more than 10–30%, and with the potential to reach a minimum height of 2–5m at maturity *in situ*. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest. Countries are to determine and justify a single value within each range. Australia identifies forest as a minimum area of 0.2 ha with woody vegetation of actual or potential height of at least 2m and actual or potential canopy cover of at least 20%. Areas of land that are temporarily unstocked with trees but are otherwise managed as forests or plantations are explicitly included within the definition (Beverley Henry A B E 2005) (IPCC-LULUCF). As defined in the Marrakash Accords, forests are land with a minimum area of 0.05 - 1.0 ha, with tree crown cover (or equivalent stocking level) of more than 10-30%, with the potential to reach a minimum height of 2-5m at maturity *in situ* A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest. Countries are to determine and justify a single value within each range. Australia identifies a forest as a minimum area of 0.2ha with woody vegetation of actual or potential height of at least 2m and actual or potential canopy cover of at least 20%. Areas of land that are temporarily unstocked with trees but are otherwise managed as forests or plantations are explicitly included within the definition. (Henry Beverley, 2005)

This latter definition of a tree for Australia was arrived at after significant negotiation, Australia was able to adopt a special definition of a forest based on the predominance of trees of lower height than in northern hemisphere regions (Biggs, 2019). This meant that species such as mallee eucalypts were identified as suitable for agroforestry in dryland agricultural regions of Australia. In Australia, a forest became defined as an area having trees taller than two metres and a canopy cover greater than 20%.

2.12 The 2007 election campaign and climate change

There was an increase in policy making by state and territory governments in Australia in the five-year period leading up to 2006/7. This was somewhat comparable to State-based activity in the USA, and there was some expectation in both countries that the national government would follow their example (Davoudi, Crawford, & Mehmood, 2009; Parliamentary Library, 2010; Taberner, 2014). This heightened level of activity was accompanied by the Fourth Assessment Report of the IPCC in early 2007, which placed an additional degree of certainty (90%) on the impact of anthropogenic GHGs on the increase in global temperatures (Pachauri, 2007).

In May 2007 the Commonwealth Government released the Shergold Report which recommended that Australia develop an emissions trading scheme (Task Group Report, 2007) and the National Greenhouse and Energy Reporting legislation came into force (Parliament of Australia, 2007b). Prime Minister Howard announced in October 2007 that, if re-elected, the Government would introduce an emissions trading scheme by no later than 2012 – more than an election cycle away. This announcement was followed a week later by a refusal of the Government to ratify the Kyoto Protocol.

2.13 Australia ratifies Kyoto and designs an ETS

In November 2007 the Rudd Labor Government was elected to office in the Federal Parliament with a commitment to ratify the Protocol. The new Prime Minister attended the Thirteenth UNFCCC Conference of the Parties (COP13) in Bali, Indonesia during that December. The Kyoto Protocol was ratified by Parliament on 12 December, one month after the election of the new Government (Rudd, 2007).

2.14 REDD: reducing emissions from deforestation and forest degradation

The Bali Action Plan and the Bali Road Map, which were endorsed at COP13, described the actions required to implement the Kyoto Protocol agenda over the period to 2012. This plan provided some additional support for the use of international mechanisms including the Clean Development Mechanism and Joint Implementation and reaffirmed the provision of technology transfer and financial assistance to less developed nations as part of the differentiated targets approach. The Action Plan included a commitment to enhanced action on climate change and the adoption of nationally appropriate mitigation commitments and action by both developed and developing countries.

The Bali Road Map included an acknowledgement that deforestation was playing a very significant role in generating global emissions. The Action Plan required pledges for better policy approaches to reducing emissions from deforestation and forest degradation (REDD) in developing countries and enhancement of forest carbon stock. When this strategy is taken together with the additional commitment to enhancing carbon stocks, it is referred to as REDD+. These strategies reflected an additional emphasis on forestry as a tool for mitigation. REDD is an approach to halting deforestation but it has also been promoted as a means to fight poverty, conserve biodiversity and sustain ecosystem services (Holloway, 2009).

2.15 The Garnaut Report

Two months after the Thirteenth UNFCCC Conference of the Parties in Bali in 2007 The Garnaut Climate Change Review was released. This interim report, authored by Professor Ross Garnaut, on the impacts of climate change on the Australian economy, had been commissioned by the Commonwealth, States and Territories. It recommended that an emissions trading scheme be established as the centrepiece of a range of climate change policies (Parliamentary Library, 2015) (Garnaut, 2008b).

2.16 The CPRS is launched and fails to be supported in the Senate

During 2008 several reports and analyses were released including the Carbon Pollution Reduction Scheme (CPRS) (Government, 2008). Another report, the Wilkins Review, analysed existing programs to ensure they were compatible with the CPRS and a Treasury modelling paper on the economics of climate change mitigation was released in October. The Treasury modelling suggested that taking early action would be an advantage as additional costs could be incurred if action was delayed (Australian Government, 2008.)

The legislation for the CPRS was introduced into the Australian Parliament in May 2009 and was rejected by the Senate, the upper chamber of Parliament, in August that year. The legislation was introduced again in December. A compromise was sought by the Leader of the Opposition, Malcolm Turnbull MP, but this negotiation was terminated when three Ministers resigned from Shadow Cabinet in protest and he was defeated in a leadership spill by Tony Abbott (Cormann, 2009). When reintroduced the CPRS was again rejected by the Senate (Parliamentary Library, 2015). The media statement issued by Senator Corman stated that he and others were unwilling to introduce legislation in advance of action by other major countries, something that was expected to be tested at the next meeting of the UNFCCC in Copenhagen in 2009 (Cormann, 2009).

2.17 The ETS or "carbon tax" is abandoned

The CPRS legislation was introduced a third time in 2009 and then rescheduled to start in 2012 but was not voted on. In the meantime, Prime Minister Rudd was replaced by Julia Gillard and an election was held in August 2010, with a commitment by Prime Minister Gillard not to implement a 'carbon tax' (ABC News, 2014).

A minority Labor Government was formed with the Australian Greens and a new multi-party approach to climate change policy formation was created. An update of the Garnaut Review was released (Garnaut, 2011). A new Commonwealth Government body, The Climate Commission, was formed to provide independent advice and the Productivity Commission asked to investigate the potential cost of abatement. The Productivity Commission reported that the cost of abatement would not be high and that market-based approaches are the best way to proceed.

2.18 Carbon Farming Initiative and Carbon Pricing Mechanism Legislation

After the election in 2010, a land-based offset scheme was introduced in March 2011 to incentivise carbon sequestration projects that could be utilised by activities in sectors of the economy other than agriculture and forestry to offset emissions and meet future reduction targets. The Carbon Credits (Carbon Farming Initiative) Bill 2011 (CFI) passed through Parliament and came into force in September 2011. Many aspects of the CFI, including the design of approved methodologies of the CFI, were legislated rather than just regulated and therefore more difficult to change. Industry was invited to propose new methodologies which would then be approved and legislated. Many of the internationally developed characteristics of the CDM and JI were incorporated into the CFI including additionality, leakage and permanence (see Table 2.1).

Table 2.1 Key terms used in carbon sequestration methodologies

Term	Explanation
Additionality	Requirement that a project or activity produces emissions reductions that are most likely to be additional to what would have occurred in the absence of the current legislation. For instance, an activity would need to be in addition to that which was required by legislation and would require additional financial support to occur.
Permanence	Permanence arrangements under the Carbon Farming Initiative to ensure that credits issued for sequestration projects represent lasting removals of carbon from the atmosphere, which are equivalent to emissions reductions. The standard period for permanence is 100 years but the ERF has introduced an option for 25 years (with a consequential discount of 20% on the level of ACCUs awarded).
Leakage	Methodologies need to account for increases in emissions as a result of the project. This is often referred to as "avoiding leakage". The Bill amends this requirement in the current law to clarify that methodologies must provide for deductions to be made for material increases in emissions that are a direct result of the project. Schedule Ministerial directions may specify the circumstances in which methodologies will need to include deductions for the indirect or flow-on effects of projects across the economy. These effects may be significant but outside the control of the proponent or difficult for proponents to estimate. For example, reductions in harvesting in one area may largely be offset by increases in harvesting elsewhere to meet unchanged demand for timber. Ministerial directions could specify a simple discount factor to account for this type of leakage (Parliament of Australia, 2014).

The policy framework for a market-based system of mitigation was released and the Clean Energy Act 2011 was created through a package of 18 bills. The Act allowed for a price on carbon and framed the special role for the land sector (Parliament of Australia, 2011a).

The Clean Energy Act 2011 also provided for carbon pollution caps, and major emitters to be captured under the Carbon Pricing Mechanism (CPM). The CPM placed a price on carbon pollution and liable entities, Australia's largest emitters were required to account for or offset the emissions they produced.

Certain industries exposed to international trade - Energy Intensive Trade Exposed Industries (EITE) - were exempted based on a benchmark of international good practice. In addition, agriculture was excluded from the obligations required under the CPM. A minimum price of $23 per tonne was placed on carbon dioxide equivalent emissions (CO_2-e) to create investment certainty in the initial phase of the scheme. The CPM came into effect in July 2012 with a compensation scheme for low income householders impacted by the mechanism. The scheme itself covered neither households nor most businesses emissions but included about 60% of Australia's emissions in electricity, stationary energy, landfill waste, water, industrial processes and fugitive emissions (CER, 2007).

2.19 The Emission Reduction Fund (ERF)

An election in 2013 delivered a new Liberal-National Party Coalition Federal Government and Prime Minister Abbott dismantled four climate change programs and introduced the Clean Energy (Carbon Tax Repeal) Bill 2013, which was successfully enacted after two attempts. Australia became the first nation to reverse action on climate change (Connor, 2014; Parliamentary Library, 2015).

The Government started the process of introducing the Direct Action Plan policies and in particular the Emissions Reduction Fund (ERF). The Green paper on the ERF was released in December 2013, the White Paper in April 2014 and the legislation was introduced into Parliament in June 2014. Following passage of the Carbon Farming Initiative Amendment Bill in November, the ERF legislation came into force. The ERF uses a reverse auction process to purchase emissions, with the Commonwealth Government funding the lowest cost carbon abatement projects that create Australian Carbon Credit Units (ACCUs) via the CFI methodologies.

This was followed by the release of a review of the CFI by the Climate Change Authority (CCA). The review acknowledged the modest success of the CFI to date and foreshadowed the possibility that the ERF could eventually encourage more participation by reducing costs and offering fixed price contracts when the Safeguard Mechanism was implemented. The Safeguard Mechanism limited the ability of firms to increase emissions over time (CCA, 2015).

The CCA review also pointed out the difficulty faced by early movers in forestry methods who commenced their sequestration projects before the eligibility starting dates included in the regulations of the CFI and reinforced by the operation of the ERF (CCA, 2015). The review also clarified the approach that should be taken in relation to co-benefits. Stakeholders who contributed to the review advocated that the ERF should take into account significant public co-benefits and pay higher prices for these attributes. The CCA dismissed these ideas and commented:

> The Government has decided against this approach, and that the ERF will focus on achieving lowest cost emissions reductions. The Authority endorses this approach for two reasons:
>
> - paying for co-benefits from the ERF would reduce the capacity of the scheme to reduce emissions, which would be at odds with its central role in achieving Australia's targets
> - the co-benefits concerned are better assessed and secured through other programs
>
> That said, to achieve the best outcomes the ERF will need to interact efficiently with other policies and programs. Projects should in general be able to secure support from both the ERF and other relevant programs where the programs are paying for different benefits and where this does not undermine additionality for the ERF (CCA, 2015) Pt 4.1.1.

This commentary appears to acknowledge that public co-benefits are created but not funded through the scheme. It is likely that earlier support for forestry programs such as the National Action Plan on Salinity had been withdrawn in anticipation that carbon agroforestry would inevitably produce co-benefits. A review of the ERF conducted by the CCA in 2017, commented on the possibility of environmental damage and recommended that proponents be required to discuss their projects with local NRM bodies rather than just indicate compliance with NRM planning (CCA, 2017b).

While this discussion progressed, the impact of the constantly changing policy landscape started to have an impact. The Woodside offsetting program, a program launched by Woodside Petroleum to partially offset emissions from one of its major projects, valued at AU$25 million with a potential total cost of AU$100 million, came to an end. This project, which involved planting mallees, was discontinued after the total responsibility for mitigation policy shifted to the Commonwealth, the subsequent failure to implement the CPRS, and the probable removal of the CPM from the statutes (Edis, 2014).

The company that had contracted with Woodside to undertake carbon forestry was CO2 Australia and these changes also had an impact on their other activities. An article by Tristan Edis in the The Australian Newspaper, Business Review section, provided a company statement:

> Recent changes in government policy, the proposed abolition of the current carbon pricing regime and continuing uncertainty in the carbon market generally has led the Company to reduce the scale of its carbon operations and pursue new growth areas, such as expanding its environmental services and trading businesses and its developing aquaculture business (Edis, 2014).

Over time, the relative simplicity of the WA Carbon Rights legislation had been replaced by a more complex approach and eventually the reverse auction process of the Commonwealth Government's Direct Action program. This new approach did not require or incentivise companies to take action, let alone at the scale of action that was initiated by Woodside.

2.20 Climate change policies and energy choices

The Howard Government released the Renewable Energy Target, a mandatory scheme that supported the achievement of prescribed levels of renewable energy. The target changed several times and eventually very limited levels of additional energy was supported (CEC, 2019; Kent, 2006).

Following these years of debate about the right approach to climate change action, the discussion on energy emerged without a robust climate policy change framework to guide discussion. The discussion about energy was disconnected from the context of climate change. Some commentators reacted opportunistically and critically to the power shortages in the southern states in early 2017 during heatwaves and storms. At the same time, the closure of the Hazelwood coal-fired power station in March 2017 and the proposed decommissioning of AGL's Liddell coal-fired station in 2022, provoked a fierce debate about energy security in Australia. Later in the year, the Minister for Energy, Josh Frydenberg, put forward a new framework for energy policy, the National Energy Guarantee (NEG), with the aim of delivering a reliable, affordable national energy supply. This policy was not adopted by the Government. Nevertheless, the Minister for Energy has argued publicly that the sale, rather than closure, of the Liddell station would be 'in the public interest'(Menadue, 2018; Murphy, 2018).

2.21 Polling of public attitudes to energy

Australians have not been persuaded to favour support for traditional fossil fuel generation for the nation's energy security at the expense of renewable energy development. According to the Lowy Poll, almost all Australians remain in favour of renewables, rather than coal, as a future energy source. In 2018, 84% of respondents (up three points since 2017) said 'the government should focus on renewables, even if this means we may need to invest more in infrastructure to make the system more reliable'. Only 14% said 'the government should focus on traditional energy sources such as coal and gas, even if this means the environment may suffer to some extent'. Even among those who took the most sceptical view about global warming (the 10% who said ‘until we are sure that global warming is really a problem, we should not take any steps that would have economic costs’), 40% favoured a focus on renewables. Nine in ten of the rest supported a focus on renewables rather than coal, as did 72% of Liberal-National Party supporters (Lowy Institute, 2018).

These attitudes are consistent with previous findings of the Lowy Institute Poll on Australians’ preference for alternative energy sources. In 2016, most Australians (88%) agreed that ‘the use of fossil fuels is in decline around the world and Australia should invest more in alternative energy sources or risk being left behind’ (Lowy Institute, 2018). However, 53% agreed (45% disagreed) that ‘Australia has an abundant supply of fossil fuels and we should continue to use and export them to keep our economy strong’ (Lowy Institute, 2018). This is consistent with a ‘no regrets’ approach to climate change policy.

2.22 The Safeguard Mechanism is designed

The Safeguard Mechanism associated with the ERF is an extension of that policy which does not have a compliance regime for emitters (Department of Environment and Energy, 2016). The design requires major emitters to keep Scope 1[9] GHG emissions within baseline levels, benchmarked on their emissions from the two years leading up to 2016. The largest reported level of emissions becomes the base which they cannot exceed. In the design there is an ability to increase the baseline to enable new major developments. Emissions that exceed the baseline can be offset by purchasing ACCUs. All large companies have been required to report their annual emissions for many years under the National Greenhouse and Energy Reporting (NGER) scheme (CER, 2007).

> The safeguard mechanism operates under the framework of the National Greenhouse and Energy Reporting scheme and applies to facilities with scope one emissions of more than 100,000 tonnes of carbon dioxide equivalent (t CO_2-e) per year. This extends to businesses across a broad range of industry sectors, including electricity generation, mining, oil and gas, manufacturing, transport, construction and waste. Collectively, these facilities account for about half of Australia’s emissions (CER, 2020).

[9] Scope 1 greenhouse gas emissions are the emissions released to the atmosphere as a direct result of an activity, or series of activities at a facility level. Scope 1 emissions are sometimes referred to as direct emissions. Scope 2 greenhouse gas emissions are the emissions released to the atmosphere from the indirect consumption of an energy commodity. For example, 'indirect emissions' come from the use of electricity produced by the burning of coal in another facility. Scope 3 emissions are indirect greenhouse gas emissions other than scope 2 emissions that are generated the wider economy. They occur as a consequence of the activities of a facility, but from sources not owned or controlled by that facility's business (Department of Environment and Energy, 2016).

At this stage the Australian Government has not required compliance with the Safeguard Mechanism. Attempts to consider the introduction of the scheme gradually have been met with resistance on the grounds that it functions like an emissions trading scheme. Others have welcomed the scheme and suggested that it is a necessary part of the requirement to meet current emissions' targets (Kerin, 2017). A review of the Safeguard Mechanism has been conducted which takes into account other developments such as the National Energy Guarantee (NEG) and its impact on the electricity generation sector, plus the complexity of arriving at a calculated baseline which embraces emissions intensity, industrial changes and other factors. The review has endeavoured to simplify the calculation of baselines (Department of Energy and Environment, 2018b). Emissions intensity is an alternative to absolute emissions and enables a calculation of emissions per unit of production.

2.23 Summary

This chapter has highlighted the multiple changes in national Climate Change policy that Australia experienced particularly between 2007 and 2016. It was noted that some early participants in emissions reduction activity ceased activity as a consequence of these multiple changes. During this period there was also a review of the role of carbon pricing including commentary on the lack of recognition for early movers whose efforts were frustrated by the changing legislated commencement dates. In addition, the Climate Change Authority suggested that the carbon price should not endeavour to price in the delivery of co-benefits, while also recommending that these co-benefits be supported by other sources of funding.

In terms of transition theory, how this element of policy development contributes to the hesitancy of taking further action at the niche level of transition is important if the new practices are to move into the meso level or socio technical regime. As Geels highlights, there needs to he a number of issues resolved to enable this transition to the meso level and essential to go further. In addition to evidence of supportive policy development, positive public opinion also needs to be secured to encourage financial support.

In Chapter 3, the variability of public opinion of action on climate change is reviewed in more detail over this same period and the fluctuations of opinion are paired against the volatile political and policy landscape.

Chapter Three

3

Attitudes to Climate Change in Australia

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3.1 Polling of attitudes produces surprising results in Australia and internationally

Since 2007 achieving robust, stable and lasting policies on climate change in line with stated and implicit international commitments has been challenging in Australia. Some legislated programs have been initially contested but components have remained in place after a change in government. Proposed measures to tackle climate change were successfully blocked in 2009 (the CPRS) and while the CPM was abolished following the election of new Coalition Government in 2013, elements of the legislation were retained (the CFI) (Akter, 2012; Cotton, 2016). Debate over the very different propositions as to what government should do has been strident and public opinion has often but not always followed government action (Capstick, 2015). Nevertheless, there have often been periods of dissonance between public attitudes and government action in relation to policy direction, targets, issues and ideologies. In climate change policy development, it is important to investigate how high levels of disagreement between public opinion and government intention comes about, how it influences policy making and what might be done to remedy the situation to create a more logical policy development pathway (Jones, 2010; Stewart, 2013).

3.2 Climate Change Attitudes: Lowy Institute and other polling

3.2.1 Polling of attitudes to climate change

Several analysts suggest that governments should gain a better understanding of the way public attitudes are formed and change over time, in order to articulate appropriate public policy responses to climate change (Shwom, 2010; Weber & Stern, 2011). A starting point might be to monitor changes in public opinion about climate change mitigation policy during the period of chaotic and continuous policy change in Australia over the last decade and a half. Several organisations have undertaken studies examining public attitudes to climate change in Australia, including the Lowy Institute, the Climate Institute and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Polling of public attitudes to climate change in the USA has also been useful in this quest to track changing public opinion, and one US study is considered in this research. These polls and their results are summarised below.

3.2.2 The Lowy Institute Poll

The Lowy Institute Poll is an annual poll of Australian attitudes to important relationships with global powers and a range of other matters including climate change, renewable energy, immigration and asylum policies. The Lowy Poll is the most complete record of public opinion volatility in relation to climate change, as it includes all the years since 2007 and uses the same questions and a similar sample size each year. The poll asks whether respondents believed the Federal Government should take a leadership role in tackling climate change. The question asked is:

> There is a controversy over what countries of the world, including Australia, should do about global warming. Please tell me which statement comes closest to your own point of view?

The three options for response are outlined in Table 3.1 below.

Table 3.1 Lowy Institute Polls 2006-2015: the questions asked each year

Colour	Statement option	Summary
Dark Blue	Global warming is a serious and pressing problem. We should begin taking even if this involves significant costs.	Urgent action
Light blue	The problem of global warming should be addressed, but its effects will be gradual so we can deal with the problem gradually by taking steps that are low in cost.	Gradual action
Orange	Until we are sure that global warming is really a problem we should not take any steps that would have economic costs.	"No regrets" action

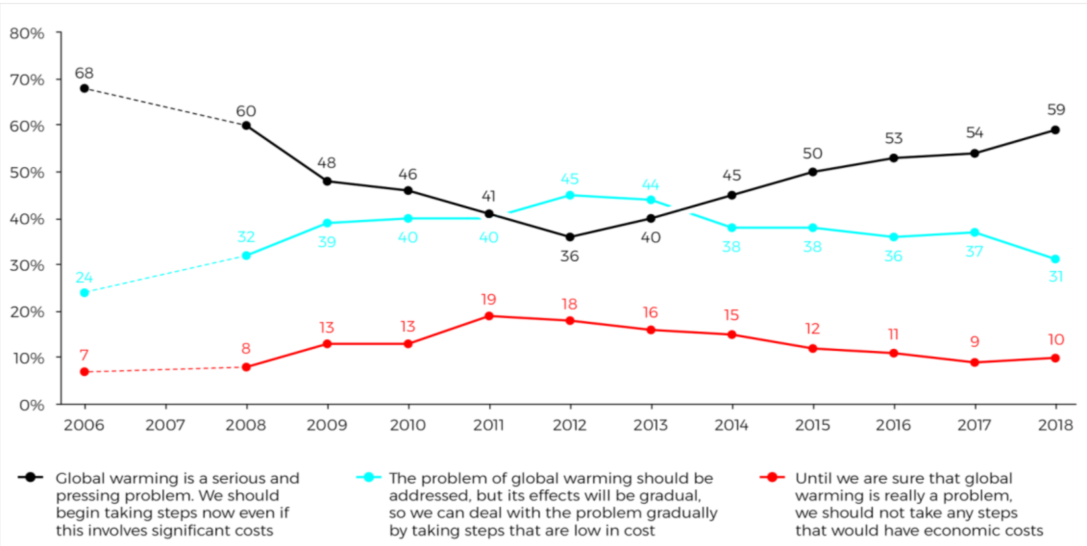

Figure 3.1 Lowy Institute Polls 2006 -2018: Climate Change

Source Lowy Institute website (Reproduced with permission).

3.2.3 A chronology of political and other events

To highlight the actual changes that accompanied the fluctuations in attitude, a chronology of climate change policies developed by the Commonwealth Parliamentary Library is utilized (Parliamentary Library, 2015). Table 3.2 below provides a comprehensive list of events that occurred over the period.

A selected list of events taken from the list has been overlaid on that graph of polling over the period 2007 to 2015 (Figure 3.2).

Table 3.2 Chronology of significant climate change events, policies and regulation between 1997 and 2015.

Date	Action
1997	UN conference of the parties in Kyoto Japan; Australia negotiated a +108% emissions target
1983	Hawke-Keating Government takes office – March 1983
1988	First global emissions reduction targets (the 'Toronto targets'): At the Toronto conference on climate change a target of 20% reduction in greenhouse gas emissions by 2005 on 1988 levels is proposed.
1988	First meeting of the Intergovernmental Panel on Climate Change (IPCC)
1989	First Australian greenhouse gas emissions reduction proposal submitted to Cabinet:
1990	IPCC releases its First Assessment Report (FAR): The IPCC FAR notes with certainty that: – a natural greenhouse effect warms the Earth – human activities contribute to atmospheric concentrations of greenhouse gases
1990	Australian Government adopts the 'Toronto targets' with provisos
1990	First global treaty on climate change established (UNFCCC): Prompted by the IPCC FAR, negotiations begin for a global treaty responding to climate change. This treaty later becomes known as the United Nations Framework Convention on Climate Change (UNFCCC).
1991	Keating Government takes office
1992	Australia signs the UNFCCC at the UN Conference in Rio de Janeiro, Brazil
1992	The National Greenhouse Response Strategy (NGRS) released: a no regrets strategy
1992	Australia ratifies UNFCCC: Australia is the ninth country to ratify the UNFCCC.
1995	First UNFCCC Conference of the Parties (COP1) held in Berlin, Germany
1996	Howard Government takes office
1997	Government says that adoption of emissions reduction targets would be devastating for Australia:
1997	Third UNFCCC COP held in Kyoto, Japan – Kyoto Protocol adopted
1998	The Australian Greenhouse Office (AGO) is established; Australia signs the Kyoto Protocol

Date	Action
1999	The AGO releases the first of four discussion papers on emissions trading
2001	Mandatory Renewable Energy Target scheme (MRET) starts
2002	Australia refuses to ratify the Kyoto Protocol
2002	Eighth UNFCCC COP held in New Delhi, India: COP8
2003	Greenhouse Gas Reduction Scheme implemented by the NSW Government: (GGAS)
2005	Kyoto Protocol comes into force
2006/ 2007	Eleventh UNFCCC COP held in Montreal, Canada: / Twelfth UNFCCC COP held in Nairobi, Kenya:
2006	Al Gore visits Australia;
	Stern Review on the Economics of Climate Change released;
	Prime Ministerial Task Group on Emissions Trading (Shergold Report) commissioned;
2007	*May:* Shergold Report' released: The Prime Ministerial Task Group on Emissions Trading releases the 'Shergold Report' which recommends Australia develop an emissions trading scheme.
	July: Government promise of an ETS
	December: Cabinet rejects ratification of Kyoto protocol
	November: Rudd Government takes Office; Thirteenth UNFCCC COP held in Bali, Indonesia – Bali Action Plan adopted; Australia ratifies the Kyoto Protocol; IPCC AR4 released – climate change announced as 90% certainty
2008	*February:* Garnaut Interim Report
	March: Kyoto Ratified
	July: CPRS Green Paper
	December: Garnaut final Report and Treasury Modelling: Al Gore visits Australia
2009	CPRS proposed in Parliament;
	August: Emissions projections released; CPRS rejected by Senate;
	October: CPRS introduced a second time
	December: Coalition leadership change to Abbott; CPRS rejected a second time; UNFCCC COP Copenhagen.
2010	*February:* Coalition Climate Change policy announced
	April: CPRS delayed until 2012
	Government Leadership change to Gillard
	Multi Party committee on Climate Change formed with Greens
	September: CPRS lapses.
2011	*February*: Independent Climate Change Commission formed
	March: Carbon Farming Bill announced
	June: Productivity Commission announces "costs not high"
	July New ETS framework vis Clean Energy Future
	November: new ETS Carbon Pricing Mechanism

Date	Action
2012	*June*: Clean Energy Finance Corporation (CEFC) legislated, *July*: Carbon price effective, Climate Change Authority formed, *August*: Australia – EU link on emissions trading *December*: Kyoto Protocol 2
2013	*March*: Productivity Commission Report, RET review, DCCEE disbanded *July*: full ETS announced for 2014 *September*: Coalition elected to government (Abbott), Four Climate Change programs dismantled, *November*: attempt at repealing the CCA and CEFC.
2014	*June*: The Government introduces the first Direct Action legislation: The Carbon Farming Initiative Amendment Bill 2014 establishes the Emissions Reduction Fund, the keystone of the Direct Action Plan. *July*: Carbon Price Mechanism repealed: The eight 'carbon tax repeal' bills are passed by the Senate, coming into effect on 1 July 2014; Australia becomes the first nation to reverse action on climate change. *November*: Carbon Farming Initiative Amendment Bill 2014 passes both houses: The first legislation of the Direct Action Plan will commence the following day; Al Gore visits Australia
2015	*August*: Australia's post-2020 emission reduction target announced: The nation will aim to reduce greenhouse gas emissions by 26-28% below 2005 levels by 2030. *September*: change in leadership of Coalition Government (Turnbull) *October*: Government states temperature commitment: Environment Minister announces the Government is committed to "keeping global warming to 2 degrees". *November*: Federal opposition releases emissions reduction target: Leader of the Opposition, Bill Shorten, announces a 45% emission reduction target by 2030, from 2005 levels, as a "basis for consultation". *December*: Government announces target of net zero emissions by 2100: Prime Minister and Environment Minister both announce at COP21 that Australia has a net zero emissions target by 2100.

Source: Adapted from the Commonwealth Parliamentary Library
(Parliamentary Library, 2015).

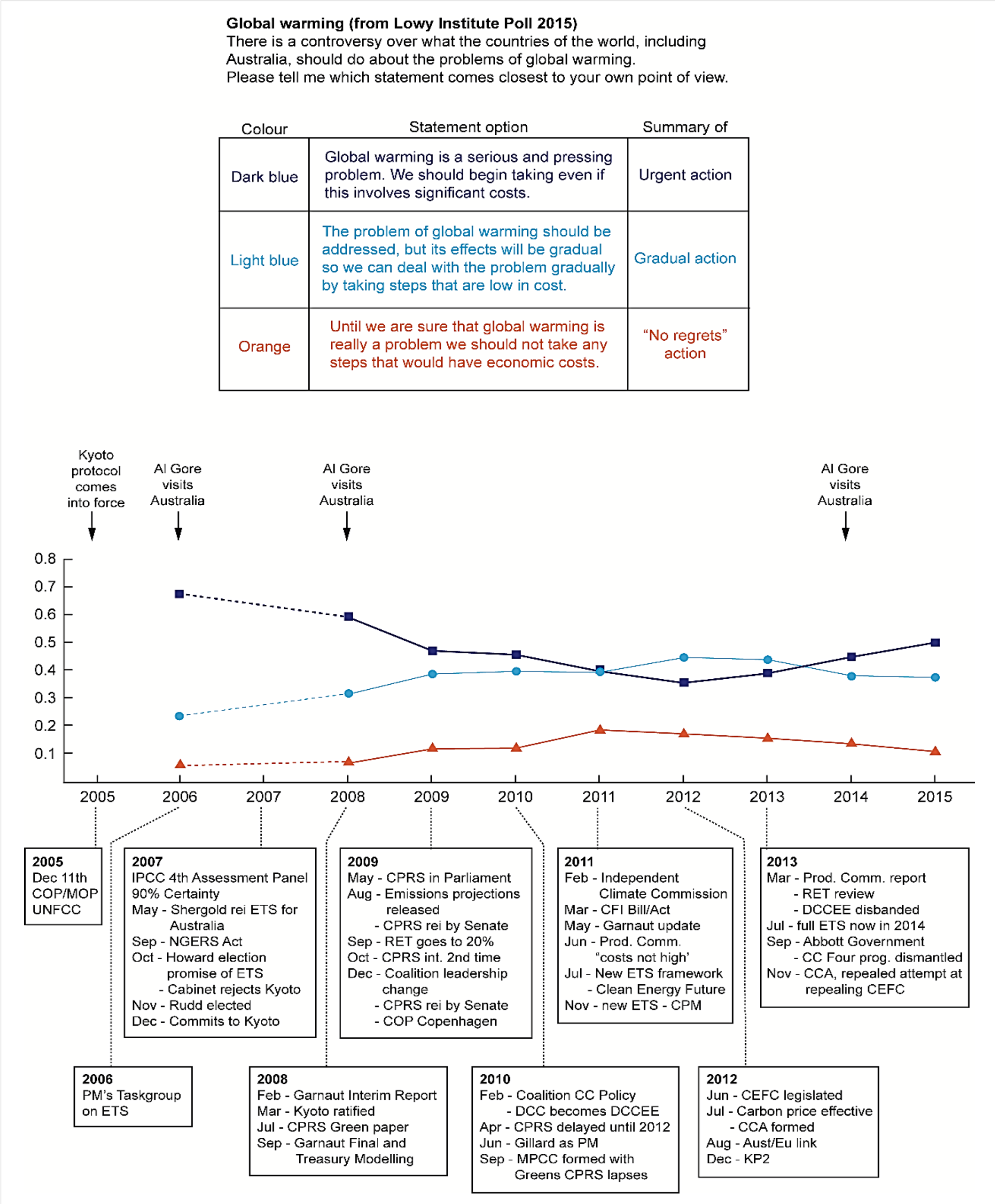

Figure 3.2 The Lowy Poll 2006-2015 with political and policy incidents overlaid[10]

[10] In September 2019 the Lowy Institute released an annotated poll. https://www.lowyinstitute.org/issues/australia-climate-change

The starting point for the series of Lowy Polls was in the period before the 2007 election when there were differences in approach to climate change policy between the major parties, but urgent action became well supported by the public. The polls indicate public support for taking *urgent* action on climate change rose from the start of the century and peaked in 2007. However, it fell soon after the election of the Rudd Government, before gradually rising again in 2014 and by 2015 was close to the level of 2007.

3.2.4 The early changes in opinion explained

In the lead up to the 2007 Federal election, the Australian Labor Party's (ALP) Opposition policy supported immediate action on climate change and the ratification of the Kyoto Protocol. The Howard Government, despite introducing a range of voluntary programs and industry reporting and regulation over many years, continued to resist taking comprehensive economy-wide action. However, in July, just a few months before the election, the Government announced a commitment to introduce an emissions trading scheme (ETS) before 2012. In this way, as the election drew near, the differences between the two parties were reduced. However, while the Howard Government proposed action, the timing for introduction of the ETS was not definite (Warren, 2019).

Despite the convincing win by the ALP in the election later that year, providing endorsement for vigorous new action on climate change, public support for *urgent* action on climate change was only maintained at a high level for a short time. After some months this strong support started to decline and support for *gradual* action rose along with support for '*no regrets'* action only.

As demonstrated in the Lowy Polls, the support for *urgent* action then fell in late 2007 and continued to fall until 2012 - some three years after a change in Government leadership and a somewhat hardening of the opposition to action on climate change. This decline in support for *urgent* action was matched by a rise in interest in *gradual* action but also a rise in taking no action at all.

3.2.5 The middle period: 2008-2012

The level of support for *gradual* action continued to rise until the end of 2011, possibly bolstered by a report from the independent government advisory body, the Productivity Commission, which supported broad economy wide policies (Productivity Commision, 2011). Other action was being introduced through a redesign of the ETS and the establishment of the Carbon Pricing Mechanism (CPM) in late 2011. Subsequently the interest in more *urgent* action started to increase again and returned near to the level observed before the 2007 election. The increase in the support for *urgent* action is achieved at the expense of the *gradual* change support but also an apparent reduction in the number of those only willing to take '*no regrets'* action. It is significant to note that this rise in support for *urgent* action took place during a period when the anti-carbon tax rhetoric was at its most virulent (Cotton, 2016).

3.2.6 The latter period: 2013 to 2017

In 2013, the newly elected Coalition Abbott Government abolished several climate change programs and Government bodies which had been legislated into existence a short time before. However, an attempt to abolish the Clean Energy Finance Corporation (CEFC) and the Climate Change Authority (CAA) failed to secure enough support from minor parties in the Senate (Coorey, 2016). The level of support for leadership and *urgent* action continued to rise. It is most likely that the minor parties and the ALP would have noted the increasing public support for *urgent* action.

The relatively less ambitious climate change policies of the Coalition Government, including the Emissions Reduction Fund (ERF), were quietly received (the Greens had lost their influence in the Senate) and the level of support for leadership on climate change in 2015 returned to the high level of 2007 (Lowy Institute, 2018).

Looking at back over this series of polls, it is possible to align attempts at ambitious, politically charged and paradigmatic changes in policy with an unexpected decrease in public support. This could be due to the manner in which the policy was presented but reinforced by the vocal opposition to the emerging policy. In other words, the hardening of political positions on climate change created a drop in public confidence, at least for a while. This phenomenon is discussed later in this chapter.

This hardening of opposing positions on climate change manifested itself in the repealing of several pieces of legislation after the election of the Abbott Government in 2013 but, as noted above, the repeal of the Clean Energy Finance Corporation (CEFC) did not receive sufficient support in the Senate to be repealed. The dissolution of both Houses of Parliament can triggered by blocked legislation. The Double Dissolution election, where both Houses of Commonwealth Parliament are dissolved and all Senators and Members of Parliament stand for re-election simultaneously, was called in 2016. However, the blocking of the CEFC was not used to trigger the double dissolution (Parliament of Australia, 2016).

Malcolm Turnbull had replaced Tony Abbott as Leader of the Liberal Party and hence Prime Minister and the Turnbull Liberal National Coalition Government was unwilling to use the blocked vote to repeal the CEFC as a trigger for the double dissolution and other unrelated blocked legislation was used instead (Coorey, 2016). Indeed the issue of climate change did not feature significantly in the lead up to the 2016 election. It is likely that this was because there was a perception that public support had reached an even higher level and political leaders did not see benefit in offering significant change or perhaps even that climate change action, at that time, had become seen as an acceptable if not *urgent* Government program.

3.2.7 The reasons for volatility

Several reasons have been proposed for this pattern of volatile change of opinion on climate change. There is some evidence that the Global Financial Crisis (GFC) and associated political events over this period caused a policy fatigue and a distraction from what might have been a level of concern on climate change up to that time (Reed, 2012). The level of polarised, sceptical and opinionated journalism was also particularly strong during this period, making it even harder to focus attention on the issue. A behaviour called 'uncertainty transfer' could be a factor, whereby areas of genuine uncertainty in climate science became conflated with aspects of science for which there was a clear scientific consensus (Capstick, 2015).

The return to previous high levels of acknowledgement of the anthropogenic nature of climate change science and the need to take *urgent* action may have been enabled by a reduction in visceral opposition, caused by the change form Abbott to Turnbull, plus improved knowledge of the adoption of action on mitigating climate change (at that time) by most Western governments. In addition, this change accompanied relief from the financial pressures caused earlier by the GFC and observable progress towards a global climate change agreement directly involving all nations, developed and developing.

Until the Paris Agreement in 2016, it was incumbent on the developed nations to adopt targets and take real action ahead of any such responsibility for action by developing nations. This was the 'differentiated targets' approach of the UNFCCC. With the adoption of the new approach embedded in the Paris Agreement, it became clear that in less developed economies, public opinion on climate change and its causes has not fluctuated over this time period (Capstick, 2015).

3.2.8 The Climate Institute Poll

The poll conducted by the Climate Institute covers the period just before and after the election of the Rudd Labor Government with a strong policy commitment to introduce an economy wide response to climate change and ambitious reduction targets. The question posed in the poll was ‘which of the major parties do you think is better at handling climate change?’. (Climate Chnage Institute, 2016)

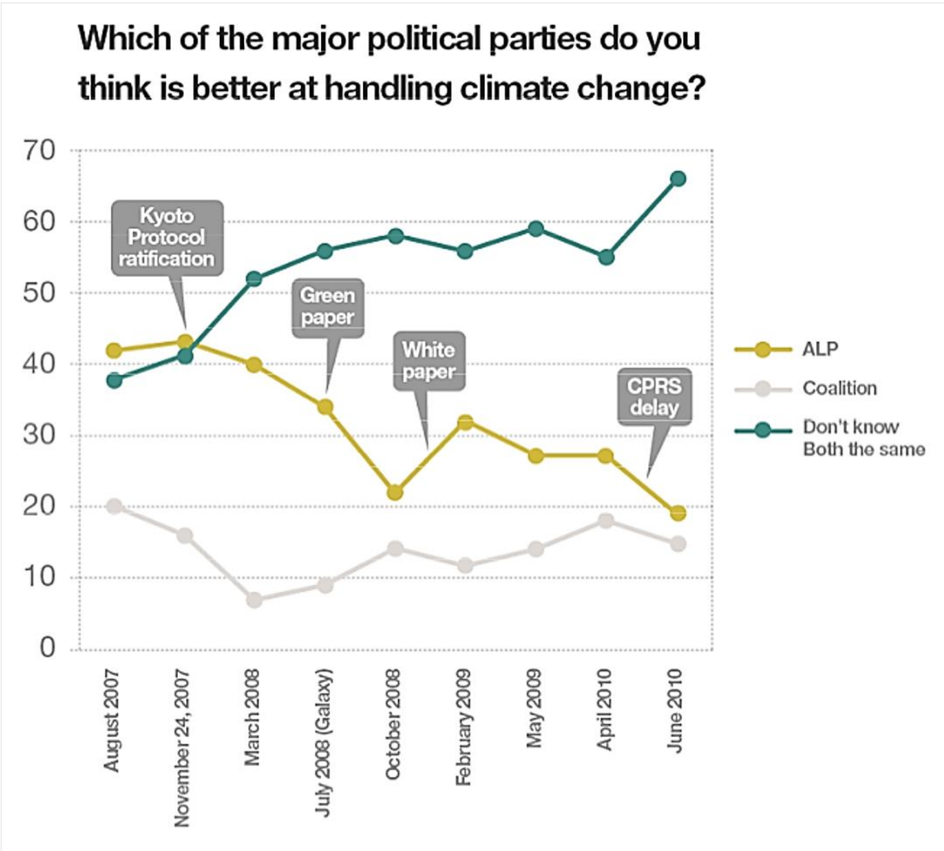

Figure 3.3 The Climate Institute Poll 2007-2010
(Climate Change Institute website, 2016)

Alongside the sharp decrease in the support for the initially *urgent* approach taken by the ALP (while in Government) there was a growth of the ‘don’t know’ response over time. Support for the Coalition (now in Opposition) also fell. There was an explicit and dramatic call for urgent action accompanying the introduction of the Carbon Pollution Reduction Scheme (CPRS). Despite initial bipartisan support for the CPRS, public support for the Government fell, presumably because of a failure to communicate adequately and appropriately in less dramatic tones.

As reflected in the Climate Institute Poll, once the leadership of the Liberal National Opposition changed (from Turnbull to Abbott), the language changed to a strong counter position. It appears from the Climate Institute Poll that people responded by indicating that they ‘did not know’ which political party was better at dealing with climate change. This wavering of public support probably undermined the Government’s appetite for new legislation once the CPRS legislation had failed to move through both Houses of Parliament (Jones, 2010; Stewart, 2013; Taft, 2014).

3.2.9 The CSIRO Survey

A longitudinal survey was conducted by CSIRO between 2010 and 2014 on attitudes to the concept of climate change and released in May 2016. This study surveyed over 17,000 Australians, 5,000 completing two or more surveys and around 300 who completed all five (CSIRO 2016). This survey was quite different to the Lowy Institute polling, which sought to uncover what people thought about government taking leadership on climate change. The CSIRO study does not reveal such large changes in the views of Australians that would align with the slump and recovery evidenced in the Lowy Poll. However, what it says about why and when people change their mind might explain the volatility in the Lowy poll and provide some caution about how to interpret the Lowy data. For instance: is a fall in support for leadership on climate change necessarily an indication of a change in attitude about the causes of climate change?

The CSIRO study highlights the changeable nature of some people’s views and the impact on voting behaviour when facing an election and then immediately after the election. The CSIRO research seems to indicate that forming an opinion about supporting certain action on climate change is conditioned to some extent by how it accords with personal belief and action. However, this relationship between personal action and endorsement of a Government position is not strong (Leviston, 2012).

Furthermore, a key feature of the CSIRO study noted by the researchers is the considerable inaccuracy when respondents predicted what other people think. Respondents tend to underestimate the impact of what other people think on their own attitudes as well as other factors, such as the views of political parties and politicians. One instance of this was the incorrectly large estimation by respondents regarding the number of people in Australia who don’t believe climate change is happening and how this estimation impacted on their own views. The study concludes that people have a tendency to establish a positioning statement that is not static. Indeed half of the repeat respondents changed their mind over the period of the survey (Dreyer, Walker, McCoy, & Teisl, 2015).

3.3 Attitudes and specific opinions

In addition to the reasons posited earlier, it is possible that the volatility in personal attitudes to climate change was the cause of the swings in opinion on what action successive federal Governments should take, and this was particularly influenced by how that policy was presented. For example, after 2007 the media appeared to become more questioning about climate change, despite there being a virtual scientific consensus on the causes. This sudden rush of media attention locally, with similar trends happening internationally, may have added to the level of confusion in public attitudes (Leviston, 2015; Lowy Institute, 2018).

