THE ROLE OF THE FACTORS THAT INFLUENCE THE ADOPTION OF THE AUSTRALIAN CARBON FARMING INITIATIVE-EMISSIONS REDUCTION FUND: A MIXED METHODS STUDY

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ABSTRACT

The Australian government established the Carbon Farming Initiative (CFI) in 2011, and by 2014 it was merged into the newly introduced Emissions Reduction Fund (ERF). The aim of the CFI-ERF was to encourage the abatement of greenhouse gasses (GHG) from different sectors of the economy (e.g. energy efficiency, transport and the land sector), and to meet Australia's Kyoto Protocol (KP) emissions reduction target. The potential for GHG abatement in the Australian land sector (farming/agriculture and forestry) presents an excellent opportunity for the development of carbon farming projects while providing other crucial environmental/ecosystem benefits. This thesis investigates the role that demography, knowledge, motivation, capacity and barriers (DKMCB) play in the adoption of the CFI-ERF/carbon sequestratoin activities from an Australian landholders perspective. A methodological framework was developed to explore the influence of DKMCB factors on adopting the initiative. The study employed a mixed methods sequential explanatory research design which comprised two phases: a quantitative and a qualitative. The quantitative phase used a survey questionnaire addressed to landholders Australia wide: 214 participants completed the questionnaire. The qualitative phase used in-depth, semi-structured interviews targeting only adopters of the policy. Seven of thirteen adopters – identified through the survey form employed in the first phase – accepted the invitation to take part in the interviews.

Rogers' Diffusion of Innovations (DOI) theory, proposed in 1962, provided the conceptual framing for this research. The DOI seeks to explain how and why intended adopters implement some new ideas and reject others. The DOI claims that the uptake of innovations, among other factors, depends on the demographic characteristics of the target population (e.g. age, gender, education level and occupation) and their networks, the features of the proposed innovation and the channels through which innovations are communicated. The quantitative results revealed that higher levels of knowledge about the CFI-ERF were associated with a decreased likelihood of adoption. Similarly, the higher the financial capacity landholders had, the less likely they were to adopt the initiative. Moral responsibility (to implement environmental practices), followed by economic return and availability of technical support were associated with an increased likelihood of adoption, while government regulations were associated with a reduction of the probability of adopting the CFI-ERF. The qualitative

results showed that there were two main types of adopters: associated adopters (associated with carbon consulting enterprises) and independent adopters (implemented CFI-ERF projects independently). Associated adopters contribution to the study was not significant since Carbon Consulting Enterprises (CCE) did all the CFI adoption process. In the case of independent adopters, level of education and motivation had a strong influence on the decision of adopting the CFI-ERF. Environmental benefits of the application of CFI-ERF activities were strong motivations of adoption for all the informants. Economic return was not as an important motivation as frequently assumed in the literature. Costs and uncertainty (policy, carbon price, and project financial-viability uncertainty) were the strongest barriers to adopting the initiative.

This study contributes to the existing knowledge on diffusion research in the environmental field and particularly to research on the adoption of the CFI-ERF. The results of this study suggest the need to rethink the design of the CFI-ERF, the way carbon credits are traded, efficiently integrate environmental benefits (ecosystem services) in the pricing of ACCUs and improve communication strategies to better communicate the environmental/ecosystem benefits to potential adopters, since the results show that environmental benefits are the strongest motivation to adopt the CFI-ERF. Additionally, the methodological framework developed for this study, along with mixed methods research designs, present a practical approach to assessing the role that specific factors (i.e. demography, knowledge, motivation, capacity and barriers) play in the adoption of innovations in the environmental area, as well as in other disciplines, using quantitative and qualitative methods.

ACRONYMS

ACCU	Australian Carbon Credit Units
BOM	Bureau of Meteorology
CCE	Carbon Consulting Enterprise
CER	Clean Energy Regulator
CFI-ERF	Carbon Farming Initiative-Emissions Reduction Fund
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DKMCB	Demography, knowledge, motivation, capacity and barriers (methodological framework factors)
DOI	Diffusion of Innovations
ERF	Emission Reduction Fund
ETS	Emissions Trading System or Emissions Trading Scheme
IPCC	International Panel on Climate Change
KP	Kyoto Protocol
NRM	Natural Resources Management
QUAN	Quantitative
QUAL	Qualitative
UNFCCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environmental Programme
WHA	World Heritage Area
ppm	Parts per million (GHG concentration)
ppb	Parts per billion (GHG concentration)

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CHAPTER 1: INTRODUCTION

The Australian Government introduced the Carbon Farming Initiative (CFI) in 2011 as one of key policy platforms to achieve the Australian emissions reduction target under the Kyoto Protocol (Department of Climate Change and Energy Efficiency [DCCEE], 2012). In 2014, the CFI was integrated with the Emissions Reductions Fund (ERF)[1], stablished as part of the Direct-Action Plan, of the newly elected Australian government. The potential of GHGs' abatement of the Australian land sector (farming/agriculture and forestry) presents a great opportunity for the development of CFI-ERF projects while providing other crucial environmental (co)benefits. The aim of this study was to investigate the role that demography, knowledge, motivation, capacity and barriers (DKMCB) play in the adoption of the CFI-ERF from Australian landholders' perspective. This thesis investigates the level of knowledge that landholders have about the CFI-ERF and the environmental benefits resulting from the adoption of CFI-ERF activities. It explores landholders' motivation and capacity for the uptake of the initiative, and the barriers landholders must overcome to adopt the CFI-ERF. This study therefore contributes to our understanding of why some landholders decide to adopt and others reject or delay the adoption of the CFI-ERF and similar innovations. This research thus presents an important opportunity to support future climate change mitigation efforts carried out in Australia, especially given Australia's commitments under the recent Paris Agreement (2015) (Department of the Environment and Energy, 2015).

1.1 BACKGROUND

> "Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems." IPCC (2014b)

Changes in climate observed around the globe have triggered diverse responses from scientists, politicians, governments at all levels, and society more generally. The international community has created different treaties such as the United Nations Framework Convention

[1] In this thesis, CFI-ERF indicates the integration of the Carbon Farming Initiative and the Emissions Reduction Fund. Refer to Chapter 2, section: The Australian Carbon Farming Initiative and the Emissions Reduction Fund.

on Climate Change (UNFCCC) and the Kyoto Protocol (KP) to coordinate efforts towards reducing the levels of GHG emissions and enhancing of carbon sinks (e.g. carbon sequestration through vegetation), to mitigate climate change. The UNFCCC, which includes obligations for all its members, came into effect in 1994 and has been ratified by 195 countries (IPCC, 2007b). The KP was adopted on 11 December 1997, in Kyoto Japan. The KP is an international treaty that sets differentiated targets of GHG reduction of emissions to its parties. Industrialized countries (Annex 1 of the protocol) have a heavier load of reductions commitments (United Nations, 1998). Australia ratified the KP for first and second commitment periods in 2007 (Parliament of Australia, 2015b) and 2015 (Parliament of Australia, 2015a) respectively.

The Australian government introduced the Carbon Farming Initiative (CFI) in 2011 to achieve the national emissions reduction target under the KP (DCCEE, 2012). The CFI started in 2012 and operated until the creation of the Emissions Reduction Fund which is the central piece of the Australian Government's Direct Action Plan. The ERF legislation became law in December 2014 (Department of the Environment, 2016). The Emissions Reduction Fund (ERF) builds on the CFI (Department of the Environment, 2016) and is administered by the Clean Energy Regulator (CER). The CFI-ERF presents landholders with the opportunity to access carbon markets through the adoption of activities (projects) aimed to: reduce on-the-land greenhouse gas emissions and enhance carbon sequestration (DCCEE, 2012). Projects accepted under the CFI-ERF can generate Australian carbon credit units (ACCU). One ACCU equals one tonne of carbon dioxide or equivalents ($CO_{2\text{-}e}$)[2]. ACCUs can then be traded in carbon markets (DCCEE, 2012). The CER accepted projects under development following the CFI rules until June 2015. The projects registered under the CFI rules were automatically transitioned and remain active under the new ERF scheme (CER, 2015a). Since July 2015 onwards, new projects, to be approved and registered, must comply with the ERF rules to be accepted (CER, 2016a).

Under the Carbon Farming Initiative rules (December 2011 to June 2015), carbon credits were traded using a fixed price. When the ERF rules entered into force (July 2015), the fixed price approach for carbon credits' trading was replaced for a reverse auction method. The

[2] The potential of other greenhouse gases, e.g. methane or nitrous oxide, are compared to CO_2 to allow standardization. Therefore, in the context of carbon trading, $CO_{2\text{-}e}$ is used as a measure to calculate the amount of GHG abatement to issuing carbon credits.

Australian Government purchases Australian Carbon Credit Units (ACCU) through reverse auctions carried out twice a year. Typically, projects able to sell ACCUs at the lowest price are successful in the ERF auctions. The price of carbon credits has changed significantly since the start of the CFI and the transition to the ERF rules. For the Australian financial years 2012-2013 and 2013-2014, ACCUs had a fixed price of A$23 and A$24.15 respectively (CER, 2015b). Under the new rules, the CER has held five auctions so far: April 2015, November 2015, April 2016, November 2006 and April 2017. ACCUs were traded on average at A$13.95, A$12.25 in April and November 2015 respectively. In April and November 2016, the average ACCU's price at the auction was A$10.23 and A$10.63 respectively (CER, 2016c; Clean Energy Regulator, 2017). The last auction occurred in April 2017 where the average price of carbon was A$11.82 per ACCU.

1.2 RATIONALE FOR THE STUDY

A range of activities aimed to encourage GHG abatement (i.e. carbon sequestration and emissions avoidance) from different sectors of the Australian economy (e.g. energy efficiency, transport, land sector and waste management) are under the scope of the CFI-ERF regulation. The interest of this thesis is to study the factors influencing the adoption of activities proposed to the land sector, specifically carbon sequestration activities from landholders' perspectives. In this thesis landholders are defined as any individual or organization with exclusive rights over the land (rural land), either by freehold[3] or leasehold[4].The rights over the land allow landholders to make any decisions about land use or land use change. Thus, a diverse range of landholders are entitled to implement any of the activities under the CFI-ERF rules.

Adopting an innovation in the carbon sequestration area is a challenging decision. Most activities aimed at increasing carbon sequestration involve reforestation[5] or afforestation[6]

[3] In Australia freehold is defined as the 'most complete' form of ownership of land in perpetuity. Any landholder(s) can sell, license, lease or mortgage that land (Australian Trade and Investment Commission, 2017).

[4] According to the Australian Trade and Investment Commission (2017), individuals and corporations can lease land in Australia. When leasing, the holder of the freehold title continues to own the freehold title of the land (Australian Trade and Investment Commission, 2017).

[5] Reforestation refers to artificial forest establishment by planting and/or seeding in places where forest existed before (Schuck, Päivinen, Hytönen, & Pajari, 2002) (i.e. where land was cleared for agricultural purposes).

[6] Afforestation is the method of stablishing forest on land where forest did not previously exist (Schuck, Päivinen, Hytönen, & Pajari, 2002).

methods which, in turn, require significant land use change that can be expensive and not easily reversed (Pannell et al., 2006). The importance of practices oriented to encourage emissions abatement, especially carbon sequestration activities, rests on the fact that they also provide crucial ecosystem services which, under the current circumstances, are progressively becoming limited (Alamgir et al., 2014). Furthermore, Bradshaw et al. (2013) state that conservation planning needs to incorporate carbon sequestration into the design of conservation schemes to improve simultaneously biodiversity and carbon emissions abatement benefits. These may also be described as co-benefits.

At the start of this study, a review of literature revealed a gap in the knowledge about the role that factors such as demography, knowledge, motivation, capacity and barriers (DKMCB) play on landholders' decisions to adopt the CFI-ERF. While a few recent studies examine the adoption of innovations in the Australian environmental land sector, including some research on Australian carbon farming initiatives (e.g. Dumbrell et al., 2016; Kragt et al. 2016; Evans et al., 2015; Maraseni & Cockfield 2015; Macintosh, 2014; Bradshaw et al. 2013; Polglase et al., 2013) there remains a need to understand the role that DKMCB factors (and their interactions) play on landholders' decisions in adopting the CFI-ERF. Considering the opinion of Australian landholders in general, and particularly of adopters of the CFI-ERF, may improve the understanding of the influence of the complex factors influencing the uptake of the CFI-ERF initiative. This improved understanding, in turn, may facilitate policy makers to (re)design policies, schemes or mechanisms aimed at reducing Australian emissions and boost carbon sequestration and associated environmental benefits from the land sector while presenting a more feasible option for landholders to generate alternative farm income.

1.3 SCOPE OF THE STUDY

This study focuses on the adoption of the Australian CFI-ERF from landholders' perspectives, with an emphasis on carbon sequestration activities, rather than alternative carbon emission perspectives. Specifically, this thesis investigates the role of factors driving the adoption of the CFI-ERF in Australia, using both quantitative (QUAN) and qualitative (QUAL) methods. Australian landholders were invited to participate in two different phases in this mixed-methods study. In the first phase (QUAN phase), landholders Australia-wide were the target population for the application of a survey questionnaire. During the second phase (QUAL phase), only adopters of the CFI-ERF (key informants) were asked to take part

via in-depth semi-structured interviews. Adoption in the context of this thesis is only reached when the projects implemented by landholders have been accepted and registered by the policy administrator[7]. This is discussed more fully in the methodology chapter.

1.4 RESEARCH AIM AND RESEARCH QUESTIONS

General aim

The overall aim of this study is to document and evaluate the role that demography, knowledge, motivation, capacity and barriers play on landholders' decisions to adopt the Carbon Farming Initiative (CFI-ERF).

Research questions

This study used a mixed methods approach to investigate the factors affecting landholders' decisions to adopt the Carbon Farming Initiative. The research design consisted of two phases: a quantitative (QUAN) and a qualitative (QUAL). Therefore, research questions were formulated accordingly.

Primary research question

What are the roles of demography, knowledge, motivation, capacity and barriers in determining the adoption of the CFI-ERF by Australian landholders?

Quantitative research question (phase one)

Do demography, knowledge, motivation, capacity and barriers predict the adoption of the CFI-ERF by Australian landholders?

Qualitative research question (phase two)

How do demography, knowledge, motivation, capacity and barriers influence the adoption of the CFI-ERF by Australian landholders?

[7] The Clean Energy Regulator (CER) administrates the CFI-ERF. The CER registers the projects accepted under the regulations.

1.5 THEORETICAL FRAMEWORK

Low levels of uptake of particular innovations tends to stimulate adoption research (Pannell et al., 2006). The adoption (or lack of adoption) of new practices in Australia has been explored from different perspectives (e.g., economics and sociology), often depending on the disciplinary orientation of the researcher(s) (Pannell et al., 2006). The discipline of the researcher influences the importance given to different drivers of innovation, e.g. economists highlight the importance of economic factors more than sociologists (Pannell et al., 2006). Also, different methods (e.g. quantitative and qualitative) have been used to investigate (or review research), or even model and predict the influence of drivers of adoption of new ideas. Regardless of the perspective employed or methods used, studying the influence of factors that influence the adoption of environmental innovations is a complex task. Most of the factors driving or impeding adoption vary greatly depending on the social, political and geographical context where such environmental schemes developed (Greiner & Gregg, 2011; Pannell et al., 2006).

Characteristics of intended adopters, as well as the features and benefits (economic, social, environmental) of innovations proposed, have been examined in a wide body of literature (Ducos, Dupraz, & Bonnieux, 2009; Meadows, Emtage, & Herbohn, 2014; Pannell et al., 2006; Stanley, Clouston, & Baker, 2006). Landholders' social contexts (Ducos et al., 2009; Dumbrell, Kragt, & Gibson, 2016; Greiner & Gregg, 2011), their communication and networks are also the subject of research (Torabi, Cooke, & Bekessy, 2016). Many scholars have combined several of these factors in their studies. Empirical studies, modelling, literature reviews and opinion pieces are part of the broad conversation regarding knowledge adoption in the land sector. This extensive variety of approaches and perspectives responds to the complexity of studying innovations and adoption in any field and particularly in the environmental land sector.

The analysis of the literature presented in Chapter 3 shows the existence of numerous factors that can influence the adoption of initiatives in the land sector. Taking cues from the published literature and considering the elements that can potentially influence the adoption of the CFI-ERF, this study advances the idea that *demography, knowledge, motivation, capacity* and *barriers* (*DKMCB*) are key overarching factors influencing the adoption of the CFI-ERF. Consequently, a methodological framework was developed that aimed to facilitate the study of the influence of DKMCB factors on the adoption of the CFI-ERF by Australian landholders. As explained in the Methods Chapter, the DKMCB combines the main

propositions of the Diffusion of Innovations (DOI) theory (Rogers, 1962) with those presented in the 'Challenges of Applying Sustainability' framework, developed by Macgregor (2009). Chapter 3 contains a detailed explanation of the methodological framework used in this study.

Research, since the early 1900s, has generated different models to explain the diffusion of technological (products and processes) and non-technological innovations (information, ideas) in different contexts (Karakaya, Hidalgo, & Nuur, 2014). Many scholars have contributed to the development of the diffusion of innovations model, especially from a sociological/geographical perspective. e.g. Tarde (1903), Chapin (1928), Pemberton (1936), Ryan and Gross (1943), Rogers (1962), L. A. Brown (1969) and M. Brown (1981). Tarde's research is regarded as the first work on diffusion of innovations (Wejnert, 2002; Padel, 2001; Valente & Rogers, 1995; Rogers, 1983). And several scholars concur that the article presented by Ryan and Gross in 1943, on the diffusion of a hybrid corn seed among farmers in Iowa, was the foundation of the development of the *innovation diffusion paradigm*. Torsten Hagerstrand (1953) brought to the table the importance of the geographical context and the information networks on the diffusion of certain innovations. Hangerstrand noted the existence of a hierarchy of social communication networks, i.e. local, regional and international networks. The next important chapter on the evolution of innovation diffusion research was put forward by Everett Rogers (1962) with his book "Diffusion of Innovations".

The Diffusion of Innovations (DOI) theory (Rogers, 1962) is the theoretical framework underpinning this study. In his book, Rogers (1962) summarizes the findings of over five hundred innovation diffusion studies. Dearing (2009) states that only a few theories have had an impact on diffusion research comparable with DOI. Researchers in almost all disciplines as well as practitioners have applied and adapted the innovation diffusion paradigm to fit their objectives for over fifty years (Dearing, 2009). For instance, proposed a model to accelerate diffusion of new practices based on the influence of opinion leaders. According to Valente and Davis (1999), most of new practices communication programs would use mass media to spread information among potential adopters. Thus, communication programs place little attention to interpersonal communication networks and the internal communication structure of the community or organization where the innovation was proposed. Similarly, Wejnert (2002) proposed a conceptual framework to analyse different models of innovation diffusion. The characteristics of any innovation are grouped in three overarching elements that influence adoption: characteristics of the innovation, characteristics of the

adopters/intended adopters and the geographical context of the adopters (Wejnert, 2002). Agriculture, e.g. Feder, Just, and Zilberman (1985); health, e.g. Fitzgerald, Ferlie, Wood, and Hawkins (2002) and education, e.g. Mintrom and Vergari (1998), are examples of fields where the application of the Diffusion of Innovations theory has increased knowledge and understanding (Dearing, 2009). Rogers' DOI explains why members of a particular target population decide to adopt and why others delay or reject new ideas (innovations). The DOI theory classifies adopters into five categories depending on their different demographic characteristics and how soon or late they adopt innovations: innovators, early adopters, early majority, late majority and laggards. For instance, innovators, who are the smallest group compared to the total of intended adopters' population are the first to adopt new ideas. Innovators like trying new ideas, have relatively good economic positions which allows them to take the risk of financial loss and their networks extend outside their social group. In contrast, laggards who are the last to adopt innovations (if ever), typically have poorer financial situations, do not like change and are often isolated from sources of new information. The other crucial concept of the DOI is the existence of *change agents*. Rogers (1962) explains that some innovations are disseminated through intended adopters' social networks while change agents are responsible for the adoption of other innovations. Change agents are professionals working for public or private organizations to encourage the adoption of new ideas or technologies (Rogers, 1962, 1983). Importantly, change agents may influence individuals' decisions about adopting any particular innovation. The intervention of change agents in the diffusion process may have a significant influence on the uptake of new ideas as they can encourage or, in some cases, they may try to decelerate the uptake of innovations considered undesirable (Rogers, 1983). Extension agents, in the farming and agricultural sector, may be considered as a good example of change agents. Extension agents usually are professionals whose role is to provide information to farmers/landholders, among various topics, on the adoption and application of new technologies (Oakley & Garforth, 1985)

1.6 RESEARCH DESIGN AND METHODS

A sequential explanatory mixed methods design (Creswell & Plano Clark, 2007, 2011; Ivankova, Creswell, & Stick, 2006) was applied to investigate the role of demography, knowledge, motivation, capacity and barriers to the adoption of the CFI-ERF in Australia. The research design consisted of a quantitative (QUAN) followed by a qualitative (QUAL) phase. Both phases of the study were integrated at different levels. Importantly, the results of

the first phase provided input for the second phase, and the results of the second phase expanded and explained the results of the first phase.

1.6.1 Methods

The QUAN phase of the study used a survey questionnaire targeting (rural) landholders Australia wide. A total of 214 valid responses were used for the QUAN data analysis. The survey questionnaire was also used to identify adopters of the CFI-ERF, who voluntarily provided contact details to participate in the second phase of the study. The questionnaire data were analysed using binary logistic regression procedures to assess whether particular factors could predict adoption of the CFI-ERF.

The QUAL phase used in-depth semi-structured interviews for data collection. The interviews were addressed only to adopters of the CFI-ERF due to the knowledge and experience gained through the implementation and registration of their CFI-ERF project. Thirteen adopters of the CFI-ERF, identified through the survey questionnaire, were invited to participate in this phase of the study. Of the 13 adopters invited, seven (informants) accepted the invitation and took part in the study. Four interviews were conducted face-to-face and three over the phone.

1.6.2 Data analysis plan

As stated above, QUAN (phase one) and QUAL (phase two) data were used to assess the role that the DKMCB factors played in the adoption of the CFI-ERF. Binary logistic regression (Hosmer, Lemeshow, & Sturdivant, 2013) tests were applied to the QUAN data to assess whether the DKMCB factors would predict the adoption of the CFI-ERF. The QUAL data collected through in-depth semi-structured interviews were analysed using a thematic qualitative text analysis approach (Kuckartz, 2014). The discussion chapter of this thesis combines the QUAN and QUAL analyses to inform our understanding of factors influencing the adoption of the CFI-ERF by Australian landholders.

1.7 THESIS STRUCTURE

Chapter 2 presents a comprehensive analysis of climate change literature. This chapter also includes an analysis of key international GHG abatement initiatives and provides a description of the CFI-ERF. Additionally, *Chapter 2* contains a detailed analysis, in terms of CFI-ERF projects approved and credits issued, based on the information available on the *Register of Projects* of the Clean Energy Regulator. *Chapter 3* provides the conceptual framework applied in this thesis and incorporates an overview of research on the factors that

influence the adoption of the CFI-ERF and similar initiatives directed to the Australian land sector considered relevant to this study. *Chapter 4* describes the research approach, the methodological model developed for this study and the methods employed for data collection and analysis. *Chapter 5* presents the quantitative (QUAL) results of the survey questionnaire applied to Australian landholders. *Chapter 6* is the qualitative (QUAL) analysis of the in-depth semi-structured interviews undertaken by adopters of the CFI-ERF. *Chapter 7* is the general discussion combining the analysis of results from the QUAN and QUAL phases. *Chapter 8* presents the conclusion and recommendations for future research.

Thesis Outline

Chapter 1	Introduction
Chapter 2	**The big picture: A context analysis to the Carbon Farming Initiative-Emissions Reduction Fund**
Chapter 3	Theoretical framework and overview of the factors that influence the adoption of the Carbon Farming Initiative-Emissions Reduction Fund
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Chapter 5	The role of demography, knowledge, motivation capacity and barriers on the adoption of the Carbon Farming Initiative-Emissions Reduction Fund: A quantitative study
Chapter 6	The role of demography, knowledge, motivation, capacity and barriers on the adoption of the Carbon Farming Initiative- Emissions Reduction Fund: A qualitative study
Chapter 7	Integrating the quantitative and qualitative results: Analysis and discussion
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CHAPTER 2: THE BIG PICTURE. A CONTEXT ANALYSIS TO THE CARBON FARMING INITIATIVE-EMISSIONS REDUCTION FUND

> The IPCC had "calculated with confidence" that, to stabilize atmospheric concentrations of long-lived GHGs (i.e., CO_2, N_2O and chlorofluorocarbons) at 1990 levels, it would be necessary to reduce current levels of emissions from human activities by 60 per cent…which delineates the key obligations of industrialized countries with respect to climate change and establishes a reduction "aim" (Breidenich et al., 1998, p. 318).

2.1 INTRODUCTION

While humankind struggles to reach effective climate change action to keep global warming below 2°C, scientific evidence on Earth's climate variations keeps mounting (IPCC, 2014). The evidence on the influence of anthropogenic GHG emissions, affecting the balance of our planet's atmosphere, demands for a prompt and decisive global action to reduce GHG emissions to counter the projected negative impacts of climate change (IPCC, 2014). Climate change impacts observed around the globe are becoming more frequent and dramatic. Various international organizations and treaties have been created; some aimed to continuing and improving research on climate change and others to designing strategies for climate adaptation and mitigation. This chapter brings together literature on climate change science and the response of the international community to anticipated effects of climate change this century. Some case studies of mechanisms intended to reduce emissions and/or enhance sinks of GHGs around the world are presented in this chapter, serving as a context for the study of the Australian Carbon Farming Initiative-Emissions Reduction Fund (CFI-ERF). Finally, this chapter incorporates an analysis of the metrics of the CFI-ERF, including methodologies accepted, number of projects approved and carbon credits issued.

2.2 GREENHOUSE GASES AND CLIMATE CHANGE

> "Climate change … refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity" (IPCC, 2007a, p. 30)

One of the main determinants of global climate is the natural accumulation of gases such as water vapour, carbon dioxide (CO_2), ozone (O_3), methane (CH_4) and nitrous oxide (N_2O).

This accumulation of gases, known as greenhouse gases (GHGs), retains heat from solar radiation as well as radiant heat released from our planet's surface (United States Global Change Research Program [USGCRP], 2009). Human development activities since mid-1700s have boosted the presence of GHGs in Earth's atmosphere. While the increase of CO_2 by about 35%, is a largely result of the use of fossil fuels, CH_4 from livestock food digestive processes and N_2O largely results from fuel combustion and use of fertilizers in agriculture (IPCC, 2007d). Figure 2.1 shows the historically averaged GHG (CO_2, CH_4 and NO_2) concentration increase from ice core data (dots) and direct atmospheric measurements (lines) (Pachauri et al., 2014).

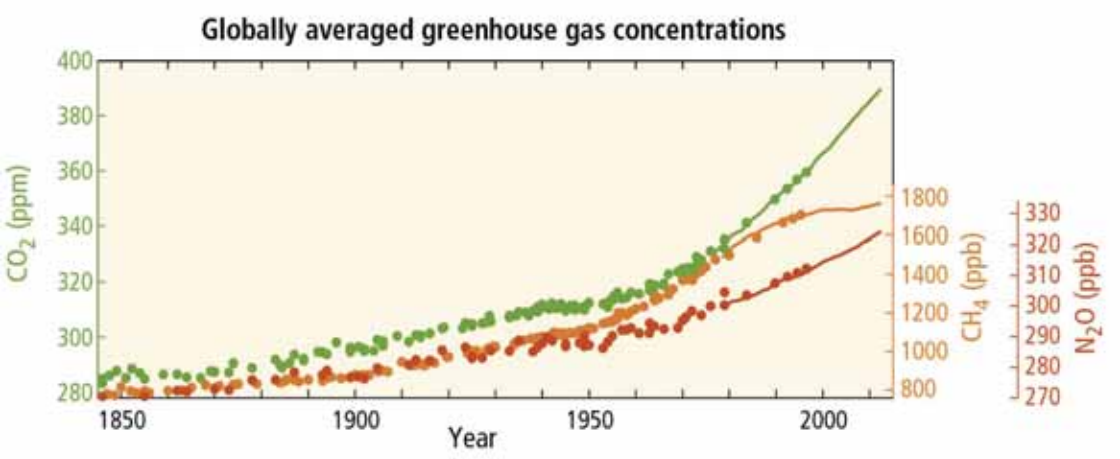

Figure 2.1 Global atmospheric GHG concentrations averaged

Source: Pachauri et al. (2014)

Climate simulations (Figure 2.2) that study how both natural forcing and human activity impact global climate. They show that without anthropogenic influences the Earth's surface temperature has slightly decreased during the last half of the 20th century, indicating that current warming around the planet is mainly caused by human activities (USGCRP, 2009).

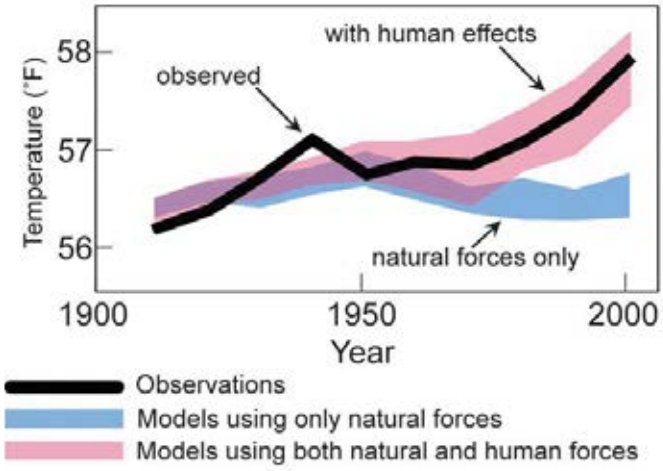

Figure 2.2 Climate change model including natural and human-induced climate forces

Source: USGCRP, 2009

2.3 IMPACTS OF CLIMATE CHANGE ON A GLOBAL SCALE

The Intergovernmental Panel on Climate Change states that "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level" (Pachauri et al., 2014, p. 40). The Earth's ocean and land surface has warmed an average of 0.85°C from 1880 to 2012 (Pachauri et al., 2014). "Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850" (Pachauri et al., 2014, p. 2). The rise of temperature is occurring throughout the planet with emphasis on the northern regions. For example, in the arctic region the temperature rise is double the global average of the past century, causing melting of the arctic sea ice by five per cent every 10 years, and increasing sea levels at 0.003 meters per year (IPCC, 2007d). Evidence shows that temperature rise has reached deep into the oceans (about 3 Km) and that ocean waters are absorbing around 80% of the increase (Pachauri et al., 2014). During the 1961 to 2003 period sea levels have risen, on average, 1.8 millimetres per year, but from 1993 to 2003 the average sea level rise has risen to 3.1 millimetres per year (IPCC, 2007c).

If the current temperature rise continues unabated, shorelines and ecosystems, water reserves, food production and health will suffer dramatic effects (Pachauri et al., 2014). The impact of climate change on the global economy has been estimated to range from 5 to 20 per cent of the *global GDP* (Eliasch, 2012). According to the UNDP, many of the most important ecosystems around the world are already under threat. If the temperature increase by 2050

surpasses 2°C (relative to pre-industrial levels), environmental degradation as well as loss of biodiversity will increase and accelerate. People and communities who mostly rely on Earth's natural resources, will suffer the most dramatic consequences (United Nations Development Programme [UNDP], 2007). Figure 2.3 provides examples of the impacts on ecosystems and sectors driven by the change in the global average temperatures (IPCC, 2007a).

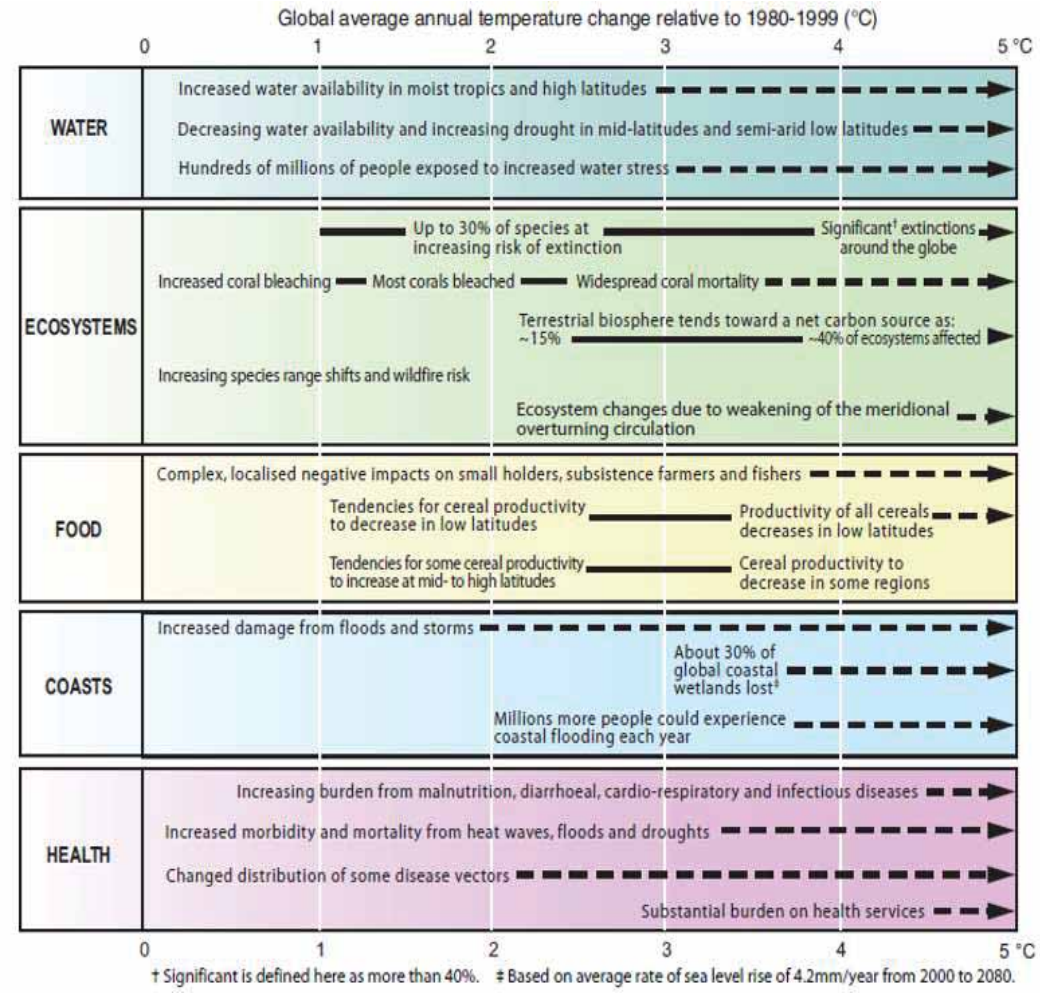

Figure 2.3 Examples of impacts associated with global average temperature change

Source: IPCC 2007

2.4 IMPACTS OF CLIMATE CHANGE ON AUSTRALIA

Various studies have examined climate change impacts in Australia. Reduction of rainfall, increasing evaporation, along with mounting demand for water due to population growth will result in reduced natural water flows and water accessibility problems for agriculture, industry and city services (Edelman et al., 2014; Reisinger et al., 2014). Significant impacts

on biodiversity have been predicted by 2020 that will drive major changes for iconic coral reefs, rainforests, wetlands and alpine areas, including very diverse and unique places such as the Great Barrier Reef and the Queensland Wet Tropics WHAs, causing disruption to the natural balance of these ecosystems and biodiversity loss (Edelman et al., 2014; Reisinger et al., 2014). These problems will increase radically by 2030 (Edelman et al., 2014).

Increasing population and subsequent development in coastal regions will intensify climate risk by 2050, largely due to sea level rise and the escalating frequency of storms and floods (Pachauri et al., 2014). In turn, these processes will damage crucial infrastructure such as residential buildings, flood-protection constructions, city drainage and sewage services. Additionally, these changes will erode as much as 100 meters of sand beaches during 21st century (Reisinger et al., 2014). Severity of droughts and fires across southern and eastern regions of Australia will increase by 2030, leading to diminished agricultural and forestry production (Reisinger et al., 2014). By 2050, heat will cause from 3,200 to 5,200 more deaths per year and between 600,000 and 1.4 million people will be more vulnerable to tropical infections such as dengue fever (CSIRO, 2011; Hennessy, 2007; Reisinger et al., 2014).

According to the Australian Bureau of Meteorology, January 2013 was the hottest month on record since the last record in January 1932, “with both the average mean temperature of 29.68°C and the average mean maximum temperature of 36.92°C”. During the unusual heat wave, which covered vast areas of the country, the hottest temperature, 49.6°C, was registered on 2 January, in Moomba, South Australia (Bureau of Meteorology, 2013).

Projections of GHG emissions and global warming (Figure 2.4) anticipate that under current use of fossil fuels, by 2050 the levels of CO_2 in the atmosphere could be twice as much as the concentrations before the industrial period, and the levels may triple by 2100 (Australian Academy of Science, 2015). The average global warming, considering this high-CO_2-emission scenario combined with emissions of other GHGs, could reach 4.5°C, with a minimum expected of 3°C and a maximum of 6°C. (Australian Academy of Science, 2015). A rapid adoption of alternative energy sources, different to those based on fossil fuels, could cause a decline of global warming that would eventuate at the end of this century and beyond (Australian Academy of Science, 2015).

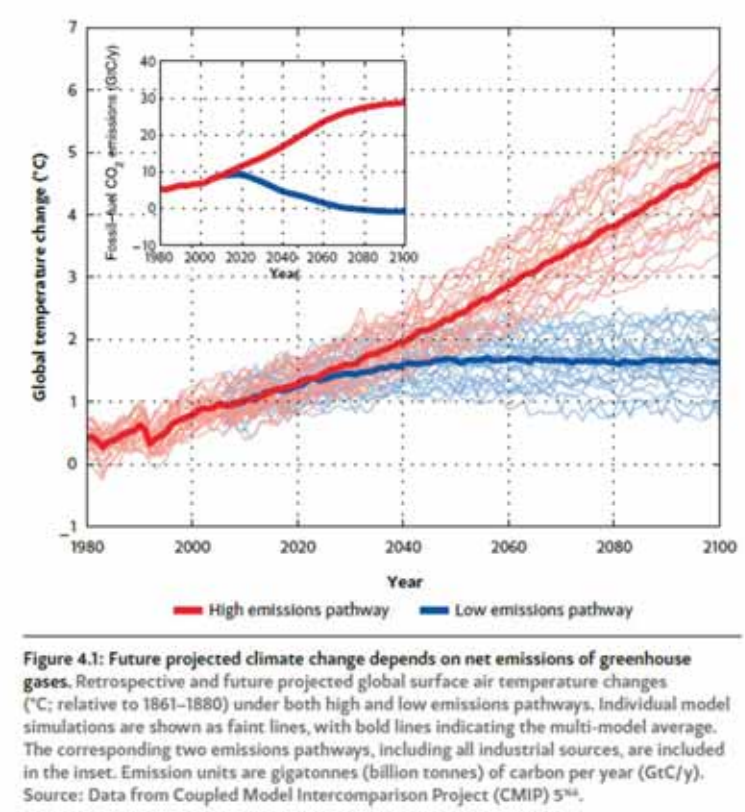

Figure 4.1: Future projected climate change depends on net emissions of greenhouse gases. Retrospective and future projected global surface air temperature changes (°C; relative to 1861–1880) under both high and low emissions pathways. Individual model simulations are shown as faint lines, with bold lines indicating the multi-model average. The corresponding two emissions pathways, including all industrial sources, are included in the inset. Emission units are gigatonnes (billion tonnes) of carbon per year (GtC/y). Source: Data from Coupled Model Intercomparison Project (CMIP) 5[54].

Figure 2.4 Projections of fossil CO2 emissions and global warming

Source: Australian Academy of Science

2.5 MITIGATION AND ADAPTATION TO CLIMATE CHANGE

Mitigation has been described as a human intervention that reduces the sources and enhances the sinks of GHGs and generally tackles the causes of climate change (Pachauri et al., 2014). Greenhouse gas abatement includes activities that reduce or eliminate greenhouse gas pollution. Adaptation refers to the "process of adjustment to actual or expected climate and its effects" (Pachauri et al., 2014, p. 118). Thus, adaptation tackles the effects of climate change (IPCC, 2001) to avoid or minimize harm in human systems and intervenes in natural systems to enable adaptation to actual and future climate change impacts (Pachauri et al., 2014, p. 118). Activities such as those covered by the Carbon Farming Initiative-Emissions Reduction Fund (CFI-ERF) are considered mitigation activities.

Mitigation and adaptation are often treated separately, however in the context of land sector carbon farming, both are integrally linked (Dang et al., 2003; van Oosterzee, Dale, & Preece, 2014). Many adaptation strategies can facilitate *long term mitigation* efforts as many mitigation strategies can also facilitate a *planned adaptation* (Dang et al., 2003), therefore

several mitigation and adaptation strategies are required to tackle the challenges generated by climate change. International climate policy negotiations are integrating both type of strategies in their approaches (Dang et al., 2003).

2.5.1 Mitigation of climate change

The IPCC states that regarding climate change, mitigation refers to "a human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs)" (Pachauri et al., 2014, p. 125). In the same context, for the United Nations Development Program (UNEP) "mitigation involves the reduction of net emissions" (United Nations Environment Programme [UNEP], 2005). Mitigation schemes can be applied to various sectors such as energy supply, transport, buildings, industry, agriculture, forestry/forests and waste management (IPCC, 2007c). *Mitigative capacity* and *mitigation potential* (Table 2.1) are important elements of climate change mitigation defined in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007b).

Table 2.1 Elements of climate change mitigation

Mitigative capacity	This is a country's ability to reduce anthropogenic greenhouse gas emissions or to enhance natural sinks, where ability refers to skills, competencies, fitness and proficiencies that a country has attained and depends on technology, institutions, wealth, equity, infrastructure and information. Mitigative capacity is rooted in a country's sustainable development path.
Mitigation Potential	In the context of climate change mitigation, the mitigation potential is the amount of mitigation that could be – but is not yet – realised over time.
	Market potential is the mitigation potential based on private costs and private discount rates, which might be expected to occur under forecast market conditions, including policies and measures currently in place, noting that barriers limit actual uptake. Private costs and discount rates reflect the perspective of private consumers and companies.
	Economic potential is the mitigation potential that considers social costs and benefits and social discount rates, assuming that market efficiency is improved by policies and measures and barriers are removed. Social costs and discount rates reflect the perspective of society. Social discount rates are lower than those used by private investors.
	Technical potential is the amount by which it is possible to reduce greenhouse gas emissions or improve energy efficiency by implementing a technology or practice that has already been demonstrated. No explicit reference to costs is made but adopting 'practical constraints' may take implicit economic considerations into account.

Source: IPCC 2007

2.5.2 Adaptation to climate change

Adaptation to climate change refers to the adoption of measurements taken to reduce the vulnerability of *human systems* to current or future climate change events (Pachauri et al., 2014). "Adaptation is a necessary step to attend to climate change effects already built into

long-term climate changes already set in motion by past or present greenhouse gas emissions" (Pachauri et al., 2014; Sustainable Tourism CRC, 2009, p. 7).

2.6 SCIENTIFIC CONSENSUS ON CLIMATE CHANGE

The issue of climate change and anthropogenic climate change have been on the table for decades. Particularly, over the last forty years, the world has witnesses many efforts to enhance and share understanding about climate change. Some of these efforts have failed to accomplish their objectives. The First World Climate Conference, in 1979, did not draw interest of policy makers (Bodansky, 2001). However, the climate change issues, discussed in the UN General Assembly as well as the Toronto Conference in 1988, the conferences in Hague and Noorwijk in 1989, and the second World Climate Conference held in 1990 raised interest of several international political leaders (Bodansky, 2001) on the climate change issue. This increasing interest on climate change was accomplished due to scientific breakthroughs and consensus.

The construction of a scientific consensus on climate change has its beginnings around two centuries ago. As early as 1827, Jean-Baptiste Fourier introduced the concept of greenhouse effect (American Chemical Society, 2017; Leiserowitz, 2007). He claimed that given the amount of energy that Earth received from the sun, global temperatures should be lower than the measured ones (American Chemical Society, 2017; Leiserowitz, 2007). Then, in 1896, Svante Arrhenius was the first to propose the link between the increase of greenhouse gas emissions from anthropogenic activities -including CO_2- could led to a rise in Earth's temperature (American Chemical Society, 2017; Leiserowitz, 2007; Bodansky, 2001).

An improved understanding of the greenhouse effect drove the discussion of the climate change issue, primarily among scientists. Measurements at different scientific stations (e.g. Mauna Loa, Hawaii) established during the early 1960s allowed scientists to confirm that the levels of CO_2 have been increasing. Keeling (1960) studied the rise of atmospheric CO_2 and showed this increase in a graphic - now known as the Keeling curve (Figure 2.5) (Harris, 2010; Bodansky, 2001).

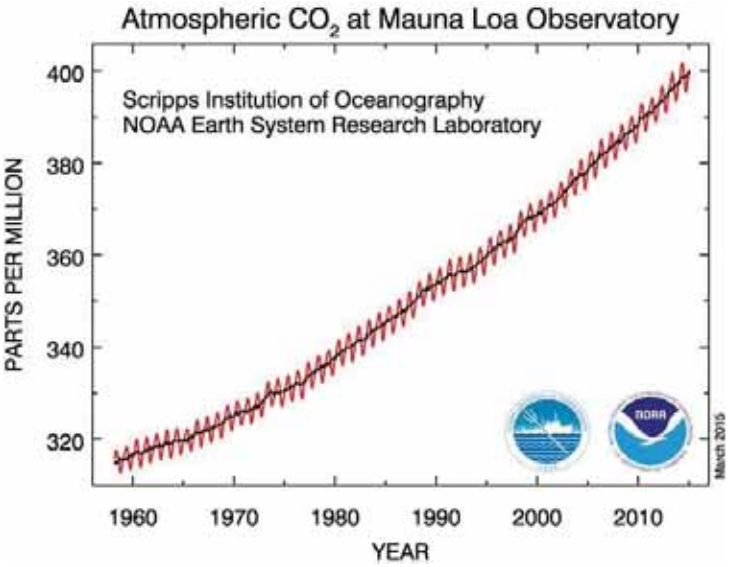

Figure 2.5 The Keeling curve

The Keeling curve shows the historical increase of atmospheric CO_2 concentration

Source: American Chemical Society (2017)

Using data collected several times a day at Mauna Loa Observatory, Keeling estimated that around 55% of the emissions from fossil fuels would remain in the atmosphere (American Chemical Society, 2017), and predicted that doubling the concentrations of CO_2 could increase the average Earth's temperature in 5 to 6 Celsius degrees, a result consistent with current predictions (Leiserowitz, 2007). Before Keeling's work, results of studies on atmospheric concentrations of CO_2 were inconsistent (Harris, 2010).

The evidence shown by Keeling (1960) became a strong push towards the understanding and acceptance of the climate change issue among the scientific community at the end of the 1960s and early 1970 (Bodansky, 2001). The advancement in computational technology has provided scientists with improved equipment which has greatly increased the accuracy of atmospheric models. This increased accuracy of the models in turn, has boosted the confidence levels among scientist (Bodansky, 2001). The improved predictability of the models led to acceptance of the climate change issues by scientific bodies. The United States National Academy of sciences, in a 1979 report, based on the results of these models, concluded that climate change will occur and its effects may be considerable (Bodansky, 2001). During the late 1980s and early 1990s, confronted by a growing evidence amassed from several sources, e.g. direct temperature measurements, historical records, paleoclimatic reconstructions, receding glaciers and computer model simulations (Leiserowitz, 2007), the

scientific community acknowledged the existence of the greenhouse effect and the influence anthropogenic emissions of other gases such as methane and nitrous oxide on the atmospheric change (Leiserowitz, 2007; Bodansky, 2001). By the 1990s only a few scientists remained sceptical to the growing consensus on climate change (Leiserowitz, 2007). Furthermore, nowadays there is a solid consensus on the climate change issue, its causes and impacts, as well as the possible ways to face the problem. In this context, Oreskes (2004, p. 1) states "The scientific consensus is clearly expressed in the reports of the Intergovernmental Panel on Climate Change (IPCC)." This improved understanding and consensus paved the way for a concerted effort to present alternatives to confront the issue of global climate change.

2.7 PUBLIC AND POLITICAL CONTEXT AROUND THE RESPONSE TO CLIMATE CHANGE

As discussed through the chapter, there is a fast-paced growing evidence that climate change is occurring. The scientific community (with few exceptions) supports the findings indicating that, in some degree, the global climate changes are a result of anthropogenic activities. With all this information available, it is crucial to understand what is the public opinion about the climate change. Leiserowitz, (2007, p.3) stress that "public opinion is critical because it is a key component of the socio-political context within which policy makers operate ". However, the scientific concepts of climate change can be difficult to understand for some people with no science background (Kvaløy, Finseraas, & Listhaug, 2012). Also, the perception of the level of threat that climate change presents is correlated with education level, 'post-materialism' and political views (Kvaløy, Finseraas, & Listhaug, 2012). Various studies conducted in Europe, U S and Japan show that public awareness and concern, as well as support of policies to mitigate and adapt to climate change are raising (Leiserowitz, 2007). In Australia, Kragt et al. (2016), based on a survey study reported a high level of acceptance among the population that climate change is, in part, a result of human actions. Also, Kragt et al. (2016) study shows a general support to climate change mitigation activities in Australia. On the other hand, rural populations of developing countries remain unaware of the issue (Leiserowitz, 2007). Lately, scholars have investigated the perception that climate change threat poses on the society. For instance, Stokes, Wike, and Carle (2015), based in a study where 45,435 surveys were conducted across 40 countries found that climate change is perceived as an important issue. Thus, a median of 54% of participants consider that climate change is a *very serious problem* (Stokes, Wike, and Carle, 2015). And Stokes Wike, and Carle (2015) explain that a median of 78% of participants agree on the importance of policies

(in their countries) to limit GHG emissions under the Paris Agreement (signed in April 2016). As shown in Figure 2.6, People in Latin America and Africa are among the most concerned about climate change (Stokes, Wike, and Carle, 2015). Ironically, "Americans and Chinese, whose economies are responsible for the greatest annual CO_2 emissions, are among the least concerned" (Stokes, Wike, and Carle, 2015, p.3) see also (Leiserowitz, 2007).

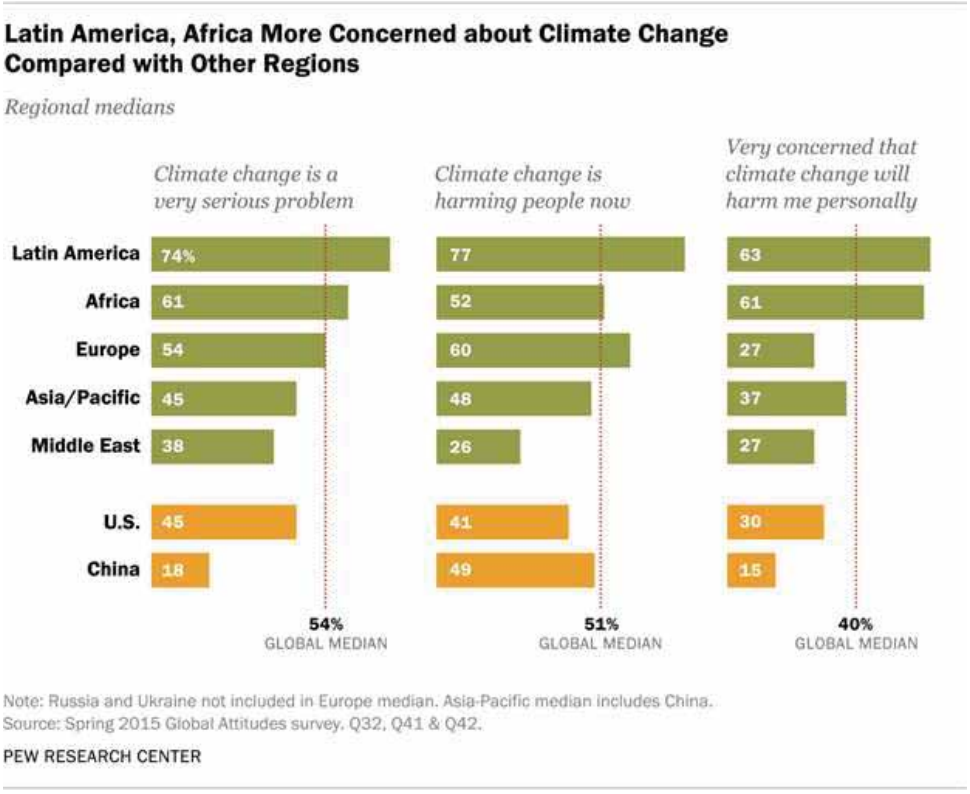

Figure 2.6 Global concern on climate change

Source: Stokes, Wike, and Carle (2015)

Conversely, Kvaløy, Finseraas, & Listhaug (2012) found that concern among wealthy and poor countries, as well as with high and low emissions of carbon dioxide is similar. Furthermore, in countries where climate natural disasters are relative more common, the public is less concerned about climate change. Kvaløy, Finseraas, & Listhaug (2012) explain that this response may be associated with their capacity to adapt to climate change.

