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Interim Report

Key Determinants of Pro-environmental Behaviour of Land Managers in the Agricultural Sector: Literature Review

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AUSTRALIA

Key Determinants of Pro-environmental Behaviour of Land Managers in the Agricultural Sector: Literature Review

Supplementary review to

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Project 2.1.3 Harnessing the science of social marketing and behaviour change for improved water quality in the GBR: an action research project

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Cover photographs: Rachel Hay

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

ABS ..... Australian Bureau of Statistics
AC..... Actual Control
ATB..... Attitudes towards Behaviour
B ..... Behaviour
BB..... Behavioural Belief
BI ..... Behavioural Intentions
CB..... Control Belief
GBR..... Great Barrier Reef
GBRMPA..... Great Barrier Reef Marine Park Authority
LMP ..... Land Management Practice
NB..... Normative Belief
NESP ..... National Environmental Science Programme
NRM..... Natural Resource Management
PBC ..... Perceived Behavioural Control
PC..... Personal Computer
PCA ..... Principal component analysis
PD..... Perceived difficulty
QLD ..... Queensland
SEM ..... Structural equation model
SN..... Subjective Norm
ToPB..... Theory of Planned Behaviour
WA..... Western Australia
WQ..... Water quality

ABBREVIATIONS

approx...... approximately
km..... kilometre
N ..... nitrogen

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EXECUTIVE SUMMARY

This report is associated with NESP Tropical Water Quality Hub Project 2.1.3 *Harnessing the science of social marketing and behaviour change for improved water quality in the GBR: an action research project.* Using insights from the science of social marketing and behaviour change this project aims to aid strategies to:

- implement (and test the efficacy of) changes to the marketing and engagement strategy associated with programmes designed to be rolled out under the *Reef 2050 Plan*
- change key behaviours, particularly amongst those who have not previously engaged, to improve water quality (WQ).

This document provides an extensive review of the existing literature that relates to pro-environmental behaviour, behaviour change and determinants of pro-environmental behaviour in agricultural settings. There is a specific focus on key determinants of behaviour particularly within the Theory of Planned Behaviour (ToPB) (Section 2.3). It is intended to be read as a supplement to the full Literature Review released prior to the commencement of the first round of data collection (Eagle et al., 2016).

The literature review indicated that:

- most research in the agricultural sector is about general attitudes towards the environment, best land management practices and perceptions of barriers and enablers to change in land management
- there is a need to distinguish between descriptive and injunctive social norms[1] which has not been done in agricultural behaviour studies
- there is widespread recognition of the various inter-related factors influencing pro-environmental behaviour and affecting adoption of best land management practices
- most research assumes a direct relationship between background factors and behaviour but the decision making is more complex
- the determinants of behaviour are different depending on theoretical and econometric approaches
- there is limited understanding of the relative importance and inter-relations between these factors, particularly for different segments of land managers
- appropriate analytical methods and techniques such as structural equation modelling (SEM) or similar are required to analyse such complex relationships between behaviour, intentions, attitudes, norms and other factors
- because of the interactive nature of the factors that influence 'behaviours' and behaviours related to water quality, there is a possibility (in the future) of creating some kind of pro-water-quality 'index' for analysis in the Structural Equation model in addition to individual behaviours which are often measured by binary responses (yes/no) or categorical responses. This is beyond the scope of the existing project.

The ToPB has been used for guidance for the development of the surveys used with both cane growers and graziers.

[1] Descriptive social norms replicate 'the extent to which behaviour is perceived as common' and what people normally do in a given circumstances while injunctive norms 'refer to the extent to which behaviour is supposed to be commonly approved or disapproved of' (Steg & Vlek, 2009, p. 311) (for more details see also Eagle et al., 2016, pp.15 - 47)

1.0 INTRODUCTION

Adoption of best land management practice strategies to improve water quality (WQ) in the Great Barrier Reef (GBR) has been low in some regions. It is likely that previous programmes may have encouraged best land management practices only amongst those who were already participate in the programmes. Project 2.1.3 - *Harnessing the science of social marketing and behaviour change for improved water quality in the GBR: an action research project* seeks to encourage best land management practice uptake amongst land managers who have not previously engaged.

Best land management practice reef-related programmes often assume that land managers are motivated by profit – offering financial (dis)incentives or seeking to 'prove' that best land management practice will raise profits. Research shows that finances are not always the sole driver of on-farm conservation activities (Greiner et al., 2009; Greiner & Gregg, 2011), it also shows that socio-cultural and environmental values are crucially important to land managers (Stoeckl et al., 2015) and residents (Larson et al., 2014). Even those who focus on money may not focus on profit; they may instead wish to minimise cost, risk (Asseng et al., 2012; Monjardino et al., 2013) and/or maintain flexibility (Greiner, 2015a). This may explain why financial payments for on-farm conservation initiatives do not always generate 'additionality'[2] (Wunder, 2007), and suggests that the incentives used to encourage best land management practice are unlikely to appeal to all land managers (see Eagle et al., 2016; Burton et al., 2008, Greiner & Gregg, 2011).

Importantly, encouraging behaviour change is not simply about getting incentives 'right'. A vast body of literature focuses on behaviour (Eagle et al., 2013), the 'power of persuasion' (Blackstock et al., 2010) and the social acceptance of new knowledge (Colvin et al., 2015) establishing that to change behaviour one must win a 'battle of ideas' (Meadows et al., 2014). Implicit or explicit persuasive messages are embedded within the water quality programmes and within all materials provided to potential participants. Messages can be 'framed' positively or negatively and communicated to target audiences through different mediums (e.g. pamphlets, extension officers). However, no single mode of framing or communication will work in all situations (Rothman & Salovey, 1997). This is due to a host of interacting factors, including the intrinsic and extrinsic motivators/incentives (Arias, 2015), value orientations (Schwartz, 1994), descriptive and injunctive social norms, social networks and preferred communication channels of targeted groups (Cialdini & Goldstein, 2004). Interacting factors also consider:

- the perceptions of intervening barriers/enablers (Colvin et al., 2015; Rolfe & Gregg, 2015); whether new or existing behaviours are targeted (Snyder et al., 2004);
- whether personal freedoms are perceived to be threatened (Ringold, 2002);
- if those involved are 'trusted and the functional literacy of targets (Blackstock et al., 2010).

Different factors may drive the behaviour of different population segments (Fishbein, 2008) and in different social contexts, hence the need to develop context-specific intervention strategies (Blackstock et al., 2010).

[2] The additionality effect of an incentive/program is the success this incentive/program has had in bringing about changes that would otherwise not have occurred, or in resisting adverse changes that would otherwise have occurred (Lobley & Potter, 1998)

1.1 Project overview and aims

Consistent with a plea to determine "*what works, for whom, in what circumstances and for how long*" (Marteau et al., 2011, p. 264; Taylor et al., 2012), this project uses insights from the science of social marketing and behaviour change (see Eagle et al., 2016) to implement (and test the efficacy of) changes to the marketing and engagement strategy associated with programmes designed to be rolled out under the *Reef 2050 Plan.* It aims to change key behaviours, particularly amongst those who have not previously engaged, to improve WQ.

The main objectives of the project are to:

1) Identify intrinsic and extrinsic motivations (motivations), value-orientations (values), norms, 'habits' (particularly relating to NRM), social networks and communication protocols of different segments of land managers (particularly graziers and cane growers) in regions where WQ improvement programmes have recently been, or will soon be, rolled out.
2) Assess reactions of land managers to the complexities of language, message framing and communication channels ('messaging') used in the programmes, perceptions of barriers to and potential enablers of adoption of these programmes, perceptions of 'threats' to personal freedoms and 'trust' in the programme.
3) Examine similarities and differences in the factors outlined in points (1) and (2) above between the land managers who have, or have not, chosen to participate in the programmes.
4) Identify mismatches between the extrinsic incentives and marketing messages of evaluated programmes and the motivations, values, norms, habits and communication protocols of both participating and non-participating land managers.
5) Work with those who are implementing new programmes to use insights from (1) – (4) above, to suggest and, where appropriate, to implement 'live' alterations to marketing and engagement strategies, i.e. undertake adaptive alterations to those strategies to encourage participation amongst those likely to be disinclined to participate.
6) Assess the efficacy of these interventions, determining if they result in changed behaviours that are likely to generate more significant improvements in WQ than would otherwise occur.

This supplementary report focusses on objective one. The research team spent approximately five months reviewing the literature and consulting with stakeholders to identify relevant behaviours that impact water quality in the GBR catchment, factors influencing pro-environmental behaviour within the agricultural sector and appropriate assessment tools and techniques to investigate the relationships between behaviour and its key determinants (e.g. norms, values, motivations) (section 2 and Eagle et al., 2016). The research team also spent time consulting with stakeholders on the development and design of an appropriate survey instrument and sampling strategy to collect data. Data will be collected form 2016-2018 from land managers who are completely engaged, partially engaged and completely disengaged in WQ improvement programmes.

2.0 LITERATURE REVIEW TO SUPPORT THE RESEARCH DESIGN

A comprehensive literature review outlining current knowledge regarding factors influencing pro-environmental behaviours, relevant theories of behaviour change and the rationale for a social marketing approach to influencing agricultural 'behaviours' that enhance water quality has been completed (Eagle et al., 2016). It was circulated for comments in June 2016, with an updated version released in late November 2016. This material was used to guide the development of cane grower and grazier questionnaires.

This review focusses specifically on literature that relates to pro-environmental behaviour, behaviour change and determinants of pro-environmental behaviour in agricultural settings.

2.1 Issues related to water quality in the GBR

The GBR is the largest World Heritage Area in the world, covering 345,000 km^2 and extending more than 2000 km along the Queensland coast. It comprises thousands of reefs and hundreds of islands made up of over 600 types of hard and soft coral (De'ath & Fabricius, 2010). Coral reefs like any other marine ecosystems are closely connected to catchment areas near the coast through ecological, hydrological, and socioeconomic processes. As such, changes in management and/or changes in use of coastal catchments can positively or negatively affect coral reefs (Doney et al., 2012; Lotze et al., 2006; Thorburn, Wilkinson, & Silburn, 2013a,b)[3]. The total GBR catchment area covers 424,000 km^2 and comprises of six major catchment regions including Cape York, Wet Tropics, Burdekin, Mackay Whitsundays, and Fitzroy. Consequently there is a variety of enterprises and climates across the catchment (GBRMPA, 2014; Thorburn, Wilkinson, & Silburn, 2013a,b).

Deterioration in water quality in the GBR catchment has been associated with changes in land-use and development, particularly the conversion of natural land into areas set aside for agriculture and urban development (van Grieken et al., 2012). Prior to European settlement, Indigenous people managed the land without cattle or intensive agriculture. Nowadays, the 30 river catchments that drain into the GBR lagoon (which cover more than 38 million hectares of land) include National parks, State forests, conservation and recreational parks and reserves, urban areas, agricultural and non-agricultural land and all infrastructure and water features (ABS, 2010). Most of the land in the GBR catchment area is used for agricultural production including beef cattle grazing (73%) particularly in larger and drier regions (e.g. Burdekin and Fitzroy), broad acre cropping (11.7%), sugar cane (2.1%) and horticulture (0.7%) (ABS, 2010[4]). Relatively smaller coastal catchments mostly support uses such as intensive sugarcane and forestry (GBRMPA, 2014). Runoff from agricultural areas may contribute to poor water quality in the GBR.

[3] Wider context such as global development and climate change impact on marine ecosystems and water quality but a detailed discussion of these factors is beyond the scope of the report

[4] There are actually 30 river catchments that drain into the GBR lagoon but ABS (2010) surveyed only 26 catchments, thus the percentage of land used reported for 26 catchments only.

The poor condition of inshore reefs and associated ecosystems (relative to areas further offshore) is associated with poor water quality (De'ath & Fabricius, 2010). This is evidenced by significant increases in sediment and nutrient loads but also by the emergence of pesticides and other pollutants not apparent in pre-European days (McKergow et al., 2005; De'ath & Fabricius, 2010; Brodie et al., 2011; Butler et al., 2013). Poor water quality puts chronic pressure on coral reefs reducing their ability to recover from severe cyclones, mass bleaching events and crown-of-thorns starfish outbreaks (Thompson et al., 2014). Slow recovery is particularly evident in inshore areas (Fabricius et al., 2005; Roff et al., 2012; GBRMPA, 2014). It is imperative to improve water quality to help build the reef's resilience.

Many modern-day land uses generate pollutants, which are transported to the GBR lagoon through the river systems (Furnas, 2003). Transport is particularly rapid during extreme events. Most of the pollutants (e.g. nitrogen, pesticides) and sediments (e.g. clay and fine silt) in river discharges are bi-products of agricultural activities (Furnas, 2003; Kroon et al., 2012). More specifically, most particulate nutrients and sediments are generated from extensive agriculture (e.g. grazing) on largely unmodified lands within 80 km of the coast. These activities, if not managed appropriately, can increase erosion rates, thus increase nutrient and sediment loads (McKergow et al., 2005).

The GBR Outlook report 2014 (GBRMPA, 2016) suggested that suspended sediment loads are mainly concentrated near the coast close to river mouths with inshore areas exposed most (Figure 1) (Reef Water Quality Protection Plan Secretariat, 2011; 2013). During the wet season and flood events, suspended sediments can spread out from large flood plumes, adjacent to the Burdekin River as far as 100 km (Bainbridge et al., 2012) and then further distributed by tides, currents and longshore drift along the coast (Wolanski et al., 2005; 2008). Substantial investment (2009 – 2013) in the best land management practices resulted in 11% estimated annual reduction in sediment loads on average to the GBR lagoon (Reef Water Quality Protection Plan Secretariat, 2014).

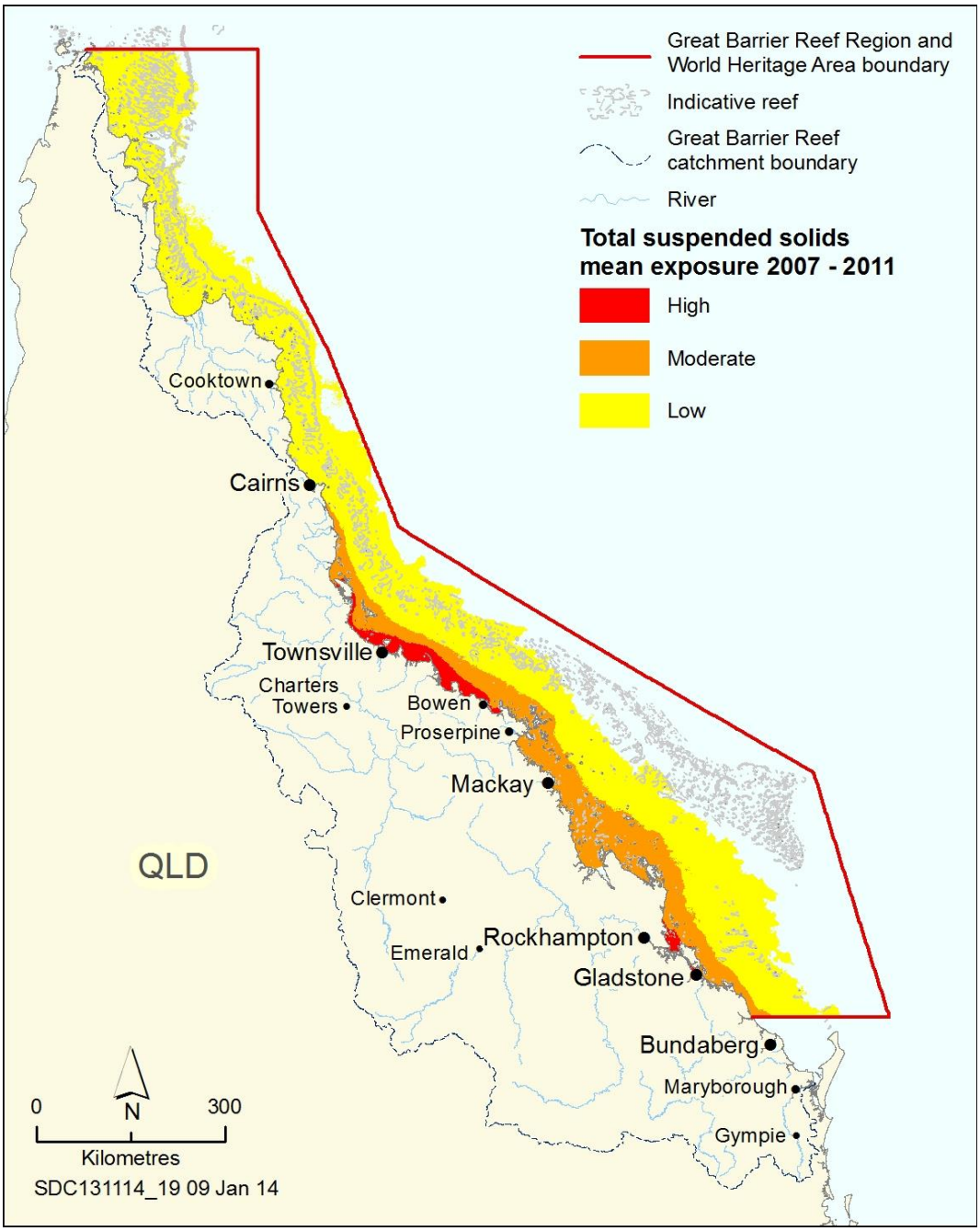

Figure 1: Exposure to suspended sediments, 2007–2011

131114_19_TSS_MeanExposure_2007- 2011

The assessment classes (high, moderate and low) are relative and derived from a combination of scaled river load data and flood plume frequency analysis from remote sensing data. The mean of the five annual distributions was selected as a way of factoring in inter-annual variability in river discharge, although it is recognised that this period was characterised by several extreme rainfall events (Source: Brodie et al., 2013)

'Maps courtesy of the Spatial Data Centre, Great Barrier Reef Marine Park Authority'

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Nutrient cycling is vital for ecosystem health. Terrestrial sources deliver additional naturally produced nutrients to the coral reefs close to the coastal area but an excess of nutrients leads to increase in algal and macroalgal growth, which can negatively affect marine ecosystem health (McCook et al., 2007; Hoegh-Gulberg & Dove, 2008). The GBR Outlook report 2014 (GBRMPA, 2016) indicated that two-thirds of the southern inshore areas are currently exposed to inorganic nitrogen at a high concentration (Figure 2), negatively

affecting nutrient cycling in the ecosystem. Significant investments into best land management practices in 2009 to 2013 resulted in 16% estimated annual reduction in inorganic N loads on average to the GBR from the GBR catchment area (Reef Water Quality Protection Plan Secretariat, 2014).

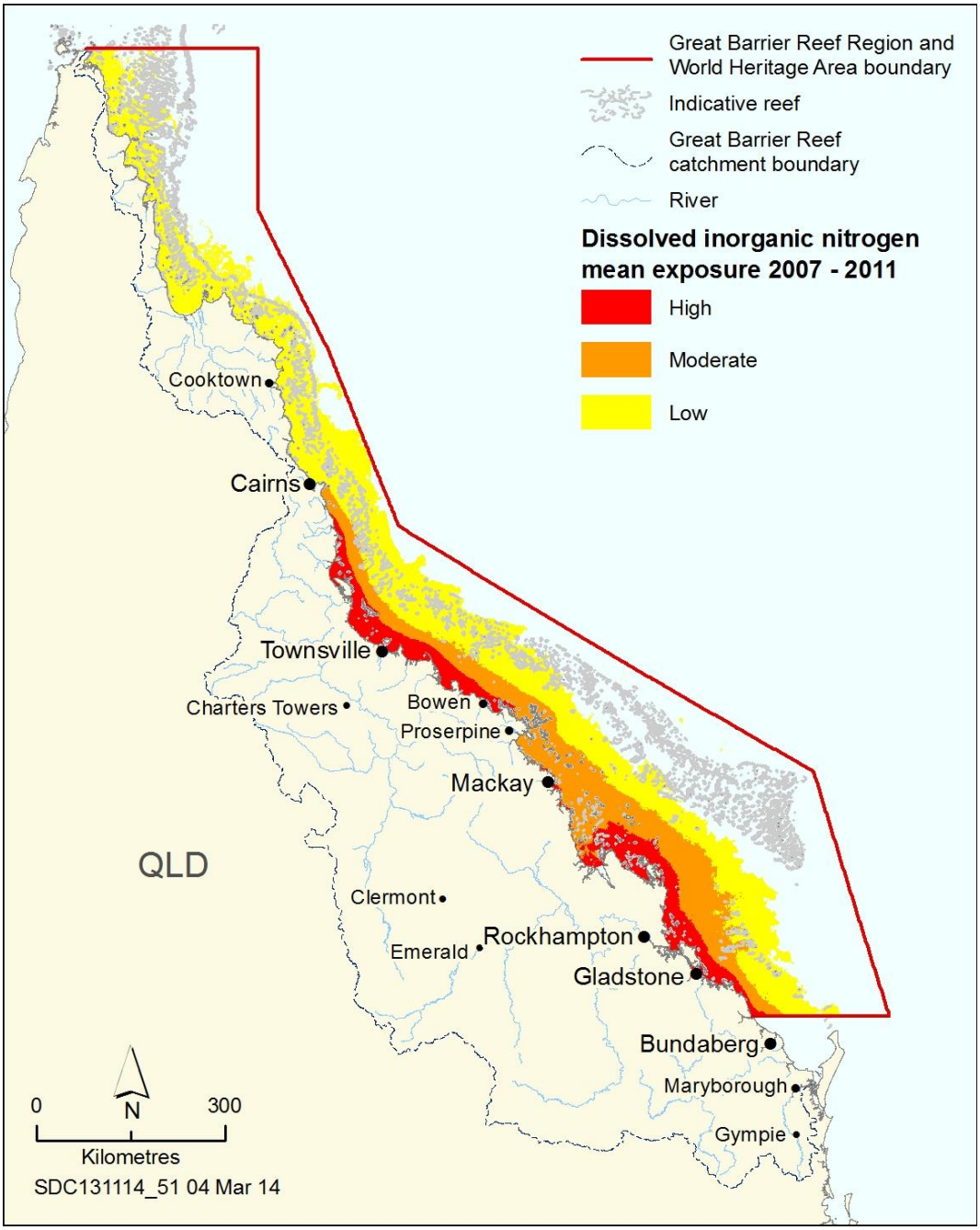

Figure 2: Exposure to dissolved inorganic nitrogen, 2007–2011

131114_51_DINMeanExposure_2007-2011
Nutrients, such as dissolved inorganic nitrogen, are now present in the ecosystem at far higher concentrations than those likely to have been present prior to European settlement. The assessment classes (high, moderate and low) are relative and derived from a combination of scaled river loads data and flood plume frequency analysis from remote sensing data. The mean of the five annual distributions was selected as a way of factoring in inter-annual variability in river discharge, although it is recognised that this period was characterised by several extreme rainfall events (Source: Brodie et al., 2013).
'Maps courtesy of the Spatial Data Centre, Great Barrier Reef Marine Park Authority'
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Nutrients are often introduced into the system with more intensive agriculture (e.g. sugar, horticulture) when inorganic fertilisers and pesticides are used to encourage crop growth (Brodie, 2007; Brodie et al., 2008; Mitchell et al., 2009; Lewis et al., 2009). Most intensive agriculture occurs on floodplains, which are very close to the end of catchment. This means that water draining off farms travels quickly to the GBR lagoon, with little chance for in-river processes to remove contaminations before they reach the sea (Furnas & Mitchell, 2001). There is a perception among some land managers that water quality issues are beyond their control.

2.2 Land Management Practices in the GBR catchments

In the last two decades increased attention has been paid to the way in which farmers and graziers manage their land and to the way in which their land management practices impact water quality (Blackstock et al., 2010). In this report, the land management practices are sometimes referred to as 'behaviours'. Much effort has been expended trying to encourage farmers and graziers to adopt 'sustainable' land management practices (sustainable 'behaviours'). For some land managers, this means changing practices ('behaviours') to ones that reduce erosion and reduce nutrient losses, thus helping to improve water quality in the GBR (Drewry, Higham, & Mitchell, 2009). Table 1 summarises some of the land management practices ('behaviours') which have been recommended.