One important trend that the CSIRO study revealed was that the percentage of 'don't know' increased over time from a low base (Dreyer et al., 2015). This shift in opinion to attitudinal uncertainty is also reflected in the Lowy Poll and the Climate Institute Poll.

The nature of the fluctuations after 2007 is highlighted by another study by McRea on scepticism and voting behaviour. This study analysed the CSIRO survey and provided a validation of the Lowy Poll outcome (McCrea, 2015). It suggests that if an incumbent government is re-elected then it is likely that support for policies will grow in line with the new government and resolve cognitive dissonance caused by the confusion of conflicting ideas (McCrea, 2015). At the start of the period in review (at least by mid-2007) there was notional bipartisan support for action on climate change, or at least the willingness to embrace an Emissions Trading Scheme (ETS). The call to action promoted by the Labor Opposition before the 2007 election was reflected in a rise of interest in more urgent action generally. This was followed after the election by an more bipartisan approach with Malcolm Turnbull as Leader of the Opposition (Dreyer et al., 2015). However, the Rudd Government then pursued a divisive approach that heightened the sense of urgency for action to such an extent that support fell away, squandering the support predicted by the McCrea study.

3.3.1 Climate fairness and justice

Governments need to secure support for policies as significant as climate change and the way these policies are presented by them can influence their degree of acceptance and support. Former Prime Minister Paul Keating proposed that "good policy is good politics" (Bramston, 2016). In complex policy areas like climate change, the importance of developing and announcing effective policy before making the call for urgent action would appear to assist in bringing communities of opinion along together, rather than highlighting differences (Hewett, 2019).

This analysis highlights the importance of securing acceptance by the public that climate change is anthropogenic, which Dreyer argues is a precondition for supporting climate change policies (Dreyer et al., 2015). Nevertheless, on the whole, the more the policy is perceived to be fair and effective, the more likely the transition of opinion from acceptance to support. Dreyer concludes that participation and procedural justice need to be key concerns when planning climate change action. Perhaps the appearance of a strong attack on these criteria of successful policy formulation (participation and procedural justice) by the Coalition in Opposition, under the leadership of Tony Abbott, was a very targeted attack on a key vulnerability of climate change policies at the time.

Kevin Rudd, on the other hand, apparently adopted the international ecological modernisation[11] approach which incorporated the notion of climate justice[12]. However Rudd's approach changed over time in favour of a pragmatic and overly moralistic approach that probably eroded support for his policy position (Curran, 2011).

McCrea (2015) suggests that to avoid the fluctuations in climate policy and, in particular, reaction to scepticism, there may be more or less opportune times to pursue climate change policies. McRea proposes that in resolving the tension and displeasure caused by inconsistencies between emerging attitudes and past voting action, a person can seek comfort and resort to past behaviour, thereby resisting the call by political agents to change (McCrea, 2015). This might happen in an election phase where the level of scepticism and previous voting behaviour might be expected to be changed by the election event. This tendency to reject the displeasure in confronting new and accumulating knowledge was highlighted in Queensland where a convention in 2012 of Liberal National Party politicians (in Government at the time) voted to preclude the teaching of climate

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[11] Ecological modernisation: from the initial contributions onwards, the aim of Ecological Modernisation Theory has been to analyse how contemporary industrialised societies deal with environmental crises. The core of all studies in the tradition of Ecological Modernisation focuses on (existing and programmed) environmental reforms in social practices, institutional designs and societal and policy discourses to safeguard societies' sustenance bases (P.J. Mol, 2000).

[12] For the last 30 years environmental justice has been a major movement and organising discourse in the arena of environmental politics, focused on environmental inequity, lack of recognition, political exclusion, and the decimation of communities. With climate change, environmental justice themes were taken up by climate justice activists, while at the same time the impacts of climate change increasingly shaped the environmental justice movement (Schlosberg, 2019).

science in schools on the basis that it was "post normal" and unsuitable for inclusion in the school curriculum (Lindenmayer, 2013).

3.3.2 Other surveys of attitudes to climate change

Evidence of considerable fluctuations in public interest and concern about climate change is revealed in a study based on a series of public opinion surveys and Gallup polls in 2014. The investigation is referred to in a 2015 WIRES[13] Climate Change article 'Iinternational trends in public perceptions of climate change over the past quarter century' (Capstick, 2015). Respondents were asked to judge whether their level of interest and understanding of the importance of climate change concern was 'a great deal' or a 'fair amount'. The summary of results from the USA, UK and Australia described an increasing perception of the importance of climate change which peaked in 2007 and gave way to increasing levels of polarisation and scepticism in subsequent years to about 2010. From that time to 2014, the level of interest and understanding of the importance of climate change rose again but not to former high levels (Capstick, 2015). Figure 3.4 (below) shows the extent to which US public survey respondents reported personally worrying about climate change over a 25-year period.

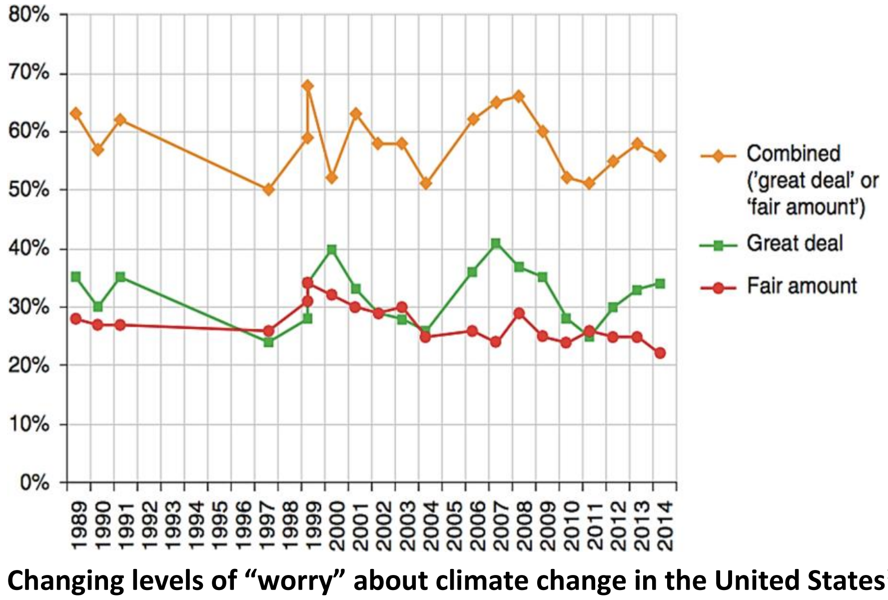

Figure 3.4 Changing levels of "worry" about climate change in the United States[14].

[13] Wiley Interdisciplinary Review: Climate Change

[14] This image was published under the terms of the Creative Commons Attribution (CC-BY) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited from the Rights Platform which manages Wiley and Sons content.

This pattern of behaviour is also reflected in a Gallop Poll in the USA, Europe and all Western democracies. Opinions on the issue of climate change were polarised and a Gallop Poll of the 111 countries found that recognition of an anthropogenic component of climate change fell in these countries between 2007/8 and 2010 (Capstick, 2015).

However, in relation to the polls in the USA, respondents indicated an immediate sensitivity to statements and 'cues' presented to them and tended to change their opinion in line with the dominant statements of the time. Another study analysed public attitudes to climate change in the USA and proposed a number of reasons for fluctuations in public opinion - extreme weather events, public access to accurate scientific information, media coverage, elite cues, and movement / countermovement advocacy (Brulle, Carmichael, & Jenkins, 2012). This research determined that elite cues (for instance party political statements and congressional inquiries) were a powerful influence along with movement and countermovement advocacy. These influences were much greater than information campaigns and mass communication. While economic factors such as the GFC have been credited with diverting attention from climate change, economics was not an important influence overall (Brulle et al., 2012; Reed, 2012).

3.3.3 A moment of bipartisanship followed by difference

The WIRES Climate Change article by Capstick incorporated 300 polls up to 2010, and showed that fluctuations in the sense of threat of climate change occurred in line with the dominant statements made for and against action (Capstick, 2015). The common feeling of alarm from climate change reached a peak in 2007 amongst a rare moment of bipartisanship on the issue. This period also coincided with the launch of the film *An Inconvenient Truth* by former US Vice President Gore (Gore, 2006). This film was effective in consolidating the awareness of the threat of climate change, although the influence was short-lived, as it was followed by virulent anti-climate change views adopted by the Republican Party in 2008. The frame of reference for this particular study by WIRES was the perceived threat of climate change, while the Australian polls sought to measure support for action to combat climate change. However, as discussed earlier, the two approaches are causally linked – denialism being expressed in response to warnings such as those delivered in *An Inconvenient Truth*. This highlights the risk associated with hyperbolic statements about climate change that can erode the support for action and policies to address the threat and can actually encourage an opposing view.

3.4 The role of climate science

The influence of scientific evidence on the discussion of climate change is analysed by Evelyn Fox Keller (2017). In an article written ten years before its publication in 2017, Keller outlines the various ways in which the expertise of scientists can be less influential on climate change public opinion than might be expected (Keller, 2017). Keller (2017) also analysed the championing of various positions against action on climate change by a range of groups in the USA in order to draw attention to the ways in which public opinion is influenced. This study preceded the work by Naomi Oreskes who defined these protagonists as 'Merchants of Doubt' and proposed that the sole intention of some groups was to raise doubt, rather than to convert people into climate sceptics (Oreskes, 2010). In relation to polling, the sowing of doubt can be a powerful force to abandon formerly held positions and convert some to a 'don't know' position, a tendency demonstrated in the results discussed earlier in this chapter.

Scientific methods often refer to the expression of phenomena in terms of levels of confidence and this alone can seed doubt. Advocates for action on climate change could consider developing ways to conceptualise and express degrees of scientific certainty before adopting policies on paradigmatic change or even approaches such as ecological modernisation and climate justice.

3.5 The wicked nature of climate change

Forming and holding a position can be difficult, given the wicked nature of climate change where it defies a simple or straightforward solution and significant economic, social and environmental impacts may be experienced (Levin K., Cashore B., Bernstein S., & Auld, 2010). Wicked problems are interconnected, and multidimensional and require cross disciplinary consideration [15]. They are "dysfunctionality within a complex system" and need to be recognised as such (i2S, 2019).

When analysing climate change, some elevate this characteristic to 'super wicked' by adding four key attributes: 1. the perception that time is running out; 2. the perception that there is no central authority; 3. the fact that people who cause the problem also seek to

[15] Wicked problems are highly complex problems. Examples include: environmental degradation, climate change, multicultural integration, cybersecurity, sprawling mega cities, political gridlock, poverty, inequality and food security. A wicked problem is a dysfunctionality within a complex system. They are unstructured, open-ended, interconnected, interdependent, multi-dimensional, systemic, often unbounded in time and space. They cross disciplines, cross borders and cross departments, making them very difficult to contain or structure (i2S, 2019).

solve it; and 4. the existence of hyperbolic discounting i.e. the problem is pushed out further in time when in fact immediate action is required (Briggs, 2019; Levin K. et al., 2010). Attributing these four characteristics of a super wicked problem to climate change highlights the range of areas where doubt can be raised, sufficient to change some people's opinions. Discussion about climate change policy requires acknowledgement of these four characteristics and in particular the complex process of developing a policy response.

3.5.1 Wicked problems and public opinion

Not only does the premise of a wicked (or super wicked) problem make policy development difficult but it could also explain the volatility of public attitudes. Hyperbolic rhetoric presented around proposals for quantitative emission reduction targets combined with technology prescriptions and debate on complex mechanisms creates another layer of uncertainty when dealing with a super wicked problem such as climate change (Levin K. et al., 2010).

Tracking the changes in opinion over time through polling suggests that an otherwise supportive public might be even more wary of policy prescriptions that do not deal adequately with wicked problems, particularly if it appears that added costs would be imposed. Briggs comments that a key feature of wicked problems is that essential to their resolution is the need for collaboration and innovative solutions that incorporate the full range of causal factors. Inherent in this complexity is the possibility of failure, requiring policy adjustment (Briggs, 2019).

This analysis can explain the counter intuitive impact of bold hyperbolic policy that actually reduces public support for action, inasmuch as the stated policies do not consider the interplay of these attributes of a wicked problem. Strident, single minded policies appear to be vulnerable to opportunistic targeting by those wishing to exploit the degree of scientific uncertainty or simply create confusion.

Given the nature of climate change as a wicked problem, the rhetoric applied to policy could have played an important role in developing, maintaining and changing public attitudes to policies aimed at managing the potential impact. A new orientation is required in the language of debate to encourage a view that the expression of opinion and policy by governments will need to be constrained into the future to achieve policy cohesion (Levin, Cashore, Bernstein, & Auld, 2012; Levin K. et al., 2010).

3.5.2 An alternative prescription for presenting policy

This discussion suggests that in the interests of effective action it is advisable to develop a consistent theme in climate change policy over several years. It has been outlined how policy uncertainty was caused not only by a challenging policy itself but also by the rhetoric used to explain the policies. To the extent that politicians seek new 'bravura'[16] ways of articulating a policy solution, they also run the risk of later contradicting themselves (Grube, 2014; Grube, 2016).

An apt example of this is the highly charged rhetoric on climate change adopted by Rudd in Australia when he took over the leadership of the Labor Opposition in 2006, promising a significant change and a positive target of policy development on climate change. His message was that climate change was the 'greatest moral challenge of our time'. Later his approach would change considerably when he withdrew the CPRS from Parliament. An alternative option would have been to call on a double dissolution of both Houses of Parliament, an action reflecting the seriousness nature of the issue and available in the Australian Constitution, using the failure of the CPRS to pass through the Senate as a trigger.

The abrupt characterisation of climate change as an immediate problem that needs to be dealt with immediately, without providing realistic timeframes and changes in practice, compounds the problem of remediation. Socio technical transition theory offers a methodological approach (discussed in Chapter 1) which suggests that thresholds of social, technological and scale need to be overcome before industries can adjust to the new challenges. Policies that do not acknowledge and accommodate these stages of readiness for effective action may tend to be less effective. One theme of this thesis is a drawing together of all the issues that tended to stand in the way of agroforestry fulfilling its promise to contribute to the mitigation of climate change and these are drawn together in Chapter 10.

3.6 Path dependence and climate change policy

Another influence on, or even impediment to, effective policy making in climate change is the failure to address the unknown or little understood barriers to progress. This approach helps bring into focus the need for distinct policy approaches that help move

[16] In classical music, a bravura is a style of both music and its performance intended to show off the skill of a performer. [1] Commonly it is a virtuosic passage performed as a solo, and often in a cadenza. The term implies "effect for effect's sake".

small scale engagement into more engagement and finally to adoption and the very different policies required to make this happen. The diagram in Chapter 10 modifies the Geels approach to carbon agroforestry and highlights the interplay of influences, market policies, and strategic approaches that enable a move form "micro" level to "meso" and "macro" level impact. The common characteristic of change required so as to make carbon agroforestry an effective means of abatement, is this need to move from the individual to broad application. Adjusting for these changing approaches to deal with a "multi-level" approach also attempts to anticipate the limitations of a top-down approach, the existence or creation of a "trust deficit" (Section 3.6.1) and critical junctures (Section 3.6.4).

Path dependency is often used to describe the continued use of a product or practice based on historical preference or use (Barton, 2021). Path dependency occurs because it is often easier or more cost effective to continue along an already set path than to create an entirely new one (van Driel, 2009). Path Dependency can include rhetorical path dependency analysis, which indicates that what works best is not necessarily determined solely by how policies are created, but also by the phenomenon of 'lock-in' which can lead to critical junctures which make it hard to change direction. This framework will also be used to help explain the volatility in climate change policies.

It is suggested that the way to deal effectively with wicked problems is to create "sticky" elements of policy that gradually gather support and build legitimacy (Levin et al., 2012). This version of path dependency may provide a useful way to judge how policy was advanced on climate change. Political leaders often look for the opportunity to promote paradigm shifts in policy. The cautionary tale however, according to path dependency theory, is that a faux paradigmatic shift for political gain that is exaggerated and not based on broad consultation, can be readily undermined by existing coalitions of opposition, instead of creating a "coalition of the willing" (Levin et al., 2010; (Grube, 2016).

3.6.1 Science and risk leading to a trust deficit

International polls verify the volatility of the debate about climate change across the board, but particularly in non-European Western democracies. The acknowledged uncertainty associated with climate science is often framed through the perspective of risk. This can enable strong rhetoric in favour of and against particular proposed actions depending on the perception of risk. This duelling of views and the resulting questioning of science could provide the earliest examples of a challenge to the liberal democratic orthodoxy of trust in institutions (Tjernström & Tietenberg, 2008).

The emergence of this ‘trust deficit’ may be found through path dependency analysis applied to climate change (Levin K. et al., 2010; Stewart, 2013; van Driel, 2009). This approach proposes that the actual process used to develop policy is crucial to its acceptance. Unexpected and unexplained critical junctures can undermine previous levels of trust and support.

Path dependence analysis would suggest that a more stable outcome would be achieved if the changes in policy were gradual and well explained. To some extent the widening gap between ‘don’t know’ and support for either or both government approaches in the Climate Institute Poll, could mirror the fluctuations between *gradual* change and *urgent* action in the Lowy Poll (noting that the Climate Institute Poll terminated in 2010). These gaps in opinion could reflect the increasing distrust of the ways the policies were being promoted and presented.

Based on this reasoning, it could be argued that the Labor Government was replaced by the Abbott Coalition Government in 2013 not specifically or solely on the issue of disputing climate change action, but also because of an objection to the way climate change policies had been presented and the consolidation of the trust deficit. In other words, the reason people shifted their support was, to an extent, based on the way the climate change agenda was prosecuted by the Government rather than a change in belief. Abbott in Opposition was also very strident and hyperbolic in his opposition to a ‘carbon tax’, so a more complex reason based around a trust deficit and/or increase in confusion may need to be explored.

Looking at this public distrust and confusion from a rhetorical path dependence perspective would suggest that politicians should avoid statements they might later regret (Grube, 2016). If a more cautious approach is ignored, it could create the setting for an amplification on both sides, once the chase for political success has commenced. Having questioned a significant number of the Government’s climate change policies, the Abbott Coalition Government proceeded to repeal significant legislation despite the continuing increase in public support for *urgent* action on climate change.

Much of the studies covered in this chapter focus on rhetoric and much of this thesis also assumes that statements and articulation of policy are a powerful influence on opinion. There is also an assumption that political parties, once they decide on a policy, will not change their attitude to any real extent, or only very gradually. What seems to happen in terms of policy development in a political context is that rhetorical statements are hard to change once used many times (Grube, 2016).

3.6.2 Binary positions a feature

Further analysis of the fluctuations in attitudes to climate change action is warranted to understand the relationship between public opinion and climate change policy development. For example it has been suggested that the changing expression of opinion by the public to climate change policy action over the period 2007 to 2015 was possibly a result of the often inaccurate perception (by some) of attitudes by others (Leviston, 2012). The 'false consensus' effect which was evident from adherents to both sides of the argument on climate change action tended to produce a rigidity in opinion and a resistance to change (Leviston, 2012). It has also been found that public attitudes to action on climate change in Australia and the USA were often quite closely related to stated political views, further polarising the differences and producing binary arguments (Morrison, Duncan, Sherley, & Parton, 2013).

As indicated earlier, polarising an issue may relate to the way people express an opinion before and after an election. This means that immediately after an election there can be a shift towards consistency with the policy associated with the election result, as observed in the USA (Brulle et al., 2012). but there can also be a considerable shift in contradiction to the policy. It appears that in Australia, after the 2013 election public opinion did shift on how climate change might be tackled (Lowy Institute, 2014). As demonstrated by the Lowy Poll, there was actually a rise in the appeal of taking action, while this was not the view of the new Government.

Evidence of a re-emergence of support for action on climate change after the 2013 election could support the idea that Prime Minister Rudd squandered the strong public support for *urgent* action when he took office by ramping up the political rhetoric. In the process, he may have actually emboldened the coalition of forces opposed to climate change and encouraged the use of similarly charged rhetoric but in a different direction. This is likely to have caused a reduction in support for *urgent* action and created more uncertainty. What is significant here is the way public opinion moved in contradiction to the policies advanced by successful Liberal National Coalition Party.

3.6.3 Top down policy development

These mixed messages may have been avoided if the process of policy development had been properly and democratically managed (Stewart, 2013). An essential element of policy development in a wicked problem area like climate change is a democratic dialogue (Jones, 2010). In this context, and as discussed earlier in this chapter, a democratically managed solution can incorporate the more collaborative and innovative approach required of wicked problems. Otherwise a paralysis can take hold of public opinion if it is buffeted by claim and counter claim where few people outside the experts are able to explain what the policy is about (for instance the CPRS). The conventional top down approach of the Australian political system was adopted in this case and "confusionists", whose main role has been to increase doubt rather than change people's position, played a significant role (Jones, 2010).

The top down approach to development of the CPRS was pursued by economists, scientists and public servants that advocated the CPRS design with the background support of the Garnaut Climate Change Report (Stewart, 2013). Indeed, one of the key reasons for the poor outcome in delivery of this policy was the failure of this coalition of forces to produce a unifying rationale for action. While some scientists provided advice and prescriptive solutions, or pragmatically endorsed government policy to achieve progress, others believe they should have remained independent and not entered into this "epistemic coalition" (Stewart 2013, p.11). In the same vein, some weather events were used to highlight climate change and used as a convenient way of characterising the urgency while this also opened up the opportunity for criticism from a range of opponents. An alternative to this top-down approach to policy making is discussed in Chapter 11, and the concept of subsidiarity is suggested as one way to pursue policy cohesion.

3.6.4 Critical junctures without increasing returns

A crucial nature of rhetorical and policy path dependency is that, following achievement of a real critical juncture, it should be possible to demonstrate "increasing returns" for the public as a whole. Introducing the CPRS was an attempt to create a critical juncture but it arguably failed to demonstrate increasing returns among the whole population. Rather, it was possible for the climate denialists to suggest that the nation faced "decreasing returns" (Stewart 2013, p. 11). The failure of this approach to reach a critical juncture may have been predictable, as wicked or super wicked problems do not resolve themselves without acknowledging the dysfunctionality of the interlocking issues (i2S, 2019). It is therefore important to communicate the precautionary nature of climate change policies and the international context of its impact.

As outlined earlier, while the CPRS was a practical and potentially enduring strategy leading to modest reduction in emissions, the hyperbolic rhetoric associated with the measures did not read well with opinion polls and other political forces. The forces of opposition were emboldened by the atmosphere of uncertainty. The passage of the legislation depended on the support of the Australian Greens, a party dedicated to advocacy of strong environmental action. Unexpectedly, this minor political party with a crucial supporting role, blocked the passage of the CPRS in the Senate. This blocking of the CPRS Bill did more than delay the legislation, it created the circumstances for continued confusion of the public.

The forces of opposition also found opportunities to voice their views three times: first when Rudd withdrew the CPRS legislation from further consideration; secondly when Prime Minister Gillard appeared to reverse her pre-election announcement that her Government would not pursue emissions trading and carbon pricing; and thirdly when Gillard described the Carbon Pricing Mechanism (CPM) as being similar to a tax (Paul Twomey, 2014). By that stage, the momentum for opposition was set to continue regardless of the features of the CPM. This interpretation is consistent with a path dependent analysis where new policies, that have a paradigm shifting impact, need to be linked to an early description of the best means of achieving ambitious goals (Levin K. et al., 2010).

This ideal of a linked and gradual approach is contrasted with the alarmist tone set by the early Rudd Government and the way it was used to describe the proposed CPRS legislation (Stewart, 2013). For example, the problem of climate change was often presented as ‘carbon pollution’ with dramatic, seemingly immediate and local catastrophic consequences if action was not taken.

Former United States Vice President Al Gore has acknowledged that overly dramatic language tends to disempower people and they can become mere observers as the conversation between proponents and climate change deniers becomes more and more strident (Stewart, 2013). The Lowy Poll chart with incidents and statements also incorporates the times when Al Gore visited Australia and reveals a minimal and not positive impact.

The nature of the CPRS and the way it was introduced has been criticised for being a single solution that would not work on its own and sceptics emerged, even from within the epistemic coalition (Stewart, 2013). By implication, if the process had been more democratically managed and part of a well discussed integrated process, then the 'deniers' would not have been provided the opportunities that allowed them to confuse the debate.

Lack of consultation, and poor explanation of the methods to be employed and a wide variety of statements from experts provided opponents with an opportunity to criticise. This in turn could have been the reason for public opinion continuing to fall from supporting *urgent* action and even below *gradual* action, accompanied by a high level of uncertainty, at least in that initial period following the election of the Labor Government in 2007.

3.7 An alternative policy approach: progressive incrementalism

An alternative to proposing paradigmatic change is to seek change through a process of progressive incrementalism – i.e. policy development characterised by small and predictable steps (Levin K. et al., 2010). A key element of the progressive incrementalism approach is to focus on explaining the methods rather than announcing ambitious goals without explanation of the means of achieving these goals. While this more collaborative and consultative approach is readily aligned to path dependency theory, it can be applied to policies reacting strongly to the past and potentially disruptive or being captive to it and politically feasible. In such a contested area as climate change, progressive incrementalism would suggest that change is best achieved through forward looking, politically feasible policies that include the means, calibrations, and settings (Levin K. et al., 2010). By contrast it seems likely that the ambition of a paradigmatic scale of ambition on climate change (even when combined with the announcement of internationally agreed emission reduction goals) but with little discussion of the means, calibrations and settings, could unleash a level of vocal opposition.

3.7.1 Early progress disrupted by rhetoric

The four discussion papers produced by the Australian Greenhouse Office in 2000 with the engagement of the States and Commonwealth, contained a set of principles for the creation of a possible national emissions trading system. These principles addressed the effectiveness and procedural justice issues that have been considered a prerequisite to convincing the public to move beyond acceptance to support (AGO, 1999; Curran, 2011; McDonald, 2013).

This calm approach was displaced, particularly after 2007 with an new language of urgency and even a securitisation threat from Rudd (McDonald, 2013). The public support for action on climate change reduced, mainly because of the way it was being tackled. The claim and counter claim over what should be done did not go well with the public who reacted against the politically charged statements (McDonald, 2013).

3.7.2 Recent changes to energy and climate change policy

Recent Australian policy development on energy policy has been centred on a blending of emissions reductions with energy security, sustainability and affordability. This trilemma of concerns can be seen as approaching the effectiveness and procedural fairness considerations. In 2017 the Chief Scientist, Allen Finkel, was commissioned by the Commonwealth to review climate change policies. The Finkel Review recommended a Clean Energy Target and introduced the notion of balancing different issues through measures of performance and assessment but included a fourth element – Rewarding the Customer (Finkel, 2017). The Government chose to adopt the notion of an energy (electricity generation) trilemma, where three factors - energy security, sustainability and affordability - need to be considered. This approach has been adopted elsewhere and could provide a flexible approach plus some degree of consideration of consumers and a level of compensation for lower income earners (Gunningham, 2013).

The National Energy Guarantee (NEG) was announced in late 2018 by the Commonwealth Government, where two main factors were to be guaranteed: reliability of service and emissions reduction (CEC, 2018). The third element of the trilemma, affordability was also to be considered. While there are specific targets for emissions reduction, the reliability and affordability were to be measured by agreed performance standards. However, the means and methods of operation were determined in advance of the specific targets relating to different elements of the trilemma policy approach. Later in the year the NEG was abandoned by the Government. The Labor Opposition has indicated their continuing support for the approach.

The NEG is possibly a model mechanism for progressive incrementalism in climate change policy. It provides an acceptable pathway and potentially a bipartisan approach to emissions management which has not been achievable to date. Despite the NEG receiving support from the Coalition party room (all Government Members of Parliament) and the possibility of bipartisan support, the Coalition Government did not legislate the NEG. A subsequent rise in opposition from within the Government Cabinet and the party room was considered partially responsible for a change in leadership and the Prime Minister to Scott Morrison (Crabb, 2018).

The initial popularity of the NEG is a reminder that considered and balanced solutions are available that could achieve bipartisan support at some stage. The NEG on its own would not provide a comprehensive approach to climate change as it was focused on the electricity sector. An alternative approach using the same balancing approach may be to create a series of sector specific trilemmas that provide the right inclusive and flexible method of implementing policies that can achieve real progress without the perception of significant disruption or paradigmatic change. Importantly it may provide the opportunity for investment in bioenergy with a reduced threat of policy change.

3.8 Summary

This chapter contains several elements that have been brought together to help interpret the fluctuations in attitude to climate change over the last decade as demonstrated through public opinion polls. However, the alignment of the Lowy Poll with a timeline of incidents including policy announcements, publications and parliamentary debate over legislation, has not completely explained the changes in mood in Australia. Looking at the USA, it was argued that the tone of political debate and the public attitude might be self-supporting. As discussed, this was not the case in Australia and another analysis was required to explain the dissonance.

It is likely that ramping up the need for climate change action for political purposes can backfire in that it creates a space for confusing, anti-action opinions to infiltrate the dialogue (Levin K. et al., 2010). As described in this chapter, the growing public interest in climate change was in contrast to the long period of Commonwealth Governments with little interest in mitigation policies. State governments on the other hand had almost universally taken practical action with various pieces of pragmatic legislation in each jurisdiction. The newly elected Rudd Government determined in 2008 that climate change policies were more likely to succeed when led by the Commonwealth rather than a range State Government approaches. However, the highly charged and urgent agenda advanced by the Commonwealth ran the risk of running ahead of the public who, by then, supported the Commonwealth Government taking lasting gradual long-term action, as demonstrated by the polls.

The term progressive incrementalism has been applied to policy development that takes small and predictable steps and may indeed achieve more progress than a quest for paradigmatic change. In place of the instability caused by the political rhetoric actually used, a more democratic and participatory approach is likely to make policies take hold.

The adoption of better, more inclusive processes of policy development can be considered a fourth pillar of sustainability.

The market-based policy option for emissions abatement involves the levers of quantity and price. This results in either rationing the emissions to an agreed level and creating a price or placing a price on carbon to generate low-cost abatement. The common themes for these strategies are cost and economic efficiency. Alternatively, a hybrid approach (a combination of market and regulation) with a gradual pathway of action can be adopted (McKibbin & Wilcoxen, 2002). The degree of participation by the broader national economy is crucial for success. Ambitious policies can be preferred on efficiency grounds but are likely to fail (Nordhaus, 2007). Gradual and steady policies are most likely to work, continue and avoid political opposition and market failure (McKibbin W., 2002). This aligns to the progressive incrementalism discussed in this chapter.

This chapter has outlined how the interaction between public attitudes and political rhetoric can frustrate the development of effective policies and suitable industry wide action on climate change and draws on path dependency to provide an explanation. In addition the significance of supportive and stable public opinion is a key factor in transition theory to ensure movement from the socio technical level of activity to landscape adoption. In addition, Geels uses the Rivoli and Waddock (2011) scenario of temporal shifts in public opinion and how this shifting can both support legislative action and also bring about hostility which frustrates legislative change.

Chapter Four

4

International Climate Change Policy and Australia

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4.1 Introduction

A report by the McKibbin Software Group to the Australian Department of Foreign Affairs and Trade prior to the UNFCCC Conference of the Parties in Paris in 2015 refers to the lack of certainty caused by the absence of a post 2020 target by Australia (McKibbin, 2015a). This report found that the perceived risk of investment in the energy sector has increased and caused higher energy prices and input costs. The absence of a long-term target therefore imposes a penalty on future investment in energy and technology. The study by the McKibbin Software Group estimated that this additional cost is three times higher than the cost of action aligned with the core Paris Agreement goal.

This level of uncertainty also significantly impacts on carbon agroforestry investment because credible emission reduction targets are required to generate demand for offsets at a company or national level. However policy certainty is improved if the preferred methods of emissions management are determined and supported (McKibbin, 2015a).

In earlier chapters the unique importance placed by Australia on carbon agroforestry is juxtaposed with the relatively poor performance of this sector in achieving emission reductions. The reasons for this lack of success have been explored, including the commencement and cessation of carbon trading, the role of regulatory confusion and change and the role of shifting public attitudes in creating policy uncertainty. In addition, the effect of some regulations governing carbon sequestration placed limitations on the expansion of the industry are outlined, as is the Emissions Reduction Fund (ERF) and the consequent removal of industry incentives to invest in carbon offsets.

4.2 Australia's unique focus on carbon agroforestry from an international perspective

Even before the signing of the UNFCCC in 1994 it was widely appreciated that carbon sequestration through forestry could contribute significantly to a national effort to reduce emissions of carbon dioxide and related global warming gases (Taylor, 2014a); (Garnaut, 2008a; Macintosh, 2011; Macintosh, 2012; McKibbin, 2015b). Carbon forestry technologies relevant to the Australian context include carbon sequestration through establishment of permanent forest sinks, bioenergy utilising forestry biomass and activities embracing both technologies (Cowie, 2007; Souza. G, 2015).

At the negotiations framing the Kyoto Protocol in 1997, Australia opted to include land clearing (change in tree cover) as part of the measurement of greenhouse emissions.

As part of their negotiations at Kyoto, Australia insisted that emissions from deforestation (one of the Article 3.3 activities) were included in their 1990 baseline. Adopting this measure enabled Australia to inflate their 1990 emissions by 132 megatons of carbon dioxide equivalent (Cordes-Holland, 2015; Leviston, 2012). This strategy enabled the mitigation task to be easier as the rate of land clearing had already started to decline (Macintosh, 2011).

Further to the agreement on Article 3.3 activities, and at the urging of key State Government officials in Western Australia, an international meeting of some of the countries in the 'Umbrella Group', including Australia, USA, Japan, New Zealand, Iceland, Russia, Canada, Norway and the Ukraine, was held in in Perth in April 2000. The purpose of the meeting was to investigate some of the opportunities and limitations provided by carbon forestry. Of particular interest was the refining of the concept of a forest so it might include smaller trees of lower height than the description of a forest in Europe. Included in the investigations was a visit to the Wheatbelt and an observation of plantings of trees such as species of mallees (Beinart, 2000; Biggs, 2019; Hamilton, 2001).

As noted previously, this meeting resulted in the adoption of a definition of a forest under Article 3.3 to ensure that changes in the smaller tree species found throughout Australia could be included in the national inventory. Article 3.3 includes emissions or carbon sequestration from reforestation, afforestation or deforestation (Australian Government, 2009).

On the other hand, in the first commitment period of the Kyoto Protocol, Australia did not include any activities under Article 3.4 which includes forest management, cropland management, grazing land management, and revegetation (Parliamentary Library, 2009). In its negotiations for the second commitment period, Australia sought to have Article 3.4 included (DOE, 2016). At the same time Australia advocated for some rule changes to ensure that the benefits achieved in the first period could be retained. It has been noted that 1990 was a wet years and there was a probability that a decline in the growth of plants could be predicted.

Modelling by the Australian Treasury and the Australian Bureau of Agricultural and Resource Economics (ABARE) at the time suggested that the contribution of forestry might not be high. However, these estimates assumed that Australia would only be recording Article 3.3 activities and would therefore be unable to exploit large opportunities because of the limitations placed on Article 3.3 activities (Cordes-Holland, 2015).

With Article 3.4 activities included, Australia had many additional opportunities for securing ‘removal units’ which had the same value as reductions in energy and other emission reduction programs (Macintosh, 2011). The estimate of the contribution of land-based activities to total emissions reduction in Australia with Article 3.3 activities alone was 6% (Australian Government, 2008.). With the addition of Article 3.4 activities, this estimate rose to 30% by 2030 and Australia anticipated issuing carbon credits to land owners for carbon sequestration activities under a future emissions trading scheme (Cordes-Holland, 2015).

This carefully negotiated position was intended to ensure that carbon forestry would play a crucial role in the abatement challenge (Golub et al., 2013). There was a concern by developing countries that LULCF activities would provide an easy pathway to compliance for developed nations (Annex 1 countries) and this might have been particularly true of Canada, the USA and Australia (Schlamadinger et al., 2007). As a consequence, limits were placed on the use of land-based activities.

Before the adoption of land-based mitigation strategies by Australia and other Annex I countries, there had to be changes to the rules governing non-anthropogenic disturbances that threatened to undermine confidence in LULUCF accounting (Schlamadinger et al., 2007). The possibility of natural disturbances reinforced the concerns about permanence and the lack of a framework for measuring emissions and sinks to ensure that developed countries in particular were held to targets that had recently been adopted. In addition, Australia supported a forward-looking approach to establishing reference points against which to measure attainment of LULUCF abatement (Cordes-Holland, 2015). This forward looking approach incorp[orated the Forest Management Reference Level (FMRL). This avoided the problems associated with comparisons with past benchmarks which could have been influenced by non-anthropogenic activity and ageing plantation stocks where the rate of carbon sequestration was slowing (Cordes-Holland, 2015). Various methods were for dealing with the non-anthropogenic and indirect effects that could disrupt the reliable calculation of emissions and removals for a particular country (Cowie, Kirschbaum, & Ward, 2007).

It is apparent that reports on the potential for the contribution of LULUCF activities to the mitigation effort made before the negotiations of the Kyoto second period were much more optimistic than reports at the end of the negotiations (Ellison, 2013; Zhang, 2011)

4.3 Australia's emissions reductions and carbon forestry

Estimates of the potential contribution of carbon sequestration predicted that bio-sequestration of carbon had the potential to make the largest immediate contribution to emissions reduction in Australia, carbon plantings being a major potential source of mitigation (Garnaut, 2008a; Gaynor, 2014). Garnaut predicted a reduced role for carbon sequestration after 2050 when carbon plantings would have matured. In terms of carbon forestry, it was estimated that new plantations would contribute 143 Mt CO_2-e per year for 20 years, using 9.1 million hectares of land. Carbon agroforestry was expected to be more profitable than existing land uses (Garnaut, 2008a).

Estimates of the potential for mitigation through afforestation in other countries have also been ambitious. For instance, afforestation projects were estimated to have the potential to offset 20% of emissions in the United States, but would have needed 25% of available cropland (Bryan BA, 2015; Polglase et al., 2011).

The assumption behind these ambitious targets was that carbon sequestration for offsets through forestry was complex but well understood and it was a low-cost strategy to start the process of industry wide emissions reductions. However, this medium-term solution to emissions reduction has been questioned and support from commentators is now conditionally linked to the achievement of co-benefits such as land care improvements. In addition, other land use issues such as competition with food production also need to be considered and adequate compensation provided for use of productive land (Lawson, 2008; Polglase P et al., 2008,; Salisbury et al., 2014a; Standish & Hulvey, 2014).

Increasingly, economic factors such as competing interests are likely to determine land use questions and it is possible that land identified as being available for carbon agroforestry would be accessed and used over a much longer time period up to 100 years (to ensure equates to "not emitting") than initially anticipated. Given the longer time period and land availability, the contribution of carbon agroforestry to meeting Australia's 2020 target of decreasing emissions by 5% compared to 2000 was scaled back from the up to 30% estimate mentioned earlier International interest in international mechanisms (Polglase et al., 2011).

Created under the Kyoto Protocol, three flexibility mechanisms were established to enable low cost abatement to be achieved across national borders. A key principle, common to the three mechanisms (Clean development Mechanism (CDM), Joint Implementation (JI) and international emissions trading (IET), is that emissions are a global concern and it does not matter where the abatement takes place. The CDM enables Annex 1 countries to generate

Certified Emission Reductions (CERs) in non-Annex 1 countries (developing countries) while JI applies the same principle of generating abatement across the two Annex 1 countries, in this case called Emission Reduction Units (ERU). IET enables these units to be traded on the international carbon market, so they can be used by any country to meet targets established under the Kyoto Protocol (DOE, 2018)

While the intention expressed in the Kyoto Protocol that the international flexibility mechanisms[17] be supplemental to the individual national task of meeting greenhouse gas abatement targets, several non-Annex 1 countries, including China, expressed the concern that this would make the task of meeting national targets far less difficult than mitigation within an Annex 1 country (Cordes-Holland, 2015). Indeed, some Annex 1 countries did express the intention to use the international flexibility mechanisms extensively to help meet their targets, to a greater extent than envisaged in the agreed notion of these mechanisms being supplementary to core national efforts. Australia was one of these, and when setting a 15% and 25% reduction of emissions in its negotiations, indicated that 20% of these targeted reductions could be derived from international credits.

4.3.1 Ambitious use of the international mechanisms

In the lead up to finalising the arrangements for the second commitment period (after COP18 in 2012 in Doha)[18], Australia was a vigorous advocate for ensuring that the international flexibility mechanisms would be extended and enhanced to enable a suitable framework for achieving abatement at least cost (UNFCCC, 2008). The Commonwealth Treasury also saw significant benefit in promoting the use of the flexibility mechanisms and envisaged a deep market with low cost options for abatement which would help minimise distortions in trade exposed industries. A report from McKinsey and Company suggested that the use of international credits, along with the extensive incorporation of carbon capture and storage in the fossil fuel power plants and forestry, could reduce the cost of compliance by up to 80% (McKinsey, 2008). Expectations were created for the

[17] The three international mechanisms are the Clean development Mechanism (CDM), Joint Implementation (JI) and international emissions trading (IET). A key principle, common to the three mechanisms, is that it does not matter where the abatement takes place. The CDM enables Annex 1 countries to generate Certified Emission Reductions (ERUs) in non-Annex 1 countries (developing countries) while JI applies the same principle of generating abatement across the two Annex 1 countries, in this case called Emission Reduction Units (ERUs). IET enables these units to be traded on the international carbon market, so they can be used by any country to meet targets established under the Kyoto Protocol (Department of Energy and Environment, 2018a)

[18] The 2012 United Nations Climate Change Conference was the 18th yearly session of the Conference of the Parties to the 1992 United Nations Framework Convention on Climate Change and the 8th session of the Meeting of the Parties to the 1997 Kyoto Protocol.

utilisation of international exchange of emission reductions in the design of the CPRS and Australia's first attempt at an emissions trading scheme reflected this enthusiasm (Cordes-Holland, 2015).

4.3.2 Doubts about the integrity of CDM

The methodologies and protocols for measuring and validating the CERs generated from CDM projects have been developed and agreed at an international level, but there have been significant concerns expressed about the integrity of the reporting of results (AEA, 2011; SEI, 2011). These concerns include financial and environmental additionality (where mitigation activities may have occurred anyway – without the need for funding or controls), suitably tight governance, and whether the policy objectives of CDM to promote sustainable development in addition to achieving emission offsets were achieved. Another risk that has been identified is the potential for double counting, where both participating countries report emission reductions from the same activity (Stern, 2010). Along with concerns about the permanence of CDM forestry projects, there was also the issue of intentional production of hydrochlorofluorocarbons (HCFs) which replaced the use of chlorofluorocarbons (CFCs) in refrigeration. HCFCs are global warming gases and there was evidence of production of these gases just to earn credits from their destruction.

4.3.3 Australian investment in CDM and JI

Investigations into the integrity of the CDM were timed to coincide with the end of the first Kyoto period and considerations as to what role the CDM would play, if any, after 2012 (SEI, 2011). The level of international CDM activity was much reduced after 2012 and the reputation of CDM offsets when applied to national targets remained a contentious and political point of disagreement in Australia where the creation of a national ETS (CPRS) was being designed to take full advantage of the international flexibility mechanisms where possible (Lloyd, 2018).

However, in 2014 the Climate Change Authority (CCA) recommended that additional funding be provided to purchase international offsets that would lift the achievement of abatement beyond the minimum target of 5%In 2017 the Turnbull Liberal National Government referenced the CCA review and indicated that international trading in credits would be recommended, a move supported strongly by industry groups (Lloyd, 2018). It is important to note that over the period from its inception, very few CDM credits were generated from LULUCF activity.

Guarded encouragement for Australia to utilise international offsets came from the Review of Climate Change Policies by the Commonwealth Department of Environment and Energy in late 2017. The review referred to the support for purchasing international credits and also the opportunities for the export of ACCUs to the international market (CommonwealthofAustralia, 2017; "Renewable Energy (Electricity) Regulations 2001," 2017). The review provided in-principle support for international units but reflected the concerns of others in relation to the integrity and the lower price causing delay in domestic action. The Commonwealth did not support the export of ACCUs as this could delay achievement of the target for emissions reduction and possibly create the risk of double counting (CommonwealthofAustralia, 2017).

4.3.4 Forestry and Joint Implementation

As international negotiations proceeded after the Paris Agreement in 2015, the method and extent of international exchange in offsets were considered just as the level of CDM and JI activities reduced significantly. Article 6 of the Paris Agreement outlines the possibility of trading international carbon units, which are called International Transferred Mitigation Outcomes (ITMOs). By 2020 the CDM and JI will come to an end (Energetics, 2017a). Leading up to that time, the level of international trade in CDM (CERs) and JI (ERUs) have tapered off and the price has dropped considerably (Energetics, 2017b); UNEP/DTU, 2018). There have been no new JI projects between 2013 and 2018, very few international forestry based projects and a modest number in agriculture (UNEP/DTU, 2018). However, the expectation is that after 2020, when new arrangements for international trade are in place, exchange in forestry and agricultural projects will be considerable (Energetiics, 2016). Australia has an opportunity to export removal units (RMUs) or equivalent (such as ACCUs) to a large emerging market.