Stokes, Wike, and Carle (2015) also investigated the level of support that the public had towards agreements aimed to limit or reduce the amount of GHG emissions. In the case of Australia, for instance, the results showed an overall strong support for the government

signing the Paris Agreement; 84% of younger and 75% of older Australians (Stokes, Wike, and Carle, 2015). Other important results suggest that people in countries with high levels of CO_2 per capita, such as The United States of America, Australia, Canada and Russia, are less worried about climate change. And the United States, the highest per capita carbon emitters among the surveyed countries, is one the less concerned about climate change and its effects (Stokes, Wike, and Carle, 2015). Finally, the willingness to pay the costs for environmental protection has been a topic of study. Gelissen (2007) argues that more people in wealthy countries are willing to economically support environmental protection practices than in poor countries. And, likewise, the economic capacity is also higher in rich countries (Gelissen, 2007). In Australia, according to Kragt et al. (2016), there is a positive view about paying for ensuring the provision of environmental services including climate change mitigation practices.

All things considered, public perception and opinion about climate change, its causes and impacts may potentially have -or should have- a significant influence on the design and implementation of climate policy. However, it is unknown -and presumably hard to assess- to what extent the public/social opinion has contributed in shaping climate policy at regional, national and global contexts. The next section presents a short account of the global response to climate change.

2.8 BRIEF HISTORY OF THE GLOBAL RESPONSE TO CLIMATE CHANGE

Confronted with the increasing evidence on the strong causal relationship between human activities and changes observed on Earth's atmosphere and the climate system, the international community has created various organizations devoted to study the causes and effects of climate change over natural systems, human systems and infrastructure. Thousands of experts - in many different disciplines around the world contribute, through national, regional and global organizations, to the advance of climate change science, providing the basis for climate-wise policy development.

Despite the advance of climate change science, climate change only started to be a political issue in the 1990s (Bodansky, 2001), and the process of creating effective policy to facilitate the design and implementation of mechanisms to adapt and mitigate climate change has endured over recent decades. This section presents a brief history of some the key international organizations and treaties created in response to global climate change (Figure 2.7).

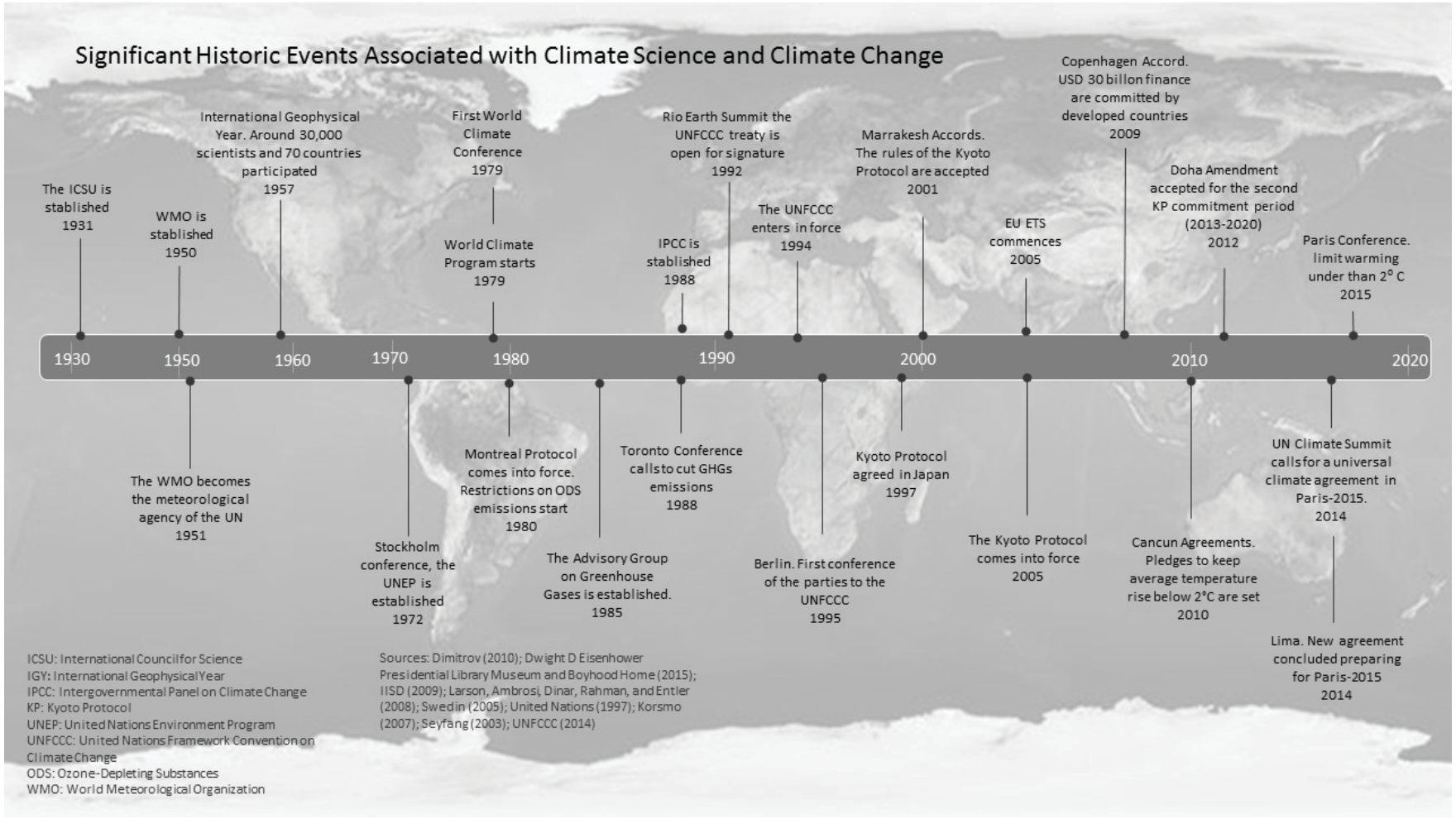

Figure 2.7 Milestones of global response to climate change.

Author: Edison M Salas (2016)

2.8.1 The International Council for Science

Arguably the first crucial step in the history of the global response to climate change was the creation of the International Council for Science (ICSU) in 1931 – originally founded as the International Council of Scientific Unions (ICSU, 2015). The ICSU, one of the oldest NGOs, originated from two different organizations, the International Association of Academies (IAA; 1899-1914) and the International Research Council (IRC; 1919-1931) (ICSU, 2015). One of the ICSU's aims is to promote collaboration among scientists, governmental agencies and national funding agencies worldwide (ICSU, 2006). In the past, important programs such as the International Biological Programme, International Geophysical Year and the International Polar Year were carried out by the ISCU. Currently, the ISCU continues its work with other key programs such as the International Geosphere-Biosphere Programme (IGBP), the World Climate Research Programme (WCRP), DIVERSITAS: An International Programme of Biodiversity Science and the International Human Dimensions Programme on Global Environmental Change (IHDP) (ICSU, 2015). The scientific contribution of the ICSU has had a notable impact, not only on the global climate change science and policy, but also in other disciplines oriented to maintain human wellbeing (ICSU, 2015).

2.8.2 The World Meteorological Organization (WMO)

The WMO was established in 1950 and is still the specialized climate agency of the United Nations (WMO, 2009). The WMO has its origins in the International Meteorological Organization which was created in 1873 (WMO, 2009). Currently, the WMO has 191 member states (WMO, 2015). The main contributions of the WMO are to assist the international community to better understand the weather, climate and water, as well as promoting the collaboration among the National Meteorological and Hydrological Services (NMHS) of its members. The WMO also promotes the *free and unrestricted exchange*, processing and standardization of data (WMO, 2015). The opportune access to data and information, provided by the WMO through its members, contributes to sustainable development, the reduction of loss of life and infrastructure and helps to prevent and mitigate climate-related disasters (WMO, 2009).

2.8.3 The United Nations Environment Program (UNEP)

The establishment of the UNEP has been considered as one of the key outcomes of the Stockholm Climate Conference in 1972. UNEP is the UN's organization commissioned to

design and promote the global environmental agenda (UNEP, 2015). UNEP aids nations on the development sustainable and environmental policy (UNEP, 2015). Importantly, UNEP has been a major player in the international response to climate change, helping to shape the global scientific and political infrastructure for environmental protection, supporting the creation of key organizations and treaties and coordinating the collaboration among countries, scientists, national, regional and international bodies which work in the development and environment arena.

2.8.4 The United Nations Framework Convention on Climate Change (UNFCCC)

Established in New York (1992) and open for signature during the Earth Summit in Rio de Janeiro in 1992 (International Institute for Sustainable Development [IISD], 2009), the UNFCCC's main objective is the "stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (IPCC, 2007b). The UNFCCC sets obligations for all its members regarding to GHG emissions. The rules of the UNFCCC came into effect in March 1994 with the signature of 50 countries (IISD, 2009). Nowadays, the UNFCCC has 196 members ("parties"), 195 nations and one *regional economic integration organization* – The European Union- (UNFCCC, 2014b). The 21st 'conference of the parties (COP21)' held in Paris in 2015 was another important chapter in the history of the response to climate change (United Nations Framework Convention on Climate Change, 2016). The COP21 served a s a meeting for the parties of the Kyoto Protocol (KP). The summit produced the Paris Agreement, which entered into force in November 2016 and has been ratified by 141 of 197 parties (UNFCCC, 2016). The main goal of the Agreement is to maintain global temperature rise below 2°C, compared to pre-industrial times, while encouraging efforts to reaching an even more ambitious goal of keeping temperature rise below 1.5°C (UNFCCC, 2016).

2.8.5 The Intergovernmental Panel on Climate Change (IPCC)

Founded in 1988 by the UNEP and the WMO (IPCC, 2004), the Intergovernmental Panel on Climate Change is undoubtedly the world's most influential organization in the climate change research arena. The IPCC's main contribution is to "assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation" (IPCC, 2010). At present, the IPCC has a membership of 195 nations (IPCC, 2015). Since its creation, the IPCC has

published five assessment reports (FAR, 1990; SAR, 1995; TAR, 2001; ARA4, 2007; ARA5, 2013/2014) and many other publications including special reports, technical papers and methodology reports (IPCC, 2010). One of the main principles of the IPCC is that its reports are "policy relevant but not policy prescriptive" (IPCC, 2015; IPCC, 2015).

2.8.6 The Kyoto Protocol

Adopted on 11 December 1997, in Kyoto Japan, the Kyoto Protocol (KP) of the UNFCCC is an international treaty that sets differentiated targets of GHG reduction of emissions to its parties. Industrialized countries (Annex B of the Protocol) have a heavier load of reductions commitments (UNFCCC, 2013).

Emissions from important sectors of the economy, such as production, transport and distribution of energy, industrial processes, transportation and fuels for aviation and maritime operation, agriculture and emissions from waste management are limited by the Protocol (Annex A of the protocol) (UNFCCC, 2013). The KP also determines which gasses (GHG) are covered by the treaty: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) (Annex A of the Protocol) (UNFCCC, 2013). The KP also states that the parties should put efforts into achieving their commitments, at least 5 per cent below 1990 levels during 2008 – 2012 period, by minimizing negative impacts of any measures to climate change, international trade, society, environment and economy (UNFCCC, 2013).

The KP also introduced the Clean Development Mechanism (CDM) and the Joint Implementation Mechanism (JI). These mechanisms are aimed to enable the development of emission reduction projects – either by developing and developed countries - thus contributing to the overall GHG-emission-reduction target, as set out by the KP (United Nations, 1998).

Amendments to the KP were introduced at the Doha Conference in 2012. An emission reduction target for the new 8-year commitment period 2013-2020 was agreed. The target for developed countries is at least 18 per cent below 1990 levels. Additionally, the composition of the parties of the protocol is different from the previous one (UNFCCC, 2014b).

The clean development mechanism (CDM).

Under the CDM, GHGs emission reduction projects undertaken in developing countries can earn a certified emission reduction (CER) credit per each tonne of CO_2 of verified abatement.

CERs can be traded or sold to developed countries so they can meet their emission reduction targets set under the KP (UNFCCC, 2013).

The joint implementation mechanism (JI)

The JI allows countries that have emission reduction targets under the KP (Annex B of the Protocol) to earn emission reduction units (ERU) by developing GHG abatement projects in other country that has a reduction commitment as well. The ERUs can be used to meet emission reduction targets defined under the KP.

The establishment of all these organizations and the treaties have had a diverse response from member countries to address the climate change issue. Signatory nations of climate change treaties, particularly the KP, have in turn designed and introduced market mechanisms, commonly known as carbon markets[8], to reduce GHG emissions. However, GHG emission reduction mechanisms are not exclusive to members of the KP, non-signatory countries have also created programs to limit or offset GHG emissions. The section below is an overview of international GHG emissions reduction mechanisms.

2.9 INTERNATIONAL GHG EMISSIONS REDUCTION MECHANISMS

Governments around the world, at a supranational, national and subnational levels, have implemented or developed plans for the application of market-based mechanisms to reduce GHG emissions, thus responding to the imminent impact of climate change. As shown in Table 2.2, several international emissions reduction initiatives have been already implemented, have been scheduled or their implementation is under consideration.

[8] Carbon Market refers to schemes created under market approaches, which allow the trading of units of CO2 or equivalents. Most of these schemes enable the trading of: 1) emission permits that have been either distributed by a regulatory body, or 2) credits generated through the reduction of GHGs (Bayon, Hawn, & Hamilton, 2007), or 3) credits generated by carbon sequestration projects. Globally, carbon trading often includes six GHGs: carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, hydro fluorocarbons and perfluorocarbons (Bayon et al., 2007).

Table 2.2 International GHG Emissions Abatement Initiatives

Mechanism	Type	Status	Mechanism	Type	Status
European Emissions Trading System (EU ETS)	Supranational	In force	California cap-and-trade program	Subnational	In force
New Zealand ETS	National	In force	Québec cap-and-trade system	Subnational	In force
Swiss ETS	National	In force	Brazil	National	Under study
Kazakhstan ETS	National	In force	Chile	National	Under study
Korean ETS	National	In force	Japan	National	Under study
Regional greenhouse gas initiative (RGGI)	Regional	In force	Mexico	National	Under study
Western climate initiative (WCI)	Regional	In force	Russia	National	Under study
China ETS	National	Scheduled	Turkey	National	Under study
Beijing (pilot) ETS	Subnational	In force	Ukraine	National	Under study
Chongqing (pilot) ETS	Subnational	In force	Thailand	National	Under study
Guangdong (pilot) ETS	Subnational	In force	Vietnam	National	Under study
Hubei (pilot) ETS	Subnational	In force	Washington	Subnational	Under study
Hubei (pilot) ETS	Subnational	In force	Manitoba	Subnational	Under study
Shanghai (pilot) ETS	Subnational	In force	Ontario	Subnational	Under study
Shenzhen (pilot) ETS	Subnational	In force	Rio de Janeiro	Subnational	Under study
Tianjin (pilot) ETS	Subnational	In force	Sao Paulo	Subnational	Under study
Tokyo cap-and-trade program	Subnational	In force			

Data from: ICAP (2015); World Bank (2014); OECD (2013)

Note: Mechanisms status as to December 2015

The coverage of GHG emissions during the last decade has increased due to the introduction of emissions reduction mechanisms worldwide. The GHG emissions coverage grew from over 2 $GtCO_2$-e in 2005 to almost 5 $GtCO_2$-e by 2015 (ICAP, 2015), which represents about 12 per cent of the global annual emissions (World Bank, 2015). According to ICAP (2015), currently, 17 ETS are in force around the world. Altogether, 35 countries, 13 states/provinces and 7 cities are covered by ETS mechanisms (ICAP, 2015). The total value of the global GHG emission reduction schemes reach US$ 30 billion. Figure 2.8 shows the evolution of global carbon trading during the last decade.

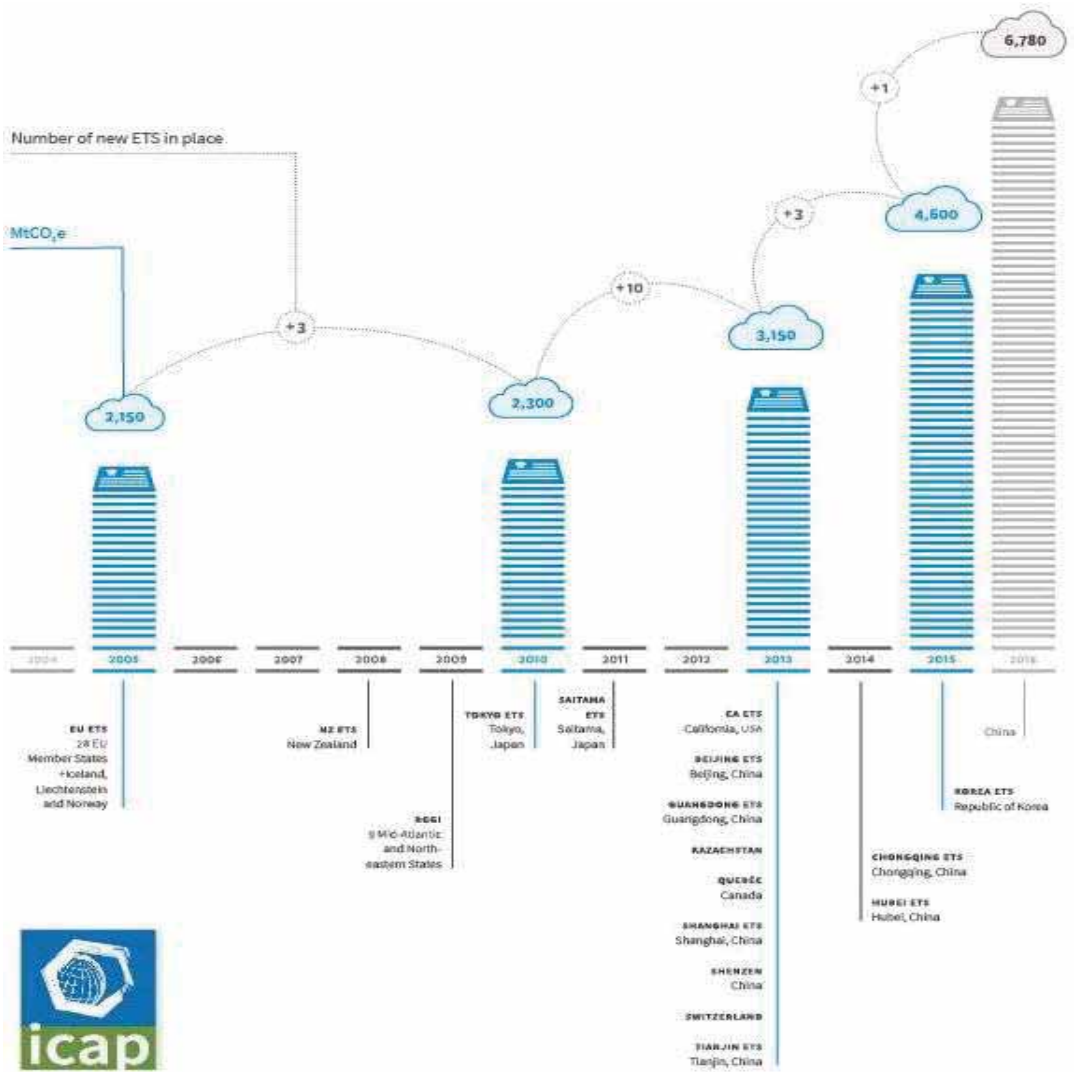

Figure 2.8 Trends of carbon markets worldwide

Source: ICAP (2015)

Internationally, the establishment of cap-and trade programs is the most widespread market option for reducing GHG emissions, as opposed to carbon taxes which proved to be unpopular among policy makers and governments (ICAP, 2017). In a cap-and-trade program, the government determines which facilities or emissions are covered by the program and sets an overall emission target, or "cap," for covered entities (firms held responsible for emissions). This cap is the sum of all allowed emissions from all included facilities. Once the cap has been set and covered entities specified, tradable emissions allowances (rights to emit) are distributed (either auctioned or freely allocated, or some combination of these). Each allowance authorizes the release of a specified amount of GHG emissions, generally one ton of carbon dioxide equivalent (CO_2e). The total number of allowances is equivalent to the

overall emissions cap (Center for Climate and Energy Solutions [CCES], 2011). Covered entities must submit allowances equivalent to the level of emissions for which they are responsible at the end of each of the program's compliance periods (CCES, 2011).

2.9.1 The European Union emissions trading system (EU ETS)

Created in 2005 by the European Parliament and Council, as the base for reducing emissions of GHGs in the European Union (EU), the EU ETS, a cap and trade system, and is the largest trading system in the world covering over the 75% of the international carbon market (European Union [EU], 2013). Active in 27 member countries of the EU, along with Croatia, Iceland, Liechtenstein and Norway, the EU ETS sets the limit for GHG emissions, which is reduced by 1.74% every year. In 2020, the GHG emissions will be 20% lower compared to 2005, thereby encouraging businesses to trade allowances or to invest in technology to reduce their overall emissions. The scheme applies to industrial sectors with high emissions levels, covering over 11,000 power generation plants, factories as well as flights to and from EU, Iceland, Liechtenstein and Norway. In total, these activities represent about the 45% of emissions from the EU.

The EU ETS has four periods of development. During the first period (2005 to 2007), which served for 'learning by doing', an excessive number of allowances were issued which caused the prices, for this period, fall to zero in 2007. During the second period (2008 to 2012) a 6.5% of allowances were retired from the market but the impact of the global economic crisis reduced the demand, which resulted in oversupply of allowances thereby influencing the carbon price. In January 2008, Iceland, Norway and Lichtenstein joined the scheme and the aviation sector was also included. During the third period (2013 to 2020), the adoption of an "EU wide cap on emissions", set to reduce by 1.74% a year and as well as gradual change from free allowance allocation to allowance auctioning, are the main reforms to be introduced. Having an effect since January 1, 2013, Croatia joined at the beginning of this period. The fourth period will run from 2021 to 2028.

The coverage of the EU ETS depends on the type of GHGs and the production sector and it covers: carbon dioxide (CO_2) from electric power plants, factories and commercial aviation, nitrous oxide (N_2O) from chemical production (nitric, adipic, glyoxal and glyoxylic acids) and perfluorocarbons (PFCs) from aluminium industry.

The market works by trading emission allowances. Each allowance entitles holders to emit one tonne of CO_2, N_2O or PFCs. Therefore, one allowance must be submitted for each tonne of GHGs resulting from an operation.

Allocation of allowances

Governments provided companies with most allowances for free. Starting in 2013 the allowances were placed for auction, following the EU plan to gradually retire the total of free allowances from the market by 2027. This makes businesses buy an increasing number of allowance each year. According to the sector the allocation of allowances follows the subsequent timetable:

- Power generating industries will have to buy all their allowances, except for businesses from the eight states that joined the EU in 2004: Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Poland and Romania which, through a special provision, are permitted to make available a certain number of free allowance to electric power plants until 2019.
- An 80% allocation of free Allowances will be given to the manufactory industries in 2013, decreasing annually to a 30% by 2020; the rest of allowances will be auctioned.
- For the aviation sector, only 15% of allowances will be auctioned during the 2013–2020 period.

2.9.2 The New Zealand emissions trading scheme (NZ ETS)

Established in 2008, the NZ ETS is an obligatory scheme adopted to meet New Zealand's emission target under the KP. Since NZ ETS started, different sectors of the economy have been integrated gradually; forestry in 2008, energy, fishing and liquid fuels in 2010, synthetic gases and waste in 2013. Participants belonging to the agricultural sector, since 2012, have an obligation to report biological emissions that are produced on their farms. The GHGs covered under the scheme are carbon dioxide (of CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). The New Zealand Unit (NZU) is the principal emission unit under the NZ ETS which is equivalent to one tonne of CO_2 or equivalents. New Zealand's reduction target of 50 per cent of GHGs' emissions from 1990 levels by 2050 was announced by the Government in March 2011. (Ministry for the Environment New Zealand, 2013).

2.9.3 The Swiss emissions trading system (Swiss ETS)

The Swiss ETS, currently in force, started in 2008 (ICAP, 2015). Its reduction target is 20% by 2020 compared to 1990 levels and possibly expanding to 40% depending on international commitments (ICAP, 2015). The Swiss ETS started with a voluntary period, 2008-2012, being an option for the tax on CO_2. The second period 2013-2020 is mandatory for energy intensive industries; which are exempt of the CO_2 tax (World Bank, 2014). In this period, 55 enterprises belonging to 25 different sectors are covered (World Bank, 2014).

During the voluntary phase, businesses were allocated free allowances, according to their specific targets, while during the second period, business covered by the ETS are allocated allowances according to an "industry benchmarking" like the one used by the EU ETS (ICAP, 2015).

2.9.4 Kazakhstan emissions trading system (KAZ ETS)

Currently in force, the KAZ ETS started in 2013 with a one-year pilot phase. The Kazakhstan government is studying the possibility of linking its scheme to other mechanisms. CO_2 emissions from 166 industries from the energy, mining, metallurgy chemicals, cement and power sectors are included. Emitters of over 20 tons of CO_2 are covered by the mandatory scheme (World Bank, 2014). In 2014, the KAZ ETS started its fully implementation (World Bank, 2015). A 100% of allowances were distributed for free in 2013, 2014 and 2015 periods. In 2016, the amount of free allowances may be reduced (ICAP, 2015).

2.9.5 The Korean emissions trading system (KETS)

The national KETS, the second largest GHG emission reductions scheme in the world, started in January 2015, becoming the first active cap-and-trade scheme in Asia (ICAP, 2015). In the first period 2015-2017, businesses from 23 subsectors are covered by the KETS. During the same period, a 100% of the allowances will be distributed for free to businesses accounting for the average of their emission in 2011 to 2013 (World Bank, 2015). The KETS covers about 66% of the nation's emissions including various GHGs (CO_2, CH_4, N_2O, PFCs, HFCs, SF_6) (ICAP, 2015).

2.9.6 The western carbon initiative (WCI) cap and trade program

The WCI cap-and-trade program includes the Canadian provinces of British Columbia, Manitoba, Ontario and Quebec, together with the US states of Arizona, California, Montana, New Mexico, Oregon, Utah and Washington (Western Carbon Initiative [WCI], 2010). It has

been designed to accomplish a reduction of emissions at low costs, while avoiding economic impacts on businesses covered by the program and to the consumers. The program, which works with three-year compliance periods, allocates a certain number of allowances which are permits to emit a definite amount of GHGs. Companies covered by the program will be able to buy, sell or bank the allowances as well as to buy offset credits in external markets. The application of the program will encourage the reduction of GHG emissions, the diversification of energy sources and progressing on regional economic, environmental and health plans. The WCI program states two phases. The first phase started in January 2013 and encompasses GHGs produced by electricity generation and import and large manufacturing industries. During the second phase, which will start in 2015, transportation, residential and commercial fuels, including industrial fuels omitted in phase 1 will be included. Through the inclusion of these sectors, the WCI program will tackle carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride, and nitrogen trifluoride emissions. Once phase two starts, the program will cover the 90% of the GHG emissions within the WCI partner regions (WCI, 2012). The target of the WCI, as declared in 2007, is to reduce emissions by 15% lower compared to 2005 levels by 2005 (CCES, 2013b).

2.9.7 The regional greenhouse gas initiative (RGGI)

Comprising nine member states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island and Vermont, the RGGI is the first mandatory ETS in the United States (ICAP, 2015). The overall target of the RGGI is to reduce, by 2020, over the 50 per cent of CO_2 emissions compared to 2005 levels. Currently, emissions from 168 energy producing plants are covered by the scheme (ICAP, 2015; World Bank, 2014). The first RGGI compulsory commitment period started in 2009 to 2011 (ICAP, 2015). Penalties applied to businesses failing to comply with the regulations are set by each state (ICAP, 2015).

2.9.8 California cap-and-trade program

California, the sixth world's economy (Miller & Swann, 2016), introduced in 2012 its emissions trading scheme (ICAP, 2015). California's ETS is the second largest in the world (regarding the total of emissions covered) after the EU ETS (CCES, 2013a). Its goal is to reduce the level of GHGs by over 16 per cent from 2013-2020, thereby reaching 1990s' levels by the end of this period (CCES, 2013a). The ETS covers emissions of CO_2, CH_4, N_2O, SF_6, HFC, PFC, NF_3 and other fluorinated GHGs (ICAP, 2015). In the first stage (2013-

2014), electricity generation and industrial plants emitting over 25,000 tonnes of GHGs were covered (CCES, 2013a). In 2015, during the second period, the program extended to include businesses from fuel (for transportation and heating) distribution sector surpassing the 25,000 tonnes. Allowances are distributed both for free and through auctioning (ICAP, 2015). The revenues generated by the auctions will be invested in local projects (CCES, 2013a). California is a member of the Western Climate Initiative since 2007 and has linked its program linked to Québec's Cap-and-Trade system in 2014 (ICAP, 2015).

2.9.9 Quebec's cap-and-trade system

Conceived as the centrepiece of Quebec's Climate Change Action Plan 2013-2020 (World Bank, 2014), Quebec's cap-and-trade system was first introduced in 2012 with a one year non-compliance period adopted as trial for business to familiarize with the program (ICAP, 2015). The compliance rules came into effect in January 2013 (ICAP, 2015). Quebec's emission reduction target is 20 per cent below 1990 levels by 2020. Emissions of CO_2, CH_4 N_2O, SF_6, NO_3, HFC, PFC and other fluorinated GHGs from the industrial and energy sectors are covered by the scheme (ICAP, 2015). Quebec has been a member of the WGI since 2008, and linked its cap-and-trade system with California's cap-and-trade program in January 2014 (ICAP, 2015; World Bank, 2014).

2.9.10 Saitama's emissions trading system

Starting in 2011, Saitama's Trading System covers CO_2 emissions from commercial and industrial sectors. Saitama's system reduction target is 25 per cent below 2005 by 2020 (ICAP, 2015). Covered entities allocated allowances through grandfathering based on historical emissions. Compliance periods of four or five years applied for the periods 2011-2014 and 2015-2019 (ICAP, 2015). Currently, there are no enforcement rules applied. The Saitama's Emissions Trading System and Tokyo Emissions Trading System are linked since 2011, which allows certain credits to be tradable between the two schemes (ICAP, 2015). Trading of permits will start during the second compliance period in 2015 (ICAP, 2015; World Bank, 2014).

2.9.11 Tokyo cap-and-trade program

Starting in 2010, Tokyo Cap-and-Trade program is the first Japan's compulsory ETS (ICAP, 2015). It is linked to Saitama's ETS since 2011 (ICAP, 2015). Tokyo's GHG emission reduction target is 25 per cent compared to 2000 levels by 2020 (ICAP, 2015). The scheme

covers CO_2 emissions 1325 entities from commercial and industrial sectors. A five-year compliance period applies for the periods 2010-2014 and 2015-2019 (ICAP, 2015). Failing to comply carries penalties in two stages. Firstly, business is required to reduce emissions (amount of reduction shortage multiplied by 1.3) and secondly, the names of entities that fail to achieve the required reduction in the first stage, will be publicly disclosed and a JPY 500,000 penalty and other surcharges will be applied (ICAP, 2015).

2.9.12 Chinese emission trading system

China has been working on the implementation of a national ETS. The Chinese ETS is scheduled to start in 2016 (ICAP, 2015; World Bank, 2014). The Chinese ETS will encompass the seven pilot schemes, which have been in operation since 2013 and 2014. Thanks to its pilot schemes, China has become the second biggest carbon market after the EU ETS, covering around 1.1 $GtCO_2$-e (World Bank, 2014).

The Chinese pilot schemes share some similar characteristics i.e. one year compliance period, however they also have some features, such as the allocation method or the penalties applied to businesses failing to comply, that differ among schemes. Table 2.3 contains a brief description of the Chinese pilot ETSs.

Table 2.3 Chinese pilot emission trading systems

Beijing Pilot ETS	The Beijing Pilot ETS started in November 2013, covers CO_2 emissions from 543 (2014) businesses from industrial and non-industrial sectors: electricity providers, heating sector, cement production, petrochemicals, manufacturers and services. Beijing ETS reduction target is 18% compared to 2010 levels. Allowances are granted for free based on 2009-2010 historical emissions and intensity. Business that fail to submit the corresponding amount of allowances according to their emissions must pay a fine ranging from 3 to 5 times the average market prices of allowances. The fine is paid for each missing allowance. The compliance period is one year.
Chongqing Pilot ETS	The Chongqing Pilot ETS started in June 2014. It covers emissions from 6 GHGs: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6. The ETS covers 242 businesses from the iron and steel, power, electrolytic aluminium, ferroalloys, calcium carbide, caustic soda and cement sectors. Chongqing pilot ETS's emission reduction target is 17% compared to 2010 levels. Allowances are allocated for free based on historical emissions. Businesses must pay a fine when they do not relinquish enough allowances to cover their emissions. The fine doubles the average market price for each missing allowance. The compliance period is one year.
Guangdong Pilot ETS	The Guangdong Pilot ETS started in December 2013. Guangdong is the largest among the seven cities and regions selected to run a pilot ETS. The ETS covers CO_2 emissions from 193 business and 18 "new entrants" from the energy, iron and steel, cement and petrochemical sectors. The coverage may be expanded to other sectors during the pilot stage. Non-compliance will incur in a fine of CNY 50,000. Businesses failing to surrender the corresponding number of permits will be penalized with the reduction of allocated allowances the following year and will be deducted double the number of missing allowances. The compliance period is one year.

Hubei Pilot ETS	The Hubei Pilot ETS started in April 2014. It covers CO_2 emissions from 138 businesses belonging to power and heat supply, iron and steel, chemicals, petrochemicals, cement, automobile manufacturing, ferrous metals, glass, pulp and paper, food and beverage sectors. Hubei ETS's emissions reduction target is 17% compared to 2010 levels. Business are allocated free permits using grandfathering approach and based on historic emissions. Lack of compliance incurs in a fine ranging from CNY 10,000 to 150,000. Businesses that not surrender enough permits will be allocated double the number of permits for each missing allowance. The compliance period is one year.
Shanghai Pilot ETS	The Shanghai Pilot ETS started in November 2013. It covers CO_2 emissions from industrial sectors: electricity, iron and steel, petrochemicals, chemicals, non-ferrous metals, building materials, textiles, paper, rubber and chemical fibre; as well as non-industrial sectors: aviation, ports, airports, railways, commercial, hotels, and finance. Shanghai ETS's target is 19% of emissions reduction compared to 2010 levels. In 2013, businesses were granted a one-off free allocation of permits based on 2009-2011 emissions. Enterprise growth and other standards were considered for some sectors: energy, airlines, ports and airports. Failing to comply can carry a fine for businesses ranging between CNY 10,000 to 50,000. Other penalties can be applied to business for severe contraventions. The compliance period is one year.
Shenzhen Pilot ETS	The Shenzhen Pilot ETS started in June 2013. It is the first of the Chinese pilot schemes to enter in operation. The ETS covers CO_2 emissions from 635 businesses and 197 public buildings. Participants are allocated free allowances based on sector-specific emission standards. Failing to comply can carry a fine for businesses ranging between CNY 50,000 to 150,000. A fine, equivalent to three times the average market price of the prior six months, will be applied to business for each allowance failed to surrender to cover their emissions. The allowances can be deducted from the following year's allocation. The compliance period is one year.
Tianjin Pilot ETS	The Tianjin Pilot ETS started in December 2013. The ETS covers CO_2 emissions from 114 entities belonging to five sectors: heat and electricity production, iron and steel, petrochemicals, chemicals, and exploration of oil and gas. Its emissions reduction target is 19% compared to 2010 levels. Allowances are allocated for free, based on 2009-2012 emissions and benchmarking is applied for new participants. Businesses that fail to comply are excluded from preferential financial support schemes and other policies for a period of three years. The compliance period is one year.

Source: World Bank, 2014; World Bank, 2015; ICAP 2015

2.9.13 Other initiatives

Worldwide, various initiatives, both national and subnational, are being considered for implementation. Most of these initiatives are being planned as a previous stage of the development of future ETSs in their respective jurisdictions (ICAP, 2015). At a national level, Brazil, Chile, Japan, Mexico, Russia, Thailand, Turkey, Ukraine and Vietnam, are considering the implementation of market-based mechanisms to tackle GHG emissions (ICAP, 2015; World Bank, 2014, 2015). At a subnational level, the Canadian states of Manitoba and Ontario; Washington in the United States; and the Brazilian states of Rio de Janeiro and Sao Paulo are planning the establishment of GHG emission reduction initiatives.

In sum, undoubtedly, carbon markets are a central piece of a complex global climate policy (Calel, 2013; Newell, Pizer, & Raimi, 2014). The application of carbon markets is a result of political success (Calel, 2013). Emissions trading has experienced a growing importance

since the start of the new century (Biedenkopf, 2017). The creation of the European Union ETS has encouraged the spread of carbon markets around the globe (Biedenkopf, 2017). At present, carbon markets cover almost all sectors of the economy -depending on the country they are applied- and carbon trading has grown to reach USD 175 billion per year (Calel, 2013). According to ICAP (2017), emissions trading continues to grow and consolidate around the world. China's national carbon market is set to be launched late this year becoming the world's largest carbon market (ICAP, 2017). Chinese experience can be interpreted as a successful story in the carbon trading arena. After running seven pilot schemes for three years, China, as stated above, is ready to launch its national carbon scheme this year (Biedenkopf, 2017; ICAP, 2017). The linkage of the California and Quebec emissions trading systems, as well as the announcement that the EU and Swiss governments have finished the negotiation to link their emissions trading systems (ICAP, 2017) are also encouraging examples of the potential that carbon markets can deliver.

However, carbon markets are not immune to criticism and predicting the operation of carbon markets is difficult. Political disputes often have been in the centre of the creation of Emission Trading Schemes (ETS) (Biedenkopf, 2017), especially when deciding the role of the ETSs and the objectives they should fulfil (Biedenkopf, 2017). Also, the effectiveness of carbon markets has been under scrutiny for "not delivering real emissions reductions, for providing financial windfalls to emitters, and for failing to provide incentives for private sector investment in low-carbon technologies" (Calel, 2013, p.1). According to Calel (2003) the analysis of early emission trading schemes in the U S revealed that carbon trading benefited only a few large firms. Historically, carbon markets must deal with the uncertainty of carbon prices (Newell, Pizer, & Raimi, 2014). For instance, The EU ETS experienced a price collapse, in part due to an excessive allocation of emissions allowances (Calel, 2003). Finally, the knowledge about the real performance of the carbon markets is very limited (Biedenkopf, 2017).

2.10 THE AUSTRALIAN CARBON FARMING INITIATIVE AND THE EMISSIONS REDUCTION FUND

In the environmental policy area, political and public support are key to the establishment of programs and schemes aimed to protect the environment. it is fundamental to observe public opinion (Pietsch & McAllister, 2010; Leiserowitz, 2007). Policy makers assessment of the values, attitudes and behaviours of ordinary citizens can predict the support or opposition that

the proposed policies will receive (Pietsch & McAllister, 2010). A crucial element to public support to climate policy is public understanding of the issue. Thus, for instance, people who do not have an adequate knowledge about climate change, its cause and effects, would not support climate change policies nor change their behaviour to towards the issue (O'Connor, Bord, Yarnal, & Wiefek, 2002). However, (Pietsch & McAllister, 2010) claim that a better understanding of the climate change problem does not guarantee support to climate change policy. In Australia, most people understand the climate change issue and consider it as the most pressing threat globally (Pietsch & McAllister, 2010). Furthermore, Australian public considered that the government should to do more to protect the environment. Pietsch and McAllister (2010) concluded that in general, Australian citizens support climate change policy, and are willing to pay to protect the environment. Though, a minority of people remain sceptical about the matter (Pietsch & McAllister, 2010).

The climate change policy in Australia has developed for over thirty years now. Climate change became a political subject around the 1980s, during the Bob Hawke and Paul Keating labor government (van Oosterzee, Dale, & Preece, 2014). Australia, at that time was part of the United Nations Framework Convention on Climate Change (UNFCCC) negotiations. This led to the establishment of National Greenhouse Response Strategy aimed to encourage GHG emissions reduction (van Oosterzee, Dale, & Preece, 2014). In late 1990s, under John Howard's government, Australia did not ratify the Kyoto Protocol. Surprisingly, John Howard's administration unlike other developed nations, during the negotiations of the Kyoto Protocol, was the one of the few to advocate an increase of emissions at a 108% (for the Australian case) compared to the 1900s emissions' level (van Oosterzee, Dale, & Preece, 2014). In 2007, after winning the election and amid a growing acceptance of climate change, Kevin Rudd signed the Koto Protocol. Two years later, Rudd' administration announced the creation of the Carbon Pollution Reduction Scheme, planned to start in 2010. Yet, the Australian senate did not pass the Carbon Pollution Reduction Scheme legislation (van Oosterzee, Dale, & Preece, 2014).

The CFI-ERF began in December 2011, as part of the Australian Government's plan for a *clean energy future*. The CFI-ERF was later integrated to the Emissions Reduction Fund (ERF), implemented by the Australian government, in December 2014 (Department of the Environment, 2016). The ERF new rules started in July 2015. Projects registered before the ERF regulation started were automatically transitioned to the new scheme (CER, 2016a). The

methodologies approved under the CFI-ERF rules are still available until they are amended (CER, 2016a).

The CFI-ERF is a voluntary scheme (Figure 2.9) that provides landholders with the opportunity to access carbon markets, presenting them with an alternative way to generate income. Activities that either sequester carbon dioxide or CO_2 equivalents (CO_2-e) from the atmosphere or reduce GHG emissions are considered to earn carbon credits. In the Australian case, these credits are known as Australian Carbon Credit Units (ACCUs), where one ACCU is a tonne of CO_2 or equivalent (CO_2-e). "Abatement from all sorts of activities, including those that reduce methane or nitrous oxide emissions, can be measured in tonnes of CO_2-e. This standardisation allows the credits from different activities to be traded more easily".

Figure 2.9 How the CFI-ERF works

As stated earlier, the Australian government introduced the ERF[9] which built on the CFI-ERF, in late 2014. With the creation of the ERF the Australian government made some other changes to the climate policy. The termination the Carbon Pricing Mechanism (CPM)[10] together with changes in the carbon trading rules were direct consequences of the inception of the new climate policy. Under the CFI rules (before the integration with the ERF), there was a fixed price of carbon. Currently, under the ERF rules, a reverse auction mechanism is

[9] The Australian government initially allocated A$ 2.55 billion to buy ACCUs. Additional funding will be considered in future budgets (Department of the Environment, 2016).

[10] The Carbon Pricing Mechanism (CPM) was a carbon trading system introduced in 2011 to put a price on carbon emissions in Australia. Intensive emission businesses "liable entities" had to comply with the rules of the CPM and surrender credits to offset their emissions. The CPM ended in July 2014 (CER, 2015b).

employed to trade carbon where the main buyer of ACCUs is the Australian government. This change in the rules of trading has impacted the price of carbon in Australia. An explanation of the evolution of the carbon price is available later in the section 'CFI-ERF Metrics'.

2.10.1 Clean Energy Regulator

The Clean Energy Regulator (CER) administers the CFI-ERF, the National Greenhouse Energy Reporting (NGER), and the Renewable Energy Target (Clean Energy Regulator, 2013a). Since its inception in April 2012, the Clean Energy Regulator approves CFI-ERF projects, issues Australian carbon credit units (ACCU) and takes adequate measurements if the CFI-ERF or the Australian National Registry of Emissions Units (ANREU) rules are not observed. Other functions of the Regulator are managing the holding, transfer, retirement, relinquishment and cancellation of units through the ANREU (DCCEE, 2012; Department of Environment and Energy, 2015).

2.10.2 Australian national registry of emissions units (ANREU)

The National Registry of Emission Units is the electronic system used to manage CFI-ERF participants' accounts to record information about the issuing, trading, and elimination of ACCUs. Accounts must be opened as part of the application process (DCCEE, 2012). The ANREU manages the ACCUs, which are issued under the CFI-ERF, as well as other types of units such as carbon units (CUs), Certified Emission Reductions (CERs), Emission Reduction Units (ERUs) and Removal Units (RMUs) resulting from other schemes (CER, 2013).

2.10.3 Australian carbon credit units (ACCUs)

An ACCU is a unit issued to a person by the Clean Energy Regulator (Regulator) by making an entry for the unit in an account kept by the person in the electronic *Australian National Registry of Emissions Units (Registry)*. An ACCU can only be issued to a person if the person has a Registry account and a Registry account can only be held by a 'fit and proper person (Clean Energy Regulator, 2013). Under the CFI-ERF, there are two types of carbon units depending on the GHG abatement activities they originate from: Kyoto ACCUs (compliance ACCUs) and non-Kyoto ACCUs:

Kyoto ACCUs

"Kyoto ACCUs are issued if the relevant offsets project is an eligible Kyoto project and the reporting period ends on or before the Kyoto abatement deadline" (Clean Energy Regulator,

2015). GHG abatement activities, such as reducing emissions from livestock, reducing emissions from fertiliser use, reforestation, avoided deforestation and reducing emissions from waste deposited in landfills before July 2012 count toward Australia's target under the KP thus can earn Kyoto ACCUs. These carbon credits are also known as compliance ACCUs that can be traded in Australia or overseas in compliance markets (DCCEE, 2012).

Non-Kyoto ACCUs

"Non-Kyoto ACCUs are issued if the relevant offsets project is an eligible non-Kyoto project, or if the relevant project is an eligible Kyoto project but the reporting period ends after the Kyoto abatement deadline" (Clean Energy Regulator, 2015). Activities such as soil carbon management, feral animal management, improved forest management and non-forest revegetation, do not count for Australia's target under the KP. Thus, under the policy these activities can earn Non-Kyoto ACCUs (DCCEE, 2012).

2.10.4 Methodologies under the CFI-ERF

Activities under the CFI-ERF, to be accepted and generate carbon credits, need to operate under approved methodologies that can be developed by independent organizations, business associations or governmental agencies. The methodologies describe the procedures to implement and monitor the offset activities. The methodologies submitted for approval are subject to an assessment process. The Emissions Reduction Assurance Committee (ERAC), established by the Australian government, assesses proposed methodologies and informs the Ministry of Environment and Energy to issue methodology determinations when appropriate. The ERAC will consider advice from the CER s to ensure new methodologies are practical and cost-effective (Department of Environment and Energy, 2015).

2.11 CFI-ERF METRICS

Although the aim of this study concerns the adoption of CFI-ERF in the land sector, specifically, land sector carbon sequestration area, this analysis also includes the emissions reduction methods, projects and credits issued in all the sectors covered by the policy. Thus, this analysis provides an overall picture of the carbon faming and trading situation in Australia. This analysis was carried out using a data set from the Registry of Projects of the

Clean Energy Regulator (Clean Energy Regulator [CER], 2016). The analysis covers the period September 2011 until June 30, 2015[11],.

As shown in Table 2.4, since the start of the CFI-ERF, September 2011 to June 30, 2015, the CER issued over 20 million ACCUs generated by 278 projects. The projects were approved under 20 methodologies classified into six method types. Vegetation type methods, with 134 register the highest number of projects while transport and energy efficiency only had two projects each. Waste projects were issued some 10 million ACCUs followed by vegetation projects with almost 9 million credits. In contrast, transport and energy efficiency projects did not receive any credits by June 2015 (CER, 2016b).

Table 2.4 Number of projects and ACCUs by method type and methodology

Method type and methodology		ACCUs	Projects registered
Agriculture		**133,328**	**14**
EmR	Destruction of methane from piggeries using engineered biodigesters	0	1
EmR	Destruction of methane generated from manure in piggeries - 1.1	133,328	7
CSe	Sequestering carbon in soils in grazing systems	0	6
Energy efficiency		**0**	**2**
EmR	Industrial electricity and fuel efficiency - methodology 2015	0	2
Savanna burning		**1,538,120**	**35**
EmR	Emissions abatement through savanna fire management - methodology 2015	1,086,462	10
EmR	Reduction of GHG emissions through early dry season savanna burning	451,658	25
Transport		**0**	**2**
EmR	Land and sea transport - methodology determination 2015	0	2
Vegetation		**8,998,759**	**134**
CSe	Avoided deforestation	240,867	6
CSe	Avoided deforestation 1.1	6,679,012	45
CSe	Designated verified carbon standard projects	173,572	2
CSe	Human-induced regeneration of a permanent even-aged native forest - 1.1	734,895	26
CSe	Native forest from managed regrowth	359,200	9
CSe	Quantifying carbon sequestration by permanent mallee plantings using the reforestation modelling tool	36,455	2
CSe	Reforestation and afforestation	282,565	5
CSe	Reforestation and afforestation - 1.2	376,109	10
CSe	Reforestation by environmental or mallee plantings – fullcam	103,218	16
CSe	Quantifying carbon sequestration by permanent environmental plantings of native species using the CFI-ERF reforestation modelling tool	12,866	13

[11] The Carbon Farming Initiative started in September 2011 and was merged to the Emissions Reduction Fund in December 2014. Nevertheless, new projects were accepted under the Carbon Farming Initiative rules until the end of June 2015 and all the projects already accepted were transitioned to the ERF. Other changes to the climate policy, such as the termination of the Carbon Pricing Mechanism, were also introduced along with the creation of the ERF

Waste		**9726,248**	**91**
EmR	Alternative waste treatment	448,105	12
EmR	Landfill gas	9,251,150	76
EmR	Capture and combustion of methane in landfill gas from legacy waste	26,993	3
Grand total		**20,396,455**	**278**

Note:
EmR Methodologies aimed to reduce the emissions of greenhouse gases
CSe Methodologies aimed to the carbon sequestration which are the focus of the present study

Data from CER (2016b)

2.11.1 Projects registered by method type

As stated earlier, the CFI-ERF has approved methodologies to develop projects in six areas: agriculture, energy efficiency, savanna burning, transport, vegetation and waste. As shown in Figure 2.10, vegetation type methodologies with 134 (48.2%) had the largest number of projects registered followed by waste methods with 91 (32.7%). Energy efficiency similarly than transport only registered 2 (0.7%) projects each (projects registered until June 30, 2015).

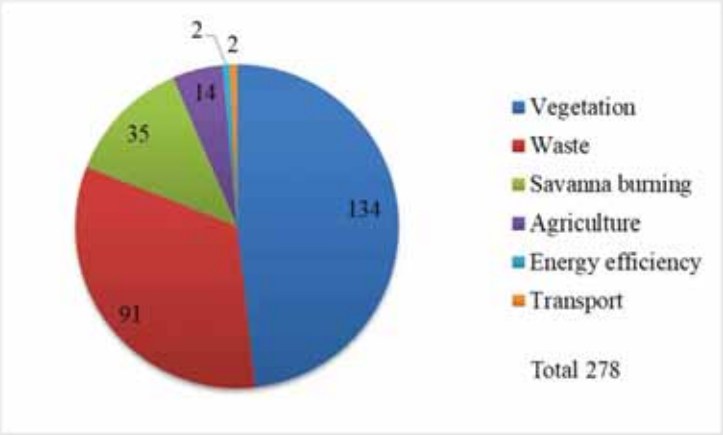

Figure 2.10 Number of projects by method type

Data from Clean Energy regulator (2016)

2.11.2 Historical increase of projects registered

The CER registered 278 projects from August 2012 to June 30, 2015[12]. The first 4 projects were registered in August 2012. On average, some 8 projects were accepted per month. March 2015, with 28, had the highest number of projects registered and during 2014, 100 projects were

[12] New projects developed under the CFI-ERF rules could be registered until June 30, 2015. The rules of the ERF started in July 1, 2015, therefore new projects had to meet the new regulations.

approved. Figure 2.11 shows the number of projects approved per month and the cumulative number of projects per year.

Figure 2.11 Projects registered per month and cumulative number of projects

Data from Clean Energy Regulator (2016).

2.11.3 Projects registered by location

All Australian states and territories record projects approved under the CFI-ERF rules (Figure 2.12). New South Wales, with 123 (44.24%), has the highest number of projects while the Australian Capital Territory records two (0.72%) projects. Interstate -projects developed that occupy land in two or more states- and nationwide projects -transport and energy efficiency projects can be developed Australia wide- are also reported: South Australia-Western Australia (1), New South Wales-Queensland-Northern Territory (1), and one project nationwide.

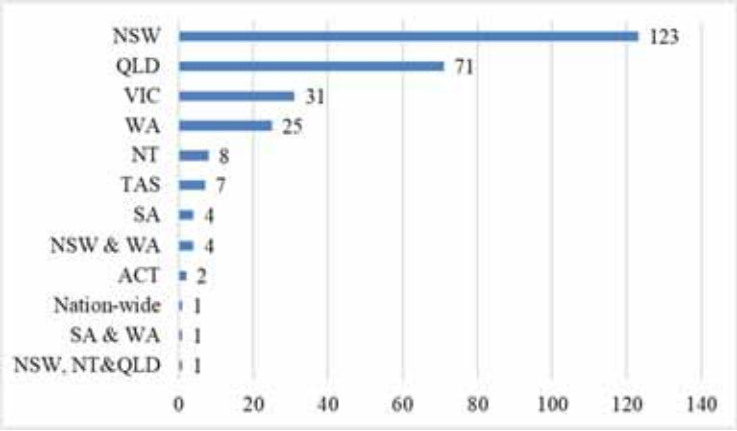

Figure 2.12 Number of projects registered per location

Data from Clean Energy Regulator (2016)

2.11.4 ACCUs issued by method type

The CER issued over 20 million ACCUs from 2012 to June 2015. Projects approved under waste methods, with almost 10 million (48%), had the highest number of credits issued. Vegetation projects, with some 9 million (44%) have the second-highest number of credits. While, transport and energy efficiency methods did not have any credits issued Figure 2.13.