Table 1: The best LMPs for water quality improvement in the GBR catchments for grazing and sugar cane industries

Grazing	***Sugar cane***
Maintaining light cattle utilization rates	Controlling nutrient and pesticide contamination of water
Managing for even utilization of pasture	Soil specific nutrient management, including regular leaf analysis and soil testing (e.g. calculating N fertiliser rates; matching fertiliser application to specific soil conditions)
Managing for a variable climate	Controlled traffic - a farming system based on permanent wheel tracks where the crop zone & traffic lanes are eternally separated
Resting/spelling pasture	Permanent beds[5]
Appropriate fire management	Minimum tillage[6]
Strategic locations of property infrastructure to avoid erosion	Tail water recycling[7]
Maintaining groundcover to minimise surface flow in areas that are prone to gully erosion	Quantitative irrigation scheduling

[5] Usually, the soil is 'cultivated to depths of up to 30 cm and then formed into narrow beds of between 1.7 to 2.0 m in width. Soil from the furrows positioned down each side of the beds is thrown onto the tops of the beds, resulting in an increase in the height of the soil of between 2 and 5 cm. The height of the bed above the furrow base is usually between 15-30 cm, depending on the depth of the prior cultivation' (Department of Economic Development, Jobs, Transport and Resources, 2017)

[6] A soil conservation method/ system that does not turn the soil over

[7] The surface water located immediately downstream from a dam, channel, drain etc. (You dictionary, 2017)

Installing recommended fencing and water point infrastructure to manage cattle use of, and access to, the riparian zone	Holistic nutrient management planning (e.g. timing fertiliser application to irrigation schedules; applying fertiliser below the surface; ensuring the amount of nutrients applied only replaces the amount used by the previous crop) Strategic and minimal use of pesticides and herbicides

Source: (Greiner, Lankester, & Patterson, 2007; Thorburn et al., 2007; Rolfe et al., 2008; Greiner, Patterson, & Miller, 2009; Lankester, Valentine, & Cottrell, 2009; van Grieken et al., 2010; Agnew, Rohde, & Bush, 2011; Akbar et al., 2014; Rolfe & Gregg, 2015)

The efforts to change land management practices or behaviours, to improve WQ, and help improve the resilience of the GBR are, essentially, efforts to change 'behaviours'. Therefore, it is important to look at the science of human behaviour. The next section of the report will discuss pro-environmental behaviour and the complexity of factors influencing such behaviours mainly focusing on ToPB.

2.3 Behaviour and Behaviour Theories

> *'Despite the overwhelming scope of environmental problems, the suitability of a behavior analytic approach to solving environmental problems is clear. Global warming, overpopulation, overflowing landfills, ozone depletion, acid rain, loss of green space, water pollution and species extinction are all problems that are primarily, if not exclusively, caused by human behavior' (Lehman & Geller, 2004, p. 17)*

Theory often is used to 'explain behaviour but not to '*change behaviour*' (Michie et al., 2008, p. 665). When developing intervention techniques for behaviour change one needs to identify behaviour predictors and then change them, which is not a trivial task (Michie et al., 2008). There is no simple link between relevant intervention techniques and theory (Hardeman et al., 2005). Furthermore, 'different techniques will address different behavioural determinants' (e.g. if the lack of skills is a determinant then it can be appropriate to work on practical skills but if there is lack of motivation to implement these skills, different intervention technique should be used) (Michie et al., 2008, p. 665).

A significant proportion of studies (see Albarracin et al., 2005; Trifiletti et al., 2005; Noar & Zimmerman, 2005; Dombrowski, Sniehotta, & Avenell, 2007) 'fails to make explicit reference to theory' (Michie & Prestwich, 2010, p.1) and uses theory as a 'loose framework'. In addition, 'where a theoretical base for an intervention is stated, there is seldom reference to a method describing how the theory informed the design of the intervention, or how the evaluation tests theory' (Michie & Prestwich, 2010, p.1; Rothman, 2004). To better understand the effect of the interventions on behaviour change and to help in developing more effective interventions, it is essential to improve methods which are 'linking behaviour change theory to designing and evaluating interventions to change behaviour' (Michie & Prestwich, 2010, p. 2).

There are numerous different theories and conceptualisations of behaviour but all of them have their own advantages and limitations (see Eagle et al., 2016). The Theory of Planned Behaviour (ToPB) originally developed by Ajzen (1991) and further modified by Fishbein and

Ajzen (2011) into an Integrative Model of Behavioural Prediction and Change (IMBPC) is one of the most popular and mostly used theoretical approaches. The difference between the two theoretical models is the inclusion of 'actual control over performance of the behaviour' (Fishbein & Ajzen, 2011, p. 21). To avoid confusion, from this point forward the Integrative Model of Behavioural Prediction and Change (a recently modified version of the ToPB) will be referred to as the ToPB. As discussed in Eagle et al. (2016), models based on the ToPB (e.g. Theory of Reasoned Action, the precursor of the ToPB) have reasonable power to explain people's behaviour in different contexts such as health (Babrow, Black, & Tiffany, 1990; Conner et al., 1990; Gerend & Shepherd, 2012); sport (Theodorakis, 1992; Chan et al., 2015), education (Davis et al., 2002; Underwood, 2012), and investment decisions (East, 1993). As such, the ToPB is deemed the most suitable theoretical approach to explore land management practices/'behaviours' in the context of this research project. This literature review will mainly focus on ToPB and its applications with more emphasis on applications in agricultural settings. The ToPB and information on key determinants of behaviour identified by other studies (section 2.3.4.1 and section 2.3.4.2) was used as a base when developing the questionnaire.

2.3.1 The Theory of Planned Behaviour

The ToPB hypothesises that three psychological constructs influence behavioural intentions (BI), which are an immediate determinant of actual behaviour (Ajzen, 2005). These key constructs include: attitudes towards behaviour (ATB), perceived or subjective norms (SNs) and perceived behavioural control (PBC) each of which derive from personal beliefs (Borges et al., 2014) (Figure 3).

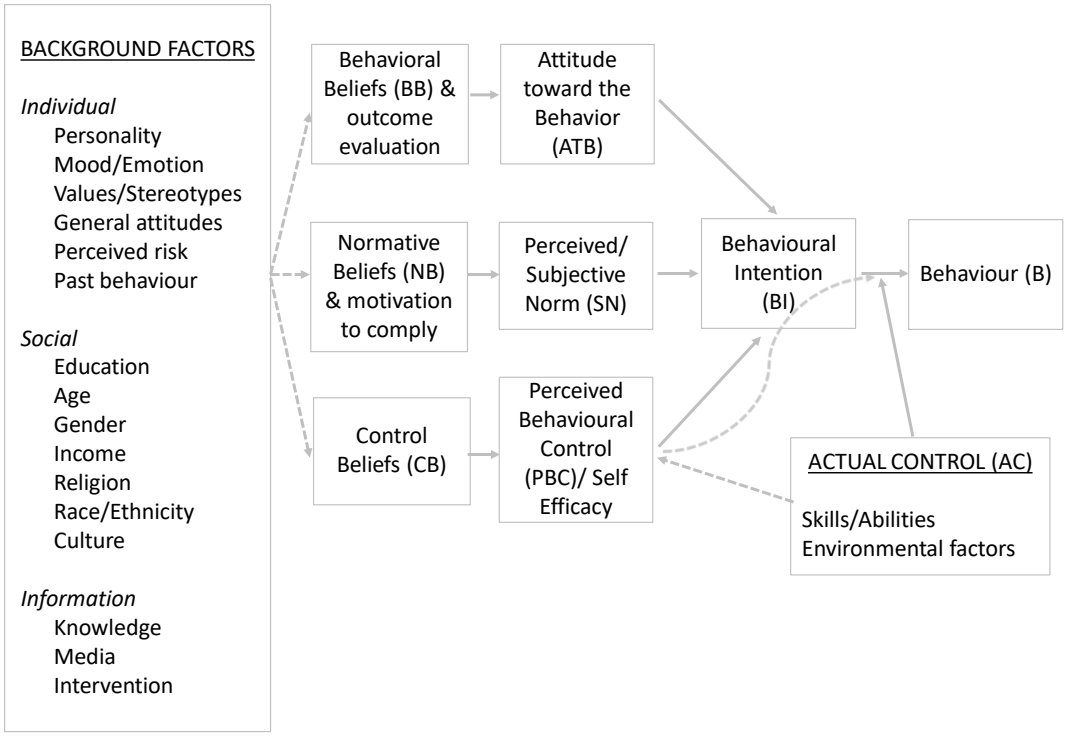

Figure 3: Integrative Model of Behavioural Prediction and Change (adopted from Fishbein & Ajzen, 2011)

Fishbein and Ajzen (2011) argue that an individual's behaviour is dependent on an individual's beliefs and that there are three key types of beliefs: behavioural beliefs, normative beliefs, and control beliefs. Behavioural beliefs (BBs) are beliefs that individuals have about the consequences (negative or positive) of their behaviour. Behavioural beliefs determine an individual's attitude toward a behaviour, which may be either positive or negative (Fishbein & Ajzen, 2011; Kreijns et al., 2013). Normative beliefs (NBs) are formed by an individual and are based on their perceptions of whether other people who are important to them (e.g. peers, authorities, family members) are likely to approve or disapprove of their behaviour. Normative beliefs are weighted by an individual's 'motivation to comply', that is, by how much they seek approval from these other people (Fishbein & Ajzen, 2011; Kreijns et al., 2013). Normative beliefs determine subjective norms (sometimes termed perceived norms) which refer to perceived social pressures on individuals to behave (or not) in certain ways. The more important groups/individuals are to an individual and/or the more strongly they are believed to approve the behaviour and/or the more often 'important people' perform this behaviour themselves, the more likely an individual will also chose to behave in that way (Fishbein & Ajzen, 2011; Borges et al., 2014).

Individuals also have their own beliefs – control beliefs (CBs) - about external factors or circumstances that facilitate or impede behaviours (Beedell & Rehman, 1999; Fishbein & Ajzen, 2011). Control beliefs influence an individuals perceived behavioural control i.e., their perceived ability to perform behaviour successfully (Fishbein & Ajzen, 2011; Borges et al., 2014). Perceived behavioural control was derived from the Social Cognitive Theory (Bandura, 1986) which is related to the concept of self-efficacy. Self-efficacy is defined as the belief 'in one's capabilities to organize and execute the courses of action required to produce given attainments' (Bandura, 1997, p.3). In short, if an individual feels that he/she can perform a behaviour and can overcome the barriers that can impede the performance, then they will be more likely to try it (Kreijns et al., 2013).

As noted earlier, there are two types of social norms, descriptive and injunctive. Descriptive social norms replicate 'the extent to which behaviour is perceived as common' and what people normally do in a given circumstances (Steg & Vlek, 2009, p. 311; Cialdini, Reno, & Kallgren, 1990). Injunctive norms 'refer to the extent to which behaviour is supposed to be commonly approved or disapproved of' (Steg & Vlek, 2009, p. 311; see also Eagle et al., 2016). 'Fear of social exclusion is viewed as a primary motive why people tend to fulfil social norms' (Bamberg & Moser, 2007, p. 16). Often individuals who believe or feel that the pro-environmental behaviour option is morally correct and socially appropriate (e.g. coherent with community/groups norms, responsibility for future generation) are more likely to be involved in pro-environmental behaviour. Strong perceived social pressure itself, however, is not a main reason for why individuals follow social norms (Sherif, 1936; Bamberg & Moser, 2007).

A behavioural intention is formed through the combination of attitudes towards behaviour, perceived or subjective norms and perceived behavioural control. Intention to behave is stronger when attitudes towards behaviour and subjective norms are more constructive and perceived behavioural control is greater (Davis et al., 2002; Fishbein & Ajzen, 2011). However, all three of these types of beliefs originate from different sources, which, as is apparent from the discussion above, include but are not limited to education, personal experience and interactions with people (e.g. colleagues, family and friends), social media, TV, Internet, radio and newspapers. Individual differences (in, for example, personality,

values/stereotypes, mood/emotions) and social differences (e.g. in education, age, gender, religion, culture) will influence peoples' experiences. They will also influence the information sources to which they are exposed, their interpretation of that information and whether or not they remember that information or are influenced by it. As such, individuals from different cultures, religions, and ethnicities are likely to have different beliefs, which will shape their behavioural intentions.

Actual behaviour (sometimes termed *performance)* depends on the strength of intention, the stronger the BI the more likely that a person will carry out the behaviour (Fishbein & Ajzen, 2011). However, it is recognised that environmental factors and constraints, skills and abilities may prevent a person from considering behaving in a certain way. In other words, an individual may not have enough actual control over performance.

On one occasion, Mark Twain said '*the weather is always doing something'* (Mark Twain's Speeches, 1910) and the big problem is that the weather is beyond land manager's control. As such, actual control (AC) over environmental factors (e.g. drought, rainfall, cyclone, and flood) and/or over actual knowledge, capital, skills, abilities, and opportunities (affordances and constraints) or sufficient availability of these factors can moderate the relationship between behavioural intention and actual behaviour (B) (Fishbein & Ajzen, 2011; Kreijns et al., 2013). Having no control over actual factors can also lead to negative intentions to perform the behaviour (Borges, Foletto, & Xavier, 2015). All three psychological constructs, attitudes towards behaviour, perceived or subjective norms and perceived behavioural control can be derived from beliefs or they can be directly elicited (Lapple & Kelley, 2013) but measuring actual control is a challenge.

2.3.2 Pro-environmental behaviour and its determinants

Steg and Vlek (2009) broadly defined environmental behaviour *'as all types of behaviour that change the availability of materials or energy from the environment or alter the structure and dynamics of ecosystems or the biosphere*' (p. 309). Pro-environmental behaviour could be defined as the behaviour which *'consciously seeks to minimize the negative impact of one's actions on the natural and built world (e.g. minimize resource and energy consumption, use of non-toxic substances, reduce waste production)'* (Kollmuss & Agyeman, 2002, p. 240) or can even benefit the environment (Steg & Vlek, 2009). Such behaviour is usually seen as a combination of self-interest and of concern for future generations, species or ecosystems, or other people (Bamberg and Moser, 2007).

For decades, researchers were trying to understand and explain why people participate in pro-environmental behaviours and what can determine participation. Most researchers investigated a variety of demographic variables (e.g. age, income, gender, and ethnicity), personality, attitudes and beliefs as determinants of pro-environmental behaviour (Oskamp et al., 1998). A number of studies investigated relationships between pro-environmental behaviour and general environmental beliefs, values and concerns (Oskamp et al., 1998; Schultz, 2001; Nordlund & Garvill, 2002; Garling et al., 2003; De Groot & Steg, 2007).

Studies on pro-environmental behaviour

Schultz & Zelezny (1998) listed statistically significant determinants of pro-environmental behaviour identified by other researchers (e.g. general and specific attitudes, knowledge/

awareness, personality/ emotions, demographic factors, farm/property characteristics etc.). The literature review identified 165 studies that investigated pro-environmental behaviour and its determinants (Appendix 1 - Table 5,

Table 6 and Figure 11). The significant determinants identified by the literature review include:

- Individual factors such as personality/emotions, values/stereotypes held by individuals, their attitudes (general and specific) towards the environment, personal and social norms, risk, health and experience;
- Social factors such as formal education, age, income, culture and self-identity; and
- Information factors such as knowledge and awareness, interventions, incentives, compensation and equity

Farm characteristics (e.g. size of the farm, off-farm work and diversification, lower debt) were found to be important significant determinants of pro-environmental behaviour in an agricultural context, which will be discussed in section 2.3.4.

Individual predictors

The personality/emotions group is comprised of personal integrity and high ethical standards; individual's emotions (e.g. level of stress, guilt) and moral concerns, habits, locus of control, high level of social responsibility for environmental improvement/degradation. Socially conscious and responsible people, for example, will behave pro-environmentally because they believe that they can make a difference and that it is their obligation to the society (Schultz et al., 1995). People with higher level of locus of control or a belief that they can regulate their own destiny are more likely to behave pro-environmentally (Hines, Hungerford, & Tomera, 1987; Schultz, Oskamp, & Mainieri, 1995).

An individual's values and stereotypes such as balance of work and lifestyle values; economic, environmental and conservation values; self-transcendent, prosocial, altruistic and biospheric values; self-enhancement (i.e. hedonic, egoistic) values and biospheric concern were found to be significant determinants of pro-environmental behaviour. Individuals, who have relatively greater values for environmental quality and conservation than others, are more likely to perform pro-environmental behaviour (Poortinga, Steg, & Vlek, 2004). Those who prioritise collective interest or self-transcendence types of values are more likely to participate in pro-environmental behaviour than those who give a priority to an individual interest or self-enhancement values (Stern et al., 1995; Nordlund & Garvill, 2002).

In the majority of studies, both general (e.g., attitudes towards climate change, financial incentives, and security) and specific attitudes (e.g. attitudes concerning a specific environmental/conservation problem) were found to be statistically significant positive/negative predictors of pro-environmental behaviour. People's positive attitudes toward the importance of a healthy environment and conservation, for example, are positively related to engagement in pro-environmental behaviour (Margai, 1997; Brandon & Lewis, 1999). Specific attitudes have been found to have stronger impact on behaviour than general attitudes (Oskamp et al., 1998).

Personal and social norms are found to be significant determinants of pro-environmental behaviour. *'Personal norms differ from social norms in that they refer to internal standards concerning a particular behaviour rather than reflecting externally imposed rules'* (Doran &

Larsen, 2016, p. 159). Personal norms often have an impact on environmental attitudes and behaviour and these relationships have been studied mainly in non-ToPB research (Dunlap et al., 2000; Mzoughi, 2011). In environmental context, individuals who feel a moral responsibility to protect the environment are more likely to perform pro-environmentally, for example, to purchase organic food, reduce electricity consumption, and reduce the use of personal cars (Nordlund & Garvill, 2003; Bamberg, Hunecke, & Blobaum, 2007).

Perceived higher risk and uncertainty were found to be negatively associated with behaviour while good health and extra training/experience have positive impact on behaviour change.

Social predictors

The literature review revealed that those who are more likely to behave pro-environmentally are higher income earners and are relatively more educated individuals (Brandon & Lewis, 1999; Poortinga, Steg, & Vlek, 2004). Younger individuals, people from strong cultural backgrounds and those who strongly identify themselves with nature are more likely to behave pro-environmentally (Featherstone & Goodwin, 1993; Poortinga, Steg, & Vlek, 2004). Culture, tradition and self-identity are found to be significant positive determinants of pro-environmental behaviour (Poortinga, Steg, & Vlek, 2004). 'Culture is embedded in tradition' (Gray et al., 2000, p. 22) and tradition is an aspect of culture which is usually passed from one generation to another generation. Self-identity, ideology, knowledge and inheritance of environmentally friendly practices are the main factors considered in cultural tradition impact on behaviour studies. Cultural tradition varies depending on community, area and region (Gray et al., 2000).

Information predictors

Information is one of the most important ways to promote pro-environmental behaviour. Information can be used to provide consulting and practical advice, as well as scientific advice and technical information (Staats et al., 2004). Information provision is expected to increase the awareness of environmental problems and provide information about other people's efforts to fix those problems, which may increase the likelihood of behaving pro-environmentally (Messick & Brewer, 1983). However, while provision of information is necessary it is not of itself sufficient to change behaviours (Australian Public Service Commission, 2007). Information and knowledge about pro-environmental behaviour (e.g. recycling; exposure to conservation information; seeking conservation information) or lack of that knowledge has been found to be a significant predictor of an individuals' behaviour (see Appendix 1 - Figure 11). The more (less) information an individual has about a particular behaviour (e.g. recycling location, materials that are recyclable; pro-conservation information campaign) the more (less) likely he/she will perform such behaviour (Schultz et al., 1995; Trumbo & O'Keefe, 2001).

Another important predictor of pro-environmental behaviour identified by this literature review is the use of behavioural interventions. Interventions can differ in terms of their aims. Some interventions can be applied to reduce negative environmental impact while others aimed to change the context in which individuals are making decisions through provision of financial benefits and rewards, educational and training opportunities, new, more efficient equipment, or laws and regulations. Interventions can change actual and perceived costs and benefits as well as pay-off structure. As such, the concept of equity is essential for understanding moral motives and for the need to share costs and benefits when encouraging pro-environmental

behaviour (Krattiger & Lesser, 1995). Kabii and Horwitz (2006) argue that the concept of equity might be mostly relevant to 'the distribution of financial and other economic incentives among land managers for encouraging' their adoption of pro-environmental behaviour (p. 15).

Financial benefits and training opportunities can make pro-environmental behaviour more attractive while information about negative consequences can make it less attractive (Garling et al., 2002; Abrahamse et al., 2005). This literature review identified that consequence-based interventions have a positive impact on pre-environmental behaviour (Midden et al., 1983; Featherstone & Goodwin, 1993). While financial benefits and rewards encourage pro-environmental behaviour, some researchers suggest that such influence is a short-term change (Thogersen & Moller, 2008; Osbaldiston & Schott, 2011) because as soon as rewards are discontinued, positive effects disappear (Unsworth, Dmitrieva, & Adriasola, 2013). Furthermore, incentive programs do not always require behaviour change and 'some people may receive benefits for default behaviour' (Schmidt, 2012, p. 51), which can raise inequality issues in a proposed incentive, thus, lead to a reduction in likelihood of performing pro-environmental behaviour.

Financial, learning and training incentives, financial compensation and equity were found to be significant positive predictors of pro-environmental behaviour in agricultural studies (Paudel et al., 2008; van Grieken et al., 2012).

2.3.3 Application of ToPB in pro-environmental behaviour context

The Theory of Planned Behaviour (ToPB) and models based on this theory were applied successfully to explain a variety of pro-environmental behaviours such as water conservation (Harland, Staats, & Wilke, 1999; Yazdanpanah et al., 2014; Pradhananga, Davenport, & Olson, 2015), recycling (Boldero, 1995; Tonglet, Phillips, & Read, 2004), environmental activism (Fielding, McDonald, & Louis, 2008), and adoption of sustainable practices in the agricultural sector (Beedell & Rehman, 1999; Fielding, Terry, Masser, & Hogg, 2008; Wauters et al., 2010; Wheeler, Zuo, & Bjornlund, 2013).

Several studies on pro-environmental behaviour extended the ToPB by including descriptive social norms (Heath & Gifford, 2002), people's habits (e.g. habit strength of car use) (Verplanken et al., 1998; Bamberg & Schmidt, 2003), personal norms (e.g. using environmentally friendly travel modes like a bike or public transport) (Harland et al., 1999; Bamberg & Schmidt, 2003), personal identity (e.g. socially reliable, socially involved, sensitive, altruistic, positive, conscientious, careful, respectful) (Mannetti, Pierro, & Livi, 2004), role of beliefs (Bamberg & Schmidt, 2003), and environmental concern for improving an understanding of the relationships between the variables and the explanatory power of the model (De Groot & Steg, 2007).

There are some arguments that ToPB constructs (e.g. attitudes towards behaviour, perceived or subjective norms, and perceived behavioural control) have been more effective in predicting environmental behaviours than other variables (e.g. demographics) such as recycling in Hong Kong (Cheung, Chan, & Wong, 1999); recycling and air pollution in 27 developed and developing countries including Austria, New Zealand, Russia, USA, Philippines etc. (Oreg & Katz-Gerro, 2006); water conservation in Bulgaria (Clark & Finley,

2007), in USA (Trumbo & O'Keefe, 2001), and in Taiwan (Lam, 2006). Lam (2006), Clark and Finley (2007), and Trumbo and O'Keefe (2001) investigated behavioural intentions for water conservation. All three studies found the attitudes towards water conservation (e.g. beliefs that it is important to conserve water), subjective norms (e.g. people that a participant knows think that water conservation is important), and perceived behavioural control/self-efficacy (e.g. things a participant can do around the house to save water will not really make much of a difference for the community) be significant predictors of the behavioural intentions. These significant predictors of the intentions were explaining variances across the variety of intentions between 10% and 66%.

Mancha et al. (2014) looked at the relationships between the intentions to complete green behaviour, attitudes towards environmentalism, environmentally focused subjective norms, and the green perceived behavioural control. These authors confirmed the composite reliability and, thus, the internal consistency of the ToPB constructs implying that they explain more than 50% of the variance, thus, the constructs demonstrate acceptable discriminant validity.

Mancha et al. (2014) also found that people who would like to join and actively participate in an environmentalist group/organisation, those who strongly believe that protecting the environment is more important than protecting peoples' jobs, and who try to save natural resources whenever possible, are more likely to consider environmentally-friendly behaviour. They also found that people, for whom the opinion about environmental protection of other people that they admire is very important, are more likely to have intentions to complete the green behaviour. People who find it easy to be friendly with the environment, those who were confident and capable of protection, who had enough resources and who also were good at leading a green lifestyle, also had positive intentions to change behaviour/implement environmentally-friendly practices/to complete green behaviour.

De Groot and Steg (2007) applied the extended ToPB to examine the relationship between behavioural intention and attitudes towards matters such as improvement in accessibility, environmental quality and traffic safety by the use of transferia[8]. Whether their family, friends, colleagues and employers thought that they should use the transferium for shopping (or working) purposes (subjective norms), and whether they were able to use the transferium (perceived behavioural control). De Groot and Steg (2007) found positive statistically significant relationships between all three ToPB constructs and intentions. Their results reveal that respondents who placed higher importance on attitudes towards the transferium for shopping and working trips relevant to environment, health, privacy, comfort, relaxation, weather etc.; those who indicated that their family, friends, colleagues and employer thought that they should use the transferium; and those who were able to use the transferium were likely to have an intent of using the transferia. Environmental concerns ('the importance of consequences of environmental problems for oneself, others, and the biosphere', p. 1824) were also positively related to attitudes towards the use of transferia but not directly to the intention of using it. De Groot and Steg (2007) highlighted that the relative importance of all

[8] Transferia/transferium relates to 'parking facilities, mostly situated along through roads, where quick transfers can be made to public transportation' (De Groot & Steg, 2007, p. 1817)

three constructs might differ for different behaviours and for different targeted groups, which are performing behaviour (De Groot & Steg, 2007).