Support for Australia to export ACCU's was reflected in submissions to the Review of Climate Change Policies by the Australian Industry Greenhouse Network (AIGN) and Energetics (Energetiics, 2016). Energetics emphasised that following the Paris agreement and new arrangements for international trade in carbon credits, that an opportunity existed for export of ACCU's from abatement projects in the land sector. In a separate report, Energetics suggested that Queensland alone could generate up to $8 billion in exported ACCU's from the land sector, once the post 2012 rules for international trading of offset credits are resolved (Energetics, 2017c) .

4.3.5 Kansai's Joint Implementation forestry project in Western Australia

A JI forestry project started in Australia is the Kansai Electric Company of Japan’s (Kansai) Oil Mallee Project in Western Australia (WA). This project appears to be the only one of its kind in Australia. It consisted of 1000 hectares of integrated plantings of Oil Mallees across 24 properties in the northern Wheatbelt of WA. The project started in 2003 and was managed by the Oil Mallee Company (OMC) and the Oil Mallee Association (OMA). Kansai planted two million seedlings in belts across cropping paddocks in the northern WA Wheatbelt, each hectare being equivalent to 1km of planting 10m wide (Oil Mallee Australia, 2012)

The participating farmers were contracted to manage the planting and protect the seedlings from disturbance such as farm animals and agricultural sprays. The farmers were provided an annual payment to compensate them for the use of the arable land. This payment was to extend for 10 years but the trees were to be retained for 100 years, the prevailing definition of permanence at that time. The trees were secured under the WA Carbon Rights Act 2003 which provided for the securing of carbon rights as separate from ownership of the land.

As the models for a national ETS emerged, the project became less and less attractive, in particular when the date for establishment of compliance with the national ETS was set at 2007 and then 2009, effectively removing a substantial amount of achieved growth, and sequestered carbon from the calculation of sequestered carbon. The project was finally cancelled by Kansai following the Japanese tsunami in 2011 which caused disruption of many Kansai Electric operations in Japan. The farmers had been paid for several years and Kansai arranged for the registration to be transferred to the land owner and the caveat on their land removed. In the absence of a scheme to generate carbon credits, there was no need for the estates to be maintained under a permanence obligation.

From the outset, Australian climate policy has contained incentives for carbon bio-sequestration through forestry programs. However, over time, the perceived role of carbon agroforestry has changed and the policy approaches used to govern it have taken different forms. This question of climate policies geared to carbon agroforestry will be discussed in more detail in Chapter 5.

4.4 Market Failure

A useful policy framework to better understand this role for carbon agroforestry at the international and national level is the concept of market failure. Market failure refers to the lack of a distributive system, or a missing market, to fairly and efficiently allocate or reallocate impacts of economic activity (Brown, 2014; Stephens, 2014b). In relation to climate change, it can refer to the need to address unmanaged shocks to the economy caused by increasing greenhouse gas emissions and the need for measures to control these emissions (Andrew, 2008; Garnaut, 2008a). Addressing market failure can take many forms including government policies designed to manage markets where there are few incentives and disincentives to achieve efficient and fair distribution of benefits and disbenefits. If greenhouse gas externalities, i.e. the adverse impact of emissions, are not controlled, continued overproduction of emissions will create an ever worsening public hazard (Brown, 2014). There can be a range of conditions creating market failure including lack of information, limited incentives to innovate and the lack of networks through which new approaches can be generated (Brown, 2014).

Governments have recognised that the market cannot necessarily support the required level of forestry growth and that financial assistance is necessary to ensure industry growth. The Managed Investment Scheme was initiated in 1997 but led to a collapse following overproduction (URS Forestry, 2009). The time value of money between the high establishment cost and harvest has meant that governments have provided some level of comfort through tax incentives, subsidies and low interest loans (Stephens, 2014b). In the case of carbon sequestration, the role of government could be necessary to assist investors to overcome this failure of the market to recognise the benefits of trees beyond the commercial market for timber products.

Indeed, market failure can create the situation where the failure of individual organisations to bear the full cost of their production has meant this cost has been passed on to the community (Andrew, 2008).The expression of market failure in the climate change context has been articulated as twofold: a failure in the market to acknowledge the external cost of not taking action; and the failure to recognise that potential advances in technology will bring external benefits to the world (Garnaut, 2010; Stern, 2005). The temptation to "free ride" on the efforts of others has also delayed action.

While market failure is a suitable lens through which to consider the availability and use of carbon agroforestry, from an innovative technological perspective, it is important to note the domains identified by (Grubb, 2015) (outlined in Chapter 1) are a reminder that a number of forces and influences are at play to hinder development and market readiness. In the context of this thesis, these other factors are acknowledged but not considered in depth.

There are many causes of market failure and they relate to the absence of the qualities that make markets work. Market based policy solutions to climate change abatement need to take account of externalities, the free rider problem, the impact of economies of scale and the existence of public goods (Andrew, 2008). When considered in the context of carbon sequestration, these factors have not been accommodated in consistent policy and market failure has occurred. Without due recognition for market failure in all its forms, poor policy can emerge leading to “government failure” (Andrew, 2008; Stephens, 2014a).

In relation specifically to carbon agroforestry, market failure is also assumed to be apparent through the lack of sufficient reward for dedicating resources to the purpose of carbon sequestration and provision of additional natural co-benefits and ecosystem services (discussed in Chapter 8). The investment framework has not provided incentives to bind these currently unrewarded attributes to carbon plantings. While this market failure can be addressed through policies, poor policy design can also create a significant risk of environmental damage (Polglase P et al., 2011). It is therefore reasonable to suggest that a lower than expected investment in carbon sequestration might have been the result of less than perfect policy design.

More recent estimates of carbon sequestration potential refer to the likelihood of carbon sequestration becoming more important after 2030 and up to 2050, contributing significantly to the abatement of emissions (Bryan, 2013; Lindenmayer, 2012; Stephens, 2014b). The projections assume a carbon price is in place and that sequestration is enhanced with incentives for biodiversity and disincentives for carbon plantings not exhibiting a range of ecosystem services. Some studies produced for the Australian National Outlook in 2015 predicted that carbon sequestration can increase significantly if the effective price on carbon increases and could influence land use and agricultural production. Potentially this activity can create a range of social and community concerns arising out of this change in land use, including competition for land between carbon (and envirommental plantings) and food production (CSIRO, 2015). This dilemma is dicussed in Chapter 8).

The amount of land dedicated to carbon agroforestry in Australia to date has been around 56,000 ha (Bryan BA, 2015). This figure represents the investment in plantations intended for the purpose of creating carbon credits and not the changes in forest cover and other land use measures. A high proportion of this national level of activity was undertaken in WA, where extensive plantings of Mallee eucalypts were designed to optimise the opportunities for maximising carbon sequestration.

In addition to these carbon plantings, environmental plantings had been created, often with public assistance such as discounted seedlings to encourage agroforestry and help remediate increased salinity. However, many land owners with the environmental plantings had been also motivated by the prospect of carbon revenues and biomass payments (Bryan, 2016). It is assumed that these environmental plantings have now been included in the National Greenhouse Gas Inventory (NGGI).

The extent of new plantings in the WA Wheatbelt declined as the assistance for seedlings was terminated and the future long-term prospects for a carbon market became uncertain. Potential land use issues also became apparent in the emerging CFI methodologies as reflected in the rainfall zones applicable to certain forestry and limits to the areas to be planted.

Finally, when the Commonwealth removed the CPM from the statutes and introduced the ERF, the price signals changed considerably. The reverse auction system delivered a lower price and the main response in terms of forestry in the ERF was in terms of Avoided Deforestation. In addition, the emphasis under the ERF moved from requiring compliance from larger emitters to a scheme where the Commonwealth Government purchased ACCUs. This will be discussed further in Chapter 5.

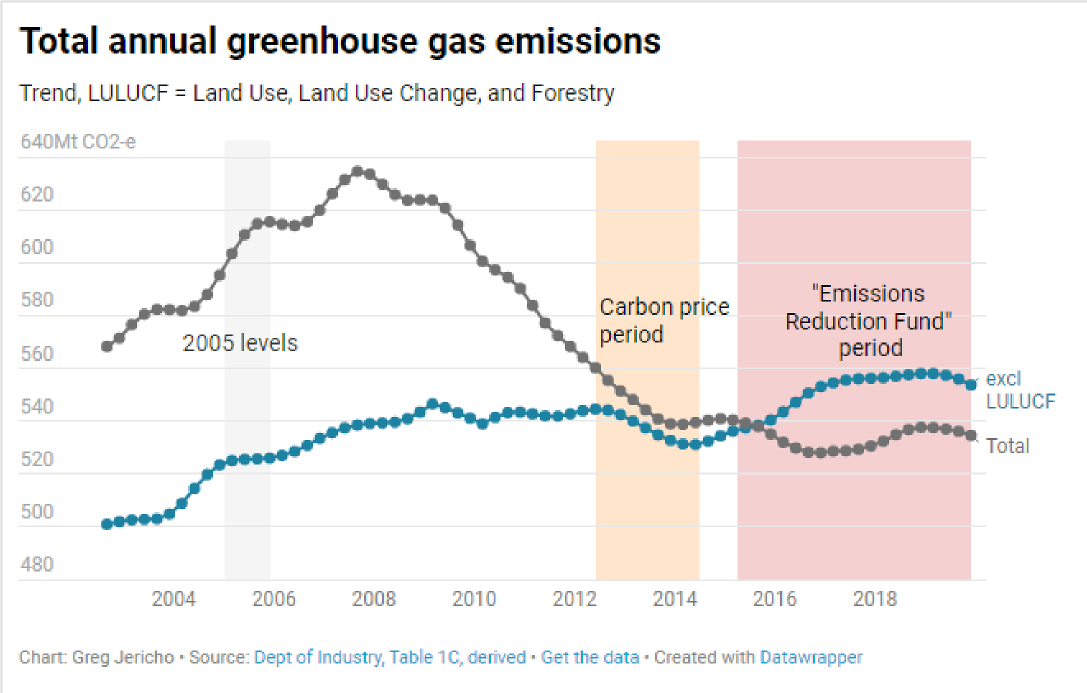

Figure 4.1 Total annual greenhouse gas emissions
The Quarterly Update of Australia's Greenhouse Gas Inventory: December 2019. Department of Industry, Science, Energy and Resources. nggi-quarterly-update-dec-2019-data-sources-2

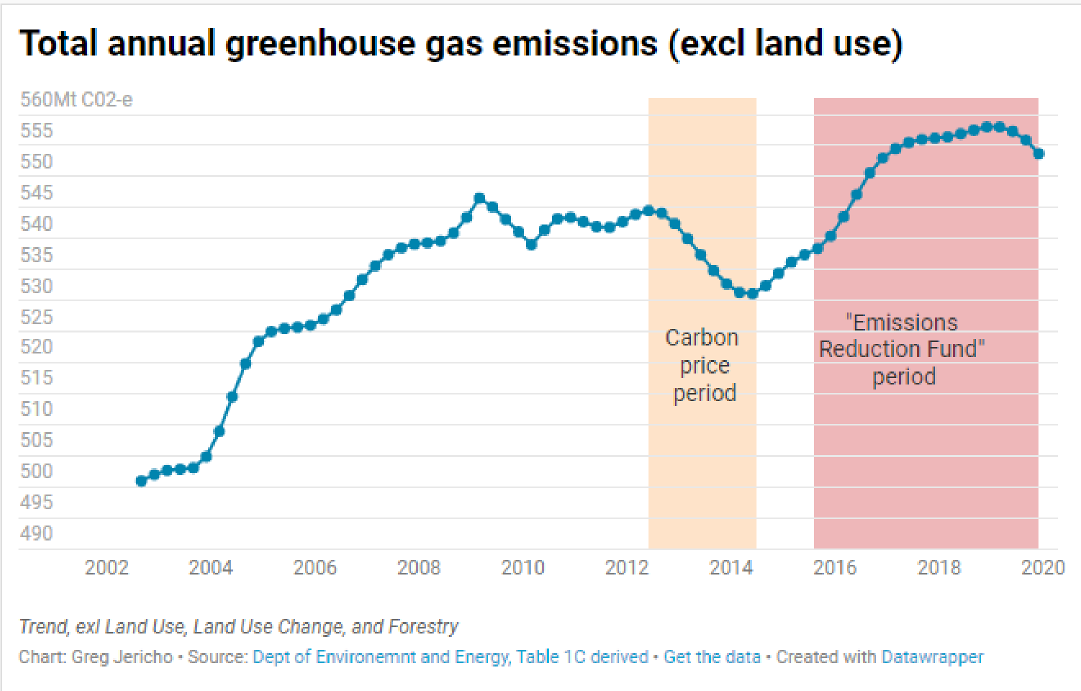

Figure 4.2 Total annual greenhouse gas emissions (excluding land use)
The Quarterly Update of Australia's Greenhouse Gas Inventory: December 2019. Department of Industry, Science, Energy and Resources. nggi-quarterly-update-dec-2019-data-sources-2

Figure 4.1 and Figure 4.2 demonstrate the overall contribution of LULUCF to the current level of the NGGI. The principal sources of reduced emissions from LULUCF activities is avoided deforestation through reduction in land clearing throughout the period, added carbon sequestration during the carbon price period and added avoided deforestation in the ERF period. During the ERF period there has been a small quantity of carbon sequestration, a considerable amount of activity using the Avoided Deforestation methodology and very little carbon agroforestry.

4.5 Conclusion

This chapter highlights the importance of the international climate change framework and the national response on the potential contribution of carbon agroforestry to meeting national targets. The rationale for action on climate change at the international and national levels rests in market failure, requiring action by governments to intervene. The international agenda provided the scope for carbon agroforestry to occupy a significant position in national policies. The inability of Australian government policies around carbon agroforestry to respond to the leadership of the international framework can be seen as policy failure and this is explored in the next chapter

This chapter also continues discussion on the initial high expectations of carbon sequestration through new forestry activity providing a form of decarbonisation with that achieved. It argues that the difference between the expectation and the outcome was the result of political change, public attitude, and policy uncertainty and failure. To these categories of influence on taking action is added the inconsistent recognition or attempted compliance with international climate change policy and its contribution to understanding why agroforestry did not transition to the socio technical or meso level, let alone to the landscape level of adoption.

There were few incentives directly related to encouragement of carbon forestry in climate change policies and even fewer than recognised the need to support the financing of time value of forestry development. The conservation and environmental benefits and ecosystem delivery continued to be undervalued or ignored. This resulted in far less carbon agroforestry being undertaken than anticipated. In addition, issues related to additionality (i.e. the changes in compliance dates), environmental integrity and land use competition created confusion.

Chapter Five

5

Policy Design Issues

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5.1 Introduction

Following the negotiation of particular conditions around forestry with the UNFCCC, carbon agroforestry has been seen as having the potential to make a significant contribution to climate change mitigation in Australia. However, in the decades following the initial UNFCCC meetings this enthusiasm has been dampened and the level of carbon sequestration has been less than forecast in Australia (Lindenmayer et al., 2012); (Australian Greens, 2017).

5.2 Impact of early market driven forestry policy

A key forestry timber policy introduced in 1997 by the Australian Government was the Managed Investment Scheme (MIS) which aimed to generate increased forestry activity and by 2002 was receiving positive recognition as an effective mechanism. The MIS provided tax relief to investors in forestry to reduce the impact of the time it takes for the trees to grow and provide a financial return. The MIS scheme was a powerful market-based mechanism, part of the Vision 2020 program, designed to build commercial forestry activity in Australia (URS, 2007).

However, by 2007 there was a growing concern about such market-driven forestry programs. The MIS projects enabled long rotation forestry to expand dramatically, but it concerns arose of inappropriate land use and a review acknowledged these community and social concerns (URS, 2007); (Australian Parliament, 2002). In particular the planting of commercial timber plantations across otherwise prime agricultural land created fears of reduced agricultural output, reduced population in country towns and a subsequent reduction in community services, all land use related concerns. The MIS program can be considered an attempt to address market failure in relation to encouraging more commercial forestry but its eventual collapse due largely to an oversupply of timber is a reminder that such interventions can have unexpected consequences (Parliament of Australia, 2007a).

The 2013 final five yearly report of Vision 2020 identified a small net fall in the total forest estate but provided a good status report against international forestry quality criteria (ABARES, 2013). Researchers, however, reported on the distinct problems caused by incentivisation and a design that allowed overproduction of the forest estate and allegations of financial mismanagement and opportunism (Cornish, 2013); (Dowler, 2017). Indeed the failure of the MIS scheme was portrayed in the press as a reason that any future market based forestry scheme might be difficult to sell to farmers, land managers and investors (Dowler, 2017).

Nevertheless, despite these difficulties, interest remained in the use of market mechanisms particularly in relation to the application of a market-based approach to carbon agroforestry (Garnaut, 2008a). Indeed, there was a strong expectation that climate change policy would include a market mechanism to encourage carbon sequestration.

5.3 Australian Federal climate change policy: The Carbon Pollution Reduction Scheme (CPRS), Carbon Pricing Mechanism (CPM) and forestry

Over a period of just five years, three different national policy levers were designed in Australia that directly or indirectly imposed a price on carbon in order to reduce or offset emissions of carbon dioxide and other greenhouse gases (GHGs).[19] The Carbon Pollution Reduction Scheme (CPRS) and the Carbon Pricing Mechanism (CPM) placed a mandatory, direct price on carbon for the largest GHG emitters, while the Carbon Farming Initiative (CFI), was a voluntary scheme that incentivised organisations and individuals to undertake emission reduction or avoidance programs. Under the ERF a reverse auction was used to identify the lowest cost projects and the Australian Government purchased the Australian Carbon Credit Units (ACCUs) created (Australian Government, 2019), indirectly placing a price on carbon in the process (see Table 5.1).

This period had its origins in 2007 when the Rudd Labor Opposition advanced a comprehensive approach to climate change including an ETS and, after winning the election, started to design what became the CPRS. The role of carbon sequestration through forestry was prominent in this scheme. The CPRS design included the requirement that around 700 firms meet obligations to manage their greenhouse gas emissions while afforestation was a key way firms could locally offset their emissions (Dargusch, Harrison, & Herbohn, 2010). This ability to offset a firm's emissions could also be achieved through access to the CDM and JI credits but limited to a minor share of total emissions. On balance, the CPRS potentially provided a large boost to forestry, projected to potentially increase over time to incorporate over 20 million hectares of agricultural land (Lawson, 2008).

[19] GHGs are measured in terms of their Global Warming Potential (GWP) relative to carbon dioxide (referred to as carbon dioxide equivalent or CO_2-e).

Table 5.1 Three policy approaches to carbon emissions reductions in Australia

Policy	Description
Carbon Pollution Reduction Scheme (CPRS)	Australia's proposed cap-and-trade emissions trading scheme. It was to have been the main element in Australia's efforts to reduce its greenhouse gas (GHG) emissions. The cap is the limit on GHGs imposed by the CPRS. The system aims at achieving the environmental outcome of reducing GHG emissions, the idea being that capping emissions creates a price for carbon and the ability to trade ensures that emissions are reduced at the lowest possible price (Department of Climate Change, 2008). Setting a limit means that the right to emit GHGs becomes scarce, and scarcity entails a price. The CPRS would have put a price on carbon in a systematic way throughout the economy (Department of Climate Change, 2008).
Carbon Pricing Mechanism (CPM)	The CPM was an emissions trading scheme that put a price on Australia's carbon pollution. It was introduced via the Clean energy Act 2011 and related legislation and applied to Australia's biggest carbon emitters (called liable entities). Under the mechanism, liable entities had to pay a price for the carbon emissions they produced in the 2012-13 and 2013-14 financial years. This covered approximately 60 per cent of Australia's carbon emissions including from electricity generation, stationary energy, landfills, wastewater, industrial processes and fugitive emissions. The CPM covered a range of large business and industrial facilities. It did not directly cover the vast majority of Australian businesses, including smaller businesses, or households (Australian Government, 2011).
Emission Reduction Fund (ERF)	In 2014 the Government allocated $2.55 billion to provide for purchasing in the ERF. Activities supported through the Emissions Reduction Fund provide important environmental, economic, social and cultural benefits for farmers, businesses, landholders, Indigenous Australians and others. (Australian Government, 2013) . A "reverse auction" is held to determine the price of ACCUs awarded to particular projects.

5.4 Early State and Commonwealth policy development

Policy uncertainty can be created both by unexpected changes in policy by governments and by political friction and disagreement. It is also created by vertical policy asymmetry whereby policy introduced by one level of government differs in focus and ambition from the policy at another. When, in 2008, the Commonwealth announced a comprehensive approach to climate change, the States agreed to hand over key responsibility for industry wide emissions reduction and national climate change policy to the Commonwealth. Prior to this time there had been quite varied approaches taken by the States. Western Australia (WA), for instance, had taken (among other policies) a quite specific action in relation to land based carbon sequestration with the Carbon Rights Act 2003 which enabled effective securitisation of land-based carbon sequestration methodologies. The approaches taken by other States are mentioned later in this chapter. The patchwork of differing environmental regulation, property rights legislation and reporting and disclosure requirements across the nation provided a prima facie case for a national approach.

As discussed in earlier chapters, the early Commonwealth approaches to climate change policy were a result of national engagement in the UNFCCC processes before the Kyoto conference and meeting of the Parties but, after that, in binding and non-binding international agreements. For instance, in 1998 the Howard Coalition Government introduced several measures encouraging voluntary greenhouse reduction efforts and mandatory efficiency programs. The Australian Greenhouse Office (AGO) was created with substantial funding as part of a negotiation with the Australian Greens to enable legislation on diesel fuel taxation rebate measure to pass through the Senate (Mitchell, 2012). As reported earlier, the AGO was the first national agency dedicated to climate change of its type in the world.

In 1999 the AGO published four discussion papers on emissions trading with the involvement of all state governments via a Council of Australian Governments (COAG) subcommittee process(AGO, 1999; Hepburn, 2008).[20] These discussion papers were followed some years later by an important contribution from all state governments on the development of a national approach to emissions trading.

The Commonwealth instigated many regulatory and voluntary participation schemes to engage with industry and provide guidance to the community about the potential policy options for future management of emissions. Included in the range of measures was the National Greenhouse Energy Reporting Scheme (NGRS) that required large companies to provide an annual report of their emissions (AGO, 1999; 2015). This measure also provided the context for the Greenhouse Challenge program, which encouraged participation in energy and carbon emissions reduction and the Greenhouse Friendly labelling and marketing program. The NGRS also established an important benchmarking process for a future national Emissions Trading Scheme (ETS).

However, the introduction of specific mandatory carbon mitigation policies in Australia has its origins in legislation introduced by several states. Most states had legislated for mitigation programs in some form or other to limit production or to offset emissions of carbon dioxide and other global warming gases. For instance, the Western

[20] The author/investigator was a member of the COAG subcommittee of officials which developed the Four Discussion Papers on National Emissions Trading, representing the Western Australian Government.

Australian (WA) Government Carbon Rights Act 2003 included the covenanting required to secure carbon sequestration on private land (Bryan BA, 2015; Mitchell, 2012). This was accompanied by the regulation of emissions from large resource projects by the Environmental Protection Authority (EPA) and the ability to use carbon offsets in addition to managing emissions. The New South Wales (NSW) Government introduced the Greenhouse Gas Abatement Scheme (GGAS) in 2003. It was the first mandatory greenhouse gas emissions trading scheme in the world. GGAS closed in 2012(in expectation of a national emissions trading scheme) with a high participation rate and 144 million abatement certificates created. (IPART, 2013) The other states pursued regulatory programs with the objective of limiting the growth of emissions.

Assessments of potential carbon forestry in Australia includes all afforestation and reforestation because changes in these activities impact on Australia's emissions profile (URS Forestry, 2009). However, when the estimate refers only to the plantings intended for carbon (rather than forestry activity as a whole), the area is considerably less. Regulatory uncertainty and complexity is identified as an important reason for the relatively smaller proportion of dedicated carbon agroforestry, ie carbon forestry on agricultural land (Lindenmayer, 2012; Stephens, 2014b). The legislative and regulatory program that introduced, changed and removed these different approaches to carbon forestry is discussed below.

Real progress towards actually establishing a market-based mitigation program, based on compliance was made in June 2007. The Howard Coalition Government announced its intention to introduce an ETS at some unspecified time after the election to be held later that year. However, the election of the Rudd Labor Government brought with it a commitment to implement an ETS immediately.

This final step in the adoption of an ETS generated two years of preparation and research with a green paper and white paper process. This policy work was built on the understanding of the role of carbon forestry and its links to climate change mitigation, established by reports such as the Garnaut Climate Change Review (Garnaut, 2008a) .

Notwithstanding the considerable experience in carbon emissions management and policy development at the state government level, there was also a readiness by the States to pass the task to the Commonwealth to ensure a national approach. The first attempt at a broadly based national ETS, the CPRS, failed to pass through the Senate. After another federal election and significant negotiations with the Australian Greens, the Carbon

Pricing Mechanism (CPM) was legislated in 2011 and entered into force in 2012. This legislation was accompanied by the creation of the Carbon Farming Initiative (CFI) methodologies through the Carbon Credits (Carbon Farming Initiative) Act 2011. This legislation restricted the creation of carbon credits to the land sector and supported the assumption that carbon forestry could be a significant source of credits.

This approach to land sector carbon credits was based on the rationale that offsets could only be generated in the one industry sector that was not subject to reporting or emissions limits, namely agriculture. This rationale had been clearly articulated in the CPRS which had a quite specific structure for covered and non-covered sectors. In the context of the domestic situation in Australia, the agricultural sector did not have any reporting obligations or mandatory targets to meet and therefore was seen as a source of credits to offset emissions in industry, transport and other covered sectors. Later the CFI was extended to include methodologies related to other industry sectors

A short period of time elapsed between the introduction of the CPM before a change in government to the Liberal National Coalition in 2013. The new Government removed the enabling legislation for the CPM and introduced the Emission Reduction Fund (ERF) in 2014. The ERF provided for a reverse auction process to guide the purchase of lowest cost CFI accredited Australian Carbon Credit Units (ACCU) by Government. The CFI was retained, and the generation of carbon credits was extended to include a range of other activities including energy efficiency. In addition, generation of ACCUs was not limited to the separate treatment of industry and agriculture as neither sector had mandated targets.

Prior to the introduction of the ERF, the CFI had been only partially successful in generating the level of credits anticipated. A review by the Climate Change Authority (CCA, 2014) noted that participation in the scheme (the CFI) had been disappointing but that the emission reductions had been achieved with environmental integrity. Nevertheless policy uncertainty had created a barrier due to the low price and little expectation of long-term engagement (Stewart, 2013). The Climate Change Authority report claimed that uncertainty had been a continuing problem with many policy amendments taking place and an unclear role and budget for the ERF after 2020.

It is important to reflect on the significance of the Commonwealth having a dominant role in setting emissions targets and policy. Later in Section 3, the case will be made for a more coordinated approach involving the state and territory governments. Recent experience with the National Cabinet, incorporating the state and territory premiers and chief ministers) established to manage the Covid 19 pandemic in Australia in 2020, may provide a model alongside a COAG Climate Change Committee.

The State Governments maintained a range of programs and related to climate change mitigation but, in the main, without strict emission compliance regimes that were once in place. For instance only two States have renewable energy polices (Climate-Action-Tracker, 2020). All States have ambition targets related to zero emissions by 2050 but depend on Commonwealth Government policies. For instance, the Western Australian Climate Change policy states;

> National leadership and economy-wide policy is critical to delivering our international commitments under the Paris Agreement. The McGowan Government is not waiting for national action, however, and is taking steps tolay the foundations of the low-carbon transition, build the industries of the future and adjust to unavoidable climate change.

But goes on to state:

> The Australian Government's safeguard mechanism applies to all facilities with direct emissions over 100,000 tonnes per annum carbon dioxide equivalent. A robust framework for Australia's largest emitters is critical to an effective and equitable transition to net zero emissions. It is also crucial to Western Australia realising its net zero aspiration, as around half our State's emissions are attributable to safeguard facilities. The State Government has sought assurances from the Australian Government that the national policy framework will deliver on our international commitments to 2030 and beyond and will continue to support strong national action (WAGovernment, 2020).

5.4.1 Establishing the additionality of projects

When carbon agroforestry projects are proposed, they need to be considered for their eligibility to receive carbon scheme incentives, and conversion into tradable carbon credit units. They first need to be assessed to ensure that the emission reductions are additional, that is, they are not activities that would have happened in the normal course of business. This concept of additionality was developed during the evolution of international emissions trading policies connected to the Kyoto Protocol and used most prominently in relation to the Clean Development Mechanism (CDM) (Cornell, 2010).

The test for projects being additional usually includes consideration of environmental and financial additionality. Environmental additionality ensures that the net effect of the project will improve the emission reductions above a baseline created by normal activities on that land (Valatin, 2012). Financial additionality ensures that the intervention is required to make the activity take place when it would otherwise not be financially viable (CCA, 2014a; Ruseva et al., 2017).

The Carbon Farming Initiative (CFI) simplified the additionality question by initially creating a 'positive' list of activities[21] that would most likely be eligible and a 'negative' list that provided examples of ineligible activities (CCA, 2012). Revegetation and forestry activities were on the positive list until this approach (the positive and negative lists) was abandoned with the introduction of the ERF (Department of Energy and Environment, 2018; Australian Government, 2018).

When treated in the CFI, additionality also includes consideration of the date at which the incentive or carbon legislation was initiated. Activities undertaken before that date are not eligible for the carbon sequestered. In the case of permanent plantings, whether newly established or induced regeneration, the date incorporated into the original CFI regulations for the initiation of carbon projects was 1 July 2007, which was directly linked to the announcement by the Howard Government of their intention to introduce an emissions trading scheme (Carbon Credits [Carbon Farming Initiative] Regulations, 2011 S. 3.28d). In other words, the reference and compliance date were set at the announcement of a potential carbon trading scheme. Another five years were to pass before a real scheme was in place (the CPM), and already some early investors, tree growers and companies were disadvantaged as they had planted prior to this early compliance date and any new date set with new legislation.

Indeed the decision to set this original date (1 July 2007) seemed to ignore the existence of state government legislation on establishing carbon rights and property (Parry, 2010). For instance, the Carbon Rights Act 2003 in WA established the circumstances for abatement policies and compliance regimes, such as the GHG abatement conditions set by the Environmental Protection Authority as part of a permit to explore and produce liquified natural gas (LNG).

The approach to setting a pre-compliance date affirmed that early action taken in advance of this 2007 date was not a result of the new regulatory intervention nor incentives

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[21] The 19 activities on the (then) positive list fall under the following categories—vegetation and wetland restoration projects, legacy landfill gas projects, early dry season burning of savannah, livestock management and other activities. The positive list was intended to be reviewed to keep pace with technological developments and latest scientific research (DCCEE 2012a).

inherent in the legislation, and thus, not additional. Additionality is also incorporated into the CFI-approved methodologies, which unfortunately ensure that early action is not rewarded. As amendments were made to the carbon schemes and CFI methodologies, the applicable starting dates were aligned with the revisions to the new legislation, bringing the dates applying to carbon agroforestry forward to 2010 and then 2011. It is reasonable to assume that this latter condition was introduced primarily to prevent the inclusion of MIS plantings which were clearly planted for reasons other than carbon. In addition, MIS project participants were likely to have benefitted from generous tax concessions.

5.5 'Additionality' replaced by 'Newness'

Following the revision of the CFI and introduction of the ERF auction process, the issue of additionality was replaced by the notion of 'newness', where the project had to start after being awarded a successful project price for the carbon estimated to be sequestered through the auction process (Australian Government, 2019; Department of the Environment and Energy, 2019). One exception to this is the CFI methodology for Avoided Deforestation where the carbon stored in existing forests is recognised and purchased alongside the removal of a permit to clear (CER, 2015).

By definition, taking early action before regulatory and legislative instruments are in place, creates a hurdle for compliance with additionality. The date of the instrument entering into force becomes the date for starting carbon accounting. Growth of the carbon stocks contained in purposeful carbon agroforestry or other organic sequestration after that date can be used to acquire carbon units (CER, 2016).

This discussion highlights that additionality has been an important principle which influences the legislation that governs the creation of carbon credits. As explained, the question of financial additionality is no longer reflected in the CFI legislation and has been replaced by a test of newness, (CCA, 2017a, 2017b). The newness test now requires that only new emission reduction activities will be credited (CCA, 2012). In late 2014, as a special concession, the Australian Government allowed for existing carbon projects to be considered eligible if they were registered by July 2015 (Alarcon et al., 2015; Ruming, 2014). The timing of this announcement did not allow much time for carbon project owners to learn about this and respond. Although the Oil Mallee Association contacted member farmers with known carbon plantings (see communication attached at Appendix A)[22], few of them registered within the tight timeframe.

It follows that early action projects that sequester carbon under earlier rules can be greatly disadvantaged. More importantly, as discussed earlier, the change of rules most likely created a disincentive for future carbon agroforestry.

A comment in the review of the CFI by the Climate Change Authority (CCA) suggested that there should be more flexibility in relation to those who had taken early action, proposing that early action projects would need to demonstrate the negative implications of ceasing or reversing the emission reduction activities (CCA, 2014b). However, this opportunity to prove that a damaging environmental outcome may result if support is not provided does not exist in the ERF legislation or associated regulations.

In the context of this history of events, many of the existing carbon agroforestry plantings can be considered as stranded assets with no prospect of participating in the ERF auction process as carbon plantings. The treatment of early action in the WA Wheatbelt has been one reason that more planting did not take place in that region.

A change from specific additionality tests, the simplified ‘positive and negative lists’ and the newness test towards a more generic practice, has been advocated by a number of organisations and carbon market specialists (van Oosterzee, 2012). In some cases, the proponents of change suggested a broader and simpler test regime would enable greater forestry activity. In addition, co-benefits related to biodiversity and ecosystem service delivery in general could be registered separately to the project and avoid potential conflict with an additionality test (van Oosterzee, 2012). In other words, a revised policy might enable compliance with an additionality or newness tests for carbon and allow growers to benefit from incentives to produce ecosystem services in the form of co-benefits including improved biodiversity and even productivity.

From as early as 2011, forestry groups have proposed a more flexible approach to the question of additionality in order to reduce sovereign risk and promote more carbon agroforestry activity. For example, in line with the original eligibility date established by the Kyoto Protocol, Australian Forest Growers proposed that the date for eligible forest should be 1990, the date established by the reporting requirements of the Kyoto protocol

[22] Appendix A is a letter from the OMA to growers advising them to register their projects. It contains the background to the issue and a pathway to registration.

(Ragg, 2011). This proposal was not accepted by the CCA and nor were other proposals designed to bring back the positive list (CCA, 2017b).

Table 5.2 provides a comparison of the CPRS, the CPM and ERF mechanisms against a range of issues associated with carbon sequestration. The evolution of the current scheme (the ERF) is based on experience, efficiency and a political dimension related to the imposition of a carbon tax on production.

Table 5.3 provides a guide to explanations of some common regulatory measures associated with recognition of carbon sequestration and avoidance of emissions.

Table 5.2 Changes in policy and regulation of carbon credits 2009 – 2013

Issues for Carbon Sequestration (CS)	CPRS 2009 (Policy not implemented)	CPM 2011/2012	ERF 2013 - present
CS included as part of policy	No	Yes	Yes
Additionality i.e.: Environmental Financial Not BAU	Intended	Applied – Common practice test *	Applied – method approval required to incorporate
Risk of reversal buffer*	Not intended	Yes	Applied
Earliest project commencement	Intended to apply 2007	July 2007 – possibly earlier if carbon contract Amended to 2010	Initially 2010 now must be new project i.e. the “newness” test
Permanence	Intended 100 years but not decided	100 + years	25 or 100 years
Avoided Deforestation (AD)	N/A	N/A	AD methodology available
Minimum size and configuration	Minimum Contiguous planting size of 0.2 ha	Total planting size in any configuration	Total planting size in any configuration
Leakage	Intended	Included	Included
Transparency	Limited		
Project approval	Auditor Government	Auditor Government	Auditor Government
Crediting periods	Intended 100 years	25 years	25 years
Averaging	Uncertain	Yes – via Farm Forestry method	Yes – via Farm Forestry method

Issues for Carbon Sequestration (CS)	CPRS 2009 (Policy not implemented)	CPM 2011/2012	ERF 2013 - present
Methodology approval	Not a methodology approach	CFI Public comment DOIC*	CFI Public comment ERAC*
Buyers	Intended industry	Industry (CPM) Voluntary market	Commonwealth (ERF) Voluntary markets
International trade	5% available to industry purchasers	No	No
Soil carbon included	No	No	Yes

*Explained in Table 5.3

Table 5.3 Some regulatory and legislated measures explained

Regulatory Measure	Explanation
Risk of reversal buffer	The risk of reversal buffer applies to all sequestration projects and reduces the carbon abatement issued during a reporting period by 5 per cent. This means that for every 100 tonnes of carbon stored by a sequestration project only 95 Australian carbon credit units will be issued, instead of 100 if the project is a 100-year permanence period project. A further 20 per cent deduction of Australian carbon credit units will be made for 25-year permanence period projects (Clean Energy Regulator, 2018c).
Permanence	Carbon stored in vegetation and soils can be released back into the atmosphere by man-made or natural events, thereby reversing the environmental benefit of the sequestration project. Sequestration is regarded as permanent if it is maintained on a net basis for 100 years. A permanence obligation maintains carbon stores for which Australian carbon credit units (ACCUs) have been issued. The Emissions Reduction Fund requires sequestration projects to choose a permanence period of either 25 (at a discounted rate of carbon accumulation compared to 100 year permanence period) or 100 years (Claen Energy Regulator, 2018).
Common Practice Test	The positive list was adopted as part of the CFI scheme to remove the need for project-level additionality tests, which can be complex and limit scheme opportunities (Carbon Credits (Carbon Farming Initiative) Bill 2011, Explanatory Memorandum). It identifies a broad set of abatement activities that are not 'common practice' in an industry or region and are therefore deemed additional. Activities that are already common practice or in widespread use are considered 'not additional'(Climate Change Authority, 2018).
Avoided Deforestation	The methodology for avoided deforestation applies to a native forest, which has received government consent to be cleared and converted to cropland or grassland. Abatement is achieved by not clearing the native forest and thereby avoiding the emissions that clearing would have produced (Department of Environment and Energy, 2018b).
Leakage	Carbon leakage is defined as the increase in emissions outside a region as a direct result of the policy to cap emission in this region (IEA, 2008). This concept can be applied to a project where activity within a project area is moved outside that boundary without changing the overall level of emissions.
Crediting periods	The standard contract period for payment for ACCUs (under the ERF)(Clayton Utz, 2014)

Regulatory Measure	Explanation
Averaging	FullCAM (a national data base) is used to calculate the predicted project average carbon stocks (PPACS) over each stratum and the project as a whole for the reporting period (Clean Energy Regulator, 2018b).
Farm Forestry methodology	A (CFI) Farm Forestry project involves establishing and maintaining trees in any part of Australia on land that has previously been used for grazing or cropping. Trees can be grown as either permanent plantings or in harvest plantations.(Clean Energy Regulator, 2018b)
DOIC	The role of Domestic Offsets Integrity Committee (DOIC) was to support the environmental integrity of carbon offsets generated under the Carbon Farming Initiative (CFI) (Department of Environment and Energy, 2018a).
ERAC	Emissions Reduction Assurance Committee (ERAC); an in dependent, expert committee which assesses whether methodology determinations (methods) meet the requirements of the Emissions Reduction Fund (DOE, 2018).

5.6 Land use planning targeting agroforestry on farmland

A key reason for differences in opinion about the potential importance of carbon agroforestry in carbon mitigation is related to the notion of land use (Garnaut, 2011); (CCA, 2014b). Mitchell (2012) also highlights the issues raised in the Australian Senate during a debate in 2008 on the awarding of tax concessions for permanent carbon forestry. The issues included threats to water and food availability and the ‘locking up’ of land in a carbon sink, arguments that were unsupported by empirical evidence (Mitchell, 2012; Jackson, 2005). Nevertheless, concerns about land use have been heightened by international experience and been embedded in international sustainability assessment frameworks and expressed in local government and land planning regulation. In Chapter 8 the importance of sustainability assessment frameworks is discussed in detail as well as the WA State and Local Government response to carbon farming.

As discussed in relation to the example of a carbon forestry proposal at Jerramungup (in Chapter 8) and elsewhere in WA, there was a high level of concern on this matter of locking up agricultural land. The international context has also provided evidence of an increasing proportion of arable land being used for fuel crops during that same time period (Jackson, 2017).

Other studies have commented on the impact of carbon agroforestry on farmland (Fredriksson & Neumayer, 2013; Jackson et al., 2005; Miyake et al., 2012). Jackson et al. (2005) found that in some cases examined internationally, the use of carbon agroforestry caused depletion of water sources in particular and caused damage to agricultural land through increasing acidity and loss of nutrients. However, in relation to the south west of Australia, including the WA Wheatbelt, the study highlighted the positive impact of the trees on reducing groundwater recharge and improving water quality (Bartle JR, 2010; Lefroy E, 1999; Olsen G, 2004). According to Jackson (2005) these and other impacts, such as reducing pesticide and nutrient run off and limiting erosion, may also occur if the croplands of the USA were planted to forestry (Jackson et al., 2005).

A full range of positive impacts, classified in line with the Millennium Ecosystem Assessment, are discussed in more detail in chapter 9 in this thesis (Bryant & Garnham, 2013; Cong, Smith, Olsson, & Brady, 2014).

In addition and closely related to regionally specific impacts, a WA study demonstrates a link between extensive land clearing and a consequential reduction in rainfall (Andrich & Imberger, 2013). This study focused on the Wheatbelt which has been extensively cleared over a 50-year period. Importantly it also referenced research that indicated that there might be an increase in rainfall associated with the introduction of trees, if the planting was strategic, comprehensive and well planned (Makarieva, 2006; Sheil, 2009).

It is therefore likely that while carbon agroforestry may change some land from food production to carbon sequestration and even bioenergy, there are likely to be important benefits to farming land which may also benefit agriculture and the health of ecosystems. Co-benefits from carbon agroforestry are also discussed in a following chapter (Chapter 8) in the context of sustainability frameworks.

5.7 The significance of environmental co-benefits

Various impacts can occur from carbon projects, both positive and negative. Since its inception, the CFI has acknowledged the potential for negative impacts to emerge. Initially, the acknowledgment and management of the potentially negative impacts were in the form of the CFI 'negative' list. More recently there are prescriptions prohibiting certain actions that are incorporated into particular CFI methodologies themselves. This has resulted in land use related restrictions such as limiting the total project area on an individual property title and restrictions about which rainfall zones could be used for particular species. Project proponents have also been required to consult with regional natural resource management (NRM) bodies to ensure they are in compliance with regional NRM plans (CER, 2016).

The CFI does not, however, concern itself with the positive impacts or 'co-benefits' associated with carbon projects. A co-benefit is an intentional or known positive outcome of a project while an ancillary benefit is an unexpected positive side effect arising out of action (Salisbury et al., 2014b). A broad definition of co-benefits can be categorised into environmental, economic and social benefits (see Table 5.4). However, apart from some broad environmental criteria, co-benefits are not officially acknowledged or incentivised in the CFI. Project proponents can identify the potential co-benefits of the project and possibly register these alongside the project, but it has no impact on the price that is secured by the ERF (Salisbury et al., 2014b). The ERF simply seeks to achieve lowest cost abatement through an auction process. This question of how to engage and value co-benefits and ecosystem services is dealt with in chapter 9 and chapter 10 viz (10.4 and 10.6).

Table 5.4 Categorization of co-benefits as defined by Salisbury
Adapted from (Salisbury et al., 2014b)

Category	Co-benefits
Environmental	Biodiversity, habitat protection & improved environmental management
Economic	Employment, improved infrastructure, technology transfer & economic activity
Social	Capacity building, access to services & enhanced utility

Environmental co-benefits are ecosystem services, examples of which are identified in Table 5.5 below. They are mostly intentional but sometimes can be ancillary.

Table 5.5 Categorization of co-benefits as defined in MEA
Adapted from (Salisbury et al., 2014b)

Ecosystem service	Description
Supporting service	Maintain conditions for life including oxygen production, soil formation, nutrient cycling, primary production, pollination and seed dispersal
Regulating services	Regulates ecosystem processes including air and water quality, flood and erosion control, waste treatment, biological control of agriculture and disease
Provisioning services	Provide products from ecosystems including food, water, wood, fibre, biochemicals and medicines
Cultural services	Non-material benefits including spiritual and religious values, knowledge systems and educational values (including aesthetics)

This broad definition of co-benefits includes services to humanity as well as ecosystem protection for the sake of biodiversity conservation alone. This inclusive definition of human interaction natural systems makes it difficult to distinguish between intentional creation of benefits and ancillary benefits (Faith, 2012). The terms 'ecosystem services' and 'co-benefits' are often used interchangeably, but in this discussion, co-benefits will be considered more concrete and therefore potentially measurable. Ecosystem services will be treated as services to humanity or the community rather than benefitting a particular group of individuals associated with a specific project.

