Environmental Management Accounting Practices in Australian Cotton Farming

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TABLE OF CONTENTS

Contents

CHAPTER FOUR

CHAPTER FIVE

ABSTRACT

Australia is one of the largest cotton exporters in the world. Cotton export significantly contributes to the Australian economy by generating billions of dollars each year. Cotton farming also contributes to the economy by creating employment opportunities for thousands of workers throughout different communities. However, despite significant contribution to the economy, cotton farming is associated with devastating environmental issues including water depletion, carbon emissions, water pollution and soil pollution.

The aim of this thesis is to examine the association between environmental management accounting (EMA) practices and the performance of cotton farming in Australia. This thesis follows the 'thesis by publication' format and comprises of three self-contained papers. The first paper examines the current environmental issues caused by the Australian cotton farming. This study uses an integrative literature review approach to examine a specific phenomenon to create new knowledge through amalgamation, critique and synthesis of data collected from academic papers published from 2007 to 2018. The paper finds four major environmental issues related to water, soil, land and biodiversity, and carbon emissions.

The second paper examines the association between the belief-based factors and the intention of the Australian cotton farmers to adopt EMA practices. The study draws on the theory of planned behaviour (TPB) and identifies the three belief-based factors, namely attitude, subjective norm and perceived behavioural control, to predict the individuals' behaviour. The partial least squares (PLS) structural modelling analysis of survey data collected from 91 cotton farmers reveals that two factors suggested by the TPB, namely attitude and perceived behavioural control serve as powerful influences on farmers' intentions to adopt EMA practices. The paper also finds that subjective norm has a strong indirect relationship with farmers' intention to adopt EMA practices through attitude and perceived behavioural control. Further, the study reveals that while the intention of more environmentally friendly farmers is largely influenced by attitude and subjective norm, the intention of less environmentally friendly farmers is primarily driven by perceived behavioural control.

The third paper examines the association between the use of EMA practices and farm performance. Drawing on stakeholder theory, the study also examines the association between the use of EMA practices and the three contingent factors, namely expected

competitive advantage, perceived stakeholders' concern and farmers' environmental commitment. The study uses PLS structural model to analyse survey data collected from 92 cotton farmers in Australia. The paper finds that farmers who expect to achieve competitive advantage through environmentally friendly initiatives, and aim to address stakeholders' concern about the natural environment, use EMA practices in their cotton farms. The study also finds that farmers who use EMA practices in their cotton farms improve the environmental and economic performance of their farm businesses.

The thesis extends the extant literature on EMA, TPB, and stakeholder theory. It provides evidence that the use of EMA practices can improve the environmental and economic performance of the organisations. It highlights the belief-based factors influencing farmers' intentions in using EMA practices. It also highlights the contingent factors that encourage farmers to use EMA practices in cotton farms.

The findings of the thesis provide farmers and policymakers with important insights into the use of effective EMA practices in achieving sustainable cotton farming. The findings of this thesis highlight the most critical environmental issues which need immediate attention of the policymakers. The findings also guide farm managers to improve positive attitudes among farm employees towards environmentally friendly farm practices such as EMA through implementing training programs.

CERTIFICATE OF ORIGINALITY

I certify that the work presented in this thesis has not been submitted for a higher degree to any other university or institution. The sources of information used and the extent, to which the work of others has been utilised, are acknowledged in the thesis. The thesis has also received the approval of the Ethics Review Committee (Human Research) at Macquarie University (Reference: 5201600730) (see Appendix 1 and 2 at end of this thesis).

Shamim Tashakor

Date

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I would also like to thank the participants of the 16th Australasian Centre for Social and Environmental Accounting Research (A-CSEAR) Conference in Nadi, Fiji, December 2017, for their comments on the earlier version of paper 2 of this thesis. I am also grateful to Professor Lee Parker, the Chief Editor of the "Accounting, Auditing and Accountability Journal" and the two anonymous reviewers for their valuable comments on this paper. This paper is accepted by the "Accounting, Auditing and Accountability Journal".

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DEDICATION

I would like to dedicate this thesis to my beloved mother for her unconditional love, endless support and encouragement.

LIST OF TABLES

CHAPTER FOUR

CHAPTER FIVE

LIST OF FIGURES

CHAPTER ONE

CHAPTER TWO

CHAPTER THREE

CHAPTER FOUR

CHAPTER FIVE

LIST OF ABBREVIATIONS

BCI	Better Cotton Initiative
CO^2	Carbon dioxide
CRDC	Cotton Research and Development Corporation
EMA	Environmental Management Accounting
FAOUN	Food and Agriculture Organization of the United Nations
FWAG	Farming and Wildlife Advisory Group
GHG	Greenhouse Gas
GM	Genetically modified
GRI	Global Reporting Initiatives
ha	Hectare
IPM	Integrated Pest Management
Kg	Kilogram
m	Meter
N_2O	Nitrous oxide
NSW	New South Wales
OECD	Organisation for Economic Cooperation and Development
QLD	Queensland
SOC	Soil Organic Carbon
t	Tone
TAFE	Technical and Further Education
TPB	Theory of Planned Behaviour
UNDSD	United Nations Division for Sustainable Development
UK	United Kingdom
US	United States of America
WWF	World Wildlife Fund

CHAPTER ONE

OVERVIEW OF THE THESIS

1. 1 INTRODUCTION

The aim of this thesis is to examine whether the use of Environmental Management Accounting (EMA) practices can help farmers increase the performance of cotton farms in Australia. The thesis achieves this aim through three objectives. First, this thesis identifies the critical environmental issues caused by the Australian cotton industry.[1] Second, drawing on the theory of planned behaviour (TPB), the thesis examines the factors that influence the intention of cotton farmers to adopt EMA practices in their farm businesses. Third, drawing on stakeholder theory, this thesis examines the association between the contingent factors, namely expected competitive advantage, perceived stakeholders' concern, farmers' environmental commitment, and the use of EMA practices by cotton farmers. Finally, the study examines the association between the use of EMA practices and the cotton farms' environmental and economic performance in Australia. These objectives are addressed through the three self-contained papers in the thesis.

Cotton is known to be the most common lucrative non-food crop in the world, generating income for over 250 million people around the world (World Wildlife Fund, 2018).[2] Cotton as the backbone of the textile industry is widely used in many other industries, such as the medical, beauty, and food industries (Cotton Australia, 2018c; Zhou et al., 2014). It is the most widely produced natural fibre globally representing about 31 per cent of the world textile market (Cotton Australia, 2014).

Australia produces high-quality cotton[3] as one of the main cotton producers[4] (e.g. China, India, the US, Pakistan and Brazil) in the world (Statista, 2016). The high yields of Australian cotton are enough to clothe 500 million people (Cotton Australia, 2014). The high-quality cotton produced by the Australian cotton farmers is greatly in demand by the global market for the production of quality yarns for use in the woven and knitted apparel

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[1] By "cotton industry", this thesis refers to the "cotton farming" phase, which includes two stages – purchase of input and growing the cotton seeds. This phase is mainly undertaken in Australia, with over 99% of the cotton being exported overseas (Cotton Australia, 2014) (please see also Appendixes 3 and 4 at the end of this thesis).
[2] The full references of all the citations in this chapter are available in the reference list at the end of this chapter on page 17.
[3] Please see Appendix 5
[4] Please see Appendix 6

sector (CottonInfo, 2018). The Australian cotton industry is one of the largest rural export[5] commodities[6] (Kidane, 2005). It exports over 99% of the grown cotton to other countries, such as China, Indonesia, Thailand, South Korea, Bangladesh and Japan, while generating over $2 billion annually and creating jobs in 152 communities (Cotton Australia, 2014; 2018a; 2018b; Williams et al., 2018).

Despite all the benefits that cotton offers to the various industries and to the Australian economy, the production of the crop causes severe environmental issues. It harms the natural resources including water, soil, and air by causing pollution, depletion, and erosion (Bevilacqua et al., 2014; Braunack, 2013; Huang et al., 2017; Tullberg et al., 2018; Williams et al., 2018). The World Wildlife Fund (2018)[7] notes that cotton production methods are not environmentally sustainable, and, eventually, will impact the industry's future production. The World Wildlife Fund (2018) also notes that "Bringing cotton production in line with even minimally acceptable environmental standards is a challenging task".[8] The most noticeable environmental impacts of the cotton production result from the use of agrochemicals (e.g. pesticides), excessive water consumption, and the conversion of habitats to agricultural use (World Wildlife Fund, 2018).

EMA practices are likely to help cotton farmers to minimise the harmful environmental issues caused by farming activities through identification, measurement, analysis and interpretation of the environmental aspects of their farming activities (Burritt et al., 2002). EMA is defined by Ferreira et al. (2010, p. 922) as a practice that "generates, analyses, and uses both financial, and non-financial information, to improve the environmental, and economic performance of a company, and contributes towards a sustainable business". The financial and non-financial information provided by EMA practices may include the cost and amount of water and energy used for irrigating cotton farms or the cost and amount of fuel used for operating agricultural machinery (Jasch, 2009). The use of EMA practices is

[5] Australia is the third largest cotton exporter (please see also Appendix 7).
[6] Cotton exports represent 30-60 per cent of the total agricultural products (Cotton Australia, 2014; 2018a; 2018b; Williams et al., 2018).
[7] The World Wildlife Fund (WWF) is the world's leading conservation organization that aims to protect the future of nature. Working with 100 countries, the WWF involves action at every level from local to global, by providing a foundation in science and ensuring the delivery of innovative solutions that meet the needs of people and nature (WWF, 2018).
[8] The quotation is taken from the World Wildlife Fund webpage.

based on a broad range of tools including measuring and comparing, for example, the amounts of input-output, wastes, and emissions, which help farmers with the identification and assessment of environmental issues, and thereby making environmentally beneficial decisions (Jasch, 2006; Schaltegger, 2018). Accordingly, cotton farmers can adopt EMA practices to enhance the environmental performance and economic performance of their farms.

Different factors could determine the use of EMA practices in organisations. While organisations within more visible environmentally sensitive industries (e.g. mining companies, chemicals and petrochemicals) (De Villiers et al., 2014; Handfield et al., 2005; Lodhia and Hess, 2014; Lodhia and Martin, 2014) are more likely to adopt environmentally sustainable practices, agribusinesses, such as cotton farming, with less visibility, are less likely to use EMA practices in managing their organisations (Handfield et al., 2005). The factors that determine the use of EMA practices could also include the culture, knowledge, expertise, and legal framework in the country (Wickramasinghe and Hopper, 2005).

The theory of planned behaviour (TPB) notes that there are three factors influencing managers' intention to adopt EMA practices, namely attitude, subjective norm, and perceived behavioural control (Ajzen, 2005). A positive *attitude* about the outcome of adopting EMA practices would encourage cotton farmers to adopt such practices on their farms. The *subjective norm,* which is related to the support and encouragement of the farmers' social group and significant parties in their life, could influence the farmers' intention to apply EMA practices. While, the *perceived behavioural control*, which includes the knowledge, abilities and means[9] of the farmers, could be associated with the farmers' intention to use the EMA practices.

Stakeholder theory also notes that factors, such as expected competitive advantage, perceived stakeholders' concern, and managers' environmental commitment, are significant factors associated with the strategic decisions including the use of EMA practices. Farmers' expectation to create *competitive advantage* over their competitors encourages them to use EMA practices on their farms. The farmers' perception that the *stakeholders* are concerned

[9] Including money, access to subsidies, and the ability to obtain loans.

about the wellbeing of the natural environment also encourages them to use EMA practices on their farms. Finally, farmers' values and *commitment* towards the sustainability of the natural environment further encourage them to use EMA practices on their farms. Hence, farmers who expect to create a competitive advantage over their competitors through adopting environmental initiatives, could address stakeholders' concern about the environmental wellbeing by using EMA practices on their cotton farms.

1. 2 MOTIVATION FOR THE RESEARCH

This thesis is motivated by three main factors, as discussed in the following subsections.

1. 2. 1 Sustainability of cotton farming

This thesis is mainly motivated by the need to increase the sustainability of cotton farming. In considering the significance of the environmental issues concerning cotton farming, any effort to enhance the sustainability of this industry is vital. In 2015, the Food and Agriculture Organization of the United Nations (FAOUN)[10] highlighted that despite the design of new programmes aiming for an improvement in the sustainability of this industry, cotton production continues to cause more environmental issues. For example, one of the programmes aiming to minimise the environmental issues was "Integrated pest management (IPM) and control" (FAO, 2015, p. 12). The ongoing environmental damage caused by the industry increases the demand for further research to identify areas where there is a lack of knowledge and to design and develop practices to minimise such damage. Recently, the reports of the FAO (2015), World Wildlife Fund (WWF, 2018), and Better Cotton Initiative (BCI, 2018)[11] strictly call for further research for sustainable cotton production following the significant environmental damage caused by the industry, such as the water crisis and the use of hazardous chemicals (BCI, 2018; FAO, 2015; WWF, 2018). In particular, the FAO (2015, p. 6) notes that "cotton production remains an intensive agricultural commodity in terms of production inputs, e.g. energy, water, fertilizers and pesticides". The report emphasises that innovative "production practices and technologies offer real opportunities

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[10] The Food and Agriculture Organization of the United Nations (FAOUN) is a specific agency of the United Nations that aims to guide international efforts to eliminate hunger (FAO, 2015).
[11] The Better Cotton Initiative (BCI) aims to make global cotton production better for the people who produce it, better for the environment it grows in, and better for the sector's future, by developing Better Cotton as a sustainable mainstream commodity (BCI, 2018).

for improving the environmental and social impacts of global cotton production" and highlights that "managing the adoption of such innovations for optimal outcomes will require continued investment in research and farmer education" (FAO, 2015, p. 6).

However, prior studies examining EMA and environmentally friendly practices have paid limited attention to cotton farming and farms' performance in this industry. Such studies have mainly focused on other industries, such as mining and construction, transportation and utilities, manufacturing, wholesale and retails, services, chemicals, pharmaceuticals, food and consumer products (Banerjee et al., 2003; Bansal and Roth, 2000; Chan et al., 2014; Gale, 2006; Gibassier, 2017; Lisi, 2015; Mokhtar et al., 2016). Schaltegger et al. (2013) highlight that the use of EMA can help increase the environmental and financial performance of businesses, such as cotton, which are heavily reliant on natural resources (e.g. soil, water, and air) (Langeveld et al., 2007; Point et al., 2012). In particular, very few studies have examined the role of EMA within the agricultural industry (Burritt et al., 2009). However, since cotton production and export, play a critical role in the Australian economy by contributing to its annual revenue, further research on the sustainability of the industry is beneficial. Therefore, this study aims to address the gap in the literature by examining the use of EMA practices by cotton farmers.

1. 2. 2 EMA practices as a solution to the environmental issues

Many studies have examined certain environmental issues associated with the cotton industry in isolation. For example, while Maraseni et al. (2010) examine Greenhouse Gas (GHG) emissions in cotton production, Hulugalle and Scott (2008) focus on the soil quality in this industry. However, an increasing number of studies call for further research that integrates the key environmental issues including soil erosion, soil salinisation, energy-use efficiency, GHG emissions, water depletion, and water pollution (e.g. Antille et al., 2016; 2018; Hulugalle and Scott, 2008; Hulugalle et al., 2015a; 2015b; Ismail et al., 2011; Roth et al., 2013). This study aims to address this gap in the literature by exploring the key environmental issues caused by cotton farming.

1. 2. 3 The factors determining EMA practices

Behavioural factors are significant determinants of management accounting practices in organisations (Hopper et al., 2009; Wickramasinghe and Hopper, 2005). Hence, researchers have called for an examination of the behavioural factors as the key elements when examining the way EMA is applied in organisations (Ball, 2005; Ball and Craig, 2010; Burritt, 2004; Kaur and Lodhia, 2018). Kaur and Lodhia (2018, p. 343) specifically note that in order to promote environmentally friendly behaviour in the community, such as recycling waste, it is crucial "to understand what encourages people to act in a particular manner before formulating policies and schemes". Prior studies have mainly examined EMA from the lens of the contingency theory (Mokhtar et al., 2016) and institutional theory (Jamil et al., 2015) and have paid limited attention to stakeholder theory and the theory of planned behaviour (TPB), which provide an important foundation in examining behavioural factors (Fielding et al., 2008; Kaur and Lodhia, 2018; Kim, 2014; Lopez-Mosquera and Sanchez, 2012). This study addresses this call for studies by examining the behavioural factors identified by stakeholder theory (expected competitive advantage, perceived stakeholders' concern, and managers' environmental commitment) and TPB (attitude, subjective norm, and perceived behavioural control) in association with the use of EMA practices by cotton farmers.

1. 2. 4 EMA studies in the mainstream accounting field in Australia

The potential benefits of EMA practices in minimising environmental issues and increasing the performance of the organisations are highlighted in prior studies (e.g. Chan et al., 2014; Qian et al., 2018). Studies note that the use of EMA practices is beneficial for all organisations (not only those within environmentally sensitive industries) to gain competitive advantages (Beske, 2012; Evans, 2016; Handfield et al., 2005). The literature review by Schaltegger et al. (2013), however, notes that there is a lack of EMA studies published in mainstream accounting journals. Given the limited number of highly cited publications, EMA still needs to grow as a mainstream field of research (Bartolomeo et al., 2000; Chan et al., 2014; Ferreira et al., 2010). According to Mokhtar et al. (2016, p. 120), "the failure to identify and quantify environmental information can be seen as a barrier to companies in making informed economic decisions". Mokhtar et al. (2016, p. 120) also note that "at the moment, there seems to be a lack of accountants' involvement in companies' environmental undertakings". In particular, very limited studies have focused on the role of EMA practices in Australian organisations. While the use of effective EMA practices can potentially help with the management of scarce resources, such as land and water, in cotton production on a dry continent, such as Australia, prior EMA studies have mainly examined the role of EMA in other countries, such as France, Germany, Italy, the Netherlands, and the

UK (Albertini, 2014; Bartolomeo et al., 2000; Chan et al., 2014), Canada (Gale, 2006), and Greece (Papaspyropoulos et al., 2012). Thus, there is very little knowledge about EMA practices in Australian cotton farming. This study extends the EMA literature by examining the use of EMA practices and its association with farms' performance in Australia.

1. 3 AIM AND OBJECTIVES

The aim of this thesis is to examine whether the use of EMA practices by Australian cotton farmers can improve the environmental and economic performance of cotton farms. In order to achieve this aim, this thesis has the following specific objectives:

I. To review EMA studies for a period of thirty years from 1989 to 2018 to identify different dimensions of EMA used in prior studies.

II. To explore the critical environmental issues caused by the Australian cotton industry for the period 2007 to 2018 based on the integrative literature review approach.

III. To examine the association between the belief-based factors (attitude, subjective norm, and perceived behavioural control) and the farmers' intention to adopt EMA practices.

IV. To investigate the association between the use of EMA practices and the environmental and economic performance in Australian cotton farms. Further, to examine the association between the contingent factors suggested by stakeholder theory, namely expected competitive advantage, perceived stakeholders' concerns, the farmers' environmental commitment, and the use of EMA practices.

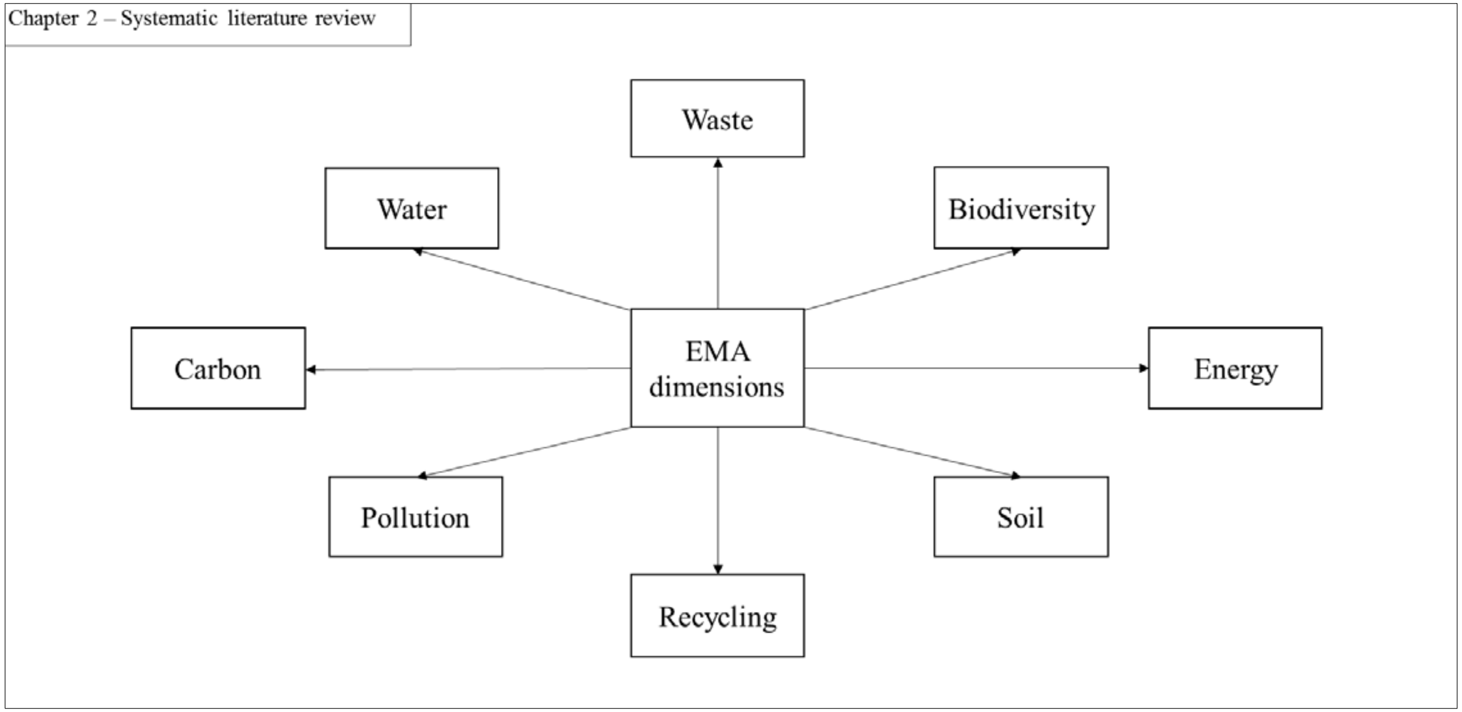
1. 4 OVERVIEW OF THE THREE PAPERS

This thesis examines the use of EMA practices in Australian cotton farming. This thesis also examines the factors that influence the use of EMA practices by Australian cotton farmers. First, this thesis reviews a body of EMA studies to identify the EMA dimensions used by prior studies (Chapter 2). Figure 1.1 presents the EMA dimensions identified in the review of EMA studies. This thesis also explores the current environmental issues caused by the cotton industry (Paper 1). Further, this thesis examines the influence of belief-based factors, namely attitude, subjective norm, and perceived behavioural control (suggested by TPB) on the intention to adopt EMA practices by cotton farmers (Paper 2). Moreover, this thesis explores the associations between the contingent factors, namely expected competitive advantage, perceived stakeholders' concern, and farmers' environmental commitment (suggested by stakeholder theory), and the use of EMA practices by cotton farmers. Furthermore, the thesis examines the relationship between the use of EMA practices and the performance (environmental and economic) of the Australian cotton farms (Paper 3). Figure 1. 2 presents the link between the three papers in the thesis. Figure 1. 2 also indicates the theoretical framework used in both paper 2 and 3.

This PhD thesis uses the 'thesis by publication'[12] format and comprises three self-contained papers[13] that have already been submitted for publication in highly ranked refereed journals. Each of these papers addresses the objectives identified in Section 1. 3. An overview of each paper is provided below.

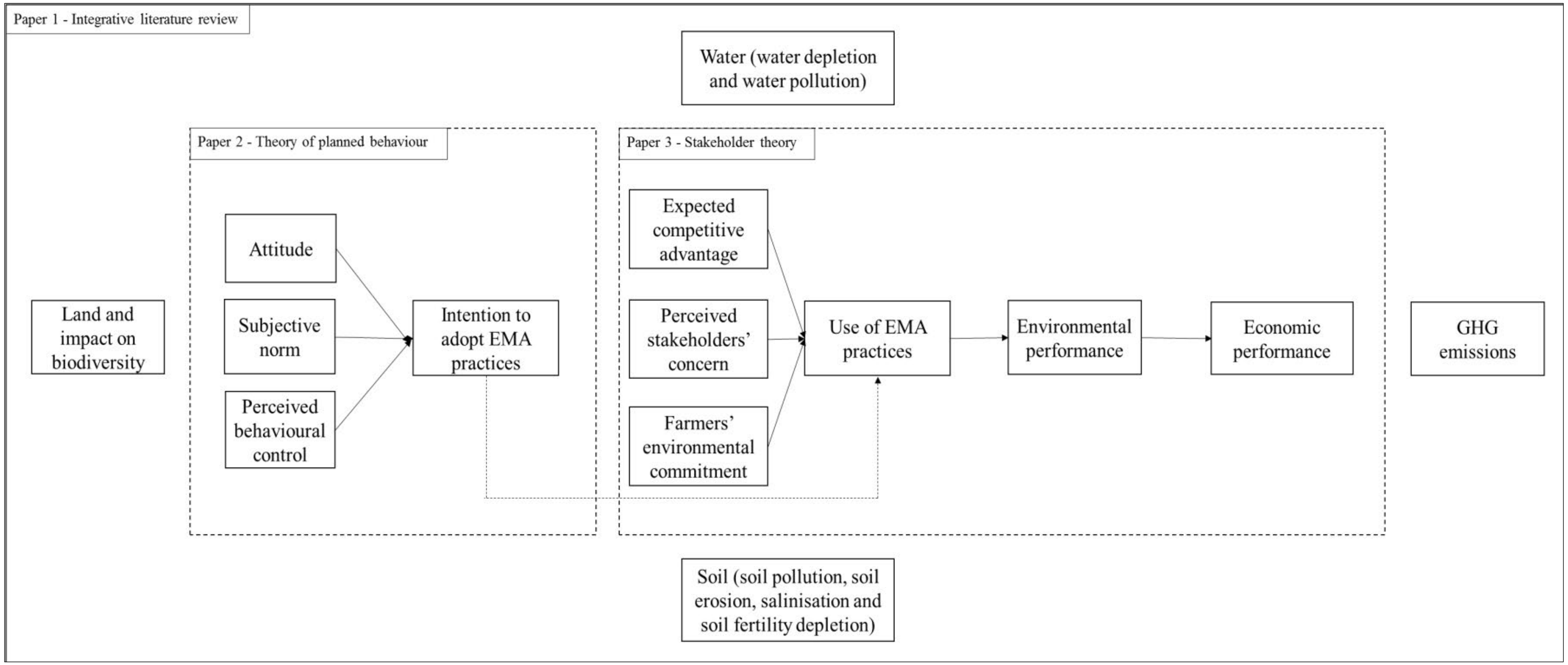
[12] Thesis 'by publication' is Macquarie University's preferred format for higher degree research theses.
[13] This thesis includes three papers and one literature review chapter in addition to the literature review sections for each separate paper.