Greaves, Zibarras, and Stride (2013) used ToPB and antecedent beliefs towards three particular pro-environmental behaviours:

- recycling as much waste as possible
- using video-conferencing for meetings that would otherwise require travel
- switching off PCs every time employees left their desks for an hour or more (p.109)

They used behavioural intention as a proxy for behaviour. An inclusion of the antecedent beliefs related to attitudes, subjective norms and perceived behavioural control is common in health psychology research (Francis et al., 2004) but very rare in research on pro-environmental behaviour (Greaves, Zibarras, & Stride, 2013). However, such an inclusion may improve an understanding of the process through which attitudes, norms, and control influence and relate to intention towards pro-environmental behaviour. Greaves, Zibarras, and Stride (2013) found positive statistically significant relationships between three constructs and the intention to implement recycling, the use of video-conferencing, and switching off PCs for an hour or more. Respondents who thought that it is beneficial for the environment to use video-conferencing more often than travel to meetings, who expected to use more video-conferencing; and who felt that the decision relevant to use of video-conferencing is under their own control were more likely to participate in recycling waste, video-conferencing, and switching off PCs. Greaves, Zibarras, and Stride (2013) also reported significant influence of the antecedent beliefs on intention to implement pro-environmental behaviour mediated through the attitudes, norms and control. Participants who recycle as much waste as possible at the work place and feel that they are really helping to reduce the amount that goes to landfill were more likely to consider implementation of all three types of pro-environmental behaviours investigated. In line with other researchers (Dunn et al., 2011) they found a small but significant direct relationship between intentions and the antecedent beliefs.

Several studies reported subjective norms (e.g. opinion of other people who are important for a participant) as the weakest predictor of pro-environmental behaviour (Cialdini & Trost, 1998; Armitage & Conner, 2001; Mannetti et al., 2004). Nigbur et al. (2010) argue that subjective norms are extremely influenced by idiosyncrasies of the investigators but social norms, which refer to behaviour acceptable in society or a group can be moderated 'by identification with a group and self-categorization' (Mancha et al., 2014, p. 3; Fishbein & Ajzen, 2011). Identification with a group may need to be balanced with the individual's habits and self-representation, which have been added by some researchers to the ToPB (Terry, Hogg, and White, 1999; Mannetti et al., 2004). Motivations and attitudes to pro-environmental behaviour have been commonly studied within the ToPB (Mannetti et al., 2004) but it was suggested that self-identity (e.g. help the environment) dimensions incorporate *'the many roles owned by an individual that affect actions and behaviour that may contribute to expectation and norms'* (Mancha et al., 2014, p. 3).

Moreover, the inclusion of self-identity as a predictor of behavioural intention is particularly important in an environmental context because pro-environmental behaviour is consistent with ecologically orientated vision and related to the morality domain (Thogersen, 1996). Beside the ToPB classical variables, Mannetti et al. (2004) included a constructed self-

identity variable (which was measuring 'identity of the typical person'' based on the respondent's ''personal identity'': socially trustworthy, sensitive, positive, altruistic, socially involved, conscientious, careful, respectful' items) (p. 231). They found that personal identity independently and significantly contributes to the explanation of behavioural intention. They found perceived behaviour control (PBC) was the most significant predictor of intentions and subjective norms were the weakest ones. A number of barriers to the intention to perform the actual behaviour (e.g., time, costs, and effort) could explain the strong impact of PBC. Participants for whom it was easy to perform recycling were more likely to consider participation in recycling behaviour while those who indicated that 'most people who are important to them would approve their performance differentiated collection and refuse disposal within the next two months' would not predict recycling behaviour (Mannetti et al., 2004, p.161). Mannetti et al. (2004) attributed to the weakness of agree-disagree measurements of norm variables which was confirmed by other studies (Trafimow & Finlay, 1996; Cialdini & Trost, 1998; Armitage & Conner, 2001). Actual impact of subjective norms can be underestimated particularly 'when it is measured by means of anonymous questionnaires completed in private settings' (Mannetti et al., 2004, p.161).

Armitage and Conner (2001) conducted a meta-analysis review of 185 ToPB studies. They found that relatively few studies measured and used actual behaviour as a separate variable, which can be a concern with predicting behaviour - only 19 studies from 185 used observational or independently rated measures of actual behaviour and 44 used self-reported behaviour. Some researchers found low correlations between observed and self-reported behaviour (Corral-Verdugo, 1997), while others suggested that self-reported behaviours are appropriate indicators of actual behaviours (Warriner, McDougall, & Claxton, 1984; Fuj, Hennessy, & Mak, 1985). In addition, the majority of behavioural studies used intentions to predict behaviour or used intentions as a proxy for actual behaviour: there is a common criticism that the relationship between actual behaviour and intentions are not always strong (Davis et al., 2008; Greaves et al., 2013). However, other researchers reported that behavioural intentions can be reliable predictors of actual behaviours (Boldero, 1995) if behaviours and attitudes are properly defined and specific in the context of the behaviour considered (Brandon & Lewis, 1999; Egmond, Jonkers, & Kok, 2005).

Nigbur et al. (2010) investigated determinants of pro-environmental behaviour using observational (Study 1) and self-reported (Study 2) measures of recycling behaviour. They also included self-identity and additional variables such as neighbourhood identification by participants, personal and perceived social norms (e.g. descriptive and injunctive social norms and their interactions) in both models for models' prediction, improvement, and comparison. First, behavioural intention was estimated using all explanatory variables mentioned above.

Those who adhered to the following points were likely to participate in recycling behaviour:

- believed that 'participating in Green Box recycling scheme[9] regularly is the right thing to do' (attitudes toward recycling);

[9] Green Box scheme is a council-operated recycling scheme using the 'Green Box' for paper, glass and tin recycling' in districts of Guildford, Surrey (UK) (Nigbur et al., 2010)

- indicated that 'participating regularly in Green Box recycling is entirely under their own control' (perceived behavioural control of recycling);
- 'feel bad about putting recyclables into the bin' (personal norms for recycling)
- identify themselves as recyclers for whom 'recycling was an important part of who they were' (self-identity)
- 'were under the impression that their neighbours recycled regularly, subsequently seemed to intend to recycle more often themselves' (descriptive social norms for recycling) (Nigbur et al., 2010, p. 272)

All other determinants were insignificant.

Participants with greater behavioural intention to perform recycling, who identified themselves as recyclers and who thought that their neighbours often participated in recycling, seemed to perform recycling more often themselves (Study 1 – participating in observed actual behaviour). Participants in self-reported actual behaviour (Study 2) also had greater behavioural intentions to perform recycling and believed that they are not alone in their neighbourhood who are involved in recycling. In line with other studies (Theodorakis, 1994; Bissonnette & Contento, 2001), the results clearly highlighted the direct linear effect of descriptive social norms and self-identity on intentions and pro-environmental observed actual behaviour.

Armitage and Conner (2001) found that the ToPB predicted self-reported behaviour better than actual behaviour. As such, in the next section of the report, pro-environmental behaviour within the agricultural sector and how the ToPB can be applied to investigate land managers' behaviours and/or behavioural intentions are examined.

2.3.4 Pro-environmental behaviour and its determinants within the agricultural sector

This literature review identified 133 qualitative and quantitative studies within the agricultural sector. The studies discussed the importance of inclusion or included psychological characteristics of farmers in the analysis. The majority of quantitative studies (Figure 4) used simple regression analysis, analysis of variance, correlations, and dimension reduction (e.g. factor analysis) to investigate the determinants of behaviour or intentions to behave pro-environmentally. However, these techniques are inadequate for analysing very complex relationships between interrelated variables that can be influenced by each other directly and indirectly (through other variables in the model). As such, approaches that are more sophisticated are needed.

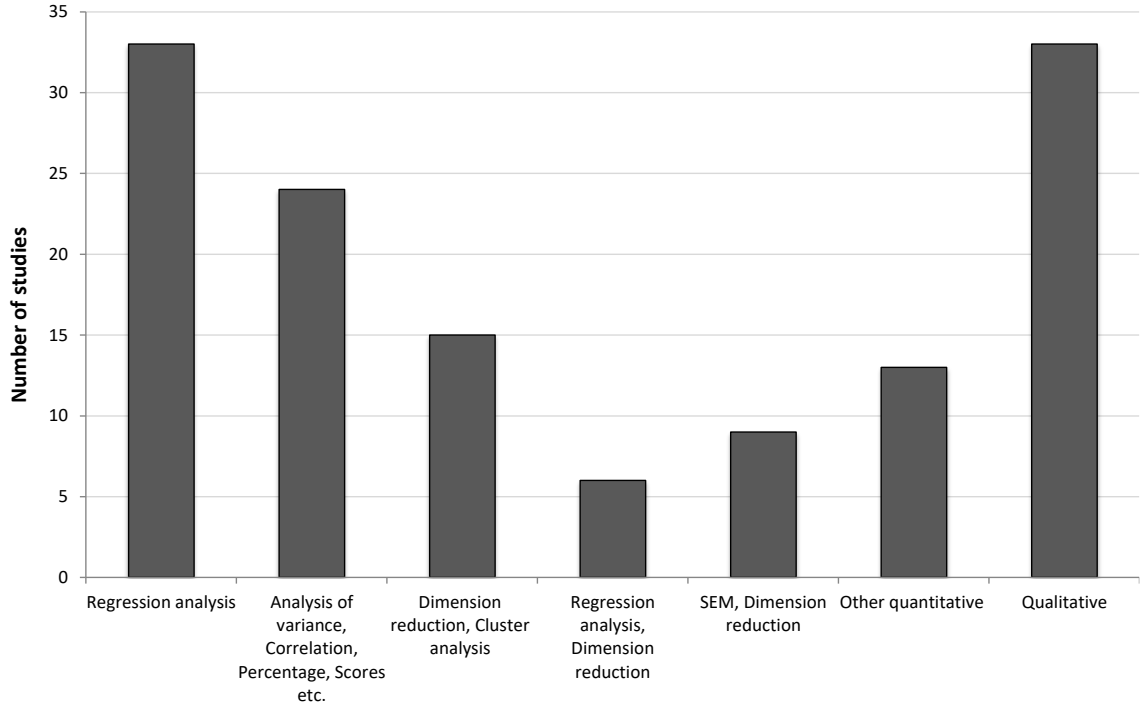

Figure 4: Studies on pro-environmental behaviour in agricultural context (N=133)

Seventy of the studies were undertaken in different parts of Australia (e.g. South Eastern Australia, Northern Australia, QLD, WA, etc.)[10]. More than half of those were undertaken in different parts of Queensland and looked at a variety of farming activities (e.g. farming in general, cropping, sugar, grazing, and forestry). Nineteen studies were undertaken in the Burdekin Dry Tropics and sixteen in the Wet Tropics regions. Only seven studies/reports have been found within the grazing industry in the Burdekin and two studies/reports within the grazing industry in the Wet Tropics (Figure 5). Even less research has been done for the cane growing industry in both regions. Twenty-four out of 133 studies used modified versions of the ToPB. The determinants of pro-environmental behaviour in the ToPB studies will be discussed in details in section 2.3.4.2.

[10] The researchers were primarily searching for studies on pro-environmental behaviour within the agricultural sector undertaken in Australia (particularly focusing on Wet Tropics and Burdekin regions).

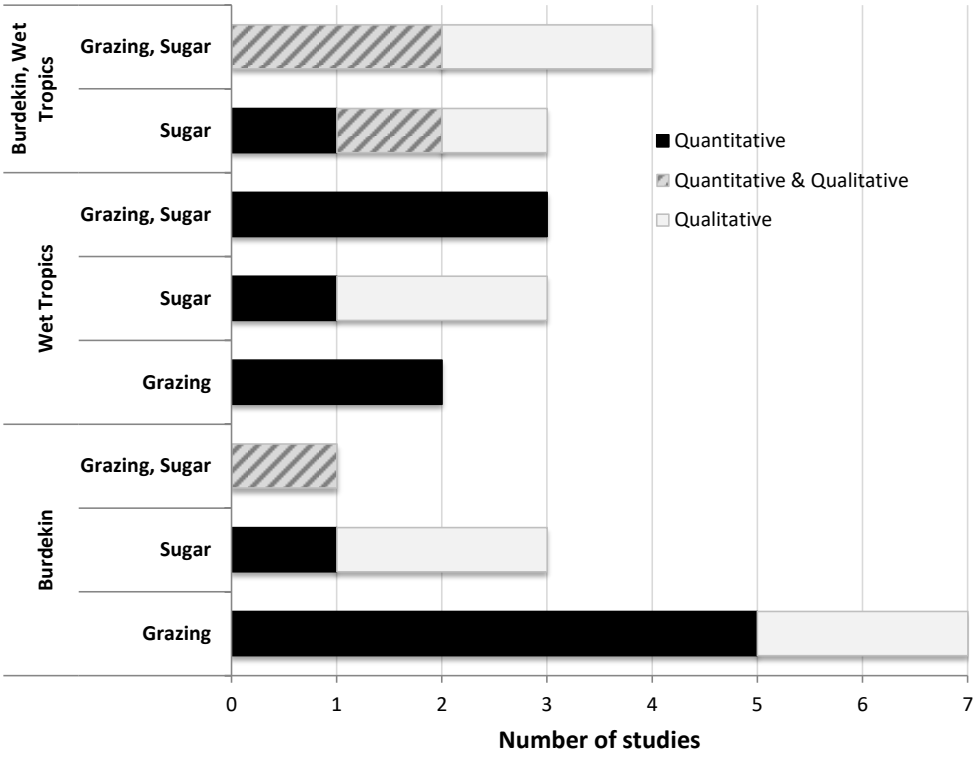

Figure 5: Studies identified by literature review within grazing and sugar cane industries in the Burdekin and the Wet Tropics regions (N=26)

Kollmuss and Agyeman (2002) recognized three groups of factors or barriers that might stop/ encourage people to be involved in pro-environmental behaviours: demographic factors such as age, education, income; internal factors (e.g. environmental knowledge, motivations and attitudes, values and responsibilities, locus of control, emotions, awareness and priorities), and external factors including economic, social, institutional and cultural factors. Recently Akbar et al. (2014) summarise a variety of socio-demographic, cultural, and economic factors that can affect farmers' pro-environmental behaviour (
Table 2).

Table 2: Factors affected land managers behaviour (adapted from Akbar et al. 2014)

Socio-demographic	***Cultural***	***Economic***	***Support services***
Age	Beliefs and values	Cost	Support from the farmers group
Gender	Local knowledge vs. scientific knowledge	Increased input costs	NRM facilitators
Education	Time management	Profitability – short and long term	Support from the Local Government
Household size	Family influence	Farm/Land value	Support from the State Government
Family situation	Lifestyle choice	Availability of funds/financial constraints	Support from the Federal Government
Farm ownership	Social prestige	Financial incentives	Support from the private consultants

Family involvement	Awareness	Taxes and levies	Peers and neighbours' support
Farm size	Openness	Alternative farming/land use	Own capacity
Multiple land use	Recognition by neighbours and community/ peer influence and encouragement from success	Market failure	Information provision and training
Length (year) of involvement	Fit in with practice of others in my community	Income risk	
Work pattern	Controlling own practice/learning by doing		
Off-farm income	Keeping and updating farm plan		
Risk management	Desire to protect natural resources		
Future viability	Desire to improve amenity of the landscape		
Role of succession (plan to pass farm on to the next generation)			
Plan to leave this occupation for good			
Intend to expand or decrease the farm size			
Community connectedness			

Source: Dunn, Gray, & Phillips, (2000); Gray et al., (2000); Lefroy, Bechstedt, & Rais, (2000); Cary, Webb, & Barr, (2002); Lockie & Rockloff, (2005); Tenge, De Graaff, & Hella, (2004); Finlay, Crockett, & Kemp, (2005); Stanley, Clouston, & Binney, (2005); Byron, Curtis, & MacKay, (2006); Shiferaw, Okello, & Reddy, (2009); Jakku & Thorburn, (2010); Brodie et al., (2012); Greer, Hopkinson, Akbar, Rolfe, & Kabir, (2012); Halkos & Jones, (2012)

Some of the factors influencing pro-environmental behaviour within the agricultural sector are potentially interrelated and might not have clear boundaries which makes the decision making process even more complicated (Kollmuss & Agyeman, 2002) (e.g. environmental knowledge is a part of environmental awareness and an individual's emotions form environmental attitudes and awareness) (Grob, 1991). Although, there is limited understanding of the psychological characteristics underlying land managers/farmers pro-environmental decisions (Hansson, Ferguson, & Olofsson, 2012). Consequently, there is rising interest in methods that allow studying such decisions by applying socio-psychological models (Wauters & Mathijs, 2013).

The combination of personal and pro-social motives, and characteristics is replicated by a number of theoretical models which are commonly applied in the agricultural context such as The Norm-activation Model (Pradhananga, et al., 2015), Theory of Reasoned Action (Carr & Tait, 1991; Barnes, Willock, Hall, & Toma, 2009; Martínez-García, Dorward, & Rehman, 2013), Behavioural Intention model (Lynne & Rola, 1988); Integrated Farming Systems model (Bewsell, Monaghan, & Kaine, 2007); Value-Belief-Norm Theory (Johansson, Rahm,

& Gyllin, 2013), Identity control theory (Burton, 2004; McGuire, Morton, & Cast, 2013), and Theory of Planned Behaviour (Brain, 2008; Greiner, 2015b; Deng et al., 2016). These models are used by the researchers to explain pro-environmental behaviour (Bamberg & Möser, 2007), adoption of the best land management practices, adoption of innovations, and conservation practices (Borges et al., 2014).

Key determinants of pro-environmental behaviour in the agricultural sector

Factors influencing pro-environmental behaviour in an agricultural context identified by this literature review are summarised in Figure 6 and Appendix 2. Behaviour is mainly influenced positively or negatively by background factors such as the farm's characteristics, personal, social and information factors, and general attitudes towards pro-environmental behaviour.

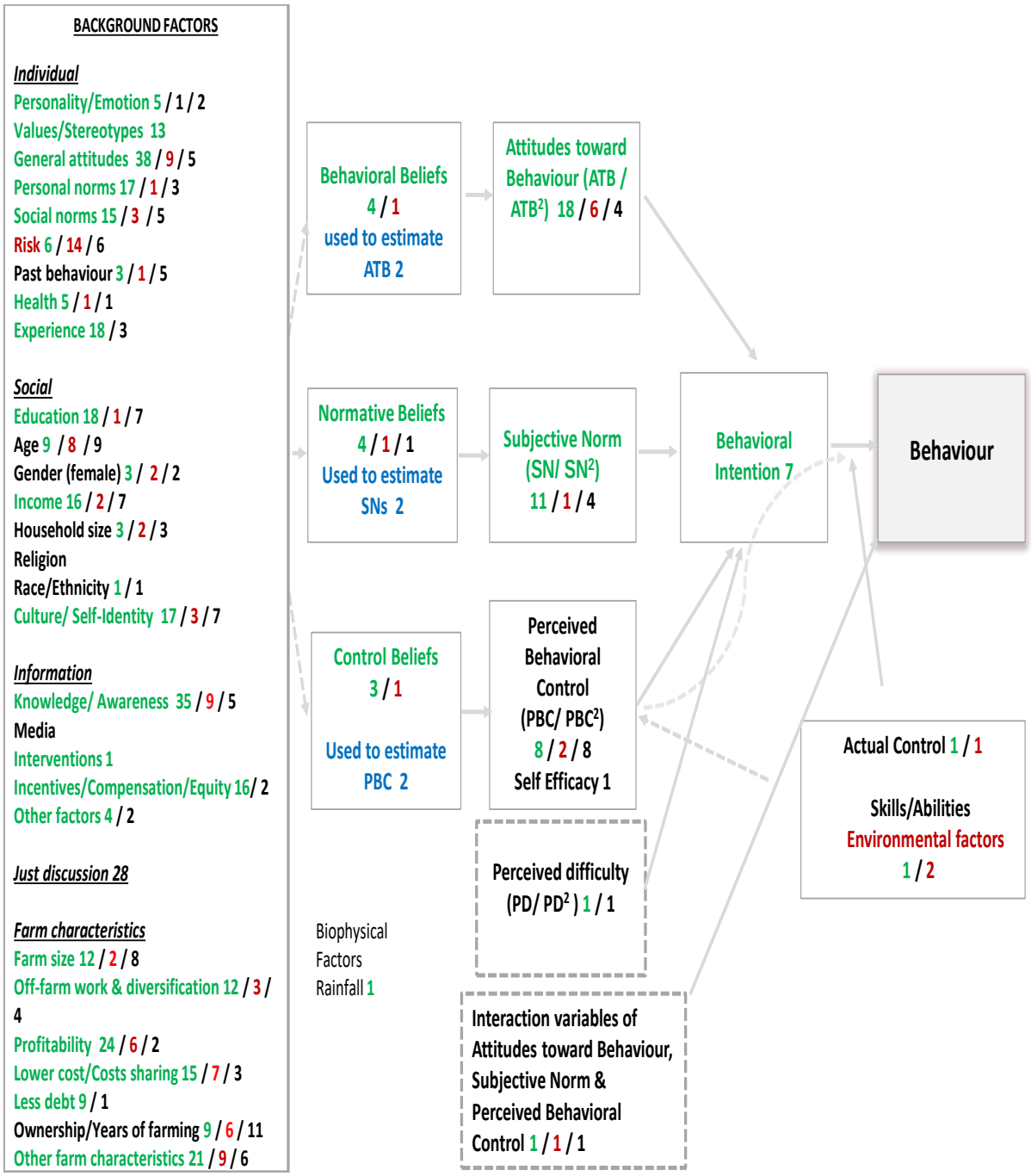

Figure 6: Determinants of pro-environmental behaviour in agricultural context (N = 133)

Note: Numbers correspond to a number of studies that included a particular variable (e.g. age, education) in the data analysis. Green colour corresponds to positive significant sign of the coefficient; Red - negative significant sign of the coefficient; Black – insignificant sign of the coefficient; Black without any numbers – variable was not included in any study. Attitudes towards behaviour (ATB); Subjective norms (SNs); Perceived behavioural control (PBC); Perceived difficulty (PD)

Farm characteristics

Most of the pro-environmental behaviour studies in the agricultural context identified the importance of inclusion of farm/property characteristics (e.g. farm ownership, size of farm, off-farm work, diversification of land use, farm profitability, costs, debt, insurance, property planning) in the analysis (Akbar et al., 2014; Borges et al., 2015). This literature review

confirms that farm characteristics play a significant role when farmers make a decision to perform or not perform pro-environmental behaviour.

The literature review findings indicate that farmers who perceived long-term profit or who perceived an increase in productivity were more likely to adopt pro-environmental behaviour. However, this is not always the case. Even though some pro-environmental practices can be potentially profitable, if they require change in lifestyle of a farmer's household which is not in line with their goals, these pro-environmental practices might not be appealing to those farmers (Lambert et al., 2006). Farmers who were aiming to reduce or share costs of labour/fuel and keep debt lower were more likely to perform pro-environmental behaviour (Lankester et al., 2009; Wheeler et al., 2013; Borges et al., 2015)

Larger farms are assumed to have greater economies of scale (Prokopy, Floress, Klotthor-Weinkauf, & Baumgart-Getz, 2008) and like any other assets owned by a farmer, also assume greater wealth/capital, and therefore more potential investment that a farmer can make, which increases the feasibility of the adoption of pro-environmental behaviour. It might be easy for a farmer on larger land to distribute the cost of adoption 'over more units of production, thereby reducing average total cost' (Kim et al., 2005, p. 113). This literature review supports these arguments. The larger the farm the more likely the farmer will adopt pro-environmental behaviour (Lankester et al., 2009; Baumgart-Getz et al., 2012). Off-farm work of the operator or household members and diversification (e.g. skills outside farming; importance of successfully diversified farm; reuse farm area; cultivating more than one crop) were found to have positive impact on pro-environmental behaviour (Comerford, 2014). Off-farm employment may generate an additional source of cash, 'can potentially improve farm productivity if it is used to finance farm input purchase or longer-term capital investment' (Reardon, Crawford, & Kelly, 1994, p. 1172; Chikwama, 2010), and increase the likelihood of adoption of pro-environmental behaviour. Moreover, part time farmers were found to be more likely to be involved in environmentally friendly behaviour because (a) the opportunity cost of conserving land from production is much lower than for those who are fully employed on their own farm; (b) they might be less worried about hidden adoption costs; and (c) they might value more the amenities generated by pro-environmental practices on their land (Kabii & Horwitz, 2006). Farmers who are practicing diverse operations on their land have an advantage to experiment with new behaviours as well as a variety of pro-environmental practices available to them for application, thus they are more likely to adopt at least some pro-environmental behaviours/practices (Rahelizatovo & Gillespie, 2004; Prokopy et al., 2008).