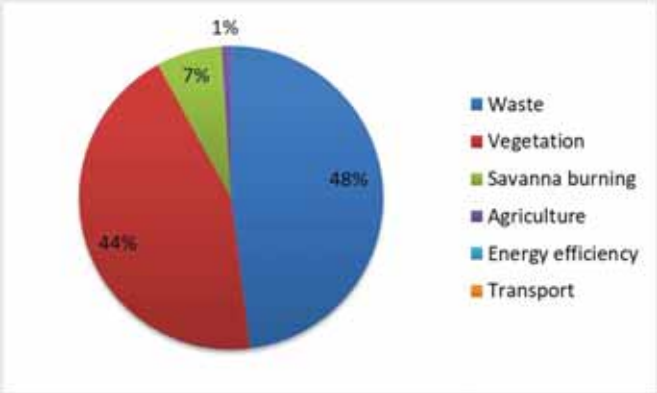

Figure 2.13 ACCUs issued by method type

Data from Clean Energy Regulator (2016)

2.11.5 ACCUs issued to Emissions reduction and carbon sequestration projects

The Carbon Farming Initiative legislation, now part of the ERF, comprises six methodology types. All the methodologies under waste, savanna burning, transport and energy efficiency as well as some farming methodologies are aimed to GHG emissions reduction. On the other hand, all the activities under vegetation type methodologies sequestrate atmospheric carbon through vegetation. As shown in Figure 2.14, the CER issued over 11 million ACCUs to projects working on GHG emission avoidance activities, and nearly 9 million credits to carbon sequestration projects.

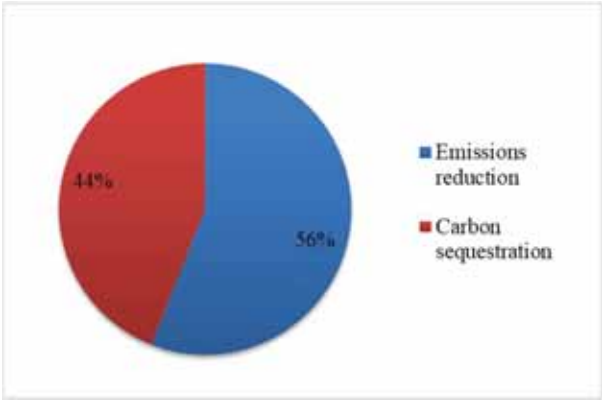

Figure 2.14 ACCUs issued by GHG abatement type

Data from Clean Energy Regulator (2016)

2.11.6 Carbon price evolution in Australia

Under the CFI-ERF rules, ACCUs were under a fixed price regulation. With the creation of the ERF the Australian Government introduced a reverse auction method to trading carbon. Typically, in a reverse auction, the cheapest carbon credits are traded. This change in the carbon trading rules had a significant impact on carbon prices. Thus, for the financial years 2012-2013 and 2013-2014, carbon credit units had a fixed price of A$23 and A$24.15 respectively (CER, 2015b). Under the new rules, the CER has held five auctions so far: April 2015, November 2015 at an average price of A$13.95, A$12.25 respectively. In 2016, during the ERF auctions, carbon credits sold at an average of A$10.23 in April and 10.69 in November. The average price in April 2017 was 11.82 per unit (CER, 2017). Figure 2.15 shows the variation of the carbon price in Australia during the fixed price period under the CFI-ERF rules and after the move to the reverse auction procedure under the ERF regulations.

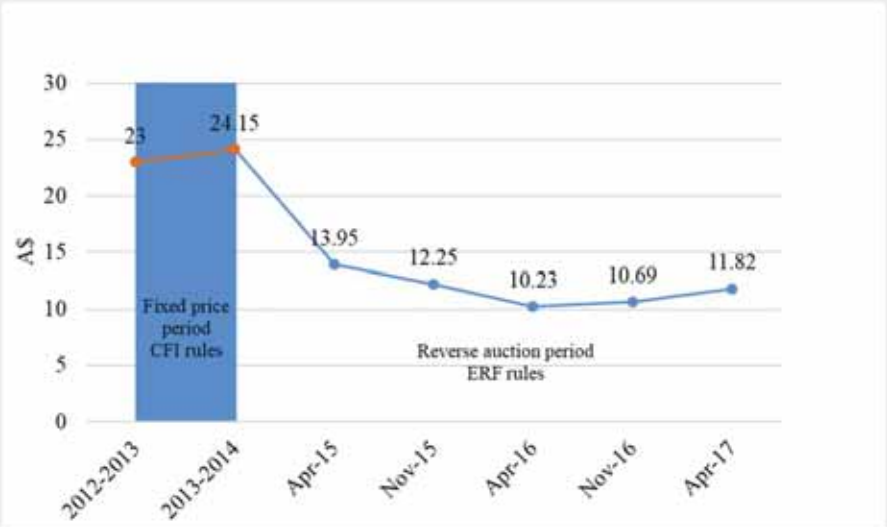

Figure 2.15 Carbon price evolution in Australia

Data from CER (2017)

2.11.7 Summary

The analysis of the Registry of Projects dataset of the Clean Energy Regulator (CER), which is the administrator of the CFI-ERF, shows that from September 2011 to June 31, 2015, the CER approved 278 projects. The projects were approved under six types of methods: agriculture, energy efficiency, savanna burning, transport, vegetation and waste. Most projects were registered under vegetation and waste methodologies, 134 (48.2%) and 91

(32.7%) projects respectively. While, energy efficiency and transport, with 2 projects each, had the least projects registered.

The CER registered the first 4 projects in August 2012, peaking up in March 2015, with 28 projects approved. With 100 projects, 2014, was the year with the most projects registered. The CER registered projects in all states and territories. and Queensland had the highest number of projects approved, 123 (44.24%) and 71 (25,54%) respectively. Two multi-state projects (projects that occupy land in more than one state), as well as one national project have also been registered. At this stage, it is difficult to assert the reason why states like New South Wales have more projects implemented. It can be assumed, concurring with Hagerstrand (1967), that adopters in New South Wales may be closer to a crucial source of information, e.g. innovators or early adopters. Early adopters during project evaluation pass on their experiences with the innovation to other interested landholders (Bellotti & Rochecouste, 2014). Or, it may be due to change agents (commercial or extension agencies) (Rogers, 1985) are either more numerous or have been more active in those jurisdictions. Consequently, there is the need to have a closer look of the diffusion mechanisms (networks), from a geographical perspective, influencing the adoption of the CFI-ERF across Australia.

During the same period, September 2011 to June 2015, the CER issued over 20 million ACCUs. The highest number of Australian Carbon Credit Units (ACCUs), around 10 million (48%), were accredited to projects under waste methodologies. Projects under agriculture methodologies have been issued around 9 million (44%) ACCUs. Regarding the type of GHG abatement type, emission avoidance projects have generated over 11 million (56%) ACCUs compared to around nearly 9 million (44%) ACCUs generated from carbon sequestration projects.

2.12 CONCLUSION

Scientists have published a vast amount of information about the changes that Earth's climate system is facing. Evidence of climate change's current impacts and predictions of future impacts on natural systems, as well as on built infrastructure are also a subject of much research as presented throughout the chapter. This scientific evidence has spurred the creation of various international organizations as well as agreements to foster the reduction of GHG emissions. Agreements, such as the KP have set reduction targets to signatory members, such is the case of Australia. Australian governments, in turn have created various mechanisms to reach its reductions targets under the KP. In 2011, the CFI-ERF was presented as one crucial

piece of Australian plan to tackle climate change. The next chapter provides a description of the CFI-ERF and an analysis of the numbers behind the policy (e.g., projects approved and carbon credits issued). Chapter three also presents the theoretical framework for this study and an overview of the literature on the factors that influence the adoption of environmental initiatives such as the CFI-ERF in Australia.

Thesis Outline

Chapter 1	Introduction
Chapter 2	The big picture: A context analysis to the Carbon Farming Initiative-Emissions Reduction Fund
Chapter 3	**Theoretical framework and overview of the factors that influence the adoption of the Carbon Farming Initiative-Emissions Reduction Fund**
Chapter 4	Methods
Chapter 5	The role of demography, knowledge, motivation capacity and barriers on the adoption of the Carbon Farming Initiative-Emissions Reduction Fund: A quantitative study
Chapter 6	The role of demography, knowledge, motivation, capacity and barriers on the adoption of the Carbon Farming Initiative- Emissions Reduction Fund: A qualitative study
Chapter 7	Integrating the quantitative and qualitative results: Analysis and discussion
Chapter 8	Conclusion and recommendations for further research

CHAPTER 3: THEORETICAL FRAMEWORK AND OVERVIEW OF THE FACTORS THAT INFLUENCE THE ADOPTION OF THE CARBON FARMING INITIATIVE-EMISSIONS REDUCTION FUND

Chapter 2 presented an overview of the science of climate change and the international organizations working towards improving the understanding of the causes of climate change and its impacts on human and natural systems. Chapter 2 also provided an overview of the global context where the Australian Climate Policy developed which, in turn, led to the introduction of the Carbon Farming Initiative and its subsequent merging into the newly stablished Emissions Reduction Fund (CFI-ERF). Chapter 3 presents the theoretical framework underpinning this thesis. The chapter discusses the evolution of the innovation diffusion paradigm including Rogers (1962) Diffusion of Innovations theory, which is the theoretical lenses of this research. Then, an overview of the factors: *demography, knowledge, motivation, capacity* and *barriers* (DKMCB) that influence the adoption of the CFI-ERF and similar innovations proposed to Australian landholders is presented in the chapter. Additionally, a description of the study area has been included at the beginning of Chapter 3.

3.1 STUDY AREA

General Information

Australia (Figure 3.1) is the sixth largest country in the world, with a land area of 7,692,024 square kilometres (Geoscience Australia, 2014). Over 24 million people live in Australia in six states and two territories: New South Wales, Queensland, South Australia, Tasmania, Victoria, Western Australia, Australian Capital Territory and Northern Territory (Australian Government, 2017). Canberra is the capital of Australia.

Figure 3.1 Study area

Source: Google maps

Australian biodiversity and the CFI-ERF

The benefits of the application of the CFI-ERF activities, throughout Australia, extend beyond GHGs' abatement and mitigation of climate change. The implementation of CFI-ERF projects, especially those under vegetation and agriculture methods[13], depending on their geographical context, can provide a range of crucial ecological/environmental benefits. For example, carbon farming projects that include avoiding deforestation, reforestation and afforestation activities can assist protecting, providing and/or restoring habitat for different plant and animal species. Additionally, carbon farming projects, purposefully applied, could serve as buffer zones to protect biodiversity high-value areas. In general, protecting or restoring natural areas is beneficial for Earth's natural balance; and particularly in the Australian context, protecting nature is vital due to its high biological richness which is famous worldwide.

[13] CFI-ERF projects can be implemented under seven different method types: agriculture, vegetation, savanna burning, waste (management), energy efficiency and transport. Refer to Chapter Three.

Australia is one of the most biological megadiverse countries in the planet. Over one million plant and animal species live in Australia (Australian Government, 2017). Close to 85 per cent of plants, 84 per cent of mammals, over 45 per cent of birds, and 89 per cent of inshore, freshwater fish are endemic species (Australian Government, 2017). Australia is home to some 378 species of mammals, 828 bird species, 300 species of lizards, 140 species of snakes and two species of crocodiles (Australian Government, 2017). Nearly half of the mammal species (140) are marsupials. There are also two species of monotremes (egg-laying mammals); the platypus and echidna (Australian Government Department of Foreign Affairs and Trade, 2016).

Some 4000 species of fish, 500 coral species, 50 mammal species and several birds find shelter and depend on Australia's marine environment (Australian Government, 2017). Sixty marine reserves, including the world famous Great Barrier Reef Marine Park, cover an area of 3.1 million square kilometres, virtually one third of the Australian Commonwealth waters (Australian Government Department of Foreign Affairs and Trade, 2016).

Nearly 18 per cent of Australia's land area equivalent to more than 137 million hectares are part of the national reserve system. A wide variety of habitats ranging from rainforest to savannas and desserts are counted as protected areas (Australian Government Department of Foreign Affairs and Trade, 2016).

Land use in Australia

Australia has an exceptional land, water, vegetation and biodiversity resources (Lesslie & Mewett, 2013) well known around the world (Australian Government Department of Foreign Affairs and Trade, 2016). Changes in land use have a significant impact on environmental, economic and social conditions, as well as on Australia's food production, natural environment and communities (Lesslie & Mewett, 2013). Among the most important, a wide variety of agricultural and forestry industries develop their activities on about 7.7 million square kilometres of Australian land surface (Lesslie & Mewett, 2013). Interestingly, nearly 94 percent of Australian farms are family-based (Hamblin, 2009).

The CFI-ERF initiative encompasses a range of methodologies allowing individuals to develop projects in different areas of the Australian economy. Projects in areas from energy efficiency, transport and waste management to the land sector (farming, agriculture and forestry) are covered under the initiative. Many of the land use activities in Australia (Table

3.1) are suitable for the application of CFI-ERF projects, and particularly for *agriculture* and *vegetation* as proposed by the policy (refer to methodology types, Chapter 3).

Table 3.1 Summary of land use activities in Australia

Land use	Area (ha)	Area (%)
Dryland horticulture	151,816	0.02
Intensive animal and plant production	208,381	0.03
Land in transition	433,413	0.06
Irrigated horticulture	546,316	0.07
Irrigated pastures	1,123,812	0.15
Rural residential and farm infrastructure	1,678,666	0.22
Mining and waste	2,029,930	0.26
Plantation forestry	2,037,523	0.27
Irrigated cropping	2,483,108	0.32
Urban intensive uses	3,668,017	0.48
Water	9,131,283	1.19
Production forestry	9,977,562	1.3
Minimal use	32,073,873	4.17
Grazing modified pastures	36,799,647	4.79
Dryland cropping	37,947,962	4.94
Nature conservation	63,868,970	8.31
Other protected areas	109,039,447	14.19
Grazing native vegetation	455,242,289	59.24
Total	768,442,015	100

Source: ABARES (2015)

As shown in Table 3.1, grazing is the dominant land use in Australia with over 492 million hectares, 64%, (grazing native vegetation over 455 million ha and grazing modified pastures nearly 36.8 million ha), is the dominant land use in Australia (ABARES, 2015). Land set aside for conservation and protected areas with nearly 173 million hectares (Nature conservation almost 63.9 million ha and other protected areas over 109 million ha) account for a 22.5% of land use in Australia (ABARES, 2015). Cropping and horticulture together occupy about 41 million (over 5%) hectares and plantation and production forestry cover about 12 million hectares (1.5%) of Australian soil. Finally, urban intensive areas occupy nearly 3.7 million hectares (0.5%) of Australia (ABARES, 2015).

Australian World Heritage areas

Australian natural uniqueness and cultural richness are internationally famous. The UNESCO has included nineteen Australian properties in the World Heritage list (Table 3.2): twelve natural, three cultural and four mixed (of natural and cultural interest) sites. The Great Barrier Reef, Kakadu National Park and Willandra Lakes Region, in 2011, were the first Australian sites registered in the UNESCO World Heritage list (UNESCO World Heritage Centre, 2017).

Table 3.2 Australia's world heritage areas

Natural			
Great Barrier Reef	1981	Australian Fossil Mammal Sites (Riversleigh / Naracoorte)	1994
Lord Howe Island Group	1982	Heard and McDonald Islands	1997
Gondwana Rainforests of Australia	1986	Macquarie Island	1997
Wet Tropics of Queensland	1988	Greater Blue Mountains Area	2000
Shark Bay, Western Australia	1991	Purnululu National Park	2003
Fraser Island	1992	Ningaloo Coast	2011
Cultural			
Royal Exhibition Building and Carlton Gardens	2004	Australian Convict Sites	2010
Sydney Opera House	2007		
Mixed			
Kakadu National Park	1981	Tasmanian Wilderness	1982
Willandra Lakes Region	1981	Uluru-Kata Tjuta National Park	1987

UNESCO World Heritage Centre (2017)

As climate change impacts are increasing around the world, mitigation activities can, in the long-run, help reduce the effects to both human but particularly natural systems. World Heritage areas could benefit from the application CFI-ERF projects, directly and indirectly. Although most of the effects of climate change mitigative actions will not be observed in the near future, some of the other benefits (co-benefits) can be observed in the short and medium term, e.g. habitat protection, provision and restauration. These beneficial effects of the implementation of CFI-ERF projects may make a significant contribution to preserve Australian World Heritage, especially Natural and Natural/Cultural World Heritage areas.

3.2 TERMINOLOGY

3.2.1 Carbon Farming

Carbon farming refers to land management practices (projects) aimed to either sequestrate CO_2 from the atmosphere through vegetation[14], e.g. reforestation, afforestation, avoided deforestation (Commonwealth of Australia, 2012); or to avoid or reduce GHG emissions from activities carried out in the land sector e.g. farming, agriculture, land use change, waste management and savanna burning (Commonwealth of Australia, 2012).

3.2.2 Land sector

Land sector in the context of carbon farming refers mainly to rural land used for commercial and non-commercial farming (e.g. agriculture, horticulture, grazing and livestock), forestry and landscape/habitat conservation, and recreational purposes. The land sector has the potential to support carbon sequestration and GHG emissions reduction activities through improved land management and/or purposive land change (e.g. reforestation and afforestation).

3.2.3 Landholder

The term landholder refers to any individual or organization that has exclusive rights over the (rural) land, either because of ownership (freehold) or lease (leasehold), and can make decisions about the actions to take regarding to land use and land use change. Therefore, a landholder is entitled to adopt any of the activities under the Carbon Farming Initiative policy. The term landowner is also used throughout this thesis as a synonym of landholder.

3.2.4 Adoption

Adoption, in the context of this study, is only achieved after the implementation of carbon farming projects under the CFI-ERF rules and their corresponding registration by the Clean Energy Regulator (CER). Acceptance and uptake are synonyms of adoption also used in this thesis.

3.3 THEORETICAL FRAMEWORK

Climate change is one of the greatest concerns of humankind. The changes that human and natural systems are experiencing have stimulated the creation of several different national and

[14] Plants use CO_2 for biochemical processes as they grow, thus helping to reduce atmospheric carbon concentrations (Commonwealth of Australia, 2012).

international strategies targeting all sectors of the economy. Several innovations have been proposed for the land sector to engage landholders working in the agricultural and forestry sectors to participate in environmental schemes. The dissatisfaction expressed by proponents for the low uptake rates of new policies and methodologies is one of the main reasons fuelling the study of adoption (Pannell et al., 2006). Thus, the adoption of innovations has been a popular research subject among scholars, policy makers and other stake holders. Several approaches have been introduced to study the adoption of innovations (Karakaya, Hidalgo, & Nuur, 2014) from the policy, the change agents and the intended adopters' perspective. This section starts with a brief review of the adoption/diffusion research evolution. Then, the section introduces the main points of Rogers' Diffusion of Innovations theory, which is the theoretical lenses used in this thesis.

3.3.1 Evolution of diffusion of innovations research

Since the early 1900s, adoption research scholars, from different disciplines, have put forward several approaches to examine the diffusion of technological and non-technological innovations (Karakaya, Hidalgo, & Nuur, 2014). According to Padel (2001), in the land sector context, the diffusion model was developed by rural sociologists to assist extension workers promoting new agricultural practices. Wejnert (2002), Padel (2001), Valente and Rogers (1995), and Rogers (1983) consider that Tarde Gabriel's book "The laws of imitation", presented in 1903, was one of the first published works on diffusion of innovations. Tarde's main aim was to understand why only around the ten percent of innovations would be adopted and ninety percent would be forgotten (Rogers, 1983). Tarde (1903) noted that some common factors (characteristics), i.e. social status and opinion leadership, play an important role in innovations' diffusion, and identified the *S curve* (sigmoid or logistic curve) (Figure 3.2) of the cumulative number of people adopting an innovation Valente and Rogers (1995). This S curve, typical in many innovation adoption studies (Dearing, 2009; Padel, 2001; Rogers, 1983), was discussed and popularized by social science scholars in the 1920s and 1930s, see: Chapin (1928) and Pemberton (1936).

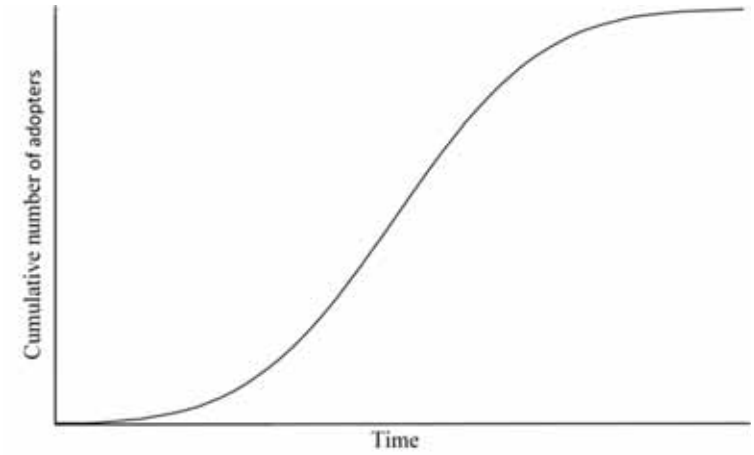

Figure 3.2 Adoption curve resulting from plotting the distribution of the cumulative number of adopters of an innovation
Source: Chapin (1928), Pemberton (1936), Ryan and Gross (1950), Rogers (1983)

Although, Tarde's work was an important start of diffusion research (Padel, 2001), Valente and Rogers (1995) and Wejnert (2002), concur that Ryan and Gross' work on the adoption of a hybrid corn seed, published in 1943, was the cornerstone of the development of the innovation diffusion paradigm. Ryan and Gross (1943), sought to explain farmers' acceptance of a hybrid corn seed in two communities in Iowa, in the United States. Their research was motivated by the extraordinary speed at which the innovation was accepted (rate of adoption); in for years over sixty percent of the target population (farmers) had adopted the new seed (Ryan and Gross, 1943). Ryan and Gross (1943) observed a difference between "diffusion agencies that informed farmers of the new seed and the sources of influence towards adoption" (Ryan & Gross, 1943, p. 15). The diffusion agents (commercial agents) were important spreading knowledge about the seed, while neighbours were a major source of influence towards acceptance (Ryan & Gross, 1943). Torsten Hagerstrand's book "Innovation diffusion as a spatial process" -first published in Swedish in 1953- was another fundamental input to the evolution of diffusion of innovations paradigm. Torsten's research article was translated to English and made available in 1967. Hagerstrand (1967) argued that the diffusion of new practices among farmers was a consequence of a learning process and depended on how the information about them spread (M. Brown, 1981). Hagerstrand (1967) also asserted that the information about an innovation would typically spread through mass media and personal networks. Thus, given the importance that personal networks have on spreading of new practices, Hagerstrand (1967) claimed that the diffusion of new ideas also depended on the geographical context. That is, the closer farmers were to the source of

information (e.g. early adopters) about an innovation -neighbourhood effect-, the more likely they were to adopt it (Lawrence A. Brown & Cox, 1971; M. Brown, 1981; Hagerstrand, 1967). He also noted the influence on adoption of an existing hierarchy of adopters' networks: local, regional and international social communication networks -hierarchy effect- (Lawrence A Brown, 1969; Lawrence A. Brown & Cox, 1971; M. Brown, 1981; Hagerstrand, 1967). Many other researchers have contributed in the development of the diffusion of innovations paradigm. Brown (1981) for example, based on prior research works, stated that the model of the uptake of an innovation was only one of the elements of diffusion. He highlighted the role of the innovation providers, who would adapt the innovation to the target population needs and economic situation and stablish agencies to provide the innovation, thus promoting adoption (Webber, 2006). Brown (1981) also noted the importance of the (positive or negative) consequences that the innovations would bring about to the adopters of the innovation proposed.

3.3.2 The diffusion of innovations theory

In 1962, Everett Rogers introduced the Diffusion of Innovations (DOI) theory (Rogers, 1962), which has gained importance among diffusion theory researchers and practitioners. Dearing (2009) states that only a few theories have had an impact on diffusion research comparable with (DOI) theory. Researchers in almost all disciplines have applied and adapted Rogers' theory to fit their research objectives for over fifty years. Agriculture, health, and education are examples of fields where the application of the DOI has increased (Dearing, 2009). However most of the approaches used were extension or modifications of the diffusion of innovations model (Johnson, 2015). For instance, Valente and Davis (1999) presented a model to accelerate acceptance of new practices using opinion leaders. They argued that innovations spread faster when promoted by opinion leaders. And, they claimed that most campaigns designed to communicate information about new practices used mass media disregarding the importance of the structure of the target population (community) or organization (Valente & Davis, 1999). The motivation for this model, according to Valente and Davis (1999) was the disregard of prior studies on the importance of collecting data on interpersonal communication networks. Similarly, Wejnert (2002) proposes a conceptual framework to analyse different models of innovation diffusion. The characteristics of any innovation are grouped in three overarching elements that influence adoption: characteristics of the innovation, characteristics of the adopters/intended adopters and the geographical context of the adopters (Wejnert, 2002). In sum, the diffusion or adoption of innovations is a

topic that has generated vast discussion among scholars and practitioners for over a century, with a strong emphasis in the last fifty years.

Considering the importance, the propositions and the suitability of the Diffusion of Innovations (DOI) framework (Rogers, 1962) to explore the adoption of the Australian CFI-ERF, the DOI was adopted as the theoretical lenses to conduct this study. The following section provides a brief review of DOI theory.

The DOI attempts to explain why and how new ideas are adopted in a particular period of time by society. Rogers (1962, 1983) states that "*Diffusion* is the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 1983, p. 34). The theory distinguishes four main elements (Table 3.3) that influence the spread of new ideas: the innovation, the communication channels, time and the social system.

Table 3.3 Elements in the diffusion of new ideas

Innovation	Innovation is an idea, practice, or object perceived as new by individuals. There are five characteristics perceived by a social system that determine its adoption: relative advantage, compatibility, complexity, trialability and observability.
Communication channel	Communication channel is the means through which a message is spread. Mass media create a knowledge of the innovation while interpersonal communication influences the attitude towards the new ideas, since individuals rely on information and experience of closer peers before adoption.
Time	It refers to the period of time that individuals take from the first knowledge of the innovation to the implementation and confirmation of the new idea. Rogers devised three elements connected with time in innovation: (1) the innovation-decision process, (2) innovativeness, and (3) an innovation's rate of adoption.
Social System	It refers to "a set of interrelated units that are engaged in joint problem solving to accomplish a common goal." Various elements influence the adoption decision inside the social system: norms opinion leadership, change agent and aid. Rogers also determines three main types of innovation decisions: (1) optional innovation-decisions, (2) collective innovation-decisions and (3) authority innovation-decisions. (4) A fourth type, named as contingent-innovation decisions, results from a sequential combination of two or more of the three main types of decision. Finally, he proposes consequences, as an element of diffusion, which refers to "the changes that occur to an individual or to a social system because of the adoption or rejection of an innovation."

Source: Rogers (1983)

3.3.3 The innovation-decision process

According to (Rogers,1983), the innovation-decision process (Figure 3.3) refers to the *mental process* necessary for individuals to pass from the first knowledge of proposed innovations, forming and attitude towards the innovations and finally accept or reject them. In turn, this process requires previous conditions and depend on individual characteristics of the intended

adopters, as well as, fundamental features of the innovation proposed (Rogers, 1983). Figure 3.3 depicts the innovation-decision process.

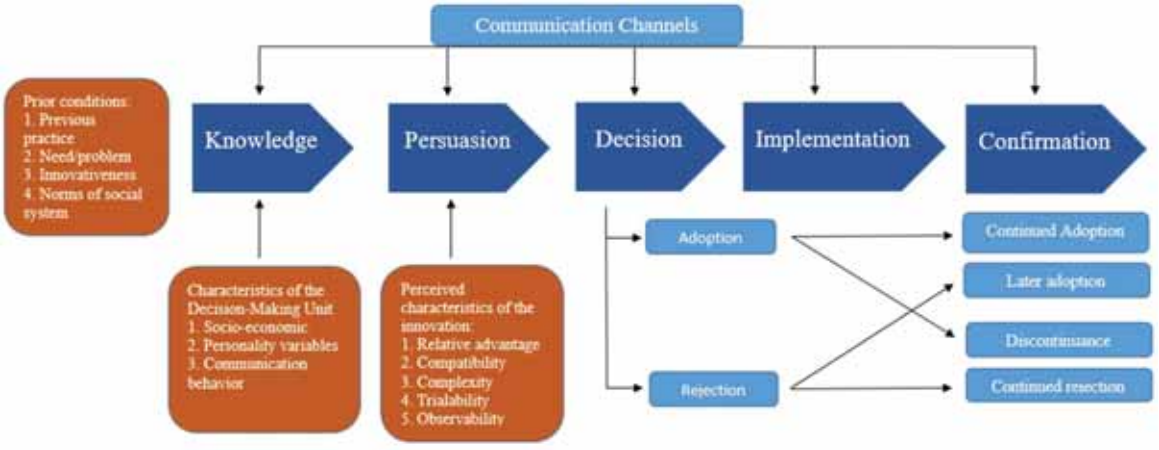

Figure 3.3 Innovation decision process

Rogers (1983, p. 165)

Thus, during the innovation-decision process, as explained by Rogers (1962), intended adopters pass through five different mental steps to adopt and continue or, if necessary, stop the application of new ideas (Rogers, 1983). The steps (elements) involved in the innovation-decision process are succinctly described in Table 3.4.

Table 3.4 Innovation-decision steps	
Knowledge	After becoming aware of the existence of an innovation, intended adopters start collecting information to learn more about the new idea, how it works and about its possible advantages and disadvantages. Some individual characteristics of the intended adopters are play an important role on this stage (socio economic characteristics, personality and communication behaviour).
Persuasion	Potential adopters look for evaluation information and start to understand the consequences of the adoption of the innovation. Here, characteristics of the innovation, e.g. compatibility of the innovation with the potential adopters' interests and activities, and the perceived relative advantage of the proposed idea are crucial aspects influencing adoption.
Decision	Here, individuals start to perform tasks leading to facilitate the decision of adopting or rejecting the innovation.
Implementation	In this stage, individuals engage in the usage of the innovation.
Confirmation	Adopters evaluate the performance of the idea and decide to continue or stop the application of the innovation.

Rogers (1983)

3.3.4 Rate of adoption

The "*rate of adoption"* is another crucial concept to explain the process of adopting innovations. It refers to the relative speed that an innovation is adopted by members of a particular social system" (Rogers, 1983, p. 23). The speed of adoption will depend on the characteristics of the innovation (e.g. complexity and trialability) and the category of adopters; some ideas will be adopted faster than others, so the rate of adoption will vary among actors.

3.3.5 Categories of adopters

Rogers conceptualized five categories of adopters (Rogers, 1983, pp. 241-251). These five categories consider the level of *innovativeness*[15] and different characteristics, *i.e.* socio economic status, personality variables and communication behaviour, of the intended adopters of the innovation. The DOI assumes a normal distribution of the number of individuals that adopt a certain innovation over time (Figure 3.4).

[15] Innovativeness refers to "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system" (Rogers, 1983, p. 36).

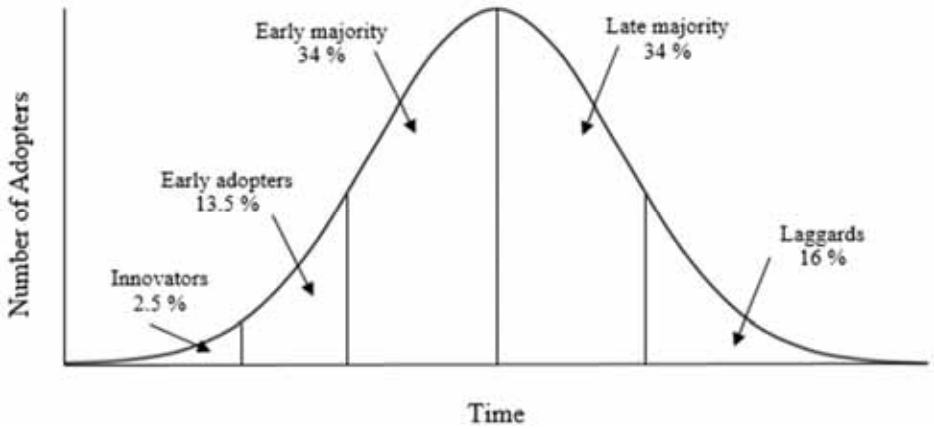

Figure 3.4 Category of adopters

Rogers (1962, 1983)

As shown in Figure 3.4, the innovators, the smallest group (2.5%), are the first to accept and adopt the proposed new ideas. In contrast, the laggards (16%) are the last group of individuals to implement innovations. A brief description, as proposed by the DOI (Rogers, 1962, 1983), of the categories of adopters is now discussed.

Innovators are 'venturesome' and 'cosmopolite' individuals who like trying new ideas and have contact with other innovators beyond their social circle. Compared to other adopters, innovators have access to more financial resources and can understand and use complex technical skills. They are important in the diffusion of innovations because they bring new ideas from outside their social circle and introduce these ideas to other members of the social system. They will take the risk of suffering losses and setbacks resulting from the application of new ideas.

Early adopters are respected members in their social system and somewhat different than the innovators, who are cosmopolites. Early adopters move inside their social circle and are considered role models and opinion leaders. They provide 'subjective' evaluation about innovations to people in their circle using their interpersonal networks. *Early adopters* are frequently consulted by potential adopters before applying any new ideas. *Change agents* often look for early adopters to accelerate diffusion processes.

By comparison, the "*early majority* adopt new ideas just before the average member of a social system" (Rogers, 1983, p. 249). They mostly interact with their peers and only occasionally have positions of leadership. They are an important connection between the

early and late adopters, notably providing linkage inside the system network. They take longer than the innovators and early adopters before using and applying new ideas.

On the other hand, the "*late majority* adopt new ideas just after the average member of a social system" (Rogers, 1983, p. 249). They have limited resources and need to be sure that the new idea works and the social norms support the innovation before adopting it to minimize risks. Although they can be persuaded about the new ideas but still need the pressure of the people in their circle to decide adopting innovations.

Finally, *laggards* are the last to adopt new ideas, and by the time of adoption – in some cases –these ideas have already been improved by other innovations. Laggards almost do not have opinion leadership. They prefer remaining inside their social circle, and many of them are isolates. Laggards often have a less fortunate economic position. Thus, they have to be sure that a new innovation will not fail before adopting it. Laggards can cause a dramatic deceleration of the innovation process.

3.3.6 Change agent

In addition to the characteristics of adopters, their social system and networks, and the characteristics of the innovation, Rogers (1983) also discusses the influence that *change agents* have on the adoption of new ideas. Rogers (1983) explains that some innovations disseminate through potential adopters own social networks, but change agents propagate other innovations. Change agents are professionals external to potential adopters' social circle (Rogers, 1983), who can influence individuals' decisions about adopting any particular innovation. They can encourage or, in some cases, they may try to decelerate the uptake of innovations considered undesirable (Rogers, 1983). Therefore, the intervention of change agents in the diffusion process can have a significant influence on the uptake of new ideas. For instance, extension agents in the farming and agricultural sector may be considered a good example of change agents. Extension agents are usually professionals working for governments or perhaps commercial organisations to provide consultancy to farmers/landholders, among various topics, on the adoption and application of new technologies (Oakley & Garforth, 1985).

3.3.7 Weaknesses of the innovation diffusion model

As stated before, the diffusion of innovations theory is largely credited to Everett Rogers, who popularized the theory in 1962. Scholars and practitioners have used the theory to

examine the diffusion of innovations in many disciplines. In fact, the study of innovations is often multidisciplinary. Although the diffusion of innovations theory has proven to be useful to guide research on adoption of innovations, some scholars have pointed out some limitations of the model. Rogers (1983) brings to light four sources of criticism to innovation research: 1) the pro-innovation bias of diffusion research, 2) the individual-blame bias in diffusion research, 3) the recall problem in diffusion research and 4) the issue of equality in the diffusion of innovations.

The pro-innovation bias of diffusion research refers to "the implication of most diffusion research that an innovation should be diffused and adopted by all members of a social system, that it should be diffused more rapidly, and that the innovation should be neither re-invented nor rejected" (Rogers, 1983, p. 92). This bias often causes that scholars only focus their attention on innovations that have spread widely among the population, therefore, innovations that failed to spread are ignored (Rogers, 1983).

The individual-blame bias is the tendency to blame an individual for his/her own problems rather than blaming the system where the individual belongs (Rogers, 1983). Thus, often social problems are caused by the system rather than by the individuals who may suffer the consequences of this system failure (Rogers, 1983). From the innovation research perspective, this individual-blame bias may be interpreted as the success or failure of the individual within the system rather that the success of failure of the system where the individual belongs (Rogers, 1983). In other words, individuals (demographic characteristics are often regarded as determinants, e.g. level of education, age, level of income) of adoption may be blamed for not adopting an innovation rather to faulting other systemic problems, e.g. lack of information or support to intended adopters (Rogers, 1983).

The recall problem in diffusion research. Rogers (1985, p.112) explains that "one weakness of diffusion research is its dependence upon recall data". Since innovations diffuse over time, researchers face the need to learn from respondents the time when they decided to adopt a new practice. The ability of accurately recalling an event, in this case the adoption of an innovation, can vary from one individual to another, consequently the data collected may often have some inaccuracies Rogers (1985).

The last of the main weaknesses of diffusion research discussed by Rogers (1985) is the issue of equality in the diffusion of innovations. The socioeconomic benefits resulting from the application of an innovation may broaden the gap between the individuals of a system.

Rogers (1985) explains that this gap broadening between higher and lower status members can occur in any system but especially in developing countries.

3.4 OVERVIEW OF THE FACTORS THAT INFLUENCE ADOPTION OF NEW PRACTICES IN THE AUSTRALIAN LAND SECTOR

The adoption (or lack of adoption) of new practices in Australia has been explored from different perspectives (e.g., economics and sociology), the approaches depending on the disciplinary orientation of the researchers (Pannell et al., 2006). The discipline of the researchers influences the importance given to different drivers of innovation, e.g. economists highlight the importance of economic factors more than sociologists (Pannell et al., 2006). Also, different methods have been used to investigate (or review research), model and predict the influence of drivers of adoption of new ideas. Regardless of the perspective employed or methods used, studying the influence of factors that influence the adoption of environmental innovations is a complex task. Most of the factors driving or impeding adoption, besides the demographic characteristics of intended adopters and the features of the innovation proposed (Pannell et al., 2006; Rogers, 1962, 1983; Stanley et al., 2006), vary greatly depending on for instance, the social, political and geographical context where environmental projects are developed (Greiner & Gregg, 2011; Greiner, Patterson, & Miller, 2009; Pannell et al., 2006; Stanley et al., 2006).

3.4.1 Adoption of innovations in the carbon sequestration context

Globally, forest carbon sequestration potential can reach 1-3 Pg CO_2 per year (Lal, 2005). Carbon sequestration through vegetation has the capacity to offset emissions from different sectors of the economy, e.g. industry, transport (Conant, 2011; Summers, Bryan, Nolan, & Hobbs, 2015), thus assisting with climate change mitigation (Lin, Macfadyen, Renwick, Cunningham, & Schellhorn, 2013). Bradshaw et al. (2013) state that conservation planning needs to incorporate carbon sequestration into design of conservation schemes to improve simultaneously biodiversity and carbon emissions abatement benefits. Carbon sequestration from managed forest systems has the potential to reduce the rate of atmospheric CO_2 concentration (Lal, 2005) and lock large amounts of carbon in living biomass or wood products (Summers et al., 2015). Schemes such as the CFI-ERF are oriented to encourage emissions abatement and particularly carbon sequestration activities, while also producing important environmental benefits (Lin et al., 2013) and crucial ecosystem services. Under the current circumstances, ecosystem services are progressively becoming limited (Alamgir et

al., 2014; Farley & Costanza, 2010). Introducing carbon prices potentially deliver opportunities for farming carbon in addition to (or instead of) traditional agriculture (Summers et al., 2015) while allowing landholders to achieve their environmental goals (Lin et al., 2013).

Adopting an innovation in the carbon sequestration area is a challenging decision and involves some risks due to the uncertainty of the outcomes (Greiner et al., 2009). Most activities aimed to increase carbon sequestration involve reforestation or afforestation methods which require significant land use change that can be expensive and not easily reversed (Pannell et al., 2006). Thus, there is an ongoing debate about the cost of reforestation, which in turn impacts on the economic viability of carbon farming projects (Summers et al., 2015).

In Australia, the study of innovations adoption proposed for the land sector is not new. For example, Guerin and Guerin (1994) conducted a review of research on the constraints to adopting innovations in the Australian agricultural and environmental management sector. They claim that the most successful innovations, in terms of adoption, were those that produced a direct economic benefit, a reduced level of risk and complexity and that were compatible with the activities already in place on the property. Likewise, lately, a considerable number of articles have been published on the adoption of environmental innovations in the land sector. This review compiles a sample of the literature on the subject.

Numerous factors influencing the adoption of environmental innovations in the Australian land sector have been pointed out in the literature. Personal characteristics (demography) of the intended adopters, landholders' goals and/or motivations, social and economic/financial context, costs, uncertainty around the policy and economic return (for market-based schemes) are among the most commonly cited factors by scholars studying adoption in the environmental land sector. Table 3.5 provides a summary of the factors discussed in the literature.

Table 3.5 Factors that influence landholders' decisions to adopting environmental innovations		
Reference/Article tittle/ Journal	Comments on articles/article type	Adoption factors
Bradshaw et al. (2013) Brave new green world – Consequences of a carbon economy for the conservation of Australian biodiversity. *Biological Conservation*	This review article analyses the main land management options under future carbon reduction scenarios and their impact on biodiversity. It also discusses some possible negative outcomes of some carbon reducing land management options	The compatibility of carbon sequestration activities, particularly, environmental plantings with beneficial biodiversity outcomes is a source of motivation for adoption Carbon price variability is a source of uncertainty. Anticipating and modelling the changes in carbon prices, its impact and the response (to the price variability) is a difficult task
Cacho, Lipper, and Moss (2013) Transaction costs of carbon offset projects: A comparative study *Ecological Economics*	The article discusses the influence of compliance cost on farmers participation in eco-innovations. It puts forward a model of exchange of carbon offsets between a project developers and landholders. The model was applied two study cases	There is a clear evidence in the literature that transaction costs are a significant barrier to adoption Some transaction costs, e.g. monitoring are recurring costs Additional payments for environmental plantings may motivate adoption increasing environmental outcomes Fixed costs reduction, e.g. registration and certification costs, may have benefit small landholders program uptake
Ducos et al. (2009) Agri-environment contract adoption under fixed and variable compliance costs *Journal of Environmental Planning and Management*	This empirical study uses the conceptual distinction between fixed and variable to explain why factors that influence adoption seem to differ from factors which determine the amount of land farmers commit to environmental programs. The study was applied to a sample of European farmers	Higher educational levels may help dealing with administrative processes reducing consulting transaction costs Education may help tackling eventual technical issues The lack of understanding of certain procedures prevent participation in the scheme Increasing compensation and/or reducing transaction costs could assist increasing adoption
Dumbrell et al. (2016) What carbon farming activities are farmers likely to adopt? A best–worst scaling survey. *Land Use Policy*	The study aims to identify which carbon sequestration practices farmers may prefer to adopt. Also, the authors of the article investigated what factors would influence the decision of adopting carbon farming practices. A *best-worst scaling survey* was used. The survey was applied to dryland cropping and mixed crop-livestock farmers in Western Australia.	Generating carbon credits was not an important adoption driver Carbon farming innovations that generate environmental and farm productivity benefits most likely to be adopted. Communicating the environmental and farm benefits of carbon farming rather than carbon trading opportunities in a voluntary market may increase uptake A combination of economic and non-economic drivers impacts landholders' decisions to adopting innovations: Investment (implementation) costs, impact on farm profitability and landholders' financial situation [capacity] Compatibility of the innovation with current practice(s) Personal values and landholder social context Public co-benefits, along with transaction costs and policy uncertainty will continue as important barriers to adoption of carbon farming activities

Evans et al. (2015) Carbon farming via assisted natural regeneration as a cost-effective mechanism for restoring biodiversity in agricultural landscapes. *Environmental Science & Policy*	The study used a discounted cash flow analysis to assess economic viability of natural regeneration against environmental planting. The study considered carbon farming economics of Queensland state, Australia.	Carbon farming activities in agricultural land deliver biodiversity, economic and social benefits There is a high uncertainty of carbon price. The collapse of the European carbon market in 2012 and recent changes in Australian climate policy generated instability of carbon price. The influence of project duration of long-term contracts along with policy risk and market uncertainty on the viability of carbon farming projects can present a significant barrier to private landholder participation
Greiner (2015) Motivations and attitudes influence farmers' willingness to participate in biodiversity conservation contracts *Agricultural Systems*	This research investigates how attitudes and motivations influence farmers' decision to participate in conservation contracts. A choice experiment was applied to pastoralists and graziers in north Australia's rangelands. The planed behaviour theory was used for the study	Cattle farmers in northern Australia as other farmers worldwide require a significant monetary incentive to remove cattle, from land under (long duration) contract, to adopt conservation schemes Many farmers need an improved knowledge on the impact on grazing management and the benefits that changes in grazing deliver to biodiversity conservation and restauration
Greiner and Gregg (2011) Farmers' intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: Empirical evidence from northern Australia. *Land Use Policy*	This case study aimed to identify graziers' motivations, impediments to adoption of conservation practices. Also, farmers' perception of effectiveness of policy to overcome impediments was investigated. The study surveyed farmers in three regions within the tropical savannas of northern Australia	Many social and economic factors and their interactions can motivate or prevent the uptake of natural resource management practices or landholders' involvement in environmental activities Landholders' land stewardship and other non-economic motivations to implement environmental practices have been overlooked Policies that consider the value of alternative motivations (other than economic) can stimulate landholders' interest in conservation. Further, policies that put more emphasis in financial incentives but undermine farmer's environmental altruism will not succeed
Greiner et al. (2009) Motivations, risk perceptions and adoption of conservation practices by farmers. *Agricultural Systems*	This paper investigates the extent that motivations and risk perception influence the decision of adopting 'best management practices'. The paper reports the findings of a survey applied to graziers in the Burdekin River catchment in Australia	Fulfilling individual goals is one of the most important landholders' motivation to adopt new practices Landholders adopt practices which enable them achieving their goals (e.g. economic, social, environmental) Conservation innovation adoption rates are higher for landholders with high conservation and lifestyle motivation than for peers (even in the same industry and region) that have strong economic and social motivations. A better understanding of landholders' motivation and risk perception for adoption of conservation practices is key to design schemes, at regional levels, that encompass different incentives thus increasing programs' effectiveness and efficiency Farmers' motivation and risks perceptions varies among industries and regions

Kragt, Gibson, Maseyk, and Wilson (2016) Public willingness to pay for carbon farming and its co-benefits. *Ecological Economics*	This research used a choice experiment across Australia to estimate community values for climate change mitigation and carbon farming practices.	Carbon farming schemes should include environmental co-benefits other than carbon abatement Schemes should consider paying higher prices for carbon credits that encompass additional environmental co-benefits to encourage a positive change in land management
Lin et al. (2013) Maximizing the Environmental Benefits of Carbon Farming through Ecosystem Service Delivery *BioScience*	This article explores the potential benefits or disbenefits (when practices are not applied correctly) of environmental programs aimed to enhance ecosystem services, biodiversity and carbon sequestration	Carbon credits trading benefits will probably not be enough to attract landholders, nevertheless effective communication about the wide range of co-benefits may motivate landholders to join carbon trading schemes Carbon farming initiatives present landholders from the agricultural sector to reach their environmental protection goals
Macintosh (2014) The carbon farming initiative: Removing the obstacles to its success. *Carbon Management*	This article presents an overview of the CFI and examines the potential barriers for its success	Barriers to the success of the CFI-ERF include: carbon market and carbon price uncertainty, transaction costs to meet participation requirements, overly regulated technical aspects of the policy (e.g. integrity and perverse impact risk management) instability of Australian climate policy.
Maraseni & Cockfield (2015) The financial implications of converting farmland to state-supported environmental plantings in the Darling Downs region, Queensland. *Agricultural Systems*	This study estimates the amount of carbon sequestrated using the Reforestation Modelling Tool of the Australian government. This estimation is compared to the profit generated from other competing land uses. Data on costs and benefits were collected from several sources. The study was conducted in in the Darling Downs region of Queensland, Australia	Worldwide, the offer of carbon credits will grow twice as fast than the demand. [This can push prices down] The Emissions Reduction Fund buys emission reduction credits from different sources (e.g. renewable energy, energy efficiency) and supports emerging technologies. Thus, it is likely that only a small portion of the funding will be used to buy credits from carbon sequestration projects
Meadows et al. (2014) Engaging Australian small-scale lifestyle landowners in natural resource management programmes – Perceptions, past experiences and policy implications. *Land Use Policy*	This study explores perceptions of small-scale rural lifestyle landowners with natural resource management extension and incentive programmes. It discusses improving programmes to address assistance needs of landholders. Data was collected from seventeen qualitative case-studies of small landholders located in Queensland, Australia.	Many small landholders willing to implement natural resource management activities do not have the knowledge, time, finance and physical abilities. Some small landholders do not have good levels of awareness and understanding about support schemes, especially incentive mechanisms.