Figure 1. 1 - A systematic literature review of EMA studies



EMA – Environmental Management Accounting; eight dimensions of EMA identified in the literature review

Figure 1. 2 – Link between the three papers in this thesis



EMA - Environmental Management Accounting

Paper 1: An Integrative Literature Review of the Current Critical Environmental Issues in the Australian Cotton Industry

Paper 1 aims to achieve the second objective of the thesis. The paper reviews the relevant literature to highlight the current critical environmental issues caused by the Australian cotton industry. This paper also aims to identify the areas where there is a lack of knowledge about the critical environmental issues associated with the cotton industry and lays the foundation for further research for a sustainable cotton industry.

Using an integrative literature review technique, this paper critically examines the academic literature published in peer-reviewed journals for a period of twelve years from 2007 to 2018. An integrative literature review combines, critiques and synthesises "the current state of knowledge on a topic" (Neuman, 2006, p. 112). The integrative literature review approach is a critical examination of a specific phenomenon that allows for creating new knowledge based on the data collected from various sources (Torraco, 2005).

The study searched for relevant terms in MultiSearch and captured 52 academic literature for the analysis. Based on the framework developed by the FAO (2015), this paper finds that the current environmental issues caused by the Australian cotton industry can be identified under four main areas such as water, soil, land and biodiversity, and GHG emissions. The review also reveals that while water-related issues (including pollution and depletion) are the most critical issues caused by the industry, the Greenhouse Gas (GHG) emissions have the least impact. Soil-related issues (including soil salinisation, soil fertility depletion, soil pollution and soil erosion), land use and impact on biodiversity found to be the second and third areas of the environmental issues, respectively.

This paper has been submitted to the *Journal of Cleaner Production* and is currently under review.

Table 1. 1 further demonstrates the link between the three papers and the objectives of this thesis.

Paper 2: Environmental Management Accounting Practices in Australian Cotton Farming: The use of the Theory of Planned Behaviour

Paper 2 aims to achieve the third objective of the thesis. Drawing on the theory of planned behaviour (TPB), the paper examines the association between the belief-based factors (attitude, subjective norm, and perceived behavioural control) and the farmers' intention to adopt EMA practices (Ajzen, 1991; 2002; 2005). This paper also examines whether this association varies between the two groups of cotton farmers (more environmentally friendly and less environmentally friendly) based on their attitudes towards the natural environment. This paper uses a survey method to collect data using a sample of the 400 largest cotton farms in Australia and uses the partial least squares (PLS) technique to analyse the data.

This paper finds that while attitude and perceived behavioural control are significantly associated with the farmers' intention to adopt EMA practices, the subjective norm has a significant indirect association with the EMA practices through farmers' attitude and perceived behavioural control. The additional analysis of this paper suggests that while attitude and subjective norm are the primary drivers of intention to adopt EMA practices among the more environmentally friendly farmers, perceived behavioural control is the only driver of intention to adopt EMA practices among the less environmentally friendly group.

This paper has been resubmitted to the *Accounting, Auditing and Accountability Journal* (ABDC journal rank 'A') with minor revision and is currently under review. An earlier version of the paper was presented at the *16th Australasian Centre for Social and Environmental Research (A-CSEAR) Conference* in Fiji, December 2017.

Paper 3: Exploring the Association between Environmental Management Accounting Practices and Farm Performance: Evidence from the Australian Cotton Farms

Paper 3 aims to achieve the fourth objective of the thesis. It examines the association between the use of EMA practices and the environmental and economic performance of cotton farms in Australia. This paper also examines the association between the three contingent factors, namely expected competitive advantage, perceived stakeholders' concerns, and the farmers' environmental commitment suggested by stakeholder theory, and the use of EMA practices by cotton farmers. Further, this paper examines whether there is an indirect association between the farmers' environmental commitment and the use of EMA practices. This paper uses the survey method to collect data from a sample of the 400 largest Australian cotton farms. The study uses the partial least squares (PLS) technique to analyse 92 survey responses.

This paper finds that the use of EMA practices significantly increases the farms' environmental performance, which, in turn, significantly improves the economic performance of cotton farms. This paper also finds that cotton farmers who expect to achieve competitive advantage through environmentally friendly initiatives and perceive that stakeholders are concerned about the sustainability of the natural environment, use EMA practices on their cotton farms. Further, the study finds that farmers' environmental commitment is indirectly associated with the use of EMA practices through expected competitive advantage and perceived stakeholders' concern.

This paper has been submitted to *The European Accounting Review Journal* (ABDC journal rank 'A*') and is currently under review. An earlier version of the paper was presented at the *Accounting and Finance Association of Australia and New Zealand (AFAANZ)* Conference (research interactive session) in Auckland, New Zealand, 2-3 July 2018. This paper was among the 12 papers presented in research interactive sessions. The papers presented in the research interactive sessions were eligible for the Ball and Brown (1968) award if judged to be the best paper.

Table 1. 1 - Research objectives[14] and the three papers of the thesis

	Paper 1
Objective 2	To examine the critical environmental issues caused by the Australian cotton industry by reviewing the key theoretical and empirical literature.
Journal publication	This paper is under review by the *Journal of Cleaner Production.*
	Paper 2
Objective 3	To examine Australian cotton farmers' intentions to adopt EMA practices based on the theory of planned behaviour (TPB).
Journal publication	This paper is accepted by the *Accounting, Auditing and Accountability Journal* (ABDC Rank A).
Conference presentation	**Environmental Management Accounting Practices in Australian Cotton Farming: The use of the Theory of Planned Behaviour** (with Appuhami, R. and Munir, R.) presented at the *16th Australasian Centre for Social and Environmental Accounting Research* (A-CSEAR) Conference in Nadi, Fiji, December 2017.
	Paper 3
Objective 4	To examine the association between EMA practices and environmental and economic performance of the Australian cotton farms. To examine the association between the contingent factors, such as expected competitive advantage, perceived stakeholders' concerns, farmers' environmental commitment, and the use of EMA practices.
Journal publication	This paper is under review by *The European Accounting Review Journal* (ABDC Rank A*).
Conference presentation	**Exploring the Association between Environmental Management Accounting Practices and Farm Performance: Evidence from the Australian Cotton Farms** (with Appuhami, R. and Munir, R.) presented at the *Accounting and Finance Association of Australia and New Zealand (AFAANZ)(research interactive session)* Conference in Auckland, New Zealand, July 2018. This paper was among the 12 papers presented in research interactive sessions. The papers presented in the research interactive session were eligible to win the Ball and Brown (1968) award if judged to be the best paper.

[14] Objective 1 is not included in this table. Objective 1 is related to the literature review chapter. This table only includes papers.

1. 5 THESIS ORGANISATION

The thesis is organised into six chapters as set out below. Chapter 2 presents a systematic literature review of the EMA studies. Chapters 3 to 5 comprise the three aforementioned self-contained papers. Each paper is in a journal format including tables, figures and references. Chapter 6 is the concluding chapter, which summarises the findings of the three papers, explains the contributions, draws an overall conclusion, identifies the limitations, and provides suggestions for future research.

Chapter 2	A Systematic Literature Review of the EMA studies for the period 1989-2018
Chapter 3	Paper 1: An Integrative Literature Review of the Current Critical Environmental Issues in the Australian Cotton Industry
Chapter 4	Paper 2: Environmental Management Accounting Practices in Australian Cotton Farming: The use of the Theory of Planned Behaviour
Chapter 5	Paper 3: Exploring the Association between Environmental Management Accounting Practices and Farm Performance: Evidence from the Australian Cotton Farms
Chapter 6	Conclusion

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CHAPTER TWO

LITERATURE REVIEW

ENVIRONMENTAL MANAGEMENT ACCOUNTING: A SYSTEMATIC LITERATURE REVIEW

1. INTRODUCTION

The objective of this chapter is to identify the various dimensions of environmental management accounting (EMA) practices by reviewing prior studies on accounting. This chapter also identifies the various measurements of EMA practices used in prior studies. The EMA dimensions and the measurements of EMA practices identified through this review helped develop the survey questions in paper 2 and paper 3 of this thesis concerning EMA practices in Australian cotton farms. The study uses a systematic literature review approach to examine a body of 63 studies published in leading accounting journals (ABDC ranked A and A*) [15] for a period from 1989 to 2018. A systematic literature review approach helps researchers to examine the "existing intellectual territory", and to draw a specific research question to further expand the "body of knowledge" (Tranfield et al., 2003, p 208).[16]

Environmental accounting, and, more specifically, EMA are increasingly flourishing in academia and industry. The publication of environmental information attracts considerable attention from academics due to the increasing need for knowledge about environmental sustainability (Passetti et al., 2018). The publication of environmental information by industry is mainly due to the growing demand from various stakeholders following a number of environmental crises caused by various organisations (e.g. BP oil spill in the Gulf of Mexico) (Sammarco et al., 2013). Although non-empirical studies on EMA studies began about three decades ago (e.g. Lehman, 1995; Rubenstein, 1992), empirical studies on EMA emerged following the reckless acts of certain organisations that threatened the well-being of the natural environment (Bartolomeo et al., 2000; Bouma et al., 2000). While some studies merely focussed on one dimension of EMA, such as carbon accounting (e.g. Moore and McPhail, 2016), or water accounting (e.g. Chalmers et al., 2012; Christ, 2014; Tello et al., 2016), others covered more dimensions, such as water, carbon, energy, and biodiversity (e.g. Chan et al., 2014; Gibassier, 2017; Parker and Chung, 2018; Passetti et al., 2018; Qian et al., 2011).

However, prior studies have not fully explored all the dimensions of EMA practices and their changes over the last 30 years. Thus, this review fills the gap in the literature by

[15] Australian Business Deans Council (ABDC) is a ranking system developed by the national council, which includes Deans, Heads and Directors of Australian University business faculties and schools (Hall, 2011).
[16] The full references of all the citations in this chapter are available in the reference list at the end of this chapter on page 59.

identifying the EMA dimensions and EMA measurements based on a systematic literature review approach.

The next section describes the research method. Section 3 presents the results of the bibliometric and descriptive analysis. Finally, Section 4 presents the conclusion including some implications and limitations, and discusses future research opportunities.

2. RESEARCH METHOD

The chapter uses a systematic literature review approach to investigate and identify the dimensions of EMA practices used in prior studies for the period from 1989 to 2018. One of the main differences between a traditional narrative literature review and a systematic literature review is that a systematic literature review is a "comprehensive, unbiased search" that is considered to be "the most efficient and high-quality method for identifying and evaluating extensive literatures" (Tranfield et al., 2003, p. 215). While a traditional narrative review simply uses a body of literature regardless of the source, year, methodology, and type, a systematic literature review is a key instrument that assists researchers to systematically identify, evaluate, and interpret the current body of documented studies (Fink, 1998) for "a specific academic inquiry" (Tranfield et al., 2003, p 208).

The most acceptable approach in the literature review is gathering related data to the field and evaluating it through different outlooks, such as methodology, context, and year (Ansari and Kant, 2017). This literature review follows the systematic literature review approach proposed by Tranfield et al. (2003). Tranfield et al. (2003) identify three steps of a systematic literature review such as *planning*, *conducting* the review, and *reporting* the findings of the review. This approach has been used by many other studies (e.g. Ansari and Kant, 2017; Schmidt and Günther, 2016; Stechemesser and Guenther, 2012). The three steps are given below:

Step 1. Planning the review

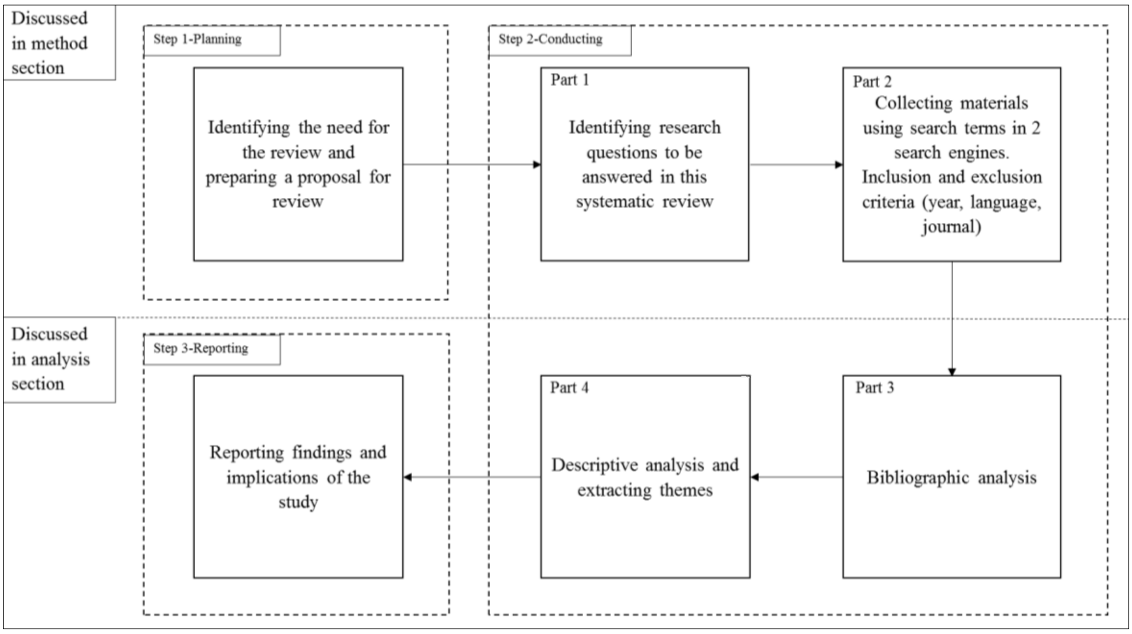
The planning step included identifying the need for a review, the preparation of a proposal[17] for review, and the development of a review protocol.[18] The review was carefully planned for a clear scope, as well as the inclusion and exclusion criteria (see below conducting step).

The review designed a proposal and planned to use search engines, including SCOPUS and Google Scholar, to collect relevant literature. The SCOPUS database is known for its wide coverage of peer-reviewed academic literature, and the use of Google Scholar allows for capturing any relevant studies not captured by SCOPUS. The study also planned to select relevant studies related to the last three decades (1989-2018) using certain search terms in the 'Title'. Further, the study only focused on leading accounting journals (ABDC ranked A and A*) to maintain the quality of the content.

Figure 2. 1 presents the three steps undertaken in the literature review. As illustrated in Figure 2. 1, while the research method section covers step 1 and step 2 (part 1 and 2 only), which are related to the selection of the relevant literature, the analysis section covers step 2 (parts 3 and 4 only) and step 3, which are related to the analysis process.

[17] The proposal is the initial plan to help the author to maintain the objectivity by providing a clear step-by-step direction (Tranfield et al., 2003).
[18] The protocol contains all the relevant information about the review including the specific research question, the target population/sample to be used for data collection, the strategy to collect relevant information as well as the inclusion/exclusion criteria (Tranfield et al., 2003).

Figure 2. 1 – Steps undertaken in the systematic literature review



Step 2. Conducting the review (including material collection, analysis, and evaluation)

This step included identification of the research questions, selection of relevant studies, quality assessment, data extraction, and monitoring progress and data synthesis. The step includes four parts.

Part 1 involved designing research questions; the questions identified for the review are given below:

1. What are the dimensions of EMA?
2. To what extent were the EMA dimensions used in prior studies?
3. How have the EMA dimensions changed over time?
4. What EMA measurements have been used in prior studies?

Part 2 involved selecting specific search terms and criteria to search using search engines, thereby identifying studies for the purpose of review. Following prior EMA studies (e.g. Schaltegger et al., 2013)[19] the review used terms, such as "environmental management

[19] Schaltegger et al. (2013) have also undertaken a similar study. However, that is different from this study for various reasons. First, Schaltegger et al. (2013) examined literature covering the period from 1973 to 2011. This review is more up to date as it covers the period from 1989 to 2018. Second, the objectives of the two reviews are different. The objective of this review is to identify EMA dimensions used and cited in prior studies.

accounting", "environmental management", "environmental accounting", "water accounting", "water management accounting", "waste accounting", "green accounting", "carbon accounting", "sustainability accounting", "full cost accounting", "triple bottom line accounting", "material flow cost accounting", "ecological accounting", "eco-control", "total cost assessment", and "sustainability balanced scorecard" in the title of the studies to capture the relevant studies (see Table 2. 1). Such title search helped the review to capture studies related to EMA. This part also included the use of the inclusion and exclusion criteria in the material collecting process. The use of the criteria in the review is discussed below:

Inclusion criteria

The study used four inclusion criteria. Criteria 1: initial search based on key terms identified in previous step on SCOPUS resulted in over 500 materials including journal articles, book chapters, and conference proceedings from various sources, fields, and languages. However, the study included only papers published in the leading (ABDC ranked A and A*) accounting journals. Criteria 2: the review only included studies published during the last three decades because EMA is a relatively newly emerged topic. Criteria 3: to minimise missing any important information due to the translation error, the study only included articles written in English. Criteria 4: the study used Google Scholar to search for relevant studies that were not captured by the SCOPUS search. Using the same criteria, the study found 19 studies of which 12 overlapped with the SCOPUS search. The study only included seven of the 19 studies captured from Google Scholar.

Exclusion criteria

The study used three exclusion criteria. Criteria 1: the study excluded unpublished documents, conference proceedings and book chapters from the dataset. Criteria 2: extremely limited studies were found in the period prior to 1989. The review period was limited to the period from 1989 to 2018. Criteria 3: studies dealing with social issues were excluded from the dataset to only consider environmental related studies.

Schaltegger et al. (2013) provided a quantitative overview of the literature. This review focuses only on academic papers published in leading accounting journals (ABDC ranked A and A*). Schaltegger et al. (2013) used papers in academic and professional journals, conference papers, working papers, books, PhD-dissertations and reports. This review focuses only on papers written in English. Schaltegger et al. (2013) used papers written in English, French and German.

The final dataset included 63 academic papers comprising 39 empirical and 24 non-empirical studies published in A and A* ranked accounting journals for the period of 1989 to May 2018. Table 1 shows the number of studies captured using different search terms.

Table 2. 1 – Key terms used to search for studies

Keywords	Articles accessed	%
Environmental management accounting	6	9.52%
Environmental management	13	20.6%
Environmental accounting	22	34.92%
Water accounting	2	3.17%
Water management accounting	1	1.58%
Waste accounting	0	0%
Green accounting	8	12.7%
Carbon accounting	4	6.35%
Sustainability accounting	4	6.35%
Full cost accounting	0	0%
Triple bottom line accounting	0	0%
Material flow cost accounting	0	0%
Ecological accounting	0	0%
Eco-control	2	3.17%
Total cost assessment	0	0%
Sustainability balanced scorecard	0	0%
Overlapped studies	1	1.58%
Total	**63**	**100%**

Step 3. Reporting and disseminating of the findings of the review

This step includes reporting the findings and making recommendations. The findings of the bibliometric analysis and descriptive analysis based on 63 academic papers are outlined in the following sections.

3. ANALYSIS AND DISCUSSION

The review examined the 63 papers based on the bibliometric and descriptive analysis. First, the review undertook a bibliometric analysis of the studies. The purpose of the bibliometric analysis was to analyse studies along various dimensions, such as the year of publication, methodology, journal, country, and industry. The results of the bibliometric analysis are presented in subsection 3. 1. The descriptive analysis focuses on the content of the 63 studies to identify the EMA dimensions and the measurements of EMA practices. The results of the descriptive analysis are presented in subsection 3. 2.

3. 1 Bibliometric analysis

3. 1. 1 EMA studies based on the year and methodology

The review examined the number of publications over three decades (1989-2018). The analysis of the studies based on the year of publication shows how EMA studies have changed over the 30-year period (1989-2018). It also shows the trend of publications during different time periods. The analysis based on the year of publication highlights the time period with the highest and lowest growth (see Table 2. 2).[20]

The published studies include empirical and non-empirical studies. Empirical studies provide empirical evidence based on data collected through research methods including qualitative and quantitative studies using surveys, interviews, content analysis, and experiments. Non-empirical studies refer to the studies that do not involve any empirical tests. In this review, all theoretical studies, debates, and literature reviews are considered as non-empirical. Table 2. 2 below shows that, during the first decade (1989-1998), only four studies were published including one empirical study. During the second decade (1999-2008), the number of publications increased to 16 including 12 empirical studies. In the most recent decade (2009-2018), the number of publications rose further to 43 including 26 empirical studies.

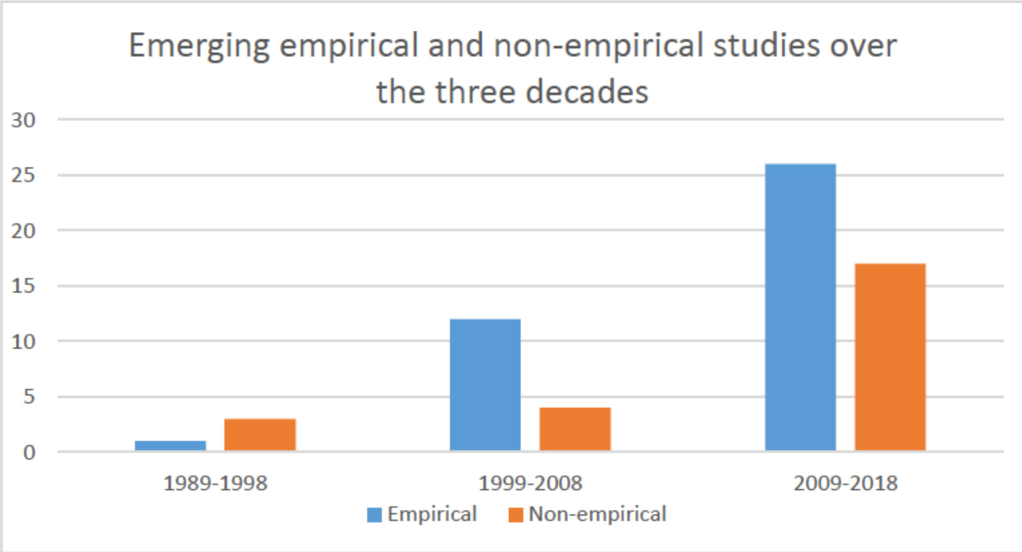
Both empirical and non-empirical studies have increased over the three decades (1989-2018). As illustrated in Figure 2. 2, during the first decade (1989-1998), the EMA studies primarily comprised of non-empirical studies. However, during the last two decades (1999-2008 and 2009-2018) the number of empirical studies increased compared to the non-empirical studies. The increase in the number of empirical studies indicates more awareness about EMA practices suggesting that more organisations applied EMA practices.

Table 2. 2 – Number and type of studies published over three decades

Period	**Empirical**	**Non-empirical**	**No. of papers in total**	**%**
2009-2018	26	17	43	**68.25%**
1999-2008	12	4	16	**25.40%**
1989-1998	1	3	4	**6.35%**
Total No.	**39**	**24**	**63**	**100%**
%	**61.90%**	**38.10%**	**100%**	-

[20] Please see Appendix 1 (Table 1 and Figure 1) for more detailed analysis based on the year.

Figure 2. 2 – Emerging studies during thirty years from 1989 to 2018



3. 1. 2 EMA studies based on academic journals

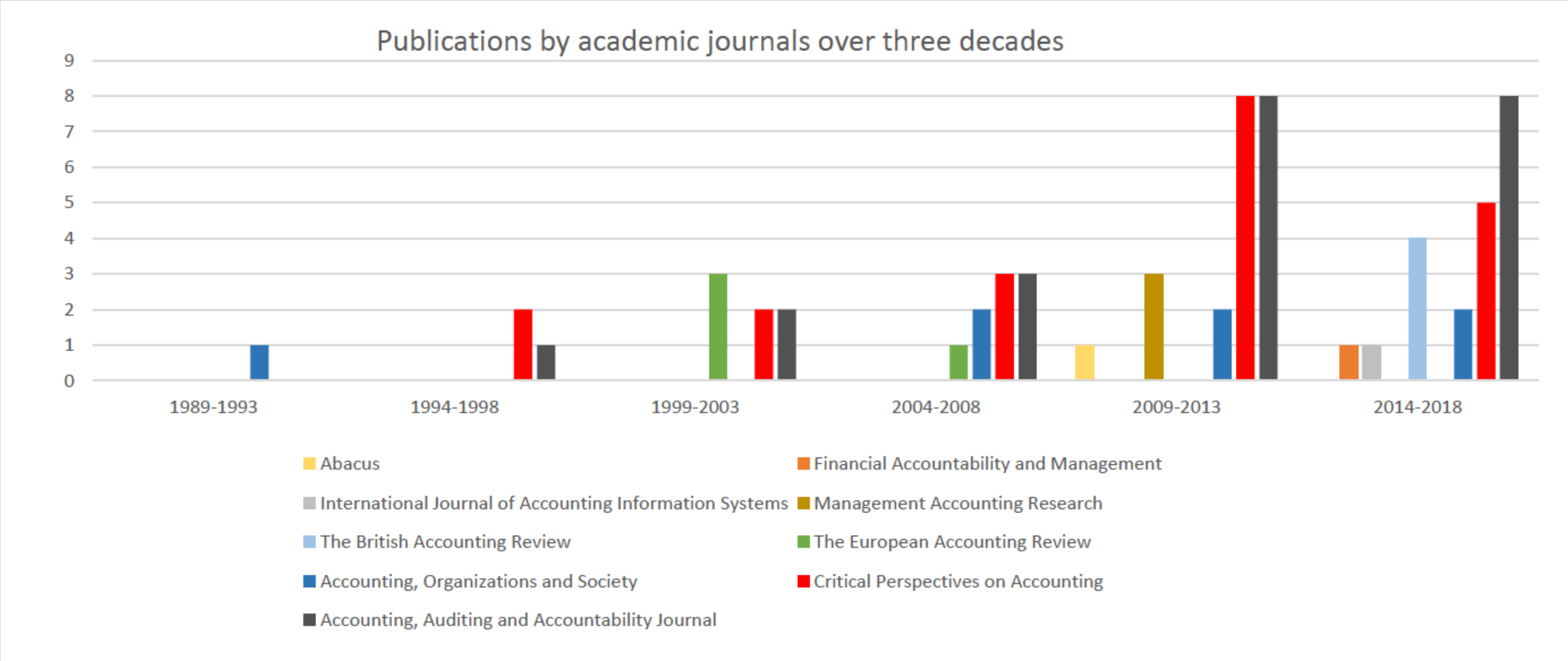
The analysis based on the name of the journals shows the contributions made by each journal towards the knowledge of EMA practices. This analysis shows the number of studies published by each journal over the period of thirty years (1989-2018). As presented in Table 2. 3, "Accounting, Organisations and Society" published the first study related to EMA about thirty years ago, followed by "Critical Perspectives on Accounting" and "Accounting, Auditing and Accountability Journal". In contrast, "Abacus" published its first and only study about ten years ago.