It is not clear if the ownership of the farm and the years of farming positively or negatively influence behaviour. Some researchers found these variables insignificant (Lambert et al., 2006) while others found that farm owners were more likely to implement pro-environmental behaviour than farmers who rented the land (Luzar & Diagne, 1999). Other farm characteristics such as reuse infrastructure, insurance, and organic certification of the farm (Byron et al., 2006; Toma et al., 2013) were positively influencing the decision to behave pro-environmentally.

Individual factors

Farmers' attitudes and personal norms were the most significant predictors of pro-environmental behaviour. Schwartz and Howard (1984) explained the difference between

attitudes and personal norms as *'attitudinal concepts [that] refer to evaluations based on material, social, and/or psychological payoffs, personal norms focus exclusively on the evaluation of acts in terms of their moral worth to the self'* (p. 245). Farmers' attitudes (general and specific) towards the environment, biosecurity, financial incentives and security, chemical use, and perceived risk and uncertainty (e.g. family and health perception of risk; cattle disease; changes in technology; climate change; wild fires) were major individual factors that influence pro-environmental behaviour. Farmers who have strong negative attitudes towards environmental regulation were less likely to adopt pro-environmental behaviour. Land owners/managers who are holding strong negative attitudes towards use of chemicals and environmental degradation were more likely to participate in pro-environmental practices. Bayard and Jolly (2007) note that those who have positive attitudes towards compliance for environmentally friendly management practices and conservation, and who perceived greater benefits from pro-environmental practice, can develop positive attitudes towards adopting pro-environmental behaviour and thus are more likely to behave pro-environmentally.

Farmers who were feeling a personal obligation to save or help the environment, who perceived environmental problems, understood good/bad consequences of behaviour (e.g. spelling paddocks during the wet season or not) and have been pro-environmentally orientated, or who belong to an environmental group or farmer/producer organisation were more likely to adopt pro-environmental behaviour (Bayard & Jolly, 2007).

Social norms play a significant role in land managers' decisions to participate in pro-environmental practices. Social norms often refer to how a community member should behave and how the other members within that community punish or reward people for breaking or following the norms (Chen et al., 2009). Mzoughi (2011) described social norms that were driving farmers' adoption decisions as those *'which shape the individual's behaviour in relation to his/her reference group, for example, the other similar farmers in the same region'* (Mzoughi, 2011, p.1536). This was supported by the literature review. Those farmers who felt that they were getting social support from other farmers within the industry, family and friends, and neighbours were more likely to adopt pro-environmental practices. However, as noted earlier, it is important to distinguish descriptive and injunctive social norms. The majority of studies identified by this literature review have not made any distinction between them, but as has been discussed by Eagle et al. (2016) 'there is a perceived conflict between messages effectiveness' (p. 50).

Some researchers suggest that descriptive and injunctive norms often predict behaviour independently (Larimer & Neighbors, 2003; Trockel et al., 2003) and that depending on the behaviour under consideration and the situation in which the norm is activated 'either injunctive or descriptive norms may be more influential in predicting behavior' (Larimer et al., 2004, p. 204). Godin and Kok (1996), for example, found that injunctive norms have relatively weak prediction power compared to descriptive norms when predicting socially sanctioned behaviours. Whereas Cialdini et al. (1990) and Reno et al. (1993) argue that 'when relevant norms are made salient through focusing attention on the norm, injunctive norms have a much broader and more enduring range of effects on behaviour than do descriptive norms' (Larimer et al., 2004, p. 205). This can result in further increase in injunctive norms' salience, which in turn may lead to maintaining social approval (Terry & Hogg, 1996; Trafimow & Finlay, 1996). As such, descriptive and injunctive norms should not

be treated as a single concept like in the majority of studies identified by the literature review. Although no study in an agricultural context has been found that investigates differences in behavioural outcomes depending on whether descriptive or injunctive messages were used.

Farmers who were trying to avoid risk and uncertainty were less likely to adopt pro-environmental behaviours because they may have needed much more information about future costs, benefits and net returns of a proposed adoption (Kim et al., 2005). More experienced farmers, those who have been undertaking extra training and who more often met with extension service personnel were more likely to perform pro-environmentally.

Social factors

Education, age, income and culture/self-identity were found to be significant determinants of pro-environmental behaviour (Hounsome et al., 2006; Borges et al., 2015). The literature review shows that a higher education level increases the likelihood of the adoption of pro-environmental behaviour. Farmers with relatively high education levels are more likely to be exposed to more ideas and have an ability to make decisions based on more comprehensive information, thus they are more likely to adopt pro-environmental behaviour than less educated farmers (Prokopy et al., 2008).

Older farmers are more likely to be resistant and sceptical towards an adaptation of pro-environmental behaviour. They are often planning benefits of adoption in a short term and it is often difficult for them to recognise potential long-term benefits of the pro-environmental behaviour 'since those benefits would not occur during their lifetime' (Kabii & Horwitz, 2006, p.12). However, some researchers found that relatively old farmers can adopt pro-environmental practices especially over an extended period. Many cattle farmers, for example, may grow 'cattle as a 'hobby' during retirement and maintaining land is often of high importance' (Kim et al., 2005, p. 118).

The farmer's financial situation was found to have a significant impact on the adoption decision. If sufficient financial resources are available to the farmer, he will have greater flexibility to adopt proposed pro-environmental practices. Farmers with a higher proportion of household income coming from their farm and who mostly rely on income generated from farm operations are more likely to adopt behaviour. Farmers on higher incomes are more likely 'to benefit from tax incentives than low income farmers' thus more likely to perform pro-environmental behaviour (Prokopy et al., 2008, p. 302).

Cultural influence (farmer's heritage, having a family member to take over the farm), self-identity (e.g. environmental; good farmer identity; productivist identity standards; conservationist identity standards), attachment to farm/land, and level of connection to nature are strong predictors of pro-environmental behaviour. When farmers with strong conservationist identity standards join the group of other farmers, 'they accepted leadership roles and provided support for farmers with strong productivist identities to start to make changes' (McGuire et al., 2013, p. 64). Attachment to place (e.g. land) and attachment to nature are believed to expand an individual's self-identity (Schultz, Shriver, Tabanico, & Khazian, 2004). As those attachments increase, the willingness to help also increases (Mayer & Frantz, 2004). As such, farmers who report strong attachment to land and nature are more likely to perform pro-environmental behaviour. Moreover, farmers with strong environmental identity (e.g. identity with nature) and who have a family member to take over

the farm are more likely to invest in soil viability and health in the long run thus they are likely to be involved in environmentally responsible behaviour (Prokopy et al., 2008).

Information factors

Exposure to information, knowledge exchange, seeking extension, consulting and scientific advice is playing a vital role in the adoption of pro-environmental behaviour. Farmers who understand the potential benefits and costs of pro-environmental practices, who have sufficient knowledge about them, who are seeking advice from natural resource management agencies/agents, who participated in the workshops and seek information on conservation, improvement and maintenance of environmental and natural resources are more likely to adopt pro-environmental behaviour.

For example, those farmers who have a sufficient knowledge of non-point source pollution, who are aware of the consequences of degraded systems, and who have enough knowledge about pro-environmental practices that can improve or reverse environmental damage are more likely to adopt such pro-environmental behaviours (Ervin & Ervin, 1982).

While financial incentives are not the sole driver of conservation activities (Greiner et al., 2009; Greiner & Gregg, 2011), they have a positive impact on the decision to perform pro-environmental behaviour. Farmers who were getting financial assistance or technical help were more responsive to pro-environmental practices and more likely to adopt pro-environmental behaviour but incentive programs can rise a few issues associated with equity (Schmidt, 2012).

Determinants of pro-environmental behaviour within the agricultural sector within the ToPB

Most of the studies on pro-environmental behaviour in an agricultural context (which are not based on ToPB or based on other behaviour models) assume that individual (e.g. self-confidence, stress, perceived risk and uncertainty, past behaviour, general attitudes towards environment, biosecurity etc.), social (e.g. age, education, culture, religion, income, good farmer identity, attachment to the land) and information (e.g. knowledge of environmental issues, costs and benefits of the proposed practice) factors directly influence the behaviour of an individual. Some studies investigated the determinants of pro-environmental behaviour including attitudes toward pro-environmental behaviour, which can also be considered as attitudes in general because there are many types of pro-environmental behaviour (e.g. spelling paddocks during the wet season; green trash blanketing; zero tillage; calculating N fertiliser rates).

The pressure to change farmers' less environmentally friendly behaviour to more environmentally friendly is increasing but the factors driving their behaviours continue to be poorly understood (Fleming & Vanclay, 2011; Price & Leviston, 2014). Better understanding of those factors is vital for a change. However, there are limited theoretical frameworks that can be used to investigate farmers' behaviour. As a result the research on pro-environmental behaviour in the agricultural sector is considerably limited (Bayard & Jolly, 2007; Fleming & Vanclay, 2011). Farmers' psychological characteristics are crucial for pro-environmental behaviour change (Price & Leviston, 2014) and the research confirmed that farmers' positive

attitudes towards the environment form their pro-environmental behaviour (Napier & Napier, 1991; Best, 2010).

The original Theory of Planned Behaviour is one of most commonly used approaches to analyse farmers' pro-environmental intentions and behaviour (Deng et al., 2016). The ToPB has been proved 'to provide a structured yet flexible model that can explain the cognitions that underlie individual farmers' willingness' to behave pro-environmentally (van Dijk, Lokhorst, Berendse, & de Snoo, 2015, p. 760; Wauters et al., 2010). Ajzen (1991) described the flexibility of the ToPB because of openness 'to the inclusion of additional predictors if it can be shown that they capture a significant proportion of the variance in intention or behaviour after the theory's current variables have been taken into account' (p. 199).

The main argument of original and modified ToPB (Fishbein & Ajzen, 2011) is that intention to perform is the direct determinant of actual behaviour (e.g. spelling paddocks during the wet season). Intention to spell paddocks during the wet season 'in turn is jointly determined' (Yazdanpanah et al., 2014, p. 64) by 3 drivers: attitude toward the specific behaviour (e.g. spelling paddocks during the wet season), subjective norm (e.g. most people who are important to a farmer think that he should be engaged in spelling paddocks during the wet season), and perceived behavioural control (e.g. it is easy for a farmer to be engaged in spelling paddocks during the wet season).

Attitudes towards specific behaviour, subjective norms and perceived behavioural control are consecutively determined by an individual's beliefs: behavioural (e.g. expected outcome from spelling paddocks during the wet season), normative (e.g. perception of what other referents think about farmer spelling paddocks during the wet season), and control beliefs (e.g. beliefs about the factors that can enable or stop a farmer to spell paddocks during the wet season). Those beliefs can be formed from a variety of sources referred to as background factors (e.g. individual, social, and information) in the ToPB as was discussed previously (Reimer at al., 2012b). It is assumed that any individual, social and demographic differences relevant to behaviour between land managers should be reflected in a farmers' beliefs (Beedell & Rehman, 1999). After each performance of the behaviour, those beliefs influence each other because of availability of new information about behavioural outcomes and the experience of control (Flick, 2013).

As was mentioned before this literature review identified 24 studies that used ToPB methodology to investigate the determinants of intentions and behaviour itself. Only one quarter of those studies have been undertaken in Australia. The majority of quantitative ToPB studies used dimension reduction (e.g. Principal Component analysis, Factor analysis), correlation (Beedell & Rehman, 1999; Willcox et al., 2012), and regression analysis such as binary Probit/Logit (Wauters et al., 2010; Wheeler et al., 2013), and Hierarchical regressions (e.g. Logit, Tobit) (Lynne et al., 1995; Fielding et al., 2008a; Meijer et al., 2015a; Flick, 2013) to investigate potential determinants of behaviour and/or behaviour intentions (Figure 7).

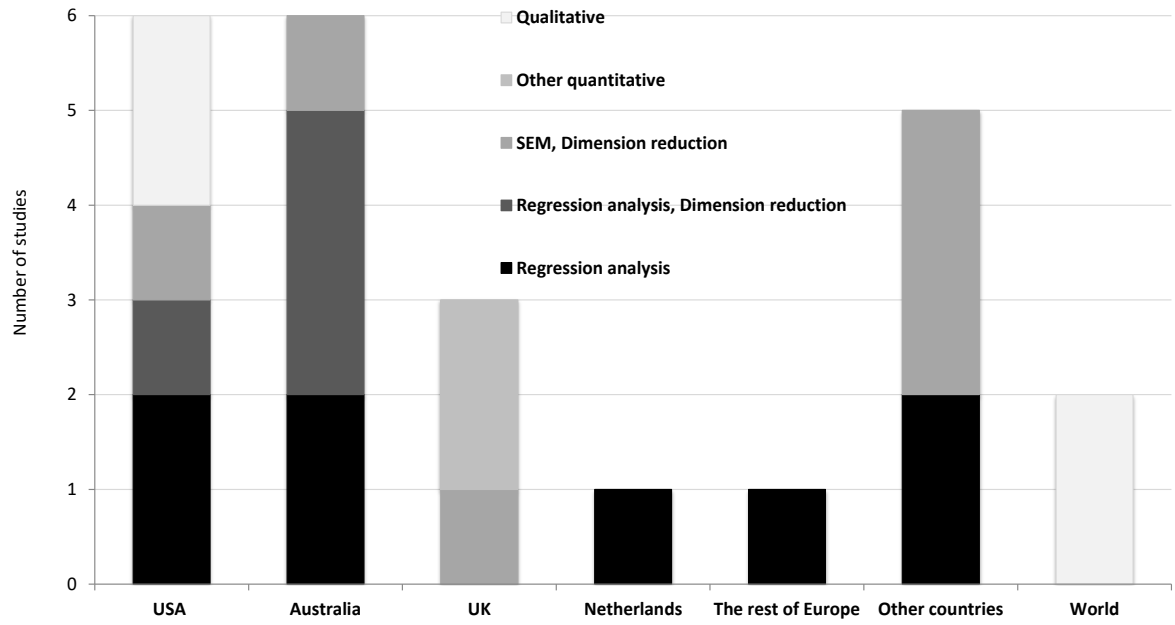

Figure 7: Studies that used ToPB in agricultural context (N=24)

However, it is difficult to capture such complex causal relationships between intentions, attitudes towards specific behaviour, subjective norms, perceived behavioural control, beliefs, background factors and actual behaviour. Although direct and mediating effects of those factors cannot be appropriately analysed by just using the regression analysis, dimension reduction and/or correlation analyses because from a methodological point of view, the relationships between potential determinants should be tested simultaneously (Yazdanpanah et al., 2014). Furthermore, as has been noted by Ajzen (1991) attitude, subjective norms, perceived behavioural control and intentions 'each reveal a different aspect of the behaviour, and each can serve as a point of attack in attempts to change it' (p. 206). As such, more sophisticated approaches such as structural equation modelling are needed.

This literature review also identified that the majority of ToPB studies used intentions to behave as a proxy for actual/self-reported behaviour (Corbett, 2002; Brain, 2008; van Dijk et al., 2015) or considered general behaviours instead of specific behaviours (Austin, Deary, & Willock, 2001; Reimer et al., 2012b; Deng et al., 2016). Most studies focus on attitudes, subjective norms and perceived behavioural control but only a few investigated the relationships between socio-economic variables (e.g. income, religion, ethnicity, debt) and their influence on intentions and behaviour. There are also suggestions that attitudes towards a particular behaviour are better predictors than socio-economic variables (Greaves et al., 2013; Meijer, Catacutan, Ajayi, Sileshi, & Nieuwenhuis, 2015a; Meijer, Catacutan, Sileshi, & Nieuwenhuis, 2015b).

As was expected, only a few of the background factors within the ToPB such as social factors (e.g. education), individual factors (e.g. personal and social norms, good health of a farmer or health of the family; relatively low perceived risk), information factors (e.g. knowledge and awareness, financial and training incentives and equity), and farm characteristics (e.g. off-farm work & diversification, farm profitability) have been found to be significant direct predictors of intentions to perform pro-environmental behaviour or to pro-

environmental behaviour itself (Manstead & Parker, 1995; Fielding et al., 2005a; Borges, et al., 2015). Farm characteristics (e.g. farmer financial resources) within the ToPB can also influence adoption of behaviour throughout farmer's perception of the relative costs and benefits as well as through perceived behavioural control (Reimer et al., 2012b). Behavioural intentions, attitudes toward behaviour, subjective norms and perceived behavioural control were significant predictors of pro-environmental behaviour (Figure 8 and Appendix 3).

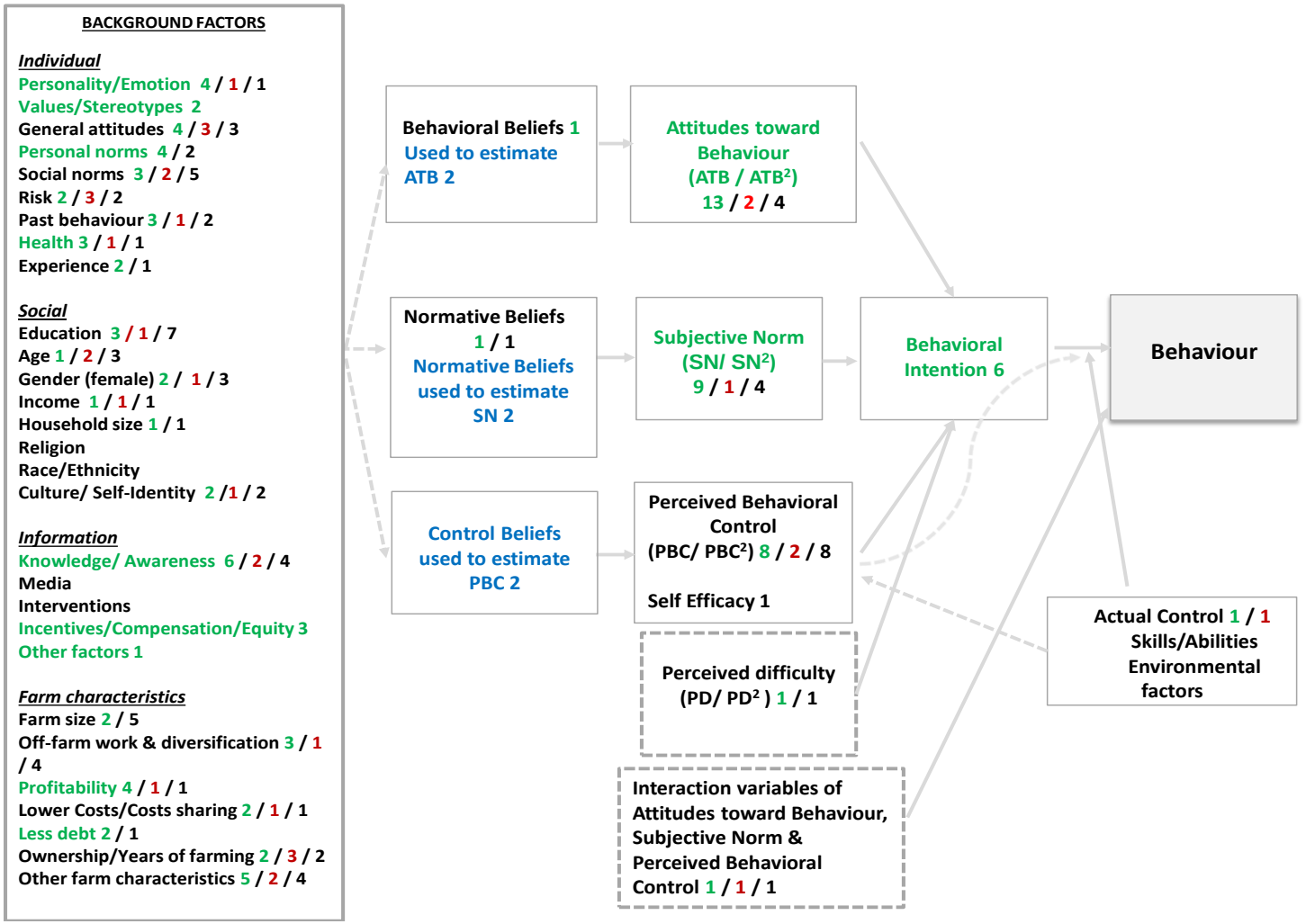

Figure 8: Determinants of pro-environmental behaviour within the agricultural sector (ToPB studies N = 24)

Note: the numbers correspond to a number of studies that included a particular variable (e.g. age, education) in the data analysis. The green colour corresponds to positive significant sign of the coefficient; Red - negative significant sign of the coefficient; Black – insignificant sign of the coefficient; Black without any numbers – variable was not included in any study. Attitudes towards behaviour (ATB); Subjective norms (SNs); Perceived behavioural control (PBC); Perceived difficulty (PD)

Intention to behave

Farmers who have strong intentions to perform/adopt a particular behaviour (e.g. planting trees) were more likely to behave pro-environmentally (e.g. actually planted trees). Those farmers with stronger intentions were showing much stronger effort to perform environmentally friendly behaviour (e.g. conserving ecological achievements on their land) (Deng et al., 2016).

Attitudes towards behaviour

Farmers with more positive attitudes towards a particular behaviour (e.g. tree planting), for example, were more likely to plant more trees (Meijer et al., 2015a). Those who had positive attitudes toward payments – for – environmental services were more likely to behave pro-environmentally (Greiner, 2015a). Farmers who hold positive attitudes towards agri-environment schemes also were more likely to perform pro-environmental behaviours (Fielding et al., 2008a, b; Wauters et al., 2010).

Subjective norms

Those who are more influenced by community are more likely to adopt water conservation practices and to adopt more intensely (Lynne et al., 1995). Farmers who feel encouraged/ influenced by others (e.g. their spouse, farmers group, community, extension workers and peers, government) were also likely to adopt pro-environmental behaviour (Flick, 2013; Deng et al., 2016).

Perceived behavioural control

Farmers who have full control when making their decision and those who control events and outcomes on their farm are more likely to adopt pro-environmental behaviours. Deng et al. (2016) found that perceived behavioural control was the most important predictor of intention, followed by subjective norm. Attitudes had the smallest influence on intentions, implying that farmers who have stronger perceptions 'of ecological achievements and abilities to conserve them and their tendency, were more crucial' to their intention and behaviour 'than their attitude toward the behaviour and pressure from others' (Deng et al., 2016, p. 387). Moreover, a significant effect of perceived behavioural control on intention shows that farmers' perceived abilities to conserve ecological successes are essential factors that influence their intention to perform a proposed behaviour. Deng et al. (2016) found that farmers who experienced pressure from their neighbours, the government and family members (subjective norms) were also more likely to have intentions to behave pro-environmentally. Consequently, farmers with strong positive intentions toward ecological achievement and conservation also exhibited greater effort to perform actual behaviour.

We have been able to identify only two studies (Lynne et al., 1995; Wauters et al., 2010) that tried to investigate the relationship between actual control (e.g. financial ability factors, skills, environmental factors such as drought) and pro-environmental behaviour in agricultural settings. Actual control is difficult to measure and the researchers often use perceived behavioural control as a proxy for actual control (Wauters et al., 2010). Lynne et al. (1995) used financial capital as a proxy for actual control and found that farmers who had an actual financial capability and full control over spending were more likely to behave pro-environmentally.

The difficulty of analysing behaviour and behaviour change created the need for considerable effort from the researchers in different research contexts to 'distil 'core' elements down into integrated frameworks so as to inform research design, policy and intervention design, and assist non-experts such as policy-makers in understanding behaviours and how they might engage with them' (Morris et al., 2012b, p.15; Morris et al., 2012a). However, such distillation unavoidably diminishes the complexity of behaviour/behaviour change and 'trading it off against comprehensibility and usability' (Morris et al., 2012b, p.15).

Jackson (2005) summarised problems, which often arise when analysing behaviour or behavioural change

> *'Beyond a certain degree of complexity, it becomes virtually impossible to establish meaningful correlations between variables or to identify causal influences on choice. Conversely, these simpler models run the risk of missing out key causal influences on a decision, by virtue of their simplicity…This means that there will always be something of tension between simplicity and complexity in modelling consumer behaviour. More complex models may aid conceptual understanding but be poorly structured for empirical quantification of attitudes or intentions… Less complex models may aid in empirical quantification but hinder conceptual understanding by omitting key variables or relationships between key variables' (p.23).*

2.3.5 Structural Equation Model as an analytical tool

In this section, a non-technical overview of Structural Equation Modelling and its role in theory evaluation in the agri-environment context is provided. This is followed by a considerably more complex technical description of the way the actual modelling process is used.

Non-Technical Overview

Structural equation modelling (SEM) is a statistical technique used for building and testing theoretical models that are intended to be used to analyse the relationships between different factors that may influence outcomes such as behaviours. As discussed in Section 2.3, the latest iteration of the Theory of Planned Behaviour (ToPB) was selected as the theoretical model because it has been widely used across a number of sectors. The ToPB is shown diagrammatically in Figure 3, with links between a range of background factors, attitudes, norms and perceived control that ultimately influence behavioural intentions and actual behaviours. In the diagrammatical form shown in Figure 3, the relative influence of any of these factors cannot be identified, nor whether that influence is positive (and thus a potential enabler of behaviour change) or negative (a potential barrier).