Moon and Cocklin (2011) Participation in biodiversity conservation: Motivations and barriers of Australian landholders. *Journal of Rural Studies*	This study reports the results of 45 qualitative interviews on motivations and barriers to adopt biodiversity conservation practices. The interviews were conducted to landholders who participated in one of three programs for biodiversity conservation operating in Queensland, Australia	Motivation and barriers were different for conservation-driven, production-driven and financially-driven landholders Non-production landholders would devote larger property proportions to conservation agreements General conservation, protection of the forest, perpetual protection, and conservation of natural features are motivations shared by conservation-driven landholders Financial incentives motivated production-driven and -financially-driven landholders Landholders perceive that involvement in conservation programs and associated benefit streams can threat their private rights over the land. Thus, some landholders would not commit to perpetual programs or, would only include unproductive lands to conservation programs Landholders did not get any regular education or training about improving the quality or the quantity of vegetation in the property areas committed to conservation Other barriers to conservation were: productivity loss, indecision about which conservation programs would reach the best conservation outcomes
Page and Bellotti (2015) Farmers value on-farm ecosystem services as important, but what are the impediments to participation in PES schemes? *Science of the Total Environment*	The study aimed to identify the values of farmers, of two local land service regions in Australia, towards on-farm ecosystem services, motivations and perceived impediments to the uptake of conservation schemes. Online surveys were used for data collection	Lack of awareness and absence of suitable information would prevent uptake of conservation schemes Nonfinancial motivations such as personal and family wellbeing, care based ethics and strong land stewardship drive the uptake to adopting conservation schemes and activities by Australian landholders Government uncertainty was considered a barrier for participation in conservation schemes Insufficient payments and lack of time are also barriers to adoption of conservation practices

Pannell et al. (2006) Understanding and promoting adoption of conservation practices by rural landholders *Australian Journal of Experimental Agriculture*	Review of literature on adoption of rural innovations through a cross-disciplinary perspective.	Age presents mixed influence on adoption of environmental practices Education sometimes influences the adoption of innovations Scholars, in general have concluded that landholders with higher education levels adopt innovations early Higher education in the case of a complex innovation or technology may allow landholders to identify the limitations of the practice, thus reducing or preventing adoption Landholders need a certain level of knowledge and skill to implement innovations and decide over methods (e.g. timing, sequencing, intensity, scale) Hands-on experience, reading, listening and watching, can help reach or improve knowledge and skills Achieving goals (e.g. environmental, economic and social) is an important motivation for adoption. Goals differ among landholders. If landholders perceive that an innovation will not allow them achieving their goals, they will not adopt it The influence of economic factors on adoption is still a subject of discussion among scholars. Economists highlight the important factors more than sociologist Economic profit has a low priority for some farmers. However, economic return may be important to reach more important goals (e.g. secure family wellbeing) Even landowners who put low importance on achieving additional profit would not adopt innovations that could result in considerable economic loss
Polglase et al. (2013) Potential for forest carbon plantings to offset greenhouse emissions in Australia: economics and constraints to implementation *Climatic Change*	The study presents estimations of economic returns for 'environmental plantings' on cleared land area across Australia. A total of 105 scenarios were run for the estimations	Economic incentives, in a market scheme, will not be enough to motivate large scale environmental plantings, thus additional payments for environmental benefits are necessary to increase uptake Landholders do not decide land use change only based on economic return Carbon plantings may be appropriate for some landholders' land management plans but not for others Availability of financial capital, or access to the capital market, due to regulatory uncertainties and innate carbon trading risks, will be a barrier to implement tree plantations

Robinson et al. (2016) Indigenous benefits and carbon offset schemes: An Australian case study. *Environmental Science & Policy*	The aim of this study was to describe ongoing indigenous carbon projects and to investigate what drives Australian indigenous people participation in these schemes. It also examines the effectiveness of the schemes in addressing indigenous' biodiversity and carbon emissions mitigation goals	Several rights, cultural values and socio-ecological system benefits should be considered as motivations for indigenous people to participate in carbon offset activities Environmental rights and stewardship, important concepts to Indigenous cultures worldwide, have not been considered by carbon co-benefit schemes.
Rochecouste, Dargusch,Cameron, and Smith (2015) An analysis of the socio-economic factors influencing the adoption of conservation agriculture as a climate change mitigation activity in Australian dryland grain production. *Agricultural Systems*	The aim of this study was to describe, using system models, the process to decide to change and adopt conservation agriculture practices by Australian dryland grain farmers. The paper presents the results of several system models.	Landholders explained that investment costs, knowledge and skills required to implement new practices were also influential factors to adoption Conditions leading to improving profitability were positive drivers. In contrast, situations that may lead to reduced profitability or created financial loss were negative drivers Unfamiliar innovations, not widely practiced or recommended by trusted fellow landholders, regardless of benefits will be slowly adopted
Schirmer and Bull (2014) Assessing the likelihood of widespread landholder adoption of afforestation and reforestation projects. *Global Environmental Change*	This paper examines landholders' willingness to adopt afforestation and the factors that influence landholders' adoption decisions. The study uses data from a survey of Australian landholders	The importance given to using the land for food production constrains the adoption of afforestation activities. Landholders are less likely to contemplate the option of planting trees in large areas, especially the more productive land areas Adoption of afforestation activities is more likely in marginal land whether environmental co-benefits are present
Sinnett, Behrendt, Ho, and Malcolm (2016) The carbon credits and economic return of environmental plantings on a prime lamb property in south eastern Australia *Land Use Policy*	This article presents the results of a case study that uses methods of farm management economics to assess whether growing trees for carbon on part of a prime lamb farm, in south-west Victoria, could be more advantageous than using that land to graze livestock.	Farmers consider co-benefits such as aesthetic reasons, wildlife corridors, habitat creation, erosion control, soil and crop protection over the economic benefits from carbon trading Environmental plantings are a competitive option only when planting methods are possible (e.g. direct seeding). But when planting requires ripping and mounding of soil, planting of tubestock and fencing, environmental plantings are no longer competitive
Smith and Sullivan (2014b) Ecosystem services within agricultural landscapes—Farmers' perceptions. *Ecological Economics*	This research uses a survey to investigate Australian farmers' perceptions about ecosystem services. The survey measures the perceptions of four attributes of twelve ecosystem services	Economic compensation to landholders is necessary to protect and improve the provision of ecosystem services for present and future generations Maintenance costs of ecosystem services, e.g. maintenance of natural habitat, are considered as a barrier by landholders Market-based schemes, such as schemes paying for ecosystem services can have an important impact within agricultural landscapes

Stanley et al. (2006) Understanding land manager constraints to the adoption of changed practices or technological innovations: Literature review	Literature review about socio economic factors preventing land managers to participate in natural resource activities, adopting new practices and technological innovations	Some barriers have been widely assumed to have strong influence on adoption of new practices despite inconclusive evidence. Little evidence exists on the relationship between formal education and adoption of innovations Training seems to increase adoption of proposed innovations The literature put too much attention on financial factors as an innovation adoption driver in the land sector Understandably, landholders having low resources to meet their own needs are less likely to invest in new land management practices. Consequently, insufficient financial viability may prevent adoption Low levels of trust on the proposed innovation or the proponents are a strong barrier to adoption
Summers et al. (2015) The costs of reforestation: A spatial model of the costs of establishing environmental and carbon plantings *Land Use Policy*	The paper presents the modelling to predict the spatially explicit costs of establishment tree plantations for carbon sequestration and mixed species plantations for carbon sequestration and biodiversity benefits. It analyses the costs of three different methods of planting trees	The variation of implementation costs which depend in various factors such as commodity prices and availability, management decisions, methodologies and several biophysical aspects are a constraint to determine the economic viability of reforestation projects.
Torabi and Bekessy (2015) Bundling and stacking in bio-sequestration schemes: Opportunities and risks identified by Australian stakeholders. *Ecosystem Services*	This paper is an empirical analysis about the benefits and barriers of bundling and stacking carbon and biodiversity credits in Australia	Carbon markets variability and political uncertainty are barriers to stablish integrated credits (credits that include a compensation for biodiversity benefits), which could increase adoption of carbon plantings
Torabi, Cooke, et al. (2016) The money or the trees: What drives landholders' participation in biodiverse carbon plantings? *Global Ecology and Conservation*	The article presents the results of a 'Bayesian Belief Network' to identify factors that may influence landholders' decision to participate in biodiverse carbon planting programmes.	The design of the program and the importance that landholders give to co-benefits of carbon plantings co-benefits influence adoption Flexible programs that consider landholders' knowledge and resource availability have higher participation rates
Torabi, Cooke, et al. (2016) The Role of Social Networks and Trusted Peers in Promoting Biodiverse Carbon Plantings. *Australian Geographer*	Seventeen interviews were conducted to landholders in Victoria, Australia who were voluntary participating in biodiverse carbon plantings. The aim was to investigate the role of social capital to understand how 'early adopters' can encourage programs locally	Landholders perception of the program design and the value of co-benefits impacts adoption rates Flexibility of programs, offering landholders options to choose from together with a flexible permanence option of stacked and bundled credits may increase adoption rates The scheme design should consider an effective communication of landscape-specific co-benefits to increase participation

van Oosterzee et al. (2014) Integrating agriculture and climate change mitigation at landscape scale: Implications from an Australian case study. *Global Environmental Change*	Literature review on emerging initiatives and governance for the integration of agriculture and forests Australia wide.	Transaction costs are a barrier to adoption to small landholders and will only favour large landholdings Project implementation costs hinder the participation of smallholders in the initiative

3.4.2 Analysing the adoption factors from the literature applying the DKMCB methodological framework

There are a wide range of factors driving the adoption of environmental innovations, as shown in Table 3.5 (above). This study therefore advances a new strategy to organize those factors and facilitate their analysis. The adoption drivers discussed in the literature are organized by employing the methodological framework developed for this study. Thus, demography, knowledge motivation, capacity and barriers (DKMCB) were considered as overarching factors driving landholders' decisions of adopting environmental innovations. The section below provides an analysis of the factors influencing the adoption of the CFI-ERF using the framework proposed for this research (Annex 2 provides a matrix of the adoption factors classified by DKMCB). The general methods chapter provides further explanation of the DKMCB framework.

3.4.2.1 Demography

Demography refers to the set of potential adopters' socio-economic characteristics that can influence the decision of adopting environmental initiatives (Rogers, 1962; 1983). Demography factors of potential adopters are widely accepted in the diffusion literature as key factors that influence the adoption of innovations (Pannell et al., 2006). The Diffusion of Innovations theory (Rogers, 1962) considers, among other factors, individuals' demographic characteristics to conceptualise the *category of adopters*. Many researchers have reported the significance of the relationship between demographic factors (e.g., age, education level, occupation) and the adoption of environmental innovations (e.g., Greiner and Gregg, 2011; Moon, Marshall, and Cocklin, 2012; Pannell et al., 2006). Dumbrell et al. (2016) also highlight the importance that landholders' personal values and social context as important demographic factors driving adoption. For instance, landholders' environmental and land stewardship attitudes are important personal factors that drive adoption of new land

management practices (Greiner, 2015; Greiner & Gregg, 2011). While Schirmer and Bull (2014) state that, in general, farmers consider it more important to use the land for food production, rather than planting trees and that they will likely use less fertile land for afforestation purposes.

Education has sometimes been associated as a driver of adoption of innovations (Pannell et al., 2006). Pannell et al. (2006), in a review about landholders' adoption of conservation practices, claim that frequently scholars have concluded that landholders with higher levels of education tend to adopt environmental innovations in the early stages. In that line, Ducos et al. (2009) state that higher educational levels can positively influence the decision of adopting environmental innovations. Landholders with higher levels of education may be better prepared for dealing with administrative processes, which in turn can help reduce, for example, consulting transaction costs and facilitate dealing with eventual technical issues (Ducos et al., 2009). However, higher education levels, in the case of complex innovations or technologies, may facilitate landholders to notice the limitations of the proposed practices, thus reducing or preventing adoption (Pannell et al., 2006). In contrast, Stanley et al. (2006) argue that little evidence exists about the relationship between formal education and the adoption of new practices. Nevertheless, Pannell et al. (2006) and Stanley et al. (2006) concur that training apparently can increase the acceptance of proposed innovations.

The influence of age on adoption of environmental innovations has been considered as a significant factor. The general assumption is that younger individuals are more likely to uptake new practices (Rogers, 1983; Stanley et al., 2006). Nevertheless, Stanley et al. (2006), in a review conducted on land managers' constraints to adoption of new practices, reports that scholars have presented conflicting evidence about the influence of age on adoption. Some researchers found non-conclusive evidence of the impact of age on adoption, while other scholars found even evidence that younger landholders were less likely to adopt new practices because other priorities such as family settlement, savings and debt commitments (Stanley et al., 2006). Further, Pannell et al. (2006) suggests that the influence of age on adoption may instead be linked with physical health.

3.4.2.2 Knowledge

Assessing potential adopters' level of knowledge about the innovation is crucial to understand any influences on the decision to adopt environmental initiatives. According to Meijer et al. (2015), knowledge consists of "factual information and understanding of how the new

technology works and what can it achieve". Rogers (1983) states that potential adopters, once exposed to the existence of the innovation, begin searching for information to augment their understanding and to reduce the uncertainty about the new idea. In this context, we define knowledge as the level of familiarity with the purpose of the initiative, how it works, and the benefits for adopters and the environment resulting from the adoption of the policy. Concurring with Rogers (1983), knowledge is achieved by actively searching and sharing information from different sources (e.g., governmental sources, experts advise, the internet) and through information sharing inside potential adopters' social networks. The concept of familiarity is commonly used to assess the landholders' level of knowledge about different aspects of the CFI-ERF. Scholars have used familiarity in diffusion research, e.g. Conroy & Iqbal (2009).

Researchers often cite that low levels of knowledge about new land management practices can have a negative impact on adoption levels (Rochecouste et al., 2015; Stanley et al., 2006) and that unfamiliar innovations, not widely practiced or recommended by trusted fellow landholders, regardless of the benefits, will be slowly adopted (Rochecouste et al., 2015). Certainly, landholders need an acceptable level of knowledge and skill to implement and decide over methods of applying innovations, e.g. timing, sequencing, intensity, scale (Pannell et al., 2006). Meadows et al. (2014) claim that often, small landholders who are willing to adopt new practices, do not have the level of knowledge required. For instance, some small landholders are not aware or do not have the knowledge on support schemes, especially incentive mechanisms (Meadows et al., 2014). Also, landholders' level of knowledge about the benefits of environmental practices needs to be improved. Greiner (2015), in a study conducted on adoption of conservation practices by grazers, found that landholders had a limited understanding about the impact that grazing management and the benefits that changes in grazing regimes deliver to biodiversity conservation and restauration. Therefore, schemes' design should consider effective communication mechanisms of the landscape-specific co-benefits to increase landholders' participation (Torabi, Cooke, et al., 2016). Finally, Pannell et al. (2006) state that hands-on experience, reading, listening and watching, can help landholders reach or improve knowledge and skills relevant to the proposed practice.

3.4.2.3 Motivation

Motivation, in the field of adoption of environmental initiatives such as is the case of the CFI-ERF, refers to the reasons that persuade individuals to perform an activity, reach a goal (Greiner, 2015; Greiner & Gregg, 2011; Kabii & Horwitz, 2006; Moon & Cocklin, 2011b; van Noordwijk, Agus, Dewi, & Purnomo, 2014) and drive behavioural change (Frey & Stutzer, 2006). Increasing understanding of motivation and its influence on the adoption of new environmental practices in the land sector is crucial (Greiner et al., 2009; Pannell et al., 2006; Rogers, 1983; Toma & Mathijs, 2007). Sinden and King (1990) argue that models aiming to study the adoption of initiatives must include the intended adopters' motivation variable.

Many researchers have studied the influence of motivation on adoption environmental innovations in the land sector (Greiner, 2015; Toma & Mathijs, 2007) as in other disciplines. Motivation, similarly to other drivers of adoption differs depending on the characteristics of landholders and the innovation proposed, the social, economic and even local geographical context (Pannell et al., 2006; Polglase et al., 2013; Stanley et al., 2006). Moon and Cocklin (2011b), for example, state that motivations are different for conservation-driven, production-driven and financially-driven landholders.

Some scholars concur that the literature puts too much attention on economic/financial factors as an innovation adoption driver in the land sector (Stanley et al., 2006). In fact, policies that overestimate financial factors, but do not value landholders' stewardship, will not achieve significant levels of acceptance (Greiner & Gregg, 2011), because landholders do not decide land use change based only on economic return (Polglase et al., 2013). Greiner and Gregg (2011) claim that landholders' land stewardship and other non-economic motivations to implement environmental practices have been overlooked. Non-financial motivations, such as personal and family wellbeing, care based-ethics and strong land stewardship drive the uptake of conservation practices (Greiner & Gregg, 2011; Page & Bellotti, 2015; Pannell et al., 2006). Adoption rates of environmental innovation are higher among landholders with high conservation and lifestyle motivation than for peers (even in the same industry and region) who have strong economic motivations (Greiner et al., 2009). For instance, farmers consider co-benefits such as aesthetic reasons, wildlife corridors, habitat creation, erosion control, and soil and crop protection over the economic benefits from carbon trading (Smith & Sullivan, 2014b). Further, schemes allowing landholders to choose from incentives such as workforce to assist with project implementation or advice and guidance (technical support)

on sustainable land management can improve acceptance (Moon & Cocklin, 2011a) and stimulate landholders' interest in conservation (Greiner & Gregg, 2011; Moon & Cocklin, 2011a).

As discussed above, economic/financial benefits are not the most important but undoubtedly, they are still significant motivations. Production landholders, landholders who use their land for productive activities (derive income from the land), had different motivations than non-production landholders to adopt land management innovations (Moon & Cocklin, 2011a). Apparently, for production landholders, financial incentives are strong drivers to participate in conservation programs (Moon & Cocklin, 2011a) and the probability of innovation adoption rises with increased incentives (Barnes, Southwell, Bruce, & Woodhams, 2014) For instance, cattle farmers in northern Australia, as with other farmers worldwide, require a significant monetary incentive to remove cattle from land under (long duration) contract, to adopt conservation schemes Greiner (2015). Moon and Cocklin (2011a) state that, these financial incentives would help landholders reduce the uncertainty and the risk of economic loss associated with adoption of conservation practices. Also, financial incentives would provide a compensation for the reduction of income due to reduction of agricultural production (Moon & Cocklin, 2011a), especially because costs associated with some conservation practices may exceed the on-farm benefits both in a short-term and long-term basis (Cary & Wilkinson, 1997). Additionally, even for farmers who consider economic profit as a low priority, financial return may be important to reach more important goals, e.g. secure family wellbeing (Pannell et al., 2006).

In the carbon sequestration context, the non-intended positive effects for the environment resulting from the application of a scheme, commonly named as co-benefits (IPCC, 2014a), are a strong motivation to adopt carbon farming innovations (Kragt et al., 2016). Carbon abatement, in the land sector delivers biodiversity, social and economic co-benefits (Evans et al., 2015; Greiner et al., 2009). The compatibility of carbon sequestration activities, particularly, environmental plantings with beneficial biodiversity outcomes is a source of motivation for adoption (Bradshaw et al., 2013). In agreement, Ducos et al. (2009) claims that carbon farming innovations and policies that generate environmental and farm productivity benefits are more likely to be adopted. However, carbon credits, in a market scheme, will not be enough to motivate large scale environmental plantings, thus additional payments for environmental benefits are necessary to increase uptake (Polglase et al., 2013; Smith & Sullivan, 2014a) especially in agricultural landscapes (Smith & Sullivan, 2014b).

Further, economic compensation to landholders is necessary to protect and improve the provision of ecosystem services for present and future generations (Smith & Sullivan, 2014b).

Understanding significant motivations can assist policy makers to (re)design environmental initiatives (Greiner et al., 2009) to appeal potential adopters' motivations while assisting them to fulfill their environmental goals regarding the innovation (Greiner & Gregg, 2011; Greiner et al., 2009; Lin et al., 2013). Appealing to influential motivations may, in turn, pave the way to increase the uptake of vital environmental innovations.

3.4.2.4 Capacity

Capacity is a concept commonly studied in many different disciplines. Climate change mitigation and adaptation are research fields where capacity has gained increasing attention. The Intergovernmental Panel on Climate Change [IPCC], (2012), defines capacity as the "combination of all the strengths, attributes, and resources available to an individual, community, society, or organization, which can be used to achieve established goals". In the context of adaptation to climate change, Adger et al. (2007, p. 727) refers to capacity as "the ability or potential of a system to respond successfully to climate variability and change". In this study, capacity refers to the set of abilities and resources that individuals and other entities have, or the possibility to gain access to the necessary resources to adopt environmental innovations. Specifically, in the context of the CFI-ERF, it also refers to the resources available that enable landholders to implement, register carbon farming projects and consequently gain access to carbon trading. In general, the presence of adequate resources can increase participation rates (Meadows et al., 2014; Torabi, Cooke, et al., 2016).

Availability or access to financial resources influence the decision of adopting environmental innovations. Stanley et al. (2006) notes that, understandably, landholders having low financial resources to meet their own needs are less likely to invest in new land management practices. Consequently, insufficient financial viability. (Polglase et al., 2013; Stanley et al., 2006) or access to the capital market, due to regulatory uncertainties and innate carbon trading risks, may prevent adoption (Polglase et al., 2013).

Implementing carbon sequestration projects, requires intensive labour, especially activities involving afforestation and reforestation. Having labour available, e.g. family labour, paid labour and volunteer labour, influences the decision of adopting an innovation (Moon and Cocklin, 2011a; Pannell et al., 2006). As in any endeavour, having available the necessary

labour assistance for execution of different tasks involved in the adoption of environmental innovations is critical (Meadows et al., 2014).

Technical support is also an important environmental innovation driver (Moon and Cocklin, 2011a; Pannell et al., 2006). Availability of technical knowledge sources, e.g. extension agents and industry related media, can impact even in the profitability of an innovation (Abadi Ghadim & Pannell, 1999). Meadows et al. (2014), suggests that small landholders need expert advice, and other resource support to improve natural resource management outputs. Collaboration among stake holders (e.g. policy makers, landcare organizations) can also increase the participation in environmental initiatives (Meadows et al, 2014).

3.4.2.5 Barriers

The term barrier has different definitions related to the field of application. In environmental science and specifically in adaptation to climate change, the IPCC (2007b) defines a barrier as "any obstacle to reaching a goal, adaptation or mitigation potential that can be overcome or attenuated by a policy, programme, or measure". Also, the Productivity Commission (2012) refers to a barrier as "anything that prevents the community from using its resources - natural, financial, human, social and physical capital - in the most advantageous way to respond to climate change". Moser and Ekstrom (2010) add that barriers "can be overcome with concerted effort, creative management, change of thinking, prioritization, and related shifts in resources, land uses, institutions, etc". In this study, barriers refer to any obstacles or circumstances that prevent or delay the adoption of climate change mitigation initiatives (e.g. policies, schemes and technologies) by the intended adopters. It is fundamental to identify and study the barriers to assessing their impact on the uptake of the proposed innovation. A systematic study of the barriers can provide input to discuss alternative solutions and focus collaborative effort to assist individuals and other entities to adopt environmental initiatives.

The strongest barriers to adoption of environmental initiatives, especially those in the carbon abatement area were those related to costs (project implementation, transaction and opportunity costs), carbon market, carbon policy and carbon price uncertainty. These factors together would increase the risks of adopting carbon farming and other environmental practices. A summary of the barriers preventing adoption of environmental initiatives is provided below.

The potential risks associated (and the impact on financial stability and project profitability) with the adoption of environmental innovations are also a constraining factor (Stanley et al.,

2006). Generally speaking, landholders would not adopt new practices when they perceive a high level of risk (Stanley et al., 2006). Even landowners who put low importance on achieving additional profit would not adopt innovations that could result in considerable economic loss (Pannell et al., 2006). Further, the lack of incentives in an active farm economy may prevent landholders adopting conservation innovations (Cary & Wilkinson, 1997). Landholders are less likely to adopt new practices when they consider that the benefits of the adoption are low, in other words when the relative advantage is minimal (Pannell et al., 2006; Rogers, 1983; Stanley et al., 2006) or not clear.

Transaction costs, in general, can negatively impact the acceptance of environmental projects (Cacho et al., 2013; Dumbrell et al., 2016; van Oosterzee et al., 2014), particularly for those projects under schemes exposed to market rules. Some of the transaction costs (e.g., monitoring and project maintenance) are recurrent and essential to meet participation requirements under market based schemes (Macintosh, 2014). According to Meadows et al. (2014); van Oosterzee et al. (2014), transaction and implementation costs under the CFI-ERF rules are a significant adoption barrier to small landholders. Consequently, high transaction costs favour large landholdings (van Oosterzee et al., 2014). Also, landholders consider maintenance of ecosystem services, e.g. care of natural habitat as a barrier to participation (Smith & Sullivan, 2014b).

Opportunity costs, the lost income due to the choice given to using the land to plant trees for carbon sequestration, instead of other productive activities (Cacho et al., 2013), has been reported as a barrier. Specific policy commitments regarding program duration (e.g. 25 or 100 years under CFI-ERF rules) on land where landholders could use for other productivity activities are a barrier (Moon & Cocklin, 2011b; Polglase et al., 2013). Changing land use to increase farm profitability in case of eventualities, e.g. variation in commodity prices is not an option due to scheme regulations (Polglase et al., 2013). Similarly, the importance given to using the land for food production constrains the adoption of carbon farming activities such as afforestation (Schirmer & Bull, 2014). Due to this opportunity costs, landholders are less likely to contemplate the option of planting trees in large areas, especially the more productive land areas (Schirmer & Bull, 2014). The barriers presented by costs that landholders have to incur to adopt, particularly in marked-based carbon farming innovations are also associated with insufficient payments (Page & Bellotti, 2015) and uncertainty of the price of carbon.

Uncertainty of the carbon prices is a barrier to adopt market-based carbon farming practices (Bradshaw et al., 2013; Evans et al., 2015; Macintosh, 2014; Maraseni & Cockfield, 2015) and reduces the willingness of landholders to make long term commitments[16] (Alamgir et al., 2014). It has been estimated that, not only in Australia but worldwide, the offer of carbon credits will grow twice as fast as the demand (Maraseni & Cockfield, 2015). This fast-growing surplus of carbon credits may cause a reduction of carbon prices due to oversupply (Maraseni & Cockfield, 2015). In Australia, (climate) policy instability has been considered a barrier (Macintosh, 2014). Changes in the policy and regulations generate instability in the carbon market and consequently of carbon prices (Evans et al., 2015). The Australian government introduced the Emissions Reduction Fund (ERF) in late 2014 (CER, 2016a). Currently, the ERF through a reverse auction buys GHG abatement credits from different sources (e.g., energy efficiency and transport) including the land sector, and supports emerging technologies (CER, 2016a; Maraseni & Cockfield, 2015). The inclusion of new sectors will increase the offer of carbon credits, which may translate in a reduction of the funding available to buy credits from carbon sequestration projects (Maraseni & Cockfield, 2015).

Other barriers to adoption of environmental innovations were: indecision about which conservation programs would reach the best conservation outcomes (Moon & Cocklin, 2011b), government uncertainty (Page & Bellotti, 2015), overly regulated technical aspects of the policy (e.g., integrity and perverse impact risk management) (Macintosh, 2014), lack of understanding of certain requirements to participation (Ducos et al., 2009) and low levels of trust on the proponents and the proposed innovation (Stanley et al., 2006). Finally, Moon and Cocklin (2011b) note that landholders perceive that involvement in conservation programs and associated benefit streams can threaten their private rights over the land. Thus, some landholders would not commit to perpetual programs or, would only include unproductive lands to conservation programs (Moon & Cocklin, 2011b).

Finally, it is important to point out that the DKMCB factors under study are closely related to each other and have some overlap. For instance, demographic characteristics such as age and level of education can have an important relationship with knowledge about the innovation. Similarly, knowledge and education (or training) about a subject related to the innovation can

[16] Commitment periods for carbon sequestration projects, which involve reforestation, afforestation and avoided deforestation, under the CFI-ERF-ERF rules are 25 or 100 years (CER, 2016a).

be a significant source of motivation. Additional, capacity -the availability or shortage of economic/financial, human and technical resources can become motivations and barriers to adopt the initiative. However, these relationships are not impediments to conduct this research employing the approach proposed, and in fact, the exploration of the relationship among DKMCB factors is a fundamental part of this study.

3.5 CONCLUSION

This chapter has provided a theoretical framework of the study, a description of the Carbon Farming Initiative-Emissions Reduction Fund (CFI-ERF), and an overview of the factors driving the adoption of the CFI-ERF and similar environmental initiatives in Australia. Although scholars have published several studies on the adoption of innovations in the Australian environmental land sector, including some research on carbon farming in Australia, a need to study the role that demography, knowledge, motivation, capacity and barriers (DKMCB) play on landholder's decision to adopting the CFI-ERF persists. The study of barriers and motivations to adopting environmental innovations in Australia dominates the literature. Also, the influence of landholders' characteristics has received considerable attention. The influence of capacity, understood as the existence or the possibility to access the necessary resources, has not received sufficient attention in the articles reviewed. The evolution of the innovation diffusion paradigm and the Diffusion of Innovations theory (Rogers, 1962) were also object of analysis in this chapter.

The next chapter (Chapter 4) contains the general methods used in this study. It starts with a literature review of the theory behind the methodological approaches chosen to conduct this research and describes the research design and the study methods. The analysis procedures applied to the quantitative and qualitative data collected on the factors that influence the adoption of the CFI-ERF are also explained in Chapter 4.

Thesis Outline

Chapter 1	Introduction
Chapter 2	The big picture: A context analysis to the Carbon Farming Initiative-Emissions Reduction Fund
Chapter 3	Theoretical framework and overview of the factors that influence the adoption of the Carbon Farming Initiative-Emissions Reduction Fund
Chapter 4	**Methods**
Chapter 5	The role of demography, knowledge, motivation capacity and barriers on the adoption of the Carbon Farming Initiative-Emissions Reduction Fund: A quantitative study
Chapter 6	The role of demography, knowledge, motivation, capacity and barriers on the adoption of the Carbon Farming Initiative- Emissions Reduction Fund: A qualitative study
Chapter 7	Integrating the quantitative and qualitative results: Analysis and discussion
Chapter 8	Conclusion and recommendations for further research

CHAPTER 4: METHODS

The overall aim of this study was to document and evaluate the role of demography, knowledge, motivation and capacity of Australian landholders[1], as well as the barriers they must overtake in their decisions to adopt the Carbon Farming Initiative (CFI-ERF) as prescribed by the Australian government. A *sequential explanatory mixed method design* was applied, which included one quantitative (QUAN) and a qualitative (QUAL) phase. During the QUAN phase, questionnaire-based survey data was collected from Australian landholders to explore how knowledge, motivation, capacity – as well as barriers – influence the adoption of the Carbon Farming Initiative. The second (QUAL) stage consisted of in-depth semi-structured interviews conducted only to adopters of the Carbon Farming Initiative (key informants) – identified through the survey questionnaires and through the Register of (CFI-ERF) Projects of the Clean Energy Regulator, Australian Government. The purpose of the second phase was to expand and explain the results of the quantitative analysis. The 'Diffusion of Innovations' theory by Everett Rogers was included as the theoretical basis. Additionally, a methodological framework was developed to guide the design of the data collection instruments (questionnaire-based survey and semi-structured interviews), as well as the analysis and interpretation of the data.

This chapter commences with a review Mixed Methods Research (MMR), and continues with the theoretical framework, accompanied by relevant definitions of the terms adopted for the framework. The final section of the chapter contains the research design and methods used for the study.

4.1 MIXED METHODS RESEARCH (MMR)

Traditionally, scientists – from different disciplines – had to choose between quantitative or qualitative methods as their approach to conduct research. Even today, qualitative and quantitative methods tend to be located into two different paradigms (Flick, Kardorff, & Steinke, 2004). According to Creswell (2009), social science researchers mostly used quantitative approaches from the late 1800s to the 1950s, when qualitative research started to

[1] The term landholder, for the purpose of this research, refers to any individual or organization, that has exclusive rights over the (rural) land, either because of ownership (freehold) or lease (leasehold), and can make decisions about the actions to take regarding to land use and land use change. Therefore, a landholder is entitled to adopt any of the activities under the Carbon Farming Initiative policy.

gain more attention. Despite the division, qualitative and quantitative methods are not opposed (Hesse-Biber, 2010a) and can be used in combination. Furthermore, researchers in different disciplines share the view that the choice of methods to be used depends on the research questions proposed for the study (Tashakkori & Teddlie, 2009). Therefore, considering the complexity of contemporary 'wicked' research questions, it becomes increasingly necessary to use complex methods to find the answers to those questions (Tashakkori & Teddlie, 2009).

After the first half of the 19th century – with the increasing interest in qualitative research – the development of mixed methods research (MMR) also gained more space (Creswell, 2009). For example, in the late 1950s, Campbell and Fisk (as cited by Creswell, 2009, p. 14) mixed different methods in their study on 'physiological traits', which originated the concept of using different methods (Creswell, 2009).

In general, the term 'mixed methods' refers to conducting a research study combining qualitative and quantitative approaches (Hesse-Biber, 2010a; Hewson, 2006; Kalaian, 2008), combining inductive and deductive considerations (Kalaian, 2008). Furthermore, Johnson, Onwuegbuzie, and Turner (2007) state that mixed methods research is the "third major research approach or research paradigm" besides quantitative and qualitative research. In comparison to qualitative and quantitative approaches, outcomes from MMR are more "informative, complete, balanced, and useful". (Johnson et al., 2007, p. 129).

Given the relatively short history of MMR, the definition of MMR is still evolving to reflect the changes in the area. Some definitions proposed by prominent mixed methods researchers have been compiled in Table 4.1.

Table 4.1 Definitions of Mixed Methods Research

Definition	Author(s)
"The class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study."	Johnson and Onwuegbuzie (2004, p. 15)
"The combined use of both quantitative and qualitative methodologies within the same study in order to address a single research question."	Hewson (2006, p. 180)
"Mixed methods research is an intellectual and practical synthesis based on qualitative and quantitative research; it is the third methodological or research paradigm (along with qualitative and quantitative research). It recognizes the importance of traditional quantitative and qualitative research but also offers a powerful third paradigm choice that often will provide the most informative, complete, balanced, and useful research results. Mixed methods research is the research paradigm that (a) partners with the philosophy of pragmatism in one of its forms (left, right, middle); (b) follows the logic of mixed methods research (including the logic of the fundamental principle and any other useful logics imported from qualitative or quantitative research that are helpful for producing defensible and usable research findings); (c) relies on qualitative and quantitative viewpoints, data collection, analysis, and inference techniques combined according to the logic of mixed methods research to address one's research question(s); and (d) is cognizant, appreciative, and inclusive of local and broader sociopolitical realities, resources, and needs."	Johnson et al. (2007, p. 129)
"Mixed methods research is a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis and the mixture of qualitative and quantitative approaches in many phases of the research process. As a method, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches, in combination, provides a better understanding of research problems than either approach alone."	Creswell and Plano Clark (2007, p. 5)
"… research in which the investigator collects and analyzes data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or a program of inquiry."	Tashakkori and Teddlie (2009, p. 287)
"In mixed methods, the researcher • collects and analyses persuasively and rigorously both qualitative and quantitative data (based on research questions); • mixes (or integrates or links) the two forms of data concurrently by combining them (or merging them), sequentially by having one build on the other, or embedding one within the other; • gives priority to one or to both forms of data (in terms of what the research emphasizes); • uses these procedures in a single study or in multiple phases of a program of study; • frames these procedures within philosophical worldviews and theoretical lenses; and • combines the procedures into specific research designs that direct the plan for conducting the study."	Creswell and Plano Clark (2011, p. 5).

Furthermore, Creswell (2009) states that MMR provides an ideal approach to conduct research when the objectives are to:

- better understand a research problem by converging (or triangulating) broad numeric trends from quantitative research and the detail of qualitative research;

- explore participant views with the intent of building on these views with quantitative research so that they can be explored with a large sample of a population;
- obtain statistical, quantitative results from a sample and then follow up with a few individuals to help explain those results in more depth; and
- best convey the trends and voices of marginalized groups or individuals. Creswell (2009, p. 121).

4.1.1 Advantages of mixed methods research

The advantages of MMR that have identified by different researchers make a strong case for its use in this study of the adoption of the CFI-ERF by Australian landholders. Some of the advantages found in MMR literature have been compiled in Table 4.2.

Table 4.2 Advantages/strengths of mixed methods research

Advantages/strengths	Author
Words, pictures, and narrative can be used to add meaning to numbers. Numbers can be used to add precision to words, pictures, and narrative. Can provide quantitative and qualitative research strength. Researcher can generate and test a grounded theory. Can answer a broader and more complete questions because the researcher is not confined to a single method or approach. A researcher can use the strengths of an additional method to overcome the weaknesses in another method by using both in a research study. Can provide stronger evidence for a conclusion through convergence and corroboration. Can add insights and understanding that might be missed when only a single method is used. Can be used to increase the generalizability of the results. Qualitative and quantitative research used together produce more complete knowledge necessary to inform theory and practice.	Johnson and Onwuegbuzie (2004)
MMR provides rich data sets including both narrative and numerical data. MMR offers a more complete understanding of the phenomenon under study identifying diverse results across different data sets.	Fowler et al. (2009)
MMR is 'practical' in the sense that the researcher is free to use all methods possible to address a research problem, and use all the tools of data collection available rather than being restricted to the types of data collection typically associated with quantitative research or qualitative research. It is also 'practical' because individuals tend to solve problems using both numbers and words, combine inductive and deductive thinking, and employ skills in observing people as well as recording behaviour. Further, MMR: • provides strengths that offset the weaknesses of both quantitative and qualitative research, • lends more evidence for studying a research problem than either quantitative or qualitative research alone, • helps answer questions that cannot be answered by quantitative or qualitative approaches alone, • provides a bridge across the sometimes-adversarial divide between quantitative and qualitative researchers, • encourages the use of multiple worldviews, or paradigms (i.e., beliefs and values), rather than the typical association of certain paradigms with quantitative research and others for qualitative research.	Creswell and Plano Clark (2011)

4.1.2 Weaknesses of mixed methods research

Undoubtedly MMR offers many advantages when exploring the adoption of environmental innovations, given the need to link ecological and social systems. Questions about the adoption of innovations need to be addressed using both QUAN and QUAL approaches, *i.e.* collecting valuable numerical data, but also allowing the different stakeholders to express their opinions and share their experiences about adopting innovations. However, as with any method, MMR also has inherent weaknesses that should be considered when planning research using an MMR approach (Johnson & Onwuegbuzie, 2004). Johnson and Onwuegbuzie (2004) present a summary of factors that may represent a challenge to conducting a study using MMR (Table 4.3).

Table 4.3 Weaknesses of mixed methods research

Weaknesses/disadvantages	Author
It can be difficult for a single researcher to carry out both qualitative and quantitative research, especially if two or more approaches are expected to be conducted concurrently; it may require a research team.	Johnson and Onwuegbuzie (2004)
Methodological purists contend that one should always work within either a qualitative or a quantitative paradigm.	
Researcher should learn about multiple methods and approaches and understand how to mix them appropriately.	
More expensive.	
More time consuming.	
Some of the details of mixed research remain to be worked out fully by research methodologists (e.g., problems of paradigm mixing, how to qualitatively analyze quantitative data, how to interpret conflicting results).	

4.1.3 Classification of mixed methods design

Creswell and Plano Clark (2011) suggest six 'major' mixed method research designs: four *basic designs* and two *additional designs* (variants using elements of the basic designs) and provide prototype versions of them (Table 4.4). These prototype versions are based on elements such as interaction, priority, timing and mixing, and its popularity among researchers (Creswell & Plano Clark, 2011).

Table 4.4 Mixed Methods Research Major Designs

Basic designs	
Convergent parallel design (Convergent design)	The QUAN and QUAL phases are implemented at the same time QUAL and QUAN phases are equally prioritised The analyses of the QUAN and QUAL components are performed independently QUAN and QUAL results are mixed in the overall interpretation
Explanatory sequential design (Explanatory design)	Two distinct interactive phases Collection and analysis of QUAN data occurs first QUAN component has priority The QUAL phase (second phase) builds on the results of the QUAN phase The interpretation of the QUAL results helps to explain the results from the QUAN phase
Exploratory sequential design (Exploratory design)	Two distinct interactive phases The collection and analysis of QUAL data occurs first The QUAN strand builds on the QUAL results The results of the QUAN strand are used to test or generalise the initial findings The researcher interprets how the QUAN results build on the initial QUAL results
Embedded design	QUAN and QUAL data are collected and analysed within a traditional QUAN or QUAL design A QUAL strand may be included within a QUAN design or, a QUAN strand may be included within a QUAL The additional strand is added to improve the overall design
Additional designs	
Transformative design	Transformative designs are developed within a 'transformative' theoretical framework Interaction, priority, timing and mixing are planned under the transformative framework context
Multiphase design	Sequential and concurrent strands are combined over a period of time The sequential and concurrent strands are implemented within a program of study responding to an overall program objective Multiphase designs are a common approach for development, adaptation and evaluation of specific programs

Source: Creswell and Plano Clark (2011)

4.2 RESEARCH DESIGN: EXPLANATORY SEQUENTIAL DESIGN

A sequential explanatory design was selected to conduct this study. According to Creswell and Plano Clark (2011), the sequential explanatory design (explanatory design) has two interactive phases: a QUAN phase and a QUAL phase. During the first phase, QUAN data is collected and analysed, then the results are used as input for the second phase, which in turn, collects QUAL data that can be used to explain the QUAN results (Creswell & Plano Clark, 2011).

As depicted in Table 4.1, in the first phase, quantitative data was collected using a questionnaire-based survey applied to landholders across Australia. In the second phase,

qualitative data was collected using semi-structured interviews conducted only to adopters of the CFI-ERF (key informants), who were identified through the survey in phase one.

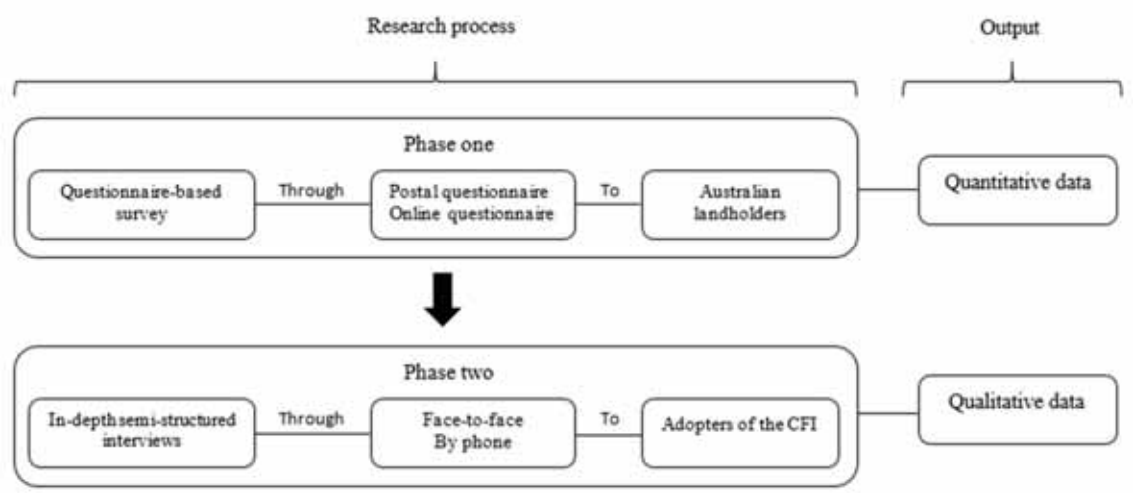

Figure 4.1 Sequential explanatory design

The rationale to employ a sequential explanatory mixed methods design, consistent with the literature, is the need to have a deeper understanding of the factors that influence the adoption of the Carbon Farming Initiative. Such factors may not be explained exclusively by quantitative data, and their corresponding analysis and interpretation. Consequently, a qualitative component for this study was considered as the best option to better explain the results of the quantitative phase.

4.3 METHODOLOGICAL FRAMEWORK

As discussed above, this study employs the Diffusion of Innovations (DOI) theory (Rogers, 1962) as a theoretical lens. Dearing (2009) states that only a few theories have had an impact on diffusion research comparable with Rogers' DOI. Researchers in almost all disciplines have applied and adapted Rogers' theory to fit their research objectives for over 50 years. Agriculture, health, and education are examples of fields where the application of the DOI theory has increased (Dearing, 2009). Although for decades, different approaches have been put forward to explain the adoption of innovations (Karakaya et al., 2014), a need exists to learn about the importance of the factors 'driving the adoption of innovations' and the interactions among them (Karakaya et al., 2014). Guerin (1999) noted that new approaches beyond the traditional diffusion models were necessary to explain innovations' adoption. This study thus includes a newly developed methodological framework (Figure 4.2) that considers the core premises of the DOI and uses (as an example) a model put forward by Macgregor

(2009) to analyse the drivers of adoption of sustainable practices. The framework focuses on the role that (1) demography of landholders, (2) knowledge (about the CFI-ERF), (3) motivation, (4) capacity and (5) barriers (to adopt the CFI-ERF) play in the adoption of the CFI-ERF or similar environmental initiatives. The factors comprising the theoretical framework are the independent variables (IV) of this study. However, the framework does not stress the importance of the time variable (the time elapsed from the inception of an initiative to its adoption) which is a central factor in many diffusion research models. Excluding the time variable facilitates the study of innovations at any point of the diffusion process, enabling to conduct cross-sectional (Payne & Payne, 2004; Shanahan, 2010) rather than longitudinal studies (Payne & Payne, 2004) which are commonplace in innovation diffusion research. The methodological framework besides bringing together some of the (most important) factors that influence the decisions to adopt or innovate -- in this case the adoption and application of the CFI-ERF by Australian landholders -- was designed to accompany the methods, guide the data collection process and the development of survey instruments.

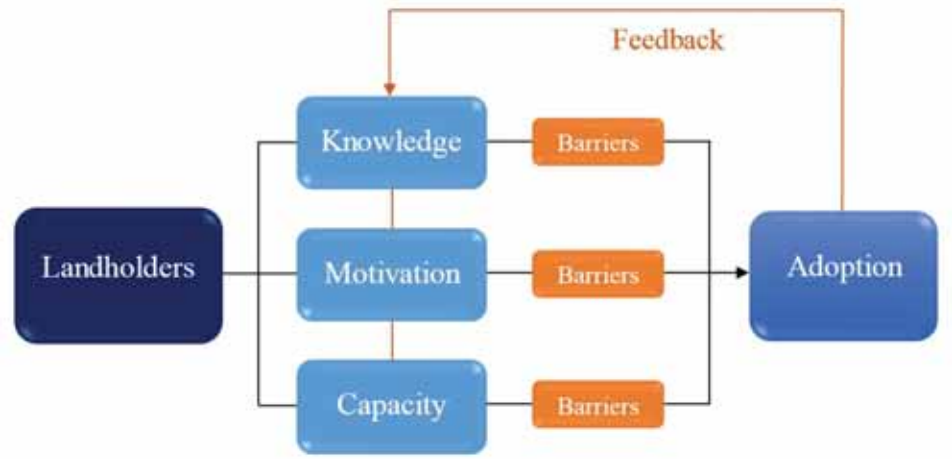

Figure 4.2 Theoretical framework

Adapted from: Macgregor (2009) and (Rogers, 1983).

The purpose of the methodological framework is to provide a practical approach to study the relationship(s) among the landholders' demographic characteristics (*i.e.* age, level of education, etc.) with the knowledge, the motivation, the capacity and the barriers that may affect the adoption of the CFI-ERF, thus preventing landholders to implement any of the

carbon farming activities[2] under the initiative. It is important to point out that this framework mainly facilitates the study of the interactions among the factors influencing the adoption rather than focussing on the time of adoption.

4.4 ETHICAL CONSIDERATIONS

Ethics approval from James Cook University was obtained as required. The Human Research Ethics Committee granted clearance number H5336 for the execution of this study. Following the ethics approval guidelines, informed consent was sought from participants. The completed questionnaire forms have been safely kept as proof of acceptance of the participants. In the case of the interviews, the informants were advised that their participation was being recorded for analysis purposes. Informants granted approval either orally, in the case of phone interviews or through a signed form for face to face interviews. All the audio recordings and data resulting from informants' contribution have been secured in my personal laptop, external hard drive and backed up in the institutional Microsoft One Drive cloud storage service. Annex 1 contains a copy of the Ethics Approval form.

4.5 METHODS

Primary data were acquired from landholders during the first and second phases of the research. During the first phase, a questionnaire-based (QUAL) survey was used (paper based and online), and during the second (QUAL) phase, semi-structured interviews – only to adopters of the CFI-ERF – were conducted. Secondary data was collected throughout the process from the Clean Energy Regulator (CER), Australian Bureau of Statistics, Queensland Government, CSIRO, Wet Tropics Management Authority (WTMA), Terrain NRM, Fitzroy Basin Association (FBA) and other relevant available databases.

4.5.1 Questionnaire-based Surveys –QUAN study (phase one)

The quantitative data collection was carried out during the first phase of the study. A questionnaire was used to collect information from Australian landholders about their level of knowledge about the CFI-ERF and the environmental benefits resulting from the adoption of activities under the policy. The questionnaire also elicits information about the motivation,

[2] There is a range of approved activities under the CFI-ERF policy which have defined methodologies for their implementation. Refer to Chapter Three.

capacity and the barriers to overcome to adopt the CFI-ERF. A copy of the questionnaire can be found in Annex 3.

Based on the literature review, the questionnaire was developed incorporating the main factors driving adoption of other environmental innovations in Australia. The first version of the questionnaire was then distributed through scholars and fellow researchers at James Cook University for review and refinement. An improved version was then made available to various Terrain (Wet Tropics) NRM Ltd officers and carbon farming practitioners to test its efficacy. The final version, including the feedback form NRM officers and carbon farming practitioners, was used for the data collection process.

A printed questionnaire and an online version of the questionnaire (SurveyMonkey online software) were used for the QUAL data collection. The distribution of the questionnaire was carried out using three different approaches:

1) The printed questionnaires were mainly distributed through Australia Post's unaddressed mail service. It is important to point out that this approach was used only for the distribution of the questionnaire in Central and North Queensland. A total of 1650 printed questionnaires were sent through the mail service to different rural postal code areas in Central and North Queensland. Along with the questionnaires, the information/informed consent sheet about the project and a pen were also sent.
2) The online questionnaire was made available for landholders using SurveyMonkey on line software (https://www.surveymonkey.com), and distributed in collaboration of NRM and landcare organizations. Terrain NRM and Fitzroy Basin Association -regional NRMs- collaborated with the distribution of the survey link through their electronic news letters. The National Landcare Network distributed the survey through their mailing list (Table 4.5).

Table 4.5 Organizations collaborating to distribute the online survey

Organization	Diffusion means
Terrain Natural Resource Management Body	Newsletter
Fitzroy Basin Association	Newsletter
National Landcare Network	Newsletter/mailing lists

3) Additionally, the link to the online questionnaire was distributed, via email, using a database of nearly 3,000 landholders nationwide provided by a private enterprise.

These different approaches were used to maximize the possibility of obtaining a representative number of responses from landholders with and without access to the Internet.

4.5.1.1 Sample size

The required sample size was determined using G*Power Version 3.1.9.2 (Faul, Erdfelder, Buchner, & Lang, 2009). An *a priori analysis* procedure was run. "The necessary sample size is computed as a function of user-specified values for the required significance level α, the desired statistical power 1 - β, and the to-be detected population effect size" (Faul, Erdfelder, Buchner, & Lang, 2009, p. 1). A sample size n=183 was needed for an effect size of 30%, with alpha error 0.05 = 5%, and power (sensitivity) 90%. Table 4.6 shows the *G Power software output.

Table 4.6 G*Power software sample size calculation output

χ^2 tests - Goodness-of-fit tests: Contingency tables		
Analysis:	A priori: Compute required sample size	
Input:	Effect size w	= 0.3
	α err prob	= 0.05
	Power (1-β err prob)	= 0.9
	Df	= 5
Output:	Non-centrality parameter λ	= 16.4700000
	Critical χ^2	= 11.0704977
	Total sample size	= 183
	Actual power	= 0.9000108

Source G*Power software by Faul et al. (2009)

The sample size for the statistical analyses collected through the printed an online survey questionnaire was n = 214. The sample size obtained surpassed the 183 cases required according to the G*Power calculations (Table 4.6).

4.5.2 Semi-structured interviews –QUAL study (phase two)

The in-depth semi-structured interview is one of the most popular methods in social research and can be applied to conduct research in many different disciplines. Semi-structured interviews consist of a verbal exchange of ideas where the purpose is to elicit useful information from an interviewee by employing a defined set of questions (Ayres, 2008; Longhurst, 2009). Having questions prepared beforehand enables the interviewer to have control over the research topic (Ayres, 2008). Despite the use of a defined set of questions, in-depth semi-structured interviews employ a flexible conversational approach (Edwards & Holland, 2013), allowing participants to discuss issues they consider important about the research topic (Longhurst, 2009) which could be left out of the original questionnaire.

Consequently, the flexibility that interviewees have to cover other aspects they consider important, related to the research topic at hand, enriches the data resulting from the interviews.

The second (QUAL) phase focused on the collection of qualitative data through in-depth semi-structured interviews targeting only adopters of the CFI-ERF. For this, the data collected through the questionnaires (in the first phase) was used to identify adopters of the CFI-ERF (key informants), who were then invited to participate in face-to-face interviews, whenever possible, and others via telephone. A copy of the interview guide has been provided in Annex 4. The purpose of the interviews was to have an in-depth examination of the research topic and to expand and explain findings resulting from the analysis of the quantitative data.

4.5.3 Data analysis plan

Descriptive and inferential statistical tests were performed to analyse the QUAN survey data using IBM Statistical Package for the Social Sciences (SPSS) version 23.0.0.2 (2015). Firstly, frequencies and percentages were computed for all the variables. Secondly, binomial logistic regression (logistic regression) (Hosmer et al., 2013) was used to test the predictability of the independent variables of the outcome of the dependent variable.

Ordinal variables (and their factors) were treated as continuous variables in the logistic regression tests. Agresti (2013) states that treating categorical variables as continuous is useful for easier interpretation of results, and the effect of a factor is more powerful when having one category rather than various categories. Additionally, ordinal variables treated as continuous retain their ordinal information which is lost when treated as categorical (Agresti, 2013). Specific details are described in Chapter 5.

The QUAL data analysis (phases two), was performed with the assistance of NVivo 11 Version 11.1.0.411 Pro edition (2016). The qualitative analysis from phase two helped explain the results from phase one (Creswell & Plano Clark, 2011; Hesse-Biber, 2010a). Specific details are described in Chapter 6.

4.6 CONCLUSION

The complexity that current research questions present has encouraged the development of new approaches to look for an array of research answers to these questions (Tashakkori & Teddlie, 2009). The study of the adoption of the Carbon Farming initiative requires the

application of both quantitative and qualitative methods to obtain a more complete understanding of the relationships among factors influencing the adoption of the policy, and thus insights into whether the initiative will be adopted by landholders. Therefore, mixed methods research was the approach chosen to conduct this study – using a sequential explanatory research design. The description and the rationale for the use of the approach as well as the methods were discussed throughout this chapter. The next chapter presents the analysis of the quantitative (QUAN) data and the interpretation of the results of the first phase of this study which provides input for the second phase.

Thesis Outline

Chapter 1	Introduction
Chapter 2	The big picture: A context analysis to the Carbon Farming Initiative-Emissions Reduction Fund
Chapter 3	Theoretical framework and overview of the factors that influence the adoption of the Carbon Farming Initiative-Emissions Reduction Fund
Chapter 4	Methods
Chapter 5	**The role of demography, knowledge, motivation capacity and barriers on the adoption of the Carbon Farming Initiative-Emissions Reduction Fund: A quantitative study**
Chapter 6	The role of demography, knowledge, motivation, capacity and barriers on the adoption of the Carbon Farming Initiative- Emissions Reduction Fund: A qualitative study
Chapter 7	Integrating the quantitative and qualitative results: Analysis and discussion
Chapter 8	Conclusion and recommendations for further research

CHAPTER 5: THE ROLE OF DEMOGRAPHY, KNOWLEDGE, MOTIVATION, CAPACITY AND BARRIERS ON THE ADOPTION OF THE CARBON FARMING INITIATIVE: A QUANTITATIVE STUDY

The overall aim of this study was to document and evaluate the role of demography, knowledge, motivation and capacity of Australian landholders, as well as the barriers they have to overtake in their decisions to adopt the Carbon Farming Initiative (CFI-ERF). The research question formulated for the quantitative (QUAN) study was: do demography, knowledge, motivation, capacity and barriers predict the adoption of the CFI-ERF?

The results revealed that knowledge, motivation and capacity were significant predictors for adoption of the CFI-ERF by landholders. Unexpectedly, knowledge was associated with a reduction of the likelihood of adoption of the CFI-ERF. Motivation, by contrast, was associated with an increased likelihood of adoption of the CFI-ERF. However, one of the internal motivation indicators, governmental regulations, was associated with a decreased likelihood of adoption. On the other hand, demography and barriers play a less important role on landholders' decisions to adopt the CFI-ERF. Nevertheless, some internal indicators of demography, and barriers also showed a significant influence on the uptake of the CFI-ERF.