The analysis based on the academic journals also indicates that only two of the leading accounting journals have been actively publishing EMA studies for the last three decades. These journals include "Accounting, Auditing and Accountability Journal" with the highest number of publications of 22 (34.92%), and "Critical Perspectives on Accounting" with 20 (31.75%) publications. A possible reason for the high number of publications by the "Accounting, Auditing and Accountability Journal" could be that it publishes a wide range of articles including multidisciplinary research articles. In contrast, "Abacus", "Financial Accountability and Management" and the "International Journal of Accounting Information Systems" made the least number of publications with only one (1.58%) publication during the last thirty years (see Figure 2. 3).

Table 2. 3 – Publications by academic journals

Journal name	**1989-1993**	**1994-1998**	**1999-2003**	**2004-2008**	**2009-2013**	**2014-2018**	**No. of papers in total**	**%**
Abacus: a journal of accounting, finance and business studies					1		**1**	**1.58%**
Financial Accountability and Management						1	**1**	**1.58%**
International Journal of Accounting Information Systems						1	**1**	**1.58%**
Management Accounting Research					3		**3**	**4.76%**
The British Accounting Review						4	**4**	**6.35%**
The European Accounting Review			3	1			**4**	**6.35%**
Accounting, Organizations and Society	1			2	2	2	**7**	**11.11%**
Critical Perspectives on Accounting		2	2	3	8	5	**20**	**31.75%**
Accounting, Auditing and Accountability Journal		1	2	3	8	8	**22**	**34.92%**
Total	**1**	**3**	**7**	**9**	**22**	**21**	**63**	**100%**
%	**1.58%**	**4.76%**	**11.11%**	**14.29%**	**34.92%**	**33.33%**	**100%**	-

Figure 2. 3 – Growth of publications by academic journals



3. 1. 3 EMA studies based on the country

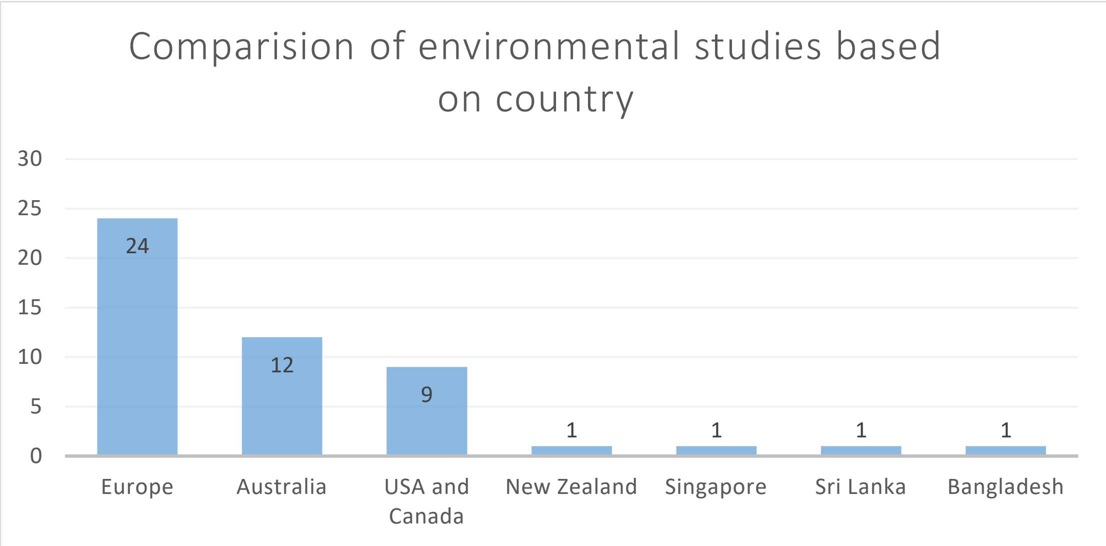
The analysis based on country shows which countries are more active in respect of the contribution to the natural environment and EMA practices. The study undertook this analysis based on the geographical place of data collection for each study. The analysis indicates that while the majority of studies were undertaken in European countries (e.g. the UK, Switzerland, Italy, Spain, France, Germany, the Netherlands, and Belgium), Australia, the US and Canada, the least number of studies were undertaken in other countries, such as New Zealand, Singapore, Sri Lanka, and Bangladesh (see Table 2. 4 and Figure 2. 4). A possible reason for the difference in the number of studies between counties might include cultural values, education, and regulatory requirements, which are different from country to country. Table 2. 4 shows that Australia has undertaken the second most number of studies. A possible reason might be that environmental research is highly promoted in developed countries. For example, governments, academic institutions, and industry bodies provide scholarships and grants for studies related to the natural environment (Department of Environment and Energy, 2018b).

Table 2. 4 – Publications based on country

Country	**No. of studies**
Europe[21]	24
Australia[22]	12
USA and Canada[23]	9
New Zealand	1
Singapore	1
Sri Lanka	1
Bangladesh	1

[21] European countries include the UK, Switzerland, Italy, Spain, France, Germany, the Netherlands, and Belgium. For the purpose of this review all these countries are considered as one.
[22] Please see Appendix 2 for more details about the studies in Australia.
[23] For the purpose of this review the US and Canada are considered as one.

Figure 2. 4 – Publications based on country[24]



3. 1. 4 EMA studies based on the industry

The analysis based on the industry shows the level of attention paid by researchers to various industries in undertaking studies related to EMA. The impact of each industry on the environment is different because the activities of each industry are different. While some industries are less environmentally sensitive and less visible due to their lower impact on the environment (Cho and Patten, 2007), other industries, which are classified as environmentally sensitive, seem to be more environmentally destructive and subject to more disclosure requirements (Cho and Patten, 2007; Handfield et al., 2005).

For the purpose of this analysis, the review used the Global Industry Classification Standard (GICS)[25] (Market Index, 2018) to classify the industry sectors used for data collection by the studies. The analysis indicates that while some sectors have attracted more attention from researchers (e.g. materials, utilities, and energy), other sectors have received less or no attention (e.g. real estates, telecommunication services, and information technology). Such different levels of attention between industry sectors suggest that the more visible industry sectors (e.g. materials, utilities, and energy) are more likely to use EMA practices due to their harmful environmental impact. Figure 2. 5 below shows the number of studies focusing

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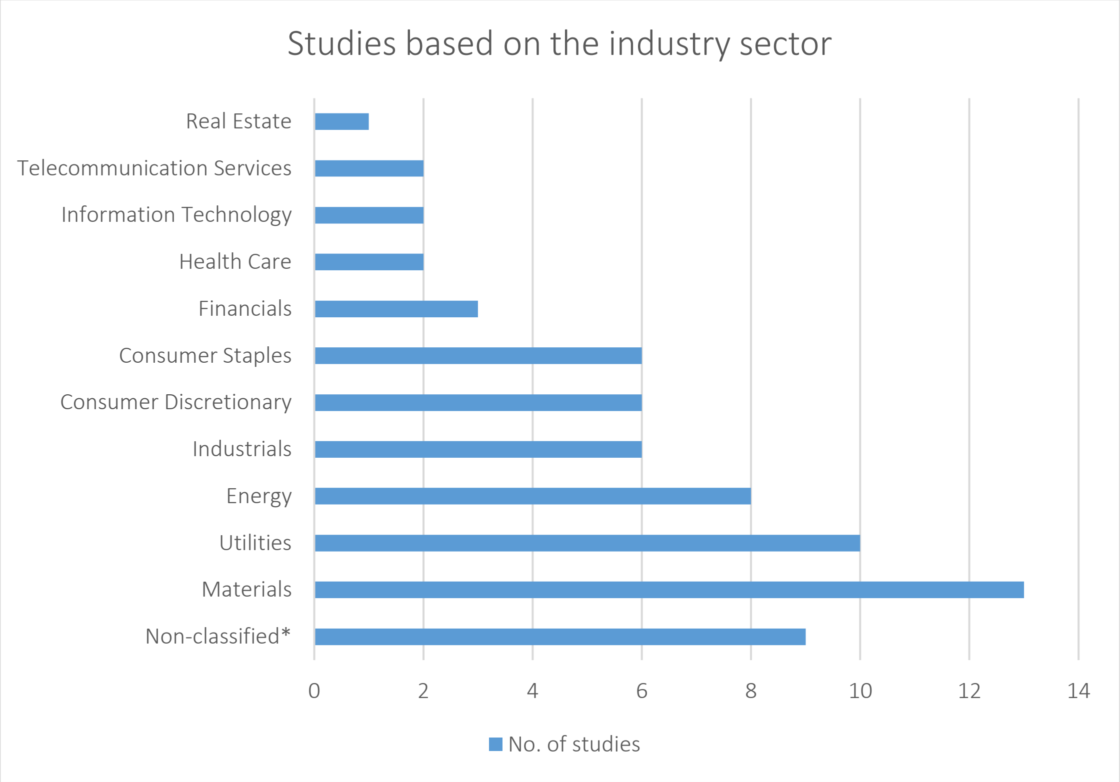
[24] Studies that collected data from two or more countries were counted towards those relevant countries accordingly. One study only mentioned "worldwide" with no specific country name. That study is not included in this graph.

[25] Please see Appendix 3 for details.

on each industry sector. It also shows the most and the least examined industry sectors in the reviewed studies.

Figure 2. 5 – Number of studies based on the industry sector



* Non-classified industries include local governments/councils (6 studies), ship-breaking industry (1 study), energy conservation, recycling waste and paper, lead-free petrol, and catalytic converters (1 study), which could not be added to any other group.

3. 2 Descriptive analysis

This section presents the descriptive analysis used to identify and extract various dimensions of EMA practices and the measurements of EMA practices used in prior studies. For the purpose of this review, the analysis identified eight dimensions of EMA based on the 63 reviewed papers. During the review, it was found that no study used detailed classification of the various dimensions of EMA. Although environmental related classifications are available (e.g. Global Reporting Initiatives (GRI)), such classifications do not provide detailed classifications related to the environmental costs, and, hence, cannot be applied to identify all the possible dimensions of EMA practices. In this regard, Schaltegger (2018) also notes that no study covers all the dimensions related to EMA. In this literature review, while some studies have identified as little as one dimension of EMA (e.g. Contrafatto and Burns, 2013), other studies have cited as many as seven (e.g. Passetti et al., 2014).

Table 2. 5 below shows the eight dimensions identified through this review and the extent to which these dimensions are cited in prior studies. Table 2. 5 also shows that while EMA practices on waste are the most cited dimension, EMA practices on soil are the least cited dimension. Table 2. 5 further shows the frequency of dimensions cited by the reviewed studies. Each dimension represents one element of EMA practices that needs to be considered in minimising the environmental impact of the activities of organisations.

EMA is defined by Jasch (2003, p. 668) as "a combined approach which provides for the transition of data from financial accounting, cost accounting and material flow balances to increase material efficiency, reduce environmental impact and risk and reduce costs of environmental protection". Ferreira et al. (2010, p. 922) also define EMA as "a technique that generates, analyses, and uses both financial, and non-financial information, to improve the environmental, and economic performance of a company, and contributes towards a sustainable business". According to previous studies "merely" identifying waste is also to be considered an EMA practice (Burritt and Schaltegger, 2002; Ferreira et al., 2010; Frost and Wilmshurst, 2000). Thus, following previous studies, the EMA practices in this review include identifying, measuring, analysing, and interpreting both the financial and non-financial data related to environmental business activities (Burritt and Schaltegger, 2002; Ferreira et al., 2010; Frost and Wilmshurst, 2000). In this thesis, EMA is considered to be a set of practices that an organisation uses with the aim of generating both financial information (e.g. cost of air, water, and soil pollution) and non-financial information (e.g. the quantity of material, water, and energy usage) to minimise the environmental impact of organisational activities. The non-financial information of EMA practices could also include identification, measurement, analysis, and interpretation of environmental business activities, such as input resources and pollution (e.g. number of wastewater recycles) (Burritt and Schaltegger, 2002; Ferreira et al., 2010; Jasch, 2003; 2009). The following sub-sections present each dimension of EMA practices.

Table 2. 5 – EMA dimensions

No	Author(s)	Title	Journal	Method	No. of dimensions	EMA dimensions							
						Pollution	Carbon	Water	Waste	Biodiversity	Energy	Soil	Recycling
1	Passetti, Cinquini and Tenucci (2018)	Implementing internal environmental management and voluntary environmental disclosure: Does organisational change happen	Accounting, Auditing and Accountability Journal	Empirical	6		√	√	√	√	√		√
2	Qian, Burritt and Monroe (2018)	Environmental Management Accounting in Local Government: Functional and Institutional Imperatives	Financial Accountability and Management	Empirical	4			√	√		√		√
3	Kaur and Lodhia (2018)	Stakeholder engagement in sustainability accounting and reporting: A study of Australian local councils	Accounting, Auditing and Accountability Journal	Empirical	3				√		√		√
4	Parker and Chung (2018)	Structuring social and environmental management control and accountability: Behind the hotel doors	Accounting, Auditing and Accountability Journal	Empirical	5		√	√	√		√		√
5	Heggen, Sridharan and Subramaniam (2018)	To the letter vs the spirit: A case analysis of contrasting environmental management responses	Accounting, Auditing and Accountability Journal	Empirical	3			√		√		√	
6	Deegan (2017)	Twenty five years of social and environmental accounting research within Critical Perspectives of Accounting: Hits, misses and ways forward	Critical Perspectives on Accounting	Non-empirical	4	√		√		√	√		
7	Gibassier (2017)	From écobilan to LCA: The elite's institutional work in the creation of an environmental management accounting tool	Critical Perspectives on Accounting	Empirical	5		√	√	√		√		√
8	Lehman (2017)	The language of environmental and social accounting research: The expression of beauty and truth	Critical Perspectives on Accounting	Non-empirical	0								
9	Brown and Tregidga (2017)	Re-politicizing social and environmental accounting through Ranci ere: On the value of dissensus	Accounting, Organizations and Society	Non-empirical	1				√				
10	Alawattage and Fernando (2017)	Postcoloniality in corporate social and environmental accountability	Accounting, Organizations and Society	Empirical	1			√					
11	Sullivan and Hannis (2017)	Mathematics maybe, but not money": On balance sheets, numbers and nature in ecological accounting	Accounting, Auditing and Accountability Journal	Empirical	4	√	√	√			√		

12	Russell, Milne and Dey (2017)	Accounts of nature and the nature of accounts: Critical reflections on environmental accounting and propositions for ecologically informed accounting	Accounting, Auditing and Accountability Journal	Non-empirical	5	√	√	√	√		√		
13	Dillard, Yuthas and Baudot (2016)	Dialogic framing of accounting information systems in social and environmental accounting domains: Lessons from, and for, microfinance	International Journal of Accounting Information Systems	Empirical	0								
14	Journeault, De Ronge and Henri (2016)	Levers of eco-control and competitive environmental strategy	The British Accounting Review	Empirical	4	√			√		√		√
15	Tello, Hazelton and Cummings (2016)	Potential users' perceptions of general purpose water accounting reports	Accounting, Auditing and Accountability Journal	Empirical	3		√	√		√			
16	Moore and McPhail (2016)	Strong structuration and carbon accounting: A position-practice perspective of policy development at the macro, industry and organizational levels	Accounting, Auditing and Accountability Journal	Empirical	3		√	√			√		
17	Roberts and Wallace (2015)	Sustaining diversity in social and environmental accounting research	Critical Perspectives on Accounting	Non-empirical	0								
18	Belal, Cooper and Khan (2015)	Corporate environmental responsibility and accountability: What chance in vulnerable Bangladesh?	Critical Perspectives on Accounting	Empirical	5	√	√	√	√			√	
19	Christ (2014)	Water management accounting and the wine supply chain: Empirical evidence from Australia	The British Accounting Review	Empirical	3			√	√			√	
20	Chan, Wang and Raffoni (2014)	An integrated approach for green design: Life-cycle, fuzzy AHP and environmental management accounting	The British Accounting Review	Empirical	6	√		√	√		√	√	√
21	Passetti, Cinquini, Marelli and Tenucci (2014)	Sustainability accounting in action: Lights and shadows in the Italian context	The British Accounting Review	Empirical	7	√	√	√	√	√	√		√
22	Contrafatto and Burns (2013)	Social and environmental accounting, organisational change and management accounting: A processual view	Management Accounting Research	Empirical	1			√					
23	Deegan (2013)	The accountant will have a central role in saving the planet . . . really? A reflection on 'green accounting and green eyeshades twenty years later'	Critical Perspectives on Accounting	Non-empirical	5	√	√	√	√		√		
24	Figge and Hahn (2013)	Value drivers o corporate eco-efficiency: Management accounting information for the efficient use of environmental resources	Management Accounting Research	Empirical	2		√				√		
25	Gray (2013)	Back to basics: What do we mean by environmental (and social) accounting and what is it for?—A reaction to Thornton	Critical Perspectives on Accounting	Non-empirical	4	√	√		√		√		
26	Pondeville, Swaen, and De Rongé (2013)	Environmental management control systems: The role of contextual and strategic factors	Management Accounting Research	Empirical	1	√							

27	Thornton (2013a)	Green accounting and green eyeshades twenty years later	Critical Perspectives on Accounting	Non-empirical	1	√							
28	Hartmann, Perego and Young (2013)	Carbon Accounting: Challenges for Research in Management Control and Performance Measurement	Abacus	Non-empirical	4	√	√		√		√		
29	Spence, Chabrak and Pucci (2013)	Doxic sunglasses: A response to ‘‘Green accounting and Green Eyeshades: Twenty years later’’	Critical Perspectives on Accounting	Non-empirical	1	√							
30	Thornton (2013b)	Green accounting and green eyeshades twenty years later rejoinder to critics	Critical Perspectives on Accounting	Non-empirical	0								
31	Cho and Patten (2013)	Green accounting: Reflections from a CSR and environmental disclosure perspective	Critical Perspectives on Accounting	Non-empirical	2	√		√					
32	Chalmers, Godfrey and Lynch (2012)	Regulatory theory insights into the past, present and future of general purpose water accounting standard setting	Accounting, Auditing and Accountability Journal	Empirical	1			√					
33	Gray and Laughlin (2012)	It was 20 years ago today: Sgt Pepper, Accounting, Auditing and Accountability Journal, green accounting and the Blue Meanies	Accounting, Auditing and Accountability Journal	Non-empirical	2		√		√				
34	Qian, Burritt and Monroe (2011)	Environmental management accounting in local government: A case of waste management	Accounting, Auditing and Accountability Journal	Empirical	5	√		√	√		√		√
35	Bowen and Wittneben (2011)	Carbon accounting: Negotiating accuracy, consistency and certainty across organisational fields	Accounting, Auditing and Accountability Journal	Empirical	2		√				√		
36	Ascui and Lovell (2011)	As frames collide: Making sense of carbon accounting	Accounting, Auditing and Accountability Journal	Non-empirical	2		√				√		
37	Zaman Mir and Shiraz Rahaman (2011)	In pursuit of environmental excellence: A stakeholder analysis of the environmental management strategies and performance of an Australian energy company	Accounting, Auditing and Accountability Journal	Empirical	4	√		√	√		√		
38	Ferreira, Moulang and Hendro (2010)	Environmental management accounting and innovation: An exploratory analysis	Accounting, Auditing and Accountability Journal	Empirical	4	√	√				√		√
39	Henri and Journeault (2010)	Eco-control: The influence of management control systems on environmental and economic performance	Accounting, Organizations and Society	Empirical	6	√		√	√	√	√		√
40	Burritt and Schaltegger (2010)	Sustainability accounting and reporting: Fad or trend?	Accounting, Auditing and Accountability Journal	Non-empirical	3		√		√		√		
41	Ball and Craig (2010)	Using neo-institutionalism to advance social and environmental accounting	Critical Perspectives on Accounting	Empirical	3				√		√		√
42	Spence, Husillos and Correa-Ruiz (2010)	Cargo cult science and the death of politics: A critical review of social and environmental accounting research	Critical Perspectives on Accounting	Non-empirical	0								
43	Lohmann (2009)	Toward a different debate in environmental accounting: The cases of carbon and cost–benefit	Accounting, Organizations and Society	Non-empirical	4	√	√	√			√		
44	Burnett and Hansen (2008)	Ecoefficiency: Defining a role for environmental cost management	Accounting, Organizations and Society	Empirical	4	√		√	√		√		

45	Owen (2008)	Chronicles of wasted time?: A personal reflection on the current state of, and future prospects for, social and environmental accounting research	Accounting, Auditing and Accountability Journal	Non-empirical	0								
46	Ball (2007)	Environmental accounting as workplace activism	Critical Perspectives on Accounting	Empirical	4	√			√	√			√
47	Albelda Pérez, Correa Ruiz and Carrasco Fenech (2007)	Environmental management systems as an embedding mechanism: A research note	Accounting, Auditing and Accountability Journal	Empirical	3	√			√				√
48	Herbohn (2005)	A full cost environmental accounting experiment	Accounting, Organizations and Society	Empirical	3			√		√		√	
49	Ball (2005)	Environmental accounting and change in UK local government	Accounting, Auditing and Accountability Journal	Empirical	5	√	√		√		√		√
50	Ball (2004)	A sustainability accounting project for the UK local government sector? Testing the social theory mapping process and locating a frame of reference	Critical Perspectives on Accounting	Empirical	1				√				
51	Everett (2004)	Exploring (false) dualisms for environmental accounting praxis	Critical Perspectives on Accounting	Non-empirical	1		√						
52	Antheaume (2004)	Valuing external costs – from theory to practice: Implications for full cost environmental accounting	European Accounting Review	Empirical	4	√	√	√	√				
53	Jones (2003)	Accounting for biodiversity: Operationalising environmental accounting	Accounting, Auditing and Accountability Journal	Empirical	0								
54	Larrinaga-Gonzalez and Bebbington (2001)	Accounting change or institutional appropriation?—A case study of the implementation of environmental accounting	Critical Perspectives on Accounting	Empirical	2	√			√				
55	Lehman (2001)	Reclaiming the public sphere: Problems and prospects for corporate social and environmental accounting	Critical Perspectives on Accounting	Non-empirical	0								
56	Bartolomeo, Bennett, Bouma, Heydkamp, James and Wolters (2000)	Environmental management accounting in Europe: Current practice and future potential	European Accounting Review	Empirical	5	√	√	√	√		√		
57	Collison and Slomp (2000)	Environmental accounting, auditing and reporting in Europe: The role of FEE	European Accounting Review	Non-empirical	1	√							
58	Bouma and Kamp-Roelands (2000)	Stakeholders expectations of an environmental management system: Some exploratory research	European Accounting Review	Empirical	3	√			√			√	
59	Boyce (2000)	Public discourse and decision making: Exploring possibilities for financial, social and environmental accounting	Accounting, Auditing and Accountability Journal	Empirical	2						√		√
60	Gallhofer and Haslam (1997)	The direction of green accounting policy: Critical reflections	Accounting, Auditing and Accountability Journal	Non-empirical	0								
61	Lehman (1995)	A legitimate concern for environmental accounting	Critical Perspectives on Accounting	Non-empirical	0								

62	Gray, Walters, Bebbington and Thompson (1995)	The greening of enterprise: An exploration of the (non) role of environmental accounting and environmental accountants in organisational change	Critical Perspectives on Accounting	Empirical	0								
63	Rubenstein (1992)	Bridging the gap between green accounting and black ink	Accounting, Organizations and Society	Non-empirical	3	√		√	√				
		Total				**29**	**23**	**28**	**31**	**8**	**29**	**6**	**16**

3. 1 Environmental management accounting (EMA) practices on waste

Waste refers to the unwanted substance produced during and after the process of producing the main products. Gale (2006, p. 1243) notes that "whatever has not left the company as a product is a sign of inefficient production and must by definition be waste and emissions". Waste produced as a result of industrial activities could be in the form of gas, liquid, or solid (including unused raw material), which may or may not be hazardous to the natural environment (Donev et al., 2015). Hazardous waste can threaten the quality of the air, water and soil, and endanger the lives of animals and humans. Studies note that waste can be minimised by increasing efficiency (Chan et al., 2014; Gale, 2006; Journeault et al., 2016). Based on the analysis, the following practices (measures)[26] of waste dimension of EMA have been identified (see Table 2. 6 below).[27]

Table 2. 6 – EMA practices on the waste dimension

Practices	Author(s)
• Identifying waste minimisation schemes	Bartolomeo et al. (2000)
• Measuring the costs of waste handling	Bouma and Kamp-Roelands (2000)
• Identifying Life Cycle Assessment (LCA) generation of waste material	Chan et al. (2014)
• Estimating the costs of production efficiency • Measuring the costs of material consumption • Measuring the amount of material consumption • Measuring the costs of waste management	Journeault et al. (2016)
• Identifying recycling wastewater	Zaman Mir and Shiraz Rahman (2011)

EMA practices on waste have been cited in most prior empirical and non-empirical studies. 31 of 63 reviewed studies cited EMA practices on waste. A chronology shows that the first study citing EMA practices on waste was undertaken in the first decade (1989-1998) and nine studies during the second decade (1999-2008) (see Table 2. 7). Most studies citing EMA practices on waste have been undertaken during the last decade (2009-2018) (21 citations). A possible reason for this increase could be that awareness about the environmental issues associated with waste had increased during this time period (see Table 2. 7).