Ecosystem services have been defined by the Resources for the Future (RFF) as 'components of nature, directly enjoyed, consumed, or used to yield human well-being' (Boyd, 2006), p. 8). This definition enables the value to be acknowledged and even potentially measured in economic welfare terms but this definition does not assist in the attribution of benefit to particular projects or policies but rather valuing some assumed general benefit.

The search continues for a rational and measurable system of accounting for economic welfare from ecosystem services as advocated by RFF. Some progress has been made to develop a method of valuing and supporting regional conservation planning. Using a more robust method of valuation would help move away from a reliance on symbolic trade-offs as the only means of determining the degree of conservation required and the value of implementing plans (Faith, 2012).

An example of trade off in this context is the advocacy for recognition of a beneficial climate effect from use of agricultural land for biofuels. The ‘food versus fuel’ debate is founded on the assumption of spiraling negative impact from transferring land used for the production of food to land for fuel crops, without considering the displacement of fossil fuel by biofuel (Berndes, 2013; Cowie et al., 2017).

In relation to discussion of valuing co-benefits, a useful listing of the potential value of co-benefits has been provided in the Workshop Manual on the ERF commissioned from the Centre for International Economics by the Kondinin Group, a leading farmer group in WA. The potential co-benefits that can accompany carbon farming projects are listed as:

- Enhancing water quality in the catchment.
- Providing protection for stock.
- Improving biodiversity by providing habitat.
- Alleviating dryland salinity through water table management.
- Improving soils – increasing soil organic carbon stocks and therefore water holding capacity.
- Providing noise buffer to farm.
- Improving broad amenity and aesthetics of the local environment (CIE, 2015).

This range of co-benefits and associated reduction in the negative externalities has been recorded in other studies (Baumber, 2016; Plantinga & Wu, 2003; Standish & Hulvey, 2014).

There have also been attempts to place value on the range of private and public co-benefits achieved through purposeful action and that emerge ancillary to that action (Paul, 2011). This research is referenced in a study for the Forest and Wood Products Association undertaken by the Centre for International Economics, relevany for forestry sites across Australia (White, 2013). The tables below make an attempt to value broad categories of benefits.

Table 5.6 Potential co-benefits for generic plantation projects
Adapted from Centre for International Economics 2013

Benefit to the Farm, but not necessarily financial benefit	$/ha
Crop and livestock health	26
Fodder improvement	10
Salinity mitigation	13
Soil erosion mitigation	10

Table 5.7 Potential co benefits for generic plantation projects (A$/hectare/year)
Adapted from (Paul, 2011)
Note: URS (2003) values have been updated from 2003 to 2011 terms

Public benefits (outside the farm) but not necessarily monetised	$/ha
Biodiversity	29
Riparian restoration and water quality	40
Salinity mitigation	20
Soil erosion mitigation	4
Aesthetics and scenic improvement	30

Table 5.8 Public benefits from Farm forestry
Source: Adapted from (Paul, 2011)
Note: URS (2003) values have been updated from 2003 to 2011 terms

Type of value	Net present value (2011) $/ha	Estimated annual value $/ha
Biodiversity	28	461
Riparian restoration and water quality	38	628
Salinity	19	314
Aesthetics/scenic improvement	29	481
Total social and environmental benefit	**118**	**1947**

5.8 Opportunity cost of land

The other aspect of this valuation of co-benefits associated with agroforestry is the need to include the costs associated with the change in land use from farming to agroforestry. The opportunity cost of the land used for carbon sequestration or other forestry follows the project throughout its life. Attempts to overcome the opportunity cost of land when making a when considering carbon agroforestry can lead to choosing less productive land or land in need of repair. However this choice may result in lower returns from forestry and carbon sequestration (CIE, 2015; Sudmeyer, 2014).

The design of the farm forestry or agroforestry project also has an impact on the costs and benefits of the project. For example, larger scale blocks of planting can effectively address particular soil types and extant unproductive conditions. Alley farming, where the forestry is laid out in narrow belts of trees across cropping programs or pasture, can spread the environmental benefits more widely (Sudmeyer, 2014).

At the same time the belts of trees can reduce available water for crops and compromise crop and pasture growth. In studies on the impact of mallees on water, the affected area, on both sides of the belt of trees can be 14m in the case of unharvested trees and 8-9m in the case of harvested trees (Peck A., 2012a; Sudmeyer, 2012; Sudmeyer & Hall, 2015).

5.9 Agroforestry as part of the farming system

Utilisation of plantation forestry for biomass rather than solely carbon could encourage more investment in forestry in general and dryland agroforestry on farmland. The integration of carbon objectives and biomass could make this even more attractive. A study by the Western Australian Department of Agriculture proposed the potential advantages:

- The land continues to generate primary produce and income for the life of the project.
- Fewer carbon offsets are generated, reducing the cost of changing land use should that be desired.
- Integrated biomass systems provide some flexibility to respond to future changes in climate, technology and product demand.
- Income for carbon offsets can offset establishment costs and provide early income in longer rotation harvest systems (Polglase P et al., 2011); Paul et al. 2013).
- Potential offsets are generated for carbon stored in harvested wood products (Sudmeyer, 2014).

Integrated Mallee agroforestry is also used as an example to demonstrate the potential for multiple opportunities for carbon, bioenergy and other biomass applications from forestry on farmland (Flugge & Abadi, 2006). A CFI methodology for Farm Forestry has been in place for some years but has not been used to support an ERF project to date.

A higher price than that achieved in the ERF auctions would most likely be needed before new plantings of carbon agroforestry are undertaken. However it is claimed that an integrated agroforestry project with multiple income streams (including eucalyptus oil, biochar and biofuel) would be more feasible under a low carbon price than just carbon (White, 2013).

5.10 Significance of "avoided deforestation" on the ERF

Since the introduction of the ERF, a major source of ACCUs has been achieved through methodologies related to Avoided Deforestation (AD). AD relates to retention of forests and remnant vegetation that can be cleared and an existing permit to clear can be forfeited in return for carbon payments. This opportunity exists principally in NSW.

Of the 192 million tonnes of CO_2-e abatement over the last seven auctions up to 2018, 125 million tonnes were achieved through a vegetation based methodology and most of this under the AD methodology. It is posited that the price achieved at the ERF reverse auctions is too low to support revegetation (Stephens, 2014a).

In WA there is a default ban on clearing native vegetation (WA Government, 1986). As the CFI AD methodology only applies where it is possible to relinquish an existing permit to clear vegetation, this methodology is difficult to apply in WA. However, native vegetation that is part of a plantation that has been created for commercial exploitation is exempt from these clearing regulations (WA Government, 1986, 2004). Nevertheless, at present, the CFI methodology for AD does not enable ACCUs to be generated from mallee plantings. The reason that the CFI AD methodology cannot apply to mallee plantings is not clear but is related to the need to prove that mallee plantings would be cleared in the absence of an AD methodology. In addition, because the Commonwealth cannot make different rules for different states, it would involve investigating other tree plantings (such as unproductive bluegum plantings) to ensure these would not become also become eligible. The OMA has corresponded with the (now) Department of Environment and Energy Department of Industry, Science, Energy and Resources on this matter (Ryan, 2018).

5.11 Carbon agroforestry has been too focused on carbon sequestration

The extent of carbon agroforestry plantings in Australia was estimated in 2012 at 65,000 hectares of which over 50 per cent comprised single species mallee plantings. Of the rest all but about 5,000 hectares had some mallee planting included in the mix of species

(Mitchell et al., 2012). The Mitchell et al (2012) study also classified the proportion of carbon agroforestry established by not for profit groups and farmers and those by commercial entities.

All of the plantings by commercial entities have been planted to secure carbon credits and thereby to offset emissions by industrial firms seeking to do so. These plantings amount to about 30 per cent of the total carbon plantings and have a permanence obligation to ensure compliance with regulations governing carbon plantings. Other mallee plantings established by individual farmers, mostly at an earlier date of establishment than commercial plantings, have been planted with just an expectation of them being regularly harvested for bioenergy or possibly retained for carbon. As there have been limited opportunities for a bioenergy industry, these trees have continued to grow beyond the optimal time for harvesting. As discussed earlier, the dates for eligibility for establishment as a carbon planting has changed and these plantings have become a non-economic asset for the farmer, while continuing to produce a range of co-benefits and ecosystem services (Baumber, 2016) but also competing with adjacent cropping programs.

5.12 A carbon payment could impact on potential bioenergy

In the feasibility study conducted by the Cooperative Research Centre Future Farm Industries (CRCFFI) into mallee aviation fuel, it was recognised that a carbon payment to the farmers was required in addition to the price for biomass in order to make the project attractive to the farmer (CRCFFI, 2014). However, the project only achieves a satisfactory level of compliance with the chosen international sustainability framework by allocating the carbon to the aviation fuel project and not to the farmer. This allocation issue is important as it influences the carbon balance of the fuel. It is mandated under the sustainability framework employed that the fuel must be 50% lower than equivalent fossil fuel. Nevertheless, the role of carbon payments is important to the future uptake of forestry for bioenergy. “An increase to $34/gt (*a price which includes the potential carbon payment*) would double the lift in farm profit and attract farmers seeking greater scale of production” (CRCFFI, 2014), p. 65.

This example highlights the importance of a carbon price on the potential for bioenergy to become a part of integrated farming and agroforestry. The CFI methodology (Farm Forestry) that accommodates the regular coppicing of trees for biomass and secures the carbon captured in the below ground element of the trees is discussed in more detail in Chapter 6.

5.13 CFI methodology design and co-benefits

The design of CFI methodologies has been influenced by the international emissions trading mechanisms, the CDM and the JI. The CFI embraces offsets generated in agricultural and industry settings. In order to draw attention to the role of offsets, Garnaut (2008) stated that “a tonne of carbon dioxide sequestered is the same as a tonne avoided”. That is to say, in line with UNFCCC (Kyoto) carbon accounting, this statement needs to be conditioned with the proviso that all permanence requirements are met. However, offsets are an alternative to actual reduction and in some countries forestry offsets are not included in the carbon accounting framework for this reason (van Oosterzee, 2012).

Where forestry has been stimulated by a price on carbon and a carbon market, there has been limited recognition of the actual co-benefits associated with carbon offsets with the main focus instead on how much carbon sequestration is achieved. Designing carbon projects can vary according to the desired efficiency of carbon sequestration to be achieved. Single species plantings are generally considered the most efficient at securing high rates of carbon sequestration while environmental plantings usually consist of a mix of local native trees species and understory, enhancing the co-benefits and biodiversity. In the voluntary market, where companies and individuals invest in forestry, a range of values including biodiversity are factored into the project design (Carbon Neutral, 2019) and a higher price (cost) of carbon than the ERF auction is necessary. It is reasonable to assume that the costs of planting and managing mixed species plantings is not significantly different to single species but the rate of carbon accumulation per hectare is significantly less.

There is no recognition for additional co-benefits in the ERF where the price is set by auction. The CFI methodologies do not incorporate the identification of embedded co-benefits nor place an explicit preference for projects with superior environmental value. Limited environmental plantings have been established in WA under the ERF program (Brooksbank, 2013).

However, the Commonwealth did create the Biodiversity Fund, which: ‘assists land managers to store carbon, enhance biodiversity and build greater environmental resilience across the Australian landscape. It provides support for the establishment of native vegetation or better management of existing native vegetation’ (BulletPoint, 2013).

Through this fund, the Commonwealth has provided funding for environmentally significant projects that could demonstrate improvement or protection to areas of natural vegetation. The grants to land managers were seen as supporting ecosystem resilience to climate change. (NationalAuditOffice, 2014)

The scheme was terminated in 2013 after allocating only one third of the $960M originally intended for distribution. While the National Audit Office was critical of the method of the grant assessment process, the Fund's closure was most likely a casualty of the election of a new Australian Government in 2013. The Biodiversity Fund program had been a tacit acknowledgement that more support was required to encourage both carbon sequestration and generation of environmental co-benefits.

This intention to support biodiversity and other co-benefits was also apparent in the growing number of CFI methodologies, prior to the termination of the CPM and associated legislation. Offset providers were able to register co-benefits and pursue a premium over the prevailing carbon price. The ACCUs retained their status via the CFI methodology as a financial instrument with all the necessary protections and controls associated with such financial controls under the Corporations Act (Commonwealth of Australiia, 2011; van Oosterzee, 2012).

5.14 Focus on negative effects

In addition to the non-inclusion of both social and ecosystem services in bio sequestration methodologies, the CFI applies specific prohibitions and guidance to ensure that the environmental safeguards (the Cancun Safeguards) proposed by the UNFCCC are observed (Bell et al., 2014; FAO, 2019). These safeguard guidelines endeavour to ensure that little or no environmental or social damage is inflicted on developing countries when forestry projects such as REDD (Reducing Emissions from Deforestation and Forest Degradation) projects are introduced with the primary objective of generating carbon(Tehan, 2013) The existence of non-carbon benefits (NCBs) is acknowledged but 'benefit sharing' is not included in the REDD frameworks nor encouraged to be a formal aspect of negotiations, due the complexity and changing nature of regional contexts (Tehan, 2013) p. 191. A focus on legal requirements and entitlements is encouraged.

At the same time some commentators suggest that NCBs be encouraged when related to reforestation projects in developing countries, highlighting their importance and they speculate on how to incentivise their inclusion in a carbon sequestration project (Buizer, Humphreys, & de Jong, 2014). The NCBs are categorised as social, environmental and governance benefits and are seen as necessary components of carbon projects in the context of developing countries.

Following this same divergence of opinion into the Australian context and the CFI, perhaps it is understandable that co-benefits are not incorporated into CFI methodologies. However, the question of how to acknowledge and reward delivery of ecosystem services is left unresolved.

Initially the CFI included a 'negative list' of unacceptable project types while the current methodologies contain limiting conditions to reduce the chance of negative impacts occurring. For example, the mallee carbon methodology (Reforestation by Environmental or Mallee Plantings) (Department of Enviromnment and Energy, 2019) prevents the planting of mallees in rainfall areas greater than 600mm, although exceptions can be made if the estimates of carbon does not exceed that for trees in the 600mm rainfall area. These limiting conditions are built into the methodologies and are directly related to potential land use issues, as discussed in Chapter 4. The rationale for inclusion of the rainfall limit can be assumed to be to prevent the expansion of carbon plantings into more productive farming land.

For the Farm Forestry Plantations methodology (Clean Energy Regulator, 2019; Department of the Environment and Energy, 2019), the restrictions are more specific, that is:

- Where annual rainfall is greater than 400 mm, projects must be no bigger than 100 hectares or 30 per cent of farm area, whichever is smaller.
- Where annual rainfall is less than 400 mm, projects must no bigger than 300 hectares or 30 per cent of farm area, whichever is smaller.

The basis for these restrictions is not stated as such but is based on concerns for land use change as expressed politically from time to time by local government (as in WA) or by farmer groups (see section 5.1.4). Conditions relating to rainfall boundaries and total permissible area of farm forestry plantings on an individual farm has limited the uptake of this CFI opportunity. This restriction and others related to rainfall were scheduled to be reviewed if the ALP had won the 2019 Federal election (Fizgibben, 2018).

The CFI also requires that projects comply with regional plans developed by local NRM groups, while also imposing restrictions that apply across the country. Funding has been provided by the Commonwealth to assist the development of these plans. One of the key principles of ecosystem management is that decisions are made at the level closest to the project in question (see principle 2 in Table 5.9). This and other principles are outlined in The Conference of Parties to the Convention on Biological Diversity Report, which has developed a system for integrated management of land, water and living resources, the 'ecosystem approach'. This was adopted in 2000 following the UNFCCC meeting, COP5, and outlined in Table 5.9 (Kickert, Tonella, Simonov, & Krupa, 1999).

Table 5.9 The 12 principles of the ecosystem approach of the Convention on Biological Diversity

Adapted from Source: CBD, 2006

1	The objectives of management of land, water and living resources are a matter of societal choice.
2	Management should be decentralized to the lowest appropriate level
3	Ecosystem managers should consider the effects (actual and potential) of their activities on adjacent and other ecosystems.
4	Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem management programmes should be given as follows:
	Reduce those market distortions that adversely affect biological diversity (i.e. eliminate perverse subsidies);
	Align incentives to promote biodiversity conservation and sustainable use;
	Internalize costs and benefits in the given ecosystem to the extent feasible (including full accounting for ecosystem goods and services)
5	Conservation of ecosystem structure and functioning, to maintain ecosystem services, should be a priority target of the ecosystem approach
6	Ecosystems must be managed within the limits of their functioning
7	The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.
8	Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.
9	Management must recognize that change is inevitable.
10	The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity
11	The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices
12	The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

This set of principles can guide policy at the regional and local level as an alternative to restrictions on size and location in a nationally determined legislative approach to carbon sequestration. Given the different conditions that exist in different regions, the principles can help avoid negative outcomes and maximise beneficial impacts.

5.15 Carbon versus biodiverse plantings

As mentioned earlier, the design of the tree plantings along with the choice of land are important factors for efficient and biodiverse agroforestry. The carbon sequestration per hectare is greater for single species plantings grown in narrow belts - superior to wide belts and block plantings. Mallees grown in narrow belts can grow 30-80 per cent more biomass than block plantings (Huxtable, 2012); (Sudmeyer, 2014). In terms of carbon sequestered, these belts can potentially provide a better financial return per hectare than block or biodiverse plantings even before consideration of opportunity cost of land as measured by displacement of crop, adjacent competition for nutrients and valuation of co-benefits. The cost of measuring the carbon sequestration is also lower in single species plantings due to the uniformity of the plantations and the likely use of modelling based on location and scientific data.

Notwithstanding the commercial advantages of single specie planting, some project proponents have sought to promote more diverse plantings to increase the co-benefits provided by the planting. While there are some indications that there is a positive link between biodiversity and the level of carbon storage or sequestration (Chen, 2018; UN WCMC, 2014) this only applies to certain technologies and certainly not to dryland agroforestry, the principle location of carbon sequestration. However, more diverse plantings tend to be advocated by regulators, rather than insisting the proponent seek the regional NRM agency advice or indeed offer compensation for the less efficient and more expensive projects (Australian Parliament, 2008).

In order to understand this dilemma, CSIRO conducted a study, specifically targeting belts and blocks of mallees. It was found that the level of biodiversity was somewhat lower in monoculture plantings than mixed revegetation but significantly better than cleared land. In other words, there was a clear and considerable improvement in the level and quality of biodiversity as the result of planting the mallees, regardless of the planting design. The study also suggested that additional measures can be taken to improve the recruitment of fauna, without compromising the necessity of uniformity for commercial utilisation of the trees (Smith, 2009).

Other studies have investigated the biodiversity of belts of mallees and discovered that dryland trees such as mallees have a greater than expected capacity to attract and host a range of beetles. The capacity to increase biodiversity has been seen as a benefit to agriculture and brings insects and other invertebrates back into the landscape (Leng, 2018; Lyons, 2008; Smith, 2007).

5.16 Co-benefits of Australian carbon agroforestry

Uncertainty over the future of carbon agroforestry has emerged gradually from a background of acknowledged land conservation benefits of reforestation and an expectation that policies would be designed to recognize the wider benefits of reforestation (Polglase P et al., 2011). It has generally been expected that policies which encourage forestry offsets also provide incentives for a range of activities that result in forestry, revegetation, shelter belts, agroforestry and restoration (Garnaut, 2008a). However, the CFI, particularly in association with the ERF, has emphasised the least cost approach to carbon sequestration rather than to preference the value of associated positive attributes or co-benefits (Mitchell, 2012).

While the approved CFI methodologies discourage ‘disbenefits’ or environmental damage, they do not reward creation of positive co-benefits. However, having removed the financial additionality test for eligible CFI activities, the CFI offers the prospect of funding forestry activity that improves productivity of the farming property. This link between forestry and farm productivity is contained in a publication titled The Emissions Reduction Fund: Benefits for Farmers (Australian Government, 2014). Therefore, support can be provided (purchase of ACCUs under ERF) where forestry and other land-based activity generates carbon credits but also results in increased productivity of the farming operation on which the activity takes place. The question of additionality in this scenario is ignored. Carbon revenues alone will not be sufficient to encourage carbon agroforestry on agricultural land. Other incentives that value eco system services need to be developed to have an expansional impact on this activity (Baumber et al., 2019; Bennett, (2011); Flugge & Abadi, 2006; Townsend et al., 2012).

Studies into the Mallee industry have highlighted the need for better recognition and valuation of the co-benefits of integrated agroforestry (Garnaut, 2011). Placing a value on these co-benefits in carbon offset programs has been advocated by the Netbalance Foundation. Their proposal suggests that there are direct positive outcomes (social, environmental and economic) that can be linked to an offset project and usually not priced into the value of that project (Salisbury et al., 2014b).

These benefits can include the possibility of increased productivity through reduced waterlogging and salinization and the avoidance of the need to create drainage systems (Flugge & Abadi, 2006). Using a broader definition could also include reduction of damage to local and state government infrastructure and impacts on households and businesses (Worley Parsons, 2009). In relation to the assessment of the Narrogin trial bioenergy plant, the positive externalities and direct benefits associated with supplying biomass to the project were estimated to be very significant but principally based around local and regional economic benefits to farming practices (Flugge & Abadi, 2006; WorleyParsons, 2009).

Systems for awarding payments for ecosystem services have existed along with detailed frameworks to enable analysis (Bryan, 2013). The payments have largely been awarded more directly by encouraging specific farming behaviour by funding national programs to ameliorate salinity or other specific problems. This funding came and went as described earlier, rather than creating a market for ecosystem services (Townsend et al., 2012).

Recent policy developments in relation to incorporation of co benefits into carbon plantings have been the Queensland

5.17 Ecosystem service delivery includes cultural values and aesthetics

In the context of an ex ante sustainability assessment, a more detailed discussion of ecosystem services delivery is warranted. Ecosystem services as defined by the MEA can be defined as having one or more of the following characteristics: supporting; provisioning; regulatory; and cultural (Laine et al., undated). In addition, the economic value of ecosystem services can be derived through analysis of whether they have a direct use or alternatively a 'non-use' value such as an option value or bequest value. These non-use values can include supporting services and biodiversity (Alcamo, 2003b; Heal, 2000).

The cultural dimension of ecosystem services includes aesthetics, such as a perceived change in the visual or aesthetic appeal of the landscape to a land holder and presumably to the public. The value placed on improving the landscape appeal is mentioned favourably in the report on Mallee aviation fuel as an additional feature of the Mallee agroforestry program (Goss K., 2014; Laine et al., undated).

5.18 Conclusion

The many changes to the Australian Government legislation governing emissions abatement has caused uncertainty and this has created a brake on the use of new carbon agroforestry as a means of creating carbon offsets. This regime of changing legislation and regulation includes the conditions for CFI methodologies and changing expectations of the Government.

The changes outlined in this chapter highlight the impact of policy uncertainty on the achievement of transition of the agroforestry practices from niche levels of activity to a more highly adopted level and subsequently to a landscape level of adoption. The combination of policy uncertainty, legislative change and the subsequent impact on public opinion, highlights the significance of a predictive framework such as transition theory as a way to analyse what and how these factors determine the pace and in what direction the transition take place.

In addition, the notional focus of the CFI on carbon is based on the Kyoto principles and a purposeful separation of carbon from NCBs. The early resistance of European climate policy to forestry as a way to reduce emissions created a limitation in the acceptance of forestry as a low-cost tool with integrity. In addition, some CFI conditions including presumptive land use measures and permanence (up to 100 years) have made it expensive. More integration of biodiversity and carbon is needed, but this link needs to be achieved without further raising the cost (Steffen & Csiro, 2009).

If a source of payments for ecosystem services were to exist in Australia, the depth of a market in ecosystem services may well support an increase in carbon agroforestry. The additional support through this mechanism may also aid the preservation of extensive plantations of carbon plantings undertaken as 'early action' plantings before consolidated national policy was achieved, where those plantations are under threat of removal. These plantings include mallees in WA. This latter measure would require a review of the current Avoided Deforestation methodology.

PART 3 –
THE OIL MALLEE CASE STUDY

Chapter Six

6

History of the Oil Mallee Project in Western Australia

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6.1 Introduction

The land sector is a major source of emissions in Australia. Contributing 12.9% of national emissions, it has the potential to be a major contributor to emissions reduction through changed agricultural practices. The Oil Mallee Project was initiated by farmers to contribute to this endeavour through carbon sequestration and bioenergy. As discussed in earlier chapters, this task was frustrated by constraints placed on agroforestry by possible concerns of extensive land use change. This chapter discusses the case study of the Oil Mallee Project to understand how the industry began and flourished for many years. It also discusses how extensive and repeated policy change and land use concerns influenced this important regional example of carbon agroforestry.

6.2 Background – Oil Mallee agroforestry and the WA Wheatbelt

The Western Australian (WA) Wheatbelt has grown in importance as a major exporter of grain over the last 100 years. In the process, areas of dryland forest were extensively cleared of vegetation, particularly in the lower rainfall regions. Very few trees were left on the farms as a result of mandated clearing. The ambition to clear and increase production was given some considerable encouragement from the WA Government in the latter part of the 1960s and into the 1980s (Taylor, 2014b). For instance, David Brand (the Premier of WA from 1959 to 1972) announced that there would be a target of 1 million acres of low rainfall arable land cleared each year to create an expanded Wheatbelt (Gaynor, 2014). The determination to clear started even earlier. In 1917 a Royal Commission acknowledged scientific evidence of the risk of salinity due to land clearing, but stated that this should not stop the opening up of the mallee lands (Beresford, 2004; Lindenmayer et al., 2012).

To give some idea of the scale of this transformation of the area for farmland, it is helpful to look at the Avon River Basin (ARB) which makes up a large portion of the Wheatbelt and includes most of the dryland agricultural region. Since 1900, over 80,000 km^2 of the 120,000 km^2 in the ARB has been cleared (Gaynor, 2014). This clearing has resuled in rising groundwater and secondary salinity and could extend to impact on 30 per cent of the ARB by 2050 (ACC 2004). Awareness of the potential damage from salinity brought forward ideas to ameliorate this growing threat to the livelihoods in the region (O’Connor, 2004).

Starting in 1993, the WA State Government has, until recently, maintained a woody crop program to demonstrate how landscape scale change with improvements to natural systems could be achieved (Salisbury et al., 2014b). The rationale for such a program was the finding that the water recharge could increase considerably after clearing, particularly in low rainfall areas, creating annual water logging and dry land salinity damage (Flugge & Abadi, 2006).

The search for a solution to problems related to the water table and salinity impacting on lower catchment areas turned towards hardy deep-rooted perennials such as Mallee eucalypt species in particular. After extensive investigation several species of Mallee eucalypts were chosen for a number of reasons, including 'their capacity to manage water' (DPAW, 2000). By 2013 over 30 million trees had been planted (O'Connor, 2004).

6.3 The Oil Mallee Association (OMA) – a short background

The OMA[23] has provided a new opportunity for agriculture in WA and supported its export to the rest of Australia. The OMA approach of integrated agroforestry has been acknowledged as an important contribution to WA agriculture, possibly among the top ten innovative practices adopted in the WA Wheatbelt (Campbell, 2018; Oil Mallee Australia, 2012; URS Forestry, 2009).

The OMA is committed to the extension of mallees as a landscape scale tool for delivery of environmental services to help manage excessive water in the landscape and the potential spread of salinity, reducing the impact of wind erosion and providing an potential additional source of income for farmers through active management of carbon sequestration and bioenergy programs.

The branding of this movement as 'Oil Mallee' arose from the intensive domestication of the different species of Mallee eucalypts and their categorisation as being suitable for different uses in different regions. In the early 1980's, Professor Allan Barton of Murdoch University, approached the then Department of Conservation and Land Management (CALM) with work that he had done in the mid-80s exploring the properties of eucalyptus oil, and more specifically one of its constituents, cineole. Professor Barton believed there was potential to grow mallee eucalypts across the WA Wheatbelt to help lower the water table and to harvest eucalyptus oil (Barton, 1999). Several areas of the Wheatbelt were planted with species of mallees with the intention of establishing an industry:

[23] A proportion of the history and background of the OMA was extracted from the OMA website. The content on that website was written and authorised by the writer of this HDR thesis.

> "The planting on degraded agricultural lands of eucalypts for leaf oil provides a commercial incentive for restoring original vegetation; a sustainable method of controlling groundwater and salinity; a product that is an environmentally benign substitute for a widely used solvent damaging to the ozone layer; and a mechanism for reducing atmospheric carbon dioxide levels. With integrated tree crop systems and improved harvesting and processing technologies, the Western Australian wheatbelt could produce large volumes of high-cineole eucalyptus oil from Mallee eucalypts" *(Barton, 1999), p. 161).*

In 1995 the farmers involved in the Oil Mallee Project at six planting locations formed a growers' representative body, the Oil Mallee Association (OMA) of Western Australia. In 1999 the OMA had 800 members and at that time took over the management of the plantings from CALM (Barton, 1999).

An original focus for the OMA was initiated with a dedicated group of farmers in and around Kalannie in the Northern Wheatbelt. Over a period of several years, this core group led by the late Don Stanley (inaugural Oil Mallee Association President), persisted in encouraging farmers to plant Oil Mallees in co-operation with CALM. Together they also guided development of a prototype harvester, necessary to harvest the Oil Mallees of varying morphology (shape and size). The potential for the trees to become a source of biomass for bioenergy was added to the initial objective of producing eucalyptus oil.

The research and development undertaken by CALM and other State agencies over many years was targeted at improving vigour (growth) and eucalyptus oil. Higher levels of cineole in the oil were favoured as the level of cineole is an important indicator of not only quality eucalyptus oil (and its solvent characteristics) but also as a deterrent to grazing in the early stages of growth. CALM conducted several research programs and initiated the establishment of orchards from which they could select seed from high performing species and individual trees.

The OMA developed a grower base of over 1000 farmers by the early 2000s. The state was divided into 6 regions, ranging from Esperance in the Southeast, up to Yuna in the North West of the Wheatbelt. Appropriate species to suit all soil types found throughout this area were made available through the Oil Mallee program.

The vision of the OMA was: to be recognised as the predominant authority on the Oil Mallee industry and to transmit its message throughout Australia via regional industry bodies and alliances; for Oil Mallee plantations to become an important part of the total agricultural ecosystem; and a valuable addition to farming income through distributed energy programs which utilised mallee biomass. The mission adopted by the OMA was to ensure mallee eucalypts are adopted widely in dryland Australia and that considerations of plantation design and grower engagement are fundamental to the establishment of this woody crop.

The objectives of the OMA, as stated in the Constitution, are:

- to collect and disseminate information concerning the oil Mallee industry:
- to advocate the growing of oil Mallee and production of their derivative products and/or genetics of improved or better quality;
- to promote the environmental service and socio-economic value of growing Oil Mallees in agricultural regions of Australia as part of a robust land use system;
- to represent Oil Mallee interests and foster strategic partnerships for oil Mallee industry development;
- to engage and carry out activities for the betterment of the Oil Mallee industry;
- to protect and advance the brand entity and integrity of "Oil Mallee";
- to identify and facilitate research projects and investment in Oil Mallee; and
- to promote Oil Mallee as part of the energy and carbon cycle (OMA, 2019).

The OMA identified the need for an industry group to lead discussion, advocacy and policy change. Individual farmers and researchers have strongly supported the OMA in this role, acknowledging the OMA as the primary source of advice on the Oil Mallee Industry.

Research and development (R&D) surrounding the Oil Mallee industry has been extensive over the last 20 years, emerging originally in the form of genetic selection in the search for improved yields of biomass and eucalyptus oil. The R&D program was given a strong boost by Western Power's interest in the creation of the Integrated Wood Processing facility, leading to the testing of methodologies for production of energy, eucalyptus oil and activated carbon.

Two research agencies Farm Industries Cooperative Research Centre for Future Farm Industries (CRCFFI) and Curtin University Centre for Chemical Engineering now established as the Fuels and Energy Technology Institute (FETI) led by John Curtin Distinguished Professor Chun-Zhu Li. The CRC conducted significant research and analysis into the potential development of an Oil Mallee industry but closed after seven years in 2014. Curtin University continues to conduct research into different types of bioenergy processes.

The OMA aims to help develop an industry that will produce eucalyptus oil, charcoal, activated carbon (biochar) and bioenergy (green electricity) from selected eucalypt species across a range of Wheatbelt conditions. The Oil Mallee Project is based on the assumption that the best way to increase Mallee integrated agroforestry is to make it as profitable as other farming options. That is, that the use of land for trees etc. is as least as profitable as cropping or other land uses. It was also anticipated that farm forestry programs (agroforestry) could add a more resilient income stream to the variable nature of dryland regional cropping (URS Forestry, 2009). The OMA has acknowledged that there are broad limitations to the development of commercial farm forestry in the WA Wheatbelt. The lower rainfall, high evaporation rates, incidence of frost and the ancient soils of the area will limit the species selection and lengthen the rotation in much of the landscape.

6.3.1 Integrated Wood Processing (IWP)

OMA and CALM recognised in the early 90s that it was going to be difficult to ensure the profitability of Oil Mallees if eucalyptus oil were the only source of revenue. Consequently, over several years, various other products derived from Oil Mallees were assessed. The OMA, Western Power Corporation, Enecon Ltd and CALM investigated the potential of establishing an Integrated Wood Processing (IWP) system where oil, charcoal, activated carbon, and electricity would be produced in a combined process. During the trial phase the Integrated Wood Processing (IWP) bioenergy plant at Narrogin successfully produced electricity, charcoal, activated carbon, and eucalyptus oil, from Mallee feedstock grown on farms in the region. After a short trial period, the Narrogin IWP project was closed when all three systems were proven to operate. Nevertheless tye project was seen as a failure in the sense that it did not prove to be an economic production system and budgetary constraints were imposed(URS Forestry, 2009).

The OMA projected that several bioenergy hubs could be created across the WA Wheatbelt. When fully operational, bioenergy plants could each produce 5 MW of electricity plus 1,000 tonnes of eucalyptus oil and 3,500 tonnes of activated carbon (biochar) from 100,000 tonnes of mallee feedstock material supplied annually from some 10 million harvested Oil Mallees.

Of particular interest to the OMA was that IWP plants like this offer significant employment opportunities for rural communities. The plant would operate 24 hours per day and a fully commercial plant is likely to create employment for up to 10 people. Additional jobs would come from tree planting, harvesting and transport of biomass. Western Power identified up to 10 potential sites around the state, for future IWP plants.

A key feature required of a potential site was substantial plantings and access to the Transmission System on to the grid.

Figure 6.1 Proposed location of bioenergy hubs
Source: OMA website

6.3.2 Carbon Sequestration

The link between Oil Mallees and their suitability for carbon sequestration is a very significant one. WA was one of the first Australian States to enact carbon rights legislation, the Carbon Rights Act 2003. The Oil Mallee Company (OMC), a company created by the OMA in partnership with CO2 Australia to assist commercial development of carbon sinks, was the first to utilise the Act in a project developed jointly with the Kansai Electric Company of Japan to create a 1000-hectare carbon sequestration planting across 24 properties in the Northern Wheatbelt.

This historic project used the integrated 'belt' planting plantation design across cropping programs that had been perfected on other properties and demonstrated a significant alignment with modern farming practices. The OMC Kansai project was one of the first purpose grown and sponsored sink projects in Australia and was seen as a model and visited by many farmers, farming groups, and commercial and research interests.

The approach often taken by carbon sink project managers is to lease land from a farmer or landowner. The lease terms varied but the conditions set for potential generation of a carbon sink[24] required the trees and the carbon to be secured under a covenant of up to 100 years. The OMA warned farmers to be aware of such long-term covenants on the use of their land, but to consider that proposals incorporated an option for more active management including harvesting of the trees at some time in the future. This ideal arrangement eventually became incorporated into the CFI Farm Forestry methodology.

6.3.3 Renewable Energy

Producing bioenergy from agroforestry can be considered carbon neutral in that the emissions from combustion or pyrolysis can be replaced with subsequent growth when managed to ensure that there are no losses in carbon sequestration elsewhere from forestry or other sources of biomass collection and processing (Göran et al., 2016; Haberl et al., 2012). The regular coppicing of Mallee plantations ensures that carbon is also secured below ground in the roots. Bioenergy also reduces emissions when it displaces fossil fuels and is classified as approaching carbon negative with the additional actions of applying the biochar residue from pyrolysis to the soil or utilising other carbon capture and storage technologies (Garnaut, 2008a).

In Europe, bioenergy is used to produce 6 per cent of electricity (Sandbag, 2017). In Australia the share of electricity production from bioenergy is just 1 per cent. Excluding electricity, bioenergy is responsible for close to 50 per cent of renewable energy, largely through steam generation in the sugar industry using plantation waste (ARENA, 2018).

As explained in Chapter 5, when a bioenergy crop is produced on agricultural land, issues of land use competition with food production are commonly raised (Berndes, 2013). In addition to this, direct land use change issue (LUC), there are assumed to be possible “knock on” effects or indirect land use change (iLUC) which suggests that additional land for agriculture will be made available by the clearing of forests, thereby creating emissions.

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[24] A **carbon sink** is any natural reservoir that absorbs more **carbon** than it releases, and thereby lowers the concentration of CO_2 from the atmosphere. Globally, the two most important **carbon sinks** are vegetation and the ocean. Source: Wikipedia

Table 6.1 Australian renewable energy consumption, by fuel type

Source: Department of the Environment and Energy (2018) Australian Energy Statistics, Tables D, F, O.

	2016–17		Average annual growth	
	PJ	**Share (per cent)**	**2016–17 (per cent)**	**10 years (per cent)**
Biomass	205.4	54.2	5.0	-0.2
– wood, woodwaste, sulphite lyes	95.1	25.1	1.9	-0.4
– bagasse	110.3	29.1	7.9	-0.1
Municipal & industrial waste	2.6	0.7	0.3	na
Biogas	15.0	4.0	-4.1	3.7
– landfill gas	12.2	3.2	-6.5	na
– other biogas	2.8	0.7	8.0	na
Biofuels	7.1	1.9	-5.3	5.3
– ethanol	6.4	1.7	3.4	na
– biodiesel	0.6	0.2	-48.7	na
Hydro	58.6	15.5	6.3	3.4
Wind	45.3	12.0	3.3	16.9
Solar PV	29.1	7.7	18.0	59.2
Solar hot water	15.7	4.2	5.7	10.0
Total	**378.7**	**100.0**	**5.3**	**3.2**

The passing of Commonwealth legislation in 2001 that set a target for the proportion of renewable energy dispatched by electricity retailers, established a market in renewable energy certificates (RECs) and provided a boost to the potential for biomass as a fuel source for production of energy. The target has been raised but the proportion of energy generated by biomass has remained very low.

The combination of a price on carbon and availability of RECs could make a significant difference to the relative costs of biomass and other forms of renewable energy. At this time the RECs are fully subscribed. The King Review, commissioned to identify low cost of carbon abatement for the ERF recommended that the carbon savings of renewable energy by recognised as well as or instead of just in renewable energy terms (AustralianGovernment, 2020).

If the REC market was developed to distinguish between eligible renewable sources on the basis of the carbon footprint, this advantage is expressed through bioenergy being considered carbon neutral or even carbon negative (if there was a BECCS plant engaged). The biomass fuel spent is replaced and the emissions absorbed by subsequent growth. The ‘base load’ characteristic of bioenergy can also be an advantage over more intermittent renewable energy sources in certain applications. This baseload characteristic of bioenergy based on biomass could provide a further decarbonisation of the grid when supporting a range of intermittent sources of energy such as wind or solar. The 'back up' source of energy would be also carbon neutral. Along with environmental reasons, this prospective opportunity fuelled interest in Oil Mallee plantings.

There are nine species of mallee eucalypts planted in WA, all but one (Eucalyptus Polybractea) are endemic. These species are listed in Table 6.2 below. Table 6.3 lists the number of trees planted between 1988 and 2007.

Table 6.2 Species of Mallee Eucalypts planted in WA

Mallee species used for plantings in WA	Approximate proportion of total trees established %
Eucalyptus loxophleba subsp. lissophoia	39
Eucalyptus kochii subsp. plennissima	23
Eucalyptus kochii subsp. Borealis *	18
Eucalyptus loxophleba subsp. gratiae	8
Eucalyptus polybrachtea	8
Eucalyptus kochii subsp. kochii	2
Eucalyptus myriadena	1
Eucalyptus angustissima subsp. Angustissima	1

*Formerly Eucalyptus horistes

Table 6.3 Number and area of Mallee plantings in WA 1988-2008

Year planted	No. Trees Planted	Hectares (2,000 stems/ha)
1988	20,000	10
1992	29,980	15
1993	22,175	11
1994	784,691	392
1995	1,992,628	996
1996	2,292,748	1,146
1997	909,083	455
1998	1,438,022	719
1999	2,552,778	1,276
2000	4,084,486	2,042
2001	2,217,364	1,109
2002	995,954	498
2003	2,550,119	1,275
2004	980,700	490
2005	775,080	388
2006	1,870,771,	935
2007	2,036,530	1,018
TOTAL	**25,553,109**	**12,777**

6.4 Commonwealth and State Government Landcare funding led to adoption of agroforestry

The planting of trees on farms accelerated in the mid 1990s, motivated by the environmental concerns of farmers with support and encouragement from the State and Commonwealth Governments. The incentive for re-afforestation came in many forms, through grants and national programs, in particular the National Action Plan for Salinity and the National Heritage Trust. In the WA Wheatbelt there were many 'early movers' who took up the opportunity to plant trees on their farms when offered discounted seedlings through these programs (*Managing Our Natural Resources*, 2010; O'Connor, 2004; Pannell & Roberts, 2010).

A decade after widespread planting had commenced, the optimum extent of planting believed to be required to achieve the anticipated environmental benefits, started to be questioned (Peck A., 2012b). It was proposed by some researchers that a much higher proportion of the landscape needed to be planted to achieve the anticipated improvements such as managing the water table. It was predicted that if 10 per cent of the area used for cropping was used for Mallee agroforestry that positive results would become evident; (Bartle J., 2010,);Pannell et al. 2004; George, 1999).

Nevertheless, while the proportion of planting per property might remain similar, the scale of planting required to achieve anticipated environmental benefits was greater in the low rainfall eastern wheatbelt where the properties are larger and productivity lower than in the higher rainfall areas of the great southern regions of Western Australia.

Early in the program Barton (1999) estimated that total planting expenditure by that time was $4 million by farmers and $3 million by CALM plus $1 million from other government programs. However, estimates by CALM suggest that by the year 2000 there had already been over 3,000 hectares of mallees planted and over $10 million spent by farmers on almost two million discounted seedlings (CALM, 2001). This initiative by the WA State Government was followed by the Commonwealth Government's National Action Plan for Salinity and Water Quality (NAP) which provided matching funds to state governments for strategic tree planting. WA received over 50 per cent of the 'on-ground' funds in this program, which concluded in 2008 (see Table 6.3 and Figure 6.2). Other programs that had assisted the growth of the Mallee plantings were the National Landcare Program (commenced in 1989); the National Dryland Salinity Program (1993) and the Natural Heritage Trust (1997).

It is important to reiterate that the Commonwealth Government assistance for distribution of seedlings was provided to help remediate increased salinity damage caused by the changes in the water table and other environmental issues exacerbated by widespread clearing. Notwithstanding the extent of planting, the NAP program later received a somewhat overall negative assessment by several Commonwealth agencies and by independent researchers including some from Western Australia (Pannell & Roberts, 2010). The criticism included assessment of the scientific and socioeconomic rationale for the program and its method of implementation. The critics also claimed that it should have been foreseen that the tree program would have limited impact on salinity damage at the catchment scale. This criticism caused some commentators to speculate that the salinity problem had been overstated and that the creation of a sense of environmental urgency had been misplaced. This sentiment may have caused the new ALP Commonwealth Government to swing support away from this area altogether (Pannell & Roberts, 2010). In March 2008 the Commonwealth Government announced the Caring for Our Country program to replace several national Land Care programs. There was no mention of salinity mitigation.

Figure 6.2 shows the annual planting of Oil Mallees by farmers (Figure 6.2) assisted by the OMA. The shape of the curve reflects the level of support from funding programs and its influence on the planting of trees. It can be assumed that the plantings after 2008 were all privately funded.