SEM allows the strength and nature of these influences to be measured. For this project, this then enables the value of the TPB in the agri-environment specific context to be evaluated in terms of its ability to explain current behaviours and, more importantly, to determine which of the influences should be targeted to enhance the likelihood of behaviour change and where there are significant barriers that should be targeted to minimise their effect. For example, if perceived or actual skills are identified as a barrier, efforts to increase skills and confidence in individual's abilities to change behaviours and maintain that change.

Detailed Technical Description of SEM

As noted above, SEM is a statistical procedure that uses statistical data and qualitative causality expectations for analysing and estimating causal relationships (Jahanshahi & Hall, 2013) between the variables. SEM is a system of equations and is a very powerful multivariate technique, which has been recognised as one of the most suitable analytical tools to investigate and understand complex interrelated relationships within the ToPB (Eagle et al., 2016; Gunzler et al., 2013). The approach has been widely used in ToPB-based studies mostly in health (Vadaparampil et al., 2004; Bryan, Schmiege, & Broaddus, 2007; Adams & Boscarino, (2011), travel (Bagley & Mokhtarian, 2002; Golob, 2003), diving (Ong & Musa, 2012), and shopping (Homer & Kahle, 1988; Hellier et al., 2003). SEM allows the structural relationship between variables in the model to be 'modelled pictorially to enable a clearer conceptualization of the theory under study' (Brain, 2008, p. 3; Byrne, 2001). 'Relative weights of model constructs are determined empirically for the particular behavior and population under investigation. This information provides guidance as to which constructs are most important to target for behaviour change effort' (Glanz, Rimer, & Viswanath, 2008, p.76). As such, the SEM has been chosen as the most appropriate approach to analyse land managers' behaviour in this project. An example of the application of this process to the agri-environment context is shown in figure 10.

History

The development of the SEM goes back to the geneticist Wright (1921) and the economist Haavelmo (1943) who first expressed the definition of the approach which would enable researchers using a combination of cause-effect information and statistical data to answer policy related questions (Pearl, 1997). The SEM was further modified by the cognitive scientist Simon in 1977 and finally re-defined by Pearl in 2000.

SEM Methodology

SEM is based on simple regression equations which are linear in parameters and which form a unified framework (Weis & Axhausen, 2009) but it is fundamentally different from a regression model. In a regression model there is a clear distinction between the dependent variable and independent variables. In SEM 'such concepts only apply in relative terms since a dependent variable in one model equation can become an independent variable in other components of the SEM system' (Gunzler et al., 2013, p. 390).

A complete SEM contains the structural and the measurement equations. Those equations are defined by 'structural equations, measurement equations for endogenous variables, and measurement equations for exogenous variables'[11] (Sharmeen et al., 2014, p. 164).

[11] The most common distinction between endogenous and exogenous usually classifies the former as internal and the latter as external in origin. In the context of SEM, the distinction is slightly different and can best be explained by a hypothetical example. When modelling a production function of sugar cane, the production of sugar cane may be called the dependent variable; as it depends on other variables including:

- Labour employed (more labour more production), and
- Amount of annual rainfall (more rainfall, more sugar cane)

However, the influence of variables on one another may go both ways. Labour employed, can be influenced by a willingness to increase productivity. Individuals who are willing to increase productivity would be more likely to employ more labour. As such, the labour employed explains productivity of sugar cane (the dependent variable) and the productivity of sugar cane explains the labour employed. Therefore, the labour employed, in this case, is endogenous. Put simply, labour employed explains but is also explained by the productivity of sugar cane. Whereas the amount of annual rainfall (exogenous variable) only explains productivity of sugar cane and is not explained by the productivity itself.

'Exogenous variables are always independent variables in the SEM equations' while endogenous variables can act as a dependent variable in 'at least one of the SEM equations...and may become independent variables in other equations' within the SEM system of equations (Gunzler et al., 2013, p. 390).

The measurement equations within the SEM are used to specify an unobserved (latent) variable 'as a linear function of other variables in the system' (Jahanshahi & Hall, 2013, p.17). If those independent (explanatory) variables in a linear function are observed they are used as indicators of the latent variable. Factor analysis is often used to guide building of the measurement equations (Jahanshahi & Hall, 2013). SEM allows modelling and testing of the effects of all exogenous variables on all endogenous variables simultaneously or sequentially, and also to account for both error correlations and direct effects between the endogenous variables' at the same time (Weis & Axhausen, 2009, p. 3).

The best and easiest way of representing the SEM is the path diagram. The path diagrams (**Error! Reference source not found.**) show the relationships between the variables in SEM. Arrows are called paths that connect variables. 'When a path points from one variable to another, it means that the first variable affects the second' (StataCorp., 2013, p. 7) (e.g. attitudes towards spelling paddocks depend on behavioural beliefs that it will improve land condition and will increase profits).

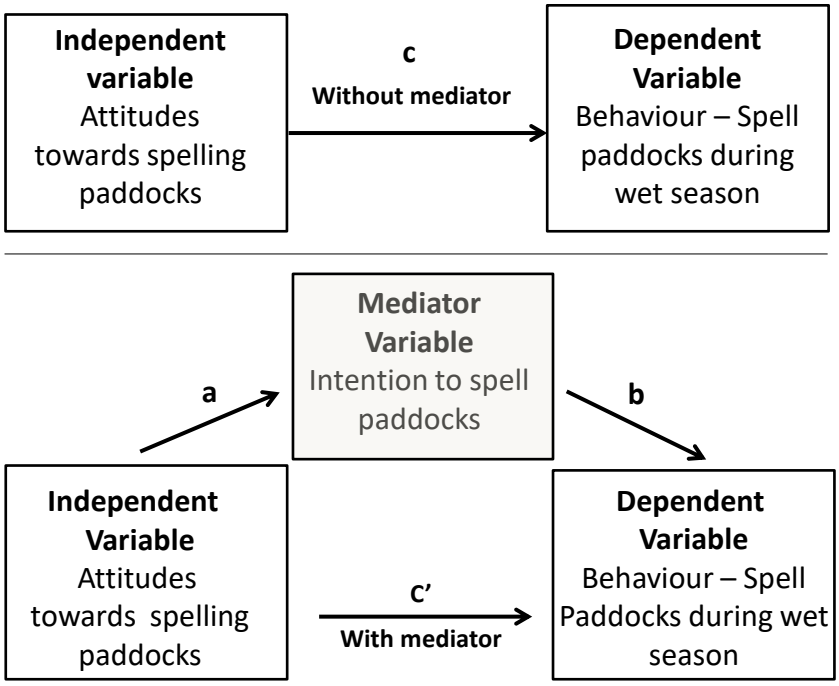

Figure 9: Simple statistical model with one mediator

SEM approach can also measure the path relationships within the ToPB and indicate the relative significance of the paths between variables in the model (Molenaar, Washington, &

Diekmann, 2000; Deng et al., 2016). This approach has also an ability to separate direct (direct influence of one variable on the other) and indirect (mediation) effects. A simple model with one mediator is shown in . An indirect effect is 'the effects along the paths between the two variables through one or more intervening variables' (Jahanshahi & Hall, 2013, p.17) which are often called mediator variables. Mediator variables are variables that 'sit between the independent variable and dependent variable and mediate the effect' of the independent variable on the dependent variable (UCLA: Statistical Consulting Group, 2017). The idea behind the analysis of mediation is that some of the effect of the independent variable is transmitted to the dependent variable through the mediator variable (path *a* and *b*). That portion of the effect that transmitted from the independent variable through the mediator is the indirect or mediation effect. Some portion of the effect of the independent variable goes directly to the dependent variable (path *c* and *c'*) which is a direct effect (UCLA: Statistical Consulting Group, 2017; Adams & Boscarino, 2011). SEM also allows one to estimate the total effect by summing indirect and direct effects between two variables (Kline 2005; Byrne 2010; Jahanshahi & Hall, 2013).

Example of the Application of SEM to a specific agri-environment behaviour

A simplified multilevel SEM based on the ToPB is shown in **Error! Reference source not found.**. Boxes are observed variables with variable names written inside them (e.g. attitudes towards spelling paddocks, farm size). Measurement errors for each variable are given in circles at the bottom (e.1, e.2, e.3 etc.). Numbers next to the arrows are simultaneously/sequentially estimated coefficients and one star (10% level), two stars (5% level) and three stars (1% level) correspond to the statistical significance of the coefficient (e.g. estimated coefficient of perceived profitability 0.42** is positive and statistically significant at 5% level).

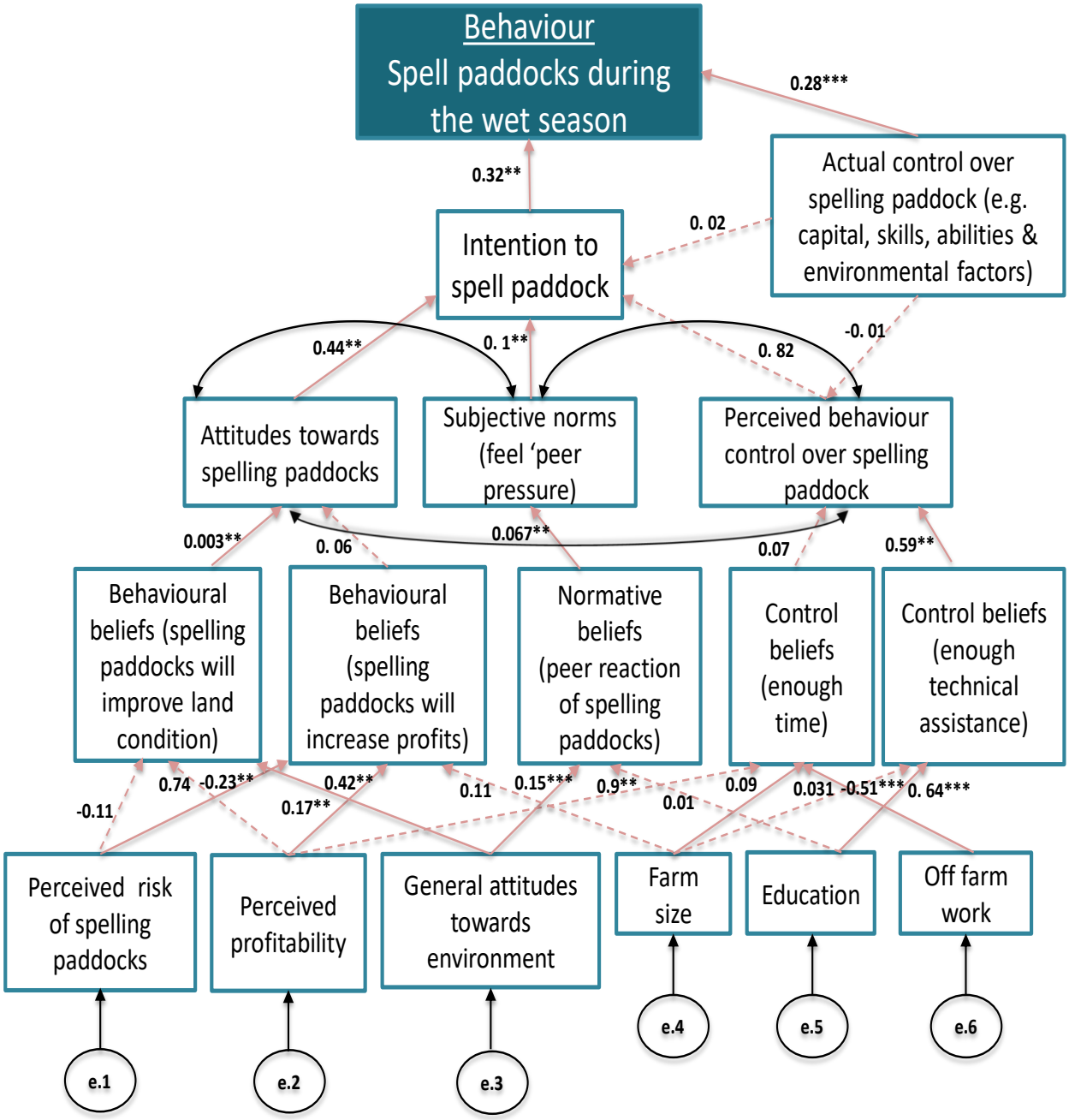

Figure 10: An example for simplified multilevel linear SEM based on the ToPB

Note: *** significant at 1% level; ** significant at 5% level; * significant at 10% level

Attitudes towards spelling paddock, for example, have indirect (mediated by intention) positive significant impact on actual behaviour. Actual control has a direct positive significant impact on actual behaviour (the estimated coefficient 0.28*** is positive and statistically significant at the 1% level of significance) implying that land managers who have actual control over their own capital and skills are more likely to perform actual behaviour (spell paddocks during the wet season) than those who do not. Perceived profitability is indirectly positively influencing behaviour through behavioural beliefs and attitudes towards spelling paddocks. However, looking at magnitudes of the coefficient estimates (**Error! Reference source not found.**), attitudes towards spelling paddock (estimated coefficient 0.44**) have the strongest direct impact on intentions to spell paddocks followed by subjective norms

(0.1**) while perceived behaviour control (estimated coefficient 0.82 which is not statistically significant) does not have any direct significant impact on intentions.

The Structural equation approach 'assumes direct causal relationships between certain dependent variables, and thus goes further than merely capturing these relationships via error correlations' (Weis & Axhausen, 2009, p. 17). Brain (2008) highlighted the assumptions associated with SEM that ideally should be met to increase reliability of the results:

- all indicators in the model should be normally distributed[12]
- latent variables should be measured by multiple indicators (variables)
- appropriate data imputation
- adequate model fit
- large sample size

However, in practice to meet all of the assumptions is quite problematic (Bagley & Mokhtarian, 2002; Brain, 2008).

SEM is 'fundamentally a hypothesis testing method (i.e., a confirmatory approach), rather than an exploratory approach (e.g., regression analyses)' (Adams & Boscarino, 2011, p. 62). It has some advantages over other statistical models that are linear in parameters (Golob, 2001; Adams & Boscarino, 2011; Jahanshahi & Hall, 2013) (e.g. hierarchical linear models such as random regression, linear mixed-effects, and multilevel model). SEM has more and much broader 'interpretable array of measures of overall model fit, more flexible modelling of residual structures and of growth functions (e.g., typically, some slope loadings can be freely estimated parameters), and a better overall capacity to model latent variables and their multivariate associations' (Tomarken & Waller, 2005, p.38; Curran 2003).

SEM allows:

- a series of regression equations being estimated simultaneously to control for how accurately the proposed model replicates the data (Kline, 2005; Byrne 2010)
- 'treatment of both exogenous and endogenous variables as random variables that may exhibit errors of measurement' (Jahanshahi & Hall, 2013, p.17).
- 'accounting for the reciprocal influences of the endogenous variables on one another' (Weis & Axhausen, 2009, p.17).
- Incorporation of observed (directly measured) and latent variables (Kline 2005; Byrne 2010)
- Latent (unobservable variables) can be modelled with multiple indicators
- Separating of measurement and specification errors
- Ability to test whole structural model and each coefficient individually
- Modelling and testing mediating variables (mediators) and their effects

[12] If this assumption is met, 'the variance of the estimated parameters is consistently estimated by sample variances, but when it is false, the standard errors of parameter estimates can be substantially underestimated, leading to false conclusions of significance' (Bagley & Mokhtarian, 2002, p. 286; West et al. 1995). However in practice, meeting this condition is problematic (Bagley & Mokhtarian, 2002) and the normality assumption is often violated (Bentler & Dudgeon, 1996). Micceri (1989) reviewed various journal articles and datasets used in those studies within the SEM and found that in majority of studies the conclusions were drawn from non-normally distributed data. Breckler (1990) and Gierl and Mulvenon (1995) also noted that it is very common for the researchers just 'to ignore the assumption of normality and to make conclusions as if the assumption were met' (Bagley & Mokhtarian, p.286).

- Ability to handle non-normal data as well as categorical variables
- Ability to model and control for error term relationships

2.3.6 Drivers and barriers for adoption of farmers' pro-environmental behaviour in the GBR catchment area

Blake (1999) identified three main barriers to pro-environmental behaviour: Individuality, responsibility, and practicality. Individuality is related to attitudes, temperament and emotions of an individual. Responsibility is related to the locus of control (e.g. lack of trust in government) and practicality mostly relates to social and institutional constraints (e.g. lack of money, lack of information). Those restrictions can stop pro-environmental behaviour irrespective of people's attitudes and intentions (Blake, 1999). The literature review identified drivers and barriers for adoption of pro-environmental practices (behaviours) by farmers in the GBR catchment area, which are listed in

Table 3.

Individual, social, and information factors are mainly driving pro-environmental behaviour. Famers who have positive environmental attitudes, care and concern about the environment, for those who place importance on social recognition, who participated in pro-environmental practices and who were involved in extra training were more likely to adopt pro-environmental practices. Information on implementation costs, rewards, long-term financial assistance and reliability of information and knowledge were the main drivers of pro-environmental behaviour. Farm characteristics were the main barriers for adoption. Hidden and/or high implementation costs, lack of cash flow, greater debt, uncertainty about tenure, perceived loss of productivity and profitability were the main barriers to pro-environmental behaviour.

Table 3: Drivers and Barriers for best land management practices adoptions identified by farmers in the GBR catchment area

Barriers for adoption	*Drivers of adoption*
Individual factors	
Social motivation	Environmental attitudes/concerns
Lack of community support	Personal norms
Risk and uncertainty	Social norms
Lack of commitment & support from family members	Social recognition
Lack of industry support	Past behaviour
Future uncertainty	Training
Other land managers are not doing it	Lifestyle motivation
No interest	Values (e.g. recreational)
	Flexibility
	Shared responsibility
Social factors	
	Higher education
	Dependence on property for income
	Pass on land in good condition
	Improvement in land condition
	Build up wealth and family assets
	Be among the best in the industry
	Be appreciated by society and/or colleagues
Information factors	
Lack of information/knowledge	Information on costs
Lack of scientific evidence	Information on outcomes
Too complicated	Higher knowledge
Lack of government incentives	Rewards, long term financial assistance
Programmes structure	Higher conservation payments
No recommended best practice industry standard	Reliability of information and knowledge
Longer contract terms	Media
	Provision of information
	Reliable and credible science
	Government advisor services
	Consistency in information from government
	Private consultants
	Participation in workshops/courses
Farm characteristics	
Hidden Costs/High costs	Cash flow availability
Lack of finance/cash flow	Profitability/Financial motivation
Low off-farm income	More people live and work on farm
Existing high level of debt	Availability of new technology
High initial capital cost	Efficiency
Uncertainty about tenure	Planning
Lack of time and labour	Diversification of production
Loss of profitability and productivity	Intention to expand
Not profitable enough	Mixed farming enterprises
Low returns on investment	Property size
Limit land use options	Working part time off-farm
Complication with property management	Long-term land managers
Limits to future development	
Lack of confidence in BSES recommendations	
Lack of available technology	
Other factors	
Trust	Confidence and trust
Rights	Building their business
Future industry viability	Long-term market
Not necessary	Confidence in their capacity
Have enough work without participating	Well established property rights
Don't want to lose control of their own land	
The land is already protected	
Too political	
A threat to property	
Uncertainty regarding chemical usage	
Infrastructure limitations	
Actual control	
Climatic conditions, drought & flooding	Availability of natural resources
Poor soil type	(e.g. surface & ground water)
	No drought

Source: Benn (2013); Bohnet et al. (2011); Byron et al. (2006); Comerford (2014); Di Bella et al. (2015); Emtage, Smith, & Herbohn (2009); Greiner & Gregg (2011); Greiner (2015a); Greiner (2015b); Greiner, Lankester, & Patterson (2007); Greiner,

Patterson, & Miller (2009); Herr et al. (2004); Lankester et al. (2009); Lockie & Rockloff (2005); Moon (2013); Moon, Marshall, & Cocklin (2012); Richards & Lawrence (2009); Thomas et al. (2007); Thorburn et al. (2007)

3.0 KEY POINTS FROM LITERATURE REVIEW

Land managers' behaviours result from very complex processes, which are influenced by a variety of socio-economic and psychological variables (Herrmann & Uttitz, 1990; Carr & Tait, 1991; Willock, Deary, Edwards-Jones et al., 1999a). As such, land managers' decision making process 'does not easily lend itself to be modelled by the mathematical methods traditionally used by agricultural economists' (Willock, Deary, Edwards-Jones et al., 1999a, p.287). Moreover, the predictors of pro-environmental behaviour within the agricultural sector depend on methodological and econometrics approaches. The literature review clearly shows that in studies that assume a direct relationship between background factors (e.g. individual, social, information, and farm characteristics) farmers' behaviours are largely driven by those background factors (

Table 4 - left panel of the table). Land managers who hold higher values for the environments, have positive attitudes toward environment and security, feel personal and social obligation to care for the environment, those who perceived low risk, more educated, with relatively higher incomes, with higher level of knowledge and awareness, who perceived increase in profitability and decrease in costs etc. are more likely to perform pro-environmentally.

However, in the ToPB studies, these background factors are forming beliefs, attitudes, norms, perceptions and behaviour intentions rather than influencing behaviour directly, thus having not direct but mediating effect on intentions and behaviours. Attitudes towards behaviour, subjective norms and intentions to perform a specific behaviour under consideration are becoming more important than background factors (

Table 4 - right panel of the table).

Table 4: Predictors of pro-environmental behaviour in agricultural context identified by literature review

Pro- environmental behaviour in agricultural context (N=133)	***Pro- environmental behaviour in agricultural context - ToPB studies (N = 23)***
Individual factors	
Personality/Emotion (+)	Personality/Emotion (+/-)
Values/Stereotypes (+)	
Positive general attitudes toward environment, security etc. (+)	General attitudes (+/-)
Personal Norms (greater personal obligation) (+)	Personal Norms (greater personal obligation) (+)
Social Norms(+)	Social Norms (+/-)
Perceived risk (-)	
Health (+)	Health (+)
Experience (+)	
Social factors	
Education (+)	Education (+/-)
Age (+/-)	
Income (+)	
Culture/ Self-Identity (+)	
Information factors	
Knowledge/Awareness (+)	Knowledge/Awareness (+/-)
Incentives/Compensation/Equity (+)	Incentives/Compensation/Equity (+)
Farm characteristics	
Larger farm size (+)	
Off-farm work & diversification (+)	Off-farm work & diversification (+)
Perceived long term profit (+)	Perceived profitability (+)
Perceived increase in productivity (+)	
Lower Costs/Costs sharing (+)	
Less debt (+)	
Ownership/Years of farming (+/-)	
Other farm characteristics (+)	
	Attitudes toward behaviour (+)
	Subjective norms (+)
	Intention to behave (+)

Note: (+) indicates positive statistically significant relationship between the factor and intention/behaviour; (-) indicates negative statistically significant relationship between the factor and intention/behaviour; (+/-) – relationships can be positive or negative.

To summarize, the literature review indicated that:

- most research in the agricultural sector is about general attitudes towards the environment, best land management practices and perceptions of barriers & enablers to change in land management
- there is a need to distinguish between descriptive and injunctive social norms which have not been done in agricultural behaviour studies
- there is widespread recognition of the various inter-related factors influencing pro-environmental behaviour and affecting adoption of best land management practices
- most research assumes a direct relationship between background factors and behaviour but the decision making is more complex
- the determinants of behaviour are different depending on theoretical and econometric approaches
- there is limited understanding of the relative importance and inter-relations between these factors, particularly for different segments of land managers
- appropriate (more sophisticated) analytical methods and techniques such as structural equation modelling (SEM) or similar is required to analyse such a complex relationships between behaviour, intentions, attitudes, norms and other factors
- because of the interactive nature of 'behaviours' there is possibility of creating some kind of pro-water-quality 'index' for analysis in the SEM (in addition, or perhaps even instead of looking at individual behaviours which are often measured by binary responses (yes/no) or categorical responses). A number of studies created such indexes by combining responses to 'behaviour' questions into a single scale and successfully used it as the dependent variable in the analysis (Vignola, Koellner, Scholz, & McDaniels, 2010; Wheeler et al., 2013).