[26] The terms "practices" and "measures" are used interchangeably in this literature review.
[27] See also Appendix 4 for a complete measures of EMA practices.

Table 2. 7 – EMA dimensions based on the year

EMA dimensions	Year						Total
	1989-1993	1994-1998	1999-2003	2004-2008	2009-2013	2014-2018	
EMA practices on waste	1	0	3	6	9	12	31
EMA practices on pollution	1	0	3	5	11	9	29
EMA practices on energy	0	0	2	2	13	12	29
EMA practices on water	1	0	1	3	8	15	28
EMA practices on carbon	0	0	1	3	10	9	23
EMA practices on recycling	0	0	1	3	4	8	16
EMA practices on biodiversity	0	0	0	2	1	5	8
EMA practices on soil	0	0	1	1	0	4	6

Studies examining the EMA practices on waste have focused on all 11 industry sectors[28] (see Table 2. 8). Industry sectors, such as materials (8 citations), energy (6 citations), and utilities (6 citations) constitute the highest number of studies on the waste dimension of EMA. A possible reason for EMA studies focusing on these industry sectors could be that these industry sectors are among the more visible environmentally sensitive industry sectors (Cho and Patten, 2007). In contrast, real estate, telecommunication services, and financials have received limited attention (1 citation) by studies on the waste dimension due to the lower disclosure requirements (Cho and Patten, 2007).

Table 2. 8 – EMA dimensions based on the industry sector

EMA dimensions	industry sectors											
	Energy	Materials	Industrials	Consumer Discretionary	Consumer Staples	Health Care	Financials	Information Technology	Telecommunication Services	Utilities	Real Estate	Non-classified
EMA practices on waste	6	8	4	4	5	2	1	2	1	6	1	8
EMA practices on pollution	5	8	5	4	3	1	1	2	1	6	1	4
EMA practices on energy	3	8	4	6	4	2	1	2	1	5	1	5
EMA practices on water	7	6	3	3	5	2	2	1	2	7	1	3
EMA practices on carbon	3	5	2	4	2	2	0	1	1	4	1	2
EMA practices on recycling	3	8	5	5	4	2	1	2	1	3	1	6
EMA practices on biodiversity	3	4	2	2	1	2	1	1	1	3	1	1
EMA practices on soil	0	2	0	0	2	0	0	0	0	0	0	1

[28] The discussion of the industry sectors is based on 11 industry sectors, as those shown as non-classified in the Table 2. 8 do not relate to any specific industry sector.

Studies citing EMA practices on waste have been undertaken in five countries including Europe[29] (e.g. the UK, Switzerland, Italy, Spain, France, Germany, the Netherlands, and Belgium), Australia, the US and Canada, Singapore, and Bangladesh (see Table 2. 9). The maximum number of studies citing EMA practices on waste was undertaken in Europe (12 citations), whereas the minimum number of studies undertaken was found in the cases of Singapore and Bangladesh (1 citation) and no studies were undertaken in New Zealand and Sri Lanka. Differing cultural values and political requirements in various countries may provide the reasons for this disparity (Hopper et al., 2009; Wickramasinghe and Hopper, 2005). Kaur and Lodhia (2018, p. 343) note that "in order to promote waste recycling behaviour in the community it is necessary to understand what encourages people to act in a particular manner before formulating policies and schemes".

Table 2. 9 – EMA dimensions based on the country

EMA dimensions	Country						
	Europe	Australia	USA & Canada	New Zealand	Singapore	Sri Lanka	Bangladesh
EMA practices on waste	12	6	5	0	1	0	1
EMA practices on pollution	10	5	3	0	0	0	1
EMA practices on energy	10	7	5	0	1	0	0
EMA practices on water	7	9	3	0	1	1	1
EMA practices on carbon	9	3	1	0	1	0	1
EMA practices on recycling	7	5	4	0	1	0	0
EMA practices on biodiversity	2	3	1	0	0	0	0
EMA practices on soil	2	3	0	0	0	0	1

3. 2 Environmental management accounting (EMA) practices on pollution (water, air, and soil)

Pollution is the presence or release of a substance or item with dangerous or toxic effects into the environment (Donev et al., 2015). Pollution is different from waste.[30] Not all waste is necessarily classified as pollution. Donev et al. (2015) highlight that pollution is always harmful, while waste is not always harmful, however, it can be, particularly when it is not disposed of properly. Pollution is usually preventable because it does not always arise from unusable substances. Pollution includes water, air, soil, and noise pollution (Belal et al.,

[29] For the purpose of this study, European countries are considered as one, which includes the UK, Switzerland, Italy, Spain, France, Germany, the Netherlands, and Belgium.
[30] As defined in the previous sub-section, waste is an unwanted substance that is a by-product of a process.

2015; Gray, 2013). The reviewed studies used different EMA practices on pollution (see Table 2. 10).

Table 2. 10 –EMA practices on the pollution dimension

Practices	Author(s)
• Measuring the costs of pollution prevention	Bartolomeo et al. (2000); Ferreira et al. (2010)
• Measuring the costs of preventing environmental incidents	Bouma and Kamp-Roelands (2000)
• Identifying emissions to the air, water, or soil • Measuring anticipated pollution	Chan et al. (2014); Ferreira et al. (2010)
• Identifying Life Cycle Assessment (LCA) generation of pollution	Ferreira et al. (2010)
• Estimating the risk of environmental liabilities and disasters • Measuring the costs associated with fines and litigation	Journeault et al. (2016); Ferreira et al. (2010)
• Measuring the costs of environmental pollution of the business • Estimating the costs of the prevention of pollution • Identifying the need for providing community leadership and exercise environmental due diligence (e.g. on water pollution and air pollution)	Zaman Mir and Shiraz Rahman (2011)

EMA practices on pollution are the second most cited EMA dimension in the reviewed studies. 29 of 63 studies cited EMA practices on the pollution dimension covering the three decades (1989-2018). The oldest study examining pollution was undertaken during the first decade (1989-1998) by Rubenstein (1992). The number of studies on pollution increased during the second decade (1999-2008) (8 citations) and reached its highest (20 citations) during the most recent decade (2009-2018) (e.g. Deegan, 2017; Sallivan and Hannis, 2017) (see Table 2. 7).

The studies examining pollution (soil, water, air, and noise) have been undertaken within all 11 industry sectors (see Table 2. 8). Materials (8 citations) and utilities (6 citations) are the most common industry sectors related studies on the pollution dimension of EMA. This suggests that the two industry sectors are the highest contributors to environmental pollution (Parker and Chung, 2018). Real estate, telecommunication services, financials, and healthcare (1 dimension) are the least examined industry sectors in relation to the pollution dimension of EMA.

Studies examining the pollution dimension of EMA practices have been undertaken in four countries. While most studies have been undertaken in European countries (the UK, Italy, Germany, the Netherlands, and France) (10 citations), Australia (5 citations), the US and Canada (3 citations) (e.g. Bartolomeo et al., 2000; Chan et al., 2014; Ferreira et al., 2010; Henri and Journeault, 2010; Passetti et al., 2018), only one study was undertaken in Bangladesh. The reason for the different number of studies in these countries could be the different regulatory settings and technology (Burnett and Hansen, 2008; De Villiers and Sharma, 2018; Wickramasinghe and Hopper, 2005).

3. 3 Environmental management accounting (EMA) practices on energy

Energy refers to any source of energy including electricity and fossil fuels, such as coal, oil, and gas. The reviewed studies used the following EMA practices on the energy dimension (see Table 2. 11).

Table 2. 11 – EMA practices on the energy dimension

Practices	Author(s)
• Measuring the amount of energy consumption • Measuring the costs of energy consumption	Ferreira et al. (2010); Journeault et al. (2016); Zaman Mir and Shiraz Rahman (2011)
• Measuring the costs of energy savings • Measuring the amount of energy savings	Parker and Chung (2018)

29 of 63 studies cited EMA practices on the energy dimension. The studies on EMA practices on energy were first cited in the second decade (1999-2008) with only four studies found in this period (e.g. Boyce, 2000; Bartolomeo et al., 2000; Burnett and Hansen, 2008). The studies on the energy dimension were mainly undertaken during the most recent decade (2009-2018) (25 citations) (e.g. Ferreira et al., 2010; Gibassier, 2017; Henri and Journeault, 2010; Kaur and Lodhia, 2018; Parker and Chung, 2018; Passetti et al., 2018) (see Table 2. 7). A possible reason for the growth of such studies could be the introduction of new policies and the increased awareness of the consequences of the excessive use of energy (e.g. impact on carbon emissions and global warming) in the most recent years (Tomer and Sadler, 2007).

The EMA practices on energy have been mainly examined in the materials industry sector (8 citations) followed by consumer discretionary (6 citations), and utilities (5 citations) (see Table 2. 8). Financials, telecommunication services, and real estate are the least examined industry sectors in relation to the energy dimension of EMA practices (1 citation). A possible reason could be that compared to the other industry sectors, materials and consumer discretionary are intensified energy consuming industry sectors.

The studies on the energy dimension of EMA practices have been mainly undertaken in four countries including European countries, Australia, the US and Canada, and Singapore (see Table 2. 9). Most studies have been undertaken in Europe (10 citations), Australia (7 citations), and the US and Canada (5 citations) (e.g. Passetti et al., 2018; Qian et al., 2018; Tello et al., 2016). Only one study has been undertaken in Singapore (Parker and Chung, 2018). Other countries, such as New Zealand, Sri Lanka, and Bangladesh, have not been included in any study concerning the energy dimension of EMA. A possible reason for the large number of studies in Europe, Australia, and the US could be the effort to create awareness about the "adverse consequences that the pursuit of capitalism" in developed countries has on the natural resources including the use of energy (Burnett and Hansen, 2008, p. 552).

3. 4 Environmental management accounting (EMA) practices on water

Water is becoming "one of the dominant environmental issues around the world, as it is critical for human life, agriculture and many industrial processes but declining in availability" (Hazelton, 2013, p. 270). Reviewed studies have used the following EMA practices on the water dimension (see Table 2. 12).

Table 2. 12 –EMA practices on the water dimension

Practices	**Author(s)**
• Measuring the long-term financial costs associated with current water management activities for the organisation's entire supply chain • Measuring the long-term environmental implications associated with water use and quality issues for the organisation's entire supply chain	Christ (2014)
• Estimating the costs of water saving • Measuring the amount of water usage • Measuring the costs of water usage	Parker and Chung (2018)
• Educating the community to exercise environmental due diligence on water issues • Measuring the water use efficiency	Zaman Mir and Shiraz Rahman (2011)

EMA practices on the water dimension have been cited by 28 of the 63 studies. According to the papers reviewed, the examination of EMA on water has increased throughout the three decades. The first examination was undertaken during the period 1989 to 1998 (1 citation) and gradually increased to its highest level (23 citations) during 2009 to 2018 (see Table 2. 7). The low number of studies during the first decade (1989-1998) (1 citation) could be due to the water scarcity problem being less known (Morrison et al., 2009). The increased number of studies in the last decade (2009-2018) could be due to greater awareness of the water crisis impacting on both organisations and communities. The importance of water for lives and the sustainability of businesses could have also contributed to the increasing research on the water dimension of EMA practices. Given the scarcity of water, Kurland and Zell (2010, p. 316) note that the need for water management should be "raising red flags for business".

The EMA practices on water have been examined in all 11 industry sectors. Energy (7 citations) and utilities (7 citations) are the two main industry sectors that have been included by the highest number of studies, followed by materials (6 citations) and consumer staples (5 citations) (e.g. Chan et al., 2014; Contrafatto and Burns, 2013; Henri and Journeault, 2010; Tello et al., 2016). Real estate and information technology are the two industry sectors that have been included by the least number of studies on the EMA practices on water (1 citation) (Passetti et al., 2018) (see Table 2. 8).

Most of the studies examining the EMA practices on water have been undertaken in Australia (9 citations) (e.g. Christ, 2014; Heggen et al., 2018; Moore and McPhail, 2016; Qian et al., 2018; Tello et al., 2016), followed by Europe (7 citations) (see Table 2. 9). A possible reason for attracting researchers' attention to examine the EMA practices on water in Australia could be that with the exception of Antarctica, Australia is the driest continent on the planet (Tello et al., 2016). While EMA practices on water are moderately examined in the US and Canada (3 citations), it is severely under-examined in some other countries (e.g. New Zealand (0 citations), Bangladesh, Singapore, and Sri Lanka (1 citation each)). A possible reason for the fewer studies on EMA practices on water might be the lack of regulatory pressure in countries, such as Bangladesh and Sri Lanka, in contrast to the presence of the enforceable regulatory pressure found in Australia and European countries (Chalmers et al., 2012; Passetti et al., 2018).

3. 5 Environmental management accounting (EMA) practices on carbon

Carbon emissions are one of the EMA dimensions cited by prior studies. Carbon emissions are created due to the use of fossil fuel, such as coal, oil, and gas. Carbon dioxide is one of the main heat-trapping gases, known as Greenhouse Gas (GHG), which contributes to global warming (Visser et al., 2015). The following EMA practices on carbon have been used in the reviewed studies (see Table 2. 13).

Table 2. 13 – EMA practices on the carbon dimension

Practices	Author(s)
• Measuring carbon accounting and GHG production • Identifying the need for Carbon Disclosure Project (CDP)	Ferreira et al. (2010); Hartman et al. (2013)
• Identifying strategies for carbon footprint reduction	Parker and Chung (2018)
• Estimating the amount of carbon sequestration • Identifying the need for grasslands and vegetation to reduce carbon emissions • Estimating the amount of grasslands and vegetation needed for reducing carbon emissions	Sullivan and Hannis (2017)

23 of 63 studies cited the EMA practices on the carbon dimension. The EMA practices on carbon emerged during the second decade (1999-2008) with only four studies (e.g. Antheaume, 2004; Bartolomeo et al., 2000) (see Table 2. 7). During the last decade (2009-2018), the sharp growth of studies indicates that the EMA practices on carbon captured more attention (19 citations) (e.g. Ascui and Lovell, 2011; Belal et al., 2015; Figge and Hahn, 2013; Gray and Laughlin, 2012; Parker and Chung 2018; Russell et al., 2017; Zaman Mir and Shiraz Rahman, 2011). A possible reason for the speedy growth of carbon studies during the last decade could be the deterioration of the global warming issue, with increasing awareness among the society. Corporations around the world also seem to have adopted environmentally friendly practices to reduce the speed of the global warming issue (Parker and Chung, 2018).

Studies on the EMA practices on carbon have examined all the industry sectors except financials (see Table 2. 8). While the highest number of studies focus on the materials (5 citations), utilities (4 citations), and consumer discretionary (4 citations) (e.g. Figge and Hahn, 2013), the least number of studies examine industry sectors, such as the telecommunication services, information technology, and real estate (1 dimension each) (Passetti et al., 2014). The main reason for the highest number of studies in these industry sectors could be the high level of carbon emissions caused by the use of excessive fossil fuel and energy (Parker and Chung, 2018).

Studies on the EMA practices on the carbon dimension have been mainly undertaken in five countries. Most of the studies were done in Europe (9 citations) followed by Australia (3 citations). Other countries, such as the US and Canada, Singapore, and Bangladesh have only been the subject of one study each, indicating that carbon studies are under-examined in these countries (see Table 2. 9). The reason for the large number of studies in European countries in comparison to the others could be the regulatory requirements on carbon emissions in European countries (Burnett and Hansen, 2008).

3. 6 Environmental management accounting (EMA) practices on recycling

The EMA practices on recycling are one of the EMA dimensions cited in prior studies. In contrast to other dimensions, recycling has been cited by fewer prior studies (16 of 63 studies). Recycling refers to the reusing of materials and substances (e.g. water, and raw and used material) in the production process rather than disposal. Recycling helps to minimise the negative impact of business activities on the natural environment (Ball, 2005). However, not all wastes can be recycled, and neither is a "100% recycling policy" totally "beneficial to the environment" (Gibarssier, 2017, p. 54). The reviewed studies used the following EMA practices on recycling (see Table 2. 14).

Table 2. 14 – EMA practices on the recycling dimension

Practices	**Author(s)**
• Measuring the costs related to recycling	Ferreira et al. (2010); Journeault et al. (2016)
• Identifying recycling as a key aspect of the green sustainability programme • Measuring the costs of recycling	Parker and Chung (2018)
• Measuring the costs of waste through recycling materials • Recognising reusing and recycling resources • Identifying alternative methods to take advantage of sustainable resources (such as recycling water) • Measuring the amount of recycled water • Measuring the costs of recycling water • Estimating the amount of treated effluent reused for irrigation purposes	Zaman Mir and Shiraz Rahman (2011)

EMA practices on recycling emerged in the second decade (1999-2008) with only four studies. During the third decade (2009-2018) the number increased to its highest of 12 studies (see Table 2. 7). A possible reason for the increasing research interest in recycling could be the increasing concern of stakeholders about the natural environment.

EMA studies on recycling have been examined in all industry sectors (see Table 2. 8). While the most examined industry sectors are materials (8 citations), industrials (5 citations) and consumer discretionary (5 citations) (e.g. Journeault et al., 2016; Parker and Chung; 2018; Passetti et al., 2018), the least examined are financials, telecommunication services and real estate (1 citation each) (Alawattage and Fernando, 2017). A possible reason could be that industry sectors, such as materials, industrials, and consumer discretionary, are more likely able to adopt practices, such as recycling (e.g. water and material) compared to the industry sectors, such as financials, telecommunication services, and real estate (Journeault et al., 2016).

EMA studies on recycling have been undertaken in four countries (see Table 2. 9). Most of the studies were undertaken in Europe (7 citations) followed by Australia (5 citations), the US and Canada (4 citations). Only one study was undertaken in Singapore and no study in the other countries, such as New Zealand, Sri Lanka, and Bangladesh.

3. 7 Environmental management accounting (EMA) practices on biodiversity

EMA practices on biodiversity are the second least cited EMA dimension as only cited by 8 out of 63 studies. Article 2 of the *Convention on Biological Diversity* in 1992, defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (Convention on Biological Diversity, 2016). Biodiversity is significant as any disparities in the population of species can easily endanger the ecosystems (Loreau et al., 2001). Loreau et al. (2001, p. 807) note that "at least some minimum number of species is essential for ecosystem functioning under constant conditions and that a larger number of species is probably essential for maintaining the stability of ecosystem processes in changing environments". The reviewed studies used the following EMA practices on biodiversity (see Table 2. 15).

Table 2. 15 – EMA practices on the biodiversity dimension

Practices	Author(s)
• Estimating the number of biodiversity in the sites	Heggen et al. (2018)
• Identifying the impact on biodiversity • Estimating the costs of the impact on biodiversity • Estimating the costs of maintaining the biodiversity of the sites	Passetti et al. (2018)

EMA practices on biodiversity are relatively new (see Table 2. 7). Examination of biodiversity emerged during the second decade (1999-2008) (2 citations) (e.g. Herbohn, 2005). A few more studies emerged during the last decade (2009-2018) (6 citations) (e.g. Passetti et al., 2018). Growing concern about the environmental crisis by organisations and the public increased the number of the studies examining biodiversity (Parker and Chung, 2017), however, due to the difficulty in quantifying biodiversity, the increase in the number of studies is very limited (Figge and Hahn, 2013).

Studies have examined EMA practices on biodiversity in all industry sectors (see Table 2. 8). While most studies focused on the industry sectors, such as materials (4 citations), energy (3 citations), and utilities (3 citations) (e.g. Heggen et al., 2018; Passetti et al., 2014; 2018), the least number of studies examined real estate, financials, and information technology (1 citation each). A possible reason for the greater number of studies on these industry sectors could be that more environmentally sensitive industry sectors, such as materials and utilities, have more impact on the biodiversity due to their operating activities compared to the less environmentally sensitive industry sectors (Boiral and Heras-Saizarbitoria, 2017).

EMA practices on biodiversity have only been undertaken in three countries (see Table 2. 9). Australia has undertaken the highest number of studies (3 citations) followed by Europe (2 citations) and the US and Canada (1 citation). The review did not find any studies that examined EMA practices on biodiversity in countries, such as New Zealand, Singapore, Sri Lanka, or Bangladesh. A possible reason for the relatively greater number of studies undertaken in Australia could be the presence of the regulatory framework in Australia, which protects biodiversity (e.g. Environment Protection and Biodiversity Conservation Act

1999)[31] (Department of Agriculture and Water Resources, 2018; Department of Environment and Energy, 2018a).

3. 8 Environmental management accounting (EMA) practices on soil

Soil has a vital role in the production of food and fibre as well as in the function of global ecosystems (Doran, 2002). Doran (2002, p. 119) defines soil health as "the capacity of a living soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health". Despite the significance of this dimension in individuals' health and industries' security, soil is the least examined EMA dimension. The followings are some of the EMA practices on soil used by the reviewed studies (see Table 2. 16).

Table 2. 16 – EMA practices on the soil dimension

Practices	Author(s)
• Identifying soil degradation prevention projects	Belal et al. (2015)
• Identifying soil clean-up projects • Measuring the costs of soil clean-up	Bouma and Kamp-Roelands (2000)

EMA practices on soil are the least examined dimension of EMA, cited by only six out of 63 studies. The EMA practices on soil emerged during the second decade (1999-2008) (2 citations) (see Table 2. 7). The first study examining soil was Bouma and Kamp-Roelands (2000), and, recently, during the third decade (2009-2018), a few more studies (4 citations) emerged (e.g. Belal et al., 2015; Chan et al., 2014; Heggen et al., 2018). A possible reason for the increased number of studies could be that, as the population grows, demand for more food and fibre increases, which leads to the need for the sustainable use of soil and more research in this area (Pimentel and Burgess, 2013). According to Pimentel and Burgess (2013, p. 454), "soil erosion continues unabated while the human population continues to increase rapidly" highlighting that 66% of the global population is suffering from hunger. Pimentel and Burgess (2013) warn that hunger will kill more people if soil conservation

[31] The *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) is the Australian Government's central piece of environmental legislation. It is a legal framework, which aims to protect and manage important flora, fauna, ecological communities, and heritage places, nationally and internationally (Department of Environment and Energy, 2018a).

continues to be ignored. Given the small increase in the number of studies, this dimension is still being under-examined.

Studies have only examined the EMA practices on soil in two industry sectors (e.g. materials (2 citations) and consumer staples (2 citations)) (see Table 2. 8). This dimension is under-examined as it has not been examined in any other industry sector. A possible reason for studies only focusing on materials and consumer staples could be that the impact of these two industry sectors on soil is more destructive compared to the other industry sectors (e.g. real estate and financials). Materials and consumer staples can harshly damage the soil by using chemicals and the heavy machinery and equipment (Antille et al., 2016; Belal et al., 2015).

Studies on EMA practices on soil have only been undertaken in Australia (3 citations), Europe (2 citations), and Bangladesh (1 citation) (see Table 2. 9). Most of the studies were undertaken in Australia because agriculture plays a very important role in the Australian economy. The export of food and fibre (e.g. cotton, wheat, and soy) generates significant income for the Australian economy (Kidane, 2005).

Overall, these issues can be interrelated and impact on each other. For example, while the inefficient use of water leads to increased waste, excessive use of energy contributes to the carbon emissions. The sustainability of businesses is secured against the sustainability of the natural resources and "to promote environmental sustainability, change is necessary" (Passetti et al., 2018, p. 1146).

4. CONCLUSION

The ongoing harmful impact of the activities of organisations on the natural environment compels the need for the use of more comprehensive environmental management accounting (EMA) practices by managers in organisations. This chapter undertook a systematic literature review to review a body of 63 EMA studies published in leading accounting journals (ABDC Ranked A and A*) for three decades (1989-2018). The findings of bibliometric analysis showed that the EMA studies emerged three decades ago from 1989 and increased significantly over that time. The EMA studies began as mainly non-empirical however, empirical studies emerged over that time. Some journals were and still are actively publishing EMA studies, such as “Accounting, Auditing and Accountability Journal”, “Critical Perspectives on Accounting” and “Accounting, Organisations and Society”. In contrast, some journals, such as “Abacus”, “Financial Accountability and Management”, and “International Journal of Accounting Information Systems” have recently published their first and only EMA study. Further, the analysis indicated that while some industry sectors have attracted more attention (e.g. materials, utilities, and energy), others have received less attention (e.g. real estate, healthcare and information technology).

The findings of the descriptive analysis identified eight dimensions of EMA including the most cited dimension (EMA practices on waste) and the least cited (EMA practices on soil) over the three decades (1989-2018). In particular, waste has been examined from the first decade (1989-1998) possibly due to the more awareness about the issues associated with waste. While soil has only begun to be cited and examined in the year 2000 and few more studies emerged during the third decade (2009-2018) when the population growth highlighted the challenge of increased demand for food. The analysis also identified the measurements used by the reviewed studies to examine EMA practices. Further, the review showed how EMA dimensions have changed over the last 30 years. The findings of the analysis indicated that while some dimensions have been examined by prior studies from three decades ago (e.g. waste, pollution, and water), others only began to be examined in the latter part of the second decade (e.g. biodiversity). The findings also showed that some EMA dimensions are more critical in some industry sectors. For example, the waste, pollution, and energy dimensions of EMA are more critical in the materials industry sector (e.g. chemicals, construction materials, packaging, metals and mining, paper and forest products).