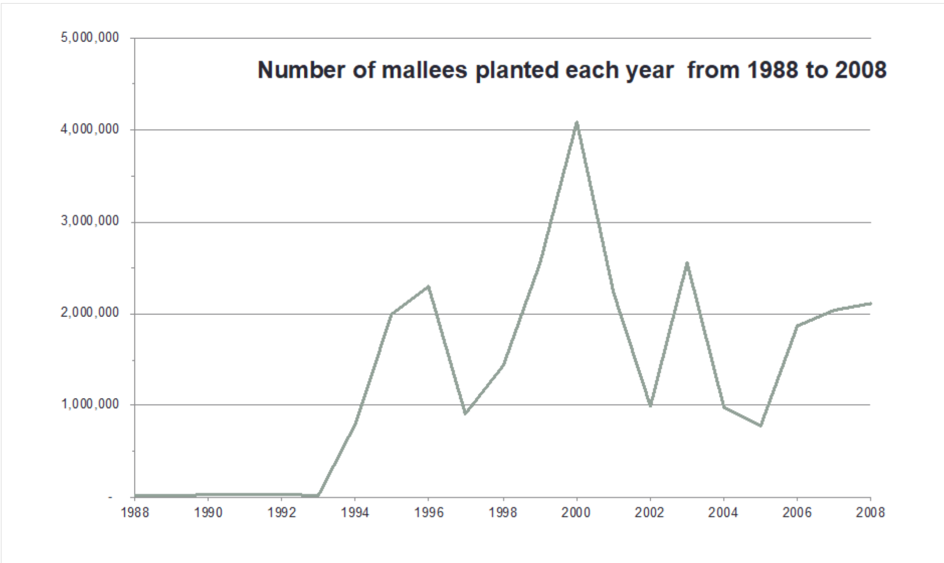

Figure 6.2 Mallees planted with public funding between 1988 and 2008 (OMA)
Graph reproduced by permission of the Oil Mallee Association

The subsequent formal review of the Caring For Our Country program in 2013 does not mention salinity nor integrated tree planting on agricultural land after allocation of $2.25 billion to environmental programs (2013). In other words, there was minimal public funding support for agroforestry after the earlier NAP program was terminated. Given the comprehensive discussion on carbon policies and the likelihood of carbon agroforestry playing a key role, it is possible that it was assumed that the carbon market would provide sufficient support for forestry and agroforestry. By 2011 it was generally believed that the Carbon Farming Initiative and associated carbon market was able to provide re-afforestation and valuable landcare services (Torabi et al., 2016).

6.5 Developing a model for carbon sequestration.

The model established for integrated Mallee plantings remained of interest to a large number of farmers. Support was required to plant the trees and farmers anticipated that revenue from carbon and bioenergy would provide compensation for the loss of land (Torabi et al., 2016).

Following the international discussions on Climate Change and the adoption by most developed countries of the Kyoto Protocol in 1992, bio-sequestration was featured as a means of generating carbon rights to offset industrial GHG emissions. A level of interest in carbon sequestration had been created in WA, encouraged by the OMA, as a means of achieving reafforestation with investment from companies and governments. Given the long term nature of carbon sequestration contracts (usually 100 years based on the carbon cycle) attention turned to the necessary step required to ensure that the creation of carbon rights could be separated from the ownership of the land. The WA Carbon Rights Act in 2003, one of the earliest state legislative measures to recognise carbon rights in Australia, made this a key objective.

This legislation made it possible for investment in creation of carbon rights on agricultural land by investors other than the farmer. In keeping with the initial ambitions for Oil Mallee planting, it was anticipated by researchers and farmers that future carbon revenues from forestry carbon sequestration could potentially contribute towards improvements in land management and repair in the dry agricultural regions (Harper, 2004; Harper, 2007; Harper et al., 2011).

Mallee plantings in particular were recognised as a way to potentially optimise this carbon revenue source as well as being a possible source of biomass for bioenergy. Therefore, well before the Commonwealth Government legislative action to limit carbon emissions, there was substantial interest in forestry activity in dryland agricultural areas of WA motivated by carbon sequestration.

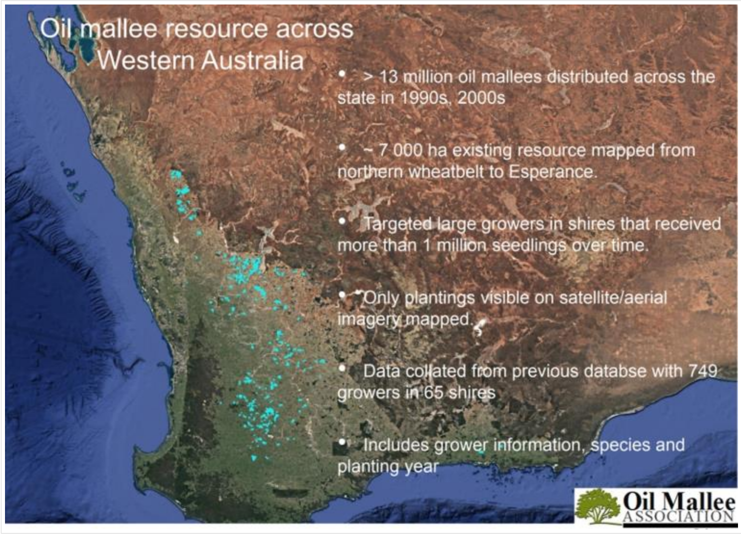

Figure 6.3 Distribution of Mallee plantings across the WA Wheatbelt
Source: OMA, 2006

6.6 Western Australian Carbon Rights legislation

The Western Australian Environmental Protection Agency (EPA) sets limits on emissions from major gas projects as part of the approval process for exploration and production and enables offset credits to be partially used as an alternative to mitigation. Once the WA Carbon Rights Act 2003 was legislated, Woodside Petroleum, a major gas producer, responded by establishing carbon plantings to achieve compliance. As discussed in earlier chapters, expectations were very high that carbon sequestration would play a significant role in offsetting emissions in Australia. The Minister for the Environment in WA predicted that 800,000 hectares of cleared land would have trees planted and would lock up 6 million tonnes of carbon, expanding over time to 2 million hectares (Edwardes 1998). A report in 1999 suggested that a total establishment of 1,450,000 hectares of tree planting for carbon sequestration could be achieved including Maritime Pine, Bluegums and Oil Mallees (Western Australia. Sustainable Land Management Technical, 1999). Despite many of these trees being scheduled for harvest they could contribute significant additional stored carbon representing up to 20 per cent of the State’s annual emissions.

A Commonwealth Government report speculated on which timber species might contribute to carbon sequestration after 2008 (AGO, 2000). Excluding commercial forestry and looking at species used for revegetation, the report considered that at the current rate of expansion there would be an additional 600,000 hectares of mallees, tea tree and other species across Australia by 2008. The report projected the rapid expansion of Oil Mallees in WA from 7,000 hectares in 1998 to 200,000 by 2012 and the potential for 0.5 to 1M hectares available for Mallee planting in WA. While this projected area of planting was not achieved, over 10,000 hectares were planted and this gave considerable momentum to the Oil Mallee carbon agroforestry industry at the time.

6.7 Land use change, a recurring feature of Mallee agroforestry

Almost as soon as the planting of mallees on farms became observed on the landscape and larger whole of paddock ‘block’ plantings emerged, some regional stakeholders such as local government and farmer groups expressed concerns about the shift of arable land use towards growing non-food crops. For instance, between 2005 and 2010 several regional local government bodies in the WA Wheatbelt adopted planning guidelines that restricted the area of tree planting on agricultural land, in particular to limit large scale block plantings which could occupy a whole property or paddock. The restrictions necessitated proponents having planning approval for tree plantings above a certain threshold area, usually 20 or 40 hectares (Planning Lands and Heritage, 2019).

This vexed issue of potentially transferring agricultural land to forestry in WA came into focus in 2010. Jerramungup Shire (located in the southern portion and higher rainfall of the WA Wheatbelt) rejected an application from a commercial carbon sequestration company to plant a mallee plantation across 1,288 hectares of land in their shire. The company appealed the decision by the Shire to the State Administrative Tribunal (SAT). The appeal was rejected on the grounds that such a new use was against the Jerramungup Local Planning Scheme and was not consistent with the State planning framework’s underlying theme to protect productive agricultural land (SAT, 2011). In relation to a specific Planning Policy on Forestry and Plantations, the tribunal also found that the proposal amounted to occupying the ‘whole farm’ or ‘whole lot’ and was therefore not a ‘complementary but ancillary use’ as required under that policy (SAT, 2011).

This case may have influenced the State Government decision in 2012 to review the State Planning Policy 2.5 (SPP2.5), a policy which governs land use issues in rural areas. In relation to tree farming, section 5.4 of the policy stated that tree farming is an acceptable use on rural land, but it should generally not occur on priority agricultural land and that local government should manage the location and extent of plantings in their communities. However, following the review, it now states that “where tree farm proposals are integrated with farm management for the purpose of natural resource management and occupy no more than 10 per cent of the farm, the proposal should not be subject to local government planning approval" (Western Australian Planning Commission, 2012) page 5. The 10 per cent guideline had been proposed by the OMA in its submission to the review to encourage integrated agroforestry and avoid excessive land use change (Dawkins, 2011a).

Box 6.1 Tree Farming – State Planning Policy 2.5

WAPC State Planning Policy 2.5 Land Use Planning in Rural Areas 2012 (Page 5)

Tree farming is a generic term used to describe land uses that centre on the planting of trees to generate economic return and/or environmental benefits. It has been an emerging industry in a number of rural locations in the south of the State. Usually this has involved the planting of trees for harvest. More recently however, the planting

of trees for the purposes of carbon sequestration has emerged as a new land use on rural land. Tree farming involving harvesting is a primary production activity that also sequesters carbon. The WAPC policy position regarding tree farming is:

a) tree farming is supported and encouraged on rural land as a means of diversifying rural economies and providing economic and environmental benefit;
b) tree farming should be an acceptable use on rural land generally, except where development of a tree farm would create an extreme or unacceptable bushfire risk or when responding to local circumstances as identified in a strategy or scheme;
c) tree farming should generally not occur on priority agricultural land;
d) local governments should manage the location, extent and application requirements for tree farming in their communities through local planning strategies, schemes and/or local planning policies;
e) in planning for tree farming, local government considerations should include but are not limited to, the potential bushfire risk, environmental and economic benefit, visual landscape and transport impacts of tree farming (where harvesting is proposed), planting thresholds, appropriate buffers and location relative to conservation estates and sensitive land uses;
f) where tree farm proposals are integrated with farm management for the purpose of natural resource management and occupy no more than 10 per cent of the farm, the proposal should not be subject to local government planning approval; and
g) the establishment of tree farms does not warrant the creation of new or smaller rural lots.

Box 6.2 State Planning Policy 2.5 – Tree Farming Definitions

WAPC State Planning Policy 2.5 Land Use Planning in Rural Areas 2012 (Page 19)

Tree farm – Saw logs - Land used, generally on a smaller scale, for commercial tree production where it is intended the trees are harvested to produce higher quality sawn timber or veneers, for furniture or the construction industry.

Tree farm – integrated - Tree farm proposals that are small in scale, integrated into existing farming operations and are generally for natural resource management purposes.

Tree farm – carbon sequestration - Land used for the capture and storage of carbon in a manner that prevents it from being released into the atmosphere. Regulated in WA by the Carbon Rights Act 2003.

The precedent set by this decision and the increasing interest of local government in managing this possible threat to agriculture was possibly one cause of the reduced level of carbon agroforestry over the last decade. The 10 per cent threshold for avoiding planning application provided a view of acceptable and sustainable integration of carbon agroforestry and agriculture. For some commercial scale projects the new ruling (SSP2.5) altered the economics of the commercial carbon agroforestry industry in WA and made it more likely that larger scale plantings would be located in the lower rainfall areas of the Wheatbelt. In these areas some of the land is degraded and greater concentrations of forestry would be permitted. While scale was important, at this time the price for carbon and the future of bioenergy remained critical determining factors as will be discussed in following chapters.

Several bodies in WA continued to promote integrated Mallee agroforestry, in particular the OMA. The Cooperative Research Centre for Future Farm Industries (CRCFFI) advanced woody tree crops as a major program of their research and development agenda. The woody tree crops program included research into optimising carbon and biomass production while also highlighting the positive water management capacities of the trees and other positive biodiversity benefits (CRCFFI, 2010, 2014) .

While early researchers provided evidence of beneficial impacts, the capacity of Mallee plantings to provide a partial solution to water table management and salinity amelioration remained a question to be resolved (George, 1999; Sudmeyer & Hall, 2015). There is acknowledgement by these researchers that there are different motivations for adopting integrated agroforestry practices on farms. One suggestion by researchers is that the coverage of trees across the landscape needs to be significantly higher than the integrated planting design proposed by the OMA. However, once the coverage of cropping land exceeds a certain level, issues of sustainable land use emerge. This thesis questions (particularly in chapter 8) the normal sustainability metrics of large-scale land use change but distinguishes between large scale plantings and integrated carbon planting.

In the case of Mallee plantings, the degree to which the planting for carbon or bioenergy is causing land use change is being determined by the manner in which they are planted – as an integrated program or a whole block or whole property planting. The diagrams in Figure 6.4 below depict how integrated mallee plantings for sequestration and bioenergy can support diverse plantings (top), and integrated farming systems for profit and sustainability (below). These integrated programs can be designed to be located across a diverse landscape and therefore reduce water table problems on the valley floor and also create preventative measures on the slopes where water collects before draining to the valleys.

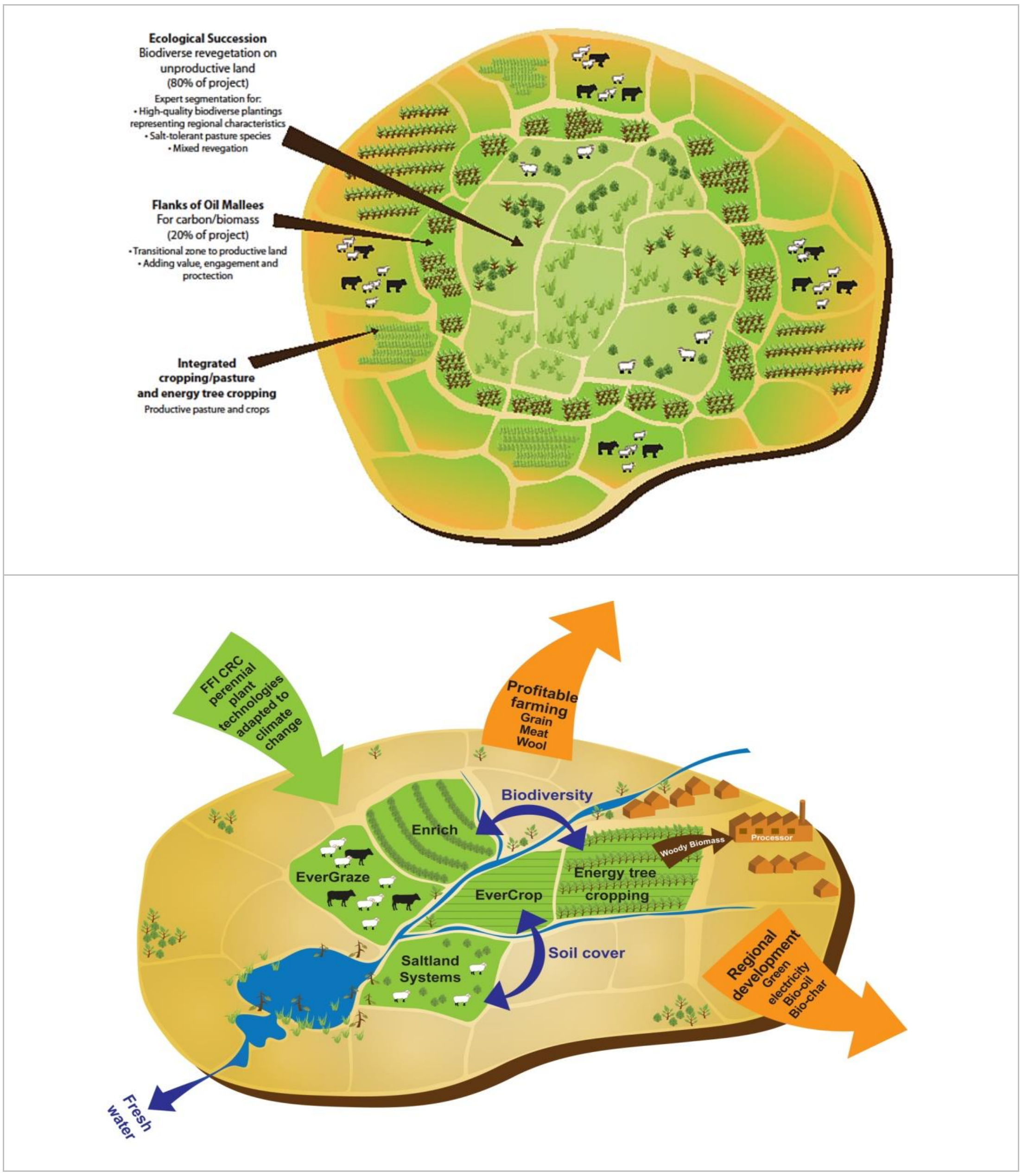

Figure 6.4 Two representations of integrated Mallee plantings
Top: OMA Presentation 2016;
Below: Website Cooperative Research Centre for Future Farm Industries, 2013

6.8 Bioenergy a key ambition: an income to farmers and reduced crop competition

A key understanding of the early OMA ambition to plant dryland eucalyptus species on farms and provide environmental benefits, was that farmers needed to be compensated for the loss of productive land. To optimise the impact of the trees on the water table and on reduction of wind speed, amongst other services, the plantings were integrated across the cropping programs, as opposed to being restricted to fence lines or alongside creeks.

This design of agroforestry usually resulted in no more than about 10 per cent of the productive land within the mallee agroforestry project area being planted with trees. In addition, the hope remained that the trees would become an agroforestry enterprise rather than remain just as shelter belts (Peck A., 2012a); (Mendham et al., 2012; Yu, Bartle, Li, & Wu, 2009).

Three principal approaches were advocated, namely carbon sequestration, eucalyptus oil production, and bioenergy, (or a combination of two or three approaches) incorporating regular harvesting (coppicing). A key feature of the coppicing is the reduction of tree root competition impacting the adjoining crop. There was an expectation that the market for carbon sequestration would be in place to overcome the cost barriers of planting and reduced crop production (Mendham et al., 2012).

As discussed earlier in this chapter a trial bioenergy plant was created at Narrogin to test the concept. The key industrial process were innovative and demonstrated that electricity production was possible and potentially economically feasible (CRCFFI, 2010; Stucley C., 2012).

Figure 6.5 Mallee plantings integrated into cropping land
Source: website OMA,

6.9 A concern about management of agricultural land

The Narrogin Bioenergy project did not proceed beyond the initial trial period and this, along with the lack of certainty, led to disappointment by farmers (Diss, 2013). This disappointment was also reflected in similar situations regarding biomass farming internationally, such as in the UK (Warren, 2016). This disappointment at the farm level about progress towards a bioenergy industry provided little to encourage a resurgence in the planting of trees.

6.10 Removal of a carbon price reduces planting

In the lead up to the introduction of the CPRS, a significant investment in carbon sequestration was anticipated. The guidelines for the eligibility of carbon agroforestry even included a description of Mallee belts in anticipation of this being an immediate and popular methodology. However, the CPRS was never introduced after the legislation was defeated in the Senate. Later the Carbon Price Mechanism (CPM) was introduced following the re-election of the minority Labor Government. The Government formed an alliance with the Australian Greens and legislated the CPM with the significant vote of the single Green member of the House of Representatives.

While the CPM was designed to accommodate carbon agroforestry, including specific reference to integrated and block Mallee plantings, the program was in place for only two years before the change of Government and legislation was introduced to remove the CPM. During that time no significant carbon sequestration using the mallee methodology took place although the CFI contribution to total ACCUs generated by other vegetation methodologies rose from 0.7 per cent in 20112/13 to 31.2 per cent in 2013/14 (Clean Energy Regulator, 2018a). Once the ERF was in place for the 2014/15 financial year, the scale of ACCU generation form CFI vegetation methodologies increased by a factor of three, although a very significant amount of this sequestration was through avoided deforestation (AD) (Clean Energy Regulator, 2018a).

6.11 Revival of eucalyptus oil industry

A Eucalyptus oil extraction plant was started in the WA Wheatbelt town of Kalannie in 2001, when the early plantings of Mallee were established in the region. This potentially provided a means of extracting value from the trees and thereby offsetting the impact of reduced cropping and competition or the ‘edge effect’. Over time this oil extraction operation has expanded and new equipment, including a large biomass fuelled boiler, installed to speed the process and reduce costs through the use of the biomass material after it has been through steam distillation.

This expansion of the Eucalyptus oil production has opened up the possibility of large scale eucalyptus oil production in the Wheatbelt, exploiting the various species of Mallee for distinct aromatic features and cineole content. As the price of oil increases there are prospects for an industry to emerge exploiting both existing block plantings and integrated approaches.

6.12 Developments in bioenergy – FETI at Curtin and Rainbow Bee Eater

The Fuel and Energy Technology Institute (FETI) at Curtin University in WA has been researching gasification technologies for several years focusing closely on Mallee biomass as the source of biomass, receiving two major grants from the Australian Renewable Energy Agency (ARENA) enabling continuing research over several years (FETI, 2018) . As a key industry body, the OMA has supported the funding applications and promoted the research outcomes.

At the same time a bioenergy project aiming to use Mallee biomass was being developed in Kalannie led by Ian Stanley a significant farmer and OMA board member. This development followed his participation with other local landowners in developing Kalannie Distillers, the local Eucalyptus oil production facility. A new technology for biogas and biochar production was developed based on using Mallee biomass. His company, Rainbow BeeEater (RBE), has tested the system using straw and has proven its efficacy with this feedstock. RBE has been commissioned to install a system in South Australia, in this case using waste timber (RBE).

6.13 Summary

This chapter has discussed the history of the OMA and highlighted its use as a case study for reflection on the practice of agroforestry across farmland. The chapter places the OMA at the centre of discussions concerning the use of farmland in Western Australia for carbon sequestration, but also potentially for bioenergy. The significance of land use change (fuel crops displacing food crops) has been raised as an issue of international concern associated with the impact of bioenergy. This concern is also expressed at the local and state government levels, quite independent of the international sustainability assessment process. The methodologies for sustainability assessment are discussed in Chapter 8 followed by proposals to recognise the positive climate effect of bioenergy and evaluate the ecosystem services delivered by agroforestry.

Chapter Seven

7

Farmers and the Oil Mallee Project

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7.1 Introduction

To build a better picture of the value of agroforestry endeavors, stakeholder views were sought from a select group of Oil Mallee growers through interviews using the instrument of a semi-structured questionnaire. The initial group of growers was drawn from those with trees planted to generate carbon credits for the Kansai Electric Company of Japan. The credits generated were to be used by Kanzai Electric Company to offset emissions from their power stations under the Joint Implementation (JI) program of the Kyoto Protocol. The design of the questionnaire allowed for a wide range of responses from the respondents, including in relation to the definition of the concepts of ecosystem services and aesthetics.

7.2 The interview program

The objective of the interview program was to determine the attitude of farmers to the Oil Mallee plantings on their property. Landowners were asked to identify the impact of the trees to their property – both positive and negative.

The questions put to the respondents included aspects of motivation, past management and future prospects for the plantings. In particular, landowners were asked to comment on their willingness to retain the trees in the absence of a payment for the carbon sequestered or a potentially commercial proposition for harvesting and bioenergy.

Indirectly the interviews also aimed to extract information about the perceived value of ecosystem services and beneficial outcomes, both related to farming practice and the environment more generally. The interviews were designed to test whether it was possible to place a notional value on the ecosystem services delivered through integrated agroforestry.

A modified hedonic approach was adopted. The survey was conducted not by comparing actual sold properties (the hedonic approach) but by asking property owners to reflect on their knowledge of the market and their judgement about the impact of the trees on the value of their property (Patton, 1990).

The survey also included reference to the Oil Mallee Code of Practice and asked for suggestions on how it might be improved. The Oil Mallee Code of Practice was a document created with intensive consultation over a period of two years to provide a guide to sustainable practices for carbon sequestration and Mallee agroforestry.

7.3 A review of existing literature on farmer opinion

A search for similar interviews or surveys revealed very few instances of concrete efforts to gain insight into the real motivation of farmers to grow trees on WA farms. Some examples are discussed.

A relatively early analysis in 1991 of the reasons farmers planted trees at that time suggested that farmers in WA were principally motivated to establish trees on their farms for environmental and land care reasons (Prinsley, 1991). The profit motive was only really evident when the forestry was located in the higher rainfall areas of the State (Prinsley, 1992).

However another investigation into the early Oil Mallee Project was undertaken (Gollagher, 1999). Gollagher interviewed seven Oil Mallee Association (OMA) Regional Managers. At the time Gollagher reported an overall positive response to questions about the role of trees on agricultural properties including the notion of improvement of the land adjacent to the trees. At the same time, the responses acknowledged that a mix of land care strategies was required to establish sufficient scale and have real impact on salinity and other environmental problems.

In order to secure greater engagement and scale of agroforestry, some form of profitable forestry practice is required (Gollagher, 1999). The OMA Regional Managers proposed that in order to persuade farmers to use more of their land for trees than they had to date, it was necessary to build an industry approach that might secure the prospect of a commercial return. The interviews conducted by Gollagher indicated that the farmers "are endeavouring to reconcile their wish to preserve and repair the environment from which they draw their living and the need to ensure their financial security, and are attempting to develop an appropriate practical strategy to do so" (Gollagher, 1999) p. 33.

A much later study was undertaken in 2013 investigating the low level of participation by WA Wheatbelt farmers in carbon farming practices and the main motivations for engagement (Kragt, Dumbrell, & Blackmore, 2017). This study revealed that policy uncertainty was a very strong reason for non-involvement and that financial incentives had not been such an important motivation for those involved. At the same time many respondents pointed out that the potential payments were too low to make a difference and that having tree plantations on the farm made it difficult to sell the property, particularly with a 100-year permanence obligation. Despite these reservations, it appeared that farmers understood the potential benefits of agroforestry and nominated these benefits as key to their participation. If the adoption of carbon farming activities could be seen to enhance production, the farmers would not hesitate to adopt a range of carbon related programs. Both this study and Smith (2014) mention the socio-cultural context of farming and the influences of other members of that community on behaviour.

In Chapter 5, which provided an introduction to the OMA and its programs, it was noted that early support from Government for trees on farms in the WA Wheatbelt was provided to help achieve a reduction in dryland salinity. Also discussed also was that the effectiveness of integrated agroforestry on salinity mitigation has been questioned by some researchers, economists and the Australian Audit Office. In the survey of farmer opinion conducted for this thesis, the question of salinity was not specifically raised with the farmers interviewed. It was left to the farmers to raise this issue if they thought it was important.

Another perspective on this dilemma of integrating trees and agriculture is provided by a study into the carbon sequestration capacity of windbreaks on farms in the USA (Possu, 2016). It is suggested that providing windbreaks to provide stock and crop protection plus soil improvement is not uncommon, but quantifying the actual delivered services is complex (Possu, 2016). Farmers establish their own view about effectiveness and value to their farm and the environment. The popularity of windbreaks is also testament to the farmer's desire to explore opportunities to extract both economic and environmental benefits.

7.4 The Interview process and results

Interviews were conducted with farmers to identify their views on a number matters as outlined above.

The interviews were based on a set of semi-structured open-ended questions. The literature on qualitative methods proposes a choice of paradigms through which an issue can be investigated (Patton, 1990). However, while Patton suggests that the investigator can choose between a logical-positivism (empirical) approach and a phenomenological (interpretive) inquiry, it is possible to design the investigation using a suitable and appropriate approach for the occasion (Patton, 1990).

In this case the investigation was heuristic[25] in that the researcher brought personal experience and insights into the industry. However, in terms of the theme of research

[25] A heuristic method of learning involves discovery and problem-solving, using reasoning and past experience. (Collins English Dictionary).

methodology, it was naturalistic (real world). The investigation used inductive logic (identifying important interrelationships) and adopted an empathetic neutrality approach (subjective but neutral). Furthermore, the researcher did not endeavour to stay detached from the analysis and remained alert to the possibility of using experience and knowledge to understand the answers given to open-ended questions (Patton, 1990).

This applied research approach highlighted issues being faced by farmers who have adopted integrated agroforestry as part of their farming system. The interview process enabled the collection of information about motivations and practices that would generate any common themes and enable hypothecation about future trends and behaviours through inductive reasoning while ensuring integrity.

The questions aimed at eliciting opinions and values. They were presented in a standardized, open-ended format, with follow up questions to elicit additional information or seek clarification on the responses. Questions about respondents' present views were followed by questions about the past and then about the future.

Qualitative interviews can uncover the significance of experience when interpreted by the researcher and a negotiated reality is created (Minichiello, 1995). This approach of reporting in the language of those being interviewed requires the interpretation of what is communicated and recognition of common themes.

All farmers gave written permission for their comments to be reflected and analysed and all but one (Farmer A) gave permission for their identity to be revealed. The interviews were recorded and the responses to each question transcribed. The summary of each interview was then sent to the interviewee for approval and editing if required.

The questions:

Q1. What initially attracted you to the idea of growing trees on your property?

Q2. What were the factors that eventually influenced your decision to proceed?

Q3. Has the existence of the trees impacted on your cropping program? If so, how?

Q4. Have you faced any challenges/obstacles in managing the plantings? Please explain.

Q5. (For Kansai growers only) What impact did the termination of the Kansai project have on your business? Was it positive or negative?

Q6. (For Kansai participants only) Once the Kansai project was terminated, did you maintain the trees on your title?

Q7. What was the impact of the trees on the valuation of your property?

Q8. Do you observe the trees impacting on the growth of adjacent crops?

Q9 Do you currently undertake regular canopy management of your trees to reduce competition (i.e. cutting the trees to the base?)

Q10. Are you aware of the Oil Mallee Code of Practice? Can you suggest ways in which it can be improved?

Table 7.1 Response to the questions asked of the farmers

Farmer / Q	1	2	3	4	5	6	7	8	9
Fuschbichler	Financial	Salinity	yes	Farm machinery	no	N/A	negative	N/A	no
Stanley	Environment	Farming Sustainability	Yes and no	Design/ machinery	No/ opportunity	yes	Neg/unless harvested	Yes/ but Not always	Yes/coppicing ripping
Haeusler	Salinity	Financial	yes	yes	yes	no	negative	unsure	no
Hood	Salinity	Wind	N/A	no	neg ($)	no	positive	N/A	no
Strahan	Salinity / wind	N/A	yes	no	positive	yes	positive	N/A	no
Avery	Salinity / financial	Salinity/ Wind	yes	no	positive	no	nil	N/A	no
Farmer A	N/A	N/A	No	no	no	N/A	nil	yes	ripping
Kerkmans	Financial	no	no	no/fence	negative	yes	negative	no	no
Spark	Salinity	Wind / Salinity	no	no	no	yes	positive	yes	no
Ashworth	Salinity	N/A	yes	yes	positive	yes	negative	yes	no
Sullivan	Salinity, carbon, bioenergy financial	Farm plan	yes	yes	_	no	positive	yes	ripping

(For information on responses to Q 10 (the Oil Mallee Code of practice) refer to Appendix B)

7.5 Discussion and Observations

A total of 34 growers were approached to be interviewed. Of these, 24 were the total number of farmer participants on the Kansai Electric 1000-hectare project. The other 10 were managers of larger plantings that were not involved in the Kansai project. Twelve Mallee growers responded and were interviewed, 10 of them being farmers with plantations established by the Kansai Electric company. From the questions and discussion, the following factors or themes were developed to analyse the responses. The responses are quite powerful evidence of a number of observed benefits which add to and sometimes contradict the research on the role of the trees. The factors used to compare responses are outlined in Table 7.2 below.

Table 7.2 Comparison of selected factors influencing opinion on Mallee plantings

	Factor	Explanation
1	Crop Competition	Extent of "competition effect" of the trees on adjacent crops
2	Environmental impact	Effectiveness of the trees to enhance natural resources management (NRM) factors including salinity and wind erosion
3	Financial outcome	Possibility of the trees producing a financial benefit
4	Improved agricultural performance	Likelihood of the trees producing a positive influence on agricultural production
5	Impact of trees on the land value	Perception of the impact of the trees on the value of the farming property
6	Shelter and other services	The extent to which the trees produced positive services such as stock shelter
7	Pests	The role the trees might have played in providing a habitat for introduced farming pests
8	Aesthetics	The degree to which the trees enhanced the aesthetics of the farming property

The questionnaire revealed some common responses to the questions and conclusions have been drawn using the themes in Table 7.2 as follows:

- In relation to the initial interest in Mallees, most of the growers saw potential landcare benefits and possibly financial return and these issues also prompted them to invest.
- While the trees have generally been observed to have an impact on cropping returns, most respondents did not see this a problem when it came to managing the planting.

- The Kansai project termination did not impact the growers greatly but only half of them maintained the covenant protecting the trees on their title.
- A majority of the growers thought that the trees had a negative impact on the value of their property, but some commented that the trees had a beneficial impact on the look of the farm.
- There was a general consensus was that the trees impacted on the adjacent crops but some commented on the possible improvement in production in some circumstances.
- Only one farmer had managed the trees by coppicing, but some others would welcome this if it were part of a commercial operation.
- Three of the farmers were familiar with the OMA Code of Practice and felt more could be done with the Code to make it helpful in a commercial situation.

Table 7.3 Summary of opinions expressed selected factors

Factor	Details
1. Crop Competition	All acknowledged the impact of the belts of trees on their cropping programs but provided a variety of views on the extent of competition. Some pointed to the impact of different annual conditions and to the type of soil. There was an additional concern about trafficability of machinery and the added complexity of spraying.
2. Environmental impact	There was universal opinion that the trees had played a useful role in one or more functions: ameliorating the rising water table, slowing the accumulation of water in low lying areas and providing wind break and shelter.
3. Financial outcome	The potential for a financial return was attractive to most growers and played a role in deciding to plant the trees. The fact that the trees would be planted at no cost was also very attractive.
4. Improved agricultural performance	Some but less than half of the farmers believed that in some areas there was a noticeable improvement in productivity.
5. Impact of trees on land value	Most of the farmers believed that the trees had a negative impact on the farm value whether deserved or not.
6. Shelter and other services	Farmers found that the trees were very effective in providing shelter for farm animals.
7. Pests	Two farmers pointed out that the trees could be used by foxes and rabbits, two important pest animals.
8. Aesthetics	Several farmers nominated the positive aesthetics the trees brought to the farm.

All growers in the scheme had the trees supplied and planted at no cost to them and were paid an annuity which was originally intended to continue for 20 years. These factors could have influenced the responses. However, many of this group of growers had plantings in addition to the Kansai project. By comparison, other Mallee growers not engaged in the Kansai project, probably had access to low cost seedlings but had outlaid the cost of establishment.

The comments portray a very positive attitude to the trees with an acknowledgement of the difficulties created by the absence of a commercial framework which would facilitate management of the potential conflicts with normal farming practice. The positive attributes and aesthetics of trees in the landscape are anticipated and acknowledged. None of the trees have been removed despite the difficulties faced in some cases with competing land use issues.

7.6 Implications for the farm sector

Agriculture as a whole contributes roughly 14% towards Australia's total emissions or 20% if you include land clearing. This is in fact can understate the level of contribution as certain elements of production, eg machinery, are covered in another sector such as transport. However various farmer organisations are advocating for achievement of carbon neutrality at some stage and these ambitions, even ahead of a mandated limit on agricultural emissions, will reduce the perceived conflicts of carbon forestry with normal farming practice. It has been suggested that, with the strategic reduction in fertilizer use, reduction in methane emissions for livestock that the use of bioenergy and carbon sequestration from forestry, carbon neutrality can be achieved (Eckard, 2020). This industry ambition to become carbon neutral with make carbon sequestration and bioenergy very much attractive.

7.7 Summary

From a transition theory perspective, it is crucial to test the perspective of the niche level participants in a practice to ensure it can be promoted to the next level of meso adoption or socio technical regime. The chapter indicates that a sample of farmers in one region of the WA wheatbelt provided information on their perception of the agroforestry, both from the impact on their cropping program but also on the likely positive contribution to their farming practice.

The farmers surveyed from the Oil Mallee Project presented an overall supportive attitude to the positive role played by the Oil Mallee plantings. While not termed ecosystem services, the farmers acknowledged that a wide range of environmental benefits, including aesthetics and biodiversity, are delivered from trees integrated on their properties. However, there was limited support for the notion that the trees might improve the actual productive capacity of the farm, particularly as the trees are not managed or exploited for biomass. As a consequence there is also a common understanding that the trees actually lower the property value of the farm which impacts on borrowing and eventual sale. These responses add context and meaning to the discussion on co-benefits and ecosystem services delivery in Chapter 8 and throughout the remainder of the thesis highlighting that these community wide and environmental benefits are not valued or rewarded.

A summary and approved record of the interviews with individual farmers is provided at Appendix B.

PART 4 –

CARBON AGROFORESTRY : LESSONS LEARNED

Chapter Eight

8

Sustainability Assessment and Carbon Agroforestry

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8.1 Introduction

All sustainability assessment frameworks for agroforestry, including bioenergy crops, contain performance criteria related to the appropriate use of land. This chapter assumes that carbon sequestration places the same potential stress on farmland and food production as land-based bioenergy. As such the pressure for regulation will apply to both technologies. Chapter 6 outlined how land use regulation impacted on carbon agroforestry projects advanced by the OMA and carbon companies which, in most cases, was developed by local and state governments. These planning regulations do not refer to sustainability as a framework per se, but rather highlight the need to avoid competition with food crops. Nevertheless, assessing the sustainability of carbon projects and bioenergy is an important consideration when seeking social licence to operate and particularly when exporting a crop or a processed agroforestry product.

This chapter considers the suitability and significance of international assessment processes on carbon sequestration and bioenergy programs, largely through the lens of bioenergy, and examines how local considerations may impact on the assumptions embedded in the assessment processes.

8.2 The sustainability of bioenergy

Agriculture, forestry and other land uses contribute a quarter of global anthropogenic emissions (Smith et al., 2014) and occupy 38 per cent of the terrestrial surface (FAO, 2007). One cause of emissions from this sector is the expansion of agriculture through land clearing. When this clearing is associated with the expansion of bioenergy crops, the positive climate change impact of this renewable energy source is compromised due to the emissions associated with clearing.

However another view is that while agricultural land has expanded at the expense of forest cover (Albanito et al., 2016; WAPC, 2012), much of the poorer quality agricultural land has been abandoned or reforested and can be used for bioenergy (Souza. G, 2015). Others suggest that the use of degraded land for bioenergy does not exempt the system from the claim that it is competing with land that has a potential use as food producing farmland (Spangenberg, 2009; Steffen & Csiro, 2009). Not only is there a definitional issue here as to what constitutes degraded land, but new technologies and new farming methods and crops are potentially able to make use of this land.

On balance there remains a concern that bioenergy crops can put pressure on land traditionally used for food (Sims, Mabee, Saddler, & Taylor, 2010). This concern has led to a complex set of measures to monitor land use through sustainability assessment and accreditation. Indeed, a critical element of the sustainability assessment process is the potential for land use change created by bioenergy crops. However, it is acknowledged that bioenergy can sometimes occupy land without necessarily disrupting overall cropping (Davis, 2013). Whether bioenergy directly or indirectly displaces farmland does not address the question of whether emissions are generated in the process of displacement. Land use change, where food crops are displaced by energy crops, can result in the opening up of forested land for agriculture in another place (induced land use change), causing emissions from the land clearing (Sims et al., 2010).

Both the pressure to grow energy crops on farmland in Europe and the controversial displacement of corn for food with corn for fuel in the USA have been created by market pressure and government policy. In the first instance by EU mandates on bioenergy use (Philippidis et al., 2019) and the latter by the quest for a degree of fuel independence (Davis, 2013; Lott, 2011; Philippidis et al., 2019; Splitter).

This same line of argument can also be applied to land used for carbon sequestration. This energy market driven pressure on land use, is similar to the carbon market driven pressure on land use (including in WA), where regulatory bodies consider the change from food crops to carbon agroforestry demands a response (see Chapter 6).

8.3 The particular case of emissions from bioenergy

Bioenergy sits uncomfortably across both the land sector and the energy sector when it comes to the reporting of emissions. As discussed in Chapter 5, under the IPCC convention, emissions for bioenergy are accounted through the land sector and reported as carbon neutral in the energy sector. In other words, the emissions produced at the point of generation are replaced over time by regeneration of biomass feedstocks. Other emissions associated with harvesting, transfer and exchange need to be acknowledged but are not disproportionately high (Cowie et al., 2017).

In the first Kyoto accounting period, some doubt was raised about the international transfer of biofuels and the possibility that not all land based emissions subsequently treated appropriately by nations that had not accounted for forestry and land use in their national accounts. This was corrected in the second Kyoto period when forest management became mandatory (Pena, 2011). Therefore, controls or standards have been adopted in the sustainability assessment processes to ensure that bioenergy retains its credible place as a pathway to lower global emissions. Consistent with this ambition, these standards should also apply to locally grown and utilised bioenergy and ephemeral carbon products generated on land including carbon sequestration.

Despite bioenergy emissions being accounted for in the land sector, most sustainability assessment frameworks (Souza, 2015) required that bioenergy emissions be substantially lower than the fossil fuel it displaces, up to 50% less. As bioenergy grows in importance, improvements in efficient technologies and land management practices will remove some of the uncertainty which has, at least in part, created this high threshold of comparison to be mandated (Berndes, Bird, & Cowie, 2011). In addition, bioenergy with carbon capture and storage (BECCS) will enable bioenergy to move beyond carbon neutral to be a negative source of emissions (Berndes et al., 2011).

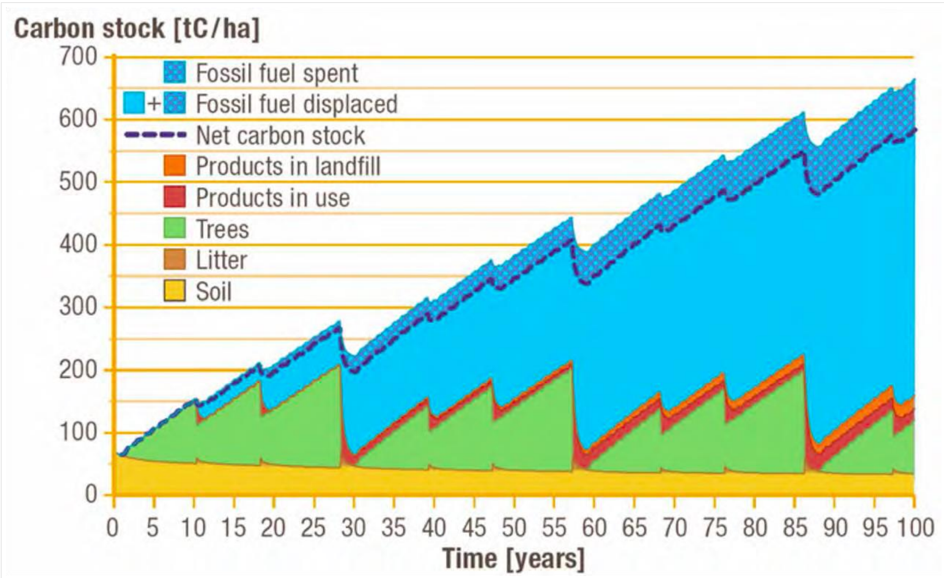

Figure 8.1 IEA Task 38

Source the IEA website: www.ieabioenergy.com/publications/ten-frequently-asked-questions-aboutbioenergy-carbon-sinks-and-global-climate-change/

Figure 8.1 demonstrates the significant levels of fossil fuel displaced by bioenergy generated by forestry-based bioenergy over time.

The diagram (Figure 8.1) demonstrates the regular harvesting or coppicing of trees (green) with consequential use of products and the waste displayed (red). The litter and soil impacts are displayed (yellow) and the fossil fuel displaced (blue), including the emissions spent. In Australia the displacement of fossil fuel has a value in the renewable sector but cannot be used to generate ACCUs under the ERF. A review commissioned by the Commonwealth and Chaired by Wal King (The King Review) recommends a change to this system and encourages the development of a CFI methodology to enable such recognition in the ERF (AustralianGovernment, 2020). This diagram displays the significantly greater climate impact of bioenergy from biomass compared to permanent carbon forests.

As discussed in Chapter Five, a significant debate has emerged relatively recently concerning the assumed carbon neutrality of bioenergy, related to the absorption of carbon emissions from the atmosphere back into a living bioenergy feedstock. There is debate about the length of payback time consistent with achieving climate change goals. In other words what is the correct time period over which carbon sequestration can occur to replace the carbon emitted from bioenergy (Brack, 2017b; Cowie et al., 2017; Searchinger et al., 2008). Increasingly the argument about carbon neutrality turns to the particular local context for the bioenergy, its sourcing of particular feedstock and its role in displacement of fossil fuels - the 'climate effect' (Cintas et al., 2016; Cowie et al., 2017). To balance this climate effect scenario, it is acknowledged that the long-term capacity of bioenergy to make a significant impact on mitigating carbon emissions through displacement of fossil fuels can be overshadowed by the short-term release of emissions from unregulated land use change. This short-termism can be exacerbated if carbon pricing drives market excesses such as inappropriate sourcing of biomass and carbon intensive processing (Berndes et al., 2011). At a local contextual level (WA Wheatbelt) these excesses can include the observed excesses of large-scale 'block' plantings leading to wholesale local displacement of farming land.