This chapter contains two main sections. The first section revisits the research questions, hypotheses and variables of the study and includes a brief description of the data collection and statistical methods. The second section presents the results of the descriptive and inferential statistical analyses of the questionnaire survey of landholders.

5.1 RESEARCH QUESTIONS AND VARIABLES OF THE STUDY

5.1.1 Research question, dependent and independent variables

The primary research question was "do demography, knowledge, motivation and capacity of Australian landholders as well as barriers predict the adoption of the Carbon Farming Initiative?" To answer this research question, one dependent variable and five independent variables were employed. *Adoption of the CFI-ERF* was the dependent variable (DV) for this study is. The DV was dichotomous. Therefore, the DV had only two possible outcomes. The DV outcomes were ADOPT or NOT ADOPT -the CFI-ERF.

The study included five independent variables (IVs). Each of the IVs included various internal indicators. As shown in Table 5.1, all IVs were composed of various internal indicators. Most of the IV's internal indictors were based on categorical ordinal data. However, the demography variable contained both ordinal and dichotomous indicators.

Table 5.1 Independent variables and indicators

Variable	Indicators	Type
Demography	Gender *	Dichotomous
	Age	Ordinal
	Level of education	Ordinal
	Occupation	Dichotomous
Knowledge	Familiarity with the CFI-ERF Familiarity with the benefits of the CFI-ERF for landholders Familiarity with the environmental benefits of the CFI-ERF Information about the CFI-ERF received	Ordinal
Motivation	Economic benefits Environmental health Availability of technical support Legal regulations Friends and family advice Care for the community Moral responsibility	Ordinal
Capacity	Financial resources Human resources Technical resources	Ordinal
Barriers	Not enough economic revenues Not enough information No training Not enough governmental incentives Shortage of financial resources Not enough knowledge Not enough technical support Complex bureaucratic process Policy uncertainty	Ordinal

* Gender had three categories. However, for inference statistics tests that included gender as an independent variable, gender was treated as a dichotomous variable; only cases that had values for male and female options were included, thus excluding those cases were gender was not stated.

5.2 DATA COLLECTION AND STATISTICAL METHODS

5.2.1 Data collection

A survey questionnaire was used to collect quantitative (QUAN) data over a 14-month period, from February 2014 to March 2015. The questionnaire targeted Australian landholders and included postal and online versions. The rationale of using postal and online

versions of the questionnaire was the need to increase the number of valid responses, considering the specificity and the geographical dispersion of the target population, and the costs associated to the data collection process (e.g., visiting landholders in rural areas increases costs greatly).

The questionnaire was developed based on the literature review that examined factors driving adoption of environmental innovations in Australia, such as the Carbon Farming Initiative presented in Chapter 4. The first version of the questionnaire was then distributed through scholars and fellow researchers at James Cook University. An improved version was then made available to various Terrain NRM officers and carbon farming practitioners to test its efficacy. Terrain NRM is the regional NRM body for the Wet Tropics bioregion of northeast Australia. The final version including the feedback form NRM officers and carbon farming practitioners was used for the data collection process. Two forms of the questionnaire survey were distributed to landholders in various regions.

Firstly, Australia Post's *unaddressed mail service* was used to distribute 1120 printed questionnaires to different rural postal code areas in Central and North Queensland. Sixty-four responses were received through this method corresponding to a 5.7% response rate: 51 valid responses (4.5%) and 13 invalids (1.2%).

Secondly, the questionnaire was made available to landholders Australia wide employing *SurveyMonkey* online software (https://www.surveymonkey.com). Natural resources management agencies (NRMs) and landcare organizations (e.g. Terrain NRM, Fitzroy Basin Association, National Landcare Network, etc.) assisted with the distribution of the link to the online questionnaire through electronic newsletters. Additionally, the link to the online questionnaire was emailed using a database of 3,000 landholders nationwide provided by a private enterprise. One-hundred-eighty-seven responses were received through this method and 163 were included in the statistical tests. Given the use of different methods to distribute the link to the online survey, and particularly the use land care organization of newsletters, it is unknown how many landholders the survey reached. Consequently, it is not possible to determine the response rate of the online survey.

In both cases -postal and online surveys- questionnaires which had 30 percent or over of unanswered questions were not included. Similarly, survey questionnaires which had unanswered the question about adopting or not the CFI-ERF (dependent variable) were also excluded.

5.2.2 Statistical methods

Descriptive and inferential statistical tests were performed to analyse the survey data using the Statistical Package for the Social Sciences (SPSS) version 23.0.0.2. Firstly, frequencies and percentages were computed for all the variables. Secondly, binary logistic regression (logistic regression) (Hosmer et al., 2013) was used to assess whether the independent variables would predict the outcome of the dependent variable. In other words, logistic regression was employed to evaluate which of the independent variables: demography, knowledge, motivation, capacity and barriers would predict adoption of the CFI-ERF.

Ordinal variables (and their indicators) were treated as continuous variables in the logistic regression tests. Agresti (2013) states that treating categorical variables as continuous is useful for easier interpretation of results, and the effect of a factor is more powerful when having one category rather than various categories. Additionally, ordinal variables treated as continuous retain their ordinal information which is lost when treated as categorical (Agresti, 2013).

5.3 SURVEY RESULTS

5.3.1 Profile of participants

Demographic information pertaining to *gender, age, level of education* and *occupation* (engaged in farming/agriculture or other occupation) of 214 participants was collected through the questionnaire survey. These demographic indicators were used later as independent variables in the inferential statistics analyses. Australian farmers' demographic data is also presented when available as a base line of landholders in Australia. The data has been accessed from the Australian Bureau of Statistics [ABS] (2017).

5.3.1.1 Gender

Figure 5.1 shows the responses to the questionnaire for the gender item. Out of 214 participants, 141 (65.89%) were male, 61 (28.50%) female, while (12) 5.61% preferred not to state their gender. The proportion of male and female farmers in Australia is: male 78% and female 22% (ABS, 2017).

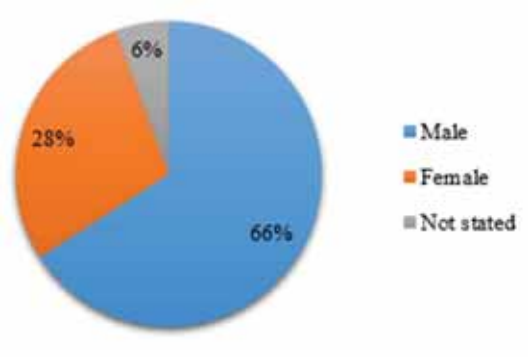

Figure 5.1 Gender of respondents

n= 214 respondents

5.3.1.2 Age

Five age categories were used in the questionnaire (Figure 5.2). Nearly half of the respondents (46.73%) were in the 46-60 age category, while the 18-30 age category recorded only 2.34% of participants. According to the ABS (2017) the average age of Australian farmers is 56 years (ABS, 2017).

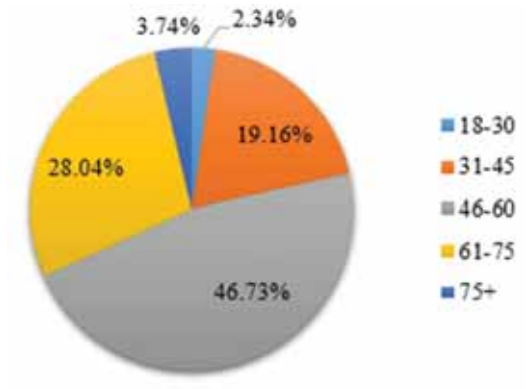

Figure 5.2 Age of respondents

n= 214 respondents

5.3.1.3 Level of education

All respondents had attained some level of formal education (Figure 5.3). Out of 214 respondents, 41.12% (88) had achieved undergraduate degrees, while 1.86% (4) had finished only primary school.

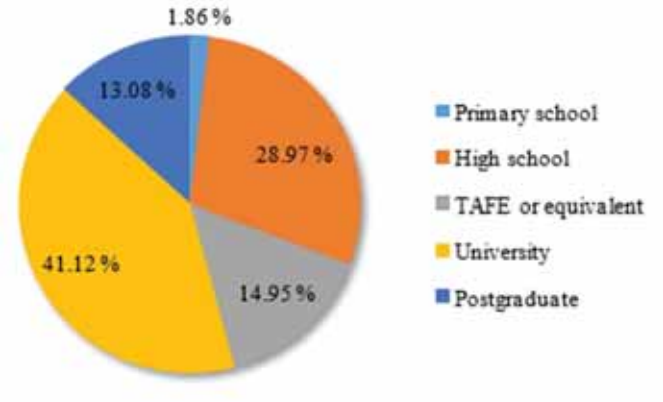

Figure 5.3 Respondents' level of education

n= 214 respondents

5.3.1.4 Occupation

Occupation was also considered as an important demographic variable. Respondents were asked whether they were engaged in farming/agricultural activities. As shown in Figure 5.4, of 214, 72% (154) had farming or agriculture as a job and 28% (60) had other off-farm occupations not reported in this study. Eighty four percent of the income of agricultural producers in 2015-16 was from agricultural production (ABS, 2017). This suggests that the majority of farmers (primarily) have farming and agriculture as their occupation.

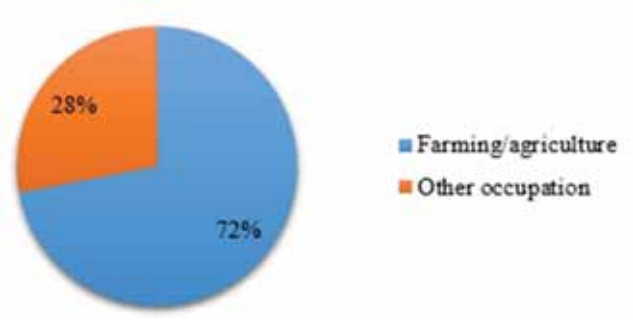

Figure 5.4 Respondents occupation

n= 214 respondents

5.3.2 Location, land use, size of property and land tenure

In addition to landholders' demographics, the survey questionnaire included items to collect information about respondents' location, land use, property size and the type of tenure that respondents had over the properties.

5.3.2.1 Location of respondents

As shown in Figure 5.5, out of 214 cases, Queensland registered the highest proportion of responses (35%). New South Wales and Western Australia both had the same proportion with 11%, while Tasmania recorded the lowest proportion with 2%.

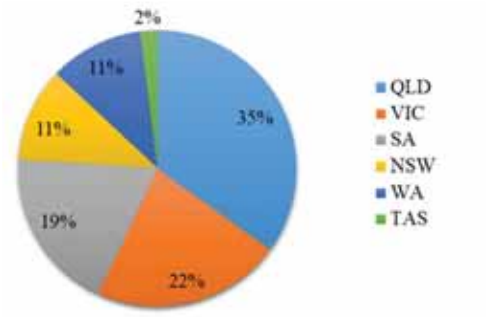

Figure 5.5 Location of respondent by state or territory

n= 214 respondents

Note: No responses were recorded from Australian Capital Territory and Northern Territory

5.3.2.2 Land use

Fourteen primary land use activities were included in the questionnaire. Land use activities were later grouped into five categories including the *other land uses* option. As shown in Figure 5.6, of 214 properties, livestock and dairy was the dominant land use with 57% while the least was forestry with 6%. A table including all the land use activities can be found in Annex 7.

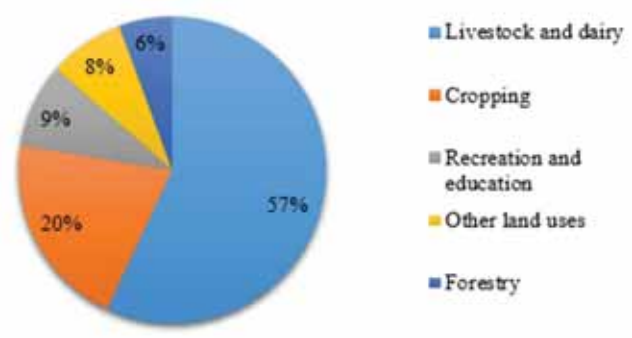

Figure 5.6 Primary land use

n= 214 properties

5.3.2.3 Size of property

There was a broad range of property sizes. The smallest property was 1 hectare and the largest was over 400,310 hectares. The mean was 6,247 and the median 400.3 hectares, respectively. To have an informative representation of property size, five arbitrary categories (a series based on powers of ten) were created as plotted in Figure 5.7. Most cases, 67 (31.3%), fell into the 1,001-10,000-hectare category, 15 cases (7%) fell into the 1,001-10,000-hectare category, while 3 (1.4%) of the properties had over 100,000 hectares. According to the ABS (2017) the average farm in Australia is 4,331 ha.

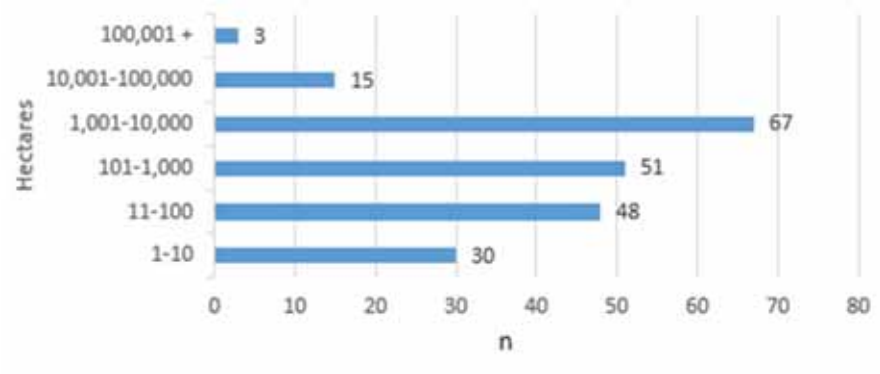

Figure 5.7 Size of property

n=214 properties

5.3.2.4 Land tenure

The results revealed that most properties were under freehold tenure. Out of 214 properties, 193 (90.2%) were freehold and 19 (8. 9%) were lease hold respectively (Figure 5.8).

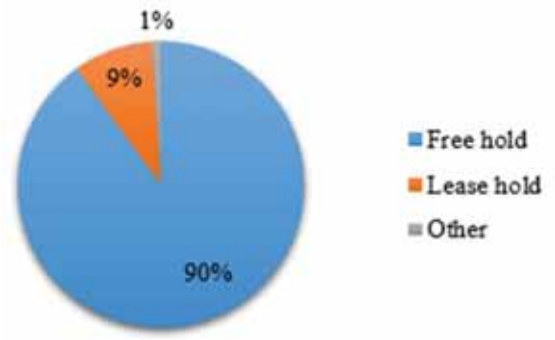

Figure 5.8 Land tenure

n=214 properties

5.3.3 Sources of information

The questionnaire survey included a multiple-choice item about sources through which participants received information about the CFI-ERF. The results show that *newspaper* with 54 (16.4%) was the highest source. Interestingly, the second highest source with 41 (12.5%) responses, was *I have not received any information*; while *Formal education* and *governmental letters* were the least scored sources with 6 (1.82%) and 5 (1.52%) responses, respectively. Table 5.2 contains a summary of the survey results.

Table 5.2 Sources of information about the CFI-ERF

	n	%
Governmental letters	5	1.52
Formal education	6	1.83
Family and friends	8	2.44
Working environment	11	3.35
Other sources	11	3.35
Television	12	3.66
Farm field days	16	4.88
Local community organizations	17	5.18
Handouts	19	5.79
Workshops/seminars	24	7.32
Natural resources management body (NRM)	28	8.54
Internet	38	11.59
Land care organizations	38	11.59
Newspaper	54	16.46
Subtotal	**287**	**87.50**
*I have not received any information	41	12.50
Total	**328**	**100.00**

Note: Source of information was a multiple-choice item allowing to choose more than one option. Results based on 214 responses.

*The item about sources of information also included the option *I have not received any information at all* as indicated in the table.

5.4 DESCRIPTIVE STATISTICS FOR ADOPTION OF THE CFI-ERF (DEPENDENT VARIABLE)

The dependent variable, adoption of the CFI-ERF (would you adopt the CFI-ERF), had only two possible outcomes: Yes or No. As shown in Figure 5.9, nearly three out of four survey respondents selected the positive option (n=159) compared to the negative alternative (n=55) choice.

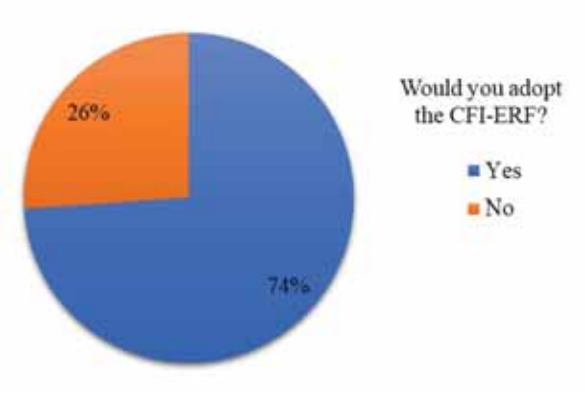

Figure 5.9 Descriptive statistics of the dependent variable adoption of the CFI-ERF

n=214 respondents

5.5 DESCRIPTIVE STATISTICS OF KNOWLEDGE, MOTIVATION, CAPACITY AND BARRIERS REGARDING THE ADOPTION OF THE CFI-ERF (INDEPENDENT VARIABLES)

This section presents the summary statistics of the internal indicators of the independent variables (IV) *knowledge, motivation, capacity* and *barriers* regarding the CFI-ERF.

All the internal indicators across all the IVs had a sample size of 214 cases. The only exception was the *policy uncertainty* indicator of the *barriers* IV which had 170 cases. The descriptive statistics of the IV *demography* and its internal indicators, i.e. *age, gender, level of education* and *occupation* were presented in Section 5.3.1 (Profile of participants).

5.5.1 Knowledge

Knowledge of the CFI-ERF was assessed using four indicators: three indicators based on the concept of familiarity and one factor on information received. Thus, the indicators *familiar with the CFI-ERF rules, familiar with CFI-ERF benefits for landholders* and *familiar with environmental benefits of the CFI-ERF* were measured by level of familiarity. Survey respondents ranked the knowledge indicators using a five-point scale from *not familiar at all* to *extremely familiar*, and for *Information received about the CFI-ERF* from *none* to *very*

much. The factor about information on the CFI-ERF was included on the premise that exposure to information is an important aspect to attain some level knowledge on the target innovation (Pannell et al., 2006; Rogers, 1983). Figure 5.10 shows the questionnaire results for *knowledge* indicators.

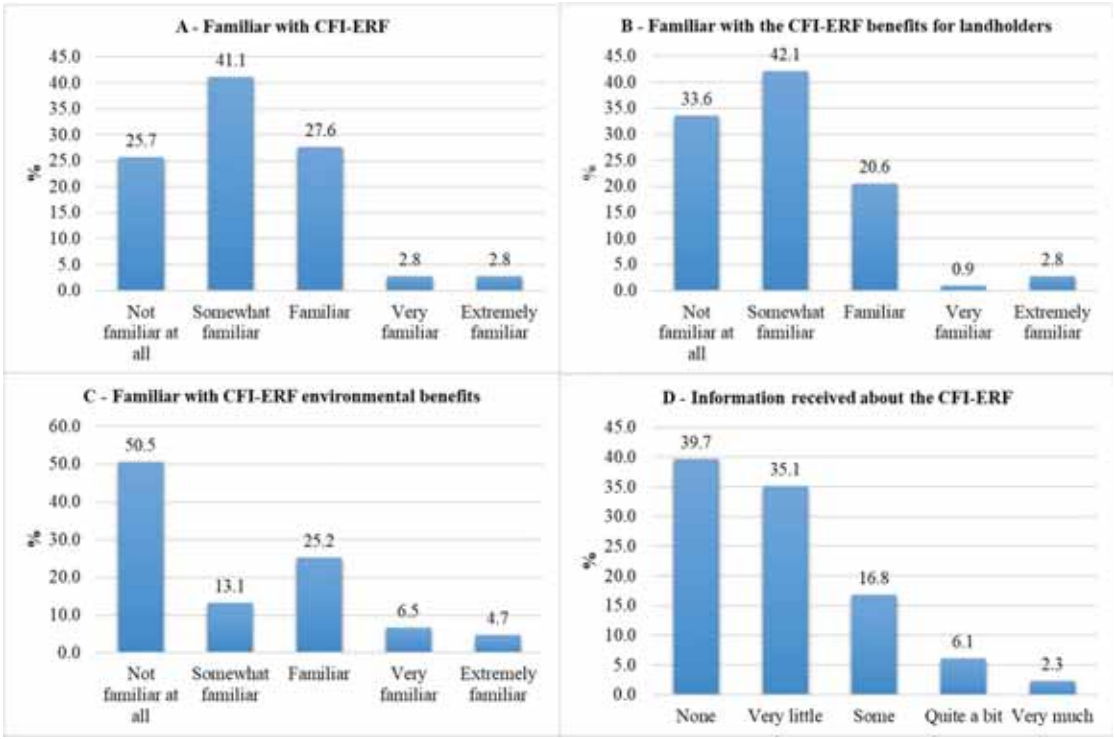

Figure 5.10 Internal indicators of *knowledge* independent variable

n=214 respondents for all the indicators

The descriptive statistics for *knowledge* indicators revealed that the survey participants had low levels of familiarity with the different aspects of the CFI-ERF. These low levels of familiarity are consistent with the lack or little information they had received about the initiative. Hence, landholders considered themselves to be rather *unfamiliar with the CFI-ERF* (Figure 5.10-A) and its *benefits for landholders* (Figure 5.10-B). Interestingly, half of the participants thought they were *not familiar at all* with the *CFI-ERF benefits for the environment* (Figure 5.10-C). And three of four participants *had not received any* or *very little information about the CFI-ERF* (Figure 5.10-D).

5.5.2 Motivation

The *motivation* variable contained seven indicators; motivations to adopting environmental innovations such as the CFI-ERF. The survey respondents ranked the *motivation* indicators

from *not important at all* to *extremely important*. Figure 5.11 depicts a summary of the survey results for *motivation* indicators.

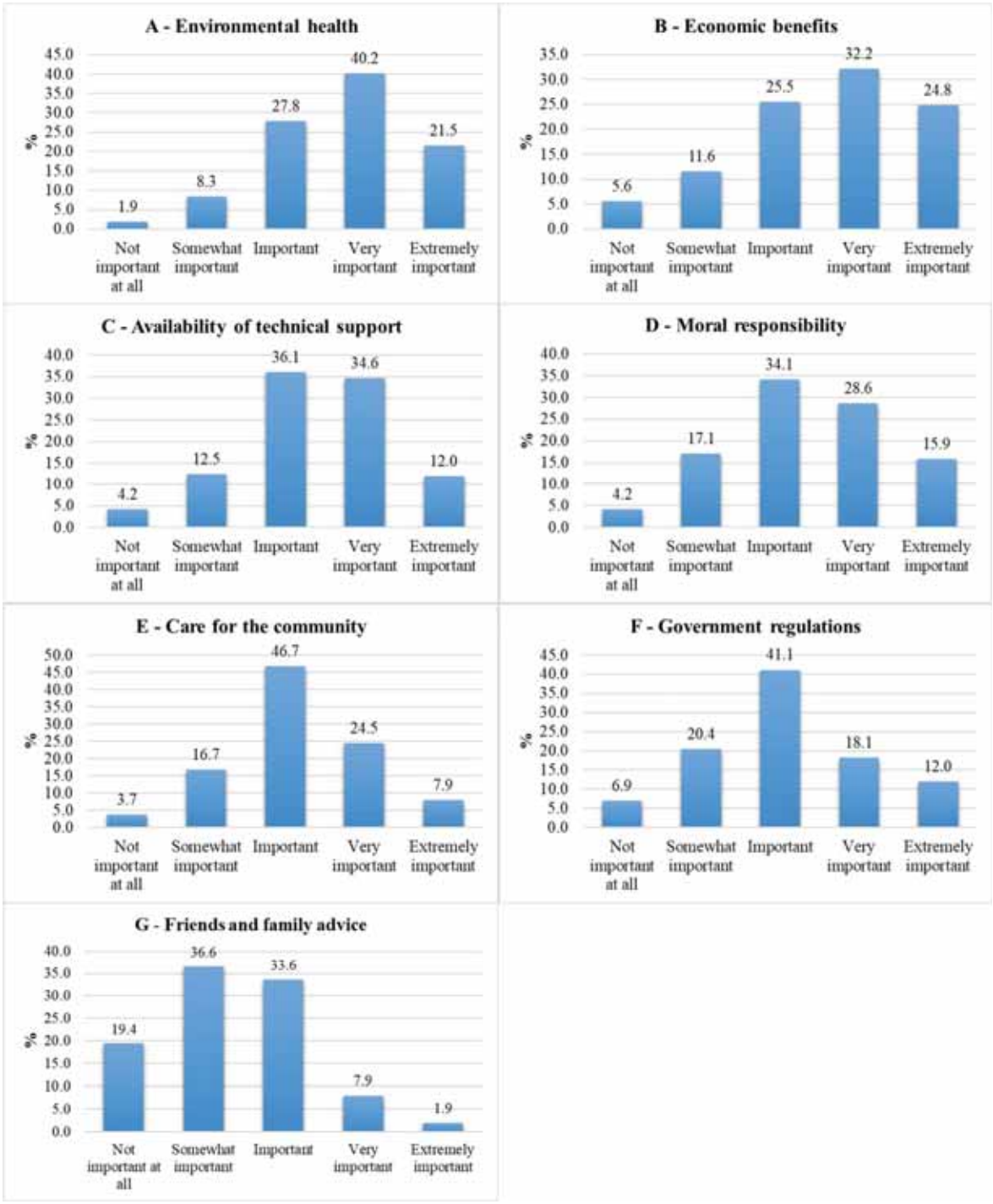

Figure 5.11 Internal indicators of *motivation*

n= 214 respondents

In general, the survey participants considered most of the indicators proposed in the questionnaire to be *important* or *very important* adoption motivations. *Environmental health* and *economic benefits* were the highest ranked by level of importance followed by *availability of technical support* and *moral responsibility*. Around six of ten respondents thought that e*nvironmental health* and *economic benefits* were *very* or *extremely important* motivations to adopt innovations such as the CFI-ERF. On the other hand, only one in ten participants considered *friends or family advice* as a *very* or *extremely important* motivation to participate in schemes such as the CFI-ERF.

5.5.3 Capacity

The *capacity* variable had three indicators measured by level of agreement. Participants were asked to rank their agreement on whether they had the resources to adopt the CFI-ERF using a five-point scale from *strongly disagree* to *strongly agree*. Figure 5.12 shows a summary of the questionnaire results for *capacity* indicators.

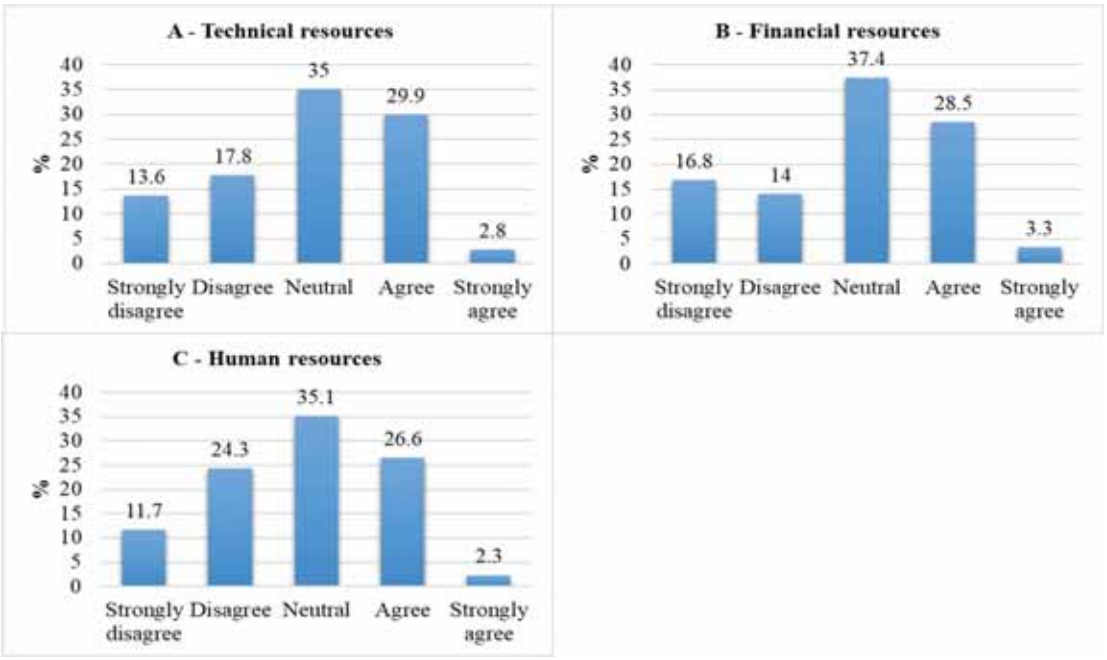

Figure 5.12 Capacity indicators descriptive statistics

n=214 respondents

In general, the results for all the capacity indicators were similar. The neutral option of agreement was the highest ranked; around 35% of participants had a neutral opinion about having the necessary resources to undertake CFI-ERF activities. However, nearly three in 10

respondents agreed to the statement of having the financial (28.5%), technical (29.9%) and human resources (26.6%) enabling them to adopt the CFI-ERF.

5.5.4 Barriers

The *barriers* variable had nine indicators assessed by level of importance. The survey respondents ranked barriers from *not important at all* to *extremely important*. The sample size was 214 cases for all the indicators, except for policy uncertainty which had 170 cases. Figure 5.13 shows a summary of the questionnaire results for the *barriers* indicators.

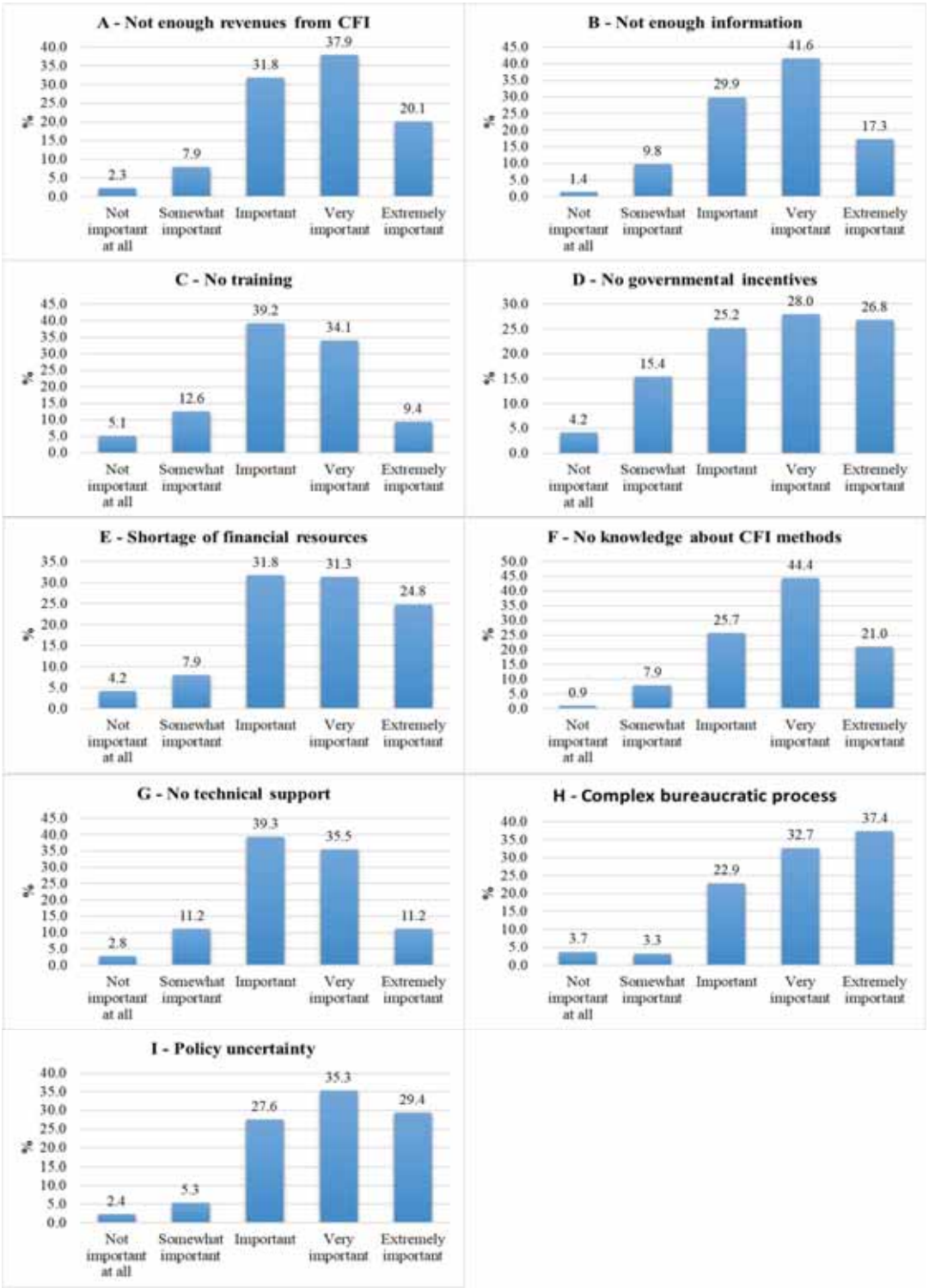

Figure 5.13 Barriers indicators descriptive statistics

n= 214 respondents, except I: policy uncertainty, where n= 170 respondents

Most of the barriers indicators were rated as either important or very important barriers to adopting the CFI-ERF. For example, around seven in ten participants considered *complex*

bureaucratic process to be either a *very important* or *extremely important* barrier to adopt the CFI-ERF. Similarly, the results show that six of ten participants thought that *policy uncertainty, no knowledge about CFI methods,* not *enough revenues from CFI* and *not enough information* were *very important* or *extremely important* barriers to adopt the initiative.

5.6 INFERENTIAL STATISTICS

This section presents the results of the binary logistic regressions applied to the data collected through a postal and online survey. The survey collected, besides the demographic information, information about *knowledge, motivation, capacity* and *barriers.* It is necessary to point out that the information on the factors is based on landholder's self-assessment scale. Thus, the information particularly about (level of) *knowledge* and *capacity*, may be misleading. Most of the time, individuals' perceptions of their knowledge about a subject differs with the reality. The same thing occurs in the case of *capacity, motivation* and *barriers*. Consequently, the results of the inferential statistics should be considered as indicative of a positive or negative relationship rather than an absolute evidence of influence on adoption.

Given the dichotomous nature of the dependent variable (DV) *Adoption of the CFI-ERF,* binary logistic regression (logistic regression) – one of the key tests for analysing categorical data (Agresti, 2013) – was selected to assess whether the independent variables (IV) predicted the outcome of the DV.

The independent variables (IV): *Knowledge*, *Motivation Capacity* and *Barriers* included various internal indicators which were measured using 5-point Likert scales (Likert, 1932). Reliability of the scales was assessed using Cronbach's alpha (Cronbach, 1951): Knowledge consisted of 4 items ($\alpha = .90$), motivation had 7 items ($\alpha = .74$), capacity had 3 items ($\alpha = .75$) and barriers 9 items ($\alpha = .83$). According to Nunnally and Bernstein (1994), scales having Cronbach's alpha coefficients greater than 0.7 can be considered acceptable. These results support the adequacy of the scales used to assess the IVs.

5.6.1 Binary logistic regression results

The inferential data analysis was conducted using binary logistic regression. The logistic regressions tests were carried out in two consecutive steps. During the first step, five independent logistic regressions were performed to assess whether the internal indicators of

demography, knowledge, motivation, capacity and *barriers* would predict adoption of the CFI-ERF. In the second step, a logistic regression was performed including all the composite IVs. Thus, before running the logistic regression test, composite variables of *knowledge, motivation, capacity* and *barriers* were computed using the mean scores approach. In both cases (for all the test), the independent variable was coded so that: *1 = adopt* and *0 = not adopt*.

5.6.2 First step: Assessing the internal indicators of demography, knowledge, motivation capacity and barriers (DKMCB).

During the first step, five independent logistic regression tests were performed. These tests assessed which of the indicators within the IVs predicted adoption of the CFI-ERF. The purpose of these test was to gain some understanding about which of the aspects (represented by the indicators) of the IVs would influence the decision of adopting the CFI-ERF. The logistic regression tests results are presented below.

5.6.2.1 Logistic regression for demography indicators

A binary logistic regression test was performed to determine the effects of demography indicators on the likelihood of adoption of the CFI-ERF. The model (Figure 5.14) included four indicators: *occupation* (dichotomous coded: 1 = farming/agriculture as occupation, 0 = other occupation) *and gender* (dichotomous coded: 1 = male, 0 = female), and *level of education and age* (ordinal with five levels).

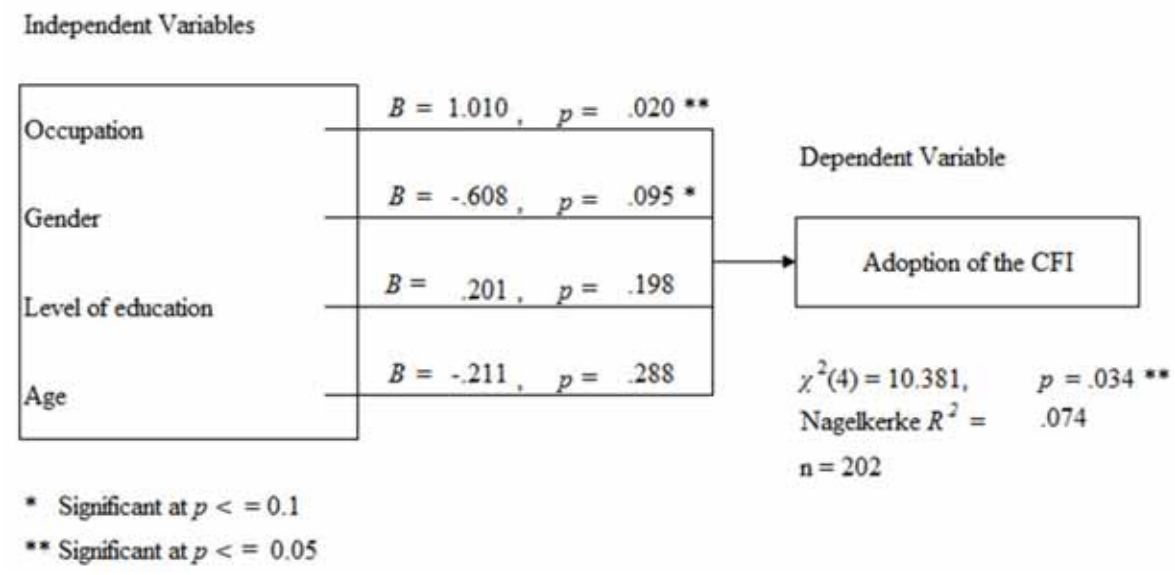

Figure 5.14 Logistic regression model for demography indicators

As shown in Figure 5.14, the logistic regression model was statistically significant, $\chi^2(4) = 10.381$, $p = .034$. The model explained 7.4% (Nagelkerke R^2) of the variance in adoption of the CFI-ERF and correctly classified 73.3% of cases. Of the four predictors assessed, two were statistically significant: *gender* and *occupation*. *Gender* indicator assessment showed that male landholders were 0.5 times less likely to adopt the CFI-ERF than females. Landholders engaged in farming/agricultural activities were 2.75 times more likely to adopt the CFI-ERF. Tables containing the complete output of the binary logistic regression test can be found in Annex 5.

5.6.2.2 Logistic regression for knowledge indicators

A binary logistic regression was performed to determine the effects of knowledge indicators: *familiar with CFI-ERF, familiar with CFI-ERF benefits for land holders, familiar with environmental benefits of the CFI-ERF* and *information about CFI-ERF* on the likelihood of adoption of the CFI-ERF. All the indicators were five-point ordinal variables. The logistic regression model shown in Figure 5.15, was statistically non-significant, $\chi^2(4) = 4.502$, $p = .342$. None of the independent variables were significant predictors. The results of the binary logistic regression suggest that when assessed individually, the knowledge indicators cannot significantly predict adoption of the CFI-ERF by landholders.

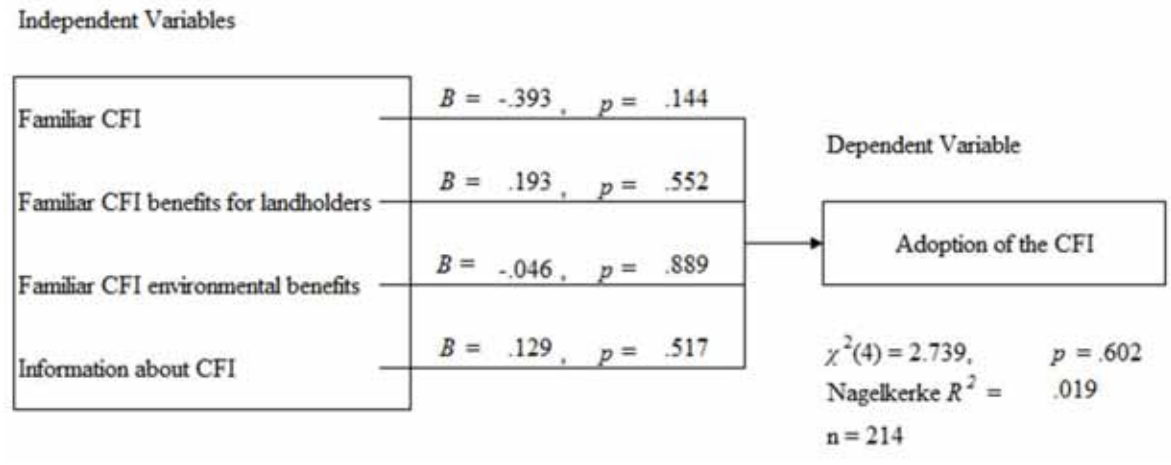

Figure 5.15 Logistic regression model for knowledge indicators

5.6.2.3 Logistic regression for motivation indicators

A logistic regression was performed to determine the effects of motivation indicators: *economic benefits (return), environmental health, availability of technical support, government regulations, friends and family advice, care for the community* and *moral*

responsibility on the likelihood of adoption of the CFI-ERF by participants. All the indicators were five-point ordinal variables.

The logistic regression model (Figure 5.16) was statistically significant, $\chi^2(7) = 38.6$, $p < .001$. The model explained 25.3% (Nagelkerke R^2) of the variance in adoption of the CFI-ERF and correctly classified 75.6% of cases.

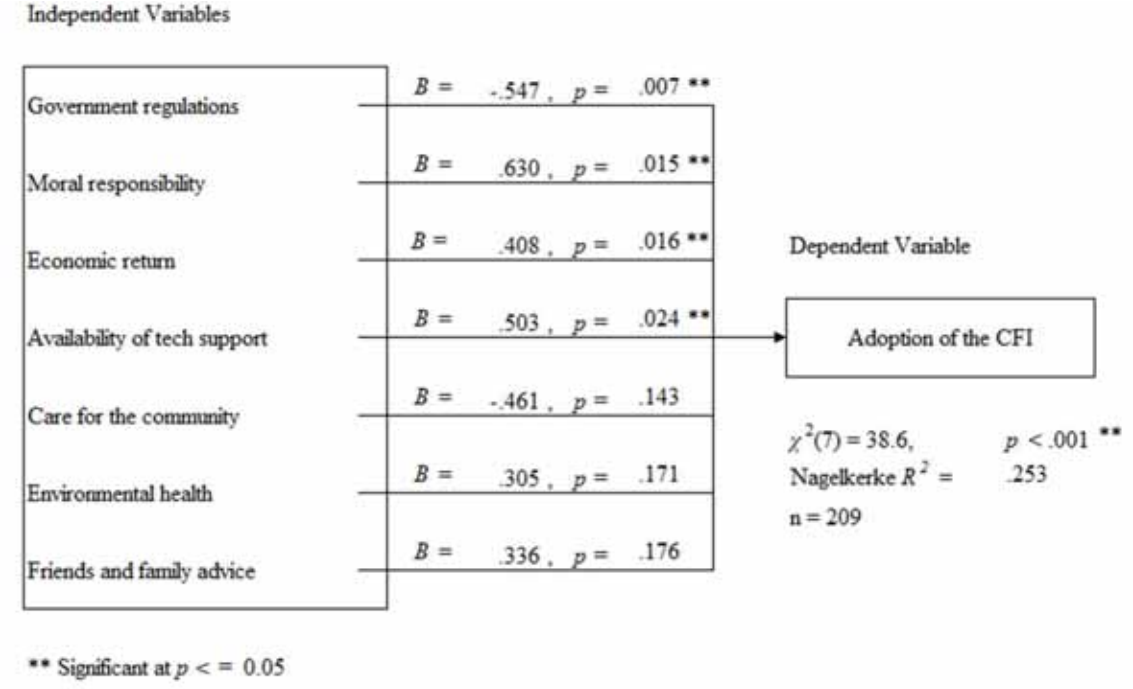

Figure 5.16 Logistic regression model for motivation indicators

As shown in Figure 5.16, of the seven predictors, four were statistically significant: *government regulations, economic benefits (return), availability of technical support, moral responsibility*. The results show that *increasing governmental regulations* was associated with a reduction in the likelihood of *adoption of the CFI-ERF*. The latter result suggest that landholders do not respond positively when innovations are imposed on them through regulations. Conversely, increasing of *economic benefits, availability of technical support* and *moral responsibility* were associated with an increased likelihood of *adoption of the CFI-ERF*.

5.6.2.4 Logistic regression for capacity indicators

A binary logistic regression was performed to determine the effects of *financial resources, human resources* and *technical resources* on the likelihood of adoption of the CFI-ERF. All the indicators were five-point ordinal variables.

The logistic regression model (Figure 5.17) was significant, $\chi^2(3) = 7.172$, $p = .067$. The model explained 4.9% (Nagelkerke R^2) of the variance in adoption of the CFI-ERF and correctly classified 75.6% of cases.

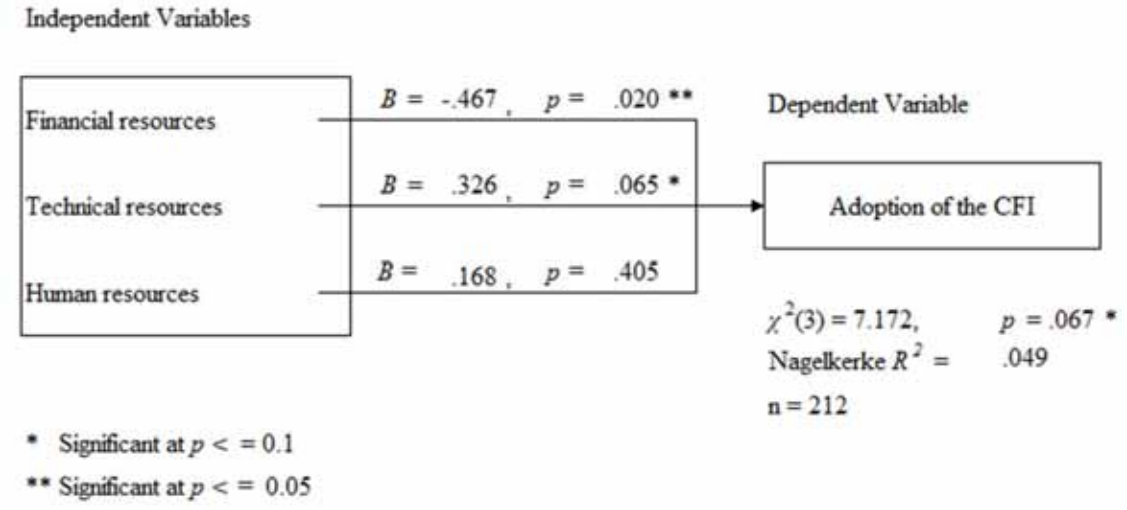

Figure 5.17 Logistic regression for capacity indicators

As shown in Figure 5.17, *financial resources* was significant $p = .020$ and *technical resources* $p = .065$. Increasing of financial resources was associated with a reduction in the likelihood of adoption of the CFI-ERF, which suggests that the better economical/financial situation landholders have, the less likely they are to adopt the CFI-ERF. Conversely an increasing of *technical resources* was associated with an increased likelihood of adoption of the CFI-ERF.

5.6.2.5 Logistic regression for barriers indicators

A logistic regression was performed to determine the effects of *not enough revenue, not enough information, not enough training opportunities on CFI-ERF, not enough governmental incentives, shortage of financial resources, not enough knowledge about CFI-ERF methodologies, not enough technical support* and *complex bureaucratic process* on the likelihood of adoption of the CFI-ERF by participants. The logistic regression model (Figure 5.18) was statistically significant, $\chi^2(8) = 19.9$, p = .011. The model explained 13.3% (Nagelkerke R^2) of the variance in adoption of the CFI-ERF and correctly classified 74.5% of cases.

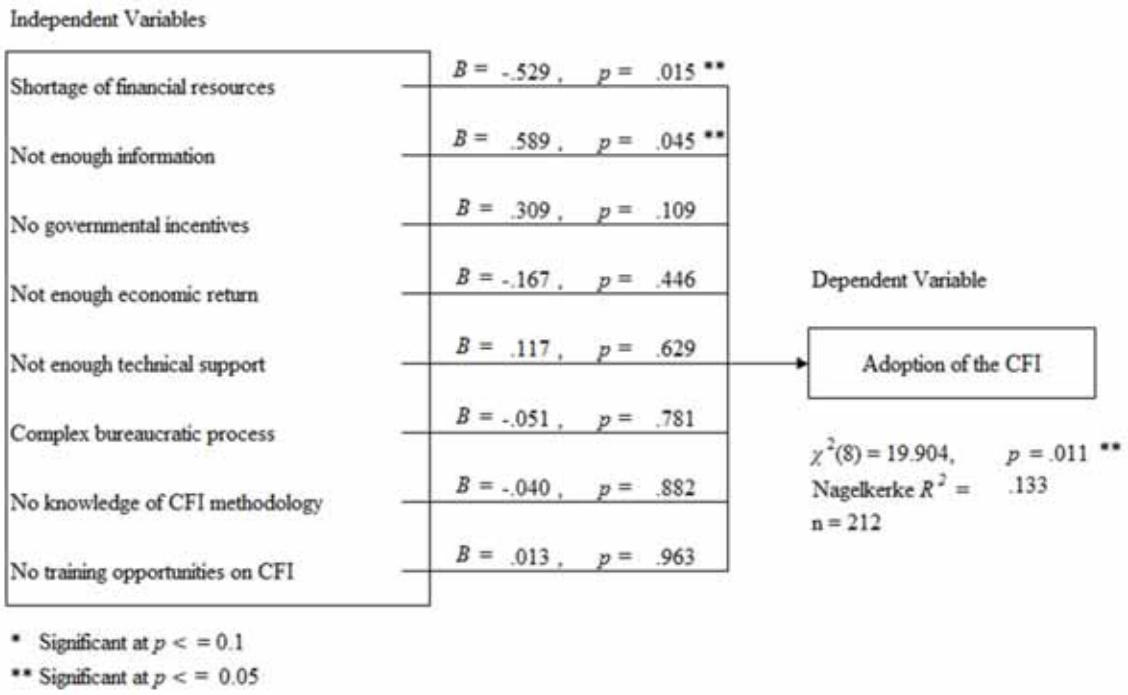

Figure 5.18 Logistic regression model for barriers factors

As shown in Figure 5.18, of the eight barriers predictors, two were statistically significant: *shortage of financial resources* and *not enough information*. Increasing of *shortage of financial resources* was associated with a reduction of the likelihood of *adoption of the CFI-ERF*, which indicates that landholders who had less economical/financial resources were more likely to adopt the CFI-ERF. Increasing of *not enough information* was associated with an increased likelihood of *adoption of the CFI-ERF*. In other words, this result suggests that the more information landholders received, the less likely they were to adopt the CFI-ERF.

5.6.3 Predicting adoption of the CFI-ERF

The final logistic regression test included all the IVs. Prior to running the logistic regression, a multicollinearity[19] linear regression test was performed to discard high levels of correlation among the independent variables: *knowledge, motivation, capacity* and *barriers, age* and *level of education*. High correlation among predictor variables (independent variables) can affect the results of regression tests (Tamura et al., 2017; Craney, 2007; Chong and Jun, 2005). *Gender* and *occupation* - dichotomous variables - were not included in the test. Typically, *variance inflation factor* (VIF) coefficients greater 5 or 10 are considered problematic (Craney, 2007). No multicollinearity issues were detected. Table 5.3 shows the results of the multicollinearity test.

Table 5.3 Independent variables multicollinearity test

Independent variables	VIF
Age	1.032
Level of education	1.026
Knowledge	1.115
Motivation	1.351
Capacity	1.071
Barriers	1.358

Note: Gender and occupation -dichotomous variables- were excluded from the test

The IVs *knowledge, motivation, capacity* and *barriers* were composite scores of their respective internal factors. In the case of demography, all the indicators were included in the model as independent variables (no composite variable was computed for demography indicators). The results of the logistic regression are shown below.