Further, the analysis revealed that European countries (e.g. the UK, Italy, Germany, France and Spain) have undertaken the highest number of EMA studies followed by Australia, the US and Canada. In contrast, New Zealand, Sri Lanka, Singapore, and Bangladesh have undertaken the least number of studies. The low number of studies in these countries could be due to the education, culture and regulatory requirements, which differ in diverse contexts. Overall, the analysis suggests that developed countries promote environmental studies more than the less advanced countries. The reason might be that the government and academic institutions promote environmental related research by providing grants and other funding assistance. For example, the funding and investment programs provided by the Australian Government aim to protect the environment and heritage, promote climate action, and provide adequate, reliable and affordable energy (Department of Environment and Energy, 2018b).

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APPENDIX 1 - Studies published during the three decades

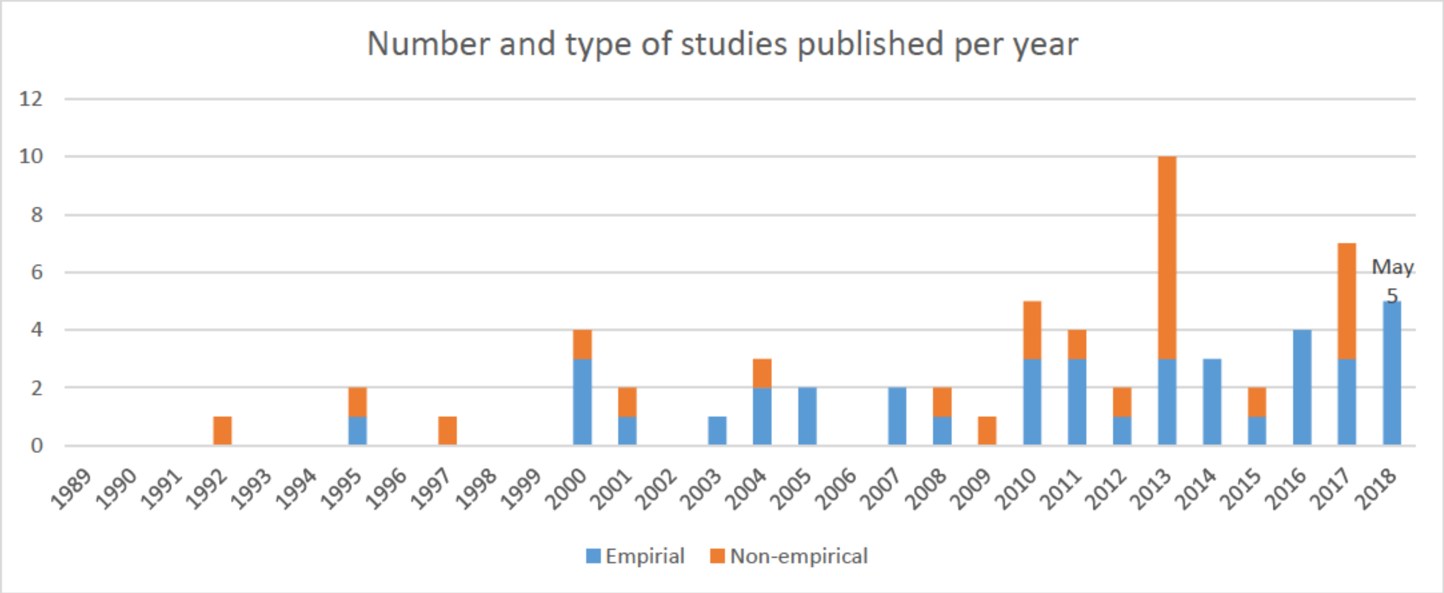
As presented in Table 1 below, no publication has been found for certain years, while in other years only one study had been undertaken. The number of publications reached its highest of ten studies in 2013.

Table 1 - Studies published during the three decades (1989-2018)

Year	Empirical	Non-empirical	No. of papers
1989	0	0	0
1990	0	0	0
1991	0	0	0
1992	0	1	1
1993	0	0	0
1994	0	0	0
1995	1	1	2
1996	0	0	0
1997	0	1	1
1998	0	0	0
1999	0	0	0
2000	3	1	4
2001	1	1	2
2002	0	0	0
2003	1	0	1
2004	2	1	3
2005	2	0	2
2006	0	0	0
2007	2	0	2
2008	1	1	2
2009	0	1	1
2010	3	2	5
2011	3	1	4
2012	1	1	2
2013	3	7	10
2014	3	0	3
2015	1	1	2
2016	4	0	4
2017	3	4	7
2018	5	0	5
Total	**39**	**24**	**63**

Figure 1 below compares the number and the type of studies published per year, during the three decades.

Figure 1 - Studies published during the three decades



APPENDIX 2 - Environmental studies in Australia

Table 1 - Environmental studies in Australia

Year	Author(s)	Title	Journal	Industry sector	Industry
2018	Qian, Burritt and Monroe (2018)	Environmental Management Accounting in Local Government: Functional and Institutional Imperatives	Financial Accountability and Management	Non-classified	Local government
2018	Kaur and and Lodhia (2018)	Stakeholder engagement in sustainability accounting and reporting: A study of Australian local councils	Accounting, Auditing and Accountability Journal	Non-classified	Three local councils
2018	Heggen, Sridharan and Subramaniam (2018)	To the letter vs the spirit: A case analysis of contrasting environmental management responses	Accounting, Auditing and Accountability Journal	Materials	Forestry industry
2016	Tello, Hazelton and Cummings (2016)	Potential users' perceptions of general purpose water accounting reports	Accounting, Auditing and Accountability Journal	Utilities	Water industry
2016	Moore and McPhail (2016)	Strong structuration and carbon accounting: A position-practice perspective of policy development at the macro, industry and organizational levels	Accounting, Auditing and Accountability Journal	Utilities	Water industry
2014	Christ (2014)	Water management accounting and the wine supply chain: Empirical evidence from Australia	British Accounting Review	Consumers discretionary	Wine industry
2012	Chalmers, Godfrey and Lynch (2012)	Regulatory theory insights into the past, present and future of general purpose water accounting standard setting	Accounting, Auditing and Accountability Journal	Utilities	Water industry
2011	Qian, Burritt and Monroe (2011)	Environmental management accounting in local government: A case of waste management	Accounting, Auditing and Accountability Journal	Non-classified	Local government
2011	Zaman Mir and Shiraz Rahaman (2011)	In pursuit of environmental excellence: A stakeholder analysis of the environmental management strategies and performance of an Australian energy company	Accounting, Auditing and Accountability Journal	Energy	Energy industry
2010	Ferreira, Moulang and Hendro (2010)	Environmental management accounting and innovation: An exploratory analysis	Accounting, Auditing and Accountability Journal	Materials, industrials, consumer discretionary	Chemical, mining, and smelting, Manufacturing, Hospitality, Transport, Construction
2005	Herbohn (2005)	A full cost environmental accounting experiment	Accounting, Organizations and Society	Materials	Forest sector, Timber industry
2000	Boyce (2000)	Public discourse and decision making: Exploring possibilities for financial, social and environmental accounting	Accounting, Auditing and Accountability Journal	Materials	Plastics and Chemical Industry

APPENDIX 3 - Industry classification based on Global Industry Classification Standard

Table 1 - Industry classification based on Global Industry Classification Standard (GICS)

GICS industry classification		
Number	**Industry sector**	**Industry group***
1	Energy	Energy Equipment & Services, Oil, Gas & Consumable Fuels
2	Materials	Chemicals, Construction Materials, Containers & Packaging, Metals & Mining, Paper & Forest Products
3	Industrials	Aerospace & Defence, Building Products, Construction & Engineering, Electrical Equipment, Industrial Conglomerates, Machinery, Trading Companies & Distributors, Commercial Services & Supplies, Professional Services, Air Freight & Logistics, Airlines, Marine, Road & Rail, Transportation Infrastructure
4	Consumer Discretionary	Auto Components, Automobiles, Household Durables, Leisure Products, Textiles, Apparel & Luxury Goods, Hotels, Restaurants & Leisure, Diversified Consumer Services, Media, Distributors, Internet & Direct Marketing Retail, Multiline Retail, Specialty Retail
5	Consumer Staples	Food & Staples Retailing, Beverages, Food Products, Tobacco, Household Products, Personal Products
6	Health Care	Health Care Equipment & Supplies, Health Care Providers & Services, Health Care Technology, Biotechnology, Pharmaceuticals, Life Sciences Tools & Services
7	Financials	Banks, Thrifts & Mortgage Finance, Diversified Financial Services, Consumer Finance, Capital Markets, Mortgage Real Estate Investment Trusts (REITs), Insurance
8	Information Technology	Internet Software & Services, IT Services, Software, Communications Equipment, Technology Hardware, Storage & Peripherals, Electronic Equipment, Instruments & Components, Semiconductors & Semiconductor Equipment
9	Telecommunication Services	Diversified Telecommunication Services, Wireless Telecommunication Services
10	Utilities	Electric Utilities, Gas Utilities, Multi-Utilities, Water Utilities, Independent Power and Renewable Electricity Producers
11	Real Estate	Equity Real Estate Investment Trusts (REITs), Real Estate Management & Development
12	Non-classified[32]	local councils, ship-breaking industry, energy conservation, recycling waste and paper, lead-free petrol and catalytic converters

*Each industry group includes its specific industries and sub-industries (Market Index, 2018).

[32] These group include local councils, ship-breaking industry, energy conservation, recycling waste and paper, lead-free petrol, and catalytic converters, which could not be added to any other group.

APPENDIX 4 - EMA practices measures

Table 1 - EMA practices (measures) used in the reviewed studies

Practices	Author(s)
Waste	
• Identifying waste minimisation schemes	Bartolomeo et al. (2000)
• Measuring the costs of waste handling	Bouma and Kamp-Roelands (2000)
• Identifying Life Cycle Assessment (LCA) generation of waste material	Chan et al. (2014)
• Estimating the costs of production efficiency • Measuring the costs of material consumption • Measuring the amount of material consumption • Measuring the costs of waste management	Journeault et al. (2016)
• Identifying recycling water	Zaman Mir and Shiraz Rahman (2011)
Pollution	
• Measuring the costs of pollution prevention	Bartolomeo et al. (2000); Ferreira et al. (2010)
• Measuring the costs of preventing environmental incidents	Bouma and Kamp-Roelands (2000)
• Identifying emissions to the air, water or soil • Measuring anticipated pollution	Chan et al. (2014); Ferreira et al. (2010)
• Identifying Life Cycle Assessment (LCA) generation of pollution	Ferreira et al. (2010)
• Estimating the risk of environmental liabilities and disasters • Measuring the costs associated with fines and litigation	Journeault et al. (2016); Ferreira et al. (2010)
• Measuring the costs of environmental pollutions of the business • Estimating the costs of the prevention of pollution • Identifying the need for providing community leadership and exercise environmental due diligence (e.g. on water pollution and air pollution)	Zaman Mir and Shiraz Rahman (2011)
Energy	
• Measuring the amount of energy consumption • Measuring the costs of energy consumption	Ferreira et al. (2010); Journeault et al. (2016); Zaman Mir and Shiraz Rahman (2011)
• Measuring the costs of energy savings • Measuring the amount of energy savings	Parker and Chung (2018)
Water	
• Measuring the long-term financial costs associated with current water management activities for the organisation's entire supply chain • Measuring the long-term environmental implications associated with water use and quality issues for the organisation's entire supply chain	Christ (2014)
• Estimating the costs of water saving • Measuring the amount of water usage • Measuring the costs of water usage	Parker and Chung (2018)
• Educating the community to exercise environmental due diligence on water issues • Measuring the water use efficiency	Zaman Mir and Shiraz Rahman (2011)

Carbon	
• Measuring carbon accounting and GHG production • Identifying the need for Carbon Disclosure Project (CDP)	Ferreira et al. (2010); Hartman et al. (2013)
• Identifying strategies for carbon footprint reduction	Parker and Chung (2018)
• Estimating the amount of carbon sequestration • Identifying the need for grasslands and vegetation to reduce carbon emissions • Estimating the amount of grasslands and vegetation need for reducing carbon emissions	Sullivan and Hannis (2017)
Recycling	
• Measuring the costs related to recycling	Ferreira et al. (2010); Journeault et al. (2016)
• Identifying recycling as a key aspect of the green sustainability programme • Measuring the costs of recycling	Parker and Chung (2018)
• Measuring the costs of waste through recycling materials • Recognising reusing and recycling resources • Identifying alternative methods to take advantage of sustainable resources (such as recycling water) • Measuring the amount of recycled water • Measuring the costs of recycling water • Estimating the amount of treated effluent reused for irrigation purposes	Zaman Mir and Shiraz Rahman (2011)
Biodiversity	
• Estimating the number of biodiversity in the sites	Heggen et al. (2018)
• Identifying the impact on biodiversity • Estimating the costs of the impact on biodiversity • Estimating the costs of maintaining the biodiversity of the sites	Passetti et al. (2018)
Soil	
• Identifying soil degradation prevention projects	Belal et al. (2015)
• Identifying soil clean-up projects • Measuring the costs of soil clean-up	Bouma and Kamp-Roelands (2000)

CHAPTER THREE

(PAPER 1)

AN INTEGRATIVE LITERATURE REVIEW OF CURRENT ENVIRONMENTAL ISSUES IN THE AUSTRALIAN COTTON INDUSTRY

This paper is under review by the *Journal of Cleaner Production.*

ABSTRACT

Purpose – The aim of this study is to explore the key environmental issues caused by the Australian cotton industry.

Design/methodology/approach – This integrative literature review examines, critiques and synthesises studies on environmental issues in the Australian cotton industry for the period 2007 to 2018.

Findings – The study finds that while water-related issues, such as pollution and depletion, are major environmental issues, the impact of the industry on climate change is minimal. The review also reveals other critical environmental issues caused by the industry, including soil salinisation, soil fertility depletion, soil pollution and soil erosion, land use, and reduction of biodiversity. The review further discusses findings in comparison with prior studies undertaken in other countries.

Practical implications – The study also highlights the implications of these findings for practice and provides insights for potential further research.

Originality/value – This study contributes to the very limited literature by integrating all the current environmental issues caused by the industry using an integrative literature review. The review highlights key areas with lack of knowledge.

Keywords: Environmental Issues, Cotton Industry, Integrative Literature Review, Australia.

1. INTRODUCTION

Australia is one of the largest cotton producers in the world, counted among other main producers, such as China, India, the USA, Pakistan and Brazil (Statista, 2016).[33] It is also the third largest cotton exporter, after the USA and India (FAO, 2015). Studies note that the cotton industry[34] is very important to the economic health of Australia in terms of generating revenue and creating employment (Kidane, 2005). For example, the industry generated over $1.25 billion in earnings for the Australian economy in the 2014–15 season and employed on average 10,000 workers (Bradburn, 2015). The industry also indirectly creates employment in related industries, such as agricultural inputs, equipment and machinery production, textile manufacturing and cottonseed crushing (FAO, 2015).

Despite its economic importance, there are significant environmental issues associated with the cotton industry. As an industry that is reliant on labour, water and energy, its activities significantly affect natural resources, including water, land and air (Braunack, 2013; Cammarano et al., 2012; Kidane, 2005; Maraseni et al., 2010; Visser et al., 2014; 2015). According to Bevilacqua et al. (2014, p. 154), "The environmental impact associated with cotton production is increasingly in the spotlight. However, data on the sustainability of cotton production are scanty and not widely available". The Food and Agriculture Organization (FAO, 2015) also indicates that despite improvements in the sustainability of cotton production through the development of new programmes, the industry continues to cause significant environmental damage. Such programmes are expected to improve "the livelihoods of producers and the environment" by focusing on "responsible natural resource stewardship", beginning with an assessment of the environmental sustainability of cotton farming (FAO, 2015, p. 1).

Few studies, however, have focussed on integrating the current environmental issues in the Australian cotton industry. Research is needed to discover areas where there is a lack of knowledge, to identify and minimise the harmful environmental issues caused by this industry's activities, thereby promoting more research to shift the industry to a more sustainable mode of operation, both economically and environmentally. Such research

[33] The full references of all the citations in this paper are available in the reference list at the end of this paper on page 100.
[34] By 'cotton industry' the study refers to the 'cotton production' phase, which includes the farming and ginning stages.

would also fulfil the increasing need for information linking the activities of the cotton industry with their environmental impacts. A wider understanding of the environmental issues caused by the industry would also lay the foundation for further research in this field.

The study aims to examine the critical environmental issues caused by the Australian cotton industry by reviewing the key theoretical and empirical literature. Based on the integrative literature approach, the study identifies, examines, critiques and synthesises the critical environmental issues caused by the Australian cotton industry. This study also assesses the extent of the impacts of the environmental issues on the physical environment and their inter-connections by using 52 scholarly research articles published in peer-reviewed journals over the last twelve years. Further, the study identifies the most critical environmental issues and sheds light on areas of the Australian cotton industry on which further research is warranted.

The contributions of this study are twofold. First, this is among the relatively few studies that examine and integrate the current environmental issues caused by the Australian cotton industry. Prior studies of the industry have focussed on each issue in isolation. For example, while some studies focus on greenhouse gas (GHG) emissions caused by the excessive use of energy and fossil fuel in this industry (Ismail et al., 2011; Maraseni et al., 2010), others examine the soil pollution caused by the industry (Hulugalle and Scott, 2008).

Second, this study has direct implications for practice. It provides the foundation for more sustainable practices by identifying areas that need improvement. It also contributes to policy development by highlighting the most harmful impacts of crop production practices that require closer examination by regulators and standard-setting bodies. Further, understanding of the environmental issues may encourage cotton growers to use more environmentally friendly farming practices and to move towards a more sustainable approach to cotton production.

2. RESEARCH METHOD

The study uses the integrative literature review approach proposed by Whittemore and Knafl (2005) to guide the analysis. The integrative literature review approach allows the amalgamation, critique and synthesis of "the current state of knowledge on a topic" in an integrated way (Neuman 2006, p. 112), and creates new knowledge based on data collected from a variety of sources (Torraco, 2005). As an approach to critically examining a particular phenomenon, the method has been used increasingly in a variety of fields, such as management and health (e.g. Carey et al., 2011; Whittemore and Knafl, 2005). According to Whittemore and Knafl (2005, p. 546), "Well-done integrative reviews present the state of the science, contribute to theory development, and have direct applicability to practice and policy".

Data sources

The study used *MultiSearch* to search for related studies. MultiSearch is a search engine covering a variety of databases. Databases in MultiSearch include BioOne 1, Business Source Premier, Cambridge University Press, CSIRO, DOAJ Directory of Open Access Journals, EBSCOhost Academic Search Premier, EBSCOhost MEDLINE Complete, Elsevier ScienceDirect, Informit Australian Public Affairs, JSTOR, Oxford University Press, ProQuest, ResearchGate, Scopus, Springer Link, Taylor and Francis, and Wiley InterScience.

Relevant studies were searched for using the terms "Cotton" and "Australia". The initial search resulted in 8,295 references, including books, articles, and sundry other publications. Given the large number of references retrieved from the initial search, the study browsed through the "Advanced Search" feature of MultiSearch using the same search terms in the 'Title' and found 344 'Articles'. However, the 344 articles include both the most recent studies as well as the old ones. Therefore, to satisfy the aim of the study in identifying *current* environmental issues in the Australian cotton industry, the study narrows down the search to the last twelve year period from 2007 to 2018. Consequently, the final search resulted in 102 'Articles' to examine the current environmental issues in the Australian cotton industry.

Screening

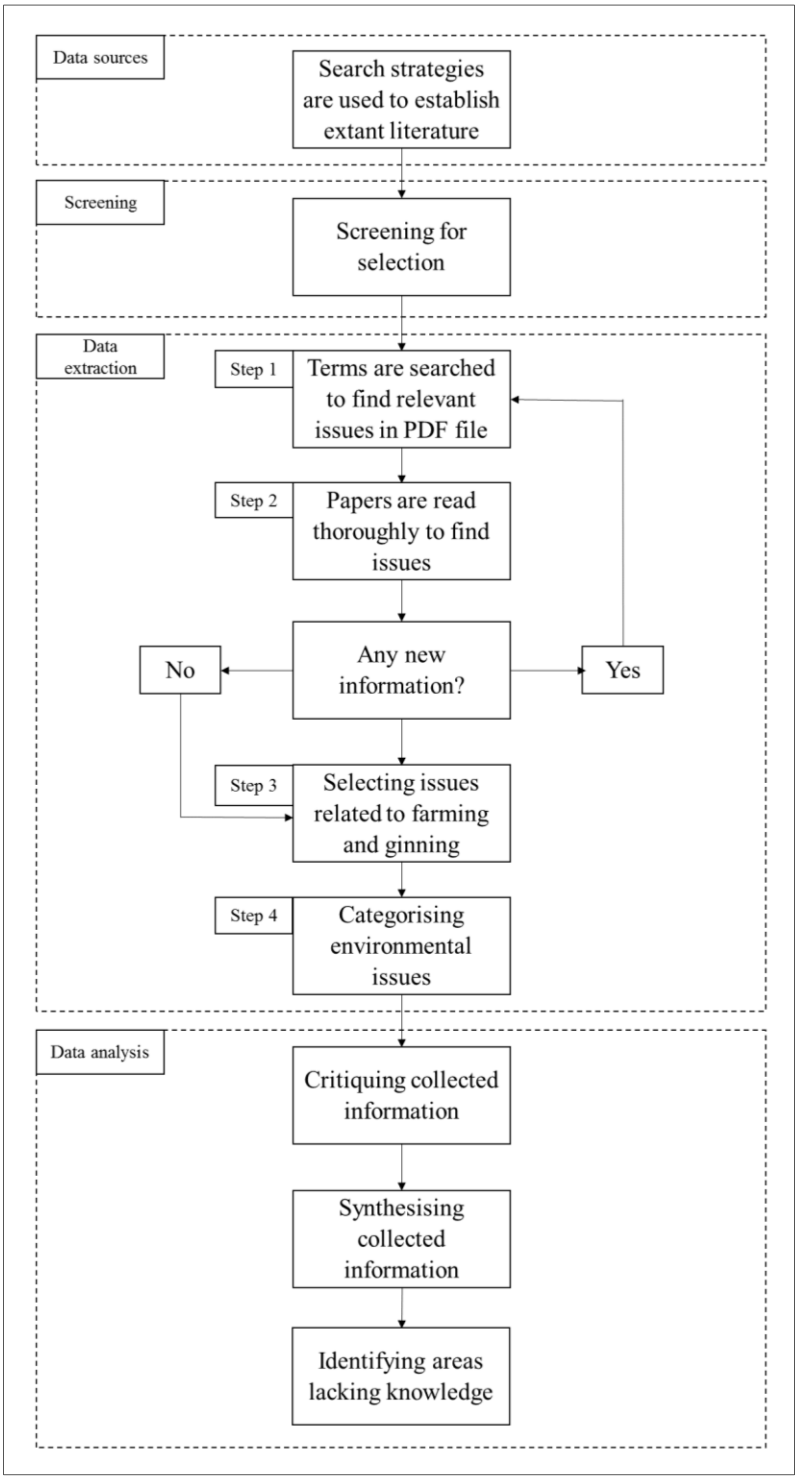
The screening process of the study involved reviewing the abstracts of the 102 articles to identify the most relevant studies. In the screening process, it is found that 52 articles are academic research papers and 54 are non-academic articles. Thus, only the 52 academic research papers from the peer-reviewed journals were identified and included in the final dataset for in-depth reading and analysis. The study selected only academic research papers from peer-reviewed journals to ensure the credibility and trustworthiness of the data. The selected academic research papers include a range of qualitative, quantitative and case studies methodologies, covering experiments, interviews, surveys and literature reviews in the Australian context. All of the articles were written in English.

Data extraction and analysis

The study follows a four-step data extraction process from 52 research papers to identify the most relevant environmental issues caused by the Australian cotton industry (see Figure 3. 1, below). In the first step, terms such as “environmental issues”, “environmental concerns”, “environmental impacts”, “pollution”, “emission”, “harm”, and “waste” were searched in PDF versions of the 52 research papers.[35] The first step also involves carefully reading the sections in which search terms were highlighted to identify environmental issues.

[35] More search terms were used to reveal related issues such as water, shortage, irrigation, dried rivers, excess, usage, thirsty, evaporation, evapotranspiration, water pollution, pesticides, herbicides and weed control, fertilizers (use and make), insecticides, chemicals, quality, standard, low, rain, other chemicals, soil salinity, water logging, drainage, leachate, leakage, underground water salinity, soil degradation, losing organic carbon, soil nitrate accumulation, cotton gin waste emission, trash into soil, soil pollution (waste and chemicals), pile, dump, landfill, carbon, insecticides, wind, water, run off, compaction, damage, issue, environmental issues, critical, tillage, harsh, degradation, health, land use, GM, ecosystem, biodiversity, biota, living, animals, mammals, plant, natural resources, aquatic, target, species, beneficial, biota, organism, biotic, bio, crop residue emissions, GHG, carbon emissions and climate change and energy use, air pollutant, global warming, resistance to Bt toxins and other pests, disease, cotton seeds emission, DDT, DDE, DDD and food chain.

Figure 3. 1 - Steps undertaken in the integrative literature review



In the second step, all 52 research papers are thoroughly re-read to ensure that all the relevant environmental issues had been identified, including those that were not captured in the first step. This second step continues iteratively until no new issues could be found.

The third step involves selecting issues related to the cotton production phase which includes farming and ginning processes[36] from among the issues identified in the first and second steps. The study focuses on issues related to the cotton production phase because (1) this phase uses the most water and pesticides compared to the other phases in the cotton supply chain (FAO, 2015), and (2) this phase of the cotton supply chain is mainly undertaken within Australia (Bradburn, 2015; Cotton Australia, 2016d).[37]

The fourth step of the data extraction process involves the categorisation of the issues identified in the previous steps. The study uses the framework developed by the FAO (2015) to categorise the issues discovered (see Table 3. 1, below). The framework includes four main categories and their sub-categories including water-related issues (water depletion and water pollution), soil-related issues (soil salinisation, soil fertility depletion, soil pollution and soil erosion), land use and biodiversity, and climate change and carbon emissions. The study then critiques, synthesises and identifies areas with a lack of knowledge. Figure 3. 1 summarises the four steps of the data collection and analysis process.