In the case of Mallee plantings (discussed in the case study in Chapters 6 and 7) the degree to which the planting for carbon or bioenergy is causing land use change is determined by the manner in which they are planted – as an integrated program or taking up a whole block or property.

8.4 Sustainability Assessment Systems

One way to help determine whether bioenergy creates unwarranted land use change and emissions from indirect land use change is to apply the filter of an international sustainability assessment process. There are several widely used indicators for the assessment of the sustainability of bioenergy (Fidelman et al., 2012; O'Connell et al., 2009).

The Food and Agriculture Organisation (FAO) Bioenergy and Food Security Criteria and Indicators (BEFSCI) project has investigated methods of identifying critical aspects of sustainable bioenergy and developed a range of tools to measure these characteristics (Beall, 2012). There are two categories of criteria - environmental and socio-economic. The environmental criteria include biodiversity, soil, water, biomass supply, greenhouse gas emissions and cross cutting tools to indicate land suitability. The socio-economic criteria include local food security, community development, energy security, gender equity, and a range of cross cutting tools that provide an integrated assessment. These indicators incorporate the nomination of particular environmental performance standards (Berndes et al., 2011).

The nominated standards of environmental performance in sustainability assessment processes can incorporate some broad regionally applicable environmental regulations for each location. While these regulations are mentioned, overlapping standards and local practices or controls are not considered in the sustainability assessment. This dilemma is considered later in this Chapter.

The FAO review on Bioenergy and Food Security (BEFS) (see Figure 8.2) from 2011 takes the bulk of these sustainability assessment criteria and implied indicators and also reviews the extent to which existing regulatory frameworks, voluntary standards and scorecards incorporate the comprehensive list of measurements. However, Figure 8.2 also shows that some frameworks, voluntary standards and scorecards do not include all sustainability criteria. The FAO review includes two additional groupings of criteria, Governance (compliance and participation/transparency) and Food Security (availability, access, utilisation and stability).

As a personal observation, it seems possible that these sustainability assessments are developed to accommodate a worst case scenario of inappropriate land use change and to meet the expectations of control expected by those hostile to bioenergy. The very number of the assessment systems suggests that a view of adequate control has not easily been achieved. The common principles of food security and the possibility of induced environmental damage elsewhere are embedded in most systems and therefore act as default systems of measuring sustainability against the threat of possible opposition. It is also clear that in most cases there is a distinctly European genesis in the creation of the particular system.

BEFS
Bioenergy and Food Security

Sustainability Aspects/Issues Addressed under the Initiatives Reviewed

	REGULATORY FRAMEWORKS								VOLUNTARY STANDARDS / CERTIFICATION SCHEMES													SCORECARDS	
	Biofuels Life Cycle Assessment Ordinance (BLCAO) - Swiss Confederation	Biomass Sustainability Order (BioNachV) - Germany	EU Renewable Energy Directive (RED)	Low Carbon Fuel Standard (LCFS) - California (USA)	Renewable Fuel Standard (RFS2) - USA	Renewable Transport Fuel Obligation (RTFO) - UK	Social Fuel Seal - Brazil	Testing Framework for Sustainable Biomass ("Cramer Criteria") - The Netherlands	Basel Criteria for Responsible Soy Production	Bonsucro (BSI)	Council on Sustainable Biomass Production (CSBP)	Forest Stewardship Council (FSC)	Global Bioenergy Partnership (GBEP)	Green Gold Label 2: Agriculture Source Criteria (GGLS2)	International Sustainability & Carbon Certification (ISCC)	Nordic Ecolabelling of Fuels	Roundtable on Responsible Soy (RTRS)	Roundtable on Sustainable Biofuels (RSB)	Roundtable on Sustainable Palm Oil (RSPO)	SEKAB Verified Sustainable Ethanol Initiative	Sustainable Biodiesel Alliance (SBA)	IDB Biofuels Sustainability Scorecard	WB/WWF Biofuels Environmental Sustainability Scorecard
1. ENVIRONMENTAL																							
1.1 Land-use changes (both direct and indirect)	√		√		√			√		√	√	√	√	√	√	√	√		√	√	√	√	√
1.2 Biodiversity and ecosystem services	√	√	√		√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
1.3 Productive capacity of land	√	√	√		√	√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√
1.4 Crop management and agrochemical use	√	√				√		√	√	√	√	√	√	√	√		√	√	√		√	√	√
1.5 Water availability and quality	√	√	√			√		√	√	√	√	√	√	√	√		√	√	√	√	√	√	√
1.6 GHG emissions	√	√	√	√	√	√		√		√	√		√		√	√	√	√	√	√	√		√
1.7 Air quality	√	√	√	√	√	√		√	√	√			√		√	√	√	√	√		√	√	√
1.8 Waste management	√		√		√	√		√	√	√	√	√		√	√		√	√	√		√	√	√
1.9 Environmental sustainability (cross-cutting)	√		√				√	√	√	√	√	√		√	√		√	√	√	√	√	√	
2. SOCIO-ECONOMIC																							
2.1 Land tenure/access and displacement			√			√		√	√	√		√	√	√	√		√	√	√			√	√
2.2 Rural and social development						√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	
2.3 Access to water and other natural resources						√			√	√	√	√			√			√				√	
2.4 Employment, wages and labour conditions			√			√		√	√	√	√	√	√		√	√	√	√	√	√	√	√	√
2.5 Human health and safety				√		√		√	√	√	√	√	√		√	√	√	√	√		√	√	√
2.6 Energy security and access								√		√			√				√		√		√	√	
2.7 Good management practices and continuous improvement				√	√			√	√	√	√	√	√	√	√	√	√	√	√		√	√	√
2.8 Social sustainability (cross-cutting)			√				√	√	√	√		√	√		√	√	√		√		√	√	
3. GOVERNANCE																							
3.1 Compliance	√	√	√	√	√	√	√	√	√	√	√	√			√	√	√	√	√	√	√	√	√
3.2 Participation and transparency			√	√		√	√	√	√	√	√	√		√	√	√	√	√	√		√	√	√
4. FOOD SECURITY																							
4.1 Food availability			√				√	√					√	√	√	√		√			√	√	√
4.2 Food access			√				√	√				√	√		√		√	√				√	√
4.3 Food utilization						√	√	√	√	√	√		√		√		√	√	√			√	
4.4 Food stability							√						√					√				√	
4.5 Food security (cross-cutting)							√						√					√					

DISCLAIMER: This table aims to provide an overview of the sustainability aspects/issues directly or indirectly addressed under each initiative, without any evaluation of the associated approaches and requirements.

The BEFS *Compilation of Bioenergy Sustainability Initiatives* (2011) is available here: www.fao.org/energy/befs/compilation/

FAO FIAT PANIS

Figure 8.2 BEFS review of sustainability assessment systems

8.5 General implications for particular bioenergy crops on agricultural land

A formal sustainability assessment is usually required by regulators and investors to accompany plans for new a bioenergy industry. As demonstrated in Table 8.1, environmental and socio-economic criteria need to be satisfied and a life cycle analysis undertaken to ensure the proposed carbon emissions savings are achieved after all stages of production and consumption.

A good example to demonstrate the sustainability assessment of existing exported biofuels is that for canola grown in the WA Wheatbelt. The EU directive applied to the canola exported from WA to Europe is part of an assessment system that incorporates land use impacts and the life cycle analysis at all stages of the project, including after the harvested seed arrives in Europe and is processed for biofuel (Australian Oilseeds Federation, 2021).

Another example of such an assessment is one that took place as part of an assessment of the use of Mallee biomass to create aviation (jet) fuel, discussed in Chapter 3. The Roundtable on Sustainable Biomaterials (RSB) assessment methodology is listed in the BEFS review published by the FAO and was the system adopted by the CRCFFI investigating the sustainability and life cycle assessment of Mallee jet fuel. The result of the assessment confirmed that such fuel would comply with appropriate sustainability criteria, but only just (CRCFFI, 2014). The BEFS Sustainability Assessment review classifies the aspects and issues related to sustainability assessment used by RSB under Environmental, Socio-Economic and Governance criteria plus consideration of the implications for Food Security i.e. land use.

To highlight the land use component of sustainability assessment, Table 8.1 reflects the land use impacts of existing and anticipated exported bioenergy products from WA and (for comparison) how carbon credits might be assessed using the Oil Mallee Code of Practice (OMCOP). Table 8.1 includes wood pellets exported from Albany, canola exported to Europe, prospective mallee aviation jet fuel and prospective carbon credits from Mallee agroforestry.

In the absence of an existing industry in place in WA exporting bioenergy, Table 8.1 indicates that bioenergy from mallee agroforestry would have positive consideration under two key aspects of sustainability, land use and LCA. All the bioenergy and carbon crops listed in Table 8.1 would most likely meet simplistic land use criteria, but would not be guaranteed to meet all of the criteria listed by the BEFSCI (2012) and BEFS (2011) summary of evaluation processes (Figure 8.1).

The principal objective of Table 8.1 is to illustrate the treatment of different exported biofuels and carbon credits when assessed for sustainability. The table lists the types of exported bioenergy and indicates whether the export is already taking place, whether and how the product is used in WA and identifies land use issues and life cycle assessment. In Table 8.2, the use of the OMCOP is compared with a range of international assessment systems to draw out differences and similarities.

Table 8.1 Examples of exported bioenergy products and international sustainability criteria plus a Code Of Practice

Form of bioenergy or carbon	Sustainability methodology currently used	Hypothetical /real /proposed	Local use options	Land use implications	Life Cycle Assessment	Impact on land
Mallee Aviation fuel	RSB* plus life cycle assessment *Roundtable on Sustainable Biofuels	Hypothetical	Transport fuel	RSB including LUC and iLUC Local planning regulations apply	RSB with full "Well Wheel" LCA	Beneficial - ecosystem services provided
Canola exported to Eu for biofuel	EU Directive on biofuels Checklist on landuse change by farmers	Real: 80% of WA canola exported to Eu for biofuels	Transport fuel	Land use evaluated by EU Biofuels directive	Low emission canola produced in Australia CSIRO review Undertaken on LCA	Beneficial - a rotation crop is provided which improves soil health and crop production.
Wood pellets (forest waste and forestry) exported to Holland	FSC* feedstock required by clients *Forest Stewardship Council	Proposed: Planned from late 2018	Limited to home heating	Replanting expected – reforestation- planted on land cleared after 1989) Local planning regulations apply	Carbon neutral – in Australia - linked to land sector	Beneficial - ecosystem services provided
Carbon credits from Mallee plantings	OMCOP CFI methodology Kyoto rules, JI, CDM	Real: carbon credits are transacted locally / hypothecated internationally	Carbon credits generated from Offsets	Land use change. Local planning regulations apply, (particularly if "block" planting is adopted)	Carbon neutral	Beneficial - ecosystem services provided – if integrated with agricultural production

8.6 Sustainability and local context

Sustainability assessments of exported bioenergy focus on the impact of the processes on the local physical environment as well as the LCA across the value chain. However, it should also be possible to assess the positive impacts, where they exist. Evaluating the efficacy of bioenergy needs to be undertaken with reference recognition of the potential for co-benefits such as improved ecosystem services delivered through bioenergy projects on agricultural land (Berndes, 2013; Harper, 2011; IEA, 2013; Salisbury et al., 2014b; Souza. G, 2015; WorleyParsons, 2009).

In some circumstances, environmental integrity is adequately supported by existing legislation or regulation. In these circumstances, the additional complexity and rigour mandated sustainability assessment indicators may not be appropriate. For instance, an evaluation of existing rules governing land clearing and protection of agricultural land in one region might indicate that normalised international assumptions about the impact of bioenergy on food security and land use change in this region may not be as important as elsewhere. Nevertheless, land use change impacts should be considered under standardised sustainability assessment guidelines using emission factors that can apply across quite different situations (Berndes, Ahlgren, Börjesson, & Cowie, 2013; Goss K., 2014; Souza. G, 2015). It is clear that the context in which biofuels displace food or fibre production should be considered.

While project proponents could seek to comply with externally developed criteria developed to cover all international situations, they could also develop regionally relevant, crop specific Codes of Practice (Berndes et al., 2013; Berndes, 2011b; Goss K., 2014). A suitable Code of Practice could accommodate locally imposed regulations at the national, state and local government levels. Compliance with all these standards would provide a solid foundation for inclusion of critical issues that might apply to individual crops and regions, identify positive attributes of biofuel crops (including ecosystem service delivery) and promote innovative additional market related practices. The role of a Code of Practice for the Oil Mallee industry is discussed later in this chapter.

8.7 Ecosystem service delivery

In the context of an ex ante sustainability assessment, a more detailed discussion of ecosystem services delivery is warranted. Ecosystem services have been defined by the MEA as having one or more of the following characteristics; supporting, provisioning, regulatory and cultural Laine et al., undated).In addition, there are ways to derive the economic value of ecosystem services through analysis of whether they have a direct use or alternatively a 'non-use' value such as an option value or bequest value. These non-use values can include supporting services and biodiversity (Alcamo, 2003a; Heal, 2000). There has been a number of studies which have monitored the level of biodiversity introduced through agroforestry (Baumber, 2016; Bryan et al., 2015; Standish & Hulvey, 2014), and some in particular that looked at integrated Mallee plantings (Leng, 2018; Lyons, 2008; Smith, 2009, 2007).

The cultural dimension of ecosystem services includes aesthetics, such as a positive change in the landscape, that could be generated by a move from a totally cleared landscape to partially forested. The value placed on improving the landscape is mentioned favourably by farmers as reported in the Oil Mallee Project Farmer survey (Chapter 7) and, in the report on Mallee aviation fuel, identified as an additional feature of the Mallee agroforestry program.

Placing a particular natural capital value on aesthetics as an ecosystem service is complex but potentially achievable through an hedonic process (Heal, 2000). This process would identify the sale price or value of properties with different levels of forestry and then attribute the values against the matching levels of forestry on the property. A survey of this kind has been conducted in Victoria where it was possible to attribute an additional 'natural capital' value to the properties with a higher level of trees (Polyakov, 2015). Within the range of properties studied, Polyakov (2015) found there was a value placed on the trees. It is important to note that a number of the properties surveyed were smaller farms of a hobby farm character rather than fully commercial rural properties. This valuing of co-benefits and ecosystem services is discussed further in Chapter 10.

8.8 Applying a contextual approach to local sustainability assessment

Many regulatory environmental systems, voluntary codes of conduct, sustainability assessment schemes and scorecards related to bioenergy, incorporate similar criteria for compliance (Fidelman et al., 2012). While these systems generally involve evaluation against a set of common criteria related to environmental performance, there is need for caution because the particular context can result in unintended consequences and risk of policy failure. Looking beyond the immediate environmental impact, the choice of feedstock, the location, the production and use of bioelectricity or biofuel, and the target fuel being displaced, all need to be considered to ensure that the resultant climate effect is achieved through reduction in emissions as measured by life cycle analysis (Cherubini, 2010; Glithero NJ, 2012; Lemoine DM, 2010) .

An integrated assessment process would ensure the climate effect of bioenergy is properly assessed, incorporating carbon sequestration, multiple outcomes and efficient processes. In addition, it can help confirm the climate effect if the project is located in an area where there are significant regulatory controls in place that address local and regional environmental and planning risks.

8.9 Incorporation of existing legislation/regulation

In relation to the question of context, many of the regulatory and non-environmental factors incorporated in the RSB sustainability assessment are already addressed in existing regulations in the State of Western Australia (Dawkins, 2011a; DPIRD., 2019; EPA, 2007; EPA., 2018; Planning Lands and Heritage, 2019). This suggests that many of the protective and precautionary factors included in the assessment process that might be needed in other situations, are not required to be assessed in such a well-regulated and governed location.

For instance the land use issues relating to agroforestry on agricultural land have been encapsulated in current planning regulations and policies which protect the productive use of good quality land (*WASAT 111*, 2011), (WAPC, 2012). (See Chapter 6 for a more detailed explanation of these planning regulations). Under these planning regulations and policies, planning permission is required for forestry to protect agricultural land and this indicates that robust land use controls are in place. The existence of these regulations reduces this issue from detailed consideration under sustainability assessment to acknowledgement of compliance, particularly when these controls are encapsulated in a Code of Practice.

At the national level, the Carbon Farming Initiative (CFI) methodologies which govern the eligibility of farm forestry carbon plantings in Australia, also contain conditions for suitable design, size and location (rainfall) of eligible projects which strictly limit the likelihood of inappropriate land use change ("Carbon Credits (Carbon Farming Initiative) Regulations ", 2011). All carbon projects seeking to be compliant with the CFI, are also required to consult with the local Catchment Authority or similar organisation.

The utilisation of existing policies and measures in Australia that govern the use of agricultural land should be the starting point for assessment of the sustainability of an agroforestry project that produces biofuels or carbon sequestration. This existing regulatory framework provides support for an assessment process where consideration of the sustainability of biofuels on agricultural land can be simplified. Existing regulation can be reviewed to ensure that key environmental, socio economic and governance regulations are in place and then used to satisfy international customers and standards. The range of sustainability assessment guidelines seems to assume a universal deficiency in controls, perhaps based on the legacy of past performance.

The requirement to comprehensively address sustainability assessment in some locations could possibly be reduced to the potential of bioenergy to displace GHGs - as long as adequate local regulations are adhered to and encompassed in a code of practice. This might be possible when suitable trade-offs between climate change impacts (fuel switching) and environmental impacts are identified and market failure in the delivery of ecosystem services is acknowledged (Berndes, 2011b; Rooney & Paul, 2017; Stephens, 2014b).

It is proposed that by looking at regional circumstances, bioenergy projects may overcome the general land use conditions related to displacement of farmland and/or the creation of emissions from clearing. It may be possible to incorporate local circumstance in codes of practice which can then be utilised as sustainability tools.

A more integrated assessment process aligned to local conditions and circumstances would involve development of locally relevant indicators and an evaluation of the effectiveness through feedback and response (O'Connell et al., 2009). This approach would more effectively capture the beneficial aspects of some forms of land use change and would have the potential to capture a variety of ecosystem services based on generalised research rather than specific outcomes or specific inputs (O'Connell et al., 2009).

8.10 The Oil Mallee Code of Practice (OMCOP)

The Oil Mallee Code of Practice (OMCOP) is outlined and described as an iterative and regionally specific set of guidelines which carries many of the conditions required of a sustainability framework.

OMCOP was developed by the OMA over two years with intensive consultation during 2014/15. OMCOP endeavours to fulfil the role of a guide to sustainable practices for agroforestry related to carbon sequestration and bioenergy. In this Chapter it is proposed that regional circumstances and conditions need to be taken into account when considering the production of bioenergy on agricultural land. In keeping with this approach, it is appropriate to have a regional and iterative planning and assessment tool to achieve best sustainability practice in a region or locality and to guide policy and certification. Compliance by bioenergy operators with suitably designed Code of Practice which specifies actions in response to local circumstances and conditions, is thought to be a sufficient guide to sustainability (Berndes et al., 2013; Berndes, 2013, 2011b; Goss K., 2014).

OMCOP is informed by existing standards and protocols and has been developed using recognized certification programs such as ISO 14001 Environmental Management Systems, the Australian Forestry Standard (AS 4708-2007) and the Forest Stewardship Council (FSC) International Standard. It also references the Code of Practice for Timber Plantations in Western Australia (Forest Industries Federation 2014). OMCOP incorporates reference to all relevant State and Commonwealth legislation and regulation which governs planning, environmental management and land management. In addition, the design of carbon projects is guided by the Commonwealth climate change legislation, including CFI legislated methodologies on the manner in which carbon sequestration is undertaken and managed.

OMCOP provides minimum standards which detail the lowest level at which a production stage meets the Code of Practice and a requirement for record keeping. The Code of Practice also contains Guidance Notes which address practical aspects of each stage of production. These Guidance Notes are to be updated in line with changes to regulations and legislation plus emerging approaches to best practice in the industry. OMCOP was developed with the assistance from the Commonwealth of Australia through funding provided under the Caring for Country program.

OMCOP encourages adoption of sustainable practices and the monitoring of its own effectiveness through continuous updating and feedback response, important activities required of an integrated assessment system (Farine et al., 2012; O'Connell; O’Connell et al., 2009). As stated earlier, the Code of Practice has the potential to capture benefits of a process that is based on generalized research rather than the specific outcomes or specific inputs required of many sustainability assessment systems (O’Connell et al., 2009).

8.11 Analysis of OMCOP against the Issues and Aspects of the BEFS sustainability frameworks

The role and relevance of sustainability frameworks applied to bioenergy has been discussed. The Bioenergy and Food Security (BEFS) table produced by the FAO (Table

8.2) indicates a range of “Aspects and Issues” addressed by several frameworks intended to encourage and validate sustainable practices and measures.

In order to investigate the adequacy of the OMCOP to achieve most of the key features of the BEFS sustainability framework, it was decided to take the list of BEFS Aspects and Issues as the basis for comparison with a range of sustainability measures. Table 8.2 contains Aspects and Issues common to the different assessment frameworks. In Table 8.3 these aspects and issues are presented with a selection of four of the frameworks – two regulatory frameworks and two voluntary standards. To this selection of frameworks is added the Oil Mallee Code of Practice to enable a comparison.

Table 8.2 The FAO Review of sustainability assessment initiatives – selected measures plus OMCOP

BEFS Aspects /Issues	LCPS[1]	RTFCO[2]	RSB[3]	FSC[4]	OMCOP[5]
Environmental					
Land use changes (LUC and ILUC)				x	x
Biodiversity and ecosystem services		x	x	x	x
Productive Capacity of land		x	x	x	
Crop Management and Agrichemical use		x	x	x	x
Water availability and quality		x	x	x	x
GHG emissions	x	x	x		
Air quality	x	x	x		
Waste management		x	x	x	
Environmental sustainability (cross cutting)			x	x	
Socio-economic					
Land tenure /access and displacement		x	x	x	x
Rural and social development		x	x	x	
Access to water and natural resources		x	x	x	
Employment, wages, and labour conditions		x	x	x	
Human health and safety	x	x	x	x	x
Energy security and access					
Good management practices, improvement	x		x	x	x
Social sustainability (cross cutting)				x	

BEFS Aspects /Issues	LCPS[1]	RTFCO[2]	RSB[3]	FSC[4]	OMCOP[5]
Governance					
Compliance	x	x	x	x	x
Participation and transparency	x	x	x	x	x
Food Security					
Food availability			x		
Food access			x	x	
Food utilization		x	x		
Food Stability			x		
Food security (cross cutting)			x		

[1] LCPS - Low Carbon Fuel Standard (USA) - Regulatory Framework
[2] RTFO - Renewable Transport Fuel Obligation (UK) – Regulatory Framework
[3] RSB - Roundtable on Sustainable Biofuels (Biomaterials)(Int) – Voluntary Standards / Certification
[4] FSC – Forest Stewardship Council – Voluntary Standard
[5] OMCOP - Oil Mallee Code of Practice (Australia) – Voluntary Code of Practice
X indicates that this aspect is addressed

Table 8.3 A comparison of the OMCOP and the areas (principles) classified by the BEFS review of sustainability assessments.

Oil Mallee Code of Practice minimum standards (selected areas)	Sustainability Aspects/Issues (BEFS Review)
2. Location Planning and Design	*Environmental*
Layout Considerations	2.7 Good management and continuous Improvement.
Existing Native Vegetation	3.1 Compliance
Planning Approvals and planting on Zoned Agricultural Land	1.2 biodiversity and ecosystem services
Planting in Public Drinking Water Source Areas	1.1 Land-use changes
Enhancing Environmental Values	1.5 Water availability and quality
Aboriginal Heritage	1.1 Biodiversity and ecosystem services
Occupational Health and Safety	2.1 Land tenure/access and displacement
	2.5 Human health and safety
3. Management Plans	*Governance*
Fire Management Plan	3.1 Compliance
Animal Management Plan	2.7 Good management practices and continuous Improvement
Location Map	3.2 Participation and transparency
4. Access	*Socio-economic*
Private Roads and Tracks	3.2 Participation and transparency
Public Roads	3.1 Compliance
5. Establishment	*Socio-economic*
Site Assessment	Good management and continuous imp.
Species Selection	Productive capacity of land
Site Preparation	Crop management and agrochemical use
6. Maintenance	*Environmental*
Fertilising	1.4 Crop management and agrochemical use

Oil Mallee Code of Practice minimum standards (selected areas)	Sustainability Aspects/Issues (BEFS Review)
Weed Control	
Insect Control	
Disease Control	
Tending	
7. Carbon Abatement	*Governance*
Oil Mallee Carbon Abatement Projects	GHG Emissions
CFI Methodologies	3.1 Compliance
CFI Integrity Standards	3.1 Compliance
CFI Reporting	3.1 Compliance
8. Harvesting	2.7 Good management practices and continuous improvement
9. Supply of Biomass	1.9 Environmental sustainability
10. Biomass Processing	3.0 Governance
11. Storage and Handling of Chemicals, Fuels and Oils	3.1 Compliance
12. Integrity in Forecasting	3.0 Governance
13. Incident Management	3.1 Compliance
14. Neighbour Relations	2.2 Rural and social development
15. Knowledge Management	3.2 Participation and Transparency

Table 8.3 shows that OMCOP achieves a significant alignment with the four BEFS frameworks with key elements and principles common to both with respect to systematic approaches to sustainability. The BEFS criteria (Aspect) which is least addressed is in relation to Food Security. The Framework that most comprehensively addresses this aspect of sustainability is the Roundtable on Sustainable Biofuels (RSB) which considers availability, access, utilisation, stability and links between them through cross cutting analysis. With the addition of these food security issues, the OMCOP would be more complete.

The application of a locally determined OMCOP would largely remove some of the less relevant aspects and issues in a range of sustainability frameworks – including the key issue of land use change and food security. The CRCFFI study on aviation fuel being produced from mallees in Western Australia used the RSB to validate the sustainability of the hypothetical project and was required to address an analysis of the food security issues (CRCFFI, 2014). In the absence of a local analysis or local set of controls incorporated into a code of practice which also acknowledged international protocols, this would always require significant attention.

8.12 Benefits of OMCOP

A code of practice that is developed for application in a region with particular specified national and local characteristics needs to have certification as to meeting the essential tests of sustainability. In terms of global compliance and recognition, certification of the code of practice would have to be undertaken by an international body that has the capacity to recognise that the absence of some specific criteria (Aspects and Issues) does not necessarily impact on the sustainability of the project in a particular region. The iterative nature of the bespoke regional sustainability methodology also needs to be monitored with updates and changes being considered by the same international organisation. A code of practice needs to be capable of being adapted for regional level application and overseen and assessed for global compliance.

The use of the OMCOP for carbon agroforestry can be advocated as preferable to an international sustainability assessment system as it specifically addresses local issues and excludes aspects that are adequately addressed by local governance controls. The OMCOP can overcome some of the dilemmas faced by proponents of agroforestry in productive farmland in dryland Australia. For instance, many proposals for agroforestry suggest that the project will be carried out on "unproductive" or "marginal" cropping land or even "abandoned land". Adoption of this approach suggests that the problem of land use conflicts will be avoided, when adoption of the OMCOP can specify the conditions under which these dilemmas can be avoided and agroforestry can be planned for productive land.

In addition there are instances, such as in Western Australia, where there are strong regulatory controls available to enforce protection of farmland and long leases of pastoral land where the State Government maintains a watching brief over the land (see 6.7 where the Jerramungup case is discussed). The recent report on Salinity by the Auditor General of Western Australia highlighted what best practices may be required to protect land from salinity encroachment, but also nominated the residual powers of the State to enforce better management (WAGovernment, 2018). These controls, policies and powers can be assumed to accommodate many of the areas identified as missing in the OMCOP as compared to the range of international sustainability assessment schemes. Oner key power in Western Australia, discussed later in section 9.2, is the broad ranging power of the State to ban land clearing.

8.12.1 Continuous improvement, adaptive governance

Advocacy for regionally appropriate sustainability assessment of bioenergy crops on agricultural land, as opposed to using a relatively static global framework needs to include a requirement for regular review. Under the variable nature and impact of climate change, it is considered necessary to adopt continuous improvement processes and adaptive governance practices to ensure that changes are recognised and factored into consideration (Termeer, 2010); (Dunford, 2018). While it is possible to have multiple levels of government involved in overseeing governance of regional projects with sustainability accreditation, it is important to ensure that guidance is available at the level of governance closest to the region involved. This principle of subsidiarity[26] is considered a key and often missing characteristic of adaptive governance of regional sustainability projects (Dunford, 2018; Steffen & Csiro, 2009). The RIRDC *Review of global bioenergy sustainability frameworks and assessment systems* (O'Connell, 2009) provides a comprehensive review of the international systems and importantly a guide to the processes required to ensure they are embedded into a systematic implementation. An important element of this process is the endorsement by "communities of consent" which include,

[26] Subsidiarity: the principle that decisions should always be taken at the lowest possible level or closest to where they will have their effect, for example in a local area rather than for a whole country (Cambridge English Dictionary on line, 17/3/20)

> "A license to operate from communities of consent is a major industry enabler. There is multitude of people and organisations involved in establishing and operating bioenergy value chains. This report makes the distinction between stakeholders, who have a direct investment, share, concern in the value chain communities of consent, which provide the stakeholders with a license to operate. This license to operate may constitute formal licensing and regulatory processes, but also refers to impacted communities who may protest vigorously and stop the formal consent processes, or consumers who provide ultimate consent by buying the product. Ideally, a community license to operate is gained at an enterprise and industry level through structured dialogue and consultation with stakeholders as well as the communities of consent." (O'Connell, 2009)

Also, while the CFI methodologies are not sustainability frameworks, they have become infused with requirements related to specific rainfall and other matters. These requirements within the methodologies address the risk of undesirable land use change. At the same time, using the WA example, local and state regulation to address concerns about land use duplicate or are even more strict than those applied through the methodology. Without modification, these carbon sequestration methodologies could remain a component of any regionally based sustainability framework or assessment system, possibly in place of other land use issues controls, such as contained in the RSB.

8.12.2 OMCOP and ecosystem services

OMCOP does not endeavour to outline the full range of ecosystem services that might be secured from adoption of these practices, but it does refer to the immediate benefits that are expected to accrue and the possibility that continuing compliance with the Code could add value to the farming operation.

Essentially OMCOP proposes that Oil Mallee plantings provide an opportunity for farmers to diversify their activities while contributing significantly to the mitigation of salinity and wind erosion, improving degraded land, and developing sustainable land-use systems. Integrated agroforestry, where belts of Mallee eucalypts are planted across crops or pasture is undertaken in many regions across the WA Wheatbelt. The Code provides managers of Oil Mallee plantings with a single reference document for Oil Mallee production systems in Western Australia. Adhering to the Code will assist growers to secure the sale of Oil Mallee products and generate revenue from their sustainable land practices (Oil Mallee Australia, 2012).

There are no specific guidelines for accreditation provided in the Code of Practice but the need for a systematic approach to auditing is identified. The Code also clarifies that in some situations, the ownership of the trees and the land can differ. For example, there might be trees grown for carbon or bioenergy by an entity not related to the farmer or land manager, but to whom the landowner charges a lease fee for access. The Code of Practice identifies the land owner as the key person who retains key responsibility when it comes to disputes.

The Code of Practice has a number of Guidance Notes which outline the different standards that might be required and incorporates more explicit references to the ecosystem services achievable at different standards of compliance. The Code of Practice document specifies ‘minimum standards’ and Guidance Notes provide ‘superior standards’ and the reasons why adopters of the Code might seek to achieve these standards.

8.12.3 OMCOP and integration

An important aspect of the Code of Practice is the emphasis placed on integrating agroforestry into the farming program. This integration model of agroforestry has been developed to enhance the impact of trees on water table management and the reduction in wind erosion. These measures to enhance the impact of the trees on salinity and wind erosion could improve the productivity of cropping programs.

Reducing the impact of salinity and wind erosion is achieved through avoiding the prospective loss of arable land in the absence of action (Berndes, 2011a; Neary, 2011; O’Connor, 2004). However, aligned to integration of agroforestry and farming is the potential to increase total farming profit and add community benefit through new forms of commerce involving new products from the forestry, including local processing of bioenergy, eucalyptus oil and other products and bi-products such as biochar (Paul et al., 2013).

As discussed in Chapter 6, there has been some doubt cast on the effectiveness of a range of technologies including agroforestry on limiting the impact of encroaching salinity (Pannell & Roberts, 2010; Pannell et al., 2012). These assessments by Pannell and Roberts (2010) also followed a report from the Australian National Audit Office in 2014 which found the funding had not necessarily been well spent when matched to the immediate objectives of the National Action Plan for Salinity (NAP) program (Auditor General, 2004). While the Pannell and Roberts report was critical of the NAP program, they did not take a broader perspective on impact of the expenditure on land use or other benefits (Pannell et al., 2012).

The OMCOP is designed to ensure practices are standardised yet flexible i.e. open to change. This enables the Code to reflect the methods of capturing environmental and ecosystem services as the impacts at the regional level are monitored and optimised. This approach is similar to the best practice guidelines developed by the IEA to provide advice and learnings to the bioenergy industry on a global scale (Berndes, 2011a; Neary, 2011).

8.13 Conclusion

This Chapter analysed the range of international sustainability assessment frameworks and the opportunity to simplify the assessment of sustainability of energy and carbon crops on farmland. With an iterative and regularly reviewed industry code of practice, the project proponent could ensure that a prospective project could meet the necessary sustainability assessment as long as it met the requirements of the code. Where national, regional and local standards exceeded or could replace the intended effect of the international assessment process, the code would be preferable and should be acceptable based on the principle of subsidiarity.

With some background provided in other chapters, it has been demonstrated that the issues of land use change, carbon neutrality of bioenergy and assumptions about biodiversity are volatile and can potentially frustrate commercial projects which can benefit farm production, ecosystem service delivery and mitigate substantial climate change impacts. Applying a transition theory framework to this set of circumstances , it is clear a fundamental question of confusing international conditions on the issue of land use, contested understandings of notions of carbon neutrality in relation to bioenergy and ambitions for dividends on biodiversity form agroforestry, have made the steps from niche to meso levels of adoption quite difficult.

The next Chapter investigates integrated agroforestry from the aspect of ecosystem services delivery and how this might be further encouraged.

Chapter Nine

9

Valuing Co-benefits of Carbon Agroforestry

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9.1 Introduction

It is an assumption of this thesis that sustainability accreditation and compliance with a range of environmental and energy policy requirements will be necessary prior to investment in carbon agroforestry being contemplated. The discussion of sustainability assessment in this thesis includes the possible shortcomings of applying international sustainability assessment processes to the sustainability of carbon agroforestry. The sustainability assessment processes do not tend to consider the positive aspects of carbon agroforestry, where they exist. A case study of integrated agroforestry utilising Mallee biomass on farmland in WA has been used to demonstrate this point.

In this Chapter, it is argued that the development of an acceptable way to identify and value the co-benefits of an integrated approach to carbon farming and bioenergy production could assist the case for the carbon agroforestry on farmland.

9.2 Background to regional sustainability assessment

It has been proposed in Chapter 8 that regional and local circumstances can be incorporated into sustainability assessment tools to counter assumptions about the negative impacts of bioenergy and land use change. For example, land use change definitions relating to agroforestry and bioenergy assume that when agricultural land is transferred to forestry, other land will be cleared for agriculture (iLUC), creating emissions from clearing and impacting food security. While the RSB has made available a 'low risk iLUC' approach, there is still a burden of proof that substantial LUC has not taken place (RSB 2015). However, if the project or category of carbon agroforestry projects can be shown to avoid the issue of iLUC, then other serious burdens of proof may be avoided – given that these conditions of approval are driven by the general uncertainty of LUC.

The two examples of biofuel crops in the WA Wheatbelt (outlined in Chapter 7) provide evidence of approaches to the way sustainability can be evaluated.

- Mallee aviation fuel has been assessed as attaining an acceptable level of sustainability using the RSB assessment system. The RSB assessment of this biofuel crop does not include land use change as a major consideration because there is an assumption that the integrated system does not create significant direct land use change (dLUC) as the agroforestry only reduces crop yields in a minor way (CRCFFI, 2014).

In the case of exported canola for bioenergy, the assessment process requires WA canola growers to attest that the land on which the grain is grown was already cleared and the life cycle assessment takes place in the country of destination, including emissions from imported biomass use as a fuel (Godard, 2018). These two examples highlight (as outlined in Chapter 5) that a key feature of bioenergy is that reduced emissions are achieved as a result of fuel switching away from fossil fuels. A more flexible approach to achieving compliance with sustainability standards is important if all options assisting the transition to a low emissions future are considered.

Some of this additional flexibility can be achieved if local regulations take a more prominent role in informing the international sustainability assessment processes, for example:

- Existing robust regulation covering the planning of rural zones (including protection of quality agricultural land);
- Vegetation management (including generalised bans on clearing native vegetation)
- Evidence of beneficial side effects of the introduction of carbon agroforestry (carbon sequestration and bioenergy) crops to farmland.

These aspects are specific and identifiable to a regional and even a local area. Notwithstanding these regulations and observations (Chapter 5), carbon agroforestry practices are limited by the CFI (as in the case of mallee eucalypts) to certain rainfall areas or to a certain scale of operation. International guidance on sustainability and national carbon methodologies should not determine good practice when local regulations and good farming common practice are in place.

Current sustainability assessment processes can overlook many positive impacts of carbon agroforestry on the environment generally or even on farming systems. A method of valuing co-benefits or ecosystem services is required. In the absence of a market or payment, these co-benefits are created with no direct financial benefit.

9.3 Existing approaches to ecosystem service valuation

The categorisation of ecosystem services was outlined in Chapter 4 and further information on how these services can be enhanced will now be discussed. Enhancement or destruction of ecosystem services can create broad benefits and disbenefits. The perceived need to value ecosystem services arises because actions by individuals, companies or governments can reduce access to ecosystem services by others without a cost penalty and actions to increase ecosystem services are not rewarded (Murtough, 2002; Smith, 2014b; Swinton, 2007). There are very few existing markets for ecosystem services but a sufficient number to make some observations about their characteristics, performance and governance. The Queensland Land Restoration Fund has been established as a scheme for valuing co-benefits in addition to carbon and a similar scheme is planned for WA(Queensland Government, 2021). (The WA Carbon Farming and Land Restoration Program Forum on 2 February 2021 was cancelled due to a COVID 19 lockdown and proximity to the State Election.)

The Productivity Commission in Australia has undertaken an investigation into the creation of markets for ecosystem services (Murtough, 2002). The Commission proposed that some common elements are necessary for a market to exist, particularly property rights. These property rights have important characteristics (see Table 9.1).

Table 9.1 Characteristics of property rights
Source: (Murtough, 2002)

Characteristics	Description
Clearly Defined	Nature and extent of the property right is unambiguous.
Verifiable	Use of the property right can be measured at reasonable cost.
Enforceable	Ownership of the property right can be enforced at reasonable cost.
Valuable	There are parties who are willing to purchase the property right.
Transferable	Use of the property right has a clear relationship with ecosystem.
Low Scientific Uncertainty	Use of the property right has a clear relationship with ecosystem services.
Low Sovereign Risk	Low in the sense that it does not prevent a market from forming. Moderate levels of risk and uncertainty.

Property rights characterised in this way enable distribution and exchange of the services between entities rather than determining the value of the services exchanged. Agriculture produces both negative and positive impacts on ecosystem services. Farmers cannot easily monetise the impact of services, as no market exists to reward positive services (e.g. management of water, improved soil, biodiversity) nor instigate compliance regimes to penalise negative services (e.g. nutrient run off, carbon emissions) (Ribaudo, 2010).

In order to place a value on the provision of ecosystem services it is important to acknowledge what is being created and what is being displaced. In order for the value of ecosystem services to be assessed against other costs, the interaction of these services with society need to be recognised, i.e. the interaction between the human realm and natural capital (Costanza et al., 2014). The perception of farmers and their own role in balancing these trade-offs has been shown to be very real but problematic for agriculture (see Chapter 7). Reducing the negative services and increasing the positive may have other impacts, such as reduced production (Smith, 2014b). This is the basis of the argument for payments from government to compensate farmers for the delivery of positive ecosystem services (Smith, 2014b; Swinton, 2007).

Following the very earliest conceptualisation of ecosystem service delivery (Costanza, 1997), there has been considerable increase in the academic literature, expanding on the concept by identifying the range of services being provided and the potential to commodify or even privatise the services through valuation (Costanza et al., 2014). The macro study undertaken by Costanza et al. in 1997 and repeated in 2014 enabled an estimate of the ecosystem loss over that period. Land use change is a major cause of ecosystem loss which therefore can potentially result in an equivalent negative impact on human wellbeing.

Ecosystem services are public goods (or common pool) resources (Sarker, 2008), i.e. they are not generally exchangeable for other services or resources (see section 10.4 below for more discussion about public goods). As a consequence, markets cannot always be used to limit or increase these services. The market-based attributed to Ronald Coase (the Coase Theorem) relies on enforceable contracts and property rights to ensure that negative externalities can be addressed where necessary (Costanza et al., 2014; Hahn, 2013). This may work well in certain situations such as the trading of carbon emissions, but if efficiency becomes a predominant concern, it is possible that unintended consequences can emerge. An example used by Costanza et al. (2014) is that monoclonal (or monocultural) eucalyptus plantings can achieve an efficient carbon sequestration function but may not maximise the potential for ecosystem delivery.

This example also illustrates a trade-off that characterises ecosystem service delivery. That is, while it is desirable that ecosystem service potential is maximised, the climate effect (net reduction of carbon emissions) of particular carbon sequestration and bioenergy projects can also be seen as a targeted benefit associated with an *optimum* set of ecosystem services.

However, in most cases when describing ecosystem service delivery, the services are bundled and non-specific and assumed to be in the service of the community and deliver social benefits. It is therefore the absence or removal of ecosystem services that is associated with social disbenefit. Market failure arguably occurs where non-specific loss of ecosystem services or the absence of their recognition exists. Adding another dimension to this discussion, Constanza et al. (2014) describes the anomaly of invoking market-based solutions where market failure has been the culprit or cause of the poor allocation of resources. Notwithstanding this possible dilemma, there is a need to encourage the provision or replacement of ecosystem services and this. The requires a value proposition that can lead to payments for ecosystem service delivery.

9.4 Payment for Ecosystem Services (PES)

There are two main types of payment for ecosystem services (PES). One is a market-based approach designed to construct property rights around a resource or capital stock (e.g. carbon.) The second is a public good or common pool resource approach where a direct payment is made for the establishment or re-establishment of a service. Vegetation can be conceived of as a common pool resource (Sarker, 2008).

In relation to the public good or common pool payment, monetary values need to be established for bundled ecosystem services in an agricultural context. Apart from the provisioning services such as food production, ecosystem services in agriculture include regulation of water, wind and climate effects, the possibility of pleasant aesthetics and cultural services and other supporting services such as soil health (TEEB, 2009). Instinctively, scientifically and experientially, farmers appreciate these services and non-market methods are proposed to secure a value as a reflection of their importance to society (Swinton, 2007).

While most ecosystem services are public goods, in order to further analyse a valuation process, an additional description of ecosystem services is required. A public good has a defining characteristic in that the service is consumed by more than one individual (Bateman, 2003). Public goods are also defined as being non-rival and therefore potentially available to all, while private goods are rival and therefore more limited in supply and subject to competitive pressure and a market determined price (Samuelson, 1954).

The valuation of some public goods can be quite complex. For example, a particular environmental amenity or location can be freely available and highly valued but if the place or amenity is difficult to access, then this otherwise high value can be challenged. The value placed on the choice and certainty of access can turn a public good into private good where there is implied rivalry i.e. not everyone can gain access. It is therefore necessary to go beyond traditional economic theory to find ways of determining what people think of and how much they care about the utility of a service. We need a non empirical approach to measurement of value that gives meaning to comparative economic analysis.

The concepts of willingness to pay (WTP) and willingness to accept (WTA) have been developed to measure attachment and behaviour. Therefore, through surveys and modelling, it is possible to make comparisons between options as well as to enable consumers to state a value and a price or a range of prices (Bateman, 2003; Hanemann, 2003). The problem associated with determining the price of a new service or product is similar to the problem of estimating the value of a set of ecosystem services or environmental disbenefits (Bateman 2003)

These non-market methods used to measure value across a range of difficult to measure valuation and can include travel costs, contingent valuation, stated and revealed preferences, hedonic valuation and cost-based approaches (Swinton, 2007). The concepts of contingent valuation, hedonic valuation and cost-based valuation are outlined below.

9.4.1 Contingent valuation

Contingent valuation is a form of welfare economics using stated preferences or revealed preferences (Olsen, 2012). When applied to ecosystem services, it involves surveying people's attitudes to different situations and can include a 'option demand' from people who are not necessarily going to utilise the ecosystem services directly. This valuing system incorporates the notion of WTP. Unlike a traditional demand curve for a service, WTP is an expression of the maximum level of payment someone is prepared to pay (Hanemann, 2003).