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Appendix 1

Table 5: Description of factors identified in previous studies that might influence pro-environmental behaviour

Factors	*Variables combined in factor's category*
Social factors	
Education	Education; Cognitive ability
Age	Age
Gender (female)	Gender
Income	Income; Total net farm income; Household (HH) annual income; Crop value; HH net income; % of HH income coming from farming activity; Gross cash income from farming less government payments; off-farm income
Household size	HH size; Number of children
Religion	Religion
Race/Ethnicity	Race; Ethnicity
Culture/ Self-Identity	Culture; Self-Identity; Environmental Identity/Connectedness to nature; Place attachment; Plans for heirs; Cultural influence (language of the survey); Family will continue farming
Individual factors	
Personality/ Emotions	Personality; Emotions; Personal integrity & high ethical standards; Stress; Personal networks; Locus of control; Motivations (benefits only); Moral concern; Responsibility; Habits; Farmer's internal self-concept
Values/Stereotypes	Balance of work & lifestyle values; Economic value; Environmental/Conservation values; Values - private benefits; Balance of work & lifestyle values; Susceptibility; Self-transcendent, prosocial, altruistic or biospheric values; Self-enhancement (i.e. hedonic, egoistic); Biospheric concern
Attitudes (general & specific towards environment)	General attitudes towards government spending on protection; technical concern; biodiversity/environment; financial incentives/security; legislation; achievement/ success in farming; pessimism; openness in farming; chemical use; environmental concern; general beliefs; antecedent beliefs; specific pro-environmental attitudes toward environment; neighbourhood identification; environmental benefits; perception of environmental problems; perceived health threat from chemicals
Personal norms	Personal norms, Membership of environmental group/ farmers group; Moral concerns related to individuals' (intrinsic) ethics; Commitment; Perceived seriousness; Membership in producers organisation
Social norms	Stewardship (responsibility to family, neighbours, future generations, God, or the farmland itself); Importance of other people; Social networks; Community influence/norms; Group norms & facilitation; Political ideology; Modelling and providing information about the behaviour of others; Social prestige; Social concerns; External self-concept
Risk	Risk & Uncertainty; Perception of risk - family & health perception of risk (e.g. break down in family relations; death of operator; family ill health; Injury or illness of operator); Market/Prices (e.g. cattle disease; declining product prices; decline in land values; disruption to live export trade; disruption to transport system; emergence of international competitors; high inflation & interest rates; loss of government support; international instability; rapid change in exchange rates); Institutional (change in government policy; more stringent leasehold conditions; new environment regulation; new industry codes of conduct; new animal welfare policy); Production (changes in technology; climate change; land degradation; new diseases; new pest animals; rapid change in consumer preferences; slowing productivity gains; spread of weeds; vegetation change; water degradation; wild fires); Risk of establishment failure; Severe Drought
Past Behaviour	Past behaviour
Health	Health
Experience	Experience; Training, Number of times met with extension service personnel

Factors	***Variables combined in factor's category***
Information factors	
Knowledge/ Awareness	Knowledge exchange; Awareness (e.g. of pollution, effort); Information & complexity; Time perspective; Detailed technical knowledge; Information & advice; Extension/consulting advice; Scientific advice; Trust; Learning from others
Media	Media
Interventions	Interventions changing actual and perceived costs and benefits; Commitment; Goal setting; Information & modelling
Incentives/compensation/equity	Financial incentives; Public support; Learning & training incentives, Information incentives
Other factors	Time savings & frames; $ value for direct government payment; Value of nonfarm assets; Parenthood; Contextualisation of problems; Compatibility & the ease of adoption
Farm characteristics	
Farm size	Land size; farm capital (acres)
Off-farm work & diversification	Off-farm work of operator or his/her spouse; skills outside farming; Farming intensity; Land used for sugarcane, grazing etc.; Proportion of total farm acres rented; Land size for operation; Land size excluding operation; Type of farming; Annual crop %; Reuse area; Farm structure & production characteristics (e.g. high value crops)
Profitability	Perceived economic benefit/Profitability; Production efficiency; Productivity change; Perception of long-term profit
Costs	Lower labour/fuel costs; Financial costs; Perceptions of short-term cost
Debt	Farm's Debt level; Debt to asset ratio
Ownership/Years of farming	Ownership; Length/years farming; Long term involvement with farming; Farming experience
Other farm characteristics	Proportion of total farm acres irrigated; Total current and intermediate farm's assets ($); Ownership type; Number of cattle; Years raising cattle; Full-time employees; Reuse infrastructure; Financial liquidity; Competitive advantage; Investment into farm; Expected loss of production; Production efficiency; Insurance; Practice characteristics; Property rights; Property planning; Irrigation; Organic certification of farm; poor soil type; time and labour requirements
ToPB variables	
Actual Control (AC)	Financial ability factors; environmental factors (e.g. drought, weather variability); Skills
Normative beliefs	Farmer's perception of peers reaction to a particular practice/behaviour (e.g. spelling paddock during the wet season)
Perceived difficulty (PD)	Perceived difficulty
Interaction variables of Attitudes toward Behaviour (ATB), Subjective Norms (SN), and Perceived Behavioural Control (PBC)	ATB*PBC; ATB*PD, ATB*SN; PBC*SN; PBC*PD; SN*PD

Table 6: Determinants of pro-environmental behaviour (N=165)

Determinants of pro-environmental behaviour		
Variable	***Significance & sign of variable / Number of studies***	
	Dependent variable - Behavioural Intention	Dependent variable - Behaviour
Social factors		
Education		(+) Hirst & Grady (1982); Guth, Green, Kellstedt, & Smidt (1995); Vogel (1996); Margai (1997); Dietz, Stern, & Guagnano (1998); Traoré et al. (1998); De Oliver (1999); Barr & Cary (2000); Henning & Cardona (2000); Kilpatrick (2000); Austin, Deary, & Willock (2001); Cary, Webb, & Barr (2002); Herr et al. (2004); Poortinga, Steg, & Vlek (2004); Kim, Gillespie, & Paudel (2005); Lambert, Sullivan, Claassen, & Foreman (2006); Paudel, Gauthier, Westra, & Hall (2008); Emtage, Smith, & Herbohn (2009); Seabrook et al. (2008); Barreiro-Hurlé et al. (2010); Mzoughi (2011); Comerford (2014); Price & Leviston (2014); Borges et al. (2015);
	(-) Wheeler et al. (2013)	(-) Luzar & Diagne (1999); Poortinga, Steg, & Vlek (2004);
	Insignificant - Fielding et al. (2008); Willcox et al. (2012); Martínez-García et al. (2013); Wheeler et al. (2013); van Dijk et al. (2015)	Insignificant - Schultz, et al. (1995); Hamburg et al. (1997); Oskamp et al. (1998); Bewket & Sterk (2002); D'Emden, Llewellyn & Burton (2006); Fielding et al. (2008); Baumgart-Getz, Prokopy, & Floress (2012); Reimer at al. (2012b); Meijer et al. (2015)
Age	(+) Willcox et al. (2012)	(+) Adesina & Baidu-Forson (1995); Brandon & Lewis (1999); Henning & Cardona (2000); Kim, Gillespie, & Paudel (2005); Byron et al. (2006); Fielding et al. (2008); Barreiro-Hurlé et al. (2010); Baumgart-Getz et al. (2012); Akbar et al. (2014)
	(-) Wheeler et al. (2013); Flick (2013)	(-) Bultena & Hoiberg (1983); Jacobsen et al. (1991); Featherstone & Goodwin (1993); Dietz et al. (1998); Henning & Cardona (2000); Cary, Webb, & Barr (2001); Poortinga, Steg, & Vlek (2004); Hounsome, Edwards, & Edwards-Jones (2006); Wheeler et al. (2013)
	Insignificant - Fielding et al. (2008); Martínez-García et al. (2013); Wheeler et al. (2013); van Dijk, et al. (2015)	Insignificant - Valdero, Unipan, & Oskamp (1997); Mainieri, Barnett, Schultz & Zelezny, (1998); Trumbo & O'Keefe (2001); Bewket & Sterk (2002)Lockie, Lawrence, Dale, & Taylor (2002); Bekele & Drake (2003); Seabrook et al. (2008); Mzoughi (2011); Reimer at al. (2012b); Borges et al. (2015); Meijer et al. (2015)
Gender (female)	(+) Wheeler et al. (2013)	(+) Guth, Green, Kellstedt, & Smidt (1995); Schultz et al. (1995); Dietz et al. (1998); Henning & Cardona (2000); Fielding et al. (2008); Mzoughi (2011)
		(-) Henning & Cardona (2000); Borges et al. (2015)
	Insignificant - Fielding et al. (2008); Wheeler et al. (2013)	Insignificant - Trumbo & O'Keefe (2001); Bekele & Drake (2003); Meijer et al. (2015);
Income	(+) Martínez-García et al. (2013)	(+) Hirst & Grady (1982); Lynne & Rola (1988); Lynne et al. (1988); Schultz et al.

Determinants of pro-environmental behaviour

Variable	***Significance & sign of variable / Number of studies***	
	Dependent variable - Behavioural Intention	Dependent variable - Behaviour
		(1995); Hamburg et al. (1997); Margai (1997); Brandon & Lewis (1999); De Oliver (1999); Luzar & Diagne (1999); Cary, Webb, & Barr (2001); Herr et al. (2004); Poortinga, Steg, & Vlek (2004); Kim, Gillespie, & Paudel (2005); Lockie & Rockloff (2005); Lambert, Sullivan, Claassen, & Foreman (2006); Emtage, Smith, & Herbohn (2009); Greiner, Patterson, & Miller (2009); Greiner & Gregg (2011); Baumgart-Getz et al. (2012); Borges et al. (2015)
	(-) Willcox et al. (2012)	(-) Guth, Green, Kellstedt, & Smidt (1995);Trumbo & O'Keefe (2001); Greiner, Lankester, & Patterson (2007); Barreiro-Hurlé et al. (2010)
		Insignificant - Featherstone & Goodwin (1993); Oskamp et al. (1998); Henning & Cardona (2000); Herr et al. (2004); Hounsome et al. (2006); Paudel et al. (2008); Seabrook et al. (2008); Meijer et al. (2015)
Household size		(+) Featherstone & Goodwin (1993); Brandon & Lewis (1999); Bekele & Drake (2003); Poortinga, Steg, & Vlek (2004); Borges et al. (2015)
		(-) Hirst & Grady (1982); Margai (1997); Oskamp et al. (1998); Luzar and Diagne (1999); Bekele & Drake (2003)
		Insignificant - Bekele & Drake (2003); Hounsome, et al. (2006); Meijer et al. (2015)
Religion		(+) Kanagy & Willits (1993); Guth, Green, Kellstedt, & Smidt (1995); Poortinga, Steg, & Vlek (2004)
		(-) Guth, Green, Kellstedt, & Smidt (1995)
		Insignificant - Dietz, Stern, & Guagnano (1998); Schultz & Zelezny (1998)
Race/Ethnicity		(+) Dietz, Stern, & Guagnano (1998); Bekele & Drake (2003)
		(-) Dietz, Stern, & Guagnano (1998)
		Insignificant - Schultz et al. (1995); Bekele & Drake (2003)
Culture/Self-Identity	(+) Wheeler et al. (2013)	(+) Featherstone & Goodwin (1993); Gray et al. (2000); Ryan, Erickson & Young (2003); Poortinga, Steg, & Vlek (2004); Kim, Gillespie, & Paudel (2005); Hounsome et al. (2006); Lambert, Sullivan, Claassen, & Foreman (2006); Greiner, Lankester, & Patterson (2007); Greiner, Patterson, & Miller (2009); Lokhorst et al. (2011); Wheeler et al. (2013); Mastrangelo et al. (2014); Greiner & Gregg (2011); Smith et al. (2014); Greiner (2015b); Morgan et al. (2015)
	(-) Wheeler et al. (2013)	(-) Herr et al. (2004); Kim, Gillespie, & Paudel (2005); Greiner, Lankester, & Patterson (2007)
	Insignificant - Wheeler et al. (2013); van Dijk et al. (2015)	Insignificant - Traoré et al. (1998); Dunn, Gray & Phillips (2000); Henning & Cardona (2000); Paudel et al. (2008); Gosling & Williams (2010); Baumgart-Getz et al. (2012); Moon, Marshall, & Cocklin (2012)

Determinants of pro-environmental behaviour

Variable	***Significance & sign of variable / Number of studies***	
	Dependent variable - Behavioural Intention	Dependent variable - Behaviour
Individual factors		
Personality/ Emotions	(+) Willcox et al. (2012); Borges et al. 2015)	(+) Heberlein & Warriner (1983); Mohai (1990); Schultz et al. (1995); Vogel (1996); Staats, Wit, & Midden (1996); Green-Demers, Pelletier, & Menard (1997); Schultz & Zelezny (1998); Kaiser et al. (1999); Austin, Deary, & Willock (2001); Quinn & Burbach (2008) (-) Mohai (1990); Austin, Deary, & Willock (2001); Staats, Harland, & Wilke (2004) Insignificant - Lynne et al. (1988); Vining & Ebreo (1992); Oskamp et al. (1998); Poortinga, Steg, & Vlek (2004); Price & Leviston (2014)
Values/Stereotypes	(+) Brain (2008)	(+) Schultz & Zelezny (1998); Willock, Deary, McGregor, et al. (1999); Willock, Deary, Edwards-Jones, et al. (1999); Kaiser et al. (1999); Stern (2000); Nordlund & Garvill (2002); Curtis & Robertson (2003); Poortinga, Steg, & Vlek (2004); Schultz et al. (2005); Byron et al. (2006); De Groot & Steg (2007); Brain (2008); De Groot & Steg (2008); Seabrook et al. (2008); Vignola et al. (2010); Bohnet et al. (2011); Reimer et al. (2012a); Price & Leviston (2014); Smith et al. (2014) (-) Schultz & Zelezny (1998); Stern (2000); Nordlund & Garvill (2002); Poortinga, Steg, & Vlek (2004); De Groot & Steg (2008); Schultz et al. (2005)
Attitudes (general & specific)	(+) Vogel (1996); Martínez-García et al. (2013); Wheeler et al. (2013) (-) Wheeler et al. (2013)	(+) Geller (1981); Hirst & Grady (1982); Midden et al. (1983); Lynne & Rola (1988); Lynne et al. (1988); Carr & Tait (1991); Napier & Napier (1991); Vining & Ebreo (1992); Napier & Brown (1993); Schultz et al. (1995); Vogel (1996); Green-Demers, Pelletier, & Menard (1997); Mainieri et al. (1997); Margai (1997); Dietz, Stern, & Guagnano (1998); Oskamp et al. (1998); Schultz & Zelezny (1998); Traoré et al. (1998); Beedell & Rehman (1999); Brandon & Lewis (1999); Kaiser et al. (1999); Lichtenberg & Zimmerman (1999); Luzar & Diagne (1999); Willock, Deary, McGregor, et al. (1999); Willock, Deary, Edwards-Jones, et al. (1999); Henning & Cardona (2000); Cary, Webb, & Barr (2001); Poortinga, Steg, & Vlek (2004); Byron et al. (2006); De Groot & Steg (2007); Greiner, Lankester, & Patterson (2007); Quinn & Burbach (2008); Seabrook et al. (2008); Emtage, Smith, & Herbohn (2009); Barreiro-Hurlé et al. (2010); Gosling & Williams (2010); Lokhorst et al. (2011); Baumgart-Getz et al. (2012); Emtage & Herbohn (2012a); Moon, Marshall, & Cocklin (2012); Reimer et al. (2012a); Andrews et al. (2013); Moon (2013); Toma et al. (2013); Wheeler et al. (2013); Comerford (2014); Greiner (2015a); Greiner (2015b); Morgan et al. (2015); Varua, Ward & Maheshwari (2015) (-) Lynne et al. (1988); Dietz, Stern, &

Determinants of pro-environmental behaviour

Variable	***Significance & sign of variable / Number of studies***	
	Dependent variable - Behavioural Intention	Dependent variable - Behaviour
		Guagnano (1998); Traoré et al. (1998); Willock, Deary, McGregor, et al. (1999); Cary, Webb, & Barr (2001); Quinn & Burbach (2008); Reimer et al. (2012a); Wheeler et al. (2013); Toma et al. (2013)
	Insignificant - Wheeler et al. (2013)	Insignificant - Midden et al. (1983); Curtis & Robertson (2003); Paudel et al. (2008); Reimer et al. (2012); Greiner (2015a)
Personal norms	(+) Wheeler et al. (2013)	(+) Vining & Ebreo (1992); Staats, et al. (1996); Cary & Wilkinson (1997); Luzar & Diagne (1999); Cary, Webb, & Barr (2001); Nordlund & Garvill (2002); Lockie & Rockloff (2005); Byron et al. (2006); Barreiro-Hurlé et al. (2010); Bohnet et al. (2011); Mzoughi (2011); Moon, Marshall, & Cocklin (2012); Reimer et al. (2012b); Borges et al. (2015); Meijer, Catacutan, Ajayi, Sileshi, & Nieuwenhuis (2015); Pradhananga et al. (2015)
		(-) Heberlein & Warriner (1983); Moon (2013)
	Insignificant - Corbett (2002); Wheeler et al. (2013)	Insignificant Traoré et al. (1998); D'Emden, Llewellyn & Burton (2006); Toma et al. (2015)
Social norms	(+) Corbett (2002); Fielding et al. (2008)	(+) Vining & Ebreo (1992); Guth et al. (1995); Mainieri et al. (1997); Dietz, Stern, & Guagnano (1998); Henning & Cardona (2000); Gray et al. (2000); Poortinga, Steg, & Vlek (2004); Michel-Guillou & Moser (2006);Greiner, Lankester, & Patterson (2007); Emtage & Herbohn (2009); Rogers (2010); Greiner & Gregg (2011); Mzoughi (2011); Moon, Marshall, & Cocklin (2012); Wauters & Mathijs (2013); Akbar et al. (2014); Borges et al. (2015); Greiner (2015b)
	(-) Fielding et al. (2008)	(-) Quinn & Burbach (2008); Greiner, Patterson, & Miller (2009)
	Insignificant - Corbett (2002); Fielding et al. (2008); van Dijk et al. (2015)	Insignificant- Oskamp et al. (1998); Ryan, Erickson & Young (2003); Staats et al. (2004); Fielding et al. (2008); Greiner (2015b)
Risk	(+) Yazdanpanah et al. (2014); Greiner (2015c)	(+) Lynne et al. (1988); Willock, Deary, McGregor, et al. (1999); Greiner, Patterson, & Miller (2009); Wheeler et al. (2013)
	(-) Wheeler et al. (2013)	(-) Feather & Amacher (1994); Adesina & Baidu-Forson (1995); Barr (1996); Henning & Cardona (2000); Kim, Gillespie, & Paudel (2005); Vignola et al. (2010); Mzoughi (2011); Reimer et al. (2012b); Comerford (2014); Smith et al. (2014); Borges et al. (2015); Rolfe & Gregg (2015)
	Insignificant - Wheeler et al. (2013)	Insignificant - Feather & Amacher (1994); Cary & Wilkinson (1997); D'Emden, Llewellyn & Burton (2006); Prokopy et al. (2008); Price & Leviston (2014)
Past Behaviour	(+)Fielding et al. (2005); Fielding et al. (2008); (-) Corbett (2002)	(+) Moon, Marshall, & Cocklin (2012); Wheeler et al. (2013)
		Insignificant - Adesina & Baidu-Forson (1995); Traoré et al. (1998); Trumbo & O'Keefe (2001); Fielding et al. (2008); Barreiro-Hurlé et al.

Determinants of pro-environmental behaviour

Variable	*Significance & sign of variable / Number of studies*	
	Dependent variable - Behavioural Intention	Dependent variable - Behaviour
		(2010); Reimer at al. (2012b)
Health	(+) Wheeler et al. (2013)	(+) Poortinga, Steg, & Vlek (2004); Hounsome, et al. (2006); Wheeler et al. (2013); Borges et al. (2015)
	(-) Wheeler et al. (2013)	
	Insignificant - Wheeler et al. (2013)	
Experience	(+) Flick (2013)	(+) Adesina & Baidu-Forson (1995); Barr & Cary (2000); Henning & Cardona (2000); Kilpatrick (2000); Cary, Webb, & Barr (2001); Lockie & Rockloff (2005); Byron et al. (2006); D'Emden, Llewellyn & Burton (2006); Seabrook et al. (2008); Lankester et al. (2009); Emtage & Herbohn (2009); Moon, Marshall, & Cocklin (2012); Toma et al. (2013); Comerford (2014); Borges et al. (2015); Wegscheidl et al. (2015)
	Insignificant - Martínez-García et al. (2013)	Insignificant - Traoré et al. (1998); Reimer et al. (2012b)
Information factors		
Knowledge/ Awareness	(+) Vogel (1996); Corbett (2002); Brain (2008); Flick (2013); Wheeler et al. (2013)	(+) Geller (1981); Napier & Napier (1991); Napier & Brown (1993); Feather & Amacher (1994); Schultz et al. (1995); Staats et al. (1996); Vogel (1996); Hamburg et al. (1997); Dietz, Stern, & Guagnano (1998); Oskamp et al. (1998); Schultz & Zelezny (1998); Traoré et al. (1998); Kaiser et al. (1999); Lichtenberg & Zimmerman (1999); Barr & Cary (2000); Beedell & Rehman (2000); Trumbo & O'Keefe (2001); Nordlund & Garvill (2002); Bekele & Drake (2003); Curtis & Robertson (2003); Kim et al. (2005); Lockie & Rockloff (2005); Byron et al. (2006); D'Emden, Llewellyn & Burton (2006); Lambert, Sullivan, Claassen, & Foreman (2006); Bayard & Jolly (2007); Greiner, Lankester, & Patterson (2007); Brain (2008); Paudel et al. (2008); Rolfe et al. (2008); Emtage, Smith, & Herbohn (2009); Greiner, Patterson, & Miller (2009); Lankester et al. (2009); Barreiro-Hurlé et al. (2010); Baumgart-Getz et al. (2012); Moon, Marshall, & Cocklin (2012); Toma et al. (2013); Akbar et al. (2014); Borges et al. (2015); Morgan et al. (2015); Rolfe & Gregg (2015); Wegscheidl et al. (2015)
	(-) Wheeler et al. (2013)	(-) Heberlein & Warriner (1983); Diekmann & Preisendoerfer (1992); Fliegenschnee & Schelakovsky (1998); Barr & Cary (2000); Dunn, Gray & Phillips (2000); Henning & Cardona (2000); Lockie & Rockloff (2005); Byron et al. (2006); Greiner, Patterson, & Miller (2009); Reimer et al. (2012b); Moon (2013)
	Insignificant - Corbett (2002); Wheeler et al. (2013)	Insignificant - Winett et al. (1985); Staats et al. (1996); Bewket & Sterk (2002); Curtis & Robertson (2003); Reimer at al. (2012); Wheeler et al. (2013); Comerford (2014)
Media Interventions		(+)Geller (1981); Hirst & Grady (1982);

Determinants of pro-environmental behaviour

Variable	***Significance & sign of variable / Number of studies***	
	Dependent variable - Behavioural Intention	Dependent variable - Behaviour
		Heberlein & Warriner (1983); Midden et al. (1983); Winett et al. (1985); Lehman & Geller (2004); Staats et al. (2004); Abrahamse et al. (2005); Steg & Vlek (2009); Akbar et al. (2014) (-) Abrahamse et al. (2005); Steg & Vlek (2009) Insignificant - Staats et al. (1996); Brandon & Lewis (1999)
Incentives	(+) Brain (2008); Greiner (2015c)	(+) Midden, et al. (1983); Featherstone & Goodwin (1993); Casey et al. (1999); Barr & Cary (2000); Bekele & Drake (2003); Lockie & Rockloff (2005); Lambert, Sullivan, Claassen, & Foreman (2006); Brain (2008); Paudel et al. (2008); van Grieken et al. (2009); Greiner & Gregg (2011); Mzoughi (2011); van Grieken et al. (2012); Moon, Marshall, & Cocklin (2012); Beharry-Borg et al. (2013); Borges et al. (2015) Insignificant - Ryan, Erickson & Young (2003); Baumgart-Getz et al. (2012)
Other factors		(+) Margai (1997); Richards, Lawrence, & Kelly (2003); Stanley et al. (2005); Bates et al. (2008); Rogers (2010); Borges et al. (2015); Insignificant - Stanley et al. (2005); Bates et al. (2008)
Farm characteristics		
Farm size		(+) Featherstone & Goodwin (1993); Cary & Wilkinson (1997); Luzar and Diagne (1999); Willock, Deary, Edwards-Jones et al. (1999); Henning & Cardona (2000); Austin, Deary, & Willock (2001); Bekele & Drake (2003); Kim, Gillespie, & Paudel (2005); Hounsome et al. (2006); Seabrook et al. (2008); Lankester et al. (2009); Baumgart-Getz et al. (2012); Borges et al. (2015)
	(-) Martínez-García et al. (2013) Insignificant - Willcox et al. (2012); van Dijk et al. (2015)	(-) Emtage, Smith, & Herbohn (2009) Insignificant - Traoré, Landry, & Amara (1998); D'Emden, Llewellyn & Burton (2006); Fielding et al. (2008); Reimer et al. (2012b); Comerford (2014); Meijer et al. (2015)
Off-farm work & diversification of land use	(+) Wheeler et al. (2013)	(+) Featherstone & Goodwin (1993); Willock, Deary, McGregor et al. (1999); Austin, Deary, & Willock (2001); Kim, Gillespie, & Paudel (2005); Byron et al. (2006); Lambert, Sullivan, Claassen, & Foreman (2006); Greiner, Patterson, & Miller (2009); Wheeler et al. (2013)
	(-) Wheeler et al. (2013)	(-) Featherstone & Goodwin (1993); Bekele & Drake (2003); Byron et al. (2006); Comerford (2014)
	Insignificant - Willcox et al. (2012); Wheeler et al. (2013)	Insignificant - Hounsome et al. (2006); Lambert, Sullivan, Claassen, & Foreman (2006); Wheeler et al. (2013); Borges et al. (2015)
Profitability	(+) Fielding et al. (2005); Wheeler et al. (2013)	(+) Barr & Cary (1992); Adesina & Baidu-Forson (1995); Reimer et al. (2012b); Borges et al. (2015); Bates, et al. (2008); Stanley et al.