[36] The other phases of the cotton supply chain include processing (spinning, weaving, knitting, dyeing, etc.) and marketing (FAO, 2015).
[37] Note that over 99% of Australian cotton is exported (Bradburn, 2015; Cotton Australian, 2016d).

Table 3. 1 - Environmental issues extracted from the literature

Author and Year	Journal	Environmental issues									
		Water			Soil				Land use and biodiversity		Climate change
		Depletion	Water quality	Other	Soil salinisation	Soil fertility depletion	Soil pollution	Soil erosion	Land use	Biodiversity	Climate change
Addison, Farrell, Roberts and Rogers (2007)	*Weed Research*			√				√			
Agbola and Evans (2012)	*Agricultural Systems*	√							√		
Antille (2018)	*Applied Engineering in Agriculture*		√				√				√
Antille, Bennett and Jensen (2016)	*Crop and Pasture Science*	√	√		√	√		√	√		√
Baker and Tann (2014)	*Austral Entomology*									√	
Baker, Leven, May and Tann (2016)	*Austral Entomology*	√									
Baker, Tann and Fitt (2011)	*Bulletin of Entomological Research*			√							
Bhuiyan, Boyd, Dougall, Martin and Hearnden (2007)	*Australasian Plant Pathology*						√	√			
Braunack (2013)	*Crop and Pasture Science*				√	√		√			√
Cammarano, Payero, Basso, Wilkens and Grace (2012)	*Crop and Pasture Science*	√									
Clement, Constable, Stiller and Liu (2012)	*Field Crops Research*		√								
Darbas, Reeve, Farquharson and Graham (2008)	*Australasian Journal of Natural Resources Law and Policy*	√	√	√				√	√	√	
Davies, Carr, Scholz and Zalucki (2011)	*Australian Journal of Entomology*		√	√			√			√	
Davies, Pufke and Zalucki (2009)	*Journal of Economic Entomology,*									√	
Dorahy, Blair, Rochester and Till (2007)	*Soil Use and Management*					√		√			
Dougall and Kahl (2007)	*Journal of Plant Nutrition*		√								
Downes and Mahon (2012a)	*Journal of Invertebrate Pathology*			√							
Downes and Mahon (2012b)	*GM Crops and Food Biotechnology in Agriculture and the Food Chain*			√				√			
Downes, Mahon and Olsen (2007)	*Journal of Invertebrate Pathology*									√	
Duggan, Yeates, Gaff and Constable (2009)	*Communications in Soil Science and Plant Analysis*									√	
Ellis, Silva, Stiller, Wilson, Vaslin, Sharman and Llewellyn (2013)	*Australasian Plant Pathology*	√									
Huang, Buchanan, Bishop and Triantafilis (2017)	*Soil Use and Management*	√	√		√						
Hulugalle and Scott (2008)	*Australian Journal of Soil Research.*	√	√		√	√		√		√	√

Hulugalle, Broughton and Tan (2015a)	*Soil and Tillage Research*	√			√						
Hulugalle, Broughton and Tan (2015b)	*Crop and Pasture Science*	√	√		√			√			
Ismail, Chen, Baillie and Symes (2011)	*Biosystems Engineering*										√
Knight, Head and Rogers (2013)	*Crop Protection*				√					√	
Lu, Downes, Wilson, Gregg, Knight, Kauter and McCorkell (2012a)	*The Netherlands Entomological Society*									√	
Lu, Downes, Wilson, Gregg, Knight, Kauter and McCrokell (2012b)	*Crop Protection*									√	
Lytton-Hitchins, Greenslade and Wilson (2015)	*Community and Ecosystem Ecology*		√		√		√	√		√	
Mackrell, Kerr and von Hellens (2009)	*Decision Support Systems*	√		√							
Maraseni, Cockfield and Maroulis (2010)	*Journal of Agricultural Science*	√					√				√
Mensah, Young and Rood-England (2015)	*Insects*		√							√	
Powell, Welsh and Eckard (2017)	*Agricultural Systems*	√					√				√
Richards, Bange and Johnston (2008)	*Agricultural Systems*	√			√						
Rogers, Reid, Rogers and Addison (2007)	*Agriculture, Ecosystems, and Environment*		√		√					√	
Roth, Harris, Gillies, Montgomery and Wigginton (2013)	*Crop and Pasture Science*	√	√		√	√					√
Scheer, Grace, Rowlings and Payero (2013)	*Nutrient Cycling in Agroecosystems*	√	√			√				√	√
Shabani and Kotey (2015)	*Journal of Agricultural Science*								√		
Silburn, Foley, Biggs, Montgomery and Gunawardena (2013)	*Crop and Pasture Science*	√	√		√			√	√	√	
Thornby, Werth and Walker (2013)	*Crop and Pasture Science*									√	
Visser, Dargusch, Smith and Grace (2014)	*Agroecology and Sustainable Food Systems*		√	√			√		√	√	√
Visser, Dargusch, Smith and Grace (2015)	*Journal of Cleaner Production*			√			√		√		√
Weaver, Ghadiri, Hulugalle and Harden (2012)	*Chemosphere*		√	√			√	√		√	
Weaver, Hulugalle, Ghadiri and Harden (2013)	*Irrigation and Drainage*	√	√		√	√					
Werth, Preston, Roberts and Taylor (2008)	*Weed Technology*		√				√				
Werth, Preston, Taylor, Charles, Roberts and Baker (2008)	*Pest Management Science*									√	
Wickson (2009)	*Journal of Risk Research*									√	
Williams, Mushtaq, Kouadio, Power, Marcussen, McRae, Cockfield (2018)	*Agricultural Water Management*	√									√
Williams, White, Mushtaq, Cockfield, Power and Kouadio (2015)	*Climatic Change*	√				√					
Wilson, Whitehouse and Herron (2018)	*Annual Review of Entomology*									√	
Yeates, Strickland and Grundy (2013)	*Crop and Pasture Science*		√		√					√	
No. of articles per category			**36**			**28**				**26**	**12**
No. of articles per issue		**20**	**20**	**10**	**14**	**8**	**10**	**12**	**7**	**22**	**12**

3. FINDINGS AND DISCUSSION

Prior studies examining the cotton industry identify high levels of emissions (Maraseni et al., 2010), excessive use of water (Bevilacqua et al., 2014; Joa et al., 2014; Martius, 2012) and pesticides (Knox et al., 2012; Srinivas, 2002) as the most significant environmental issues caused by the cotton industry (Bevilacqua et al., 2014, p. 154). However, as presented in Table 3. 1, a deep examination of the 52 studies shows that these are far from being the only problems caused by the industry (Table 3. 1). Drawing on the environmental framework developed by the FAO (2015), this review categorises the environmental issues identified into four main types:

- Water-related issues – water depletion and water quality;
- Soil-related issues – soil salinisation, soil fertility depletion, soil pollution, and soil erosion;
- Land use and impact on biodiversity-related issues; and
- Climate change and GHG emissions related issues.

3. 1 Water-related issues

Water is one of the most critical inputs in cotton production. Prior studies highlight a positive relationship between the yield and the amount of water used for irrigation in cotton farming (Bevilacqua et al., 2014; Roth et al., 2013; Zhang et al., 2015). Morrison et al. (2009, p. 21) claim that cotton is a very "thirsty plant", grown in arid but extremely irrigated areas. According to Zwart and Bastiaanssen (2004), for every cubic metre of water used, 0.14–0.33kg of cotton lint and 0.41–0.95kg of cottonseed are produced. On average, cotton crops use between six and seven megalitres of irrigation water per hectare, depending on the amount of seasonal rain received (Roth et al., 2013). The farming stage in the cotton production process is known to be the most water-intensive (Bevilacqua et al., 2014; Joa et al., 2014; Zhang et al., 2015). Farmers use irrigation where normal rainfall does not suffice for crop cultivation (Bevilacqua et al., 2014). Cotton farmers use different irrigation methods including surface, sprinkler, and drip irrigation,[38] depending on factors such as the type of

[38] Surface irrigation (flood or furrow irrigation) involves using furrows to run water through a field using pipes thus flooding it. Sprinkler irrigation, also common in the cotton industry, uses centrally or laterally pivoted sprinklers to disperse water over the cotton plants. In surface or subsurface drip irrigation, pipes are used on the surface or beneath the soil to disperse water through the field (Cotton Incorporated, 2016).

soil, the design, geometry and height of the field, and the water source.[39] Among these methods, surface (furrow or flood) irrigation systems are the most common and least efficient (Roth et al., 2013).

The use of water has become a critical environmental issue caused by the industry. As Table 3. 1 presents, 36 out of 52 studies confirm the water-related environmental issues caused by the Australian cotton industry. The study finds two main water-related environmental issues, water depletion and water quality, each of which is discussed immediately below.

Water depletion

Twenty of the 52 studies note water depletion as an environmental issue caused by the Australian cotton industry. Water depletion refers to the reduction of existing natural water resources. Water depletion happens when the total amount of withdrawal is greater than the amount of recharge. Withdrawn water is usually replaced naturally by precipitation over time (FAO, 2015).

Water depletion largely depends on the irrigation method used. In Australia, 80–90% of irrigated cotton is grown using a surface irrigation system such as flood or furrow, with a low level of water efficiency (Antille et al., 2016; Roth et al., 2013). According to Roth et al. (2013), the water depletion issue and the inefficient use of water in the cotton industry are critical and must be addressed. Water inefficiency is mainly a result of the high level of water loss from on-farm storage, evapotranspiration, and deep drainage[40] during water extraction and delivery to the field. Silburn et al. (2013) claim that although the excessive deep drainage could help to recharge groundwater aquifers, it can also cause plant nutrients and other chemicals to penetrate underneath the root area and into underground water, leading to eutrophication.[41] In addition, Silburn et al. (2013, p. 1056) highlight the "over-extraction of groundwater"[42] as a common issue in cotton farming. The most recent example of water depletion is the dryness of the Darling River, which according to Neal (2016), "has

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[39] Surface or underground.
[40] Deep drainage refers to water infiltration that passes beneath the root zone because of the excessive irrigation required.
[41] Eutrophication happens when nutrients penetrate the soil and move into the groundwater. Also see the next section on water pollution.
[42] A report by the Organisation for Economic Cooperation and Development (OECD), updated in 2014, estimates that about 22% of all water consumed in Australia is groundwater and about 78% is surface water and other sources (OECD, 2015).

stopped flowing south of Wilcannia in western [New South Wales] (NSW), reducing it to a few stinking stagnant pools and kilometres of dry mud". Neal (2016)[43] also notes that "Farmers along the Lower Darling blame […] cotton growers around St George, Moree, Goondiwindi, and Narrabri upstream for taking—and being allowed to take—too much irrigation water to fill huge private dams".

Water pollution

Twenty of the 52 studies identify the negative impact of cotton farming on water quality as one of the critical environmental issues caused by the Australian cotton industry. Pollutants such as synthetic pesticides and other chemicals used for pest and weed management, severely harm the quality of fresh water in lakes, rivers and aquifers (Antille et al., 2016; Hulugalle et al., 2015a; 2015b; Weaver et al., 2012; Yeates et al., 2013). The FAO (2015) reports that the method of spray application, the weather conditions at the time of spray application, and the distance between the crops and the water bodies have a strong impact on spray drift reaching bodies of fresh water. A study by Weaver et al. (2012), which examines Organochlorine pesticides (OCP) in soil under irrigated cotton production, finds that residues of chemicals, such as dichlorodiphenyltrichloroethane (DDT) and dichlorodiphenylethane (DDE), persist in lower layers of vertisols in NSW decades after the application of the chemicals. According to studies, irrigation or rainwater moves these pesticides into the deeper layers of soil, indicating that the chemicals can thus enter the food chain. Weaver et al. (2012, p. 336) also note that "… [pesticides'] presence at depths of 1.2 m suggests that they could move into groundwater that may eventually be used for domestic and stock consumption".

Crop nutrients, soil residues and application of minerals and fertilisers, both organic and synthetic, on cotton farms also severely reduce water quality (Hodgkin and Hamilton, 1993; Weaver et al., 2013). Weaver et al. (2013, p. 108) note that additional plant nutrients, such as nitrogen, phosphorus, calcium and magnesium, can move down from the surface of "swelling clay soils" and spread through waterways. These nutrients cause severe eutrophication in aquatic ecosystems by causing excessive algae growth (Hodgkin and Hamilton, 1993). Decomposing biomass and organisms, and high levels of organic

[43] This quote is taken from a website.

substances also reduce water quality, killing fish and other organisms (FAO, 2015). Reduced water quality usually limits the survival of other life forms, threatening biodiversity and ecosystems including both animal and human health (FAO, 2015). Further, when soil salinity increases due to irrigation or rising groundwater, more water is required to wash the salt from the soil. With increasing irrigation, more nutrients and chemicals such as pesticides, herbicides, and fertilisers residue on the soil and plants move down through the soil reaching the underground water, contributing to water pollution.

Water-related issues such as water depletion and water pollution which recorded as the most critical issues in the Australian cotton industry, have also become a significant issue in other cotton-producing countries (Bevilacqua et al., 2014; FAO, 2015; Joa et al., 2014; Martius, 2012; Zhang et al., 2015). For example, in Uzbekistan, one of the world's largest cotton exporters, the removal of water from rivers flowing into the Aral Sea to irrigate large cotton farms is the main reason for the reduction of the Central Asian Sea and its transformation into a desert (Morrison et al., 2009). Bevilacqua et al. (2014) also note that irrigation sources in China and Egypt are severely threatened due to the irrigation of cotton farms, suggesting that a switch from flood to drip irrigation should be considered.

According to Darbas et al. (2008, p. 103), "Water was considered the most important [natural resource management] NRM issue facing the cotton industry and was likely to remain so in 10 years time". Chapagain et al. (2006, p. 201) also note that "Cotton consumption is responsible for 2.6% of the global water use". Considering these hidden links between cotton consumers and the impact of cotton production on water, it appears that the externalities of water use in cotton production are not adequately accounted for in the price paid for cotton products by foreign consumers. Increasing prices and labelling products with information about their water footprint is an important aspect of any government policy aiming to reduce the negative externalities of cotton production, such as water depletion and pollution (Chapagain et al., 2006).

3. 2 Soil-related issues

As presented in Table 3. 1, the review shows that 28 out of the 52 studies highlight soil-related environmental issues caused by the Australian cotton industry. As discussed below, soil-related issues caused by the industry include soil salinisation, soil fertility depletion, soil pollution, and soil erosion.

Soil salinisation

The review shows that 14 of the 52 studies cite soil salinisation as an environmental issue caused by the Australian cotton industry. Soil salinisation refers to an increase in the amount of salt in the soil. A high level of salt in the soil can effectively decrease soil quality and suitability for agricultural activities by preventing plants from absorbing water (FAO, 2015).[44] Soil salinisation usually results from the evaporation of water from the soil surface, leaving sodium and other mineral deposits around the root area (FAO, 2015). According to Weaver et al. (2013), soil salinisation happens in irrigated cotton due to limited drainage and the presence of salt in irrigation water. Particularly in semi-arid areas, salinisation is a serious problem, exacerbated by surface irrigation methods such as flood or furrow. The reason for this is that surface irrigation involves more surface evaporation and leads to salt accumulating on the soil surface (Qadir et al., 2009; Sharma and Minhas, 2005). Weaver et al. (2013, p. 106) also note that in irrigated cotton farming, salinisation of shallow groundwater reserves is “a distinct possibility”, which leads to salinisation of the root area and to “poor subsoil structure and, thus, limited drainage” even when using high-quality water for irrigation.

Prior studies note that in addition to flood or furrow irrigation, drip irrigation can also cause salt accumulation in cotton farming due to the limited leachate (Liu et al., 2012), suggesting that there is an association between the amount of irrigation water and the amount of salt accumulation in cotton farming. While excessive irrigation leads to less water use efficiency in this industry, poor irrigation and “the lack of deep drainage could lead to salt accumulation” (Silburn et al., 2013, pp. 1065-1066). The FAO (2015, p. 25) notes that “poor on-farm water use efficiency; poor construction, operation and maintenance of irrigation canals causing excessive seepage losses; and inadequate or lack of drainage infrastructure or … [its] poor quality of construction, operation and maintenance” increase salinisation problems relating to irrigation in cotton farming.

According to the FAO (2015), depending on the soil type when groundwater is less than three metres from the surface, shallow groundwater may rise to the surface instead of percolating deep through the soil profile, and then evaporates from the surface, leaving salt

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[44] Excessive salt in the soil causes water to flow back into the soil from the plants’ roots, meaning that the plants cannot be watered properly regardless of the soil moisture (FAO, 2015).

behind. Silburn et al. (2013) also report that the salinisation problem in cotton farming increases in certain situations, such as deep drainage and that this is one of the most common problems in North Queensland cotton farms at present. Soil salinisation due to cotton farming is also a critical issue in other cotton-producing countries (Bevilacqua et al., 2014; FAO, 2015).

Soil fertility depletion

The review shows that eight of the 47 studies cite soil fertility depletion caused by cotton farming as an environmental concern. Fertile soil is defined in the literature as "productive land" that increases "farm profitability" and preserves "soil resources" for the future generation of farmers to make a living (Hulugalle and Scott, 2008, p. 174). The FAO (2015) notes that soil fertility is critical in growing a high-quality yield, because the plants absorb water, nutrients and air through the soil. According to Hulugalle and Scott (2008), the presence of fauna such as earthworms and ants in the soil, in addition to minerals and nutrients, is an indicator of soil quality.[45] However, excessive use of insecticides, historically used in this industry to manage pests, in addition to other management practices reduces soil quality in terms of the abundance and activity of beneficial soil biota (Hulugalle and Scott, 2008).

Several studies note that other factors—such as tillage intensity, excessive fertiliser application, burning of crop residues, nutrient leaching, and frequent nutrient exportation in monocultures—contribute to soil fertility depletion in Australian cotton farming (Antille et al., 2016; Hulugalle and Scott, 2008; Weaver et al., 2013). These factors deplete the soil's organic properties, leading to soil fertility degradation. For example, Hulugalle and Scott (2008, pp. 177–178) note that "in many cotton farms, soil organic carbon (SOC), a key indicator of soil quality and fertility, has decreased" mainly due to "insufficient amounts of crop residues being returned to the soil" and "management practices such as intensive tillage operations, burning of crop stubble, excessive water, and N [nitrogen] application rates". Maraseni et al. (2010) also note that while fertiliser application and tillage, as part of soil

[45] Studies identify various indicators of soil quality including soil structural guides such as solidity, penetrability and measures such as water holding capacity, strength, and drainage and percolation. Labile, microbial, and total soil organic carbon (SOC) level, soil pH, nitrates, phosphates, salinity, sodicity, exchangeable cations and cation capacity and level of accumulated herbicides and pesticides and other toxins are also used in assessment (Hulugalle and Scott, 2008, p. 174).

fertility management, could be critical in restoring soil fertility, these practices could also contribute to other environmental issues, such as GHG emissions, as discussed below.

Soil pollution

The review shows that ten of the 52 studies highlight soil pollution in the Australian cotton industry. Soil pollution is different from soil fertility depletion. Soil pollution happens when the soil is contaminated with various chemicals and other waste, such as gin waste, whereas soil fertility depletion occurs when soil loses its organic properties. Several studies indicate that in addition to cotton gin waste emissions and trash, other factors, such as pesticides, herbicides and other chemical residue in the soil contribute to the soil pollution caused by the Australian cotton industry (Visser et al., 2015; Weaver et al., 2012). For example, as explained in the water quality section above, studies by Weaver et al. (2012) show that the residue of Organochlorine pesticides (OCPs), such as DDT and DDE[46] have remained in the lower layers of vertisols in NSW after decades have passed since application in 1982. Pesticide residue in the soil could reach the food chain by moving into livestock feed and, hence, into the human body. Cotton Australia (2016b) reports that in 1994, insecticide residue was found in gin trash fed to beef cattle, leading to an enormous industry and government crisis in Australia. In 1995, following this incident, there was a growing concern about proper insecticide management because of health concerns. Further, Visser et al. (2015, p. 678) note that “gin trash is potentially a significant source of emissions” and that because it is disposed of as “landfill … in static piles” it emits a large amount of methane and nitrous oxide, causing additional issues, as discussed in the section on climate change, below. The FAO (2015) also reports that pesticide residue damages biotic and abiotic agents, and changes soil-microbe-plant dynamics, ultimately affecting both soil and crop health.

Soil erosion

Twelve of the 52 studies identify soil erosion as a significant environmental issue caused by the Australian cotton industry. Soil erosion refers to a condition where soil particles become loose and move downhill or over long distances (Pimentel and Burgess, 2013). According to Pimentel (2006, p. 119), “soil erosion is one of the most serious environmental and public

[46] Dichlorodiphenyltrichloroethane and dichlorodiphenylethane are both chemicals that have historically been used as pesticides.

health problems facing human society". Soil erosion reduces the quality of soil, air, and water, and decreases soil fertility, leading to reduced productivity, profitability, and human health (Antille et al., 2016; Koch et al., 2013; Pimentel, 2006; Pimentel and Burgess, 2013). In cotton production, the soil becomes vulnerable to erosion due to certain causes, such as water (either through irrigation or rain), and human activities including intense tillage and the use of heavy agricultural machinery. Several studies highlight the causal factors in soil erosion in the Australian cotton industry including soil compaction (due to the use of heavy machinery), lack of soil organisms and tillage (Antille et al., 2016; Hulugalle and Scott, 2008; Silburn et al., 2013). According to Hulugalle and Scott (2008), if the land is conventionally[47] tilled or the topsoil lacks organic substance, the soil is more vulnerable to erosion. This view is shared by Antille et al. (2016, p. 3), who state that, in cotton farming, "a cycle of compaction–tillage–recompaction … leads to progressive degradation of soil structure, loss of soil organic carbon (SOC) and a decline in crop productivity", increasing soil erosion. Further, Antille et al. (2016) note that studies conducted in the Murray-Darling Basin,[48] show extensive damage, costing the Australian government $150 million for the capital work, repairs and improvements to infrastructure to remedy soil structure erosions. Audit data show a relatively high rate of soil erosion on Australian cotton lands (7 t/ha/year) (Gleeson and Dalley, 2006).

Soil erosion is dangerous and costly, and it is also an issue in other parts of the world. Pimentel (2006, p. 119) notes that "Each year about 10 million ha of cropland are lost due to soil erosion". Pimentel (2006, p. 130) also notes that soil erosion caused 30% of the world's arable land to become unproductive over a period of just four decades. Most of the eroded soil is washed into rivers and lakes, contributing to waterways' vulnerability to flooding and contamination with agricultural chemicals. Soil erosion weakens the soil's ability to store water and nourish plants, leading to a lack of support for the soil's organic biota, forests and other ecosystems. It also increases the amount of dust transferred by the wind, causing dangerous air pollution and stirring up about 20 transmissible human disease agents, such as anthrax and tuberculosis. According to Pimentel and Burgess (2013, p. 443), "Overall, soil is being lost from agricultural areas 10 to 40 times faster than the rate of soil

[47] Conventional tillage involves incorporating residue into the soil.
[48] The Murray-Darling Basin is one of the areas hosting cotton farms in Australia.

formation imperilling humanity's food security".

3. 3 Land use and biodiversity

The review shows that 26 of the 52 studies highlight issues relating to land use and biodiversity in the Australian cotton industry (e.g. Agbola and Evans, 2012; Antille et al., 2016; Darbas et al., 2008; Davies et al., 2009; 2011).

Land use

Seven of the 52 studies identify land use as one of the environmental issues in which the Australian cotton industry plays a part. In cotton production, land use includes the use of land as a resource, from cultivating plants to processing cotton to manufacturing fibre for textiles (Muthu et al., 2012). Land used for cotton is also suitable for food production, forestation and animal habitats. The land is a limited resource, and needs to be used wisely (Agbola and Evans, 2012; Kidane, 2005). Land use is an issue in the Australian cotton industry because with population growth and increased demand for food, clothing and housing, competition for ever scarcer land will also increase, eventually threatening food security and the production of natural fibres such as cotton (FAO, 2012; Kidane, 2005; Shabani and Kotey, 2015). Most of the Australian population resides in major cities in eastern Australia, where the cotton farms are also located (Kidane, 2005). Currently, 200,000 ha of land is used for cotton farming in Australia, mainly located in NSW and Queensland (Cotton Australia, 2016a). Competition for land is also associated with the cotton industry internationally. According to the FAO (2015, p. 5), a total of 32,429,000 ha of land is used for cotton farming globally, representing 2.3% of the world's arable land.

Biodiversity

The review shows that 22 of the 52 studies note the impact of the cotton industry on biodiversity. Article 2 of the *Convention on Biological Diversity* in 1992, defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (Convention on Biological Diversity, 2016). According to Fitt (2000, p. 794), cotton fields usually host a large variety of insects including 450 different species in an unsprayed Australian field, and a large proportion of these are beneficial. The main beneficial groups in cotton fields are similar in most parts of the world, but their value is unknown because of uncommon large-scale experiments on unsprayed land, and the difficulty in categorising the damaging species and their impact. One of the main barriers to the development of integrated pest management (IPM)[49] in cotton is the lack of suitable tools to control and manage target pests without destroying these beneficial species (Fitt, 2000).