9.4.2 Hedonic valuation

The concept of hedonic valuation of ecosystem services refers to the differentiation between property sales. When one property has significant projects delivering ecosystem services and another does not, the price difference reflects the impact of projects on productivity (often in the case of a farm) or the added value of these services (in a recreational setting or a specific horticultural pursuit). The value of some ecosystem services will be easily determined, such as provisioning and regulating services to do with production and soil quality, which are measurable and have a market value. The value of other services such as natural pest control may be less obvious, which means that they may be undervalued.

Studies have shown that land with proximity to natural bush and water can attract higher prices when the agricultural values are similar to other land without these characteristics. ln these circumstances, capitalisation of non-market ecosystem services may occur, and amenity values such as landscape and water bodies may be recognised (Ma, 2010; Polyakov 2015). It has been suggested that natural capital can be recognised in the value of farming properties as a reflection of the commitment of farmers to manage productive and non-productive land and natural assets (Manson, 2015).

9.4.3 Cost based methods of valuation

Cost based methods of valuation do not reflect stated preferences but rather the real cost of replacement of a necessary service which has been disrupted by a new form of production or land use. Alternatively, cost based methods can be used to put a value on the cost of avoided damage when pre-emptive action is required (Olsen, 2012). In the case of a farm, this might be the cost of a shelter belt or the replacement of a shelter belt if one has been removed.

9.4.4 Factor income

Factor Income approaches are based on the relationship of market-based services and non-market ecosystem services and the degree of interplay between them. If the removal of a non-market ecosystem service reduces the productivity of the marketed goods or services, then the value of the ecosystem service can be estimated. The same would apply if a non-market service were added to a system causing an increase in production (Khan, 2014). This process would be difficult to value if the addition or removal of a non-market service did not improve production but created public benefits unrelated or minimally related to production.

The impact of a relatively small change of non-market ecosystem services to an agricultural production system can be measured and can produce additional income (Swinton, 2007). This impact provides a guide to the value of that service. In the context of agricultural landscapes, there is evidence of potential value in beneficial insects and pollinators that are supported by vegetation (including agroforestry) that is grown near agricultural land. More broadly, there is a growing recognition of a link between the management of ecosystem services and sustainable and possibly improved agricultural production (Costanza, 1997; Smith, 2014b; Swinton, 2007).

As discussed, in the absence of markets for these services, non-market valuations can guide policies and incentives that can be introduced for the benefit and/or protection of society. The linking of climate change policies, markets and ecosystem services has become more common (TEEB, 2009). The preservation of forests to prevent clearing and consequential emissions (avoided deforestation), achieves a very clear justification for payment for ecosystem services. The TEEB report of 2009 also links dependence on protection zones across the world to the livelihoods of significant populations of rural and ocean people. In addition, where preventing damage to vulnerable environments is cheaper than restoration, the value of ecosystems becomes obvious. Nevertheless, restoration can still produces significant social and community benefits (TEEB, 2009).

9.5 International application of Payment for Ecosystem Services (PES)

While PES is largely a theoretical construct, there are some international examples that demonstrate how placing a value on a service or a desired attribute can alter the prevailing dynamic of degradation or environmental damage. The examples below highlight the way in which policy on PES can has beneficial impacts on ecosystem services.

9.5.1 The Grains to Green Program in China.

This program encouraged the conversion of grain fields to forest in order to prevent erosion and flooding and also to improve the habitat for giant Pandas (TEEB, 2009). Grain farmers were paid to plant trees and maintain the forest for eight years.

9.5.2 Costa Rica

The early adoption of PES in Costa Rica resulted in forest owners being paid for the services they delivered and people using the forest were required to pay. The scheme has been reviewed and seen to be beneficial but inequitable in that large forest owners benefit and there is little benefit to smaller and poorer forest owners, limiting the social benefit (Barton, 2013; Ina, 2012).

9.5.3 Agricultural Environmental Policies and PES

In the EU and USA there is a blend of Agricultural Environmental Policies (AEP) and PES and the use of one or the other is based on over-riding regulations and the time of adoption. AEP programs in the EU and USA have sometimes been described as ecosystem payments for setting aside land but have allegedly been used to contain over production (Potter & Wolf, 2014).

Potter and Wolf (2014) provide a useful history of PES and the evolution of AEP. They note the market based foundations of PES have been challenged by both green and neoliberal thoughts about the role of markets versus regulation. The agricultural community is not particularly inclined to take up the policies of the environmental community where these PES policies originated, particularly in developing countries. It appears that the PES schemes are still largely experimental and often input based rather than outcomes or performance based. In reality, they are similar to AEP programs that remain voluntary schemes with standardised payment systems. To gain better acceptance, PES schemes need to fit within a normalised AEP culture established between rural communities and governments (Potter & Wolf, 2014).

9.5.4 New York City

In the 1990's New York City started paying for improved land management in the Catskills watershed in order to preserve the city's access to clean water. This payment cost effectively enabled the city to avoid the cost of a water treatment plant (Thiel, 2018).

9.5.5 Bush Tender program

The Australian State of Victoria has an internationally recognised Bush Tender program where landowners compete through an auction to have State Government invest in improving remnant bush to achieve environmental outcomes. These environmental outcomes include ecosystem connectivity, biodiversity conservation, salinity control, maintenance of water quality, land protection and carbon sequestration. (Victorian Government).

The Bush Tender Program is often aligned with the Environmental Stewardship Program in the United Kingdom and the Conservation Reserve Program in the United States. The Environmental Stewardship program provides incentives for protection of specific upland and sometimes lowland sites. This approach of rewarding specific sites is being challenged and greater collaboration between land owners is being proposed to achieve a more landscape scale approach (Franks, 2013). The advantages of a landscape scale approach are argued on the basis of connectivity and permeability of a patchwork of sites, improvements in adaptation to climate change and other benefits to species. There is also discussion of integration of landscape forms including the incorporation of both farmland and natural habitat (Franks, 2013).

9.6 PES and a landscape scale approach

Discussion of examples of PES leads to consideration of the efficacy of the programs and the scale required to have the desired effect. Potter and Wolf (2014) suggest that financial support is moving opportunistically towards farming communities and away from preservation of natural sites. However, the trend is towards integration and a landscape scale approach. The integration of the Mallee plantings with farmland throughout the WA

Wheatbelt provides a good example of a landscape scale approach which, along with buffers and links to natural bush would possibly provide a good candidate for financial support under this trending approach to PES. If the PES scheme offsets the reduced production brought about by integrated agroforestry, then the 'trade off' between best practice sustainable farming and lost production can be accommodated.

9.6.1 Hedonic values and Mallee plantings

In the agricultural sector, the value of an ecosystem service for which there is no market can be determined through valuation of similar farming properties with different levels of that service (Heal, 2000). The comparison of future discounted valuation of properties can reveal the value placed on remnant tree cover and preservation of the natural vegetation (Polyakov 2015).

However, the difference in value can reveal the sacrificial trade-off made when integrating sustainable farming practices including planting trees on arable land. The normal practice of valuing farms is through the productive capacity of the property, namely the net arable hectares available for farming. The presence of trees can reduce the value of the farm by the area they occupy. This difference in value is the amount that might need to be provided in the form of a PES to encourage the farmer to leave the trees in place.

9.6.2 Contingent Valuation and Mallee agroforestry

When investigating the values farmers place on the full range of services delivered by agriculture as outlined by the Millennium Ecosystem Assessment (United Nations, 2000), the dual nature of agriculture becomes itself evident. The technical practices and interventions by farmers to maintain and increase production can also include practices that damage or reduce the long term productivity of the soil and reduce ecosystem services and their role in maintaining a suitable habitat for native fauna (Smith, 2014a). The dilemma is manifest in an assumption that a trade-off is required between production and valuable sustainable farming practices. In other words, the opportunity cost associated with delivery or protection of ecosystem services or biodiversity needs to be greater than the private benefit to the landowner. Smith (2014) also refers to other research that shows that farmers are willing to acknowledge their role in protecting ecosystem services and their benefit to the society as a whole, even if they do not recognise the collective term "ecosystem services". This opinion was reflected in the opinions of farmers reported in the Oil Mallee Project case study in Chapter 7.

A pilot survey of farmer attitude to ecosystem service delivery was conducted in New South Wales that revealed a high knowledge and awareness of particular threats to ecosystem services and to the productivity of agricultural land (Smith, 2014b). Despite this awareness, there was also an assumption of an implicit trade-off favouring particular agricultural practices and production. This is seen as setting up the case for payment of ecosystem services to reduce the risk of this trade off. In addition, cross-farm boundary issues exist when there is no incentive to take action and protect the interests of others when the issue has little or no impact locally. This cross-boundary issue also creates the circumstances for the payment for ecosystem services by providing a reason for action to create mutual benefit, financial on one side of the boundary and protection of ecosystem services on the other.

An example of this cross-boundary issue arose when policies were being devised to manage lateral water flows and reduce the impact of salinity on low lying land in the WA Wheatbelt in the 1990s. It was acknowledged that providing a reward to farmers who grew trees on the higher slopes of the catchment would provide benefit to the managers of low-lying land (Schofield, 1991).

The policy design implications are profound in that the science on its own is not sufficient in many instances to influence traditional practice. Many farmers would be reluctant to change practices and behaviour. Payment for ecosystem services may well overcome this initial hesitation, even if the payments do not fully compensate them for the opportunity cost.

9.7 Beyond valuation – addressing natural capital repair

In relation to the protection and repair of the Australia's natural capital, the Wentworth Group of Concerned Scientists have developed five long term institutional and economic reforms that together contribute to an overview that creates a 'healthy environment and a productive economy' (Wentworth Group, 2015). These proposed reforms address many of the landscape scale issues that they propose need to be addressed by engaging landowners and managers through a range of measures and markets.

The proposed reforms are:

- **Fix land use and water planning:** Develop regional scale land and water use plans that address the cumulative impacts of development on the environment and long-term costs to the economy.

- **Use markets:** Eliminate fossil fuel subsidies, set a long-term emissions reduction target and introduce an equitable, broad-based land tax to pay farmers, indigenous communities and other landholders to transform the way we manage the Australian landscape.
- **Conserve natural capital:** Close gaps in our national system of public and private reserves and commit resources to a long-term plan to conserve our threatened native plants, animals and ecosystems.
- **Regonalise management:** Embed and give prominence to natural resource management at the regional scale to reconnect people to the land, so that investment decisions are underpinned by an understanding of how landscapes function.
- **Create environmental accounts:** Establish regional scale, national environmental accounts that monitor the condition of our environmental assets, so that people can make better decisions to support a healthy and productive Australia (Wentworth Group, 2015).

The Wentworth Group Reform No 2 (Use markets) details the degree of market failure associated with the non-accounting of ecosystem loss in agriculture and the necessity to reward framers for good practice that includes good management of unvalued ecosystem assets. In broad terms, the Wentworth Group reform strategies provide a strong framework for broad analysis of the total Australian landscape, particularly the agricultural landscapes.

The reference to regionalisation of management provides an opportunity to reference the Oil Mallee Project as a case study. Local circumstances have led to farmer and scientific interest and leadership and the potential for regionally relevant management processes such as the OMCOP, providing a particularly strong example of an integrated model particularly relevant to the WA Wheatbelt region.

The Wentworth Group approach suggests that the key to preserving and building ecosystem services is to adequately compensate farmers for their contribution where that action places a cost on the farming system. A starting point could be a carbon price and the addition of payments that value the additional investment required to build ecosystem services. The Queensland Land Restoration Fund has a very similar approach adding to carbon farming by providing support for production of co benefits and tools for measuring ecosystem services. International and national voluntary carbon markets encourage higher prices such as the Gold Standard carbon projects which go beyond the standard carbon price and provide additional services to the landscape and other Sustainable Development goals (Gold Standard, 2019).

One Gold Standard carbon credit supplier in WA is the Carbon Neutral Charitable Fund (CNCF) which claims that the prerequisites of its carbon credits are: contribution to a real reduction of CO_2 emissions**;** involvement of the local population through participation in the project; and the project respect the environment and contribute to the conservation of biodiversity and the sustainable use of natural resources. In addition, a project must be verified by UN accredited independent auditors (Carbon Neutral, 2019).

The Wentworth Group Blueprint acknowledges the need to provide support for farmers to meet their objectives of reducing ecosystem services loss and building resilience and suggests that a type of Gold Standard form of carbon credit be created to reflect the larger cost of superior credits (Wentworth Group, 2015).

9.8 How to integrate the natural capital repair measures

On a national level, the use of carbon sinks (bio-sequestration) has been expected to deliver significant carbon offsets and provide a major underpinning of the emissions reduction policies of government. This investigation provides theoretical and qualitative support for a multifaceted integrated approach to encourage more land-based carbon mitigation through carbon agroforestry. I.e.

- Integration of carbon agroforestry with agriculture on both productive and less productive land;
- Integration of carbon revenues with PES to incentivise planting of trees across agriculture programs where appropriate; and
- Integration and simplification of sustainability assessment with an industry code of practice to reflect local priorities and environmental governance, including removal of most rainfall and density restrictions contained within CFI methodologies.

A framework can be developed which enables the many aspects of carbon agroforestry to be encouraged. The environmental and community benefits of agroforestry and carbon agroforestry need to be acknowledged and brought together in this framework which includes:

- Support for the valuing of a full range of ecosystem services through a number of proxy measures;
- Incorporation of these values into funding and/or market-based approaches to carbon and bioenergy;
- Fully investigate the trade-offs between industrial applications (such as bioenergy) of agroforestry and the life cycle and climate change impacts of different land uses; and
- Devolution of management and governance of land-based climate change policies to the State and local level.

If these factors are considered together, it is likely that climate change policies can more easily access land-based decarbonisation. This framework can result in a significant boost in agroforestry with multiple commercial, social, environmental and cultural benefits.

9.9 The function of a Marginal Abatement Curve (MAC)

The carbon abatement strategies adopted by landowners and investors or encouraged by governments, will be significantly guided by cost. Despite the large opportunity for abatement provided by carbon forestry, when compared with other options, land-based abatement is not necessarily achieved at the lowest cost of abatement technologies. In particular, the time over which abatement takes place presents significant additional capital cost driven by the slow rate of growth of trees in the early stages. Total abatement is assumed to occur over the life of the project, i.e. towards full growth and maintenance of function but carbon credits are only issued on the actual growth achieved over time.

When the estimated marginal costs of abatement of various technologies are ordered from lowest to highest, the Marginal Abatement Curve (MAC) is created. One such analysis has been created by RepuTex Energy, an energy and carbon advisory firm (RepuTex Energy, 2019). The curve in Figure 9.1 presents carbon abatement technologies which are positive (no net cost or better) below the Y axis and the varying costs of abatement per tonne of CO_2-e above the X axis. Carbon agroforestry is represented by the LULUCF category and it cuts in halfway across the Y axis.

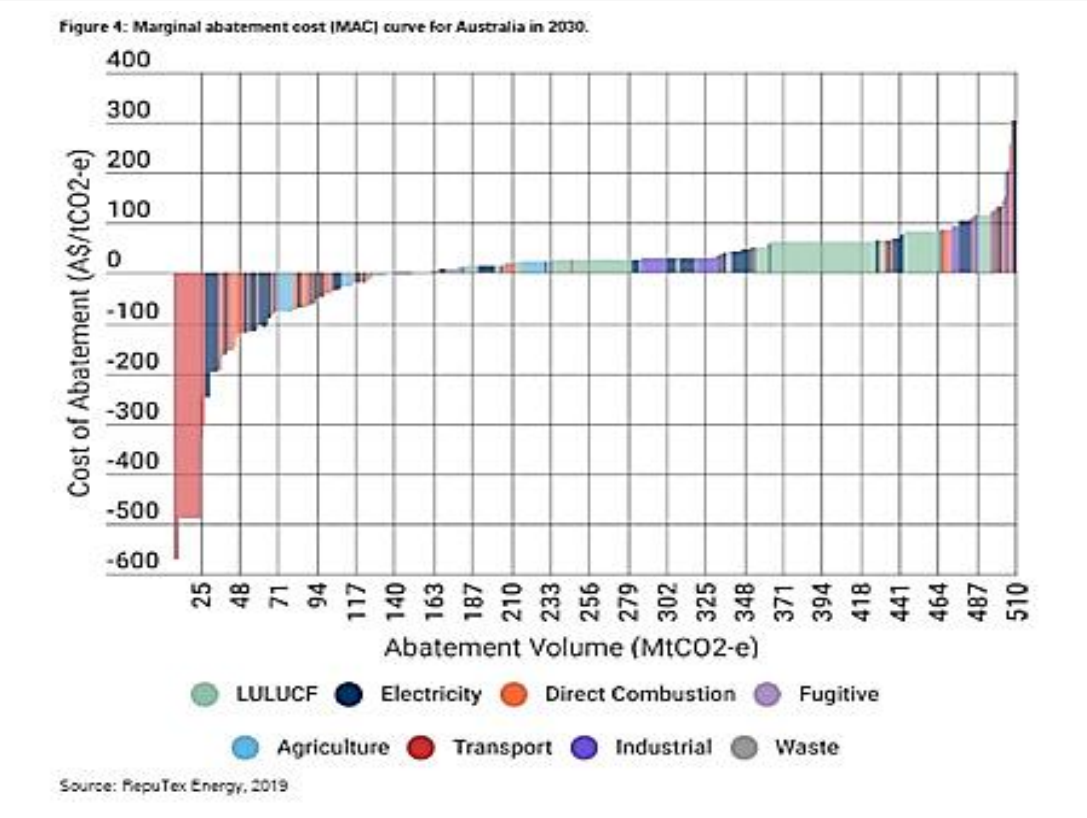

Figure 9.1 RepuTex marginal abatement cost (MAC) curve for Australia in 2030 (2019)

9.10 Discussion and findings

A MAC analysis demonstrates the possible methods for reducing carbon emissions. However, the curve does not provide a guide as to when each of the methodologies might be available or ready for adoption. For instance, some technologies with high levels of abatement may have a high initial cost and it may take some years before the full impact of abatement is realised e.g. carbon agroforestry. It would therefore be unwise to adopt a strategy of utilising all low-cost methods before moving along the curve to higher cost technologies, as a cost reflective market might suggest. RepuTex advises that selecting the lowest cost abatement can lock in carbon intensive capital and may cause further reductions to be more difficult and more expensive to reach. To set up a longer term approach, costly measures should be considered and potentially implemented before cheaper options are exploited (RepuTex Energy, 2019).

Energetics, an energy consulting firm undertook the task of modelling and analysis of Australia's Abatement Opportunities for the (then) Commonwealth Department of Environment in 2016. Unlike the RepuTex MAC, which took an investor perspective, Energetics used a generalised societal model which encompassed costs of adjustment but did not assume a rate of technological advance, as did RepuTex. In this instance the role of Land Use and Land change and Forestry (LULCF) was revealed as a significant opportunity for abatement by 2030.

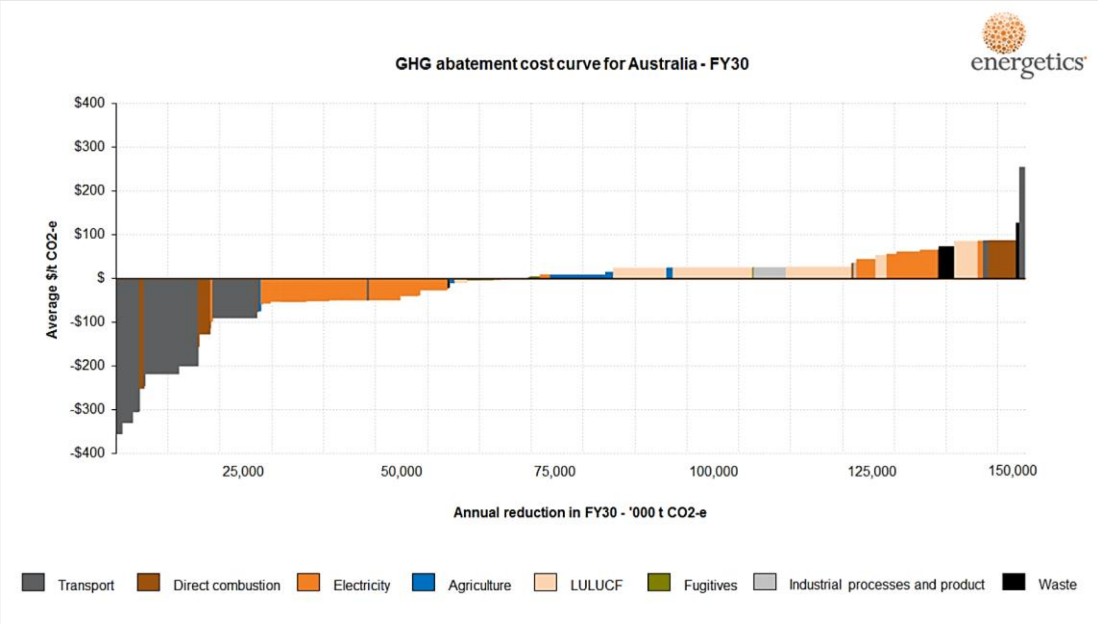

Figure 9.2 Cumulative abatement potential by grouping
(Energetics)

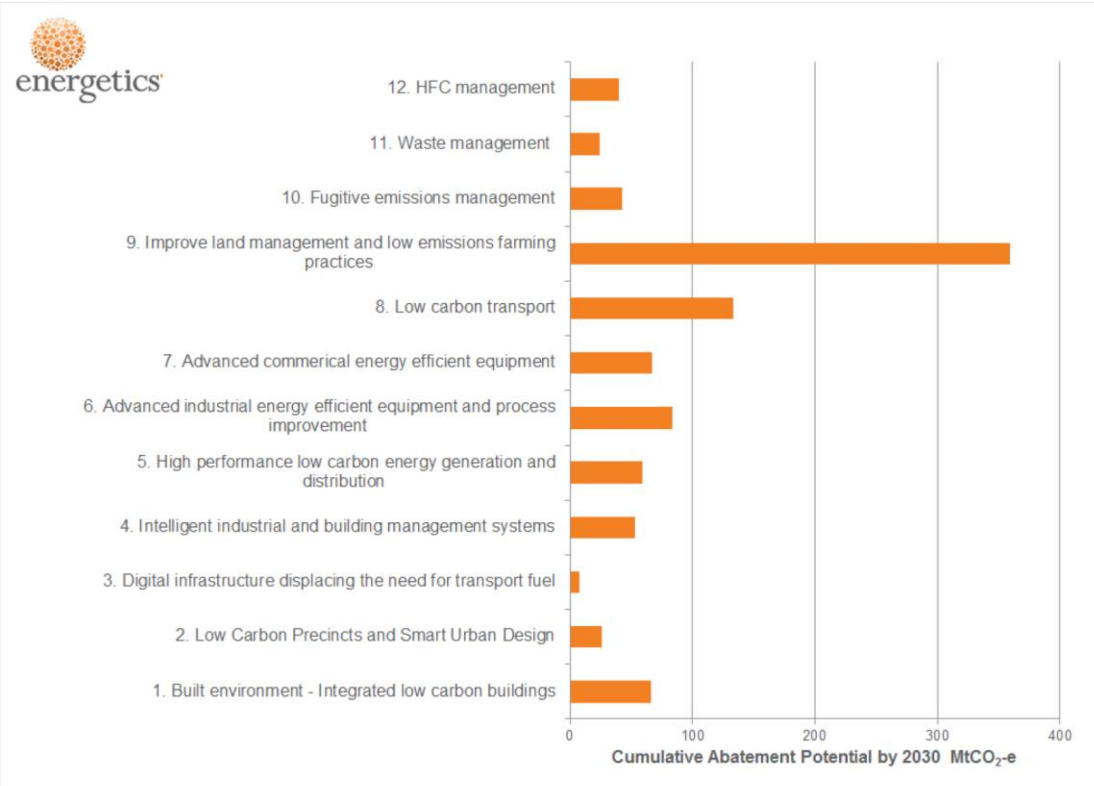

Figure 9.3 Australian 2030 abatement cost curve (Energetics)

The significant point is that the abatement will take place throughout that period, with a slow start as the afforestation component starts to contribute, i.e. as the trees grow. The opportunity for LULUCF to play its part would not have occurred in this timeframe if the uptake of this strategy were left until it was next in line and all lower cost strategies had been undertaken.

There are doubts cast on the utility of abatement curves, partly because not all factors incorporated or assumptions are clear, but also because the availability or readiness of the technology is not necessarily described. This can mean that a technology might be in a *domain* or *socio technical transitional* level and ready for immediate application or need significant more attention to move to a *transforming* impact and *landscape* level of adoption (Geels, 2017; Grubb, 2015).

What is required is a staged approach to abatement that optimises the delivery of abatement at the most desirable time and abatement that also enhances delivery of desirable ecosystem services. The timing of abatement mandated by government would be determined by government analysis and the quantity and nature of ecosystem services would be reflected in regional characteristics.

9.11 Conclusion

Identifying and valuing ecosystem delivery and environmental damage has been tested in many locations. In some cases the impact has been quite specific and in other situations quite generalised. There is however a strong case made by the Wentworth Group of Scientists and others for Australia to move on the creation of an approach to carbon sequestration that also rewards ecosystem service delivery.

It is anticipated that incorporation of both a staged approach to abatement and an emphasis on valuing ecosystem services would favour carbon forestry over some lower cost abatement. The Commonwealth Government has investigated the availability of more low-cost abatement (The King Review) and therefore continues to highlight the intention of continuing the low cost abatement approach of the ERF. Clearly the addition of ecosystem services as an additional requirement or bonus to abatement, would favour carbon forestry but at a cost. The MAC curve highlights this embedded cost of carbon forestry and a change in policy would be required to insist on the higher cost abatement being adopted.

While a standard methodological approach to measuring and valuing ecosystem service delivery has not been arrived at in this discussion, there have been a number of "add on" schemes to encourage this high value abatement through grant schemes. These schemes (summarised earlier in Chapter 9) attempt to use the carbon market to achieve environmental goals, but are limited to specific budgets for the grants and not integrated into the national abatement program. Nevertheless, there is clear acknowledgement that if PES was incorporated into a carbon abatement scheme, such as the ERF, there would most likely be many willing landowners. One challenge for a scheme that provided PES as well as carbon abatement via a methodology such as the Farm Forestry methodology which incorporates regular coppicing of the trees, is to demonstrate that strong ecosystem delivery is maintained over the cycle of growth and harvesting. A very real start to validating the ability of bioenergy crops to provide ecosystem service delivery has been made in parts of the USA with some indicators being used to compare bioenergy crops. These indicators include methane consumption by soil methanotrophs, predation of pest eggs by beneficial insects, pollination of sentinel sunflower plants (maize and prairie only), occurrence of obligate grassland birds, and pest aphid pressure (Werling, 2014). This same cooperative extension service lists the range of ecosystem services provided by bioenergy crops including woody crops some of which are directly related to the indicators listed above and some could be measured in situ (Harlow, 2019).

The range of ecosystem services which align with the MEA categorisation of ecosystem services are as follows:

- **Wildlife habitat enhancement**. Native perennial bunchgrasses such as switchgrass provide overhead cover and nesting materials for birds and animals. They are host plants for the larvae of maturing butterflies and moths, and ground-feeding songbirds and gamebirds eat their seeds. They are harvested infrequently, often in the winter, which doesn't interfere with wildlife breeding cycles.
- **Biodiversity**. Perennial grasses and woody crops for biofuels have been shown to provide greater biodiversity than row crops, especially as these crops, in the larger context, diversify the agricultural landscape.
- **Pollination**. Perennial grasses offer habitat for a wide range of pollinators such as bees and butterflies; as native plants, they are a good source of nectar and pollen. Shrub willow, for example, is one of the earliest species to flower in the spring, providing nectar for pollinators.
- **Provide energy sources** for heat and fuel.

- **Provide biomass fibre** that is useful for many bioproducts such as mulch, absorbents and fibreboard.
- **Rural development**. Bringing marginal land into use for producing bioenergy crops can help improve the employment prospects and tax bases in rural areas
- **Carbon Sequestration.** Shrub willow and perennial grasses capture carbon dioxide from the atmosphere and store it in their vast root systems, keeping it out of the atmosphere. This helps curb greenhouse gas emissions. Energy-efficient crops that provide more energy than they use in production, such as perennial grasses and woody crops, also contribute to a reduction in greenhouse gas emissions.
- **Erosion control**. Land use and conventional agricultural practices have exacerbated soil degradation and erosion. The dense roots and perennial ground cover of perennial bioenergy crops hold the soil in place and help with flood control.
- **Prevention of runoff**, especially in sensitive areas such as wetlands and riparian buffer zones. Perennial crops increase water absorption by adding organic matter and aerating the soil through their extensive root systems
- **Reduction of nutrient and chemical loading** in surface waters. Bioenergy crops require fewer fertilizer and chemical inputs than most agricultural crops. When grown as a riparian buffer, these perennials filter nonpoint pollution sources.
- **Recreation and scenic beauty**.

Most of these services have been identified earlier in the thesis and a specific study on mallees and natural biodiversity discussed (Smith, 2009).

It is therefore possible to make some general assumptions about the delivery of ecosystem services, particularly when the design of the plantings and local conditions are described. Just as FULLCAM can provide guidance on the growth of biomass based on location, rainfall and soil, it may be possible to value certain types and significance of ecosystem delivery based on some level of baseline data.

PART 5 –
CONCLUSIONS

Chapter Ten

10

Conclusions and Transitions for Carbon Agroforestry

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10.1 Introduction

There were initially high expectations globally that the land sector, including carbon agroforestry, could play a major role in reducing global GHG emissions. The land sector as a whole featured prominently in early Australian climate change policies including both reduced clearing and carbon sequestration. The significance placed on this latter form of emission reduction might have indicated a pathway to a more widely adopted strategy incorporating carbon sequestration utilising the land sector more whole-heartedly. This thesis has examined the reasons why carbon agroforestry failed to meet the expectation of its immediate contribution to carbon mitigation targets in Australia to date and the opportunity to encourage greater adoption in the future. It has proposed that a number of issues need to be taken into account beyond the effectiveness of the technology, notably the importance of acquiring and holding public support through presentation of a blend of scientific and pragmatic advice, achieving a recognised sustainability accreditation governed at a regional level, recognising the ecosystem benefits of integrated carbon agroforestry and adding value through BECS and BECCS.

Agroforestry, forestry incorporated into farming systems, has been chosen as a particular focus of the research, though much of the full range of LULUCF activities could be analysed through a similar lens as adopted here. For example, BECS (Bioenergy and Carbon Sequestration) and its companion technology BECCS (Bioenergy Carbon Capture and Storage), have been identified as an important neutral and negative emissions approaches that can help to reach the emission reduction targets identified in the Paris Agreement. However, the lack of a consistent path utilising the opportunities of forestry to produce BECS has caused this early focus to become constrained.

The overall research question behind this thesis was: 'Why has carbon agroforestry failed to meet the expectation for carbon mitigation in Australia and what can be done to change this?'

A number of objectives were identified to help understand the reasons behind the lack of uptake and the thesis framed these in Chapter 1:

1. To outline the uncertainty created by a period of volatile global and local climate policy and the impact of the volatility of public support for action on mitigation, particularly in relation to carbon agroforestry.
2. To identify key technical and governance issues confronting carbon agroforestry in Australia.

3. To explain the role played by multiple and standardised sustainability assessments in the acceptability of carbon agroforestry and bioenergy projects, despite the variation in local context.
4. To outline the extent and importance of environmental co-benefits to the potential expansion of carbon agroforestry.
5. To use the activities and programs of the OMA as a case study to highlight the challenges and potential benefits of carbon agroforestry and bioenergy as part of a local socio-technical transition.
6. To identify mechanisms that are available to value these co-benefits and ecosystem services.
7. To explore whether a socio-technical transition framework can help to understand the factors that have limited carbon agroforestry's growth and what critical factors need to be addressed.

These objectives are discussed in the following sections.

10.2 Uncertainty and volatility in climate policy

Despite the predictions by the UNFCCC of increases in the concentration of global warming gases, uncertainty, fuelled by political debate regarding the magnitude of the mitigation task, created a chaotic pattern of regulatory change and a polarisation of political views on the solutions. Discussion of this situation suggested that the extent of regulatory uncertainty and associated fluctuations in public support is also rooted in the way the policies are delivered, articulated and presented at various times during the decade in question (approximately 2006 - 2016).

As a result, Australia experienced a volatile policy journey as market-based abatement systems including emissions trading, mandated carbon offsets and auctioning (ERF) were considered. This period provides rich material for interpretation of the various attempts to create an effective and long-lasting mitigation program. Public attitudes to action on climate change fluctuated but not in a predictable way, providing an additional level of uncertainty to the debate on emissions reduction. This uncertainty plus successive policy changes have created market, policy and government failure in the area of carbon agroforestry as a method of reducing emissions.

Even in 2020 as climate change is highlighted as a contributor to predicted extremes in weather patterns, bipartisan agreement on the degree of policy urgency required has not been achieved and uncertainty continues. This situation has not dampened the level of community and industry interest in securing effective strategies to reduce greenhouse gas emissions. The following issues highlight the uncertainties created by a lack of continuing and stable government policy.

From industry compliance to government purchasing program

A robust market in carbon, in the sense that investment was required in new practices and technologies, did not emerge despite the promise of a national market and the availability of the three international flexibility mechanisms (International Emissions Trading, Clean Development Mechanism and Joint Implementation) as working models and potentially providing low-cost carbon credits. The generation of carbon credits from forestry moved from enforcing industry compliance with national climate and environmental goals (i.e. the Carbon Pricing Mechanism) to a federal Government purchasing program to help meet the achievement of national mitigation targets (the Emissions Reduction Fund).

Policy uncertainty and changing dates

At the same time, political volatility created policy uncertainty through regular changes in the design of climate change policies, legislation and regulation. In particular, with each change in policy, the dates for initiating eligible forestry activity changed, creating a significant problem for early action in forestry, i.e. action that had been taken in advance of a national scheme. Despite several reports estimating that carbon sequestration could play a significant role in meeting mitigation targets, the actual level of investment in carbon sequestration has been much lower than expected.

Competing levels of government

Another relevant feature of this period was the broad acceptance by the Australian States of the dominant policy position by the Commonwealth and, through agreement, the winding back of their own emission reduction action, policy and commitments. As the Commonwealth had ratified the Kyoto Protocol, it followed that the authority for climate change policy should rest with the Commonwealth. While the State Governments had adopted some climate change objectives and renewable energy policies, they subsequently stalled complementary emission reduction programs and support. Furthermore, when a range of national policies was repealed, the states were left without effective states-based policies. Had the individual states and territories kept their state-based policies, this could have created the possibility of linking federal policies and regulation to an established pathway for carbon agroforestry, utilising a more coordinated approach.

While investment in bioenergy could have made a significant difference to the level of carbon sequestration, it has not proven to be an area of renewable energy that has attracted significant policy support. Investment in the bioenergy value chain requires confidence in long term policy settings.

Bioenergy is a neutral or potentially negative emissions technology, which can provide a pathway to a more consistent, financially sustainable and constructive contribution by agroforestry to meeting the increasingly challenging targets for emission reduction. There have been many local and regulatory barriers placed in the path of forestry-based bioenergy, including the sourcing of suitable biomass, challenges to carbon neutrality and presumptive questions around land use. This thesis highlights the robust evidence of a climate effect from bioenergy being a low emissions source of energy, if it is used efficiently to displace fossil fuels, and if measures are applied to minimise direct and indirect LUC emissions and with application of regional governance to avoid land use conflicts. Also, while bioenergy is concurrently considered a relatively high cost form of renewable energy, this does not take account of considerable co-benefits delivered.

Pricing carbon

A change from the ETS based CPM to the reverse auction system (ERF) resulted in a low price on carbon, too low to motivate investment in reafforestation or agroforestry, as had been originally expected. It has become clear that carbon alone will not be sufficient to secure carbon agroforestry and additional support is required through payments for ecosystem services or additional processing activity such as bioenergy. Other means of pricing carbon credits may be required to balance public and private concerns and assure suitable and lasting environmental benefits.

10.3 The role of sustainability assessments

Sustainability assessment frameworks tend to highlight the negative impact of land use change from food crops to energy crops (for instance the ‘food versus fuel’ paradigm). These have negatively influenced the acceptability of forestry on agricultural land. Increasingly, projects involving bioenergy, and to a lesser extent carbon sequestration, require an assessment against the international standards established by one of the many sustainability assessment frameworks. In the case of biofuels or biomass being exported, compliance is required by the importing country. These international rules take a strong pre-emptive position on forestry undertaken on arable farmland but fail to recognize the potential benefits of integrated agroforestry on dryland farming systems, such as those in Australia. Indeed the IPCC SR1.5 goal includes a large requirement for BECCS and negative carbon technologies and an integrated agroforestry approach can contribute to this goal.

Land use assessment criteria governing the accreditation of carbon sequestration and biofuel crops on farmland should also include the ‘climate effects’ of carbon sequestration and fuel switching, i.e. official recognition as a carbon neutral in the energy sector or even carbon negative activity. This issue has not been entirely resolved at an international level and faces opposition from some researchers who question the near carbon neutrality (in the energy sector) of bioenergy. Nevertheless, advocacy for the recognition of the benefits of utilising bioenergy as a means of reducing fossil fuels continues to be made.

Within Australia, awareness and sensitivity about particular land use change, i.e. conversion from agricultural land to carbon agroforestry, has created concern at all levels of government. For example, existing land use planning regulations have been strengthened, often in ways that makes large scale carbon agroforestry more difficult. In WA, the state in which the Oil Mallee Project case study is based, agricultural planning regulations have been specifically modified to limit and control carbon agroforestry on agricultural land. At the Commonwealth level of government, eligibility conditions constraining carbon sequestration and farm forestry to low rainfall zones and area limits have also been written into CFI methodologies to control opportunistic plantings on arable land. All of these conditions and regulations are aimed at limiting land use change from usual agricultural practices.

This imposition of rules as part of a national carbon program (the CFI) overlooks the opportunity to respond to local conditions and enable delegation of planning authority to regional Natural Resource Management groups, as recommended at an earlier stage of policy development. All of these regulations and policies have hindered the adoption of carbon agroforestry in the local context and have not enabled the opportunity to demonstrate co-benefits of the activity.

10.4 The lack of recognition and importance of environmental co-benefits to carbon agroforestry

The environmental co-benefits of agroforestry have been identified through research and acknowledged in forestry programs. Early integrated agroforestry adoption was supported by public funding in order to ameliorate land degradation and salinity encroachment. However, this early form of proxy payment for ecosystem services (PES) was not sufficient to fully incentivise many farmers to allocate a portion of their productive capacity to forestry. For the farmers who participated, there was an expectation that future revenue from carbon sequestration and bioenergy could be available to compensate for the opportunity cost of the land provided for the trees. However, this compensation was never fully realised. The benefits (co-benefits /ecosystem services) brought about by introducing trees, while significant, are considered insufficient to compensate for the loss of cropping land. Indeed, farmers discovered that their farms were actually discounted in property value in proportion to the degree of tree cover occupied by the plantations.

An announcement by the Commonwealth in 2020 has proposed a biodiversity certification of carbon projects and land set aside which can translate into recognition by banks and other institutions of the higher value of the land created through improved environmental stewardship (Foley, 2020). The comments by a farmer group in the article by Mark Foley in The Age Newspaper on 24 May echo the sentiments revealed in the survey of farmers in Chapter 7. "The burr under the saddle for farmers has always been that we've been regulated by government to maintain biodiversity and deliver a broader community good at our own expense, and that's not equitable." (Foley, 2020). This modest trial of a scheme to reward farmers for biodiversity management could provide more evidence of the need for more support.

10.5 The Oil Mallee case study

In the WA Wheatbelt, reforestation and agroforestry has been a deliberate strategy to deal with the negative impact of widespread State Government mandated clearing of land during the mid 20th century. Problems attributed to this clearing of trees across whole landscapes were identified in the latter part of the century and various methods of land care explored. Tree planting was undertaken in an attempt to repair those parts of the landscape that had become progressively less productive and to prevent further damage to productive land by a rising water table and inevitable wind erosion.

Starting in the 1990s agroforestry (forestry on farmland or agriculture incorporating trees) in WA was encouraged, financially supported and widely adopted in some areas. For example, planting mallee eucalypts was adopted by around a quarter of WA Wheatbelt farmers, before the advent of a carbon market, although the size of plantations across the Wheatbelt varied considerably.

While the reparation of the landscape was identified as desirable, integrated agroforestry was not attempted until some form of financial support was forthcoming. This support came first as direct State Government funding for seedlings and the expectation of a market for carbon plus and the lure of a profitable bioenergy industry. After the bioenergy industry faltered at the demonstration level in 2005, the task of repairing the landscape was assigned to an emerging national carbon market. At the national level, the use of carbon sinks (bio-sequestration) was expected to deliver significant carbon offsets, provide a major underpinning of the emissions reduction policies of government and have a beneficial impact on the land.

The history of the Oil Mallee Association (OMA) and its early achievements provides a useful guide to the early mitigation methodology of integrated carbon agroforestry. While programs of the OMA delivered many environmental co-benefits, the allocation of land came at cost to the farmer in opportunity cost. A survey of Oil Mallee growers has reinforced evidence of their enthusiasm for trees on farms, but it also highlighted a concern and ultimately a reluctance to continue with integrated agroforestry due to the absence of sufficient financial recognition of the co-benefits as an offset to lost production.

The Oil Mallee Code of Practice was introduced as a new form of a sustainability framework to guide industry good practice and governance. It was developed with extensive consultation and has merit as a guide to good practice. It created, adapted and incorporated many forestry guidelines and sustainability practices suited to the dryland farming regions of WA. Codes of Practice can be an alternative approach to sustainability assessment, which ideally ensure all local potential benefits of forestry are recognised and pitfalls avoided.

It is noted that the early Commonwealth funding of seedlings for integrated Oil Mallee agroforestry was motivated by the expectation of associated environmental benefits. There is an acknowledged recognition by the OMA of the need to create and preserve natural capital and promote natural ecosystem services through a targeted market-based solution.

10.6 Mechanisms that value co-benefits and ecosystem services

Promotion of the environmental benefits of CFI land-based methodologies are key to their adoption, particularly when integrated into agriculture. What is not as certain is whether and how these additional benefits can be valued and purchased or traded. Various methodologies of valuing ecosystem services were explored in an attempt to discover if additional revenue, over and above carbon sequestration payments and bioenergy, would promote more forestry and, in particular agroforestry. The prominent methods for valuation of ecosystem services discussed are hedonic pricing (using discounted valuation), contingent valuation (based on reduced production and environmental damage trade-offs) and the Wentworth group approach which incorporates many tools to improve understanding of natural capital including establishing environmental accounts.

A future carbon price needs to be high enough to stimulate carbon agroforestry and also address the issues of ecosystem service provision and/or the opportunity cost of using arable farmland. The value of this additional cost to achieve desirable multiple outcomes is addressed through a measure of willingness to pay (WTP) for ecosystem services.

10.7 Policy implications

While there has been support for carbon agroforestry and bioenergy from the international community, particularly following the Paris Conference of the UNFCCC in 2016, the introduction of these technologies into the Australian context has been uneven and limited. In order to achieve a transition to a new lower carbon economy utilising these technologies, there has to be a positive interplay between public opinion and policy leading to appropriate measures like a carbon price and payments for ecosystem services. In the absence of a clear and positive approach to carbon afforestation with appropriate and localised governance frameworks, a range of broad-based international sustainability tools and planning controls have significantly frustrated the expansion of carbon agroforestry as well as niche level innovation and experimentation of forestry and bioenergy.

This research proposes that, to achieve adoption of sustainable carbon agroforestry at the landscape or macro level there needs to be a reduction of uncertainty and acknowledgement of carbon agroforestry and bioenergy as tools of mitigation. The three key areas are supportive public opinion, localised sustainability assessment and governance and the pricing of carbon, bioenergy and ecosystem services. The lack of interplay between these areas has been a key reason why the use carbon agroforestry has not been more widespread.

Public opinion

Accommodating or changing public opinion is an important element of policy making. Announcements on Climate Change should be consistent and measured, avoiding overly ambitious short term targets, political opportunism and hyperbole.

One way to achieve this measured approach is to adopt progressive incrementalism, that is, to transition carefully and mindfully utilise the least disruptive methods of mitigation and avoid the high social cost and community antagonism of a too rapid transformation. This may change in the light of the Covid-19 pandemic and subsequent economic collapse which could provide the opportunity for a more acceptable, articulated and targeted radical change as a way of rebuilding the new economy.

In order to establish a lasting national approach to climate change, it is advisable to recreate a national agreement between the Commonwealth and State Governments. Such an agreement existed for some years up to 2008 after which time the Commonwealth assumed primary carriage of carbon mitigation policies. A partnership approach is preferable as a way of bringing together bipartisan policy and this can also be seen demonstrated in the Commonwealth and State partnerships established in a National Cabinet over the Covid-19 response.

Sustainability Assessment

In order to reduce the uncertainty around land use, ensure coherent land use policies, localised sustainability assessment processes and ensure a regionalised approach to governance, a new process is required. In relation to agroforestry, the Oil Mallee Code of Practice provides a valuable model of an appropriate sustainability assessment process. All bioenergy policies should be aligned to UNFCCC definitions and protocols, thereby legitimising the climate effect of bioenergy.