Determinants of pro-environmental behaviour

Variable	*Significance & sign of variable / Number of studies*	
	Dependent variable - Behavioural Intention	Dependent variable - Behaviour
		(2005); Akbar et al. (2014); Barr & Cary (2000); Barr and Cary (1992); Cary & Wilkinson (1997); Seabrook et al. (2008); Halpin et al. (2008); Greiner, Patterson, & Miller (2009); Cary, Webb, & Barr (2001); Lockie & Rockloff (2005); Rolfe et al. (2008); Moon (2013); Roebeling et al. (2004); Feather & Amacher (1994); Greiner & Gregg (2011); Smith et al. (2014); Greiner (2015b); Morgan et al. (2015); Wegscheidl et al. (2015)
	Insignificant - Wheeler et al. (2013)	(-) Lynne et al. (1988); Greiner, Lankester, & Patterson (2007); Greiner & Gregg (2011); Reimer et al. (2012a); Reimer at al. (2012b); Insignificant - Baumgart-Getz et al. (2012); Andrews, Clawson, Gramig, & Raymond (2013)
Lower costs/Costs sharing if positive High cost if negative		(+) Barr (1996); Cotching & Sims (2000); Dunn, Gray & Phillips (2000); Henning & Cardona (2000); Qureshi et al. (2001); Curtis & Robertson (2003); Rolfe et al. (2008); Lankester et al. (2009); Reimer at al. (2012b); Andrews et al. (2013); Beharry-Borg et al. (2013); Smith et al. (2014); Borges et al. (2015); Wegscheidl et al. (2015)
		(-) Barr & Cary (1992); Rolfe et al. (2008); Paudel et al. (2008); Mzoughi (2011); Reimer at al. (2012b); Rolfe & Gregg (2015)
	Insignificant (Fielding, et al., 2005)	Insignificant - Cary & Wilkinson (1997); D'Emden, Llewellyn & Burton (2006); Lambert, Sullivan, Claassen, & Foreman (2006)
Lower debt	(+) Wheeler et al. (2013)	(+) Featherstone & Goodwin (1993); Henning & Cardona (2000); Herr et al. (2004); Kim, Gillespie, & Paudel (2005); Greiner, Lankester, & Patterson (2007); Paudel et al. (2008); Greiner, Patterson, & Miller (2009); Lankester et al. (2009)
		(-) Borges et al. (2015)
	Insignificant - Wheeler et al. (2013)	Insignificant - Hounsome et al. (2006)
Ownership/Years of farming	(+) Wheeler et al. (2013)	(+) Lynne et al. (1988); Luzar & Diagne (1999); Qureshi et al. (2001); Kim et al. (2005); Lambert et al. (2006); Borges et al. (2015)
	(-) Wheeler et al. (2013)	(-) Herr et al. (2004); Reimer at al. (2012b); Wheeler et al. (2013)
	Insignificant - Willcox et al. (2012); Wheeler et al. (2013)	Insignificant - Norris & Batie (1987); Traoré et al. (1998); Bewket & Sterk (2002); Bekele & Drake (2003); Lambert, Sullivan, Claassen, & Foreman (2006); Paudel et al. (2008); Seabrook et al. (2008); Baumgart-Getz et al. (2012); Akbar et al. (2014)
Other farm characteristics	(+) Wheeler et al. (2013)	(+) Norris & Batie (1987); Featherstone & Goodwin (1993); Henning & Cardona (2000); Cary, Webb, & Barr (2001); Bekele & Drake (2003); Herr et al. (2004); Kim, Gillespie, & Paudel (2005); Lockie & Rockloff (2005); Byron et al. (2006); Lambert, Sullivan, Claassen, & Foreman (2006); Bewsell et al. (2007); Brain (2008); Greiner, Patterson, & Miller (2009); Emtage, Smith, & Herbohn

Determinants of pro-environmental behaviour

Variable	***Significance & sign of variable / Number of studies***	
	Dependent variable - Behavioural Intention	Dependent variable - Behaviour
	(-)Wheeler et al. (2013)	(2009); Baumgart-Getz et al. (2012); Reimer at al. (2012b); Toma et al. (2013); Wheeler et al. (2013); Borges et al. (2015); Akbar et al. (2014); Wegscheidl et al. (2015) (-) Barr and Cary (1992); Featherstone & Goodwin (1993); Traoré et al. (1998); Bekele & Drake (2003); Kim, Gillespie, & Paudel (2005); Lankester et al. (2009); Barreiro-Hurlé et al. (2010); Greiner & Gregg (2011); Mzoughi (2011); Reimer at al. (2012b)
	Insignificant - Willcox et al. (2012); Wheeler et al. (2013)	Insignificant - Feather & Amacher (1994); Bekele & Drake (2003); Hounsome et al. (2006); Price & Leviston (2014); Meijer et al. (2015)
Studies that just discussed behaviour and/or factors		Bond & Wonder (1980); Guerin & Guerin (1994); Lockie et al. (1995); Howden et al. (1998); Johnson et al. (1998); Emtage, Herbohn, & Harrison (2001); Reeve (2001); Shrapnel & Davie (2001); Breetz et al. (2005); Maybery, Crase, & Gullifer (2005); Davis (2006); Emtage, Herbohn, & Harrison (2006); Pannell et al. (2006); Emtage, Herbohn, & Harrison (2007); Thomas et al. (2007); Thorburn et al. (2007); Keipert et al. (2008); Emtage & Herbohn (2009); Richards & Lawrence (2009); Blackstock et al. (2010); van Grieken et al. (2010); Agnew, Rohde & Bush (2011); Ashburner et al. (2012); Benn (2013); McIvor (2012); Thorburn et al. (2013a); Thorburn et al (2013b); Di Bella et al. (2015)
ToPB variables		
Behavioural Beliefs (BBs)	(+) Martínez-García et al. (2013)	(+) Feather & Amacher (1994); Trumbo & O'Keefe (2001); Vignola et al. (2010); Price & Leviston (2014)
	(-) Martínez-García et al. (2013)	
	Used to estimate ATB Borges et al. (2014)	Used to estimate ATB Meijer, Catacutan, Ajayi, Sileshi, & Nieuwenhuis (2015)
Attitudes towards Behaviour (ATB)/ ATB[2]	(+) Brain (2008); Fielding et al. (2008); Wauters et al. (2010); Willcox et al. (2012); Flick (2013); Martínez-García et al. (2013); Borges et al. (2014); van Dijk et al. (2015); Deng et al. (2016)	(+) Lynne et al. (1995); Beedell & Rehman (1999); Luzar and Diagne (1999); Austin, Deary, & Willock (2001); Trumbo & O'Keefe (2001); De Groot & Steg (2007); Barreiro-Hurlé et al. (2010); Barnes et al. (2013); Toma et al. (2013); Greiner (2015a); Meijer et al. (2015)
	(-) Wauters et al. (2010); Martínez-García et al. (2013)	(-) Bayard & Jolly (2007); Barnes et al. (2009); Barnes et al. (2013); Poppenborg & Koellner (2013)
	Insignificant - Corbett (2002); Wauters et al. (2010)	Insignificant - Austin, Deary, & Willock (2001); Fielding et al. (2008)
Normative Beliefs (NBs)	(+) Yazdanpanah et al. (2014)	(+) Kilpatrick (2000); Lankester et al. (2009); Emtage & Herbohn (2012b); (-) Greiner (2015b)
	Used to estimate SNs - Borges et al. (2014) Insignificant - Fielding et al. (2005)	Used to estimate SNs - Meijer et al. (2015)

Determinants of pro-environmental behaviour

Variable	***Significance & sign of variable / Number of studies***	
	Dependent variable - Behavioural Intention	Dependent variable - Behaviour
Subjective Norms SNs/ SN^2	(+) Brain (2008); Willcox et al. (2012); Flick (2013); Martínez-García et al. (2013); Borges et al. (2014); Deng et al. (2016)	(+) Lynne et al. (1995); Beedell & Rehman (1999); De Groot & Steg (2007); Brain (2008); Wauters & Mathijs (2013); Price & Leviston (2014)
	(-) Wauters et al. (2010) Insignificant - Corbett (2002); Fielding et al. (2008); Wauters et al. (2010); van Dijk, et al. (2015)	Insignificant -Fielding et al. (2008); Meijer et al. (2015)
Control Beliefs (CBs)		(+) Seabrook et al. (2008); Vignola et al. (2010); Pradhananga et al. (2015) (-) Rolfe & Gregg (2015)
	Used to estimate PBC - Borges et al. (2014)	Used to estimate PBC – Meijer et al. (2015)
Perceived Behavioural Control (PBC)/ PBC^2	(+) Fielding et al. (2008); Flick (2013); Borges et al. (2014); van Dijk et al. (2015); Deng et al. (2016)	(+) Lynne et al. (1995); De Groot & Steg (2007); Fielding et al. (2008); Flick (2013)
		(-) Poppenborg & Koellner (2013); Yazdanpanah et al. (2014)
	Insignificant - Corbett (2002); Brain (2008); Wauters et al. (2010); Willcox et al. (2012); Yazdanpanah et al. (2014)	Insignificant - Beedell & Rehman (1999); Fielding et al. (2008); Meijer et al. (2015)
Self Efficacy	Insignificant - Corbett (2002)	(+) Trumbo & O'Keefe (2001)
Actual Control (AC) (Not in drought)		(+) Lynne et al. (1995); Byron et al. (2006) (-) Greiner, Lankester, & Patterson (2007); Lankester et al. (2009); Price & Leviston (2014)
Behavioural Intentions (BI)		(+) Geller (1981); Vogel (1996); Kaiser et al. (1999); Staats et al. (2004); Fielding et al. (2008); Wauters et al. (2010); Flick (2013); Yazdanpanah et al. (2014); Deng et al. (2016)
Interaction variables of three main constructs		(+) Lynne et al. (1995) (-) Lynne et al. (1995) Insignificant - Lynne et al. (1995)
Perceived difficulty (PD)/ PD^2	(-) Wauters et al. (2010) Insignificant - Wauters et al. (2010)	
Biophysical factors		
Average annual rainfall (mm)		(+) D'Emden, Llewellyn & Burton (2006)

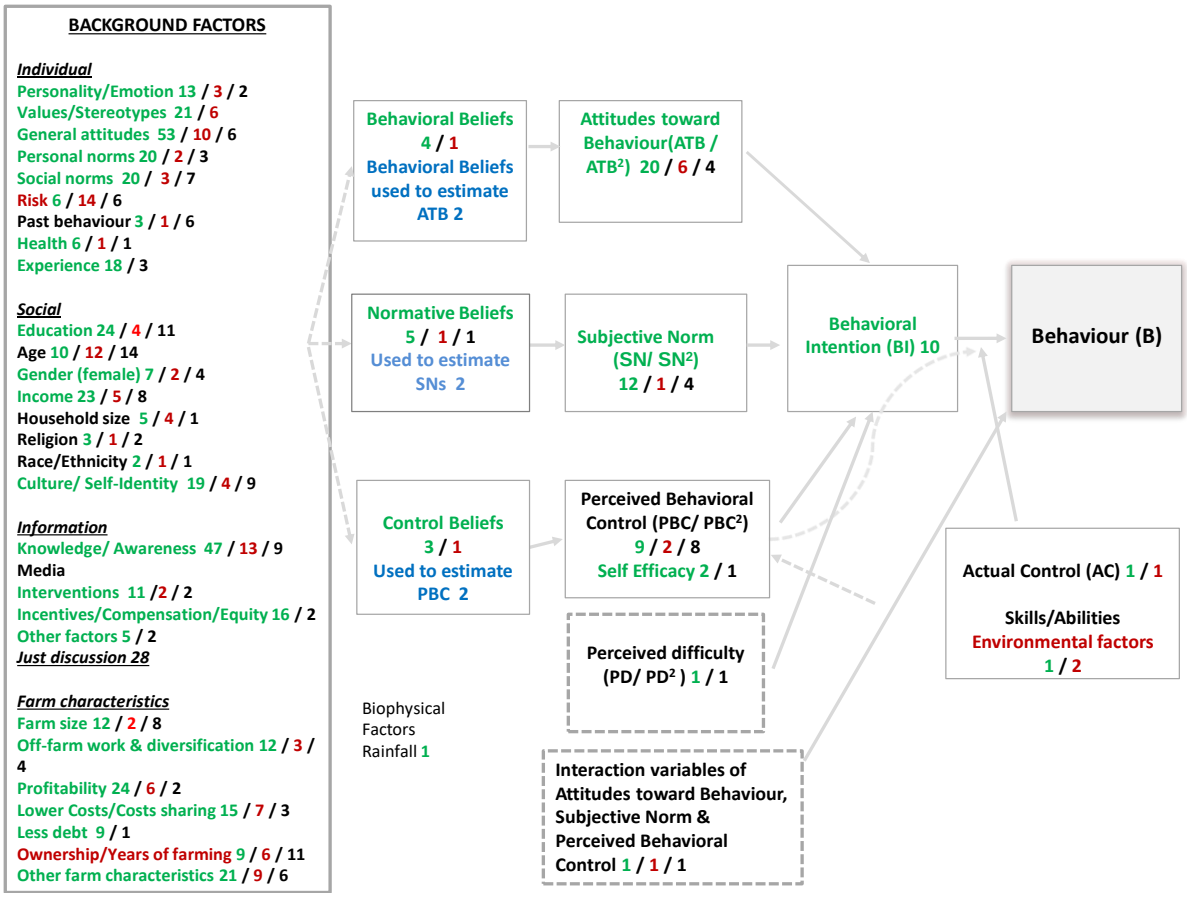

Figure 11: Determinants of pro-environmental behaviour (N = 165)

Green colour - positive significant sign of the coefficient; Red - negative significant sign of the coefficient; Black – insignificant sign of the coefficient; Black without any numbers – variable was not included

Appendix 2

Table 7: Determinants of pro-environmental behaviour in agricultural context (N=133)

Determinants of pro-environmental behaviour in agricultural context	
Variable	***Significance & sign of variables / Number of studies***
Social factors	
Education	(+) Vogel (1996); Traoré et al. (1998); Barr & Cary (2000); Henning & Cardona (2000); Kilpatrick (2000); Austin, Deary, & Willock (2001); Herr et al. (2004); Barreiro-Hurlé et al. (2010); Cary, Webb, & Barr (2002); Kim, Gillespie, & Paudel (2005); Lambert, Sullivan, Claassen, & Foreman (2006); Paudel, Gauthier, Westra, & Hall (2008); Seabrook et al. (2008); Emtage, Smith, & Herbohn (2009); Mzoughi (2011); Comerford (2014); Price & Leviston (2014); Borges et al. (2015) (-) Luzar & Diagne (1999); Wheeler et al. (2013) Insignificant - Bewket & Sterk (2002); D'Emden, Llewellyn & Burton (2006); Fielding et al. (2008); Baumgart – Getz et al. (2012); Reimer et al. (2012b); Willcox et al. (2012); Martínez-García et al. (2013); Wheeler et al. (2013); Meijer et al. (2015); van Dijk et al. (2015)
Age	(+) Adesina & Baidu-Forson (1995); Henning & Cardona (2000); Kim, Gillespie, & Paudel (2005); Byron et al. (2006); Fielding et al. (2008); Barreiro-Hurlé et al. (2010); Baumgart – Getz et al. (2012); Willcox et al. (2012); Akbar et al. (2014) (-) Bultena & Hoiberg (1983); Jacobsen et al. (1991); Featherstone & Goodwin (1993); Henning & Cardona (2000); Cary, Webb, & Barr (2001); Hounsome et al. (2006); Flick (2013); Wheeler et al. (2013) Insignificant - Bewket & Sterk (2002); Lockie et al. (2002); Bekele & Drake (2003); Fielding et al. (2008); Seabrook et al. (2008); Mzoughi (2011); Reimer at al. (2012b); Martínez-García et al. (2013); Wheeler et al. (2013); Borges et al. (2015); Meijer et al. (2015); van Dijk et al. (2015)
Gender (female)	(+) Henning & Cardona (2000); Fielding et al. (2008); Mzoughi (2011); Wheeler et al. (2013) (-) Henning & Cardona (2000); Borges et al. (2015) Insignificant - Bekele & Drake (2003); Fielding et al. (2008); Wheeler et al. (2013); Meijer et al. (2015)
Income	(+) Lynne & Rola (1988); Lynne et al. (1988); Luzar and Diagne (1999); Herr et al. (2004); Kim, Gillespie, & Paudel (2005); Lockie & Rockloff (2005); Lambert, Sullivan, Claassen, & Foreman (2006); Emtage, Smith, & Herbohn (2009); Greiner, Patterson, & Miller (2009); Greiner & Gregg (2011); Baumgart-Getz et al. (2012); Martínez-García et al. (2013); Borges et al. (2015) (-) Cary, Webb, & Barr (2001); Greiner, Lankester, & Patterson (2007); Barreiro-Hurlé et al. (2010); Willcox et al. (2012) Insignificant – Featherstone & Goodwin (1993); Henning & Cardona (2000); Herr et al. (2004); Hounsome et al. (2006); Paudel, Gauthier, Westra, & Hall (2008); Seabrook et al. (2008); Meijer et al. (2015)
Household size	(+) Featherstone & Goodwin (1993); Bekele & Drake (2003); Borges et al. (2015) (-) Luzar and Diagne (1999); Bekele & Drake (2003) Insignificant – Bekele & Drake (2003); Hounsome et al. (2006); Meijer et al. (2015)
Religion	
Race/Ethnicity	(+) Bekele & Drake (2003) Insignificant - Bekele & Drake (2003)
Culture/Self-Identity	(+) Featherstone & Goodwin (1993); Gray et al. (2000); Ryan, Erickson & Young (2003); Kim, Gillespie, & Paudel (2005); Hounsome et al. (2006); Lambert, Sullivan, Claassen, & Foreman (2006); Greiner, Lankester, & Patterson (2007); Greiner, Patterson, & Miller (2009); Greiner & Gregg (2011); Lokhorst et al. (2011); Wheeler et al. (2013); Mastrangelo et al. (2014); Smith et al. (2014); Greiner (2015b); Morgan et al. (2015) (-) Herr et al. (2004); Kim, Gillespie, & Paudel (2005); Greiner, Lankester, & Patterson (2007); Wheeler et al. (2013) Insignificant - Traoré et al. (1998); Dunn, Gray & Phillips (2000); Henning & Cardona (2000); Paudel et al. (2008); Gosling & Williams (2010); Baumgart-Getz et al. (2012);

Determinants of pro-environmental behaviour in agricultural context

Variable	***Significance & sign of variables / Number of studies***
	Moon, Marshall, & Cocklin (2012); Wheeler et al. (2013); van Dijk et al. (2015)
Individual factors	
Personality/ Emotions	(+) Vogel (1996); Austin, Deary, & Willock (2001); Quinn & Burbach (2008); Willcox et al. (2012); Borges et al. (2015) (-) Austin, Deary, & Willock (2001) Insignificant - Lynne et al. (1988); Price & Leviston (2014)
Values/Stereotypes	(+) Willock, Deary, Edwards-Jones et al. (1999); Willock, Deary, McGregor et al. (1999); Curtis & Robertson (2003); Byron et al. (2006); Brain (2008); Seabrook et al. (2008); Vignola et al. (2010); Bohnet et al. (2011); Reimer et al. (2012a); Price & Leviston (2014); Smith et al. (2014)
Attitudes (general & specific)	(+) Lynne et al. (1988); Lynne & Rola (1988); Carr & Tait (1991); Napier & Napier (1991); Napier & Brown (1993); Vogel (1996); Traoré et al. (1998); Beedell & Rehman (1999); Lichtenberg & Zimmerman (1999); Luzar & Diagne (1999); Willock, Deary, McGregor et al. (1999); Willock, Deary, Edwards-Jones, et al. (1999); Henning & Cardona (2000); Cary, Webb, & Barr (2001); Byron et al. (2006); Lankester, & Patterson (2007); Quinn & Burbach (2008); Seabrook et al. (2008); Emtage, Smith, & Herbohn (2009); Barreiro-Hurlé et al. (2010); Gosling & Williams (2010);Lokhorst et al. (2011); Baumgart-Getz et al. (2012); Andrews, et al. (2013); Comerford (2014); Emtage & Herbohn (2012a); Greiner, Moon, Marshall, & Cocklin (2012); Reimer et al. (2012a); Martínez-García et al. (2013); Moon (2013); Toma et al. (2013); Wheeler et al. (2013); Greiner (2015a); Greiner (2015b); Morgan et al. (2015); Varua, Ward & Maheshwari (2015) (-) Traoré, et al. (1998); Lynne et al. (1988); Cary, Webb, & Barr (2001); Quinn & Burbach (2008); Reimer et al. (2012a); Toma et al. (2013); Wheeler et al. (2013) Insignificant - Willock, Deary, McGregor et al. (1999); Curtis & Robertson (2003); Paudel et al. (2008); Reimer et al. (2012); Wheeler et al. (2013); Greiner (2015a)
Personal norms	(+) Cary & Wilkinson (1997); Luzar and Diagne (1999); Cary, Webb, & Barr (2001); Lockie & Rockloff (2005); Byron et al. (2006); Barreiro-Hurlé et al. (2010); Bohnet et al. (2011); Mzoughi (2011); Reimer et al. (2012b); Moon, Marshall, & Cocklin (2012); Wheeler et al. (2013); Borges et al. (2015); Meijer, Catacutan, Ajayi, Sileshi, & Nieuwenhuis (2015); Pradhananga et al. (2015) (-) Moon (2013) Insignificant - Traoré et al. (1998); Corbett (2002); D'Emden, Llewellyn & Burton (2006); Wheeler et al. (2013); Toma et al. (2015)
Social norms	(+) Gray et al (2000); Henning & Cardona (2000); Corbett (2002); Ryan, Erickson & Young (2003); Michel-Guillou & Moser (2006); Greiner, Lankester, & Patterson (2007); Fielding et al. (2008); Emtage & Herbohn (2009); Rogers (2010); Mzoughi (2011); Greiner & Gregg (2011); Moon, Marshall, & Cocklin (2012); Wauters & Mathijs (2013); Akbar et al. (2014); Borges et al. (2015); Greiner (2015b) (-) Fielding et al. (2008); Quinn & Burbach (2008); Greiner, Patterson, & Miller (2009) Insignificant - Corbett (2002); Fielding et al. (2008); Greiner (2015b); van Dijk et al. (2015)
Risk	(+) Lynne et al. (1988); Willock, Deary, McGregor et al. (1999); Greiner, Patterson, & Miller (2009); Wheeler et al. (2013) Yazdanpanah et al. (2014) (-) Feather & Amacher (1994); Adesina & Baidu-Forson (1995); Barr (1996); Henning & Cardona (2000); Kim, Gillespie, & Paudel, 2005; Vignola et al. (2010); Mzoughi (2011); Reimer et al. (2012b); Wheeler et al. (2013); Comerford (2014); Smith et al. (2014); Borges et al. (2015); Greiner (2015c); Rolfe & Gregg (2015) Insignificant - Feather & Amacher (1994); Cary & Wilkinson (1997); D'Emden, Llewellyn & Burton (2006); Prokopy et al. (2008); Wheeler et al. (2013); Price & Leviston (2014)
Past Behaviour	(+) Fielding et al. (2005); Fielding et al. (2008); Wheeler et al. (2013) (-) Corbett (2002) Insignificant - Adesina & Baidu-Forson (1995); Traoré et al. (1998); Fielding et al. (2008); Barreiro-Hurlé et al. (2010); Reimer et al. (2012b)
Health	(+) Hounsome et al. (2006); Moon, Marshall, & Cocklin (2012); Wheeler et al. (2013); Borges et al. (2015) (-) Wheeler et al. (2013) Insignificant - Wheeler et al. (2013)
Experience	(+) Adesina & Baidu-Forson (1995); Barr & Cary (2000); Henning & Cardona (2000);