Pest management has become a challenge for the cotton industry. Several studies indicate that excessive use of chemicals, such as pesticides, insecticides, and fungicides in cotton production negatively impacts on biodiversity (e.g. Mensah et al., 2015; Visser et al., 2014; Weaver et al., 2012). According to Rieple and Singh (2010), only 0.1% of the applied chemicals, such as pesticides get to the targeted pests and the other 99.9% left to impact on the physical environment. These chemicals kill pests and unwanted insects, as well as disease-causing agents. The chemicals also kill non-target pests and organisms during and after application through contact with the air, soil and the plants (Jin et al., 2011). In relation to the use of chemical insecticides in the Australian cotton industry, Davies et al. (2011, p. 429) note that "while very effective against pests initially, such control measures [chemical insecticides] proved disastrous, promoting resistance development and variation in pest status among non-target species and inflicting serious environmental and health concerns on cotton-growing regions regularly exposed to insecticide overuse". These chemicals are also harmful to farm workers, as well as to aquatic life through contact with water and reduce the abundance and activity of soil biota (Lytton-Hitchins et al., 2015). The most recent disastrous incident caused by pesticide drift from cotton farms was in the Darlington Point area of NSW in 2013 which caused the deaths of numerous hives on neighbouring beekeeping farms (Murphy, 2017).

The use of genetically modified (GM) cotton in the industry has also negatively affected biodiversity. While some studies claim that emerging GM technology[50] has decreased the use of pesticides and herbicides (Antille et al., 2016; Braunack, 2013; Downes and Mahon,

[49] Integrated pest management helps to reduce reliance on chemical control of pests and to ensure that some non-chemical regulation of pest populations is used. 'Stewardship helps to ensure that the industry has access to technologies, such as biotechnology traits and 'softer' insecticides from which to build an IPM system' (CottonInfo, 2016, p. 54). Integrated pest management aims to maintain pest populations at levels that do not cause economic damage and to sustain profitability year-after-year.
[50] Including Roundup Ready, Bollgard II, and the recently developed Bollgard III.

2012a; 2012b) by releasing Bt chemical[51] to kill unwanted pests, many studies note that GM cotton also destroys non-target organisms (Knox et al., 2006). Bt chemicals released by GM varieties could also raise additional issues such as the resistance of some pests to these chemicals (Downes and Mahon, 2012b).

The cotton industry's impact on biodiversity has also become an issue in other cotton-producing countries. Studies by Bevilacqua et al. (2014) comparing the environmental impacts of cotton production in four countries (Egypt, China, India and the US) indicate that Indian cotton producers are the worst in terms of ecosystem quality due to high fuel consumption and lower productivity. Based on a study of environmental issues in cotton production in China, Zhang et al. (2015) also highlight that the impact of soil emissions on ecosystems and biodiversity is 82.90% due to the toxic chemicals in pesticides used in cotton production. This impact is 15.90% for air emissions due to fertiliser use and 15.70% for water pollution and eutrophication due to Nitrate leaching into nearby bodies of water. The studies in the US also show that the cost of environmental damage due to pesticide usage is as high as $9 billion per year. These studies suggest that for every dollar spent on pesticides, there are profits of $3–5 which are offset by $3 in environmental costs including damages to biodiversity and ecosystems (Rieple and Singh, 2010).

3. 4 Climate change and GHG emissions

Twelve of the 52 studies identify climate change and greenhouse gas (GHG) emissions to be critical environmental issues caused by the Australian cotton industry. Climate change and GHG emissions are among the greatest concerns of the current time (Apgar et al., 2009). GHGs are gases that hold the heat in the atmosphere causing global warming. GHGs are mainly comprised of carbon dioxide (CO_2), a small amount of methane, and nitrous oxide (N_2O) (Visser et al., 2015).

According to Visser et al. (2015, p. 682), the production of one bale[52] of cotton to the point of export in Australia has a total carbon footprint of 323 kg CO_2e/ha. This amount includes 182 kg CO_2e for the farming, 73.1 kg CO_2e for the gin to the port supply chain, and 68.1 kg CO_2e from emissions from the stockpile gin trash at the gins. Several studies also highlight

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[51] GM cotton is supplemented with additional genes to produce proteins from the soil bacterium Bacillus thuringiensis (Bt) to kill pests.
[52] Each bale weighs 227kg.

that the high levels of GHG emissions caused by the cotton industry result from the use of energy and fossil fuel to run agricultural machinery and equipment during the various stages of cotton production (Ismail et al., 2011; Maraseni et al., 2010; Roth et al., 2013; Visser et al., 2015). Other CO_2- and N_2O-producing activities contributing to GHG emissions include cottonseed production,[53] the use of electricity in irrigation and ginning, residue burning, carbon accumulation in soil, the use of nitrogen (N) in fertilizers, and the production, packaging, storage and transportation of fertilizers, herbicides and pesticides (Ismail et al., 2011; Maraseni et al., 2010; Visser et al., 2015).

Studies also note that the industry contributes to global warming. Maraseni et al. (2010, p. 504) report that N_2O caused 6% of observed global warming and 6.3% of Australia's GHG emissions. Further, Maraseni et al. (2010, p. 501) note that irrigated cotton produces the highest amount of emissions (4841 kg CO_2e/ha) highlighting the GHG emissions caused by energy use for irrigating cotton crops in Australia.

The factors contributing to carbon emission also vary between different stages of cotton production in Australia. This is because cotton farming in Australia is highly mechanised. In the farming stage, GHG emissions are due to the use of fossil fuels to operate machinery for land preparation and ploughing, cottonseed production, planting, applying agrochemicals, crop cultivation, harvesting, slashing, stalk pulling and transport (Maraseni et al., 2010, p. 501). In the ginning stage, GHG emissions are due to the energy used to operate ginning machines and equipment to separate cotton lint from the seeds and trash. According to Ismail et al. (2011, p. 140), about 60.38 kg of CO_2e emissions is produced to gin one bale of cotton. Gin trash is also a significant source of emissions. According to Visser et al. (2015), about 9,300 tons of trash is produced annually. Visser et al. (2015) also note the ginning itself represents 85% of emissions, and transport and storage contribute to the remaining 15%.

GHG emissions caused by the cotton industry have also become an issue in other countries such as India, China, and the USA (Bevilacqua et al., 2014; Rieple and Singh, 2010). According to Bevilacqua et al. (2014, p. 154), the highest GHG emissions, which is 0.89 kg of CO2e per kilogram of cotton, are produced by Indian cotton producers. The emissions

[53] Cotton seed for planting is produced off-farm and transported to the farm, which must be considered when estimating GHG emissions.

during the cotton production stage in India are equal to 2.81 CO_2e/kg (Bevilacqua et al., 2014, p. 164).

A report by the Carbon Trust details the amount of GHGs emitted by the main cotton producers including Australia. Among these producers, Australia creates the lowest amount of GHG emissions, equal to 4.4 tCO_2e/t lint, whereas India creates the highest amount about 11.7 tCO_2e/t lint, followed by China at 9.6 tCO_2e/t lint, the USA at 7.0 tCO_2e/t lint, and Brazil at 6.4 tCO_2e/t lint (Carbon Trust, 2011). The report also shows that fertiliser production causes the most GHG emissions compared to other activities in the cotton industry. Further, the report shows that in Australia, the use of electricity in ginning and fuel consumption in mechanical processes are responsible for 15% and 17% of total GHG emissions respectively, being the highest of all cotton-producing countries (Carbon Trust 2011). This high level of GHG emissions is primarily caused by Australia's highly mechanised cotton farming activities.

4. SUMMARY AND CONCLUDING REMARKS

The aim of the study is to review, identify and integrate the critical environmental issues caused by the Australian cotton industry. Drawing on the integrative literature review approach, the study identifies four categories of environmental issues related to water, soil, land use and climate change including GHG emissions. The study also discusses each category and provides a comparison with the cotton industry in other main cotton-producing countries. Further, the review highlights some recommendations to minimise current environmental issues leading to a sustainable cotton production.

The study identifies water-related issues, such as water depletion and water pollution, as the most critical issues caused by the Australian cotton industry. As highlighted in 36 of the 52 studies reviewed, water has become the central issue mainly because Australia is a dry continent, and cotton farming uses excessive water (Darbas et al., 2008; Roth et al., 2013; Vardon et al., 2007). While some recent research reports published by The Cotton Research and Development Corporation (CRDC) indicate a 40% reduction in water usage by the industry (Apparel Resources, 2016), there are still opportunities for improvement in a more sustainable cotton farming, thus, further research is critical to identify mechanisms to achieve sustainable water use in the industry.

The study also finds GHG emissions to be the least critical issue (highlighted in twelve studies only) of concern in the Australian cotton industry. Australia’s low GHG emissions mainly result from the use of GM cotton, which has reduced pesticide usage by 90% (Cotton Australia, 2016c). However, the highly mechanised agricultural activities in Australia still is known to be a key factor contributing to the GHG emissions. The review also finds that the industry contributes to environmental issues related to soil, land use, and biodiversity in Australia.

Implications

The study provides some valuable information for academics and researchers by highlighting the areas of concern that require further examination in the Australian cotton industry. In particular, the present review suggests that the most significant environmental issues in this industry are still related to water usage and recommends that further research is critical for the sustainable water use in the industry.

The study also provides some valuable guidelines for policymakers, farmers and managers in the cotton industry. First, the review provides suggestions for farmers and policymakers on the origins of critical issues and, thus, highlights the areas where attention needs to be focussed to reduce these issues. Second, the study can help policymakers understand where the cotton industry stands in terms of the severity and urgency of critical environmental issues. For example, GHG emissions seem to be the most critical issue in India, whereas in Australia it is the least critical.

Limitations of the study

Several limitations of the study should be noted. First, the scope of the review is the cotton production industry, focusing only on the cotton farming and ginning stages of the supply chain. The environmental issues associated with the other stages of the supply chain are not examined in this review. Second, this review focuses only on the Australian context based on 52 academic research papers. There can be other environmental issues caused by the cotton industry in other countries, depending on their climates and the types of technology used. Therefore, the findings might not be generalisable to the cotton industries in other countries. These limitations also create avenues for future research.

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CHAPTER FOUR

(PAPER 2)

ENVIRONMENTAL MANAGEMENT ACCOUNTING PRACTICES IN AUSTRALIAN COTTON FARMING: THE USE OF THE THEORY OF PLANNED BEHAVIOUR

This paper is accepted by *Accounting, Auditing and Accountability Journal* (ABDC Rank A).

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ABSTRACT

Purpose – The aim of this study is to examine the association between the belief-based factors (attitude, subjective norm and perceived behavioural control) and environmental management accounting (EMA) practices.

Design/methodology/approach – Drawing on the theory of planned behaviour (TPB), the study develops a structural model and uses Partial Least Squares (PLS) technique to analyse data collected based on a survey of the Australian cotton farmers.

Findings – The findings indicate that while attitude and perceived behavioural control significantly influence farmers' intention to adopt EMA practices, subjective norm has a significant indirect influence on EMA practices through farmers' attitude and perceived behavioural control. Further, the study reveals that while the intention of more environmentally friendly farmers is largely influenced by attitude and subjective norm, the intention of less environmentally friendly farmers is primarily driven by perceived behavioural control.

Practical implications – The study provides important insights into the role of attitude, subjective norm, and perceived behavioural control in motivating farmers towards adopting EMA practices. Such insights could also help farmers in designing effective EMA practices.

Originality/value – This study contributes to very limited EMA literature on TPB by integrating three belief-based factors, namely attitude, subjective norm and perceived behavioural control.

Keywords: Cotton Farming, Farmers, Belief-based Factors, Theory of Planned Behaviour, Environmental Management Accounting, Australia.

1. INTRODUCTION

Cotton is known to be the backbone of the textile industry. Many countries[54] including Australia, rely on the economic contributions made by producing and exporting cotton (FAO, 2015).[55] Cotton exports contribute over $2 billion to the Australian economy each year, supporting 152 rural communities (Cotton Australia, 2016b) and making Australia the world's third largest cotton exporter (FAO, 2015).

Despite the great economic contribution of cotton production,[56] the environmental costs and issues caused by this industry cannot be overlooked. Studies show that this industry's activities cause significant environmental issues, such as pollution and depletion of water, and damage to soil, land, biodiversity and the atmosphere (Lytton-Hitchins et al., 2015; Maraseni et al., 2010; Roth et al., 2013). Factors contributing to these issues include the use and manufacture of fertilizers, tillage, eutrophication and excessive consumption of energy and fuel in this industry (FAO, 2015; Hulugalle et al., 2015a; 2015b).

In response to these environmental issues, the Food and Agriculture Organisation of the United Nations (FAOUN) calls for an interdisciplinary approach to tackle the environmental issues caused by this industry (FAO, 2015). According to the FAO (2015, p. XI) "Water use and management, soil management, production efficiency and energy usage, greenhouse gas emissions and biodiversity", in addition to chemical use, are the "list of important environmental issues" requiring research studies for an immediate improvement in cotton production. In this regard, further research is paramount to analyse different aspects of the environmental impacts of cotton farming. Such research could also examine the environmental impact of crop rotations on soil quality, hydrology (Hulugalle and Scott, 2008) and irrigation (including rainfall) for areas of potential improvement (Roth et al., 2013).

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[54] The world's main cotton exporters include: the USA, India, Australia, Francophone Africa, Uzbekistan, Brazil, Pakistan and Turkey (FAO, 2015).

[55] The full references of all the citations in this paper are available in the reference list at the end of this paper on page 152.

[56] The terms cotton production, cotton farming and cotton industry are used interchangeably in this study. Over 99 per cent of the cotton produced in Australia is exported, and the Australian cotton industry mainly conducts the farming and ginning phases (Cotton Australia, 2016b).

Environmental management accounting (EMA) is likely to play a key role in minimising environmental issues in Australian cotton farming. EMA allows farmers in the cotton industry to identify, measure, analyse and interpret the environmental aspects of their farming activities such as disposal of pesticides and other chemicals, and the impact of chemicals on soil and water pollution, impact of tillage on soil erosion, and the impact of excessive irrigation on water depletion (Burritt et al., 2002). According to Jasch (2006), the use of such accounting practices could help to identify, quantify, and minimise the environmental impacts by measuring and comparing the amount of inputs and outputs, as well as waste and emissions. EMA information in the cotton industry may be financial (such as the amount of money spent for pollution prevention of pesticide disposal) or non-financial (such as the amount of water used for irrigating cotton farms) (Jasch, 2009). Further, studies note that EMA can be treated as a useful tool to manage the environmental and financial performance of industries (Mokhtar et al., 2016), including agriculture, which is heavily reliant on natural resources such as soil, water and air (Langeveld et al., 2007).

However, a review of the literature suggests that there is limited knowledge of EMA practices in cotton farming (Schaltegger et al., 2013). Previous studies mostly examine the role of EMA in other industries. For example, while Burritt et al. (2009) examine EMA practices in rice mills in Philippine, Gale (2006a) studies EMA in Canadian paper mills. Prior studies have also paid limited attention to farmers' behavioural factors, such as attitude, subjective norm and perceived behavioural control which could provide a platform for designing effective EMA practices to minimise the environmental issues caused by cotton farming.

The aim of this study therefore, is to examine Australian cotton farmers' intentions to adopt EMA practices. Drawing on the theory of planned behaviour (TPB), the study also explores the extent to which farmers' behaviour-related factors, such as attitude, subjective norm and perceived behavioural control, impact on their intention to adopt EMA practices. *Attitude* is an individual's positive or negative evaluation of the outcome of performing a particular behaviour, and *subjective norm* is an individual's perception of the extent of the agreement they receive from the significant people in their life in relation to the performance of a particular behaviour. *Perceived behavioural control* is the ability of the individual to perform a particular behaviour, evidenced by skills, time and financial abilities. The study uses Partial

Least Squares (PLS) technique to analyse data collected from cotton farmers through a mail survey.

This study makes three important contributions to the literature. First, the study contributes to the management accounting literature by examining EMA practices in Australian cotton farming. Previous studies mainly focus on current EMA practices in organisations (more historically oriented). Thus, the findings of those studies provide very limited information about the managers/farmers' intentions to use EMA practices in the future. The examination of farmers' intention to use EMA practices therefore, is more future-oriented and fills a gap in very limited EMA literature.

Second, this study makes a major contribution to interdisciplinary research by linking EMA practices (accounting) to belief-based factors drawing on TPB (psychology) literature. Previous studies on TPB examine belief-based factors, namely attitude, subjective norm and perceived behavioural control in areas such as organic farming (Läpple and Kelley, 2013), waste paper recycling (Cheung et al., 1999), sustainability reporting (Thoradeniya et al., 2015), and environmental activism (Fielding et al., 2008). However, this study uses a novel approach by using TPB to examine whether the belief-based factors are associated with farmers' intentions to adopt EMA practices.

Finally, the study contributes to the literature on agriculture and cotton farming. Prior studies highlight the importance of minimising various environmental issues (e.g. water pollution and depletion, soil erosion and carbon emissions) associated with cotton farming (e.g. Antille et al., 2016; Braunack, 2013; Maraseni et al., 2010). In particular, cotton farming in Australia has become more mechanised, and has increased carbon emissions, leading to environmental risk. Cotton farming in Australia also uses an excessive amount of water (over two-thirds of cotton farmers in Australia grow irrigated cotton), leading to water depletion (Bevilacqua et al., 2014; Roth et al., 2013). Very limited studies, however, provide empirical evidence on the practices that cotton farmers could use to minimise such environmental issues. Thus, given the significant environmental issues associated with cotton farming in Australia and lack of knowledge about the practices to be used to minimise such environmental issues, this study examines EMA practices that could minimise environmental issues in Australian cotton farming.

The remainder of this paper is set out as follows. Section 2 presents the theoretical framework of this study. Section 3 discusses the relevant literature and develops hypotheses for the study. Section 4 describes the research method, followed by Section 5, which presents the results of the data analysis. Section 6 concludes the paper with some implications and limitations and provides insights into future research.

2. THEORETICAL FRAMEWORK

The study draws on the theory of planned behaviour (TPB) to develop the theoretical framework. TPB,[57] which was introduced by Ajzen in 1985, explains that the intention to engage in a particular behaviour is the first determinant of an individual's behaviour (Ajzen, 1991; 2002; 2005; Fielding et al., 2008; Läpple and Kelley, 2013). In general, the stronger the intention to engage in a behaviour, the higher the likelihood of its performance (Ajzen, 1991). TPB argues that behavioural intentions are predicted by three belief-based factors including attitude, subjective norm, and perceived behavioural control (Ajzen, 1991). Together, these three factors (attitude, subjective norm and perceived behavioural control) predict human intention towards a behaviour (Ajzen, 2005) (see Figure 4. 1).

TPB had initially been used in social psychology to explain specific health-related human behaviour such as healthy eating (Povey et al., 2000), exercise (Rhodes et al., 2002), and smoking (Norman et al., 1999). TPB is also well supported across other disciplines including education, engineering, tourism and environmental studies (Han et al., 2017; Li et al., 2013; MacFarlane and Woolfson, 2013). For example, it has been used in environmental studies to explain intentions to engage in environmental activism (Fielding et al., 2008), recycling (Botetzagias et al., 2015; Cheung et al., 1999), pro-environmental behaviour in young people (De Leeuw and Schmidt, 2015), sustainability reporting (Thoradeniya et al., 2015), and environmental behavioural intentions in a workplace setting (Greaves et al., 2013). More recently, TPB has been used in agricultural studies to explain farmers' behavioural intentions. For example, Läpple and Kelley (2013) used TPB to examine the adoption of organic farming among Irish farmers. TPB has also been used to explain farmers' intention

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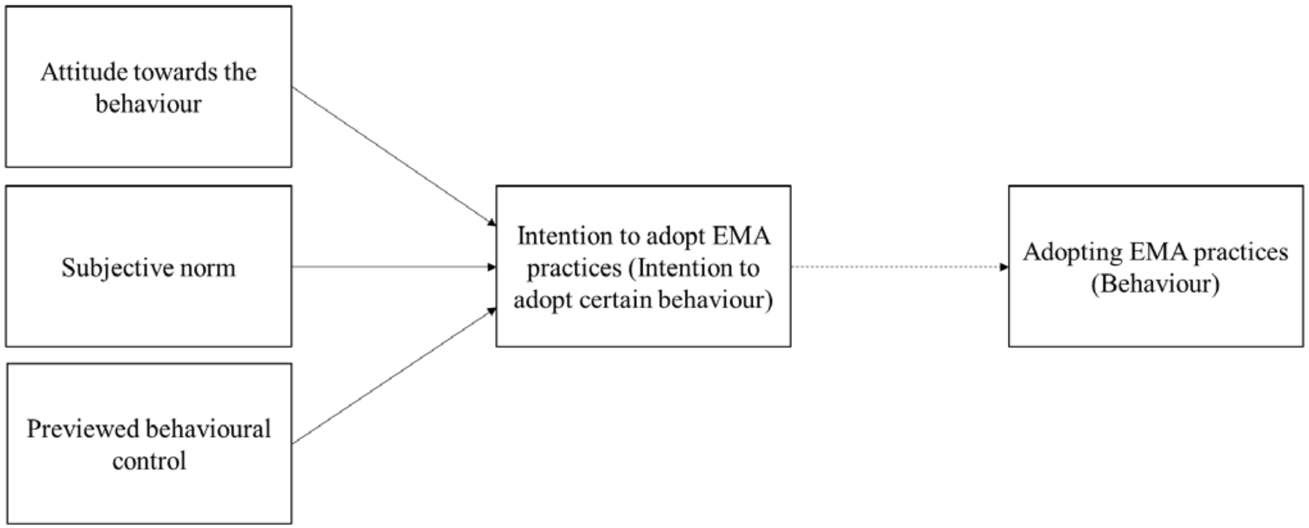
[57] The theory of planned behaviour is an extension of the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975) developed by adding an extra predictor of intentions and behaviour in response to the limitations of TRA in "dealing with behaviours over which people have incomplete volitional control" (Ajzen, 1991, p.181). The additional predictor of intentions and behaviour is called perceived behavioural control (Ajzen, 1991).

to adopt improved natural grassland (Borges et al., 2016; Borges et al., 2014), and determine farmers' agricultural land use practices (Poppenborg and Koellner, 2013). Following previous studies, this study also uses TPB to examine the associations between the three belief-based factors and farmers' intention to use EMA practices in cotton farming and develops the following theoretical framework.

Figure 4. 1 - The theory of planned behaviour



EMA – Environmental Management Accounting

Ajzen (2005)

Hypotheses development

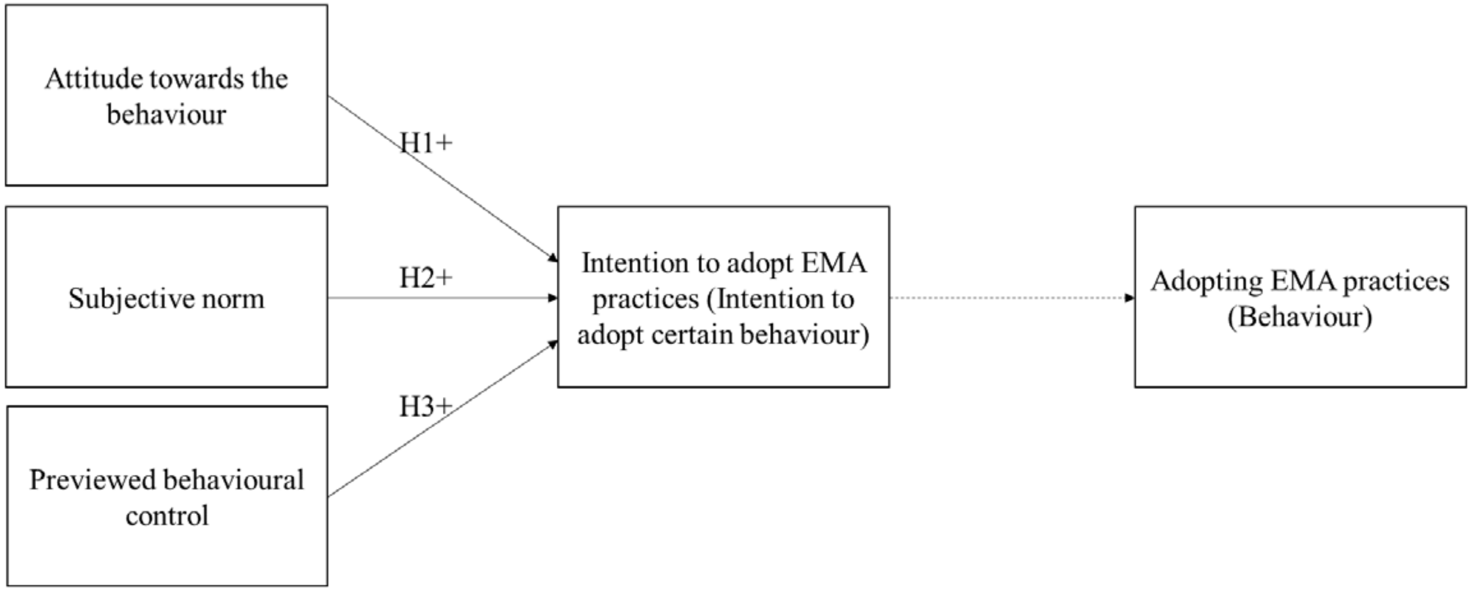
EMA is a relatively new concept in management accounting. EMA primarily focuses on the environmental performance of organisations by providing financial information about environmental costs, earnings and savings, as well as non-financial information about the use and flows of energy, water and materials (including waste) (Jasch, 2009). EMA practices generating financial information include measuring the cost of for example, input resources (e.g. energy, water and material) and environmental pollution (e.g. air, water and soil). EMA practices also include identifying, measuring, analysing and interpreting non-financial information (e.g. number of wastewater recycles) related to environmental business activities such as input resources and pollution (Burritt and Schaltegger, 2002; Ferreira et al., 2010; Jasch, 2003; 2009). According to previous studies 'merely' identification of waste is also a practice of EMA (Burritt and Schaltegger, 2002; Ferreira et al., 2010; Frost and Wilmshurst, 2000; Gale, 2006b). Thus, following previous studies, EMA practices in this study include identifying, measuring, analysing and interpreting both financial and non-financial data related to environmental business activities (Burritt and Schaltegger, 2002; Ferreira et al., 2010; Frost and Wilmshurst, 2000) (see Appendix 1). The use of such practices can help farmers to maximise input material efficiency, minimise waste, reduce environmental harm and environmental protection costs (Ferreira et al., 2010; Jasch, 2009).