A logistic regression was performed to determine the effects of *gender, age, level of education, occupation, knowledge, motivation, capacity* and *barriers* on the likelihood of adoption of the CFI-ERF. The logistic regression model (Figure 5.19) was statistically

[19] Multicollinearity is present when two or more independent variables are highly correlated. Multicollinearity makes difficult to assess the relationship between independent and dependent variables, thus negatively impacting on the reliability of regression analyses (Tamura et al., 2017; Craney, 2007; Chong & Jun, 2005).

significant, $\chi^2(8) = 24.437$, $p = .002$. The model explained 16.7% (Nagelkerke R^2) of the variance in adoption of the CFI-ERF and correctly classified 72.1% of cases.

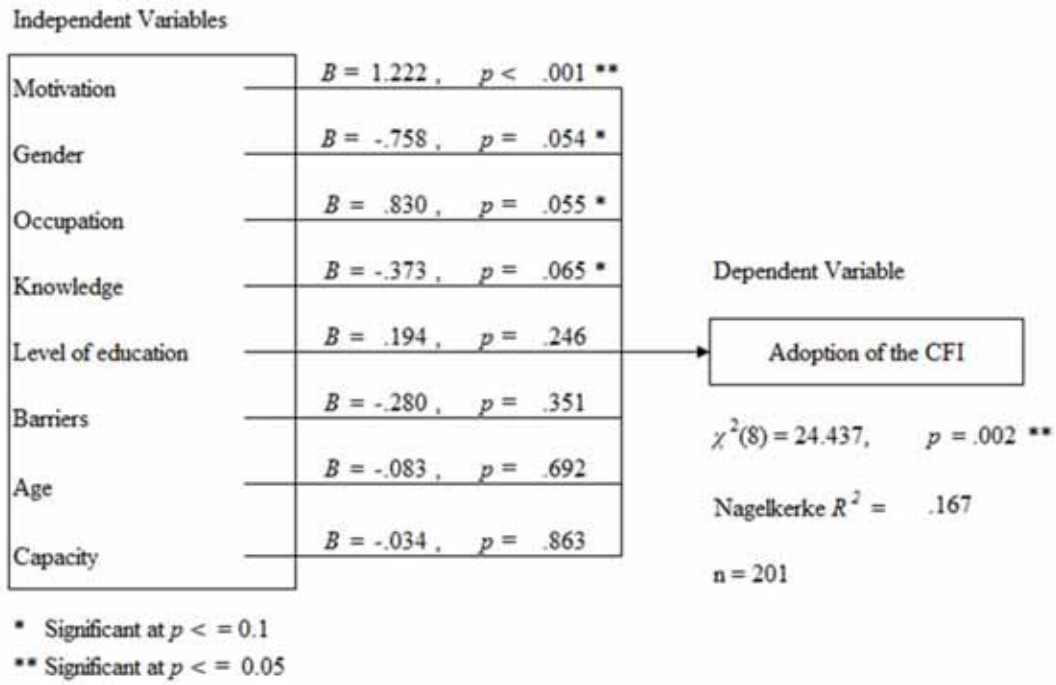

Figure 5.19 Main model: all the independent variables included

As shown in Figure 5.19, of the eight predictors, four were statistically significant: *Gender, occupation, knowledge* and *motivation*. Male landholders were 0.22 times less likely to adopt the CFI-ERF. Landholders engaged in farming/agriculture as occupation were 2.3 times more likely to adopt the CFI-ERF. Increasing motivation was associated with an increase in the likelihood of adoption of the CFI-ERF. Conversely, increasing knowledge was associated with a reduction of the likelihood of adoption of the CFI-ERF.

5.7 SUMMARY AND CONCLUSIONS

5.7.1 Summary and discussion

Descriptive statistics (n = 214)

The results show that 66% of respondents were male, 29% were female and 5% preferred not to state their gender. Almost half (48%) of landholders were in the 40-60 age range. All survey respondents had attained some level of formal education. Forty-one percent of participants had attained a university degree, while some (2% of participants) had only attained primary education. In-farm activities were the main occupation of 72% of participants.

Queensland and Victoria recorded the highest number of participants with 36% and 22%, respectively. Livestock (and grazing) and dairy production, with 57%, were the predominant land use activities. Property size showed a wide dispersion with land areas ranging from 1 to over 10,000 hectares. Most of the properties, 67 (31.3%), had from 1,001-10,000 hectares in size, 15 (7%) had from 1,001-10,000 hectares, while 3 (1.4%) of the properties had over 100,000 hectares. The mean property size was 6,247 ha and the median 400.3 ha.

Participants were asked about the information they received about the CFI-ERF, and the sources through which that information was made available to them. *Newspapers*, with 16.4%, was the highest rated option. Interestingly, *I have not received any information at all* (12.5%) was the second highest rated option. This result revealed a need of improvement in the communication strategy about the CFI-ERF to landholders and the benefits of its adoption.

Binary logistic regression for the internal indicators of the independent variables

When running the individual logistic regressions for the internal indicators of *demography*, *knowledge, motivation, capacity* and *barriers*, the tests produced the following results:

- The model for the *demography* factor was statistically significant *(p* = .034). Out of four demographic indicators: *age, gender, level of education* and *occupation*, only *occupation (p* = .020) and *gender (p* = .095) were found to be significant. The results showed that landholders engaged in on-farm occupations were almost three times more likely to adopt the CFI-ERF than landholders who had their main occupation off farm. This result is consistent with the literature; landholders would adopt practices compatible with their activities and interests (Pannell et al., 2006; Polglase et al., 2013; Rogers, 1983) and that assist them in reaching their goals (social, economic and environmental) (Greiner & Gregg, 2011; Lin et al., 2013). Females were 0.5 times more likely to adopt the CFI-ERF than males. There is no evidence in the literature about the influence of gender on adoption of initiatives in the land sector. Stanley et al. (2006) state that the relationship of gender and uptake of new practices is unclear. Nevertheless, Stanley et al. (2006) highlights the importance of female landholders in the management of natural resources.
- The model for internal indicators of *knowledge* was statistically non-significant (*p* = .342) and no significant predictors were recorded.

- The model for *motivation* was significant ($p < .001$) and four indicators: *government regulations (*p=.007), *moral responsibility* (p= .0.15), *economic benefits (*p= .016), and *availability of technical support* (p=.024), were found to be significant. Economic benefits, availability of technical support and moral responsibility were associated with an increased likelihood of adoption of the CFI-ERF. Landholders' environmental values and land stewardship motivate adoption of environmental practices such as the CFI-ERF (Greiner & Gregg, 2011; Page & Bellotti, 2015; Pannell et al., 2006). Many scholars argue that *economic benefits* are significant motivations but not the most important motivations to adopt market-based innovations e.g. Moon & Cocklin (2011b); Pannell et al. (2006); Polglase et al. (2013); Smith & Sullivan (2014a). Increasing of governmental regulations was associated with a reduction in the likelihood of adoption of the CFI-ERF. Apparently, landholders do not feel motivated to change practices in their land when the new practices are mandatory. Finally, access to technical support showed a positive impact on the likelihood of adopting the CFI-ERF. Understandably, having advice and technical support about the practice proposed as is the case of the CFI-ERF encourages uptake. Further, Moon and Cocklin (2011a) argue that schemes allowing landholders to choose from incentives such as workforce to assist with project implementation or advice and guidance (technical support) on sustainable land management can achieve higher levels of acceptance.
- The model for *capacity* indicators was significant (p = .067). Two indicators, *financial resources* (p= .020) and *technical resources* (p = .065) were statistically significant. Interestingly, an increase in financial capacity factor was associated with a reduction of the likelihood of adoption of the CFI-ERF, which suggest that landholders who have an advantageous financial position are less interested in adopting the CFI-ERF. There was no evidence in the literature about high levels of financial capacity associated to a reduction of likelihood of the adoption of market-based innovations such as the CFI-ERF. Conversely, and increase in technical resources was associated with an increased likelihood of adoption of the CFI-ERF. This finding is consistent with the results of the motivation indicator which shows a positive relationship between having technical support as an incentive and the likelihood of adoption of the CFI-ERF. Meadows et al., (2014);Moon and Cocklin (2011a); Pannell et al. (2006)

argue that access to technical support has a positive influence on the adoption of innovations.

- The model for *barriers* indicators was significant ($p < .011$) and two indicators: not enough information ($p = .045$) and shortage of financial resources ($p = .015$) were significant. An increase in not enough information was associated with an increase in adoption of the CFI-ERF. In other words, the more information participants had about the CFI-ERF, the less likely they were to adopt. Presumably, the information that reaches landholders may not show a relative advantage of the CFI-ERF to support its adoption (Rogers, 1983), and a stronger message about the potential beneficial outcomes (for the farm, farmer and the environment) that the adoption of the CFI-ERF may deliver needs to be communicated. Pannell et al. (2006) argue that if information from external sources is not encouraging landholders will not adopt the proposed innovation. An increase in shortage of financial capacity was associated with a decrease in the likelihood of adoption of the CFI-ERF. Understandably, landholders in a less advantageous financial position will hardly adopt innovations that require a certain level of economic investment (Pannell et al., 2006), especially in absence of financial support.

Binary logistic regression for independent variables (composite variables).

The main logistic regression test replicated the results of demographic indicators discussed before. The test showed that occupation and gender were significant demographic aspects. Landholders engaged in farming/agricultural activities were three times more likely to adopt the CFI-ERF than landholders whose main occupation was off-farm. Female landholders were 0.5 times more likely to adopt the initiative than males, while age and education were not statistically significant.

Knowledge ($p = 0.049$) and Motivation ($p < .001$) were found to be significant predictors for adoption of the Carbon Farming Initiative. Interestingly, knowledge was found to be negatively associated with the likelihood for adoption of the CFI-ERF; in other words, the likelihood of adopting the CFI-ERF decreased as level of knowledge (familiarity) with the CFI-ERF increased. It can be assumed that as landholders increase their familiarity with the CFI-ERF, the potential benefits of adopting the policy become less attractive or more difficult to attain, at least under the current conditions of carbon trading in Australia. And presumably the constraints may become more evident as knowledge increases. This result was explored

during the second phase of the study through in-depth interviews to adopters of the CFI-ERF discussed in the following chapter of this thesis.

Motivation was positively associated with adoption of the CFI-ERF; increasing in motivation was associated with an increase in the likelihood of adoption of the CFI-ERF. Moral responsibility (p = .015*)* was found the best predictor of the motivation indicators followed by economic benefits (p = .016).

5.8 DISCUSSION

The results revealed that *motivation* was the strongest predictor for adoption of the CFI-ERF. An increased motivation was associated with an increase in adoption of the CFI-ERF, and *government regulations*, *moral responsibility*, *economic benefits* and *availability of technical support* were significant motivation predictors of adoption. *Moral responsibility*, *economic benefits* and *availability of technical support* were associated with an increase of the likelihood of adoption of the CFI-ERF.

Interestingly, higher levels of knowledge and information about the CFI-ERF, as well as, financial capacity were associated with a reduction of the likelihood of adopting the CFI-ERF. In other words, participants enjoying a comfortable financial situation who had a good knowledge (and received enough information) about the CFI-ERF were less likely to adopt the policy. While there was no evidence in the literature about the relationship of high financial capacity levels with a reduction of adopting innovations, the relationship of high levels of knowledge with a reduction of likelihood of adopting innovations is consistence with the claims that increased knowledge about the proposed innovation assists potential adopters to make better decisions (Pannell et al., 2006; Rogers, 1983) about adopting or rejecting an innovation.

Demographic characteristics have had much attention in diffusion research as factors that influence adoption (Stanley et al., 2006) and it is widely accepted that the older landholders are, the less likely they are to adopt innovations (Rogers, 1983; Stanley et al., 2006). However, the results show no significant relationship between landholders' age and adoption of the CFI-ERF. Stanley et al. (2006) claim that the adoption rates do not diminish with landholder's age. Gender and occupation (engaged in farming/agriculture or other off-farm occupations) significantly predicted adoption of the CFI-ERF. Landholders mainly engaged in farming/agriculture were almost three times more likely to adopt the CFI-ERF than landholders whose main occupation was off-farm. This result is consistent with the literature;

landholders would adopt practices compatible with their current activities and interests (Pannell et al., 2006; Polglase et al., 2013; Rogers, 1983) and that may assist them to reach their goals (social, economic and environmental) (Greiner & Gregg, 2011; Lin et al., 2013). Female landholders were slightly (0.5 times) more likely to adopt the CFI-ERF than males. There is no evidence in the literature about the influence of gender on adoption of initiatives in the land sector. Stanley et al. (2006) state that the relationship of gender and uptake of new practices is unclear. Nevertheless, Stanley et al. (2006) highlight increasing participation and the importance of female landholders in the management of natural resources.

From the theoretical standpoint, some results concur with what has been stated in the diffusion of innovations theory. Demography, in particular gender and occupation were found to be significant predictors of adoption. Concurring with the DOI theory, occupation, which can be a determinant of the interests of landholders (on new ideas) as well as compatibility (of current practices) with the innovations proposed, was positively related with adoption of the CFI. However, age, according with the DOI has typically been related with non-adoption, was not a significant predictor of adoption. Furthermore, knowledge often has been considered to have a positive influence on adoption of new practices, in this study, the results show that knowledge has is negative relation with adoption of the CFI. Finally, the descriptive statistics results show that the majority of respondents, including the adopters have attained high levels of education. This may be related with the complexity that some innovations pose to target populations. Which makes difficult for some potential adopters, the technicalities of new practices, as is the case of carbon sequestration practices. This concurs with the statements of the DOI that complexity of the innovation can have a major impact on adoption.

5.9 CONCLUSION

The research question for the quantitative study was: do demography, knowledge, motivation, capacity and barriers predict the adoption of the CFI-ERF? The results revealed that motivation and knowledge significantly predicted adoption. Motivation was positively associated with and increased likelihood of adoption but, unexpectedly, and increased knowledge was associated with a reduction of the likelihood of adopting the CFI-ERF. Some internal indicators of the adoption factors were found to be significant predictors as well. Table 5.4 provides a summary of the DKMCB factors' internal indicators that significantly predict adoption of the CFI-ERF.

Table 5.4 Summary of significant indicators by factor

Indicators	Comments
Demography indicators	
Occupation	Landholders engaged in in farm occupations were three times more likely to adopt the CFI-ERF
Gender	Female landholders were 0.5 times more likely to adopt the CFI-ERF than males
Motivation indicators	
Moral responsibility	Positively associated with the likelihood of adopting the CFI-ERF
Economic return	Positively associated with the likelihood of adopting the CFI-ERF
Availability of technical support	Positively associated with the likelihood of adopting the CFI-ERF
Government regulations	Negatively associated with a reduction on the likelihood of adoption
Capacity indicators	
Technical resources	Positively associated with the likelihood of adopting the CFI-ERF
Financial resources	Negatively associated with the likelihood of adopting the CFI-ERF
Barriers indicators	
Not enough information	The less information the more likely landholders were to adopt the CFI-ERF
Shortage of financial resources	Associated with a reduction of adoption of the CFI-ERF

Note: While the knowledge factor (composite score of knowledge indicators) was a significant predictor of adoption of the CFI-ERF, the internal indicators of knowledge when assessed individually did not significantly predict the adoption of the CFI-ERF.

The next chapter contains the analysis and results of the qualitative (QUAL) component of this research work and builds on the analysis of the quantitative (QUAN) results. Semi-structured interviews were conducted to landholders who have adopted the CFI-ERF. The aim of the QUAL phase of this study was to have an in-depth look on the role that *demography*, *knowledge*, *motivation*, *capacity* and *barriers*, had on the adoption of the CFI-ERF and better explain the results from the QUAN component of the thesis. Finally, an analysis combining the results of the QUAN and QUAL phases is provided in the discussion chapter (Chapter 7).

Thesis Outline

Chapter 1	Introduction
Chapter 2	The big picture: A context analysis to the Carbon Farming Initiative-Emissions Reduction Fund
Chapter 3	Theoretical framework and overview of the factors that influence the adoption of the Carbon Farming Initiative-Emissions Reduction Fund
Chapter 4	Methods
Chapter 5	The role of demography, knowledge, motivation capacity and barriers on the adoption of the Carbon Farming Initiative-Emissions Reduction Fund: A quantitative study
Chapter 6	**The role of demography, knowledge, motivation, capacity and barriers on the adoption of the Carbon Farming Initiative- Emissions Reduction Fund: A qualitative study**
Chapter 7	Integrating the quantitative and qualitative results: Analysis and discussion
Chapter 8	Conclusion and recommendations for further research

CHAPTER 6: THE ROLE OF DEMOGRAPHY, KNOWLEDGE, MOTIVATION, CAPACITY AND BARRIERS ON THE ADOPTION OF THE CARBON FARMING INITIATIVE. A QUALITATIVE STUDY

The previous chapter presented the quantitative (QUAN) analysis and results of a questionnaire survey applied to Australian landholders about the adoption of the Carbon Farming Initiative (CFI-ERF). This chapter reports the results of the qualitative (QUAL) analysis of semi-structured interviews conducted with adopters of the CFI-ERF. Both chapters are part of a mixed methods research (MMR) approach. The present QUAL study was designed to investigate how demography, knowledge, motivation, capacity and barriers influence Australian landholders' decisions to adopt the CFI-ERF.

Interestingly, the analysis revealed the existence of two distinct groups of adopters. This distinction depended on whether the informants adopted the CFI-ERF independently or in association with Carbon Consultancy Enterprises (CCE), subsequently referred as *independent adopter*s and *associated adopters* respectively. The results showed substantial differences between independent and associated adopters. For instance, associated adopters had larger properties and committed larger land area to CFI-ERF projects than independent adopters. However, the contribution of associated adopters to the analysis of the factors under study was marginal as the CCEs did all the project implementation and registration work. Thus, the results section reports the *demography, property information* and *type of project* implemented for both adopters' groups. Concerning *knowledge, motivation, capacity and barriers* factors, only the results of interview data analysis conducted to independent adopters are reported here.

This chapter begins by briefly revisiting the CFI-ERF and contains a short account of some of the propositions of Diffusion of Innovations theory (Rogers, 1962) deemed necessary for the argument of this chapter. The second section includes a description of the research method, including the deductive thematic approach used for the data analysis. The last section contains the results of the analysis of the interview data.

6.1 BACKGROUND CONTEXT

6.1.1 The Carbon Farming Initiative

The Carbon Farming Initiative (CFI-ERF) began in December 2011. The Australian government introduced the CFI-ERF to encourage land-based climate change mitigation, assisting the country to reach its carbon emission reduction commitment under the Kyoto Protocol (DCCEE, 2012). One of the aims of the CFI-ERF was to present Australian landholders the opportunity to access carbon markets and diversify farm income through the implementation of carbon farming projects (DCCEE, 2012). Under the CFI-ERF landholders and organizations could voluntarily apply one or more carbon farming activities following approved methodologies. After complying with the CFI-ERF rules, landowners (project proponents) would gain approval as certified abatement entities and start generating Australian Carbon Credit Units (ACCU). ACCUs would be awarded to abatement entities based on the amount of greenhouse gas (GHG) emissions avoided, or carbon dioxide (CO_2) sequestered through vegetation. One ACCU equals one tonne of carbon dioxide or equivalents (CO_2-e) (DCCEE, 2012). The CFI-ERF rules allowed trading ACCUs in both voluntary as well as compliance markets (Macintosh, 2014; van Oosterzee, 2012). Thus, individuals or other entities could voluntarily buy ACCUs to offset their GHG emissions and liable entities, under the rules of the Carbon Pricing Mechanism (CPM)[20], had an obligation to surrender carbon credits, which could include CFI-ERF ACCUs, to counterbalance their emissions (Clean Energy Regulator [CER], 2015b). The Clean Energy Regulator (CER) supervises the whole process, from the registration of new projects to the issuing and trading of ACCUs.

Given the importance of the CFI-ERF to supporting the abatement of GHGs it is crucial to understand how the factors: demography, knowledge, motivation, capacity and barriers, components of the methodological framework developed for this study, influence landholders' (potential adopters) decision of adopting the initiative. As stated in Chapter 3, the Diffusion of Innovations theory (Rogers, 1962) presented an ideal theoretical basis to study the factors that influence the adoption of the CFI-ERF.

[20] The Carbon Pricing Mechanism (CPM) was a carbon trading system introduced in 2011 to put a price on carbon emissions in Australia. Intensive emission businesses "liable entities" had to comply with the rules of the CPM and surrender credits to offset their emissions. The CPM ended in July 2014 (CER, 2015b).

6.1.2 Carbon Farming Initiative Transition into the Emission Reduction Fund

The Australian Government, in December 2014, introduced the Emissions Reduction Fund (ERF) which builds on the CFI-ERF (Department of the Environment, 2016). The Emissions Reduction Fund (ERF) is the central piece of the Australian Government's Direct Action Plan. The ERF legislation entered into force in December 2014 (Department of the Environment, 2016). The ERF builds on the Carbon Farming Initiative (CFI-ERF). The CER accepted projects under development following the CFI-ERF rules until June 2015. The projects registered under the CFI-ERF rules were automatically transitioned and remain active under the new ERF scheme (CER, 2015a). Since July 2015 onwards, new projects, to be accepted and registered, must comply with the ERF rules to be accepted (CER, 2016a).

With the creation of the ERF the Australian Government also dismantled the CPM, thus changing the rules of carbon trading so that all carbon trading is now voluntary. Under the ERF, instead of having a fixed price, the Australian Government purchases ACCUs using a reverse auction method. The price of carbon credits has changed significantly since the start of the CFI-ERF (under the ERF rules). For the financial years 2012-2013 and 2013-2014, carbon credit units had a fixed price of A$23 and A$24.15 respectively (CER, 2015b). Under the new rules, the CER has held three auctions so far: April 2015, November 2015 and April 2016, where carbon units were traded on average at A$13.95, A$12.25 and A$10.23 respectively (CER, 2016c; Clean Energy Regulator, 2017).

6.2 METHODS

As described in the methods chapter (Chapter 4), this case study employed a mixed methods research (MMR) approach (Creswell & Plano Clark, 2011; Johnson et al., 2007), specifically a sequential explanatory design (Creswell & Plano Clark, 2011). The research design involved two sequential phases (components); first a quantitative (QUAN) phase followed by a qualitative (QUAL) phase. Consistent with the MMR literature the QUAL component of the study expands and explains the findings of the QUAN phase (Creswell & Plano Clark, 2011). Thus, the results of QUAL phase provide an in-depth look at the role that demography, knowledge, motivation, capacity and barriers had on the adoption of the CFI-ERF by Australian landholders.

QUAL research can use a variety of data collection methods depending on the field, the purpose of the study, the nature of the research question, the training, and experience, as well as the resources that the investigators have at hand. Some of the most commonly used

methods in QUAL research are participant observation, in-depth interviews and focus groups. As explained in Chapter 4, this phase of the study employs semi-structured interviews for data collection.

6.2.1 Semi-structured interviews

The semi-structured interview questionnaire had 41 questions distributed in seven sections. As a strategy to maintain the interests of the informants, the questions about the factors influencing the adoption of the CFI-ERF came first and the questions related to demography and information about the land were prompted last (Annex 6 contains a copy of the semi-structured interview guide). The interview outline included the following sections:

1. Knowledge about the Carbon Farming Initiative
2. Motivation to adopt the Carbon Farming Initiative
3. Capacity to adopt the Carbon Farming Initiative and
4. Barriers to adopting the Carbon Farming Initiative
5. Questions about adoption of the Carbon Farming Initiative
6. Demography of informants
7. Information about the land

6.2.2 Informant selection

As discussed in Chapter 4, the QUAL study used a *purposive sampling* method (Oliver, 2006; Palys, 2008). The primary selection criterion was: landholders (adopters) who had CFI-ERF projects implemented and accepted by the Clean Energy Regulator (CER)[21]. The rationale for this criterion was the knowledge and experience that adopters of the CFI-ERF have accumulated through the planning and implementation of their projects, following the CFI-ERF methodologies and navigating the process of having their projects approved by the CER. Thus, thirteen adopters of the CFI-ERF (key informants), who were identified through the questionnaire survey used in the QUAN phase of this study, were invited to participate in the in-depth semi-structured interviews. Seven out of the 13 participants accepted the invitation. Four interviews were conducted face to face and three over the phone. The interviews occurred from November 2014 to May 2015.

[21] The CER, as noted in chapter three, is the administrator of the CFI-ERF.

6.3 DATA ANALYSIS

The interview data analysis used a thematic qualitative text analysis approach (Kuckartz, 2014). Researchers often use inductive and deductive considerations to develop the themes for the coding process (Kuckartz, 2014) and the subsequent analysis and interpretation of results. This study, employed a dominant deductive strategy following the methodological framework (Chapter 4) that guides this research. Thus, the analysis was mainly delimited to six themes: adoption (dependent variable), demography, knowledge (and information), motivation, capacity, and barriers. Aditionally, thematic coding was employed to determine subthemes within each of the main themes.

This current section also provided a brief justification about the adequacy of qualitative thematic analysis to explore the data collected using in-depth semi-structured interviews. The next section presents the results of the QUAL data analysis. It starts with the results related to type and size of projects implemented, as well as property size and land use and continues with the results concerning the factors that influence the adoption of the CFI-ERF.

6.4 RESULTS

As stated above, the interview data analysis process used a deductive approach. The factors composing the methodological framework: *adoption* (dependent variable), *knowledge, motivation, capacity* and *barriers* (independent variables) were the main themes guiding the analysis of the interview data. In other words, the factors of the framework were used for the coding process of emerging subthemes identified from the data. The results related to *adoption*, e.g. type and size of the project, are presented first and serve as a background information for the analysis of the influence of the other factors on the uptake of the policy. Figure 6.1 shows the themes and their corresponding subthemes used during the coding process and the data analysis, respectively.

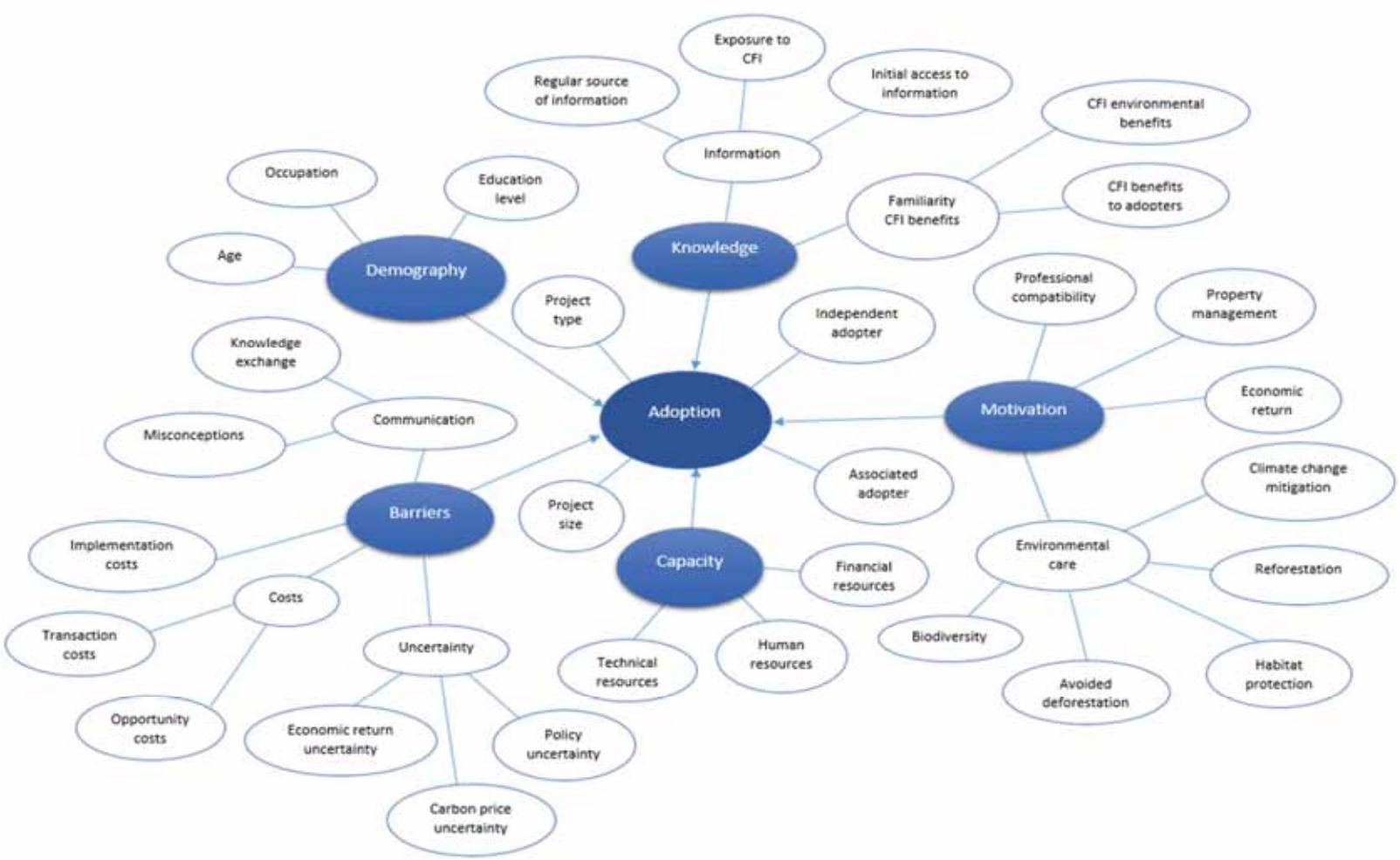

Figure 6.1 Themes and subthemes discussed by the interview informants

(n=7)

One of the first results drawn from the analysis of the QUAN data revealed the existence of a fundamental difference between the interview participants. Five of seven informants implemented their projects independently (henceforth referred as *independent adopters*), while the other two informants established their projects in association with Carbon Consultancy Enterprises (CCEs) (henceforth referred as *associated adopters*). CCEs, acting as change agents[22], assisted associated adopters throughout the process of adoption of the CFI-ERF. The DOI discusses the impact that change agents can have on adoption, and sometimes on decelerating and preventing adoption of innovations (Rogers, 1962, 1983).

6.4.1 Associated adopters

Both associated adopters who took part in the interview expressed that the CCEs used their own resources to implement and later register the projects with the Clean Energy Regulator (CER). Due to CCEs' strong intervention, associated adopters did not experience first-hand the adoption process. Therefore, associated adopters' contribution to the discussion of the influence that DKMCB factors have on the adoption of the CFI-ERF was limited. The impact that CCEs have on the adoption of the CFI-ERF and consequently in Australia's carbon trading needs to be studied. For the reasons noted above, this chapter only presents the information about associated adopters' *demography, land use and property size*, and *type of project implemented*.

6.4.1.1 Demography of associated adopters

The associated adopters were middle-aged individuals with secondary education and engaged in farming activities, mainly sheep breeding. Information about the role in the management of the property was also gathered as part of the informants' occupation. Both informants said they managed their properties themselves and that they did not employ paid workers for the daily farm activities. In other words, both were family run farms. Table 6.1 presents a summary of the associated adopters' demography and the affiliation codes for the data analysis.

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[22] "A change agent is an individual who influences clients' innovation decisions in a direction deemed desirable by a change agency. In most cases a change agent seeks to secure the adoption of new ideas, but he or she may also attempt to slow the diffusion process and prevent the adoption of certain innovations" (Rogers, 1983, p. 312).

Table 6.1 Demography of associated adopters

Affiliation code	Age (years)	Education	Occupation	Role in the property management
ASO1	51	Year 10	Grazier	Owner/Manager
ASO2	56	Year 12	Farmer/grazier	Leaseholder/Manager

Source: Semi-structured interviews (n=2)

6.4.1.2 Property information and type of projects implemented by the associated adopters

The results showed that associated adopters had large properties and had implemented large projects as well. Interestingly, in both cases, the proportion of land committed to the projects compared to the property size is considerable; over one-third in one case and over three-quarters of the property in the second instance. This size of the projects implemented and the proportion of land committed may respond to the goals (e.g. economic return, social and environmental benefits) set by both stake holders; associated adopters and CCEs respectively. Both informants applied the same type of methodology for the implementation of their projects. Table 6.2 shows information about the property and type of project implemented.

Table 6.2 Associated adopters: project implemented and property information

Informant	Project type	Project size (ha)	Property size (ha)	Land comitted to CFI-ERF project (%)
ASO1	Avoided deforestation	3,000	8,166	36.74
ASO2	Avoided deforestation	10,000 (2 projects)	13,300	75.19

Source: Semi-structured interviews (n=2)

6.4.2 Independent adopters

As stated before, the semi-structures data analysis revealed that Australian landholders were either adopting projects independently or in association with Carbon Consulting Enterprises (CCE). This section presents the results of the quantitative data analysis of the group of adopters who implemented carbon farming independently. The section starts with independent adopters, demographics, as well as the information about their properties and type of projects developed. Then, the results concerning knowledge, motivation, capacity and barriers are provided.

6.4.2.1 Demography

Most independent adopters were middle-aged people with tertiary education degrees. The age of the participants ranged from 46 to 67 years. All the informants had accomplished higher education degrees, including postgrad degrees in some cases. High education levels may have a positive impact on adoption of innovations (Ducos et al., 2009). Most participants had off-farm occupations, and some of them have held leadership positions. Despite off-farm work, all were actively engaged in the management and daily operation of their properties. In all cases, the farms were family operated and did not have paid employees to perform the day-to-day farm work. Table 6.3 contains a summary of demographic information of the respondents and their affiliation codes used during data analysis.

Table 6.3 Demography of independent adopters

Affiliation code	Age (years)	Education	Occupation	Role in the property management
INA1	63	PhD	Environmental consultant, Environmental scientist	Owner/manager
INA2	58	Associate Diploma (through a university)	Retired (Natural Resources Management body)	Owner/Manager
INA3	67	Bachelor of Science	Semi-retired (Business owner)	Owner/Manager
INA4	61	Higher education	Conservationist nursery farmer	Owner/Manager
INA5	46	Tertiary education (enrolled in MBA degree)	Business owner and forester	Manager

Source: Semi-structured interviews (n=5)

6.4.2.2 Independent adopters' property and type of projects implemented information

The results showed that independent adopters had smaller properties and consequently had implemented smaller projects than associated adopters. Interestingly, all informants applied the same type of methodology for the implementation of their projects. Table 6.4 shows the information about property size and type of project implemented.

Table 6.4 Independent adopters: project implemented and property information

Informant	Project type	Project size (ha)	Property size (ha)	Land comitted to CFI-ERF project (%)
INA1	Environmental plantings	40	183	21.86
INA2	Environmental plantings	1	80	1.25
INA3	Environmental plantings	32	800	4.00
INA4	Environmental plantings	20	121	16.53
INA5	Environmental plantings		2	

Source: Semi-structured interviews (n=5)

6.4.2.3 Knowledge

Knowledge is one of the factors included in the methodological framework (Chapter 4) that guides this study. It is important to assess the influence that knowledge had on the decision to implement activities under the CFI-ERF. Considering that knowledge occurs after the intended adopter's exposure to a particular innovation, which stimulates the search for information about how the new idea works and its advantages and disadvantages (Rogers, 1983), questions about information acquisition and level of knowledge were part of the interview plan.

Exposure to the existence of the CFI-ERF

The first *exposure to the existence of the CFI-ERF*, in some cases, was a direct result of landholders' awareness of the changes that the climate is experiencing. Informants' interest in climate change motivated them to follow the policy development in the area. Therefore, the exposure to the existence of the CFI-ERF was a direct result of this process. Moreover, some of the independent adopters were aware of the CFI-ERF even before it started. The quotes below illustrate this knowledge and awareness.

> Well, we have always been interested in adapting to climate change. And, as farmers we have been aware that the climate was changing and we have always had an interest in what was being developed. And, when the legislation first went through we have followed it from the newspapers, the news, then we followed up on the internet to find out more about it (INA3).

> For the first time, it was when the policy was first announced by the government in 2010, when they were considering formulating the policy. I was obviously keeping a watching brief because I am interested in it. I work full-time in the area. I was aware when they were developing the policy and when the legislation got passed in 2011. I pretty much knew on the same day

> because I watch this space. I knew straight away that the legislation got passed and I had been waiting for that for about 10 years (INA5).

Independent adopters' working environment also played an important role in the process of exposure to the CFI-ERF. Some independent adopters had been working in the carbon farming area and had been involved in carbon farming projects at different levels. Therefore, independent adopters were aware when the government started the CFI-ERF.

> When it first started… 2010. We were involved in a project before the Carbon Farming Initiative, which was called then CPRS or Carbon Pollution Reduction Scheme, and the change of government and policy started the CFI-ERF and we were right up-to-date with the times (INA1).

> It was through my employment at that time [I became] interested in following the policy development around this area… (INA2).

In summary, independent adopters had been active in the environmental area. Therefore, independent adopters' first exposure to the CFI-ERF was a direct consequence of either their personal interests, their occupation or both.

Access to information

All the independent adopters said they received no unsolicited information from any source. Instead, the independent adopters started an active process of collecting information about the CFI-ERF. One informant said: "No, I do not recall receiving any unsolicited (information) in the post or by email," (INA 2). Similarly, another adopter explained: "I haven't received any unsolicited information; I have been actively looking for it" (INA 5).

Considering that the independent adopters did not receive any unsolicited information, the next step was to investigate how they built their knowledge about the initiative and what sources the informants used to achieve the necessary level of knowledge about the CFI-ERF. Thus, the independent adopters expressed that they had been very active in gathering information. The internet was independent adopter's primary tool to find information and learn about the CFI-ERF. Different organizations, including Australian governmental agencies, offered information about the CFI-ERF through their websites. The quotes below reflect these points:

> Initially through internet searches, but we started the project years ago to sequester carbon under the original form of carbon farming policy. But we initially searched and found information on

> the internet and then we engaged in the department of climate change or whatever it was at the time. It's changed a few times (INA1).

> … [I] mainly just went straight to the website, to all the websites, three different websites: Clean Energy Regulator, DAFF [Department of Agriculture, Fisheries and Forestry] and [Department of] Environment or Climate Change and Environment, whatever it was called (INA3).

> Through the internet. All through looking at the Clean Energy Regulator, whatever it was called then, their website, and other government websites, media reports, all through the internet (INA5).

Regular sources of information

The informants had first access to information about the CFI-ERF and the changes in the policy using different means. But after that initial access to information, what were the sources of regular information about the initiative? How did the informants keep up-to-date with all the developments of the CFI-ERF? Again, independent adopters used different strategies to obtain information about the CFI-ERF on a regular basis. Personal networks, community groups and governmental and other organizations working in the carbon farming sector were sources of regular information:

> The primary source [of information] was probably Andrew from this [carbon consultancy] company in Brisbane. They were a carbon consultancy. I originally was put in contact by Landcare Queensland I think. They were looking for projects in North Queensland, potential carbon-type projects (INA2).

> There are two critical ones [sources of information], the Clean Energy Regulator (CER) website because they are the government regulator, and the Carbon Market Institute (CMI) because they are the industry regulator (INA5).

Different applications and internet tools such as social networks and email listings have been independent adopters' critical sources of regular information. One informant said: "We keep up to date with the internet information as much as we can." (INA1). The Clean Energy Regulator (CER), as well as other organizations, use these resources to circulate information to subscribers to their email listings. Additionally, independent adopters have actively used several of these sources of information at the same time. The quote below illustrates:

> [I receive information] pretty much every week from the Clean Energy Regulator. I am on their email list. Twitter, LinkedIn; I am on forums on Twitter and LinkedIn that deal with the carbon farming initiative... a lot of information comes through on social media (INA5).

Although independent adopters acknowledged that governmental agencies, including the CER, were their main sources of information, some informants expressed some concerns about the flow of information. Therefore, the informants stressed the need and importance that other sources had when procuring regular information about the CFI-ERF. The quotes below explain this issue:

> Irregularly, we got ourselves put on the mailing list from the department in Canberra [Department of Climate Change] and that would send out information from time to time but not regularly, just occasionally… The Regulator [CER] came in later and by now keep us up to date with what's going on, but it's just as things change, but they inform us of some things and not other things, so we have to keep up to date separately as well (INA1).

> My primary source is via some community groups but not mainly now Clean Energy (CER). Say, they don't give you any advice, what they do is just say log in to this internet website and do something. But big deal, it's not a person helping you or supporting you or making it easy for you (INA4).

All the independent were members of a community organization or other typs of bodies in the land care arena. "We are founding members of the Environmental Farmers Network… And also we also members of a land care group explained one participant" (INA3). Some of the adopters received information through the organizations while others did not. And, in some cases the interview participants were the information source inside their organized group. Below are the responses to the questions about interviewees involvement in a organization and whether they had received information from them:

> TREAT…Trees for the rehabilitation of Atherton Tablelands, vegetation... It's community group which supports landholders planting trees. That's all coming through government funding, government grants, and mostly for conservation purposes. [Have you received any information about the Carbon Farming Initiative in this organization?] Other that what I have written no. I have written for TREAT (INA 1).

> There would have been information on the government's websites. At the time I was also a director of terrain natural resource management. The local regional natural resources

> management body for the wet tropics. And the Terrain was very interested in becoming involved in the carbon business (INA 2).

Independent adopters' knowledge about the CFI-ERF.

After covering the discussion about how the adopters had gathered information about the CFI-ERF, the next step was to explore informants' knowledge of the benefits of the CFI-ERF for landholders and for the environment. Understandably, adopters' level of knowledge is not static; it depends on internal (e.g. health, other occupations) and external factors (e.g. policy evolution). Rapid changes affect the level of knowledge about the CFI-ERF. "It's hard to keep up with all the changes, but I'm pretty familiar with most of it (CFI-ERF), but things do change," (INA1), explained one informant. Some particular circumstances, such as a lack of clarity of the innovation regulations, in this case the CFI-ERF, can have a positive or negative impact on the knowledge level. The quote below illustrates this point.

> … Now, it's [level of knowledge] dropping. [Why?] I've lost interest because, when I first started working on the project with Andrew, we thought that there would be more revegetated area that could be included in a project and there might actually be some returns – some net return – but as the project developed and the rules became clearer, the amount of area reduced greatly…(INA2)

Knowledge about benefits for landholders of the adoption of the CFI-ERF

The interviews also elicited information about the knowledge that the informants had about the benefits for landholders resulting from the adoption of the CFI-ERF. Most the participants considered that land rehabilitation and improving land management considering the (future) impact of climate change were benefits for landholders. Along with land management, diversification of income for land that otherwise would not generate a profit, and community wellbeing were also mentioned:

> To put in rehabilitation works to reforest areas that had been degraded… places like creeks and gullies and eroded banks. (To establish) shelter belts for protection of crops or livestock, so they've got protection from the wind and the sun. Improve water quality. Desalinization of soils in some places where the forest had been cleared originally and have been grazed or cropped too much…There is a whole range of (land) rehabilitation benefits (INA1).

> With climate change… the land where we were planting the trees on, would have minimal benefit in the future from traditional farming because of decreases in rainfall. And it's not very fertile land…we saw that as a good way to diversify income for that land (INA3).

> Community development has a lot of projects are in rural Australia, and whenever you have projects outside of the city, you have a good economic activity (INA5).

In summary, the independent landholders considered that most of the benefits for landholders are tied to land rehabilitation and property improvement, which are equally or more important than economic benefits. “There are a whole bunch of other benefits of planting trees aside from the carbon payment (INA5),” one adopter said. And, independent adopters acknowledge that there may be economic benefits resulting from the implementation of the CFI-ERF depending on the size of the project. One adopter said: “If you do it on a big enough scale, the government in effect is paying you to plant trees, (INA3).

Independent adopters’ knowledge about ecosystem/environmental benefits of the CFI-ERF

This section contains the informants’ opinions about the benefits to ecosystems and the environment of adopting the CFI-ERF activities. All the participants were familiar with the ecosystem benefits resulting from the implementation of CFI-ERF. Most of the environmental benefits of CFI-ERF activities, especially in the land sector are linked to each other. For instance, implementing reforestation projects has a direct impact on wildlife habitat provision and therefore for biodiversity protection and restoration. Similarly, if successfully applied, CFI-ERF activities are intended to help mitigate against climate change. These views are shared by the adopters of the CFI-ERF:

> The intended benefits would be to reforest parts of Australia and that would be a great benefit to the diversity and for ecosystems as a whole, ecosystem services and of course the benefits of carbon sequestration and also rehabilitating land that’s been damaged because it’s too expensive to rehabilitate land. If people on the land can derive income from the trees and plants and they can offset some of the costs of rehabilitating and that’s the intention (INA 1).

> It’s re-establishing native vegetation, which in turn provides habitat for a whole range of native wildlife, yeah. One of the bigger threats to our biodiversity is loss of or the fragmentation of habit, so reinstatement of habitat is very important to me, particularly on the Atherton Tablelands where the impacts of climate change are still unclear but do not look promising at all. The best scientific advice that I can find is to re-establish as much habitat as we can and get existing habitat into as good a condition as we can and try to build a resilience (INA2).

> The first benefit is reducing emissions or locking up carbon, addressing climate change. The second one is it is good common sense; it’s a good thing to do in general. There’s biodiversity benefits with the tree planting; there are a whole bunch of other benefits of planting trees aside from the carbon payment (INA5).

Undoubtedly, knowledge about the benefits (e.g. social, financial, environmental) or the lack of benefits of innovations, in general, can be a source of motivation or a barrier to adoption respectively. Thus, it is important for intended adopters to have the knowledge about the benefits or disadvantages of adopting the CFI-ERF to make the best possible informed decision (Pannell et al., 2006). As discussed in the next section, in the specific case of the independent adopters of CFI-ERF, the elevated number of environmental/ecosystem benefits has been an important motivation for independent adopters to implement CFI-ERF projects.

6.4.2.4 Motivation

Motivation, as stated earlier, refers to the reasons and motives to adopt an innovation. Most of the motivations of independent adopters were altruistic and revolved around environmentally friendly practices. Climate change mitigation, reforestation, habitat protection and restoration were among the main motivations to adopting the CFI-ERF. Experimentation, knowledge sharing and peer recognition were also influential reasons to engage in carbon farming activities. Economic profit, for independent adopters, was not considered as important as environmental care motivations to implement CFI-ERF activities. Furthermore, informants regarded financial return as instrumental to expand existing or establish new carbon farming projects, thus achieving additional environmental benefits.

Climate change mitigation

Addressing climate change mitigation is one of the principal purposes of GHG abatement policies. Australia, like many countries around the world, have implemented policies to address climate change. When asked about the main motivation to adopting the CFI-ERF, climate change adaptation and mitigation were among their primary motivations to implementing carbon farming activities. The quotes below reflect the opinion of the participants about this point:

> We have always been interested in adapting to climate change and as farmers, we have been aware that the climate was changing and we have always had an interest in what was being developed (INA3).

> We are doing it because we are trying to sequestrate carbon because we are worried about climate change (INA3).

> I am a true believer of climate change; I believe in human-induced climate change (INA5).

Environmental care: reforestation, avoided deforestation and habitat protection

Along with climate change adaptation and mitigation, other environmental protection and restoration activities were among independent adopters' motivations to adopt the CFI-ERF. Reforestation was one of the strongest drivers for CFI-ERF activities implementation. All the informants were already carrying out reforestation works, even before the introduction of the CFI-ERF. "To be perfectly honest about this, we were doing tree planting anyway…" said one adopter. Another informant added: "The principal one [motivation] was to reforest part of our land." And, "we bought the property specifically to revegetate part of it – that's one of the specific reasons" explained another informant. Wildlife habitat restoration and protection, together with the benefits to biodiversity resulting from the application of carbon farming activities, were also strong motivations for the independent adopters for the uptake of the CFI-ERF. Another informant explained:

> My partner and I purchased that block of land in 2005 with the express purpose of protecting the remnant habitat and restoring the degraded pasture to be rainforest. What we're dealing with is a very, very high valued forest in the Atherton Tablelands. It's got quite a number of endemic species, a number of rare and endangered species and the habitat for those species has disappeared, below 10% of the original forest cover. And a number of those species are facing further declines, so that's the main reason to keep it (INA2).

Research, knowledge sharing and community wellbeing were also strong motivations for independent adopters, especially for those who held leadership positions. Some of the informants had established their projects as research or demonstration sites aiming to be able to encourage more landholders to implement CFI-ERF projects. The quotes below illustrate these motivations:

> The other principal one [motivation] was to design it [the project] as experimental environmental planting because there is a lot of misinformation and a lot of confusion about the methods for planting (INA1).

> I wanted to look at all the problems in registering a carbon farming project under the various methodologies so that I could be ready to do it on a large scale (INA5).

> Being on the board of Terrain NRM there was a time when we thought we could develop a really strong new and different funding stream to come into the region…through the CFI-ERF (INA2).

Property management

Adapting land management to the impacts of climate change was one of the motivations to adopt the CFI-ERF. In this context, informants considered the implementation of CFI-ERF projects as the best option for some areas in their properties that may not be suitable for other productive activities. Thus, implementing CFI-ERF activities in certain areas would result in a reduction of opportunity cost and would also present a prospect to diversify the income of the farm through carbon trading. The quotes below illustrate these motivations:

> The land, where we were planting the trees on, will have minimal benefit in the future from traditional farming because of decreases in rainfall. And it's not very fertile land. So, we saw that [developing a CFI-ERF project] as a good way to diversify income for that land. It's also the best use of this particular bit of land. It's an…outcrop on a slope that's hard to graze without losing soil (INA3).

> I have an economic incentive to get some carbon in the ground so that I can get some carbon credits in the future (INA5).

Besides motivations to address issues such as climate change mitigation, reforestation, habitat protection etc., which will benefit all of us, other altruistic motivations leading to benefits for the community were expressed. One informant simply said: "Because I am Australian and I love my country" (INA4).

6.4.2.5 Capacity

Capacity refers to the existence and/or the accessibility to the necessary resources to implement CFI-ERF projects. Independent adopters were asked about the availability or access they had to financial, human and technical resources. Independent adopters when possible used their resources and, in most cases, also had to employ different strategies to secure the resources needed to implementing activities under the CFI-ERF policy. Independent adopters' training and skills (e.g., research on tree planting methods) were crucial to maximise the resources at hand.

Financial resources

Most independent adopters used a combination of their financial-economic resources and grants provided to landholders by different organizations to execute environmental projects. Only one of the independent adopters established a CFI-ERF project without any financial assistance from any entity. Logically, the availability of financial-economic resources had an

impact on the different aspects of the project development. The shortage of resources especially limited the size of the project. Also, as explained in the quoted below, shortage of resources restrained the ability of hiring labor to assist in the implementation and maintenance of environmental planting projects. Consequently, some adopters had to rely on the assistance of family and friends which at some point can threaten the stability of a project.

> I self-funded it [the project] and got family and friends to assist with planting; I planted in my spare time on weekends. I drew funding from other areas of my life and it's been hard work. This is why I have two hectares, and not [the] two hundred hectares I wanted to have. I still don't have the finances I need (INA5).

Other independent adopters used their economic resources to cover part(s) of the project establishment costs. "We had enough money set aside to revegetate a lot of the paddock", one informant said. And, due to the low financial resources available, independent adopters used different strategies to reduce implementation costs. The following quote explains this point:

> We didn't have a lot of money but that's why I developed a nursery and we collected seeds that belonged to our area… but the reason that made it cheaper for us was [that] I grew the seeds and then I involved the community to plant the trees (INA4).

In most cases, the independent adopters had *financial support* from different programs and organizations (e.g., Australian Government's biodiversity fund and regional catchment management authorities) working in the environmental area. Originally, those funds were granted for other projects related to biodiversity protection, reforestation and for research ventures. However, the compatibility of those projects with the CFI-ERF rules allowed their proponents to register them under the CFI-ERF policy. It is important to note that these funds in most cases were awarded even before the inception of the CFI-ERF. The quotes below illustrate this point:

> For the first project, which is less than a hectare that was in 10 different plots, that was our own money, a small amount. The second project that was worth $400,000; that was the linkage project and that was enough to plant and maintain the forest for the first three years. And then we got the biodiversity fund which was sort of $325,000 to plant up the next 12 hectares and maintain the original ARC [Australian Research Council] project and the new biodiversity fund project. So, we got financial support through the biodiversity fund which was linked to the Clean Energy Futures (INA1).

> We did get financial support from the catchment management authorities… to replant trees after the first direct seeding failed because we had two poor seasons for direct seeding of trees, and had the management authority help us with funding to replant (INA3).

Understandably, there are not enough sources of financial support. Therefore not all landholders can attain funding that would allow them to develop CFI-ERF or other environmental projects. Landholders willing to adopt the CFI-ERF, but unable to access any grants and without enough economic resources, may not be able to implement any of the activities under the policy. In this context, independent adopters recognized they were in a fortunate position compared to an 'average' landholder. The following quotes highlight this point:

> I already had grant money through the vegetation incentives program…I had a grant at the time. I still did a lot of work myself, but the grant offset costs. I was in a unique situation I suppose (INA2).

> If a landholder or farmer does not have that spare cash, they would have to get a grant. So, if they don't have spare cash or have a grant, then they won't do it, they simply won't do it (INA1).