Determinants of pro-environmental behaviour in agricultural context

Variable	*Significance & sign of variables / Number of studies*
	Kilpatrick (2000); Cary, Webb, & Barr (2001); Lockie & Rockloff (2005); Byron et al. (2006); D'Emden, Llewellyn & Burton (2006); Seabrook et al. (2008); Emtage, Smith, & Herbohn (2009); Lankester et al. (2009); Moon, Marshall, & Cocklin (2012); Flick (2013); Toma et al. (2013); Comerford (2014); Borges et al. (2015); Wegscheidl et al. (2015) Insignificant - Traoré et al. (1998); Reimer et al. (2012b); Martínez-García et al. (2013)
Information factors	
Knowledge/ Awareness	(+) Napier & Napier (1991), Napier & Brown (1993); Feather & Amacher (1994); Vogel (1996); Traoré et al. (1998); Lichtenberg & Zimmerman (1999); Barr & Cary (2000); Beedell & Rehman (2000); Corbett (2002); Bekele & Drake (2003); Curtis & Robertson (2003); Kim et al. (2005); Lockie & Rockloff (2005); Byron et al. (2006); D'Emden, Llewellyn & Burton (2006); Lambert, Sullivan, Claassen, & Foreman (2006); Bayard & Jolly (2007); Greiner, Lankester, & Patterson (2007); Brain (2008); Paudel et al. (2008); Rolfe et al. (2008); Emtage, Smith, & Herbohn (2009); Greiner, Patterson, & Miller (2009); Lankester et al. (2009); Barreiro-Hurlé et al. (2010); Baumgart-Getz et al. (2012); Moon, Marshall, & Cocklin (2012); Toma et al. (2013); Flick (2013); Wheeler et al. (2013); Akbar et al. (2014); Borges et al. (2015); Morgan et al. (2015); Rolfe & Gregg (2015); Wegscheidl et al. (2015) (-) Barr & Cary (2000); Dunn, Gray & Phillips (2000); Henning & Cardona (2000); Lockie & Rockloff (2005); Byron et al. (2006); Greiner, Patterson, & Miller (2009); Reimer et al. (2012b); Moon (2013); Wheeler et al. (2013) Insignificant - Bewket & Sterk (2002); Corbett (2002); Curtis & Robertson (2003); Wheeler et al. (2013); Reimer et al. (2012); Comerford (2014)
Media	
Interventions	(+) Akbar et al., 2014
Incentives	(+) Featherstone & Goodwin (1993); Casey, Schmitz, Swinton & Zilberman (1999); Barr & Cary (2000); Bekele & Drake (2003); Lockie & Rockloff (2005); Lambert, Sullivan, Claassen, & Foreman (2006); Paudel et al. (2008); van Grieken et al. (2009); Greiner & Gregg (2011); Mzoughi (2011); Moon, Marshall, & Cocklin (2012); van Grieken et al. (2012) Insignificant - Ryan, Erickson & Young (2003); Brain (2008); Baumgart-Getz et al. (2012); Beharry-Borg et al. (2013); Borges et al. (2015); Greiner (2015c)
Other factors	(+) Richards et al. (2003); Stanley et al. (2005); Bates et al. (2008); Rogers (2010); Borges et al. (2015) Insignificant - Stanley et al. (2005); Bates et al. (2008);
Farm characteristics	
Farm size	(+) Featherstone & Goodwin (1993); Cary & Wilkinson (1997); Luzar & Diagne (1999); Willock, Deary, Edwards-Jones et al. (1999); Henning & Cardona (2000); Austin, Deary, & Willock (2001); Bekele & Drake (2003); Kim, Gillespie, & Paudel (2005); Hounsome et al. (2006); Seabrook et al. (2008); Lankester et al. (2009); Baumgart-Getz et al. (2012); Borges et al. (2015) (-) Emtage, Smith, & Herbohn (2009); Martínez-García et al. (2013) Insignificant - Traoré, Landry, & Amara (1998); D'Emden, Llewellyn & Burton (2006); Fielding et al. (2008); Reimer et al. (2012b); Willcox et al. (2012); Comerford (2014); Meijer et al. (2015); van Dijk, et al. (2015)
Off-farm work & diversification	(+) Featherstone & Goodwin (1993); Willock, Deary, McGregor et al. (1999); Austin, Deary, & Willock (2001); Kim, Gillespie, & Paudel (2005); Byron et al. (2006); Lambert, Sullivan, Claassen, & Foreman (2006); Greiner, Patterson, & Miller (2009); Wheeler et al. (2013); Comerford (2014) (-) Featherstone & Goodwin (1993); Bekele & Drake (2003); Byron et al. (2006); Wheeler et al. (2013) Insignificant - Hounsome et al. (2006); Lambert, Sullivan, Claassen, & Foreman (2006); Willcox et al. (2012); Wheeler et al. (2013); Borges et al. (2015)
Profitability	(+) Barr & Cary (1992); Feather & Amacher (1994); Adesina & Baidu-Forson (1995); Cary & Wilkinson (1997); Barr & Cary (2000); Webb, & Barr (2001); Cary, Roebeling et al. (2004); Fielding et al. (2005); Lockie & Rockloff (2005); Stanley et al. (2005); Greiner, Lankester, & Patterson (2007); Bates et al. (2008); Halpin et al. (2008); Rolfe et al.

Determinants of pro-environmental behaviour in agricultural context

Variable	***Significance & sign of variables / Number of studies***
	(2008); Seabrook et al. (2008); Greiner, Patterson, & Miller (2009); Greiner & Gregg (2011); Reimer et al. (2012b); Moon (2013); Wheeler et al. (2013); Akbar et al. (2014); Smith et al. (2014); Borges et al. (2015); Greiner (2015b); Morgan et al. (2015); Wegscheidl et al. (2015) (-) Lynne et al. (1988); Greiner, Lankester, & Patterson (2007); Greiner & Gregg (2011); Reimer et al. (2012a); Reimer et al. (2012b) Insignificant - Baumgart-Getz et al. (2012); Andrews et al. (2013); Wheeler et al. (2013)
Lower costs/Costs sharing if positive High costs if negative	(+) Barr (1996); Cotching & Sims (2000); Dunn, Gray & Phillips (2000); Henning & Cardona (2000); Qureshi et al. (2001); Curtis & Robertson (2003); Rolfe et al. (2008); Reimer at al. (2012b); Andrews et al. (2013); Beharry-Borg et al. (2013); Smith et al. (2014); Borges et al. (2015); Wegscheidl et al. (2015) (-) Barr & Cary (1992); Paudel et al. (2008); Rolfe et al. (2008); Lankester et al. (2009); Mzoughi (2011); Reimer et al. (2012b); Rolfe & Gregg (2015) Insignificant - Cary & Wilkinson (1997); Fielding et al. (2005); Lambert, Sullivan, Claassen, & Foreman (2006); D'Emden, Llewellyn & Burton (2006)
Lower debt	(+) Featherstone & Goodwin (1993); Henning & Cardona (2000); Herr et al. (2004); Kim, Gillespie, & Paudel (2005); Greiner, Lankester, & Patterson (2007); Paudel, Gauthier, Westra, & Hall (2008); Greiner, Patterson, & Miller (2009); Lankester et al. (2009); Wheeler et al. (2013) (-) Borges et al. (2015) Insignificant - Hounsome et al. (2006); Wheeler et al. (2013)
Ownership/Years of farming	(+) Lynne et al. (1988); Luzar and Diagne (1999); Qureshi et al. (2001); Kim et al. (2005); Lambert et al. (2006); Wheeler et al. (2013); Borges et al. (2015) (-) Herr et al. (2004); Reimer et al. (2012b); Wheeler et al. (2013) Insignificant - Norris & Batie (1987); Traoré et al. (1998); Bewket & Sterk (2002); Bekele & Drake (2003); Lambert, Sullivan, Claassen, & Foreman, 2006; Lambert, Sullivan, Claassen, & Foreman (2006); Paudel et al. (2008); Seabrook et al. (2008); Baumgart-Getz et al. (2012); Willcox et al. (2012); Wheeler et al. (2013); Akbar et al. (2014)
Other farm characteristics	(+) Norris & Batie (1987); Featherstone & Goodwin (1993); Henning & Cardona (2000); Cary, Webb, & Barr (2001); Bekele & Drake (2003); Herr et al. (2004); Kim, Gillespie, & Paudel (2005); Lockie & Rockloff (2005); Byron et al. (2006); Lambert, Sullivan, Claassen, & Foreman (2006); Bewsell et al. (2007); Brain (2008); Emtage, Smith, & Herbohn (2009); Greiner, Patterson, & Miller (2009); Baumgart-Getz et al. (2012); Reimer et al. (2012b); Toma et al. (2013); Wheeler et al. (2013); Akbar et al. (2014); Borges et al. (2015); Wegscheidl et al. (2015) (-) Barr and Cary (1992); Featherstone & Goodwin (1993); Traoré et al. (1998); Bekele & Drake (2003); Kim, Gillespie, & Paudel (2005); Lankester et al. (2009); Barreiro-Hurlé et al. (2010); Greiner & Gregg (2011); Mzoughi (2011); Reimer at al. (2012b); Wheeler et al. (2013) Insignificant - Feather & Amacher (1994); Bekele & Drake (2003); Hounsome et al. (2006); Willcox et al. (2012); Wheeler et al. (2013)
Studies that just discussed factors	Bond & Wonder (1980); Guerin & Guerin (1994); Lockie et al. (1995); Howden et al. (1998); Johnson et al. (1998); Emtage, Herbohn, & Harrison (2001); Reeve (2001); Shrapnel & Davie (2001); Breetz et al. (2005); Maybery, Crase, & Gullifer (2005); Davis 2006; Emtage, Herbohn, & Harrison (2006); Pannell et al. (2006); Emtage, Herbohn, & Harrison (2007); Thomas et al. (2007); Thorburn et al. (2007); Keipert et al. (2008); Emtage & Herbohn (2009); Richards & Lawrence (2009); Blackstock et al. (2010); van Grieken et al. (2010); Agnew, Rohde & Bush (2011); Ashburner et al. (2012); McIvor (2012); Benn (2013); Thorburn et al (2013b); Thorburn et al. (2013a); Di Bella et al. (2015)
Behavioural Beliefs (BB)	(+) Feather & Amacher (1994); Vignola et al. (2010); Martínez-García et al. (2013); Price & Leviston (2014) (-) Martínez-García et al. (2013)
Control Beliefs (CB)	(+) Seabrook et al. (2008); Vignola et al. (2010); Pradhananga et al. (2015) (-) Rolfe & Gregg (2015)
Normative Beliefs	(+) Kilpatrick (2000); Lankester et al. (2009); Emtage & Herbohn (2012b); Yazdanpanah et al. (2014) (-) Greiner (2015b) Insignificant – Fielding et al. (2005)

Determinants of pro-environmental behaviour in agricultural context

Variable	*Significance & sign of variables / Number of studies*
Attitudes Toward Behaviour (ATB)	(+) Lynne et al. (1995); Beedell & Rehman (1999); Luzar & Diagne (1999); Austin, Deary, & Willock (2001); Brain (2008); Fielding et al. (2008); Barreiro-Hurlé et al. (2010); Wauters et al. (2010); Willcox et al. (2012); Barnes et al. (2013); Flick (2013); Martínez-García et al. (2013); Toma et al. (2013); Borges et al. (2014); Greiner (2015a); Meijer et al. (2015); van Dijk et al. (2015); Deng et al. (2016) (-) Bayard & Jolly (2007); Barnes et al. (2009); Wauters et al. (2010); Barnes et al. (2013); Martínez-García et al. (2013); Poppenborg & Koellner (2013) Insignificant - Austin, Deary, & Willock (2001); Corbett (2002); Fielding et al. (2008); Wauters et al. (2010)
Subjective Norms SNs/ SN^2	(+) Lynne et al. (1995); Beedell & Rehman (1999); Brain (2008); Willcox et al. (2012); Flick (2013) Martínez-García et al. (2013); Wauters & Mathijs (2013); Borges et al. (2014); Price & Leviston (2014); Deng et al. (2016) (-) Wauters et al. (2010) Insignificant - Corbett (2002); Fielding et al. (2008); Wauters et al. (2010); Meijer et al. (2015); van Dijk et al. (2015);
Perceived Behavioural Control (PBC)/ PBC^2	(+) Lynne et al. (1995); Fielding et al. (2008); Flick (2013); Borges et al. (2014); van Dijk et al. (2015); Deng et al. (2016); (-) Poppenborg & Koellner (2013); Yazdanpanah et al. (2014) Insignificant - Beedell & Rehman (1999); Corbett (2002); Brain (2008); Fielding et al. (2008); Wauters et al. (2010); Willcox et al. (2012); Yazdanpanah et al. (2014); Meijer et al. (2015)
Self Efficacy	Insignificant - Corbett (2002)
Actual control (Not in drought)	(+) Lynne et al. (1995); Byron et al. (2006) (-) Greiner, Lankester, & Patterson (2007); Lankester et al. (2009); Price & Leviston (2014)
Behavioural Intentions (BI)	(+) Vogel (1996); Fielding et al. (2008); Wauters et al. (2010); Flick (2013); Yazdanpanah et al. (2014); Deng et al. (2016);
Interaction variables of three main constructs	(+) Lynne et al. (1995) (-) Lynne et al. (1995) Insignificant - Lynne et al. (1995)
Perceived difficulty (PD)/ PD^2	(-) Wauters et al. (2010) Insignificant - Wauters et al. (2010)
Biophysical factors	
Average annual rainfall (mm)	(+) D'Emden, Llewellyn & Burton (2006)

Appendix 3

Table 8: Determinants of pro-environmental behaviour in agricultural context within ToPB

Determinants of pro-environmental behaviour in agricultural context (ToPB studies) N=24		
Variable	***Significance & sign of variable / Number of studies***	
	Dependent variable - Behavioural Intention	Dependent variable - Behaviour
Social factors		
Education	(-) Wheeler et al. (2013) Insignificant - Fielding et al. (2008); Willcox et al. (2012); Wheeler et al. (2013); van Dijk et al. (2015)	(+) Austin, Deary, & Willock (2001); Price & Leviston (2014); Borges et al. (2015); Insignificant - Fielding et al. (2008); Reimer et al. (2012b); Meijer et al. (2015)
Age	(+) Willcox et al. (2012) (-) Flick (2013); Wheeler et al. (2013) Insignificant - Fielding et al. (2008); Wheeler et al. (2013); van Dijk et al. (2015)	(+) Fielding et al. (2008) (-) Wheeler et al. (2013) Insignificant – Reimer at al. (2012b); Borges et al. (2015); Meijer et al. (2015);
Gender (female)	(+) Wheeler et al. (2013) Insignificant - Fielding et al. (2008); Wheeler et al. (2013)	(+) Fielding et al. (2008) (-) Borges et al. (2015) Insignificant - Meijer et al. (2015)
Income	(-) Willcox et al. (2012)	(+) Borges et al. (2015) Insignificant - Meijer et al. (2015)
Household size		(+) Borges et al. (2015) Insignificant - Meijer et al. (2015)
Religion		
Race/Ethnicity		
Culture/Self-Identity	(+) Wheeler et al. (2013) (-) Wheeler et al. (2013) Insignificant - Wheeler et al. (2013); van Dijk et al. (2015)	(+) Wheeler et al. (2013)
Individual factors		
Personality/ Emotions	(+) Willcox et al. (2012); Borges et al. (2015)	(+) Austin, Deary, & Willock (2001); Quinn & Burbach (2008) (-) Austin, Deary, & Willock (2001) Insignificant - Price & Leviston (2014)
Values/Stereotypes	(+) Brain (2008)	(+) Brain (2008); Price & Leviston (2014)
Attitudes (general & specific)	(+) Wheeler et al. (2013) (-) Wheeler et al. 2013 Insignificant - Wheeler et al. (2013)	(+) Beedell & Rehman (1999); Quinn & Burbach (2008); Wheeler et al. (2013); Greiner (2015a) (-) Quinn & Burbach (2008); Wheeler et al. (2013) Insignificant - Reimer et al. (2012); Greiner (2015a)
Personal norms	(+) Wheeler et al. (2013) Insignificant - Corbett (2002); Wheeler et al. (2013)	(+) Reimer et al. (2012b); Borges et al. (2015); Meijer, Catacutan, Ajayi, Sileshi, & Nieuwenhuis (2015)
Social norms	(+) Corbett (2002); Fielding et al. (2008) (-) Fielding et al. (2008) Insignificant - Corbett (2002); Fielding et al. (2008); van Dijk et al. (2015)	(+) Borges et al. (2015) (-) Quinn & Burbach (2008) Insignificant - Fielding et al. (2008); Greiner (2015b)

Determinants of pro-environmental behaviour in agricultural context (ToPB studies) N=24

Variable	***Significance & sign of variable / Number of studies***	
	Dependent variable - Behavioural Intention	Dependent variable - Behaviour
Risk	(+) Yazdanpanah et al. (2014) (-) Wheeler et al. (2013) Insignificant - Wheeler et al. (2013)	(+) Wheeler et al. (2013) (-) Reimer et al. (2012b); Borges et al. (2015) Insignificant - Price & Leviston (2014)
Past Behaviour	(+) Fielding et al. (2005); Fielding et al. (2008); (-) Corbett (2002)	(+) Wheeler et al. (2013) Insignificant - Fielding et al. (2008); Reimer et al. (2012b)
Health	(+) Wheeler et al. (2013) (-) Wheeler et al. (2013) Insignificant - Wheeler et al. (2013)	(+) Wheeler et al. (2013); Borges et al. (2015)
Experience	(+) Flick (2013)	(+) Borges et al. (2015) Insignificant - Reimer et al. (2012b)
Information factors		
Knowledge/ Awareness	(+) Corbett (2002); Brain (2008); Flick (2013); Wheeler et al. (2013) (-) Wheeler et al. (2013) Insignificant - Corbett (2002); Wheeler et al. (2013)	(+) Beedell & Rehman (2000); Brain (2008); Borges et al. (2015) (-) Reimer et al. (2012b) Insignificant - Reimer et al. (2012); Wheeler et al. (2013)
Media		
Interventions		
Incentives	(+) Brain (2008)	(+) Brain (2008); Borges et al. (2015)
Other factors		(+) Borges et al. (2015)
Farm characteristics		
Farm size	 Insignificant - Willcox et al. (2012); van Dijk et al. (2015)	(+) Austin, Deary, & Willock (2001); Borges et al. (2015) Insignificant- Fielding et al. (2008); Reimer et al. (2012b); Meijer et al. (2015)
Off-farm work & diversification of land use	(+) Wheeler et al. (2013) (-) Wheeler et al. (2013) Insignificant - Willcox et al. (2012); Wheeler et al. (2013)	(+) Austin, Deary, & Willock (2001); Wheeler et al. (2013) Insignificant - Wheeler et al. (2013); Borges et al. (2015)
Profitability	(+) Fielding et al. (2005); Wheeler et al. (2013) Insignificant - Wheeler et al. (2013)	(+) Reimer et al. (2012b); Borges et al. (2015) (-) Reimer et al. (2012b)
Costs	 Insignificant – Fielding et al. (2005)	(+) Reimer at al. (2012b); Borges et al. (2015) (-) Reimer et al. (2012b)
Debt	(+) Wheeler et al. (2013) Insignificant - Wheeler et al. (2013)	(-) Borges et al. (2015)
Ownership/Years of farming	(+) Wheeler et al. (2013) (-) Wheeler et al. (2013) Insignificant - Willcox et al. (2012); Wheeler et al. (2013)	(+) Borges et al. (2015) (-) Reimer et al. (2012b); Wheeler et al. (2013)
Other farm characteristics	(+) Wheeler et al. (2013) (-) Wheeler et al. (2013) Insignificant - Willcox et al. (2012); Wheeler et al. (2013)	(+) Brain (2008); Reimer et al. (2012b); Wheeler et al. (2013); Borges et al. (2015) (-) Reimer at al. (2012b) Insignificant - Price & Leviston (2014); Meijer et al. (2015)
ToPB variables		
Behavioural Beliefs (BBs)	Used to estimate ATB – Borges et al. (2014)	(+) Price & Leviston (2014) Used to estimate ATB - Meijer, Catacutan,

Determinants of pro-environmental behaviour in agricultural context (ToPB studies) N=24

Variable	***Significance & sign of variable / Number of studies***	
	Dependent variable - Behavioural Intention	Dependent variable - Behaviour
		Ajayi, Sileshi, & Nieuwenhuis (2015)
Attitudes towards Behaviour (ATB)/ ATB[2]	(+) Brain (2008); Fielding et al. (2008); Wauters et al. (2010); Willcox et al. (2012); Flick (2013); Borges et al. (2014); van Dijk et al. (2015); Deng et al. (2016)	(+) Lynne et al. (1995); Beedell & Rehman (1999); Austin, Deary, & Willock (2001); Greiner (2015a); Meijer et al. (2015)
	(-) Wauters et al. (2010)	(-) Poppenborg & Koellner (2013)
	Insignificant - Corbett (2002); Wauters et al. (2010)	Insignificant - Austin, Deary, & Willock (2001); Fielding et al. (2008)
Normative Beliefs (NBs)	(+) Yazdanpanah et al. (2014) Used to estimate SNs – Borges et al. (2014) Insignificant – Fielding et al. (2005)	Used to estimate SNs - Meijer, Catacutan, Ajayi, Sileshi, & Nieuwenhuis (2015)
Subjective Norms SNs/ SN[2]	(+) Brain (2008); Willcox et al. (2012); Flick (2013); Borges et al. (2014); Deng et al. (2016); (-) Wauters et al. (2010)	(+) Lynne et al. (1995); Beedell & Rehman (1999); Brain (2008); Price & Leviston (2014)
	Insignificant - Corbett (2002); Fielding et al. (2008); Wauters et al. (2010); van Dijk et al. (2015)	Insignificant - Fielding et al. (2008); Meijer et al. (2015)
Control Beliefs (CBs)	Used to estimate PBC – Borges et al. (2014)	Used to estimate PBC - Meijer, Catacutan, Ajayi, Sileshi, & Nieuwenhuis (2015)
Perceived Behavioural Control (PBC)/ PBC[2]	(+) Fielding et al. (2008); Flick (2013); Borges et al. (2014); van Dijk et al. (2015); Deng et al. (2016)	(+) Lynne et al. (1995); Fielding et al. (2008); Flick (2013)
		(-) Poppenborg & Koellner (2013); Yazdanpanah et al. (2014)
	Insignificant - Corbett (2002); Wauters et al. (2010); Brain (2008); Willcox et al. (2012); Yazdanpanah et al. (2014)	Insignificant - Beedell & Rehman (1999); Fielding et al. (2008); Meijer et al. (2015)
Self Efficacy	Insignificant - Corbett (2002)	
Actual Control (AC)		(+) Lynne et al. (1995) (-) Price & Leviston (2014)
Behavioural Intentions (BI)		(+) Fielding et al. (2008); Wauters et al. (2010); Flick (2013); Yazdanpanah et al. (2014); Deng et al. 2016
Interaction variables of three main constructs		(+) Lynne et al. (1995) (-) Lynne et al. (1995) Insignificant - Lynne et al. (1995)
Perceived difficulty (PD)/ PD[2]	(-) Wauters et al. (2010) Insignificant - Wauters et al. (2010)	

Glossary of terms

Additionality	The success an incentive/program has had in bringing about changes that would otherwise not have occurred, or in resisting adverse changes that would otherwise have occurred
Composite reliability	Composite reliability is a measure of scale reliability. It is a measure of the overall reliability of a collection of heterogeneous but similar items. Individual item reliability (test the reliability of the items using Croinbach Alpha) vs. composite reliability (of the construct, the latent variable) (Zencaroline, 2007; Mancha et al., 2014)
Dependent variable	Dependent variable is a variable that depends on other factors (e.g. number of fishing trips depends on being male)
Descriptive norms	What people actually do (for more information see Eagle et al., 2016)
Direct effect	The *direct effect* is the pathway from the exogenous variable (the independent variable) to the dependent variable while controlling for the mediator (Gunzler et al., 2013)
Discriminant validity	Discriminant validity tests measures/concepts that should *not* be related are, in reality, unrelated (Research methods, 2006)
Endogenous variable	Variable which is explained by other variables or functional relationship in the model (see footnote 10 for details)
Exogenous variable	Variable which is not explained by functional relationships in the model and their values are independent (see footnote 10 for details)
Extrinsic incentives	An intangible award of recognition, a sense of achievement and satisfaction
Independent (explanatory) variable	Independent variable is a variable that stands alone and is not changed/influenced by other variables (e.g. age, gender). Number of fishing trips, for example, is not going to change a person's age or gender
Internal consistency	Internal consistency is a way to measure how well a constructed measure is actually measuring what one wants to measure. The internal consistency of the constructs can be confirmed by the composite reliability scores (Mancha et a., 2014)
Injunctive norms	Portrayal of what people ought to do (for more information see Eagle et al., 2016)
Intrinsic incentives	Usually financial or tangible rewards
Latent (unobserved) variable	Unobserved (or latent) variables are variables for which there are no measurements in the dataset. Latent variables (from Latin: present participle of *lateo* ("lie hidden"), are variables that are not directly observed but are rather inferred (through a mathematical model) from other variables that are observed or measured directly. Sometimes the unobserved variable is unobserved because it isn't directly measurable or may not be measured for practical reasons. Sometimes latent variables correspond to abstract concepts such as mental states, morale, conservatism etc. and can be inferred or estimated using directly measured variables in the model (Tabachnick & Fidell, 2001)
Mediation (indirect) effect	The *indirect effect* describes the pathway from the exogenous variable (the independent variable) to the dependent variable through the mediator (Gunzler et al., 2013)

Mediator	The *mediator* helps to explain 'how or why an independent variable influences' a dependent variable. For example, 'a tobacco prevention program may teach participants how to stop taking smoking breaks at work' (the independent variable) 'which changes their social norms about tobacco use (the intermediate *mediator*) and subsequently leads to a reduction in smoking behavior' (the dependent variable) (Gunzler, Chen, & Zhang, 2013, p. 390)
Observed variable	Observed variables are variables for which there are direct measurements in the dataset

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