Pricing Carbon, bioenergy and ecosystem services

Greater investment in quality carbon agroforestry is likely to be achieved with policies that encourage payment for ecosystem services (PES) and encourage bioenergy which can provide additional financial compensation to farmers for the productive land they dedicate to biomass production.

Policies that encourage abatement should consider a more strategic approach than targeting the lowest cost forms of abatement and target methodologies that can deliver results aligned to an emissions reduction target. The marginal cost of abatement (MAC) curve displays methodologies and encourages a progressive adoption process from low to high. A more strategic approach would look at the time period when the most carbon is abated or sequestered. Carbon agroforestry is sometimes achieved at a relatively high initial cost particularly if the opportunity cost of land is included, but potentially the cost could be lower if it reaches maximum capacity if aligned to a target.

A compliance market would generate more flexibility than the ERF, where carbon credits are purchased by Government at the lowest cost indicated by a reverse auction. Under a compliance market, companies seeking to make the most of their investment in carbon offsets can choose to select higher cost, long lasting projects such as carbon agroforestry with farmer participation. The projects can be designed to achieve multiple objectives such as environmental services and carbon sequestration. As the mandatory elements of the Safeguard Mechanism start to be enforced, companies are likely to look for carbon credits for more than just their role as offsets.

The establishment of a target for bioenergy would stimulate carbon agroforestry and finance would be available from bioenergy project proponents. The risk of significant land use change from productive agricultural land to bioenergy could be limited through state and local government planning rules, by strategies determined by regional NRM bodies and via Codes of Practice. CFI methodologies and sustainability assessment processes would need to be modified as a result. A State Planning regulation that has already accommodated a suitable approach is SSP2.5 of the WA Planning Commission, which endorses a level of integrated agroforestry projects on farms without requiring planning approval.

Table 10.1 Summary of strategies to overcome constraints on carbon agroforestry

Encouraging Carbon agroforestry and Bioenergy	Strategies
Public opinion	Target messages aligned to strategy and limit hyperbolic rhetoric
	Adopt progressive incrementalism and avoid high social cost approach
	Recreate a National Agreement on Climate Change
Sustainability Assessment	Invoke land use and sustainability coherence and regionalise governance
	Improve understanding of the climate effect of bioenergy
	Use the Codes of Practice as a model of localised sustainability assessment
Pricing Carbon, Bioenergy and ESS	Encourage and enable Bioenergy
	Adopt PES
	Strategic MAC adoption in carbon market
	Create compliance market

10.8 Socio-Technical transitions in the context of Carbon agroforestry

If the purpose of expanding carbon agroforestry is to increase the availability of opportunities for significant mitigation, an important consideration will be the conditions under which this transition to a major landscape change takes place and the manner and speed of the transition.

Movement of practices in agriculture towards sustainability are inevitably long term and brought about by socio-technical transitions that connect innovation to practice changes and finally to norm setting and stability. Transition theory was discussed in Chapter 1 as an introduction to the discussion of the actual barriers and promoters of growth that would be considered, their function and their capacity for disruption and acceptance. The multilevel perspective of Geels (2017) provided a lens which moved the focus to recognition of multiple *micro* initiatives, some of which would eventually find a way to insert themselves into the *mesa* level of current regimes of practice and perhaps then be elevated into a *landscape* with dominant governance and rules. It is likely that only by encouraging experimentation which hopefully leads to adoption by sufficient numbers of practitioners, will systemic change lead to *regime* status backed by research findings. This confirmation of practice would then enable incorporation into a *landscape* scale adopted with support from industry and governments.

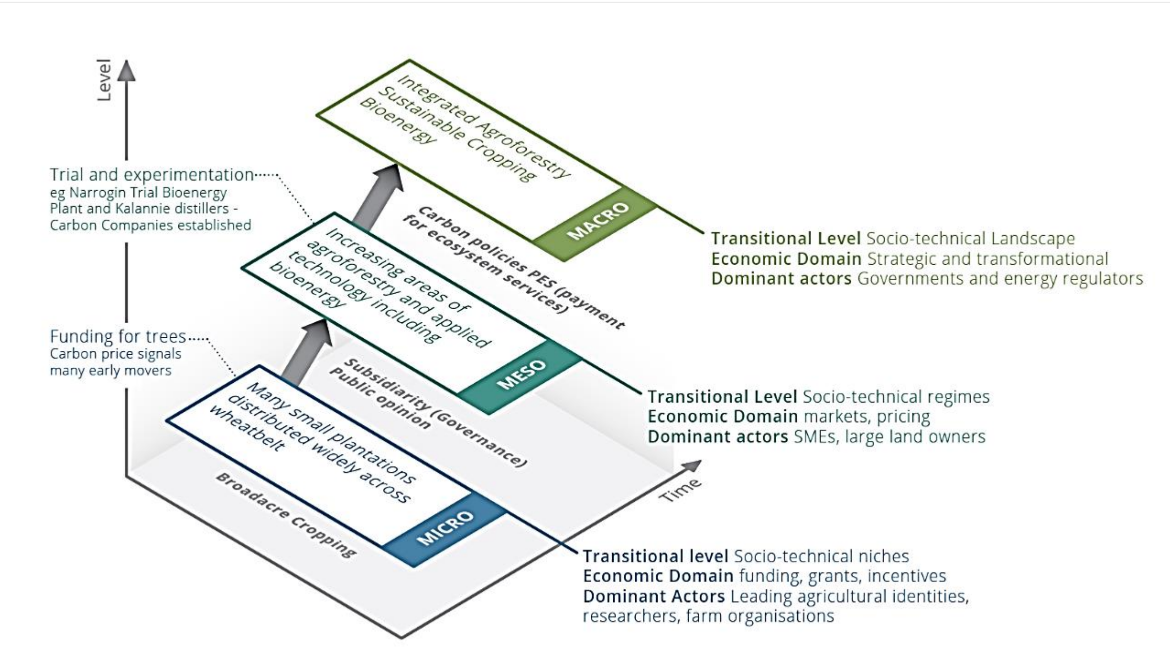

Figure 10.1 Adapting Geel's multi level transition to agroforestry

The policies and facilitating measures for this socio-technical transition, as it relates to integrated carbon agroforestry are outlined and summarised in Figure 10.1. The transition from cropping to the micro level *niche* activity of tree plantings was assisted by government funding for seedlings and a possible carbon price. The dominant players in this transition are leading farming identities, researchers and farmer organisations.

The transition to the meso level with *regimes* of activity incorporates trialling and experimentation and the emergence of commercial entities exploiting the new opportunities. This results in increasing areas of agroforestry and new technologies such as key examples of bioenergy in research laboratories and in the field. The dominant influences in this transition are markets, large landowners and the emergence of small companies investing in the prospective new industry. New and appropriate sustainability measures are developed with strong local evidence and increasing public support for carbon policies that result in tangible community benefits.

In order for the transition to the macro level, there needs to be stable carbon policies and recognition of the delivery of eco system services and suitable rewards to farmers for the resulting public benefit. Ideally a system of sustainable integrated agroforestry is created alongside high quality and productive cropping programs. The dominant players in this landscape wide adoption of carbon agroforestry would be carbon markets, and supportive government frameworks embedded in regulation and legislation.

Application of the transition management approach to the analysis surrounding the adoption of integrated agroforestry informs the discussion on policy development and implementation. In particular, a broader version of transition management theory proposes an incremental approach to implementation which is nevertheless reflected in ambitious policy and governance (Bilali, 2018; Kemp, 2003).

10.9 A final word: how to facilitate carbon agroforestry

The final research objective (No7) contains the brief to identify the critical factors that can facilitate increased integrated agroforestry based on findings and recommendations reached throughout the thesis. The focus of this section is on the socio technical transition from early stages of meso level with evidence of trialling and experimentation but with limited recent expansion of agroforestry to the macro level of widespread adoption.

The environmental and community benefits of agroforestry including carbon agroforestry have been identified and a supportive framework has been outlined that could encourage the rejuvenation of the carbon agroforestry industry.

Assuming the existence of positive public attitudes to climate change action and a stable national set of policies, a framework to support carbon agroforestry should include:

1. Support for the valuing of a range of ecosystem services through a number of proxy measures (such as discussed in Chapter 9 with reference to the Wentworth Group and the Queensland Land Restoration Fund);
2. Incorporation of these values into funding and/or market-based, targeted approaches to carbon and bioenergy;
3. Formal acknowledgement of the positive climate effects of bioenergy when practised as integrated agroforestry;
4. Devolution of design, management and governance of projects from the national level to the state and local regional land management levels but aligned with national policies on climate change; and
5. State and Commonwealth policy and regulation encouraging cost effective and sustainable carbon sequestration and regional bioenergy production based on farm forestry.

Without this combination of factors being considered, it is unlikely that climate change policies can access land-based decarbonisation. This framework can result in a significant boost in agroforestry with multiple commercial, social, environmental and cultural benefits, including sustainable reductions in carbon emissions.

10.10 Limitations and further research

The focus of this research was on utilising existing information to identify the influences on carbon agroforestry and the reasons why its assumed expansion as a mitigation tool did not eventuate. It drew upon extensive previous research, but additional quantitative data was not provided. Attention was drawn to the necessity of combining a range of factors in a systematic approach to advancing carbon agroforestry, based on an analysis of existing research and information and evidence from the Oil Mallee case study. The qualitative data relating to farmer opinion from the case study was limited only by the size of the sample.

Further research would be valuable to quantify the impact of a higher price on carbon, hypothecating a value on ecosystem services in different regions, recalculating the climate change impact of regional bioenergy and adoption of more localised controls of carbon agroforestry. Greater clarity on these issues would inform policy to gradually transition agricultural practices towards a more sustainable approach incorporating integrated agroforestry and bioenergy. These issues and others from each of the thesis objectives and associated conclusions are set out in Table 10.2 along with potential further work.

Table 10.2 Conclusions and further work by research objective/sub-question

Objective/Sub-question	Key Conclusions/Findings	Further Work
Overall Research Question: Why has carbon agroforestry failed to meet the expectation for carbon mitigation in Australia and what can be done to change this?		
Impact of volatility uncertainty on public attitudes on policy	Target messages should be aligned to strategy and limit overly political and hyperbolic rhetoric. Adoption of progressive incrementalism would avoid high social cost	Comparative studies on the way governments message the public on climate change; measuring the impact of contemporary expression of a climate emergency on public opinion
	A National Agreement on Climate Change is required.	
Key technical and governance issues confronting carbon agroforestry in Australia	Land use conflicts reflect international and local concerns.	The impact of land use issues embedded in ERF methodologies and comparison with sustainability systems.
	The climate effect of bioenergy needs to be recognised.	Further analysis of the climate effect of bioenergy, particularly addressing the doubts being expressed on the carbon neutrality of bioenergy.
	A compliance market would assist adoption.	Modelling a compliance market with recognition for impact rather than just price.
Sustainability assessments and the acceptability of carbon agroforestry and bioenergy projects	Land use and sustainability coherence and regional governance required.	Comparison of Codes of Practice used in forestry and other biofuel production.
	Use of the Oil Mallee Code of Practice as a model of localised sustainability assessment would establish a sustainability model for industry.	

Objective/Sub-question	Key Conclusions/Findings	Further Work
The extent and importance of environmental co-benefits to carbon agroforestry	Regionally based sustainability standards with local governance would establish certainty.	Identification of actual co-benefits applicable to different regions.
The activities and programs of the Oil Mallee Association of Australia Inc	Founded through direct funding carbon agroforestry became a key factor in its growth	A detailed history is required as the founders and others can tell a very interesting story.
Mechanisms that value these co-benefits and ecosystem services.	Incentivise PES, bioenergy. This would aid a strategic approach to abatement options	Test financial barriers to participation by farmers including valuing co-benefits and costing disbenefits.
A socio-technical transition framework to understand the factors that have limited carbon agroforestry's growth	Transition theory provides an important method of understanding the growth of carbon agroforestry	Does transition theory explain market failure in carbon agroforestry?

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APPENDICES

Appendix A OMA Registration of Plantations Letter

(Ref: footnote 21 page 104)

Dear Oil Mallee Grower

URGENT: REGISTRATION OF PLANTATIONS BY 30 JUNE 2015

This letter is to update you of the upcoming 30 June deadline to register existing mallee plantings under the Emissions Reduction Fund (**ERF**) and to outline the aggregation option that OMA has developed with leading practitioners Fares Rural and Corporate Carbon in order to provide a 'no regrets' solution that meets the looming deadline.

All growers wishing to retain an option to take part in the ERF with existing plantations of mallees, need to register these plantings with the Regulator by 30 June this year. This facility for registration overcomes the otherwise necessary condition of "newness" required in the ERF.

For individual growers, the registration process and subsequent reporting is complex and exhaustive.

We recommend an approach developed by Corporate Carbon to give landholders the option to join an aggregated carbon project (**Aggregation Project**). Under this scenario, landholders are given the opportunity to participate in the aggregated project and sell their carbon abatement on a flexible success fee basis, which avoids upfront cost and risk. OMA is supporting this aggregated carbon project and will play an active role in facilitating participation from interested mallee growers.

Further information on the proposed WA Oil Mallee Aggregation Project is provided overleaf. The next step for interested parties is to complete and return the attached expression of interest (**EOI**).

We urge you to register with the Regulator or return the EOI indicating your interest in participating in the Aggregation Project.

Yours sincerely,

Simon Dawkins
Director
Oil Mallee Association
0412563388
simon.dawkins@oilmallee.org.au

Attached: Outline on the Aggregation project (from page2) and the EOI Form (page8).

BACKGROUND: NEED TO REGISTER BEFORE 30 JUNE 2015

This advice comes at a late stage in the lead up to the June 30 deadline and subsequent Emissions Reduction Fund (**ERF**) auctions. The OMA has been very keen to offer the best advice it can and waited until the first auction had passed and a level of consultation had taken place.

In summary, all growers aiming to take part in the next auction or wishing to retain an option to take part in future carbon sales with existing plantations of mallees, need to be involved in the registration of these plantings with the Clean Energy Regulator by 30 June this year. This facility for registration of existing plantations overcomes the otherwise necessary condition of "newness" required in the ERF.

The subsequent ERF auction process enables landowners and others to propose emission reduction activities (in our case carbon sequestration) with a price and timetable into a "reverse auction" from which the lowest cost options are identified and purchased by the Commonwealth Government. For eligible carbon sequestration projects the plantings have to be protected from clearing for at least 25 years. While this permanence obligation will need to be discussed with those holding an interest in the land (including your bank) it does not have to be registered on the title.

Due to the scale of most mallee plantings being less than 100 ha, the OMA considers that an aggregated approach is the most practical and low cost option for growers.

An important element in the process of understanding the best way to proceed was the adoption by the OMA of the following basic principles before approaching growers:

1. **Carbon Right:** That landowners are to retain ownership of carbon right - unless specifically assigned to another party.
2. **Exit Strategy**: That an exit strategy from any agreement be available – unless the landowner specifically opts out of this condition.
3. **Aggregation:** That aggregation of plantings is essential to meet the cost of compliance. In recognition of the economies of scale, we note that a minimum size threshold will need to be reached for the project to proceed. It is also possible that aggregation opportunities will be offered only to growers with larger plantings to enter into the auction process. However, the minimum size of planting has not been set at this stage.

The OMA believes that the proposal outlined below can achieve these principles.

W.A. OIL MALLEE AGGREGATION PROJECT

The WA Oil Mallee Aggregation Project has been developed by Corporate Carbon, in conjunction with Fares Rural and OMA, and is unique to mallee growers in WA. The proposed process will facilitate participation while retaining a level of autonomy and flexibility for landowners. This 'end-to-end' solution for ERF landholder participation removes barriers and minimises risk.

Under the Aggregation Project, Corporate Carbon manages all of the required registration, establishment, implementation, monitoring, offsets reporting, audit and Australian Carbon Credit Unit (**ACCU**) issuance activities, and enters into a contract with the landholder to purchase ACCUs for the Aggregation Project. This removes not only the upfront cost and hassle of a carbon sequestration project, it also removes the potential risks of an ERF contract with Government, such as contract delivery shortfall, make good and damages.

[redacted] will represent Corporate Carbon.

Fares Rural will assist in all technical matters with carbon offsets reporting and ensuring that carbon credit yields are maximised. Dan Wildy will represent Fares Rural.

The OMA will also take a proactive role in liaising with landholders to provide information and to ensure that all mallee planting details are correct.

Should a grower wish to participate in the Aggregation Project , further information will be provided by Corporate Carbon. If a grower ultimately commits to participation in the Project the grower will enter into a formal contract with Corporate Carbon. The participation steps towards the formal contract stage are outlined below.

The OMA's role in relation to the Aggregation Project is a facilitative one only as a representative body for WA oil mallee growers. Neither the OMA nor any of its directors or officers makes any representations regarding the Aggregation Project. Nor do they accept any liability in connection with the Aggregation Project. It will be the responsibility of individual growers to consider (and take any required advice) on the detailed terms of participation in the Aggregation Project in due course.

PAYMENT FOR AUSTRALIAN CARBON CREDIT UNITS (ACCUs)

Marketing options to monetise ACCUs will be discussed with landholders. As a current indication of price, Corporate Carbon is currently prepared to pay landholders $10.00 per ACCU for credits that are created over a ten year period under a successful ERF aggregation project. The balance of the revenue from the sale of ACCUs to the ERF will be used to pay the carbon services delivery team. Both OMA and Fares Rural will receive payment for their assistance in the aggregation project from Corporate Carbon. Corporate Carbon will receive the rest of the revenue from the sale of ACCUs.

For example, using the above pricing and based on the Weighted Average Abatement price of $13.95 from the recent ERF Auction, the carbon services team would have received $3.95 per ACCU and the landholder $10.00.

Corporate Carbon is able to offer this pricing as a function of their recent success in the first auction, in addition to their anticipation of a successful ERF contract for the Mallee Aggregation Project. The volume of abatement that will be offered into the auction will be a function of landholder participation interest and Corporate Carbon's risk management position.

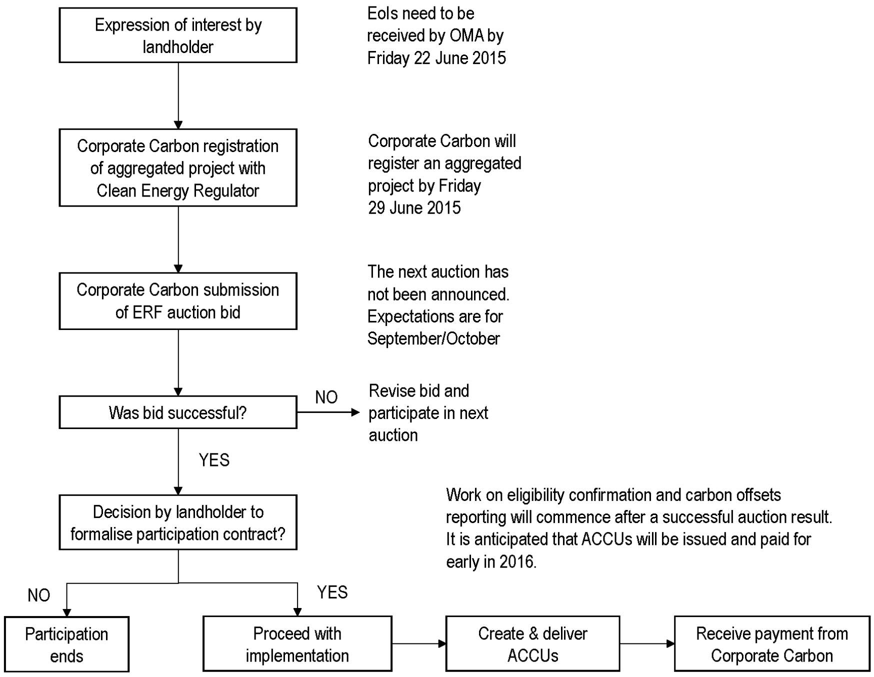
The actual price payable by Corporate Carbon to landowners under the finalised Aggregation Project will be a matter for negotiation between the landowners and Corporate Carbon at a later stage in the development of the Aggregation Project.

LANDHOLDER ACTION REQUIRED

Attached is an Expression of Interest (**EOI**) form to be signed and returned as soon as possible. This form does not commit the landowner to proceeding with the sale of carbon at this stage. By submitting the EOI the landowner agrees to takes part in a process that is intended to result in their mallee plantings being registered with the Regulator as part of the larger Aggregation Project entered into for the next auction, hence avoiding the 30 June project registration deadline.

However, as explained below, signing and returning an EOI does not bind a landowner to participating in the Aggregation Project - it is just a non-binding expression of interest in doing so.

The participation steps in the Aggregation Project are presented in the diagram below.



Note that eligibility criteria will have to be met prior to the creation of ACCUs. For example, Eligible Interest Holder Consent forms and planting records will need to be provided (plantings after 1 July 2007 are automatically eligible, while plantings prior to 30 June 2007 will require additional information to prove eligibility).

These eligibility checks will be completed after the project registration stage. While eligibility may affect the potential yield of ACCUs, the proposed process gives landholders the greatest chances of successful participation in the ERF. Note: Apart from questions of age eligibility, some older plantings of may not warrant registration as they will have reached maturity or near full potential growth.

OBLIGATIONS TO PROCEED

There are no obligations for the landholder to proceed at the project registration stage, or even after a successful auction result. This means that the landholder may elect not to proceed with inclusion of their plantings in the Aggregation Project. However, if a landowner does not proceed, their registration with the Regulator will lapse.

Flexible participation options can also be arranged, including:

- partial participation where only a nominated portion of landholder plantings is included in the Aggregation Project
- 'wait and see' participation which provides the option (but not obligation) to sell ACCUs
- early release from aggregation participation should farm operation priorities change.

However, once a decision to proceed has been made, the main obligations relate to project implementation and to maintaining the stored carbon in the mallee plantings over a period of at least 25 years, after which there are no further obligations for the landholder.

IMPLICATIONS FOR FUTURE HARVESTING

The proposed methodology for the aggregation project is 'Reforestation by Environmental or Mallee Plantings—FullCAM'. (FullCam refers to the modelling of growth and carbon as opposed to direct measurement). This requires that any mallee plantings are managed for a 25 year period as a permanent carbon planting with no harvesting. There may be opportunities for landholders seeking to switch to harvesting at a later date. Corporate Carbon are able to provide options that enable partial harvesting of a landholder's plantings. However, landholders should be aware that participation in the proposed aggregation project will involve a commitment not to harvest at least a portion of existing plantings.

MEMBERSHIP OF THE OMA

The OMA is requesting that all growers join (or rejoin) the OMA and take an active interest in the database which contains details of their planting. Your committee needs to have the resources to assist your consideration of future options for mallee plantings.

ABOUT FARES RURAL

Fares Rural is a Western Australian company which is actively engaged in the generation of carbon credits. Fares Rural owns its own high quality mallee plantings and is actively involved in the growing and management of these and other eucalypts plantings. Fares Rural is well regarded within the reforestation sector and continues to be involved in all aspects of the development of the forest carbon industry.

ABOUT CORPORATE CARBON

Corporate Carbon (Australian Financial Services Licence Number 430199) has been involved with the Carbon Farming Initiative and Emissions Reduction Fund since before their inception. They were the first private Australian company to author a methodology and have it 'determined' into the CFI Regulations, and are the only Australian company to author three Determinations.

Corporate Carbon were successful in the first Emissions Reduction Fund and are Australia's largest multi-method carbon contractor with approximately 5.5 million tonnes of abatement under contract. Corporate Carbon's portfolio of carbon projects currently spans 19 projects under 6 different methodologies (alternative waste treatment, soil carbon, reforestation, environmental plantings, land transport, afforestation and savanna burning).

EXPRESSION OF INTEREST AND CONSENT TO UNDERTAKE CARBON EMISSIONS REDUCTION PROJECT

FARM COLLABORATOR

-- *(insert name of farm owner/manager)*

-- *(insert name of farm)*

-- *(insert farm address)*

Dear Sir/Madam

As the owner or owner's representative of -- *(insert name of farm)* this letter is to confirm our intention to work with Oil Mallee Association on carbon emissions reduction projects (either emissions avoidance or enhanced sequestration) on the farm with the goal of accessing the Emissions Reduction Fund (ERF).

Consent is given to Corporate Carbon Solutions to undertake emissions reduction projects on the farm identified above for the crediting period of the project.

This consent is conditional on a further decision to implement the projects, which will only be made once the final eligibility of the plantings have been established and commercial terms agreed.

We understand that if the project does proceed and the project creates Australian Carbon Credit Units (ACCUs) Oil Mallee Association and Corporate Carbon Solutions will receive a share of the revenue from the sale of ACCUs to the Government as their fee.

Yours sincerely,

[INSERT NAME OF FARM HERE]

____

(Signature)

____

(Insert Name of Farm Owner/Manager Signatory)

Date:

Appendix B Specific Comments of Farmers on Factors

Factor 1. Crop Competition

Ray Sullivan: “in some areas there is significant competition”

Mike Kerkmans: “no real observable impact in general” “it may evidence some competition effect if there is a big crop and it becomes really dry”- he did not feel that there was significant impact of the trees on his (former) farm with the larger proportion of trees and sees little evidence of competition on his return to the area”

Farmer A: “has observed an impact on the adjacent crops … and he would have been thinking of the benefits to stock and a way of reducing damage to the land where sheep grazed and disturbed the yellow sandy (wadjil) soil” “they have ripped the edges of the rows of trees twice since they bought the property and have observed that the crop grows right back to the trees”.

Graham Haeusler: “The trees have become a problem, the moisture loss on adjacent loss on adjacent cropping was a specific problem last year – the impact can be noticed up to 7 metres from the edge of the trees, resulting in “crop failure” over a considerable area alongside the belts of trees and covering a significant area alongside the belts of trees and covering a significant component of the alleys (the area between the belts of trees).

Ernie Strahan: “when the cropping is adjacent to the trees an area of at least 3 metres into the crop is very reduced compared to most of the crop in the alley – the impact is very apparent when first when taking a first pass, “the combe is only half full” in relation to the impact of the trees on the cropping results, it is too hard to measure because the trees vary as do the seasons”.

David Hood: There are other problems including the roots intercepting the crops adjacent to the rows on both sides of the trees. Despite this David believes the returns from this area are better than before the trees were planted – te advance of the roots is gradual”.

Carl Fuchsbichler: “ the level of competition depends on the season – if the season was bad (dry) then the impact might be reduced growth reaching out 20 metres on both sides of the belts of trees – if the season was good, the impact might be half of that, but the biger the tree the more the crop competition is evidenced – losses from competition was worse on the better land – the red land”.

Jo and Walter Ashworth: “the trees impacted too much because the spacing was wrong – this caused a degree of double spraying and double seeding as the track taken by the machinery created overlapping of the equipment” “the trees take away moisture and nutrients from the crop”.

Ian Stanley: “the impacts were different for different areas and seasonally dependent – one could say that the longer the trees were left without being cut, the greater the competition” ”where threes are over 8 years old the competition is unacceptable” “when they have coppiced (without using the biomass) the competition turns to zero but it is very expensive and not cost effective in terms of increased crop returns…”.

Summary

All acknowledged the impact of the belts of trees on their cropping programs but provided a variety of views on the extent of competition. Some pointed to the impact of different annual conditions and to the type of soil. There was an additional concern about trafficability of machinery and the added complexity of spraying.

Factor 2. Environmental impact

Peter Spark: "The land care benefits were of keen interest as they are planted on low lying areas with salt problems – Peter and his father have been trying lots of different treatments including belts of trees" - "other areas in salty areas are planted in blocks including Old Man Saltbush".

Ray Sullivan: 'the motivation (for having trees planted on their farm) was based on bioenergy, carbon and salinity management".

Mike Kerkmans: "the environmental benefits were very important – controlling the water table and reducing erosion".

Farmer A: "thinking more about benefits to stock and a way of reducing damage to the land where the sheep grazed and disturbed the yellow sandy (wadjil) soil".

Graham Haeusler: "there was no cost (for the planting of the trees) and the farmer was to be paid for the land occupied by the trees – it was considered that the trees would help control the rising water table". In Graham's opinion there is still a salt problem with salt scalds still [present – but reduced where the trees have an impact" "the water table presents a problem with it continuing to bring salt to the surface … and the trees are slowing the encroachment of water particularly in lower lying areas and slopes where the salt scalds are still apparent".

Ernie Strahan: "the main reasons for planting the trees was to reduce wind erosion, combat the rising water table and therefore ameliorate the spread of damage by salinity". Ernie has been around the area for a long time and was involved in clearing the vegetation in the 40's and 50's. He recalls the difficulty of removing the reshooting Mallees where they had been removed by chains strung between two large tractors".

David Hood: "there were some problem areas where David thought trees might be beneficial – including a serious issue of wind erosion which was particularly severe on the yellow sandy areas or wadjil soils, the topsoil had been largely blown away".

Karl Fuchsbichler: "there was an attraction to the potential land care benefits by targeting the low-lying areas of the property".

Jo and Walter Ashworth: "the concept of trees being planted is a good one with benefits achieved through managing recharge and reducing the impact of salinity.

Ian Stanley: "the early planting of trees on the Stanley farm was all about populating the farm with local native trees that had been fully removed" "there was a strong desire to improve the sustainability of farming systems – at the same time there was Government assistance and a groundswell of land care groups and others pushing to develop new industries on farmland"

Duncan Avery: "the conservation benefits included wind reduction, water table management, an increase in birdlife and shelter for the sheep"

Summary

There was universal opinion that the trees had played a useful role in one or more functions: ameliorating the rising water table, slowing the accumulation of water in low lying areas and providing wind break and shelter.

Factor 3. Financial outcome

Ray Sullivan: " a mix of interests – an industry based on bioenergy, carbon and salinity".

Mike Kerkmans: "the financial deal (by Kansai) was attractive".

Farmer A: "there are distinct advantages to promoting these trees on farmland if there is a commercial purpose other than carbon and something was created from biomass".

Graham Hauesler: "there was no cost to the farmer (for planting of the trees) and the farmer was to be paid for the land occupied by the tree – and it was possible that there would be some income eventually from the sale of biomass".

Ernie Strahan: "the annual payments for the 20 hectares of trees was quite small but was very pleased with savings made by having the trees provided and planted".

Carl Fuchsbichler: "an interest was to generate annual income off the area set aside for the trees as a carbon project and potentially gain more income from eucalyptus oil, bioenergy and carbon credits".

Jo and Walter Ashworth: "it would help if there was some income also being derived from regular harvesting and/or revenue from carbon".

Ian Stanley: "there was an opportunity to generate income on the land they occupy including carbon, eucalyptus oil and bioenergy".

Summary

The potential for a financial return was attractive to most growers and played a role in deciding to plant the trees. The fact that the trees would be planted at no cost was also very attractive.

Factor 4. Improved agricultural performance

Peter Spark: "he has observed on farms that paddocks have become more productive after the trees were planted" "now with the addition of 300,000 trees there is much more evidence wildlife such as lizards, birds etc – the farm looks very healthy and beautiful and there has been no loss in productivity" " the trees do have an impact but this varies from year to year – for example, the trees can be beneficial in wet years while being a problem in dry years – however in dry years the wind break caused by the trees can reduce the drying out in the middle of the alley – Peter believes he has observed on farms that paddocks have become more productive after trees were planted".

Mike Kerkmans: "no observable impact (of the trees on cropping)".

David Hood: "there are other problems including roots intercepting the crops adjacent to the rows on both sides of the trees, despite this, David believes the returns from this area are better than before the trees were planted" " David has other trees of about the same size of the Kansai plantings – they have been placed on salt impacted land and the land has improved as a result of the rows of trees" " the area is not particularly affected by salt but is on the valley floor and salt is a problem from time to time – the emergence of moisture has been controlled – he has used other methods of control including application of gypsum and lime and "humates"" " the trees have an impact – a positive one – the trees make a problem appear better better than it would be otherwise".

Ian Stanley: "there was the problem of crop competition along the rows but in some areas there were improvements in crop performance – there was , in some areas, much more negative impact than anticipated and in other areas there was positive or neutral impact – it's important to realise that these impacts were different for different areas and seasonally dependent" " Ian believes that they have observed the instances where there has been an improvement in yield between the rows but they cannot measure this – for instance it's hard to compare the yield before the trees were there" " it's true that if the they (the trees) grow beyond a certain age the impact of the wind decreases – but this positive impact does not make upo for the losses on the edge – but if the trees are regularly coppiced this impact (the "edge effect") disappears".

Summary

Some but less than half of the farmers believed that in some areas there was a noticeable improvement in productivity.

Factor 5. Impact of trees on land value

Peter Spark: "while the value of the farm, in the view of his neighbours, was reduced by existence of the trees (indeed "ruined"), Peter believes the trees should have had no impact or even a positive effect" "in terms of measurement of impact of tres before and after planting, people will believe what they want to believe and the sceptics will not change their view – some farmers believe the soil is there to hold up the plants – a sort of hydroponics" .

Mike Kerkmans: Mike has never come across the idea that the trees would impact on the valuation of the property. When they sold Marlingu, the trees were included and the price was about right – but at the time trees attracted a lease payment aligned to the Kansai carbon sequestration project. On reflection, if he was buying a farm now with belts of trees, he would be inclined to think of the trees as part of te "non arable" land component. Mike referred also to the payments to farmers in parts of the USA for "set aside" land.

Farmer A does not believe the trees would have any impact, positive or negative, on the value of the area on which they are planted, but he did remove the trees on his farm when he was able to do so. The previous owner was assumed to like the trees for their benefit to stock, while Farmer A has been more involved in cropping.

Graham Haeusler: Graham was unsure about the impact of the trees on property value, but assumed it would be negative.

Ernie Strahan: He believes there is little impact. He pointed out how a number of things were raised when the property was sold, but it's possible that among all the issues raised, the buyer's dislike of the trees may have played a role in negotiations.

David Hood: David is in te process of selling the property with the most trees and believes the price will be improved by the existence of the trees and is definitely not sorry for planting them across the farm.

Carl Fuschsbichler: When Carl purchased the property, the sale agreement was non-conditional so there was limited opportunity to negotiate, but the seller removed all the covenants relating to the trees.

Jo and Walter Ashworth: The purchase of the farm was priced as a whole and they don't believe the trees lowered the price, however there was a leasehold structure associated with the trees and an annual payment from Kansai Electric. Now they believe the trees would devalue the property even though there are probably benefits that cannot be observed.

Ian Stanley: Ian believes that as they are after many years of growth, they would have a negative impact on value. Where the trees have been regularly harvested for Eucalyptus oil, they would have no impact on land value.

Duncan Avery: Duncan believes there would be no impact on the value of the farm.

Summary

Most of the farmers believed that the trees had a negative impact on the farm value whether deserved or not.

Factor 6. Shelter and other services

Peter Spark: Peter believed that the trees he planted would also provide shelter for sheep and reduce wind erosion.

Ray Sullivan: Cleary with trees being reintroduced on to this totally cleared farmland, the impact of the wind has been reduced.

Farmer A: believes the previous owner was very aware of the benefits to stock rather than being concerned about the crop competition.

Ernie Strahan: Ernie had already [planted many trees on his farm and believed they played a role in reducing the wind speed as long as the trees were oriented correctly. He believes the sheep enjoy the shade and shelter provided by the tree and access the diversity of food available in the belts, including the softer leaves. He observed in earlier times the sheep liking the younger softer leaves. He compares this liking of Mallee leaves to their attraction to rose bushes. If you want success with sheep, you have to provide these sorts of benefits of shade and shelter.

David Hood: He has noticed the sheep really appreciate the shelter provided by the trees although he did anticipate this before planting. They do not touch the trees and weeds have never been a problem as the high density of planting controls this. David would prefer to have the trees for protection rather than the option of harvesting and production.

Carl Fuchsbichler: Carl believes the trees have helped protect the soil particularly in relation to wind erosion. One down side is that the sheep congregate next to the trees and create more bare patches.

Summary

Farmers found that the trees were very effective in providing shelter for farm animals.

Factor 7. Pests

Jo and Walter Ashworth: The trees have provided shelter for foxes who use the trees as habitat and can attack lambs from the cover.

Duncan Avery: at one time, rabbits were a problem as they used the belts of trees as places to establish their warrens.

Summary

Two farmers pointed out that the trees could be used by foxes and rabbits, two important pest animals.

Factor 8. Aesthetics

Peter Spark: Peter wished he had taken a photo of the farm when they bought it 20 years ago when it was 50% bare. Now the farm looks healthy and beautiful.

Ray Sullivan: Ray considers the aesthetics very important.

Mike Kerkmans: Mike believes the look of the farm is a very distinct attraction. While some people think trees "get in the way" of farming, "the look" of the place is very important. He is proud of the way his efforts have changed a barren landscape of that part of the northern wheatbelt.

Graham Haeusler: The trees add to the landscape in a cosmetic way as the country around his area is very bare.

Ernie Strahan: Ernie believes the look of the trees adds to the attractiveness of the farm.

David Hood: The trees make a problem appear better than it would otherwise. The aesthetics of the trees improves the look of the whole far.

Jo and Walter Ashworth: There is a strong positive feeling about the look of the trees – the aesthetics are very obvious and appreciated.

Summary

Several farmers nominated the positive aesthetics the trees brought to the farm.

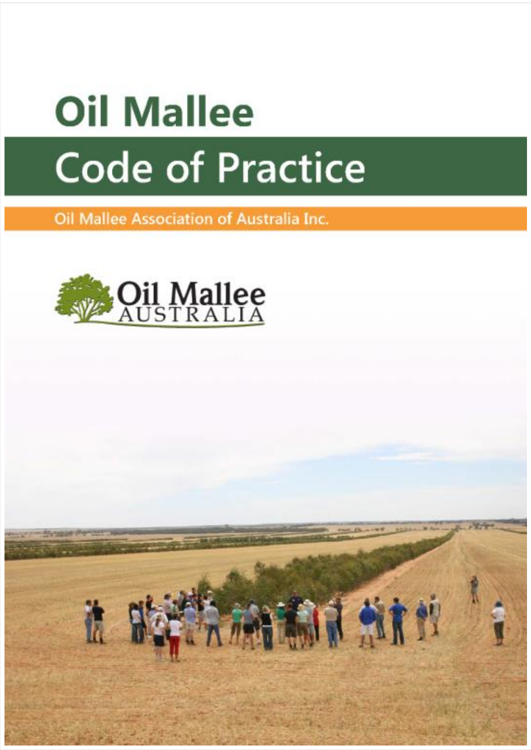
Appendix C OMA Code of Practice

The OMA has developed a series of steps that it recommends using when establishing a Mallee planting. These practices are under constant review and will be updated from time to time.

The Code of Practice in broad terms, summarises the desired standards for key industry players such as nurseries, contractors and growers and describes the practices of the industry to others including local government, transport contractors, regulators and industry.

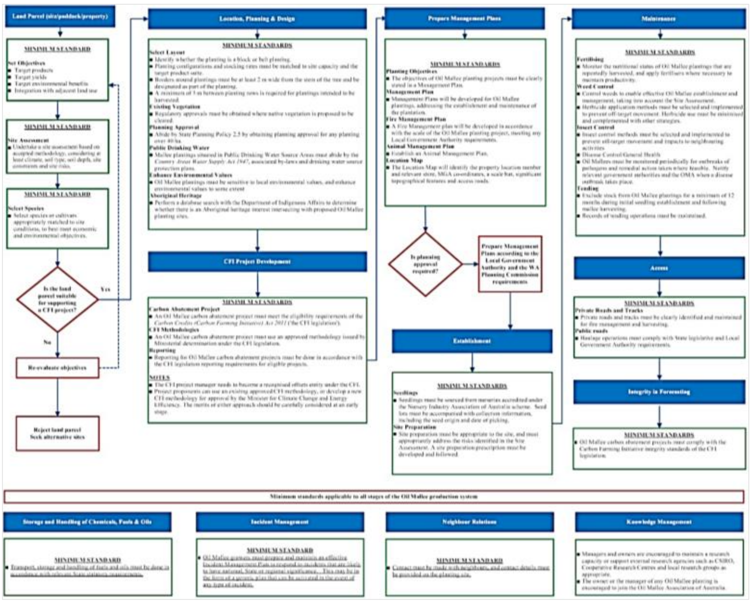
The Code of Practice will be reviewed and upgraded to include all stages of the oil Mallee industry value chain. This will include addressing requirements for processing, renewable energy legislation, guidelines for carbon sinks and other government regulation.

C.1 Code of Practice



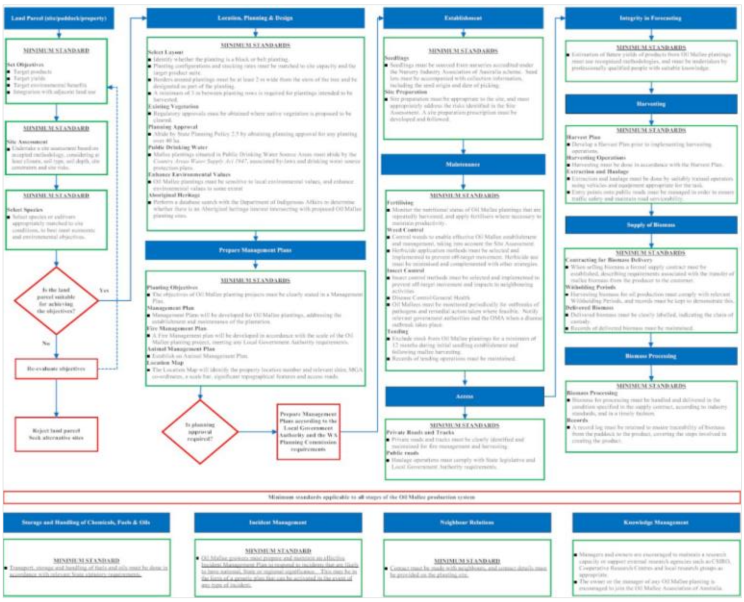
Link: https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/oil_Mallee_code_of_practice_2012_final_draft_.pdf

C.2 Code of Practice – Roadmap: Carbon Abatement



Link: https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/cop_road_map_-_carbon_abatement_v2.pdf

C.3 Code of Practice – Roadmap: Harvest



Link: https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/cop_road_map_-_harvest_v2.pdf

C.4 Guidance Notes

Source	Title and Link
Oil Mallee Association	"Relevant Acts and Regulations" (gn 1) https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/gn_1_relevant_acts_and_regulations.pdf
Oil Mallee Association	"Layout Considerations" (gn 2.1) https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/gn_2.1_layout_considerations.pdf
Oil Mallee Association	"Existing Native Vegetation" (gn 2.2) https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/gn_2.2_existing_native_vegetation.pdf
Oil Mallee Association	"Planting in Public Drinking Water Source Areas" (gn 2.4) https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/gn_2.4_planting_in_public_drinking_water_source_areas.pdf
Oil Mallee Association	"Occupational Health and Safety" (gn 2.7) https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/gn_2.7_occupational_health_and_safety.pdf
Oil Mallee Association	"Carbon Abatement Projects" (gn 7.1) https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/gn_7.1_carbon_abatement_projects.pdf
Oil Mallee Association	"Carbon Farming Initiatives – CFI Methodologies" (gn 7.2) https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/gn_7.2_carbon_farming_initiatives__cfi__methodologies.pdf
Oil Mallee Association	"Harvest Plans" (gn 8.1) https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/gn_8.1_harvest_plans.pdf
Oil Mallee Association	"Integrity in Forecasting" (gn 12.1) https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/gn_12.1_integrity_in_forecasting.pdf
Fire Emergency Services Authority Western Australia	"FESA Guidelines on Fire Protection Measures" https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/fesa_guidelines_for_plantation_fire_protection_2011.pdf
Australian Government	"Carbon Farming Initiative Handbook" https://www.oilMallee.org.au/uploads/1/2/4/8/124851687/cfi-handbook-20120403-pdf.pdf

Appendix D Permissions for Copyright

Figure 10.2 BEFS review of sustainability assessment systems

After receiving the email below, it was clear that specific permission was not required as the diagram came from a website.

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Kind regards,
Radhika

From: CPAC-Web
Sent: 22 February 2019 08:50
To: Copyright <Copyright@fao.org>
Subject: FW: Permission to use diagram

Dear Colleagues,

Please advise on the request below.

Thank you.
Regards,
Layla

Layla Nobile
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Government Relations Branch (CPAC)
Food and Agriculture Organization of the United Nations (FAO)
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Figure 3.1 Lowy Institute Polls 2006 -2018: Climate Change

Dear Simon

Thanks for getting in contact. It's fine to reproduce the climate attitudes data, provided the attribution is correct; e.g. Lowy Institute Polls 2007-2019, or Lowy Institute annual opinion polling 2007-2019.

You might be interested in this chart, which has a timeline beneath the graphed attitudes (similar to what you've done with your overlay).

https://www.lowyinstitute.org/issues/australia-climate-change

Best regards
Alex
Alexandra Oliver
Program Director, Polling