Human resources

The interview elicited information about *human resources* to understand how this capacity factor impacted the adoption of the CFI-ERF, and to learn whether the informants had family-like or industrial-like farms. The first question asked about the number of people that worked in the informants' properties on a daily basis. The results revealed no difference between independent and associated adopters; all the informants would manage and work in their properties either themselves or with their spouses. In other words, all the informants had family-like properties and did not have farm workers employed in their properties on a regular basis. Therefore, all independent adopters had to hire workers at some point in the project's development. Therefore, the costs of hiring workers were a direct consequence of the CFI-ERF project development:

> We contracted a company – a forestry company – who plants trees as a commercial business…we sought them out and, we contracted them to plant the trees. There were twelve people to plant the twenty-seven thousand trees in one week (INA1).

> I used the Tablelands Regional Council's Community Revegetation Unit. They did the site preparation; I bought seedlings from them. They did some of the maintenance on the sites (INA2).

In addition to contracting workers, in most cases, the independent adopters also managed to get voluntary assistance from various organizations and community groups, especially during tree planting. "We also got some help in the planting of trees with the Conservation Volunteers for about five days," said one informant. "I self-funded it [the project] and got family and friends to assist with planting; I planted in my spare time on weekends," explained another informant.

Thechnical resources

Technical advice and adequate information about the process of implementation of innovations can have a significative impact on their adoption. Appropriate support can save time and other valuable resources that adopting particular innovations demand. In this study, only one of the independent adopters expressed having assistance in some aspects of the CFI-ERF. However, this support was provided by an individual external to the administrators of the CFI-ERF:

> I was very fortunate to have Andrew. He was my resource, he…knew how to use the models to do the calculations, and he could do the mapping and all of this stuff, so he was my primary resource (INA2).

Independent adopters also, in the absence of an adequate technical support, looked for advice from different sources and built their technical knowledge through experimentation. Nevertheless, it is important to consider that all the independent adopters had high levels of education, and in some cases science training and experience in the environmental area. These education, training and experience enabled them to embark on research and understand complex technical material as well. The quotes below explain:

> …Then the issue was how we do this. We sought advice from a lot of people. We studied up on it. We tested a lot of ideas. And I've mentioned, the first experiment that we did that we specifically did to test the spade method of planting trees against the auger method of planting trees. We know the auger method is very expensive, time-consuming; it's hard work. The spade method is much simpler, more straightforward, still hard work but it requires one person to plant a tree, and one person, one professional planter can plant 800 to 1200 trees per day…

> We didn't start with the knowledge; we didn't have prior experience on revegetating forest, so we sought advice and researched every aspect of what we're doing, and we made some mistakes but mostly we learnt enough to be able to make it work, and we had good success (INA1).

> We both have had science training. We have both been involved in – at all the levels – in a number of different types of projects. So we do, I think, we probably have had more, in that way, more significant resources, in human capital sense, than perhaps the average farmer (INA3).

6.4.2.6 Barriers

In this study, *barriers* refer to the difficulties, constraints or limitations that landholders encounter in overcoming and adopting a particular innovation. These barriers can hinder or even prevent the adoption of innovations especially when the intended adopters do not get assistance to deal with the impact of these constraints. Independent adopters showed an in-depth knowledge about such barriers, due to their experience going through the process of adopting of the CFI-ERF.

Independent adopters expressed their opinions about some barriers they consider significant to adopting the initiative. The informants also provided opinions about ongoing barriers that they considered critical (*i.e.,* barriers that persisted after adopting and becoming recognized offset entities by the regulator). Financial and economic factors, and uncertainty (*i.e.,* policy and carbon price uncertainty) were among the main barriers reported. The complexity of the policy and disconnection (lack of communication) between adopters and the CER, were also significant impediments. Understandably, most of these barriers were intertwined; some of them were the cause or result of other barriers. For instance, policy uncertainty would produce uncertainty in the price of carbon, which in turn would produce uncertainty on the economic return of adopting the CFI-ERF. It is important to point out that only independent adopters expressed their views about barriers. Associated adopters (CEEs) reported no barriers to adopting the CFI-ERF because, as stated before, CEEs carried out all the adoption process using their own capacity (financial, human, technical); from the implementation to the registration of the projects with the Clean Energy Regulator (CER). Put simply, the associated adopters did not experience first-hand the CFI-ERF adoption-implementation process.

The results show that economic and financial factors along with uncertainty were common barriers to adopting the CFI-ERF among the informants. The *economic barriers* can be divided into three broad categories, and are now discussed. Costs incurred during the project

application (implementation costs[23]), to comply with regulations (transaction costs[24]) and lost revenue (opportunity costs[25]) due to using the land for CFI-ERF activities instead of other traditional productive activities, were among the most common economic barriers reported.

Costs and financial availability

The availability (shortage) of financial resources and support to cover substantial expenses during project development were significant barriers reported by the informants. Some adopters had to cover those costs without any funding, which in turn had a direct impact on the size of the project. The following quotes refer to the implementation cost as a significant barrier for landholders to adopt the CFI-ERF:

> To start-up, costs are probably the biggest impediments because to reforest at a landscape scale is going to cost anywhere between five to twenty-five thousand dollars (per hectare) sometimes more depending on what you're doing. So you have to find that money… sometimes fifty-thousand dollars per hectare to revegetate, so it's a very expensive exercise (INA1).

> I self-funded it [the project] and got family and friends to assist with planting; I planted in my spare time on weekends. I drew funding from other areas of my life and it's been a hard work. This is why I have two hectares, and not [the] two hundred hectares I wanted to have. I still don't have the finances I need (INA5).

The shortage of economic resources and the difficulty to access to credit also have a considerable impact on the adoption of carbon farming projects. Getting a loan money from financial institutions is (too) risky due to the uncertainty of generating income from carbon farming projects. That is why landholders sometimes prefer to invest in farming activities that can have less risk. The following quote illustrates this point.

> We would not have done that [get a loan] for a principal reason… uncertainty about it [economic revenues from projects] because even if we got a loan, we would never know whether we could pay it back from planting trees. There is no way we would ever go to loan for such an uncertain project. If we were growing cattle I may go and get a loan because I know I

[23] Implementation costs are the expenses of setting up CFI-ERF projects, e.g. buying and planting trees.

[24] Transaction costs include the costs resulting from the negotiation, registration and auditing of CFI-ERF projects.

[25] Opportunity costs mainly refer to the lost revenue resulting from using the land for CFI-ERF projects rather than other productive activities.

> can grow cattle, sell them, pay back the loan. With trees, I still don't know whether we're going to make any money out of the 40,000 trees we've planted. I still don't know (INA1).

One of the barriers linked to implementation costs is the time period that, depending on the type of project, adopters have to wait until getting some economic return from the application of their CFI-ERF projects. The quote below provides a good example of these two barriers interacting:

> If someone is anticipating making some money from the Carbon Farming Initiative, they will do cost-benefit analysis, model how much (it) costs to start growing a forest; where you've got to spray beforehand, you have to buy the trees, get them in the ground – you could use either yourself or contractors to put trees in the ground – and you have to maintain them. So, all those costs had to come up in the first three to four years but the carbon credits, you don't get them, provided that you already have trees on the ground, for a number of years. You can't get them in advance; you can only get them afterwards. So you may have five years of no income from substantial expense for every hectare (INA1).

There are a series of other costs aligned with the bureaucratic processes involved in the developing of CFI-ERF projects, namely *transaction costs*. The expenses associated with the project auditing process[26] were considered as one of the most significative barriers, which in turn can have a significant impact on the prospect of attaining economic returns from the application of carbon farming projects. What is more, auditing costs, from the views of some adopters, can be prohibitive and have dramatic effects on the stability of the project. When asked whether ongoing barriers existed, one of the informants said: "Just that one…the auditing. If I can't resolve that issue then I'll have to cancel the project – let it lapse" (INA2). The quotes below expand on this issue:

> The barrier that came up after getting the project approved was getting it audited. The cost of getting an audit done, at the time, was way too expensive for me. I kept quotes of thousands of dollars, and I wasn't going to pay that because I knew there was no way I was going to get it back in credits…The cost of getting an audit done to satisfy the regulator that we've made all… we have stated in our project, [that the] application is all correct, that the information is all correct, that we've got the records. It seems to be more about looking at it from an accountancy

[26] Auditing is a compulsory step to assess the accuracy of the amount of abatement reported, as a result of the application of the project, to support the issuing Australian Carbon Credit Units (ACCUs). Note: one tonne of carbon dioxide or equivalents (CO2-e) equals one ACCU.

> point of view; that all the papers are in order and all the records are there, rather than…there are the trees, and you can actually see them (INA2).

> Another barrier is the cost of auditing small projects... Because it's about five thousand dollars to audit our project and it's got to be done three times, and if we were successful in this reverse auction process, I'm sure we'd be getting paid less than we'll be paying in auditing (INA3).

Therefore, opportunity costs should be considered when designing any policy intended for landholders or any other sector of the economy. Sacrificing income from using the land for carbon farming activities, instead of undertaking traditional productive activities, is indeed a significant impediment that can prevent landholders from adopting the CFI-ERF. The following quotes illustrate this barrier:

> Of course, there's a side factor of lost opportunity cost or lost revenue from cattle because we could have been making twenty-five to thirty thousand dollars a year from cattle just by growing cattle on this grass… So that's a serious cost, so not only have we got all the upfront cost of planting a forest, we also lost income by taking the cattle off because you can't grow cattle and trees at the same time, they are not compatible (INA1).

> When it started up, there was a price of twenty-three dollars; you probably broke even… It's broke even about twenty-two, twenty-three dollars, compared to what you would earn if you run one sheep to the hectare on that land. But counting the upfront cost, which is quite considerable, but the price we are talking about now is just nowhere near to covering the upfront cost (INA3).

Uncertainty

Uncertainty was a common concern among the independent adopters. The barriers resulting from uncertainty mainly revolved around three aspects: policy uncertainty, carbon price uncertainty and uncertainty about the economic benefits of the participation in the scheme. The Australian climate policy, including the Carbon Farming Initiative (introduced in 2011), as part of its normal evolution, has undergone a series of dramatic amendments. Some of these changes have been very drastic producing great uncertainty among adopters. In some cases, this uncertainty undermined the confidence of landholders to the point that they considered discontinuing the development of their projects. The quotes below illustrate their concerns:

> … The rules have changed a bit since then but again that's the problem the whole way has been uncertainty about policy. We had four changes in legislation, three or four changes in legislation, in the last six years and dramatic changes in policy which just makes it too hard, and

> farmers have got a lot of work to do in their properties without having to worry about policy changes (INA1).

> I've lost interest because…when I first started working on the project with Andrew we thought that there would be more revegetated area that could be included in a project and there might actually be some returns, some net return. But as the project developed and the rules became clearer, the amount of area reduced greatly and it got to a tipping point… Is it worth keeping going with this? Or should I just give up now? I decided [to continue] because I had put so much energy into it already that I would keep going. And my hope was that we would be able to use my experience as a case study for others, so that my experience would be shared with other people who might be able to benefit from it (INA2).

Furthermore, one of the independent adopters explained that some of the policy amendments did exclude other landholders from participating in the scheme. The dramatic changes in the rules made it impossible to include some reforested areas as CFI-ERF projects. It is important to note that this informant indicates that these projects started before the inception of the CFI-ERF but were excluded because of the new rules (introduced by the CFI-ERF):

> We did some work with landholders across the Tablelands a number of years ago in 2008 and we measured thirty-seven different properties of trees with the idea to putting them up as carbon projects and the government changed the rules so that before… while we were doing the measuring and the plot assessments they were eligible; within two years they were not eligible. So, none of them – not one – can claim carbon credits because of the rules (INA1).

The substitution of CFI-ERF for the Emissions Reduction Fund (ERF), the central piece of the Direct-Action Plan introduced by Australian's government, proved to be a major source of uncertainty both from the policy and economic perspectives. Besides all the adaptations that landholders had to undergo in their projects to comply with the new rules of the ERF, they also had to deal with the uncertainty of carbon prices[27], due to the introduction of a reverse auction mechanism to trade ACCUs. The lack of stability of the price of carbon also means uncertainty about the economic benefits of adopting the CFI-ERF and the prospects of expanding existing or implementing new carbon farming projects:

[27] The CFI-ERF had a fixed carbon price for 2012-2013 and 2013-2014 financial periods at a price of A$23 and A$24.15 respectively.

> The main barriers at the moment are uncertainty about the price of carbon because, now that the rules have changed under the Direct Action Plan, we have no idea what we might be paid… and that would stop other farmers from adopting (INA3).

> There is no benefit based on current bureaucratic process that we have to endure without any locked in price or anything… an environmental benefit is when the landowners benefit so that they can grow more forest, or improve their soils (INA4).

The reverse auction[28] trading approach of the ERF, where the Australian government is the only buyer, has a direct impact on the price of carbon credits. Understandably, the costs of generating carbon credits highly depend on the type of GHG abatement activity (CFI-ERF methodology applied). For instance, generating carbon credits from GHG emission reduction activities (e.g. reduction of methane emissions from landfills) may have different costs than those resulting from carbon sequestration activities such as reforestation activities. One adopter explained:

> The main issue is the price – the price of carbon. So, with the Direct Action auction process driving down the price of carbon, it is very hard for land-based, land sector projects to compete with industrial efficiency and other projects (INA5).

Furthermore, an ERF reverse auction employs a blind auction approach. The participants in the process have to present confidential bids and typically, the cheapest offers are successful. Therefore, this blind reverse auction approach adds more uncertainty to the price of carbon credits:

> The other impediment is the government policy… there's no evolution, we're gonna stick to this blind auction process and there is not a clear market signal. We don't know what the prices are for the different methodologies and the different projects. So there's no transparency in the market (INA5).

Communication and information

Undoubtedly, a two-way fluid *communication* between different stakeholders is essential and can have a direct impact on the acceptance and success of any policy. Therefore, administrators should provide adequate information about important aspects of the policy. Moreover, adopters of the policy should be considered a valuable source of information to

[28] During an ERF reverse auction, the Australian government would buy carbon credits from bidders who offer the cheapest prices.

detect issues, and if necessary correct or expand any particular policy and its rules. This feedback process may help to attain the purpose(s) of the innovation. However, an independent adopter expressed concern that policy makers and bureaucrats were not considering their views on important aspects of the CFI-ERF. The following quote exemplifies this point:

> No one asks us; no one talks to us. It's all done in an office. That's a barrier because they know nothing, they have no knowledge on growing rainforest… They have no knowledge on the different bioregions. In other words, there's such a lack of knowledge by the government (INA4).

Additionally, there were claims that policy makers and administrators not only had ignored landholders' views but also had disregarded opinions of experts on the field. The following quote refers to the need to openly consider actual adopters', and experts' knowledge in the design and future development of the policy:

> No one ever asks us – the people that are doing it – how or what the best way is. And another person who has great knowledge of it, who works for EHP [Department of Environment and Heritage Protection] he's never asked (INA4).

An apparent failure of communication between the administrator of the CFI-ERF and service providers, in this case the auditors, had also created a barrier for the informants. Specifically, the adopters were receiving contradictory information about the costs of performing an audit to their projects. This situation caused frustration to adopters. The quote below explains:

> When I was trying to get it to happen [the audit], there was a complete disjunct between the regulator and the auditors. The regulators were saying, 'it shouldn't cost that much to do an audit'. They [CER officers] thought a couple hundred dollars. And the auditors would say, 'they don't know what they're talking about – they don't know what's involved in an audit. When I do an audit, I have to meet all these standards and to meet all these standards I can't do it for a couple hundred dollars' (INA2).

Finally, non-effective communication can create misconceptions and it seems some opinions might have created a negative environment, discouraging other potential adopters to consider the implementation of CFI-ERF activities. That was the view of one of the adopters:

> I think to a lot of people the whole thing has just had a lot of bad press. People talk in very negative terms about it – locally anyway – and a typical comment would be, 'it just all seems too hard' (INA2).

Policy complexity

The design of any *policy* and the *rules* it contains can represent a barrier to its acceptance by the intended adopters. Long, expensive and complicated bureaucratic processes can hinder or prevent the adoption of the initiatives. Therefore, completing all the requirements should be reasonably straightforward, so that critical policies do not become exclusive limiting the participation of typical landholders. Informants claim that the complexity of the CFI-ERF is a barrier; understanding and applying CFI-ERF methodologies is excessively time-consuming, and that more importance is given to the paperwork rather to the actual reforestation. The quotes below explain this issue:

> I think the government policy is an impediment… the time it takes to either understand the methodology and implement it properly or develop your own methodology which costs a lot of money. So, the technical aspects, the methodologies are highly technical and you have to follow them correctly, so that takes a lot of time and effort as well (INA5).

> It seems to be more about looking at it from an accountancy point of view. That all the papers are in order and all the records are there, rather than…there are the trees and you can actually see them (INA2).

> The bureaucracy; there will be no really great benefit for the environment unless they change and simplify the system. After all, mother nature is not a factory, it's not a manufacturing process (INA4).

6.5 SUMMARY AND CONCLUSIONS

6.5.1 Summary

As explained in Chapter, given the overlap among the DKMCB factors, the results about the influence on the adoption of the CFI-ERF are interpreted as indicative. In other words, the results indicate the existence of a relationship of the factors and the adoption of the policy rather than an absolute predictability of adoption.

One of the first results from the QUAL data analysis revealed the existence of two different groups of adopters: informants who adopted the CFI-ERF independently (independent adopters), and informants who implemented their projects in association with CCEs (associated adopters). As stated before, associated adopters did not experience first-hand the process of adopting the CFI-ERF. Associated adopters explained that CCEs did all the project implementation and registration work using their own resources. Due to this strong intervention of CCEs, associated adopters' contribution to the analysis of the factors of

adoption was limited. Nevertheless, the comparison of demographic characteristics as well as property size and type of projects implemented showed interesting insights (Annex 8 contains a matrix of the analysis of property and type of projects adopted). Associated adopters' properties and projects implemented were considerably larger than those of independent adopters. It can be assumed that the size of project implemented by associated adopters in conjunction with CCEs responds to a potential profitability of carbon trading resulting from the venture. Also, because CCEs did all the project implementation work at their own capacity, it can be assumed that not having the financial and bureaucratic burden of the implementation of the project facilitated landholders' decision of adopting the CFI-ERF. In contrast, all independent adopters' projects were relatively small because they had to deal with all the implementation process and use or gain access to the necessary (financial, human and technical) resources themselves, which had a direct impact on project size.

Level of education also showed a difference between adopter groups, as associated adopters had achieved secondary education while all independent adopters had tertiary education qualifications. This result does not imply that in general landholders working in association with CCEs may, in general, have lower levels of education than independent adopters. However, it supports the argument that higher levels of education enable landholders to deal, for instance, with administrative processes involved in the adoption of the CFI-ERF and reduce some costs, e.g. consultancy expenses and tackling technical issues (Ducos et al., 2009).

Independent adopters in general had a good understanding of the CFI-ERF, its benefits and disadvantages. All independent adopters increased their knowledge through the implementation and registration process of their own projects. And in some cases, informants conducted research on different aspects of the adoption process (e.g., tree planting methods). Environmental benefits (Sinnett et al., 2016; Torabi & Bekessy, 2015; Torabi, Mata, et al., 2016) were the main motivation of independent adopters, followed by economic return. Costs and uncertainty of the carbon policy and carbon prices (Dumbrell et al., 2016; Evans et al., 2015; Page & Bellotti, 2015; Torabi & Bekessy, 2015) shortage of economic resource, and the difficulty of accessing to credit due to the uncertainty of potential profitability of the projects (Summers et al., 2015) were strong barriers for the informants. Finally, all the independent adopters agreed that transaction costs were a significant barrier (Macintosh, 2014; van Oosterzee et al., 2014), especially the auditing process as required by the CFI-ERF

legislation. Thus, the informants considered that a mechanism to reduce some of the fixed costs to meet the policy requirements (Cacho et al., 2013) is crucial going forward.

Regarding the theoretical perspective of this thesis, some of the results concur with the claims of the DOI and other oppose. For instance, the DOI, in the definition of categories of adopters, states that innovators are often young individuals with high levels of education and capable of manage and understand complex information. The results of the study reveal that, in fact, most of the adopters of the CFI-ERF had high levels of education, even, some of them had training in science. Therefore, they are able to understand complex knowledge about innovation. Also, complexity of the innovation has been found as a significant barrier to adopting the innovation, which also agrees with the postulates of the DOI. And communication and communication means are crucial on the spread of the new practice. On the other hand, age of the potential adopters, which has had a major attention in the DOI as an important factor, in this study, age was found non-significant in predicting the adoption of the CFI. Furthermore, motivation to adopt innovations is not directly addressed by the DOI theory, however, in the present study, motivation (e.g. *economic benefits/return, availability of technical support and moral responsibility)* is one of the most significant factors indicating strong relationship with innovation adoption.

6.5.2 Conclusion

Adopting innovations depends on a series of factors. The design and the purpose of the innovation, the characteristics of the intended adopters and the means through which the existence and the advantages of the innovation are spread are essential to achieving ideal levels of acceptance. Intended adopters usually have different levels of knowledge about innovations, and their motivations and capacity to adopt a particular innovation are also varied. Additionally, certain circumstances can pose barriers to intended adopters to implement new ideas.

In this study, two groups of adopters have been identified. The first group, associated adopters implemented their projects in association with Carbon Consulting Enterprises (CCE). CCEs, did all the project implementation and registration work. Due to the intervention of CCEs, associated adopters did not experience the adoption process first hand, for instance the informants did not have any complications in accessing information about the initiative or either use their financial, human and technical resources. Thus, the contribution of associated adopters to this study was limited. In contrast, the independent adopters had to

work hard to learn about the initiative and attain the resources needed to adopt it. They also had to overcome a series of barriers to adopt the CFI-ERF, and some of these barriers-- especially uncertainty about the policy and carbon prices-- even threatened the stability of some established projects.

These results regarding the associated adopters highlight the need for more research investigating the impact that Carbon Consulting Enterprises (CCE) have as change agents on the adoption of the CFI-ERF in the land sector. It is important to understand how the CCEs surmounted the barriers to adopting the CFI-ERF and how viable it is for CCEs to meet their commitments with the landholders working with them.

The next chapter presents a discussion of the QUAL and QUAN results together and considers these against the propositions of the Diffusion of Innovations theory. Importantly, some of the findings obtained in the QUAN phase will be examined and reflected on in the context of the QUAL results, which is the primary rationale for the application of mixed methods approaches. This chapter also discusses the theoretical and practical implications of this study and the usefulness of its approach to assess not only the application of other environmental policies, but also to study what factors and how the interactions among them impact on the adoption of any particular innovation by the target population.

Thesis Outline

Chapter 1	Introduction
Chapter 2	The big picture. A context analysis to the Carbon Farming Initiative-Emissions Reduction Fund
Chapter 3	Theoretical framework and overview of the factors that influence the adoption of the Carbon Farming Initiative-Emissions Reduction Fund
Chapter 4	Methods
Chapter 5	The role of demography, knowledge, motivation capacity and barriers on the adoption of the Carbon Farming Initiative-Emissions Reduction Fund: A quantitative study
Chapter 6	The role of demography, knowledge, motivation, capacity and barriers on the adoption of the Carbon Farming Initiative- Emissions Reduction Fund: A qualitative study
Chapter 7	**Integrating the quantitative and qualitative results: Analysis and discussion**
Chapter 8	Conclusion and recommendations for further research

CHAPTER 7: INTEGRATING THE QUANTITATIVE AND QUALITATIVE RESULTS: ANALYSIS AND DISCUSSION

Chapters Five and Six presented the results of the present study which used a sequential explanatory mixed method research (MMR) design. The study investigated the role of demography, knowledge, motivation, capacity and barriers to the adoption of the Carbon Farming Initiative (CFI-ERF). The research design comprised of two consecutive phases: one quantitative (QUAN) and one qualitative (QUAL). This chapter combines the QUAN and QUAL results and discusses the role of the factors that influence the adoption of the CFI-ERF. Knowledge and motivation were found to be significant factors that influence landholders' decisions in adopting the CFI-ERF. Interestingly, the QUAN results revealed that the more knowledge landholders had about the CFI-ERF, the less likely they were to adopt the initiative. Ecosystem and environmental benefits were the main drivers of adoption according to the informants interviewed during the QUAL phase. Informants also explained the most constraining barriers to adopting the CFI-ERF. Some of these barriers related to costs and were unavoidable (e.g. cost of implementing the projects). Other barriers originate from the design and some changes that the policy has undergone, particularly now that the CFI-ERF is part of the Emissions Reduction Fund (ERF) (e.g. uncertainty over carbon prices that emerged partly as a result of the reverse auction process). A brief overview of the research outline, showing the integration of the research questions with the MMR approach adopted in this thesis, has been included to provide an overview of the research procedure.

7.1 RESEARCH METHODS AND QUESTIONS

7.1.1 Approach

A sequential explanatory mixed methods design (Creswell & Plano Clark, 2007, 2011; Ivankova et al., 2006) was applied to investigate the role of demography, knowledge, motivation, capacity and barriers to the adoption of the CFI-ERF. Consequently, the research process consisted of two consecutive phases: first a QUAN phase followed by QUAL one. Additionally, both phases of the study were integrated at different levels; the results of the first phase provided input for the second phase, and the results of the second phase expanded and explained the results of the first phase.

Research questions were formulated for each phase of the study. In other words, the first phase addressed a research question through the analysis of QUAN data using statistical methods. On the other hand, the second phase addressed a research question through the analysis of interview data using quantitative methods. Figure 7.1 shows the outline of the research process, the research questions and the integration between the QUAN and QUAL phases.

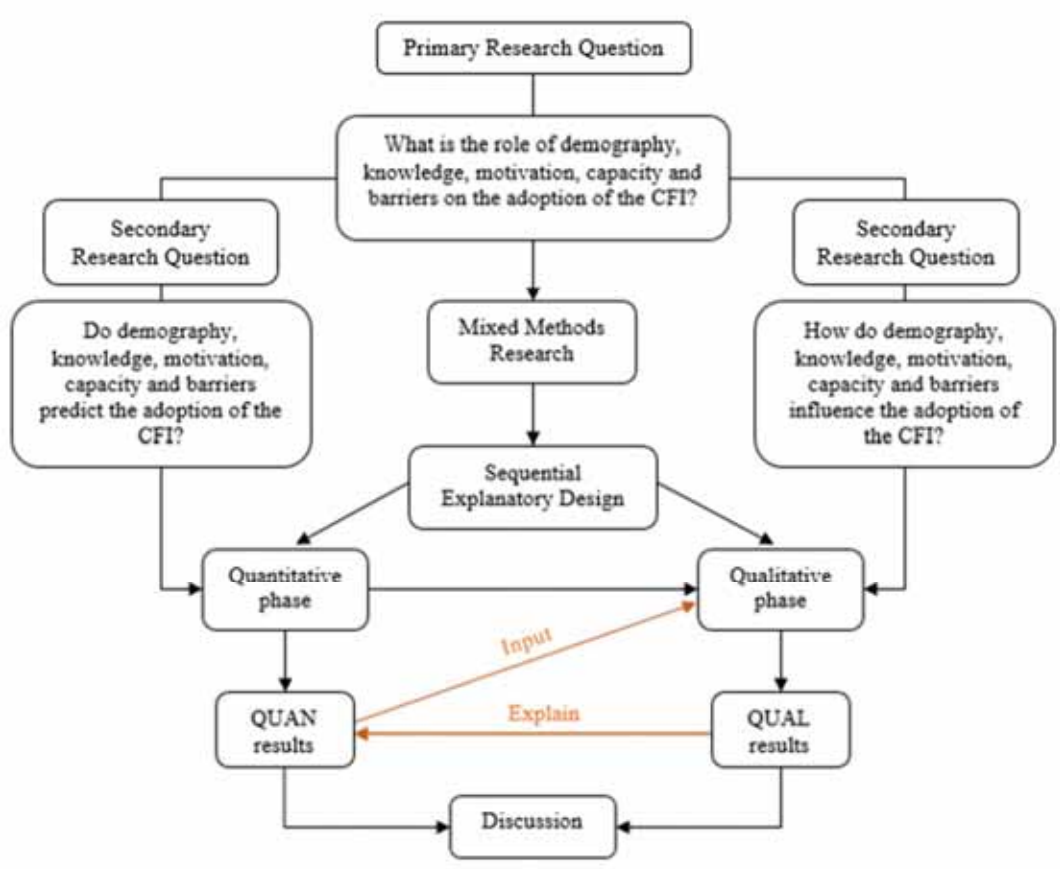

Figure 7.1 Research questions and research design

7.2 STUDY PARTICIPANTS

The QUAN phase of the study used a survey questionnaire targeting (rural) landholders across Australia. A total of 214 valid responses were used for the QUAN data analysis. The survey questionnaire was also used to identify adopters of the CFI-ERF, who voluntarily provided contact details to participate in the second phase of the study. Chapter 5 contains detailed explanations of the QUAN research methods, participant recruitment protocols, as well as participant demographic characteristics.

The QUAL phase used in-depth semi-structured interviews for data collection. The interviews were addressed only to adopters of the CFI-ERF due to the knowledge and experience gained through the implementation and registration of their CFI-ERF projects. Thirteen adopters of the CFI-ERF, identified through the survey questionnaire, were invited to participate in the second phase of the study. Of the thirteen adopters invited, seven (informants) accepted the invitation and took part in the study. Four interviews were conducted face-to-face and three over the phone. As explained in Chapter 6, all the informants had implemented carbon sequestration projects. Specifically, two projects were under avoided deforestation and five were under environmental plantings methodologies. A complete description of the QUAL phase participants and projects implemented can be found in Chapter 6.

7.3 RESULTS OF THE STUDY

This section provides a discussion of the main findings of this research through integration of the primary results from the quantitative and qualitative phases. The quantitative findings are expanded and explained by the qualitative results, which is consistent with the purpose of explanatory sequential mixed methods approach (Creswell & Plano Clark, 2011). Thus, the integration of QUAN and QUAL results in this discussion aims to provide a deeper understanding of the role that the factors, subject of this study, played on the adoption of the CFI-ERF. Although the intention of this chapter is not to introduce new data, some quotes from the key informants who participated in the in-depth interviews have been included. The quotes provided in some passages of this chapter help explain some QUAN results and to support the argument of this thesis.

7.3.1 Independent versus associated adopters

The existence of two different groups of adopters was one of the first findings drawn from the QUAL data analysis: landholders who implemented CFI-ERF projects independently (here termed independent adopters) and landholders who implemented CFI-ERF projects in association with Carbon Consulting Enterprises (CCE) (here termed associated adopters). CCEs, acting as change agents[29], facilitated associated adopters in the adoption and implementation of the CFI-ERF. The Diffusion of Innovations theory (DOI) discusses the

[29] "A change agent is an individual who influences clients' innovation decisions in a direction deemed desirable by a change agency. In most cases a change agent seeks to secure the adoption of new ideas, but he or she may also attempt to slow the diffusion process and prevent the adoption of certain innovations" (Rogers, 1983, p. 312).

impact that change agents can have on the adoption, and sometimes on decelerating and preventing adoption of innovations (Rogers, 1962, 1983). In fact, as expressed by the associated adopters, the CCEs used their own resources to implement and later register the projects with the Clean Energy Regulator (CER). Due to CCEs' strong intervention, associated adopters did not experience first-hand the adoption process. Therefore, associated adopters' contribution to the discussion of the influence that the factors under study have on the adoption of the CFI-ERF was limited. Consequently, the QUAN results only include the opinions of the independent adopters.

The next section evaluates and synthesizes the combined results of the QUAN and QUAL phases for all the factors under study, i.e. demography, knowledge, motivation, capacity and barriers. For readability purposes, in the factor by factor analysis, the QUAN results are introduced first, followed by the QUAL explanation when available.

7.3.2 The role of demography in the adoption of the CFI-ERF

Many studies have reported that demographic factors have a significant influence on the adoption of new ideas (e.g. Greiner, 2015; Greiner & Gregg, 2011; Pannell et al., 2006). Demography of potential adopters is also a central factor of study in the DOI (Rogers, 1962, 1983). In the QUAN study, of the four demographic indicators (i.e. gender, age, level of education and occupation or other activities), only *occupation*[30] and *gender* were found to be significant predictors.

According to the binary logistic regression test, *occupation* was found to be the strongest demography predictor of adoption. The results showed that landholders mainly engaged in farming/agricultural activities (commonly landholders also have other off-farm activities) were almost three times more likely to adopt the CFI-ERF than landholders whose primary occupation is off-farm. The results of the QUAL phase also support the influence of occupation on the adoption of the CFI-ERF. Although some informants had off-farm professional activities, they were mainly engaged in running their properties. In all cases, the informants operate their properties themselves without employing paid workers to assist in the day-to-day work. Also, many of the informants had participated or were involved in environmental projects (besides their own projects) from managing and consulting positions. These results support the importance of the innovation compatibility, not only with adopters'

[30] Occupation assessed whether landholders' main occupation was on-farm or off-farm.

occupation but also with the adopters' personal interests (Pannell et al., 2006), as argued by the DOI theory (Rogers, 1983).

The binary logistic regression predicted that female landholders were slightly more likely (0.5 times) to adopt the CFI-ERF than males, hence showing the importance of *gender*. The QUAL results showed that in all cases the projects are run by both spouses/partners together.

The QUAL results expanded on some of the demography indicators revealing a critical influence of *level of education* on the adoption of the CFI-ERF. In all cases, the informants had attained tertiary education degrees and some of them had also attained postgrad degrees. What is more, some of the informants had training in science-based disciplines. This high level of education and, in most cases science training of the interview participants, as explained later, facilitated the informants to conduct research on some aspects of the implementation of environmental plantings under the CFI-ERF. According to Ducos et al. (2009), high levels of education can have a positive influence in the adoption of new practices in the land sector since education can help reduce some costs e.g. contracting assistance to deal with administrative procedures required by regulations. Also, education allows landholders to understand and deal with technical difficulties (Ducos et al., 2009).

7.3.3 The role of knowledge in the adoption of the CFI-ERF

During the QUAN data analysis, the predictability of *level of knowledge*[31] of adoption of the CFI-ERF was assessed used binary logistic regression. The results showed that an increasing level of knowledge was associated with a decreased likelihood of adoption of the CFI-ERF. Put simply, the results suggested that the more the participants knew about the CFI-ERF, the less likely they were to adopt the initiative. Since adoption constitutes a learning process (Pannell et al., 2006; Rogers, 1983), increasing knowledge about an initiative may either encourage or prevent adoption of innovations. Landholders are inclined to adopt initiatives when they learn whether the innovation presents relative advantages (Rogers, 1983; Stanley et al., 2006). Conversely, landholders reject an innovation when the information they receive about the innovation or the results of trials are not reassuring (Pannell et al., 2006). During the in-depth interviews, looking for an explanation for this finding, informants were asked the following questions: 1) if you had to start over (developing and implementing your CFI-ERF

[31] The level of knowledge variable was a composite score of four predictors: familiarity with the CFI-ERF, familiarity with the benefits of the CFI-ERF for landholders, familiarity with the environmental benefits of the CFI-ERF and information about the CFI-ERF (refer to Chapter Four).

project), would you do it?; and 2) would you recommend other landholders to adopt the CFI-ERF?

When asked if they would start over if they had to, the informants responded positively and negatively. However, despite landholders' positive or negative perspectives, the interviewees highlighted the shortcomings, especially those related to the costs of running a CFI-ERF project, including those associated with the carbon price, and consequently the prospects of achieving an economic return. The quotes below illustrate this point.

> Yes, because I'm a true believer [of carbon farming to mitigate climate change]. Although right now it is not a financially good decision. I've put a lot of money in and I haven't gotten anything back. It is my career. It doesn't look good when you try to persuade other people when they want to know how much profit has been made (INA5).

> No, probably no. Permit me to clarify that … for carbon farming, I don't think so, we would have done something different. We might have rehabilitated some of the property areas where we thought it was important, but not at the scale we did. It is actually thirty hectares… and it still requires a lot of maintenance; weed control mostly. And at some stage, we want to put cattle back on, but that means that we will have to fence areas where we wanna [want to] keep cattle, so they do not damage the trees (INA1).

Similarly, when asked if they would recommend other landholders to adopt the CFI-ERF, informants said that it is difficult to make a case in favour of adopting the initiative given the present conditions [at the time of the interviews]. Thus, informants said that they would not recommend other landholders to implement CFI-ERF projects especially if the potential adopters' expectations are to get economical/financial benefits from carbon trading due to the price of carbon credits. One informant said: "under the current [circumstances], no. I'd be suggesting wait a bit longer until it becomes clear what your carbon credits are going to be worth" (INA2). The quotes below explain more about these issues:

> No… I got to expand a little bit because I think it's important. If someone from the land, [e.g.] my neighbour across the road, said look we are thinking about planting trees to try to sell carbon, I would say don't. I would say don't even think about it. If you will plant trees to rehabilitate your eroded galleys and you got a spare ten or twenty or thirty thousand dollars for a couple of hectares, then do it. Do not plant for carbon because you will not know whether you are gonna [going to] get returns from it or not. So, if it's just for better management of your property, go ahead (INA1).

> We have been trying to encourage other farmers to look at it, but it's hard to justify really…It's a good idea to have more carbon in your soil but if you get nine times the benefit of getting the carbon in the soil just from increasing production without worrying about trying to register for carbon farm[ing], because it is a far too riskier thing to do. It's a good idea generally to plant trees and to have them as part of your farm plan, but to go the extra step and register [your tree planting area] as a carbon farming [project]… [it is] really hard to justify (INA 3).

One of the informants also added that he/she lost an opportunity to get some return from the implementation of the project due to government bureaucracy. The informant explained that the government intervened and hampered negotiations between the informant and an enterprise(s) interested in buying his/her *story*[32]. This may be an isolated case, but it is worth highlighting to illustrate how very specific issues may impact on the adopters' decision of recommending or not the adoption of the CFI-ERF to peers.

> Well, I am so disillusioned myself in having deals broken because of the bureaucracy that none of them [landholders]… won't have a part of it because there is no benefit that they can see. And, with the carbon price now at a very low price, why would we [recommend the CFI-ERF]?... No, I wouldn't (INA4).

Informants' opinions presented above show that there are many difficulties that landholders who are willing to adopt the CFI-ERF must endure. The informants indicate that the uncertainty about carbon prices makes adopting the initiative a risky enterprise, particularly because of the high costs of implementing and maintenance of environmental planting projects (Sinnett et al., 2016; Summers et al., 2015; van Oosterzee et al., 2014) which specially impact small landholders thus favouring large landholders (van Oosterzee et al., 2014). Scholars argue the impact of costs (implementation and transaction costs) on profit, even when landholders' main motivations are not economic gain (Greiner et al., 2009; Lin et al., 2013; Pannell et al., 2006; Stanley et al., 2006). As the DOI theory (Rogers, 1983) explains, a better understanding of an innovation allows intended adopters to make better (more informed) decisions of either adopting or rejecting an innovation. Additionally, Rogers (1983) argued that if members of a target population do not perceive a relative advantage (among other factors discussed in this chapter) of the proposed innovation, they will not adopt it. The QUAL analysis found in this study suggest that the economic and bureaucratic

[32] In this case, the informant explained that business organizations such as RACQ offered economical compensation to publicize his/her 'story' of protecting ecosystem and rehabilitating natural habitat.

circumstances, posed by the initiative are discouraging and that is why the more landholders know about the CFI-ERF, the less they are willing to adopt it.

To sum up, the knowledge acquired by (independent) adopters through their experience and through their networks, in the case of the adoption of the CFI-ERF seems to weight against adopting the innovation. In fact, the expressions of some of the interviewees, suggest that when they first adopted the innovation, they had totally different expectations. Then, as they accumulated more information and processed it, they started to have a negative opinion about the benefits, other than environmental, of implementing carbon farming activities.

7.3.4 The role of motivation in the adoption of the CFI-ERF

In the QUAN phase, survey respondents ranked the importance of seven motivation indicators (refer to Chapter 5) to adopt the CFI-ERF. The indicators were assessed using binary logistic regression to test whether the indicators predicted the adoption of the CFI-ERF. Of the seven indicators four were statistically significant; *government regulations* was the strongest predictor, followed by *moral responsibility*, *economic return,* and *availability of technical support*. Interestingly, the results showed that the higher the score of government regulations, the less likely the participants were to adopt the CFI-ERF. This suggests that, in the context of this study, regulations introduced by the government to induce the adoption of environmental innovations, such as the CFI-ERF, can have in fact had the opposite effect, encouraging non- adoption by the intended population. On the other hand, the high scores of *moral responsibility*, *economic return* and *availability of technical support,* were associated with an increase of the likelihood of adopting the CFI-ERF. The QUAL results showed consistency with the QUAN results. All the independent adopters stated that climate change mitigation along with environmental, ecosystem and biodiversity benefits were their primary motivations to adopt CFI-ERF activities. Specifically, the informants considered reforestation and its co-benefits, *i.e.* habitat restoration and biodiversity conservation, as the most important reasons to implement their projects (Dumbrell et al., 2016; Evans et al., 2015; Greiner & Gregg, 2011; Schirmer & Bull, 2014). Informants' interest in protecting the remaining ecosystems and restoring degrading land must, therefore, be regarded as part of their responsibility to protect nature (environmental concern) (Bamberg, 2003). Economic return was also considered significant. Understandably, most landholders expect some financial incentive (Greiner, 2015) that can be used to achieve greater goals, e.g. family wellbeing, property improvement (Greiner et al., 2009). They also want to make up the

expenses of implementing and running their projects. Further, some informants intended using that return to expand their CFI-ERF projects. Other important motivations that had driven the uptake of the CFI-ERF by the informants were: research and knowledge sharing with other landholders interested in the initiative, and community wellbeing. Land and environmental stewardship were strong adoption drivers (Greiner & Gregg, 2011; Lin et al., 2013; Page & Bellotti, 2015; Torabi, Cooke, et al., 2016) and nearly all independent adopters were doing reforestation and habitat restoration even before the initiative started. Thus, the CFI-ERF vegetation methodologies were compatible with informants' farm activities (Rogers, 1983) and environmental attitudes (Page & Bellotti, 2015). Environmental policies such as the CFI-ERF have to be designed in a way that provides an opportunity to landholders to achieve their environmental goals (Lin et al., 2013) while providing reasonable economic incentives to account for cost incurred due to project implementation (Ducos et al., 2009; Greiner, 2015; Kragt et al., 2016; Rochecouste et al., 2015).

7.3.5 The role of capacity in the adoption of the CFI-ERF

Three indicators of capacity were included in the questionnaire used in the QUAN phase. Australian landholders were asked to rank their level of agreement using a five-point Likert scale (from strongly disagree to strongly agree) about whether they had the financial, human and technical resources to adopt the CFI-ERF (refer to Chapter 5). Responses were assessed using binary logistic regression tests. Of the three indicators, two: *financial resources* and *technical resources* significantly predicted adoption of the CFI-ERF. The results showed that the more financial resources landholders had, the less likely they were to adopt the CFI-ERF. This result suggests an apparent lack of interest of landholders who enjoy a good financial situation to adopting market schemes such as the CFI-ERF. No evidence could be found in the review of literature to support this finding. But a general assumption that people enjoying a rather comfortable financial situation do not feel the need to look for alternative sources of income may help explain this point. Another explanation may come from the access to information; landholders in an advantageous financial position may be more aware of the financial risk (e.g., regulation changes, upfront establishment costs contrasted to revenue generation over decades) associated carbon trading in Australia (Greiner et al., 2009; Polglase et al., 2013). On the other hand, the more technical resources landholders had was associated with an increased likelihood of adopting the CFI-ERF. Naturally, the availability of technical support can encourage the adoption of the CFI-ERF due to the confidence provided to landholders in the development and implementation of projects (Ducos et al., 2009; Pannell

et al., 2006). In the in-depth interviews, key informants were asked about the resources they had when facing the process of adopting the CFI-ERF. Most of the informants used a combination of their economic resources and grants from organizations working in the environmental arena to cover the expenses of implementing their CFI-ERF projects. The informants who attained funding acknowledged that they were in a fortunate position compared with other landholders who may not be able to obtain grants. Only one informant said that he used his own financial resources to implement the project, which in turn restricted the size of the CFI-ERF project implemented. Regarding human resources, it is important to point out that in all cases, the day-to-day work in the property was carried out without using paid workers. In other words, the independent adopters had family-like farms run by the informants (and their partners) themselves. This clarification is important since small landholders may have different capacities (financial, human and technical resources) and organizational structure than large landholdings. All informants, at some point of the project implementation and for various tasks (e.g. land preparation, tree planting and herbicide spraying) had to hire paid employees (or get help from volunteers and family members). Since labour expenses along other implementation costs come at the beginning of the application of the project, but the expected economic return from forest carbon sequestration (if any) will be achieved over decades, landholders face a substantial impediment to access the required capital (Polglase et al., 2013).

7.3.6 The role of barriers in the adoption of the CFI-ERF

The QUAN analysis of the barriers variable showed two significant indicators: shortage of financial resources and not enough information. Interestingly, the results revealed that the higher the *shortage of financial resources* the more likely landholders were to adopt the CFI-ERF. This result suggests that landholders who are not in a strong financial position are more open to adopting the CFI-ERF than landholders who enjoy a more advantageous financial position. This finding implies that the decision of adopting the CFI-ERF may also be influenced by the need (or not) to generate additional income for the farm. Similar results were obtained when analysing the *financial resources* indicator composing the *capacity* factor (the more financial resources landholders had, the less likely they were to adopt the CFI-ERF).

In the case of *not enough information,* the results indicated that the less information landholders received about the CFI-ERF, the more likely they were to adopt the initiative. A

similar result was found when analysing the knowledge factor (the higher the level of knowledge the less likely landholders were to adopt the CFI-ERF). These results suggest that landholders that had received/collected sufficient information, and had therefore increased their level of knowledge (became more familiar) about the initiative, may consider that the CFI-ERF does not present a relative advantage see (Pannell et al., 2006; Rogers, 1983) over other farm activities or schemes. According to Pannell et al., 2006, landholders will not adopt an innovation that does not facilitate fulfilling their goals (e.g., economic, environmental, personal). This may explain why, in the case of this study, landholders having high levels of knowledge about the CFI-ERF may not opt for adopting the initiative, at least under the current arrangements. Nevertheless, lack of awareness and appropriate information about particular schemes have been reported as barriers to adoption (Page & Bellotti, 2015).

During the QUAL phase informants considered costs (implementation, transaction and opportunity costs), uncertainty (policy, carbon price and economic return uncertainty) and communication failures as some of the constraints for the uptake of the policy. *Costs* are always a barrier to adopting innovations (Cacho et al., 2013; Ducos et al., 2009; Dumbrell et al., 2016; Macintosh, 2014). Financial support to cover significant expenses, especially for carbon sequestration projects, can be hard to obtain due to market risks and regulatory uncertainty (Polglase et al., 2013). Thus, the policy should ensure a competitive economic return to cover the implementation costs (Rochecouste et al., 2015). Informants explained that high implementation costs (e.g., land preparation, buying trees and planting) for environmental planting projects are a significant impediment. Also, opportunity costs are an important factor to consider when thinking about starting a CFI-ERF project, *i.e.* using the land to plant trees to generate carbon credits, instead of other activities, can significantly reduce farm productivity (Moon & Cocklin, 2011b). Thus, informants are clear and accept that implementation and opportunity costs are unavoidable when establishing CFI-ERF projects. Although implementation and opportunity costs are a strong barrier, all the informants agreed that the transaction costs, specifically the cost associated with the auditing[33] process, which is part of the CFI-ERF regulation (Clean Energy Regulator [CER] 2016a), was one of the main barriers after having their projects approved. According to the informants, auditing is too expensive, especially for small landholders (van Oosterzee et al.,

[33] Most of the projects have to be audited at least three times to ensure a reasonable accuracy of the amount of abatement reported (CER, 2016a).

2014) and it may be difficult to recover that investment. One informant said: "… it's about 5,000 dollars to audit our project and it's got to be done three times and if we were successful in this reverse auction process, I'm sure we'd be getting paid less than we'll be paying in auditing". Thus, it is too risky to incur in more expenses, considering the uncertainty of carbon prices (Bradshaw et al., 2013; Evans et al., 2015; Gowen, Rolfe, & Donaghy, 2010) especially now that the reverse auction implemented by the Clean Energy Regulator (CER) has pushed prices down. The price of carbon in Australia has gone from AU$ 24.15 in 2013-14 to be traded at an average price of AU$ 10.69 in the last action occurred in November 2016. Large investment expenses are related to a reduction of adoption (Rochecouste et al., 2015) which in turn causes uncertainty in the economic return from the carbon farming project. Rochecouste et al. (2015) state that to increase uptake, new practices should clearly demonstrate the level of investment needed, the return of investment and economic benefit.

Uncertainty was one of the main barriers in informants' opinions. Interviewees mentioned policy uncertainty, carbon price uncertainty and consequently, uncertainty of economic return as significant impediments to adopting the CFI-ERF. In general, environmental policies have to be dynamic and adapt to the changing conditions of the context (e.g. geographic, political, economic) to achieve its goals (Mickwitz, 2003). Nevertheless, according to the interview informants, policy changes around the CFI-ERF (e.g., changes in projects' eligibility requirements, variations in the carbon trading mechanism) in Australia have been dramatic to the point that, in some cases, these changes have prevented some landholders from registering their projects under the scheme. One informant said:

> We did some work with landholders across the tablelands a number of years ago, 2008 and measured 37 different properties of trees with the idea to putting them up as carbon projects and the government changed the rules so that before… while we were doing the measuring and the plot assessments, they were eligible. Within two years they were not eligible. So, none of them, not one, can claim carbon credits because of the [new] rules (INA1).

Further, since December 2014, the CFI-ERF itself became part of the Emissions Reduction Fund (ERF)[34] which for instance introduced a 'reverse auction' method for carbon trading which increased the uncertainty of the price of carbon as explained next. The uncertainty of

[34] The newly elected Australian Government introduced the Emissions Reduction Fund (ERF) in 2014 as part of its Direct-Action Plan. The ERF builds on the Carbon Farming Initiative (CFI) and the Carbon Farming Initiative legislation (CER, 2015).

the carbon price is also a significant barrier. Undoubtedly, the price carbon credits[35] generated through CFI-ERF projects, like any other goods, depend on the market forces. With the inception of the ERF, a reverse auction method was implemented which drives the price of carbon down. During a reverse auction, the Australian government purchases the cheapest carbon credits. The carbon price in Australia has gone from A$24.15 (CER, 2015b) in 2014 (fixed price period) under the CFI-ERF rules to A$10.65 in the last auction occurred in November 2016 (CER, 2016a). This dramatic fluctuation of the prices of carbon in Australia makes the probability for landholders of achieving an economic return even more uncertain. Also, according to the informants, the costs of generating credits from environmental plantings are higher compared to those resulting from other activities accepted under the CFI-ERF rules (e.g. energy efficiency and transport). And because all the credits, despite their origin, enter the auction in equal conditions, it is tough for (small) landholders with environmental plantings to match the carbon prices from other activities. In the end, the cheapest credits are successfully traded during the reverse auction. In general, this makes it difficult for the land sector carbon farming and particularly to environmental plantings to compete with other areas of the economy in the carbon trading. There is a strong agreement among informants and scholars that market based schemes should consider additional incentives (payments) to credits resulting from activities that deliver crucial environmental (co)benefits (Kragt et al., 2016; Polglase et al., 2013; Torabi & Bekessy, 2015). Environmental plantings, which mainly deal with reforestation and afforestation, have the potential to deliver highly valued environmental benefits (e.g. forest connectivity, habitat provision and biodiversity protection) along with carbon abatement (Bradshaw et al., 2013; Evans et al., 2015; Lin et al., 2013; Polglase et al., 2013; Sinnett et al., 2016). Bundling incentives of environmental policies are necessary to increase their acceptance (Greiner, 2015; Greiner et al., 2009). Torabi and Bekessy (2015) argue that designing bundled credits and setting premium pricing for biodiversity benefits of carbon plantings can be a viable policy alternative to provide landholders an economic return to cover for transaction costs.

7.3.7 Independent adopters as innovators

From the Diffusion of Innovations DOI (Rogers 1962) theory perspective, the independent adopters (in-depth-interview informants), as named in this study, are *innovators*. The profile

[35] Australian Carbon Credit Units (ACCU) under the CFI-ERF rules had a fixed price from 2012 to 2014. The ACCUs would enter a flexible period since 2015 but with a set price floor (refer to Chapter Three).

of the independent adopters matches with most of the innovators' characteristics identified by Rogers (1983). All the interview informants have high levels of education, and some have science training, and they have used their learning and researching skills to increase their knowledge (Pannell et al., 2006; Rogers, 1983) about the CFI-ERF. High levels of education also helped independent adopters to avoid some expenses (e.g., consulting expenses to deal with administrative process required under the scheme) and tackle technical issues (Ducos et al., 2009). Independent adopters used their knowledge and experience to attain the necessary resources (e.g., human resources: volunteers' assistance especially during tree planting) to implement their projects under the CFI-ERF rules. Independent adopters have social and professional networks outside their circle (Rogers, 1983), which they have used to acquire and share information to implement and register their projects. Most of the independent adopters have held leadership positions (Rogers, 1983), and one of their motivations to adopt the initiative was to share their experience and knowledge with their peers. Further, all the independent adopters' primary motivations were altruistic (Greiner & Gregg, 2011) and linked to environmental (co)benefits from reforestation and forest regeneration, e.g. ecosystem and biodiversity protection, habitat provision and forest connectivity (Dumbrell et al., 2016; Evans et al., 2015; Greiner & Gregg, 2011; Schirmer & Bull, 2014).

7.4 SUMMARY AND CONCLUSIONS

The integrated analysis of the QUAN and QUAL phases show that the most influencing factors for the adoption of the CFI-ERF are *knowledge, motivation* and *barriers*. The level of knowledge (QUAN analysis), was opposed to what was initially assumed; it was found to have an adverse influence on the adoption of the CFI-ERF, suggesting that the more landholders knew about the different aspects of the initiative, the less likely they are to adopt it. In other words, some landholders who attained a good level of knowledge about the CFI-ERF, aparently do not perceive a relative advantage of the application of the innovation (Pannell et al., 2006; Rogers, 1983), or the innovation does not assist in achieving intended adopters goals (Pannell et al., 2006). Also, the results suggest that ecosystem and environmental benefits are the strongest motivations (Greiner & Gregg, 2011; Greiner et al., 2009; Page & Bellotti, 2015) of the adoption of the CFI-ERF in the land sector (farming and forestry). Ecosystem and environmental benefits have been a strong influence in adoption, at least to independent adopters, despite the barriers they had to overcome. The main adoption barriers are related to high implementation, opportunity and transaction costs (Cacho et al., 2013; Ducos et al., 2009; Dumbrell et al., 2016; Macintosh, 2014; van Oosterzee et al., 2014)

of establishing and maintaining CFI-ERF projects; particularly, environmental planting projects (van Oosterzee et al., 2014) which, as argued by the interviewees, generate carbon credits at a higher cost than emissions avoidance methods, e.g. landfill gas[36]. Achieving a significant economic, at least in the present conditions and considering the prices of carbon and the carbon trading method, is tough. Thus, more attention needs to be drawn to the non-financial/economic motivations (Greiner & Gregg, 2011; Greiner et al., 2009) that drive the adoption of the CFI-ERF and other environmental initiatives that often are neglected (Greiner & Gregg, 2011). As stated above, the results of the QUAN and QUAL analysis carried out in this study suggest that non-economic/financial benefits (e.g. biodiversity and habitat protection and restoration) are strong motivations to adoption of the CFI-ERF. Nevertheless, providing additional fair incentives for the adoption of new environmental practices could increase adoption rates.

The results of this study suggest that the adoption of an innovation heavily depend on the motivation of intended adopters. Motivations in turn are closely aligned with the occupation of individuals and other factors such as landholders' personal values and believes. The next important factor to consider is level of education, and ability of manage new -complex- information and even conduct research. The survey participants demonstrated that in absence of adequate sources of information, they can research and produce their own knowledge about the innovation.

Other factors that have drawn vast attention, such as age seem to be less important. According to Rogers (1985), innovators tend to be younger individuals, which is not the case in this study. Even, low financial capacity (and a lack of financial sources) has not been a definitive barrier to adopt the CFI-ERF and lack of information as explained above can be overcome. Landholders, in this case, innovators -considering the time elapsed since the introduction of the policy- as proposed by Rogers (1985), would adopt the innovation, setting small projects according to their availability of economic resources.

The complexity of the innovation, concurring with the DOI, appears to have a significant influence on adoption of innovations. As stated by Rogers (1985), generally speaking, the less complex an innovation the easier and faster would be adopted. Considering the overall results

[36] The landfill gas method consists in trapping and destroying, through combustion, methane emitted by the decomposition of waste in landfills (Australian Government, 2015).

of this study, the adoption or non-adoption of an innovation, seems to depend, mainly, as stated before, on landholders' motivations, level of education, occupation and the complexity of the proposed new practice. From this perspective, other factors, particularly demographic factors seem to be almost irrelevant. Considering that conclusion, it appears that DOI's categorization of adopters presents some issues (Mahajan, Muller, & Srivastava, 1990) and seems rather unfair. Thus, if an innovation is too complex, is not compatible with landholders' occupation, interests and by extension with landholders' motivations, it can be argued that the innovation is very unlikely to be adopted by a particular landholder(s). Consequently, that adopter(s) may possible fall in the 'laggards' category. Now, if another innovation is not so complex, is compatible with the landholders' occupation, interests and motivations, the same landholder(s) would probably adopt the innovation straightaway, thus falling in the innovators category (Mahajan, Muller, & Srivastava, 1990). In sum, the adopter's categorization seems to be too general and mainly dependent on the innovation proposed at a particular time.

Applying the DKMCB theoretical can provide a different perspective on the adoption of innovations. One of the advantages of the model is that it does not stress its focus on the diffusion process as such but on the factors that influence potential adopters' decisions. Identifying the most significant factors can assist policy makers and other stake holders to focus efforts on enhancing the factors perceived as positive and avoiding or eliminating negative factors. Studying the adoption factors also allows scholars to assess innovation adoption without considering the time parameter, since in many cases funds and other resources are not enough to undergo research for an extended time, as often required when assessing innovation diffusion. The inclusion of the time variable in diffusion research and collecting data at defined intervals allows to establish the rate of adoption of an innovation (Rogers, 1985). The rate of adoption is an important concept worth investigating and useful from the theoretical perspective. However, identifying the main factors influencing adoption can be more useful in, for instance, the applied research realm.

Thesis Outline

Chapter 1	Introduction
Chapter 2	The big picture: A context analysis to the Carbon Farming Initiative-Emissions Reduction Fund
Chapter 3	Theoretical framework and overview of the factors that influence the adoption of the Carbon Farming Initiative-Emissions Reduction Fund
Chapter 4	Methods
Chapter 5	The role of demography, knowledge, motivation capacity and barriers on the adoption of the Carbon Farming Initiative-Emissions Reduction Fund: A quantitative study
Chapter 6	The role of demography, knowledge, motivation, capacity and barriers on the adoption of the Carbon Farming Initiative- Emissions Reduction Fund: A qualitative study
Chapter 7	Integrating the quantitative and qualitative results: Analysis and discussion
Chapter 8	**Conclusion and recommendations for further research**

CHAPTER 8: CONCLUSION AND RECOMMENDATIONS FOR FURTHER RESEARCH

In 2011 the Australian government created the Carbon Farming Initiative (CFI-ERF) for achieving Australian international GHG reduction targets committed under the Kyoto Protocol. To set the context and provide a rational of the importance of the CFI-ERF, this thesis started with a brief review of the climate change science and the international evolution of the global climate policy aimed to study climate change, mitigate its causes and adapt to its impacts.

Australian climate policy before, during and after the establishment of the CFI-ERF has undergone a series of (dramatic) changes. For instance, one of the most significant changes resulted in the creation of the Emissions Reduction Fund (ERF) which builds on the CFI-ERF. This shift in policy direction was perceived by adopters, potential adopters and other stakeholders as a strong signal of instability. The uncertainty generated by the changes around the CFI-ERF were discussed by participants in this study as well as by many scholars researching the carbon farming area.

Motivation, knowledge and barriers play the most significant role in the decision to adopt the CFI-ERF in the Australian land sector. Environmental/ecosystem benefits were the most influential motivations to adopt the CFI-ERF. Reforestation and afforestation, biodiversity protection and habitat provision were common motivations between adopters of the CFI-ERF Economic return was also a significant motivation.

The role that knowledge played in adopting the CFI-ERF was somehow unexpected because it was associated with a reduction in the likelihood of adopting the CFI-ERF. The results revealed that the more potential landholders new about the CFI-ERF, the less likely they were to adopt the policy. Considering landholders need to reduce uncertainty about an innovation before adopting it (Pannell, 2006; Rogers, 1983), this result suggests that landholders are not getting adequate, or apparently landholders are getting negative information about the benefits and disadvantages of adopting the CFI-ERF, which in turn has a negative impact on the likelihood of adopting the CFI-ERF.

8.1 IMPLICATIONS OF THE STUDY FOR ADOPTION RESEARCH AND POLICY

This study is a contribution to the existing body of knowledge on diffusion of environmental initiatives. It helps to understand the complex process of diffusion (adoption) of innovations in, but not limited to, the environmental area. Therefore, this thesis provides a practical framework to assess relevant factors influencing the adoption of innovation proposed by governments and other organizations such is the case of the Carbon Farming Initiative-Emissions Reduction Fund (CFI-ERF). The framework suggests the important role of demography, (level of) knowledge, motivation, capacity and barriers to adopting the CFI-ERF while considers the opinions of the intended adopters of the policy.

8.2 POLICY IMPLICATIONS

The results of this case study can assist policy makers in designing effective policies as well as better strategies to improve the uptake of proposed environmental innovations. But above all the results of this study suggest the current carbon trading scheme could be made more attractive to Australian landholders by presenting reasonable benefits and a fair opportunity to generate income through carbon trading. Any effort made to encourage GHG abatement in Australia is important. But it is crucial to encourage the development of projects such as (but not only) environmental plantings, because if well managed they present more benefits for the environment than just GHG emissions abatement.

The lack of differentiation between carbon credits and their origin, together with the inclusion of projects, especially from the energy efficiency sector, are reducing the competitiveness of credits coming from the environmental sector (thus making those activities less attractive). The inclusion other sectors of the economy in the Australian carbon trading scheme and the reverse auction implemented (for carbon trading) by the Australian government are already pushing down the price of carbon credits. Lower prices of carbon are/will make it tougher for projects such as environmental plantings (especially from small landholdings) to generate carbon credits at a price that will allow them to compete with credits from other sectors of the economy. In this context, it is safe to assume that the prospect of landholders adopting projects in the environmental carbon sequestration land-based sector (farming/agriculture and forestry) may not rapidly increase. Therefore, as the key informants of this study and many scholars propose, there is the need to either include additional incentives, such as including

payments for environmental services (PES) in the carbon trading equation, or perhaps differentiate the credits from different sectors of the economy.

All in all, harnessing some of the immense carbon sequestration potential of the land sector should be one of the main goals of the Australian climate policy. One of the keys to increase adoption of environmental innovations then would be to design environmental schemes able to appeal landholders' environmental and land stewardship values (Greiner & Gregg, 2011) while providing incentives and a reasonable and clear compensation for their participation. The implications for carbon trading policy oriented to the land sector is summarized in the remarks below.

To increase the adoption of the CFI-ERF (and similar initiatives in the carbon farming arena) some steps should be considered. First, an approach for reducing transaction (fixed) costs originating from the policy (e.g., auditing, monitoring and reporting costs), is needed to increase adoption (Cacho et al., 2013; Ducos et al., 2009). Second, concurring with Meadows et al. (2014), the interview informants state that payment schemes for environmental services or benefits should be integrated to the Australian carbon trading policy. Thus, a linkage of environmental benefits with carbon credits, giving a higher value to those credits originated from projects with high environmental outcomes (Torabi & Bekessy, 2015) is deemed necessary. Third, it is also important to develop an effective tool to value environmental (co)benefits (Torabi & Bekessy, 2015) resulting from CFI-ERF projects. Fourth, a communication strategy that highlights the benefits of carbon farming activities for the environment (Dumbrell et al., 2016; Evans et al., 2015; Torabi, Mata, et al., 2016), the farm (Dumbrell et al., 2016) and the community (Evans et al., 2015; Greiner, 2015; Pannell et al., 2006) should be put in place. Fifth, an analysis of the adequacy of the reverse auction procedure (which pushes prices down) for carbon trading in Australia is needed, as it increases the uncertainty of the price of carbon credits and therefore the expected net returns, especially for carbon sequestration projects. Finally, the complexity of the adoption process should be reduced (Dumbrell et al., 2016; Rochecouste et al., 2015) to facilitate, particularly small landholders, understand the policy requirements (Dumbrell et al., 2016) to implement CFI-ERF projects and their contribution to enhancing the environmental benefits. A quote by one of the interview participants illustrates this point: "there will be no really great benefit for the environment [and the adopters] unless they [the Clean Energy Regulator] change and simplify the system," (INA4).

8.3 LIMITATIONS OF THE STUDY

This case study does not investigate the broader socio-political factors that influence the adoption of the CFI-ERF policy in Australia. The case study analyses the adoption of the CFI-ERF only in the carbon sequestration land sector. The other sectors of the Australian economy (e.g. transport or energy efficiency) that can potentially develop and register CFI-ERF projects are not part of this study. This research was conducted in a period during a transition of the Australian government which, in turn, brought changes to the climate policy including the Carbon Farming Initiative itself. This uncertainty in the Australian climate policy may have had some impact in the acceptance of the CFI-ERF. Also, the uncertainty and volatility of carbon prices, not only in Australia but internationally as well, may have impacted on the adoption of the policy. The effects of this uncertainty may not be well represented in the results of the present research.

The QUAN phase used a random sampling procedure targeting rural landholders Australia wide, therefore some of the participants may not have had any previous knowledge about the CFI-ERF. That is why, when designing the research procedure, a qualitative phase was included to learn from the experience of landholders who had adopted the initiative to have a fuller picture of the influence of demography, knowledge, motivation, capacity and barrier on the adoption of the CFI-ERF.

8.4 SUGGESTIONS FOR FURTHER RESEARCH

The results of the qualitative phase revealed the existence of two groups of landholders, based on whether they adopted the CFI-ERF independently (independent adopters) or in conjunction with Carbon Consulting Enterprises (CCE) (associated adopters). The intervention of CCEs in the adoption of the carbon farming initiative raises a series of questions worth investigating. The nature and the terms of the contracts between the CCEs and the adopters was not part of this research. Nevertheless, given CCEs influence on the adoption of the CFI-ERF, it becomes crucial to understand:

- the extent of the CCE's contribution to the adoption of the CFI-ERF;
- the potential emission abatement of projects developed to date by CCEs;
- what factors affect the work of CCEs in the actual context of the CFI-ERF and how;
- what criteria carbon CCEs apply for selecting landholdings/landholders to develop projects (e.g. minimum land extension required);

- The criteria applied by CCE's when choosing the type of CFI-ERF projects to implement
- what the adoption barriers are for developing projects in association with landholders and;
- how do CCEs deal with those barriers.

Finally, the existence of these two groups of adopters (independent and associated adopters), due to the action of CCEs, can have serious implications in the future of climate policy in Australia. Therefore, expanding this study to include the views of CCEs on the factors influencing the adoption of the CFI-ERF becomes crucial to have a clearer understanding of the present, and plan the future of the GHG emissions abatement policy. This is important in the carbon sequestration land sector (farming/agriculture and forestry) which is the core subject of this research, but also beyond.

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ANNEXES

ANNEX 1: ETHICS APPROVAL

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ANNEX 2: ADOPTION FACTORS MATRIX CLASSIFIED PER DKMCB

	Demography	Knowledge	Motivation	Capacity	Barriers
Bradshaw et al. (2013) *Biological Conservation*			-The compatibility of carbon sequestration activities, particularly, environmental plantings with beneficial biodiversity outcomes is a source of motivation for adoption		-Carbon price variability is a source of uncertainty -Anticipating and modelling the changes in carbon prices, its impact and the response (to price variability) is a difficult task
Cacho et al. (2013) *Ecological Economics*			-Additional payments for environmental plantings may motivate adoption increasing environmental outcomes -Fixed costs reduction, e.g. registration and certification costs, may have benefit small landholders program uptake		- The literature shows that transaction costs are a significant barrier to adoption -Some transaction costs, e.g. monitoring are recurring costs
Ducos et al. (2009) *Journal of Environmental Planning and Management*	-Higher educational levels may help dealing with administrative processes reducing consulting transaction costs -Education may help tackling eventual technical issues	Communicating the benefits of carbon farming for the environment and the farm rather than carbon trading in a voluntary market may increase uptake	-Increasing compensation and/or reducing transaction costs could assist increasing adoption -Generating carbon credits was not an important adoption driver -Carbon farming innovations that generate environmental and farm productivity benefits most likely to be adopted		-The lack of understanding of certain procedures prevent participation in the scheme

Dumbrell et al. (2016) *Land Use Policy*	-Personal values -Landholders' social context		-Public co-benefits are a significant motivation for adoption of new practices	-Landholder's financial situation can influence the adoption of innovations	-Transaction costs and policy uncertainty will continue as important barriers to adoption of carbon farming activities
Evans et al. (2015) *Environmental Science & Policy*		Many farmers lack a clear under-standing of the impact of grazing practices on biodiversity, and how changes in grazing regimes can help to restore and safeguard biodiversity	-Carbon farming activities in agricultural land deliver biodiversity, economic and social benefits		-There is a high uncertainty of carbon price -Recent changes in Australian climate policy generated instability of carbon prices
Greiner (2015) *Agricultural Systems*			-Cattle farmers in northern Australia as other farmers worldwide require a significant monetary incentive to remove cattle, from land under (long duration) contract to adopt conservation schemes		

Greiner and Gregg (2011) *Land Use Policy*			-Social and economic factors and their interactions can motivate the uptake of natural resource management practices Landholders' land stewardship and other non-economic motivations to implement environmental practices have been overlooked -Policies that consider the value of alternative motivations (other than economic) can stimulate landholders' interest in conservation		-Social and economic factors and their interactions can prevent the uptake of natural resource management practices
Greiner et al. (2009) *Agricultural Systems*			-Fulfilling individual goals (e.g. economic, social, environmental) is one of the most important landholders' motivation to adopt new practices -Conservation innovation adoption rates are higher for landholders with high conservation and lifestyle motivation than for peers (even in the same industry and region) that have strong economic motivations -A better understanding of landholders' motivation and risk perception for adoption of conservation practices is key to design schemes, at regional levels, that encompass different incentives thus increasing programs' effectiveness and efficiency -Farmers' motivations differ among industries and regions		

Moon and Cocklin (2011b) *Journal of Rural Studies*			-Motivations were different for conservation-driven, production-driven and financially-driven landholders -Financial incentives motivated production-driven and -financially-driven landholders	-Landholders did not get any regular education or training about improving the quality or the quantity of vegetation in the property areas committed to conservation	-Motivation and barriers were different for conservation-driven, production-driven and financially-driven landholders -Landholders perceive that involvement in conservation programs and associated benefit streams can threat their private rights over the land. Thus, some landholders would not commit to perpetual programs or, would only include unproductive lands to conservation programs -Other barriers to conservation were: productivity loss, indecision about which conservation programs would reach the best conservation outcomes
Kragt et al. (2016) *Ecological Economics*			-Carbon farming schemes should include environmental co-benefits other than carbon abatement -Schemes should consider paying higher prices for carbon credits having additional environmental co-benefits to encourage a positive change in land management		

Lin et al. (2013) *BioScience*		-Effective communication about the wide range of co-benefits may motivate landholders to join carbon trading schemes	-Carbon credits trading benefits will probably not be enough to attract landholders -Carbon farming initiatives present landholders from the agricultural sector to reach their environmental protection goals		
Macintosh (2014) *Carbon Management*					-Carbon market and carbon price uncertainty Transaction costs to meet participation requirements -Overly regulated technical aspects of the policy (e.g. integrity and perverse impact risk management) -Instability of Australian climate policy.
(Maraseni & Cockfield, 2015) *Agricultural Systems*					-Worldwide, the offer of carbon credits will grow twice as fast than the demand. [This can push prices down] -It is likely that only a small portion of the funding will be used to buy credits from carbon sequestration projects for the Emissions Reduction Fund buys emission reduction credits from different sources (e.g. energy efficiency) and supports emerging technologies

Meadows et al. (2014) *Land Use Policy*		-Many small landholders willing to adopt environmental initiatives do not have the level of knowledge required -Some small landholders are not aware or do not have the knowledge on support schemes, especially incentive mechanisms.		-Small landholders willing to implement NRM activities do not have the time, finance and physical abilities.	
Page and Bellotti (2015) *Science of the Total Environment*		Landholders' lack of awareness and absence of suitable information would prevent uptake of conservation schemes	-Non-financial motivations such as personal and family wellbeing, care based-ethics and strong land stewardship drive the uptake of conservation schemes and activities		-Government uncertainty was considered a barrier for participation in conservation schemes -Insufficient payments and lack of time are also barriers to adoption of conservation practices

Pannell et al. (2006) *Australian Journal of Experimental Agriculture*	Age presents mixed influence on adoption of environmental practices Higher education in the case of a complex innovation or technology may allow landholders to notice the limitations of the practice, thus reducing or preventing adoption	Landholder need a certain level of knowledge and skill to implement innovations and decide over methods (e.g. timing, sequencing, intensity, scale) Hands-on experience, reading, listening and watching, can help reach or improve knowledge and skills	-Goals differ among landholders Achieving goals (e.g. environmental, economic and social) is an important motivation for adoption. -Economic profit has a low priority for some farmers. However, economic return may be important to reach more important goals (e.g. secure family wellbeing)		-If landholders perceive that an innovation will not allow them achieving their goals, they will not adopt it -Even landowners who put low importance on achieving additional profit would not adopt innovations that could result in considerable economic loss
(Polglase et al., 2013) *Climatic Change*			-Economic incentives, in a market scheme, will not be enough to motivate large scale environmental plantings, thus additional payments for environmental benefits are necessary to increase uptake -Landholders do not decide land use change only based on economic return		-Availability of financial capital, or access to the capital market, due to regulatory uncertainties and innate carbon trading risks, will be a barrier to implement tree plantations
Robinson et al. (2016) *Environmental Science & Policy*			-Several rights, cultural values and socio-ecological system benefits should be considered as motivations for indigenous people to participate in carbon offset activities		-Environmental rights and stewardship, important concepts to Indigenous cultures worldwide, have not been considered by carbon co-benefit schemes.

Rochecouste et al. (2015) *Agricultural Systems*		-knowledge and skills required to implement new practices were also influential factors to adoption -Unfamiliar innovations, not widely practiced or recommended by trusted fellow landholders, regardless of benefits will be slowly adopted	-Conditions leading to improving profitability were positive drivers.		-Conditions leading to improving profitability were positive drivers.
Schirmer and Bull (2014) *Global Environmental Change*			-Scheme design influences the adoption of afforestation practices		-Scheme design influences the adoption of afforestation practices -The importance given to using the land for food production constrains the adoption of afforestation activities. -Landholders are less likely to contemplate the option of planting trees in large areas, especially the more productive land areas
Sinnett et al. (2016) *Land Use Policy*			-Farmers consider co-benefits such as aesthetic reasons, wildlife corridors, habitat creation, erosion control, soil and crop protection over the economic benefits from carbon trading		-Environmental plantings are a competitive option only when planting methods are possible (e.g. direct seeding). But when planting requires ripping and mounding of soil, planting of tubestock and fencing, environmental plantings are no longer competitive

Smith and Sullivan (2014b) *Ecological Economics*			-Economic compensation to landholders is necessary to protect and improve the provision of ecosystem services for present and future generations -Market-based schemes, such as schemes paying for ecosystem services can have an important impact within agricultural landscapes		-Maintenance costs of ecosystem services, e.g. maintenance of natural habitat, are considered as a barrier by landholders
Stanley et al. (2006)	-Little evidence exists on the relationship between formal education and adoption of innovations		-The literature puts too much attention on financial factors as an innovation adoption driver in the land sector	-Training seems to increase adoption of proposed innovations Understandably, landholders having low resources to meet their own needs are less likely to invest in new land management practices.	-Some barriers have been widely assumed to have strong influence on adoption of new practices despite inconclusive evidence -Low levels of trust on the proposed innovation or the proponents are a strong barrier to adoption -Insufficient financial viability may prevent adoption
Summers et al. (2015) *Land Use Policy*					-The variation of implementation costs which depend in various factors such as commodity prices and availability, management decisions, methodologies and several biophysical aspects are a constraint to determine the economic viability of reforestation projects

Torabi and Bekessy (2015) *Ecosystem Services*			-Integrated credits (credits that include a compensation for biodiversity benefits) can increase adoption of carbon plantings		-Carbon markets variability and political uncertainty are barriers to stablish integrated credits (credits that include a compensation for biodiversity benefits), which could increase adoption of carbon plantings
Torabi, Cooke, et al. (2016) *Australian Geographer*		-Landholders perception of the program design and the value of co-benefits impacts adoption rates	-Flexibility of programs, offering landholders options to choose from together with a flexible permanence option of stacked and bundled credits may increase adoption rates	-Resource availability can increase participation rates	
Torabi, Cooke, et al. (2016) *Global Ecology and Conservation*		-Flexible programs that consider landholders' knowledge have higher uptake rates	-The design of the program influence adoption -The importance that landholders give to co-benefits of carbon plantings co-benefits influence adoption -The scheme design should consider an effective communication of landscape-specific co-benefits to increase participation		
van Oosterzee et al. (2014) *Global Environmental Change*					-Transaction costs are an adoption barrier to small landholders and will only favour large landholdings -Project implementation costs hinder the participation of smallholders in the initiative

ANNEX 3: SURVEY QUESTIONNAIRE

SURVEY QUESTIONNAIRE

Please complete the following questionnaire

SECTION 1: Questions about land use

1. **What is your land used for? Please tick one or more activities that you consider appropriate**

☐ Fruit crops ☐ Hobby farming ☐ Tourism/Ecotourism

☐ Cereals and grains crops ☐ Forestry production ☐ Educational activities

☐ Sugar cane ☐ Forest conservation ☐ Dairy products

☐ Grazing & livestock ☐ Forest regeneration ☐ Poultry production

☐ Non-food crops (wool and other fibres, for bio fuels, for essential oils, for pharmaceuticals, etc.)

☐ Other (please specify): _____

2. What is the primary use of the land? Please tick ONE of the following options

☐ Fruit crops ☐ Hobby farming ☐ Tourism/Ecotourism

☐ Cereals and grains crops ☐ Forestry production ☐ Educational activities

☐ Sugar cane ☐ Forest conservation ☐ Dairy products

☐ Grazing & livestock ☐ Forest regeneration ☐ Poultry production

☐ Non-food crops (wool and other fibres, for bio fuels, for essential oils, for pharmaceuticals, etc.)

☐ Other (please specify): _____

3. Have you heard about the Carbon Farming Initiative?

☐ Yes ☐ No

If not, please skip to question 11

Please tick one option you agree the most

4. I am familiar with the Carbon Farming Initiative

Not familiar at all	Not very familiar	familiar	very familiar	extremely familiar
1	2	3	4	5

5. I am familiar with the benefits that the Carbon Farming Initiative offers to landholders/farmers

Not familiar at all	Not very familiar	familiar	very familiar	extremely familiar
1	2	3	4	5

6. I have received adequate information about the Carbon Farming Initiative

None	Very little	Some	Quite a bit	Very much
1	2	3	4	5

7. I have received information about the Carbon Farming Initiative through… Tick one or more options you consider appropriate

- ☐ Formal education
- ☐ Workshops/seminars
- ☐ TV spots
- ☐ Newspaper
- ☐ Internet/websites
- ☐ Natural resources management bodies (NRMs)
- ☐ Family/friends
- ☐ Brochures/handouts
- ☐ Working environment
- ☐ Governmental letters
- ☐ Land care organizations
- ☐ I have not received any information at all
- ☐ Farm field days
- ☐ Local community organization
- ☐ Other (please specify) _____

8. Do you know about the <u>environmental benefits of adopting activities</u> under the Carbon Farming Initiative?

Yes ☐

No ☐

<u>if not, please skip to question 11</u>

9. I am familiar with the <u>benefits for the environment resulting from the adoption</u> of activities under the Carbon Farming Initiative

Not familiar at all	Not very familiar	familiar	very familiar	extremely familiar
1	2	3	4	5

10. Please list three environmental benefits resulting from the <u>adoption</u> of carbon farming activities that you consider important

_____

_____

Section 3: Motivation to adopt (implement) activities under the Carbon Farming Initiative

Please rate the importance of the following factors that would make you decide to adopt new initiatives such as the Carbon Farming Initiative. <u>Circle one option for each factor</u>.

		Not important at all	Somewhat important	Important	Very important	Extremely important
11.	Economic benefits	1	2	3	4	5
12.	Environmental health	1	2	3	4	5
13.	Availability of technical support	1	2	3	4	5
14.	Legal regulations	1	2	3	4	5
15.	Friends and family advice	1	2	3	4	5
16.	Care for the community	1	2	3	4	5
17.	Moral responsibility	1	2	3	4	5

Section 4: Capacity to adopt (implement) carbon farming initiative activities. Please rate your level of agreement with the following statements. Please circle one option for each statement.

		Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
18.	I (the organization I represent) have the financial resources to implement Carbon Farming Initiative activities	1	2	3	4	5
19.	I (the organization I represent) have the human resources to implement Carbon Farming Initiative activities	1	2	3	4	5
20.	I (the organization I represent) have the technical resources to implement Carbon Farming Initiative activities	1	2	3	4	5

Section 5: Questions about barriers to adopt the Carbon Farming Initiative

Please rate the importance of the following barriers to adopt activities under the Carbon Farming Initiative. Please circle one of the options

		Not important at all	Somewhat important	Important	Very important	Extremely important
21.	Not enough economic revenues from implementing carbon farming activities	1	2	3	4	5
22.	Not enough information about the Carbon Farming Initiative	1	2	3	4	5
23.	Not enough training opportunities about the Carbon Farming Initiative	1	2	3	4	5
24.	Not enough governmental incentives	1	2	3	4	5
25.	Shortage of Financial resources	1	2	3	4	5
26.	Not enough knowledge/information about the methodologies to adopt the Carbon Farming Initiative	1	2	3	4	5
27.	Not enough technical support	1	2	3	4	5
28.	Complex bureaucratic process	1	2	3	4	5

29. In your opinion what are the main constraints to adopt activities under the Carbon Farming Initiative? Please chose 3

- ☐ Lack of information
- ☐ Lack of governmental incentives
- ☐ Shortage of Financial resources
- ☐ Shortage of human resources
- ☐ Lack of (technical) support
- ☐ Complexity of the methodologies
- ☐ I have other priorities
- ☐ Just not interested
- ☐ Other (please specify): _____

Section 6: Adoption of the Carbon Farming Initiative

30. **Have you adopted any of the activities under the Carbon Farming Initiative?**

☐ Yes

☐ No

Which of the Carbon Farming Initiative activity(ies) have you (your organization) implemented? Please specify

_____
_____
_____

<u>If yes, please skip to question 32</u>

31. Considering your particular situation. Would you adopt any activities under the Carbon Farming Initiative?

Yes

☐ No

32. Section 7: Adoption of new technologies/methodologies. Please tick one of the options that you agree the most

In my case…

☐ I adopt new technologies/methodologies as soon as they become available

☐ I rather wait to see if the new technologies/methodologies work before adopting them

☐ I wait until most people have adopted the new technologies/methodologies before adopting them

☐ I prefer using technologies/methodologies I already know and adopt new ones if they are mandatory by the law

Section 8: Information about you

33. Gender:

☐ Male ☐ Female

34. What year were you born?

☐ Before 1939

☐ Between 1939-1953

☐ Between 1954-1968

☐ Between 1969-1983

☐ Between 1984-1996

35. What is the highest level of education you have completed?

☐ Primary school

☐ High school

☐ TAFE or Equivalent

☐ University

☐ Postgraduate

☐ Other (please specify) _____

36. Is farming/agricultural production your primary occupation?

☐ Yes

☐ No

If not, what is your primary occupation? Please specify: _____

37. What is your role in the management of the property?

☐ Proprietor

☐ Proprietor/manager

☐ Manager

☐ Farm worker

☐ Other (please specify) _____

Section 9: Information about the land

38. What is the dominant land tenure?

Leasehold

☐ Freehold

☐ Other (please specify) _____

39. Size of property?

Acres ☐ **or** **Hectares** ☐

40. State or Territory

- ☐ New South Wales
- ☐ Queensland
- ☐ South Australia
- ☐ Tasmania
- ☐ Victoria
- ☐ Western Australia
- ☐ Australian Capital Territory
- ☐ Northern Territory

41. Postcode ☐

42. Would you like to…?

- ☐ Enter the draw to win one of the gift cards valued 100
- ☐ Receive information about the results of the survey

Please enter you preferred contact method, so we can contact you should you win one of the AUD 100 gift cards or if you want to get further information about the results of this research.

Email: _____

Phone: _____

Mobile: _____

Best time to call: _____

YOUR CONTACT INFORMATION WILL BE STRICTLY CONFIDENTIAL

Thank you for taking the time to complete this survey!

ANNEX 4: TABULATED DESCRIPTIVE STATISTICS OF THE INTERNAL INDICATORS OF THE INDEPENDENT VARIABLES

Knowledge

Knowledge of the CFI-ERF was assessed using four indicators: three indicators based on the concept of familiarity and one factor about information received. Thus, the indicators *familiar with the CFI-ERF rules, familiar with CFI-ERF benefits for landholders* and *familiar with environmental benefits of the CFI-ERF* were measured by level of familiarity. Survey respondents ranked the knowledge indicators using a five-point scale from *not familiar at all* to *extremely familiar*, and for *Information received about the CFI-ERF* from *none* to *very much*. The factor about information on the CFI-ERF was included on the premise that exposure to information is an important aspect to attain some level knowledge on the target innovation. The table below shows the descriptive statistics of knowledge indicators.

Descriptive statistics of knowledge indicators

	Not familiar at all	Somewhat familiar	familiar	Very familiar	Extremely familiar	Total	
	%	%	%	%	%	%	n
Familiar with CFI-ERF rules	25.7	41.1	27.6	2.80	2.80	100	214
Familiar with CFI-ERF landholder benefits	33.6	42.1	20.6	0.93	2.80	100	214
Familiar with CFI-ERF environmental benefits	50.5	13.1	25.2	6.54	4.67	100	214
	None	Very little	Some	Quite a bit	Very much		
Information received about the CFI-ERF	39.7	35.1	16.8	6.07	2.34	100	214

Motivation

The *motivation* variable contained seven indicators measured by level of importance. The survey respondents ranked the motivation indicators from *not important at all* to *extremely important*. The table below shows a summary of the questionnaire results.

Descriptive statistics of motivation indicators							
	Not important at all	Somewhat important	Important	Very important	Extremely important	Total	
	%	%	%	%	%	%	n
Economic benefits	5.56	11.6	25.5	32.2	24.8	100	214
Environmental health	1.85	8.33	27.8	40.2	21.5	100	214
Availability of technical support	4.17	12.5	36.1	34.6	12.0	100	214
Government regulations	6.94	20.4	41.1	18.1	12.0	100	214
Friends and family advice	19.4	36.6	33.6	7.94	1.90	100	214
Care for the community	3.70	16.7	46.7	24.5	7.90	100	214
Moral responsibility	4.17	17.1	34.1	28.6	15.9	100	214

Capacity

The *capacity* variable had three indicators measured by level of agreement. Participants were asked to rank their agreement on whether they had the resources to adopt the CFI-ERF from *strongly disagree* to *strongly agree*. The table below shows a summary of the questionnaire results.

Descriptive statistics of capacity indicators							
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total	
	%	%	%	%	%	%	n
Financial resources	16.8	14.0	37.4	28.5	3.3	100	214
Human resources	11.7	24.3	35.1	26.6	2.3	100	214
Technical resources	13.6	17.8	35.0	29.9	2.8	100	214

Barriers

The *barriers* variable had nine indicators measured by level of importance. The survey respondents ranked barriers from *not important at all* to *extremely important*. A summary of the questionnaire results is shown in the table below.

Descriptive statistics of barriers indicators

	Not important at all	Somewhat important	Important	Very important	Extremely important	Total	
	%	%	%	%	%	%	n
Not enough revenues from CFI-ERF	2.34	7.94	31.8	37.9	20.1	100	214
Not enough information	1.40	9.81	29.9	41.6	17.3	100	214
No training	5.14	12.6	39.2	34.1	9.40	100	214
No governmental incentives	4.21	15.4	25.2	28.0	26.8	100	214
Shortage of financial resources	4.21	7.94	31.8	31.3	24.8	100	214
No knowledge about CFI-ERF methods	0.93	7.94	25.7	44.4	21.0	100	214
No technical support	2.80	11.2	39.3	35.5	11.2	100	214
Complex bureaucratic process	3.74	3.27	22.9	32.7	37.4	100	214
*Policy uncertainty	2.35	5.29	27.6	35.3	29.4	100	170

*Note: Policy uncertainty contains 170 cases.

ANNEX 5: TABULATED OUTPUT OF THE LOGISTIC REGRESSION TESTS

OUTPUT OF THE LOGISTIC REGRESSION TEST FOR DEMOGRAPHY INDICATORS

The table below shows the output of the binary logistic regression test for demography internal indicators.

Binary logistic regression output for demography indicators

Logistic regression predicting likelihood of Adoption of the CFI-ERF based on knowledge: gender, age, level of education and occupation (farming/agriculture as occupation).

	B	SE	Wald	df	p	Odds Ratio	95% CI for EXP(B)	
							Lower	Upper
Gender	-.608	.363	2.794	1	.095	.545	.267	1.110
Age	-.211	.198	1.131	1	.288	.810	.549	1.195
Level of education	.201	.157	1.655	1	.198	1.223	.900	1.662
Occupation	1.010	.433	5.427	1	.020	2.745	1.174	6.418
Constant	1.027	.814	1.590	1	.207	2.793		

Model $X^2(4)$	= 10.381, p =.034
Nagelkerke R^2	= 7.40
n	= 202

Note: In this analysis, the DV adoption of the CFI-ERF was coded so that 0 = would not adopt and 1 = would adopt. The IV gender was coded so that 0 = female and 1 = male. The IV occupation was coded so that 0 = other occupation and 1 = farming/agriculture as occupation. For this analysis Ten cases with gender not stated were excluded. Two outliers with residual greater than 2.500 were excluded.

OUTPUT OF THE LOGISTIC REGRESSION TEST FOR KNOWLEDGE INDICATORS

The table below shows the output of the binary logistic regression test for knowledge internal indicators.

Binary logistic regression output for knowledge indicators

Logistic regression predicting likelihood of Adoption of the CFI-ERF based on knowledge: Familiar with CFI-ERF, Familiar with CFI-ERF benefits for land holders, Familiar with environmental benefits of the CFI-ERF and Information about CFI-ERF.

	B	SE	Wald	df	p	Odds Ratio	95% CI for EXP(B)	
							Lower	Upper
Familiar with CFI-ERF	-.393	.269	2.134	1	.144	.675	.398	1.144
Familiar with CFI-ERF benefits for landholders	.193	.325	.353	1	.552	1.213	.641	2.296
Familiar with environmental benefits of the CFI-ERF	-.046	.328	.020	1	.889	.955	.502	1.817
Information about CFI-ERF	.129	.199	.420	1	.517	1.137	.771	1.679
Constant	1.264	.402	9.865	1	.002	3.538		
Model $X^2(4)$	= 4.502, p =.342							
Nagelkerke R^2	= .19							
n	= 214							

Note: In this analysis, the DV adoption of the CFI-ERF was coded so that 0 = would not adopt and 1 = would adopt.

OUTPUT OF THE LOGISTIC REGRESSION TEST FOR MOTIVATION INDICATORS

The table below shows the output of the binary logistic regression test for motivation internal indicators.

Binary logistic regression output for motivation indicators

Logistic regression predicting likelihood of Adoption of the CFI-ERF based on motivation: Economic benefits, Environmental health, Availability of technical support, Government regulations, Friends and family advice, Care for the community and Moral responsibility.

	B	SE	Wald	df	p	Odds Ratio	95% CI for EXP(B)	
							Lower	Upper
Economic benefits	.408	.170	5.763	1	.016	1.504	1.078	2.099

Environmental health	.305	.223	1.872	1	.171	1.357	.876	2.102
Availability of technical support	.503	.223	5.074	1	.024	1.654	1.068	2.564
Government regulations	-.547	.205	7.154	1	.007	.579	.388	.864
Friends and family advice	.336	.249	1.827	1	.176	1.400	.860	2.279
Care for the community	-.461	.315	2.148	1	.143	.630	.340	1.168
Moral responsibility	.630	.259	5.906	1	.015	1.878	1.130	3.121
Constant	-2.592	.982	6.963	1	.008	.075		
Model $X^2(7)$	= 38.6, $p < .001$							
Nagelkerke R^2	= 25.3							
n	= 209							

Note: (1) In this analysis, the DV adoption of the CFI-ERF was coded so that 0 = would not adopt and 1 = would adopt. (2) The logistic regression analysis was run twice. Five outliers (cases) with residuals greater than 2.500 were excluded from the analysis after the first iteration to improve the model fit.

OUTPUT OF THE LOGISTIC REGRESSION TEST FOR CAPACITY INDICATORS

The table below shows the output of the binary logistic regression test for capacity internal indicators.

Binary logistic regression output for capacity indicators

Logistic regression predicting likelihood of Adoption of the CFI-ERF based on Capacity: Financial resources, Human resources and Technical resources.

	B	SE	Wald	*df*	*p*	Odds Ratio	95% CI for EXP(B)	
							Lower	Upper
Financial resources	-.467	.200	5.447	1	.020	.627	.423	.928
Human resources	.168	.202	.693	1	.405	1.183	.797	1.756
Technical resources	.326	.177	3.406	1	.065	1.385	.980	1.959
Constant	1.073	.562	3.643	1	.056	2.923		

Model $X^2(4)$ = 4.502, p =.342

Nagelkerke R^2 = .19

n = 212

Note: (1) In this analysis, the DV adoption of the CFI-ERF was coded so that 0 = would not adopt and 1 = would adopt. (2). Two outliers (cases) with studentized residuals greater than 2.500 were excluded from the analysis.

OUTPUT OF THE LOGISTIC REGRESSION TEST FOR BARRIERS INDICATORS

The table below shows the output of the binary logistic regression test for barriers internal indicators.

Binary logistic regression output for barriers indicators

Logistic regression predicting likelihood of Adoption of the CFI-ERF based on barriers: Not enough revenues, not enough information, not enough training opportunities on CFI-ERF, not enough governmental incentives, shortage of financial resources, not enough knowledge about CFI-ERF methodologies, not enough technical support, complex bureaucratic process.

	B	SE	Wald	df	p	Odds Ratio	95% CI for EXP(B)	
							Lower	Upper
Shortage of financial resources	-.529	.217	5.932	1	.015	.589	.385	.902
Not enough information	.589	.294	4.008	1	.045	1.801	1.012	3.205
Not enough governmental incentives	.309	.193	2.567	1	.109	1.362	.933	1.986
Not enough revenues	-.167	.218	.582	1	.446	.847	.552	1.299
Not enough technical support	.117	.243	.233	1	.629	1.125	.698	1.811
Complex bureaucratic process	-.051	.183	.077	1	.781	.950	.664	1.360
Not enough knowledge about CFI-ERF methodologies	-.040	.269	.022	1	.882	.961	.567	1.628
Not enough training opportunities on CFI-ERF	.013	.287	.002	1	.963	1.013	.578	1.778
Constant	.439	.933	.221	1	.638	1.551		
Model X2(8)	= 19.904, p < .001							
Nagelkerke R2	= 13.3							
N	= 212							

Note: (1) In this analysis, the DV adoption of the CFI-ERF was coded so that 0 = would not adopt and 1 = would adopt. (2) Two outliers (cases) with studentized greater than 2.5 were analysed and excluded from the analysis to improve the model fit. (3) Policy uncertainty was not included in the analysis due to lower number of cases recorded, n = 170.

MAIN MODEL: LOGISTIC REGRESSION INCLUDING ALL THE INDEPENDENT VARIABLES

The table below shows the binary logistic regression output of the main model. The main model includes all the *demography* indicators and the *knowledge, motivation capacity* and *barriers* independent variables which are composite scores of their respective internal indicators.

Binary logistic regression output for all the independent variables

Logistic regression predicting likelihood of Adoption of the CFI-ERF based on Gender, Age, Level of education, Occupation, Knowledge, Motivation, Capacity and Barriers.

	B	SE	Wald	df	p	Odds Ratio	95% CI for EXP(B)	
							Lower	Upper
Motivation	1.222	.346	12.497	1	.000	3.394	1.724	6.682
Gender (male)	-.758	.394	3.712	1	.054	.468	.217	1.013
Occupation	.830	.433	3.673	1	.055	2.293	.981	5.356
Knowledge	-.373	.202	3.408	1	.065	.689	.464	1.023
Level of education	.194	.167	1.345	1	.246	1.214	.875	1.683
Barriers	-.280	.300	.871	1	.351	.756	.420	1.361
Age	-.083	.210	.157	1	.692	.920	.609	1.389
Capacity	-.034	.199	.030	1	.863	.966	.654	1.427
Constant	-1.295	1.707	.576	1	.448	.274		
Model X2(8)	= 24.4, p < .002							
Nagelkerke R2	= .167							
N	= 201							

Note: (1) In this analysis, the DV adoption of the CFI-ERF was coded so that 0 = would not adopt and 1 = would adopt. (2). 12 non-stated gender cases were excluded from the analysis. (3) 3 outliers (cases) with studentized values greater than 2.5 were excluded from the analysis to improve the model fit.

ANNEX 6: GUIDE FOR THE SEMI-STRUCTURED INTERVIEWS

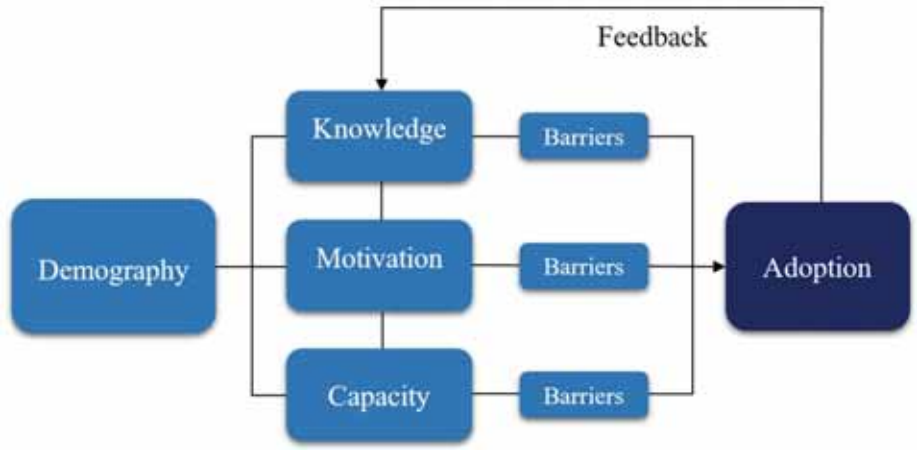
GUIDE FOR THE SEMI-STRUCTURED INTERVIEWS

Introduction

• Introduction to the project and the subject areas that I shall ask about.
• Informed consent form, according to HREC guidelines, will be sent out before interview

During the interview I shall ask questions according to the methodological model developed for this research project. As a strategy to get a better outcome from the interviews, I shall ask the questions about demography at the end of the interview.

Methodological model



Adapted from: Macgregor (2009) and Rogers (1983)

Interview outline

- Knowledge about the Carbon Farming Initiative
- Motivation to adopt the Carbon Farming Initiative
- Capacity to adopt the Carbon Farming Initiative and
- Barriers to adopt the Carbon Farming Initiative
- Questions about adoption of the Carbon Farming Initiative
- Demography of informants

- Information about the land

Semi-structured Questionnaire

Section 1: Questions about Knowledge of the Carbon Farming Initiative (CFI-ERF)

1. Where did you hear about the Carbon Farming Initiative for the first time?
2. Have you received any unsolicited information about the CFI-ERF?
3. How did you access the information about the CFI-ERF? How did you gain knowledge about the CFI-ERF?
4. Do (did) you get information about the Carbon Farming Initiative on a regular basis? From whom?
5. What is your primary source of information about the CFI-ERF?
6. On a scale from 1 to 5, (being 1 the lowest and 5 the highest) what would be your level of knowledge about the CFI-ERF?
7. In your opinion, what are the main environmental benefits of carbon farming activities?
8. Have you received any training on the implementation of CFI-ERF activities? Who? Where?
9. Have you visited any other ongoing CFI-ERF projects?

Section 2: Questions about the motivation to adopt the Carbon Farming Initiative

10. Why did you decide to start your CFI-ERF project?
11. What were your motivations (motives)?
12. Which of the CFI-ERF activities did you Implement (adopt)?
13. In your opinion, what could be the best way to motivate landholders/farmers to adopt/implement CFI-ERF activities?
14. Please mention three reasons you consider (the most) important to adopt/implement CFI-ERF activities. Why?

Section 3: Questions about the capacity to adopt the Carbon Farming Initiative

15. When you started, did you have the necessary resources to develop your project? economic/financial resources, human resources, technical assistance.
16. How did you face the costs for the project implementation? Did you get any financial support?
    Own resources, grants, loans, etc.?
17. Did you get any assistance during the development of your project?

Human resources, Financial support, technical support.

18. Who assisted you?
19. How many people participated directly in the development (implementation) of your project? Did you hire workers or had volunteers to assist you in the implementation of the project?
20. How many people work with you (on the property) on your daily activities?

Section 4: Questions about the barriers to adopt the Carbon Farming Initiative?

21. In your opinion, what are the main barriers/constraints to adopt the CFI-ERF?
    NB: When necessary mention examples of barriers.
    Why does … represent a barrier?
22. How did you overcome these barriers?
23. In your case, are there any ongoing barriers for your project?
24. What should the administrators of the CFI-ERF do to assist landholders overcome the barriers you have mentioned?

Section 5: Questions about adoption of the Carbon Farming Initiative

25. Which of the CFI-ERF activity/ies have you implemented in your property?
26. What is the size of your project?
27. Which of the CFI-ERF activities did you implement?
28. When did you start the development of your project?
29. When did you get your project approved?
30. From your experience, do you consider CFI-ERF activities are viable option to generate income for landholders?

    Why/ why not?

31. Would you recommend/encourage other landholders to implement any of the CFI-ERF activities?

    Why/ why not?

32. If you had to start over, would you do it again?

Section 6: Demography and background of landholders

33. What year where you born?
34. What is the highest level of education you have completed?

35. What is your occupation?
36. What is the role in the management of the property?
37. Are you a member of any landholders' organization? E.g. farmers, land care organization. (Which one?)

Section 7: Information about the land

38. What is the size of the property? In acres or hectares
39. What is the main activity the land is used for?
40. What was the land used for before the implementation of the project?
41. What is the land tenure?

ANNEX 7: PRIMARY LAND USE OF THE PROPERTY

Fourteen options of land use activities, including *other land uses*, were presented to landholders in the questionnaire. The activities were later groped in five items for descriptive analysis procedure which are shown in the table below.

Land use	n	%
Livestock and dairy	**122**	**57**
Grazing & livestock	114	53.3
Dairy products	8	3.7
Cropping	**44**	**20.6**
Fruit crops	6	2.8
Cereals and grains	29	13.6
Sugar cane	5	2.3
Non-food crops	4	1.9
Forestry	**12**	**5.7**
Forestry production	1	0.5
Forest conservation	7	3.3
Forest regeneration	4	1.9
Recreation and education	**19**	**8.9**
Hobby farming	17	7.9
Tourism/ecotourism	1	0.5
Educational activities	1	0.5
Other land uses	**17**	**7.9**
Total	**214**	**100**

ANNEX 8: INFORMATION ABOUT THE LAND AND PROJECT TYPE

Case analysis of property, land use and type of project								
Case	Property size (ha)	Project size (ha)	% land for CFI-ERF project	Primary land (property)	Former land use (project)	Project type (CFI-ERF methodology)	Land tenure	Case summary
Independent adopters	183	40	21.86	Growing trees (130 ha intact forest)	Timber production Cattle grazing	Establishment and management of permanent native forests (A)	Freehold	The project has 40ha in a 183ha freehold property. Currently, the main land use of the land is growing trees, and includes 130ha of intact forest. Part of the land of the property was cleared over 70 years ago and used for cattle grazing.
	80	1	1.25	Natural environments	Logging and grazing	Establishment and management of permanent native forest (A)	Freehold	The project started as 3ha and came down to 1 due to CFI-ERF rules shift. The property is freehold 80ha. The project sits on formerly logging and grazing land. Currently the land use is natural environments.
	800	32	4	75% grazing and cropping 25% trees after 30 years of planting trees	Sheep breeding	Establishment and management of permanent native forest (A)	Freehold	The project comprises 32ha in an 800ha freehold property. Currently, 75% of the land is used for grazing and cropping and 25% for trees planted over 30 years. The former land use of the land where the project was implemented was sheep breeding.
	121	20	16.53	Farming	Dairy farming	Establishment and management of permanent native forest (A)	Freehold	The project comprises 20ha in a 121ha freehold property. The main use of the property is farming and the land where the project was developed was formerly used for dairy farming.
	_____	2	_____	Beef cattle raising	Beef cattle raising	Establishment and management of permanent native forest (A)	Leasehold	Two hectares in leasehold property. The project is a pilot project of 2ha in size, planned to expand to 3000ha. The main use of the land is beef cattle raising and the project also sits on a land formerly used for beef cattle raising.

Associated adopters	8,166	3,000	36.74	Grade A wool Sheep breeding	Grade A sheep grazing	Protection of native forests through the prevention of clearing (B)	Freehold	The project is 3,000ha in size in an 8,166ha freehold property. The land is mainly used for grade A sheep breeding and the land were the project sits was formerly used for grade A sheep grazing.
	13,300	10,000 (2 projects)	75.19	Grazing	Grazing	Protection of native forests through the prevention of clearing (B)	Leasehold	A total of 10,000ha have been used for the implementation of 2 projects in a 13,300ha leasehold property. The main land use of the property is grazing and the former use where the project sits was also grazing.
Theme summary	Largest property 13,300ha, the smallest was 80ha	Smallest project 1ha. Two CFI-ERF projects in 10,000ha	Average: 19.2% Median: 25.93%	Most of the land currently used for productive activities: sheep and cattle grazing and cropping	Before CFI-ERF projects land was mainly used for sheep and cattle grazing and logging	Five projects were under “A” and two projects were under “B” methodologies	Five were freehold land and two leasehold land	