The intention to adopt EMA practices by farmers and managers in the cotton production industry could be driven by different internal and external factors[58] including regulations, and demands by activists and stakeholders (Fielding et al., 2008; Greaves et al., 2013; Läpple and Kelley, 2013). According to TPB, the internal factors include belief-based factors, such as personal attitude, subjective norm and perceived behavioural control (including skills, knowledge and ability) which affect farmers' behaviour (Ajzen, 2005). TPB notes that these belief-based factors are determined by personal, social and informational factors including emotions, intelligence, values, general attitudes, personality traits, age, gender, race, ethnicity, education, income, religion, experience, knowledge and media exposure (Ajzen, 2005).

[58]A detailed discussion of external factors is out of the scope of this study.

According to TPB, individuals who hold a positive attitude towards a particular behaviour, think that they have normative support and perceive that they have the ability to perform the behaviour, develop stronger intentions to perform the behaviour. The stronger the intention to perform the behaviour, the more likely that it will be performed (Ajzen, 2005). The following sub-sections discuss the hypotheses developed in the study based on the three main determining factors of the TPB, namely attitude, subjective norm and perceived behavioural control. Figure 4. 2 presents a summary of the hypotheses and constructs of this study.

Figure 4. 2 - Structural model: Attitude towards the behaviour, subjective norm, perceived behavioural control, and intention to adopt EMA practices



EMA – Environmental Management Accounting

Attitude

Attitude of an individual is one of the belief-based factors influencing the individual's intention to perform a certain behaviour (Ajzen, 1991). Attitude indicates the positive or negative evaluation of a certain behaviour (Ajzen, 1991). Fielding et al. (2008, p. 139) define attitude as "the overall positive or negative evaluation of performing the behaviour". Ajzen (1991) notes that attitude can be predicted from individuals' beliefs about the outcomes of the behaviour[59] and the evaluation of those outcomes. According to TPB, individuals who hold positive attitudes towards a particular behaviour are likely to undertake that behaviour (Ajzen, 2005).

Previous studies have examined the influence of attitude on behavioural intentions in different settings, disciplines, countries, cultures and age groups (Botetzagias et al., 2015; Kuasirikun, 2005; Thomas and Upton, 2014). Such studies note that having a positive attitude towards a particular behaviour leads individuals to perform that behaviour. Health-related studies indicate that the positive attitude of participants drives their intentions towards developing healthy habits, such as adopting a healthy diet, exercise plan and completing a substance abuse programme (Armitage et al., 2002; Povey et al., 2000; Zemore and Ajzen, 2014).

The role of attitude on behavioural intentions has also been examined in agricultural studies (e.g. Poppenborg and Koellner, 2013). These studies find that attitude is influential in farmers' decision-making and in the adoption of business strategies (Hansson et al., 2012). By examining 220 South Korean farmers, Poppenborg and Koellner (2013) find that farmers holding a positive attitude towards the ecosystem, such as prevention of soil erosion, improvement of water quality, and conservation of plants and animals, are likely to plant annual or perennial crops[60] to better protect soil fertility and the broader ecosystem. Similarly, Kim (2014) finds that a negative attitude towards genetically modified (GM) food and its ecological impact leads people to avoid buying GM food.

Farmers' attitude is also likely to influence their intentions to adopt management practices such as EMA. Farmers can use various management accounting practices to minimise

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[59] Known as behavioural beliefs.

[60] Monoculture causes extreme damage to soil fertility, while planting annual or perennial crops helps to sustain soil fertility.

environmental issues. For example, in a survey of 465 households, Li et al. (2013) find that farmers' attitude influences the adoption of environmentally friendly farming practices similar to the use of EMA such as measuring the consumption of energy and identifying the level of pollution. Graymore and Wallis (2010) also find that positive attitude among farmers and residents in rural and regional West Victoria, Australia, determines the water saving practices they adopt including measuring the cost and quantity of water usage. Further, findings by Beedell and Rehman (2000) suggest that farmers with greater environmental awareness are more likely to adopt practices such as EMA (e.g. cost of land protection, measuring pesticides usage, and identifying the harmful impacts of farming activities). This study therefore, based on TPB and the above discussion, proposes the following first hypothesis:

> **H1:** *There is a positive relationship between cotton farmers' attitude and their intention to adopt EMA practices.*

Subjective norm

Subjective norm is one of the belief-based factors influencing the intention of an individual to engage in a certain behaviour (Ajzen, 1991). MacFarlane and Woolfson (2013, p. 47) define subjective norm as "an individual's perception of how significant others will approve of their behavior". TPB also notes that subjective norm is the individual's beliefs which are influenced by the likelihood of approval or disapproval by groups important to the individual[61] (Ajzen, 2005). These important groups might include family, friends, colleagues, supervisors, financial institutions, or the wider society. Prior studies on subjective norm in the field of agriculture also note that subjective norm is dependent on the people who are important in farmers' lives, such as friends, families, other farmers, government agencies, media, suppliers, crop consultants and lenders. Based on a survey of 698 farmers in eastern Nebraska in the US, Artikov et al. (2006) find that farmers' decisions to use climate forecasts are strongly influenced by others, such as family, other farmers, government agencies and lenders.

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[61] Known as normative beliefs.

Subjective norm is likely to influence farmers' intentions to adopt EMA practices. For example, Läpple and Kelley (2013) examine the uptake of organic farming among 193 Irish farmers and find that farmers who perceived that their family, other farmers, farm advisors, farm information events and press are supportive towards organic farming, are more likely to adopt organic farming practices. Beedell and Rehman (2000) also examine farmers' conservation behaviour and find that farmers who are members of the Farming and Wildlife Advisory Group (FWAG) are more involved with environmentally friendly farming practices similar to EMA such as identifying the structure of the landscape, and measuring the cost of protecting ecosystems and biodiversity than other farmers. Further, a more recent study by Li et al. (2013) suggests that farmers' decision to adopt practices similar to EMA such as measuring energy usage is influenced by their subjective norm. The findings of the above studies indicate that farmers who are under greater normative pressure from referent bodies and associated groups, including government and non-government organisations, are more likely to undertake EMA practices aimed at protecting the natural environment. Therefore, based on TPB and the above discussion, the study proposes the following second hypothesis:

> **H2:** *There is a positive relationship between cotton farmers' subjective norms and their intention to adopt EMA practices.*

Perceived behavioural control

Perceived behavioural control is one of the belief-based factors influencing the intention of an individual to perform a certain behaviour (Ajzen, 1991). According to TPB, perceived behavioural control refers to the extent to which an individual perceives a particular behaviour to be easy or difficult to perform depending on the individual's volitional control[62] (Ajzen, 1991). Botetzagias et al. (2015, p. 59) define perceived behavioural control as "the individual's perceived ability to perform the behavior". TPB notes that perceived behavioural control is primarily dependent on the availability of requisite opportunities and resources, such as money, time, skills and the assistance of others (Ajzen, 2002). The more control over resources, supports and opportunities an individual has to perform a particular

[62] Known as control beliefs.

behaviour, the more likely they will engage in that behaviour (Botetzagias et al., 2015; Zemore and Ajzen, 2014).

Perceived behavioural control also has a direct impact on actual behaviour and on behavioural intention (Ajzen, 2005; Zemore and Ajzen, 2014). It helps individuals to perform the behaviour with greater ease by providing them with access to support, such as assistance from others, time and money (Ajzen, 2005). Prior studies also provide empirical evidence that perceived behavioural control influences individual behaviour. For example, a study by Botetzagias et al. (2015), in the context of recycling, finds that knowledge and ability to use recycling is the most important predictor of the behaviour among 293 Greek citizens. Chen and Tung (2014) also find that perceived behavioural control has a positive and significant influence on travellers choosing green hotels.

Perceived behavioural control is likely to influence farmers' intentions to adopt EMA practices. Farmers who possess sufficient resources are more likely to adopt EMA practices such as measuring the amount of waste, measuring the amount of pollutions and identifying the harmful impact of pesticides use on ecosystems. The more economic incentives and the knowledge of EMA practices farmers have, the more likely they are to adopt such practices. For example, the findings of Deng et al. (2016) indicate that farmers' means and abilities are more likely to influence their practices similar to EMA such as identifying the land protection practices, measuring the cost of forest management technology and Grain to Green Programs[63] (e.g. measuring costs of soil erosion prevention and water depletion). Further, based on a sample of 193 Irish farmers, Läpple and Kelley (2013) find that the abilities and resources of farmers are influential in adopting environmentally friendly farming practices similar to EMA such as measuring chemical usage. The findings of Borges et al. (2014) also suggest that the use of practices similar to EMA such as measuring and minimising the cost of input of livestock farming[64] depends on farmers' ability, and on easier access to improved natural grassland.

[63] Grain to Green Programs are Chinese restoration programs which aim to restore damaged natural vegetation, to prevent soil erosion and water depletion in environmentally fragile areas, and to support rural economic development (Deng et al., 2016).
[64] In addition to minimising costs, the use of natural grassland for grazing livestock improves animals' health and the soil fertility.

The findings of the above studies indicate that farmers who possess sufficient time and resources are more likely to use EMA practices. Based on TPB and the above discussion, the study proposes the following third hypothesis:

> **H3:** *There is a positive relationship between cotton farmers' perceived behavioural control and their intentions to adopt EMA practices.*

3. RESEARCH METHOD

3. 1 Sample selection and data collection

The study focuses on cotton farmers in Australia. The initial population of the study was about 1,200 cotton farms, including publicly listed cotton agri-businesses, large corporate farms and small family farms[65] (Cotton Australia, 2013b; 2016a). The cotton farms included in the population of this study are mainly located in New South Wales (NSW) and Queensland (QLD), because the two states commonly use the same water resources (e.g. Murray and Darling Rivers) for irrigation and have the similar climatic condition suitable for cotton farming (Cammarano et al., 2012; CottonInfo, 2015).[66] After deducting subsidiary farms,[67] the final population of the study consists of 875 cotton farms. 875 cotton farms in the final population have been ranked based on farm size[68] and the largest 400 farms (measured as a number of employees) were selected as the sample for the study.[69] Large farms are likely to use more EMA practices than small farms (Läpple and Kelley, 2013). The sample size is considered large enough to be representative of the population (Van der Stede et al., 2005).[70]

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[65] Listed agri-businesses are publicly owned by shares, corporate farms are private companies and family farms include small farms, mainly owned by the farmer and his/her family. The majority of the farms in the sample are family farms.

[66] Only two (NSW and QLD) out of six states in Australia primarily grow cotton. The two states commenced cotton farming in the same time period (1960s). In addition to sharing water resources and the same climatic condition, farmers in the two states use the same farming technique and method (Cotton Australia, 2013a). It is also likely that farmers in the two regions share the same cultural and education background.

[67] In general, Australia's cotton farms are family businesses, owned by farmers and their families (Cotton Australia, 2013b; 2017). Some farmers own more than one farm, and parent companies and their subsidiaries are counted as one, reducing the final population to 875 cotton farms.

[68] Farm size is measured by the number of employees, including full-time, part-time, casual and contractors.

[69] Farmers' contact details were obtained from a private mail list provider; they are not publicly available.

[70] A sample size of 45.71% (400/875) of the population with the response rate of 30.75% (123/400) is considered large enough to be representative of the population (Van der Stede et al., 2005).

The survey method was used for this study due to its ability to collect the required data from a representative subset of a population (Birnberg et al., 1990; Cobanoglu et al., 2001; Van der Stede et al., 2005). The survey was designed based on established survey instrument and measurement scales adapted from prior studies on TPB and environmental management accounting (Ferreira et al., 2010; Frost and Wilmshurst, 2000; Läpple and Kelley, 2013). The survey includes different sections with multiple questions to capture data regarding farmers' belief-based attitude, subjective norm, perceived behavioural control and their intentions towards adopting EMA practices (see Appendix 1).[71]

This study used the three steps suggested by Dillman (2000) in administering the survey. First, telephone calls were made to check the accuracy of the farmers' contact details. Second, a survey pack with a cover letter, questionnaire,[72] reply-paid envelope and a pre-numbered postcard were posted to all 400 farmers. Third, two follow-up reminders were sent to farmers three and eight weeks after the initial mail-out.[73] To encourage completion of the survey, participants were provided with their choice of two movie tickets or a preferred movie DVD as a token of appreciation (Appuhami, 2017; Hall, 2008). Participants were also informed that their responses would remain anonymous and were promised a summary of the results. Of the 400 distributed surveys, 123 were returned, indicating a response rate of 30.75 percent,[74] which is a higher response rate than those indicated in recent management accounting studies (e.g. Appuhami, 2017; Hall, 2008; Mahama and Cheng, 2013). Of the 123 responses, 32 were excluded because of missing data. Therefore, 91 usable responses were used as the final sample for the study. Table 4. 1 shows the details of the sample selection.

Table 4. 1 - Sample selection

Steps	Numbers
Total number of surveys administered	400
Total responses received (30.75%)	123
Number of incomplete questionnaires/deleted	(32)
Total number of responses used for analysis (22.75% response rate)	91

[71] Farmers' attitude towards the environment is used to classify farmers into homogeneous groups for the additional analysis in this study.
[72] Appendix 2 at the end of the thesis includes the participant information letter and the full survey instrument.
[73] The fourth step (follow-up phone calls) recommended by Dillman (2000) was not adopted due to ethical concerns.
[74] Data collection for this study took place during a very busy season, when cotton farmers were spending most of their time on the farm. This could be a possible reason for not receiving more responses.

The study undertook an independent sample *t*-test to compare early respondents (30%) to late respondents (30%) (non-response bias)[75] for all constructs in the study (De Villiers and Van Staden, 2010). The results show that there are no significant differences between early and late respondents (p-values range from 0.957 to 0.958, two-tailed test). The mean size of the two groups of respondents is very similar, including early respondents ($\bar{x}$ = 4.3852) and late respondents ($\bar{x}$ = 4.3667).

3. 1. 1 Descriptive statistics

The study collected demographic information, such as farm size (measured as a number of employees), farm age and whether irrigation or rain-fed cotton is grown by the sample farmers (e.g. Greaves et al., 2013; Läpple and Kelley, 2013; Withers et al., 2011). As shown in the descriptive statistics for the demographic variables in Table 4. 2, the average farm size (measured as a number of employees) was eight employees, with the smallest farm having only one employee, being the farmer themselves,[76] and the largest farm having 120 employees. The average time that a farm has been in use is 59 years. The youngest farm has been in use for ten years, and the oldest for 180. More than two-thirds of the farmers use irrigation, while less than one-third grow rain-fed cotton.

Table 4. 2 - Descriptive statistics for demographic variables

Descriptive Statistics				
Variable	Minimum	Maximum	Mean	Std. Deviation
Farm size (no. of employees)	1	120	8.791	16.873
Farm age (years)	10	180	59.230	39.332
Irrigation/Rain-fed (fully irrigated=1; partly irrigated=2; rain-fed=3)	1	3	2.033	0.706

3. 2 Variable measurement

The study measures four latent variables, namely the intention to adopt EMA practices (INTEMA), farmers' attitude (ATT), subjective norm (SN), and perceived behavioural

[75] The study ensured that non-response bias does not influence the study using different ways. First, the anonymity of responses potentially increased the response rate and encouraged respondents to provide their actual opinion. Second, the response rate of 22.75% which is higher than other management accounting studies indicates that the probability of a non-response bias is not higher than prior studies using survey (De Villiers and Van Staden, 2010). Early responses represent participants who are willing to participate in the survey, while, late responses represent farmers who are not willing or are not able to participate in the survey (De Villiers and Van Staden, 2010). The above tests indicate that there is no influence of non-response bias.
[76] The sample includes both male (87%) and female (13%) farmers.

control (PBC). Measurement of all four variables is based on the scales used in prior studies on environmental management accounting and TPB. Additional questions based on the studies on agriculture and farming have been developed to capture more detailed information (e.g. Antille et al., 2016; Läpple and Kelley, 2013; Withers et al., 2011). The study uses a seven-point Likert scale ranging from '1' (disagreement/less likely/negative stance) to '7' (agreement/most likely/positive stance), with '4' representing as a neutral stance. Appendix 1 shows the questions and scales used in this study. Following prior studies (e.g. Appuhami, 2017; Hall, 2008) the survey was pilot tested among 15 academics and 10 PhD students for clarity and comprehensibility. The pilot test resulted in some revisions to the survey such as modifications to the expression of some sentences, the order of the sections and the graphical layout of the questionnaire. No modifications were suggested to the established survey questions.

3. 2. 1 Intention to adopt EMA practices

The study uses a 15-item scale including ten items from Frost and Wilmshurst (2000) and five items developed by Ferreira et al. (2010)[77] to measure farmers' intention to adopt EMA practices (INTEMA) to capture more comprehensive data about the EMA practices in cotton farming in Australia (see Appendix 1). The questions added based on Frost and Wilmshurst (2000) have been revised in order to make it more understandable to cotton farmers in Australia. The Cronbach's alpha test shows 0.931 for this scale and is well above the minimum required 0.70. The results of the exploratory factor analysis show a single factor with an eigenvalue greater than 1, and factor loading ranging from 0.574 to 0.926. This factor explains 77.37 percent of the total variance.

3. 2. 2 Attitude

The study measures farmers' attitude (ATT)[78] using a four-item scale based on Läpple and Kelley (2013). The Cronbach's alpha test shows 0.803 for this scale indicating an acceptable

[77] The study uses only 5 items from Ferreira et al. (2010) because the survey used by Ferreira et al. (2010) includes some formal EMA practices designed for big corporations which have management accountants (e.g. Development and use of environment-related key performance indicators (KPIs), Product life cycle cost assessments, Product inventory analyses, Product impact analyses, Product improvement analysis). These EMA practices are not applicable for farm businesses which do not usually have management accountant positions, and do not use such EMA practices.

[78] As farmers are not familiar with the term "environmental management accounting" (EMA), the survey used in the study uses the term "environmentally friendly practices" with examples for EMA practices within bracket

level of reliability. The results of the exploratory factor analysis show a single factor with an eigenvalue greater than 1 and factor loading ranging from 0.634 to 0.801. This factor accounts for 70.45 percent of the total variance.

3. 2. 3 Subjective norm

The study measures subjective norm (SN) using an eight-item scale of which five items were adapted from Läpple and Kelley (2013), and three were designed based on Ajzen (2005) to capture more detailed information about subjective norm among Australian cotton farmers. Subjective norm measures the level of influence of significant parties in farmers' decisions. The Cronbach's alpha test shows 0.928 for this scale indicating an acceptable level of reliability. The results of the exploratory factor analysis show a single factor with an eigenvalue greater than 1 and factor loading ranging from 0.721 to 0.922. This factor accounts for 76.28 percent of the total variance.

3. 2. 4 Perceived behavioural control

The study measures perceived behavioural control (PBC) using Läpple and Kelley's (2013) five-item scale. PBC measures the ability of farmers to adopt EMA practices in terms of skills, knowledge and support. The Cronbach's alpha test shows 0.934 for this scale indicating an acceptable level of reliability. The results of the exploratory factor analysis show a single factor with an eigenvalue greater than 1 and factor loading ranging from 0.879 to 0.941 accounting for 85.26 percent of the total variance.

3. 2. 5 Control variables

The study uses farm size (number of employees), farm age and irrigation method (irrigation/rain-fed) as control variables which could influence the intention to adopt EMA practices. Following Hall (2008), the study also aims to minimise the impact of the endogeneity issue by incorporating control variables into the model. Table 4. 3 shows the variables used for this study. The farm size used as a control variable is measured based on the number of employees because the support of employees on a farm can influence the intention to adopt EMA practices (Ajzen, 2005). Based on previous studies, larger farms are

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and statement has also been added to the survey requesting the survey participants to refer to the survey section with more examples for EMA practices.

more likely to harm the natural environment than small farms (Beedell and Rehman, 1999). Thus, it is expected that the farmers on the larger farms would be more likely to adopt EMA practices (Beedell and Rehman, 1999; Läpple and Kelley, 2013). The study also controls for farm age, which could influence on the early, medium and late adoption of EMA practices (Läpple and Kelley, 2013). Studies also note that the longer a farm has been in use, the more impact it could have on the environment (Withers et al., 2011). Further, the use of irrigation is included in the model as a control variable because it could influence on the water sources and farmers' intention to adopt EMA practices (Agbola and Evans, 2012; Antille et al., 2016).[79] According to studies, minimising water consumption and increasing water use efficiency in cotton farming can influence farmers' intention to use EMA practices (Frost and Wilmshurst, 2000).

Table 4. 3 - Summary of observed, latent and control variables

Observed Variable	Acronym
Intention to adopt EMA practices	INTEMA
Latent Variables	
Attitude (belief-based attitude)	ATT
Subjective norm	SN
Perceived behavioural control	PBC
Control Variables	
Farm size	SIZE
Farm age	FAGE
Irrigation or rain-fed	IRRIRF

4. RESULTS

This study uses the partial least squares (PLS) technique to measure the model and test the hypotheses. The PLS technique has increasingly been used in recent management and behavioural research (e.g. Hall, 2008; Mahama and Cheng, 2013) because of its ability to analyse reflective models (Lowry and Gaskin, 2014) based on data from a small sample size (Appuhami, 2017).[80] Moreover, because it uses less restrictive assumptions about the data

[79] The study does not control for the region of the cotton farms because the sample cotton farms are primarily located in NSW and QLD which share the same water resources (e.g. Murray and Darling Rivers) and climatic condition. The study does not also control for gender of the farmers because number of female farmers in the sample is insignificant (79 male (87%) and 12 female (13%) farmers).

[80] The minimum required sample size for the PLS model in this study is 60, which is lower than the study sample of 91. This minimum sample is calculated based on the formula that it must be ten times the number of paths of the largest multiple regression in the model (Hulland, 1999). In the model used in the study, the largest

such as making no distributional assumptions (Hair et al., 2011; Hair et al., 2014; Lowry and Gaskin, 2014). The PLS technique is a form of structural equation modelling (SEM), which incorporates several latent and observed variables. The technique identifies measurement errors using covariance structure analysis (Fornell, 1982). The bootstrapping resampling technique[81] in PLS generates R^2, which is used to assess the stability of the model. The study uses SmartPLS (version 3.2.6) to analyse the measurement model and structural model simultaneously.

4. 1 Measurement model

The PLS measurement model shows the potential relationships between the observed variable (INTEMA) and latent variables (ATT, SN, PBC). The study uses a number of methods to ensure the reliability (including individual item and composite) and validity (including convergent and discriminant) of all the variables used in the measurement model. First, the study examines the factor loadings for each variable to test the reliability of individual items. All items loading on their relevant constructs with factor loadings above 0.70 are retained in the model (Hair et al., 2014). Following Hair et al. (2014), the study retained all items with the loadings between 0.40 and 0.70 because they do not cause the average variance extracted (AVE) to fall below the threshold 0.50. However, items SN 6 and SN 8 were removed because they were not the highest values of the outer loading on the associated construct in cross-loading (Hair et al., 2014). Table 4. 4 shows the factor loadings from the PLS measurement model. Further, the study uses a measure of composite reliability by Fornell and Larcker (1981) and Cronbach's (1951) alpha test to test the reliability of each variable. As Table 4. 5 shows, the values of composite reliability and Cronbach's alpha for all the variables are above 0.70 confirming acceptable composite reliability (Nunally and Bernstein, 1978).

The study also examines convergent validity, which measures the correlations between scale items for each variable by using the AVE statistics. As presented in Table 4. 5, all variables in the model have an AVE value higher than the threshold 0.50 indicating acceptable convergent validity (Chin, 1998; Hulland, 1999). Furthermore, the study measures

regression has six (6) paths (including independent and control variables), and therefore the minimum sample required for the study is 60 (6 x 10).

[81] There is no goodness of fit used in PLS, and multivariate normality is not applied to PLS (Hulland, 1999). Instead, PLS uses the bootstrapping resampling method.

discriminant validity by comparing the square root of the AVE statistics for each variable with the correlations between the latent variables (Chin, 1998). The purpose of discriminant validity test is to identify if a latent variable shares more variance with its measures than with other latent variables. Table 4. 5 shows that the square roots of AVE are larger than the relevant correlations between latent variables confirming acceptable discriminant validity. The above tests from the PLS measurement model confirm that the reliability (including individual item and composite) and the validity (including convergent and discriminant) of the variables used in the measurement model are acceptable.

Table 4. 4 - Factor loadings from PLS measurement model

Variables[82]	ATT	SN	PBC	INTEMA
Attitude (ATT)				
ATT 1	**0.712**	0.411	0.285	0.274
ATT 2	**0.824**	0.577	0.470	0.365
ATT 3	**0.809**	0.742	0.629	0.395
ATT 4	**0.798**	0.525	0.412	0.378
Subjective norm (SN)				
SN 1	0.702	**0.872**	0.681	0.359
SN 2	0.628	**0.887**	0.517	0.319
SN 3	0.700	**0.927**	0.641	0.431
SN 4	0.590	**0.880**	0.561	0.381
SN 5	0.480	**0.816**	0.470	0.272
SN 7	0.659	**0.850**	0.604	0.306
Perceived behavioural control (PBC)				
PBC 1	0.459	0.556	**0.875**	0.343
PBC 2	0.516	0.604	**0.927**	0.335
PBC 3	0.542	0.630	**0.927**	0.416
PBC 4	0.542	0.608	**0.926**	0.493
PBC 5	0.585	0.641	**0.910**	0.506
Intention to adopt EMA practices (INTEMA)				
INTEMA 1	0.250	0.276	0.331	**0.670**
INTEMA 2	0.358	0.402	0.423	**0.772**
INTEMA 3	0.222	0.282	0.329	**0.796**
INTEMA 4	0.250	0.282	0.345	**0.813**
INTEMA 5	0.439	0.406	0.467	**0.667**
INTEMA 6	0.373	0.278	0.334	**0.825**
INTEMA 7	0.202	0.189	0.217	**0.720**
INTEMA 8	0.188	0.163	0.207	**0.766**
INTEMA 9	0.419	0.235	0.212	**0.784**
INTEMA 10	0.412	0.419	0.600	**0.549**
INTEMA 11	0.424	0.314	0.391	**0.737**
INTEMA 12	0.460	0.313	0.389	**0.734**
INTEMA 13	0.508	0.382	0.358	**0.837**
INTEMA 14	0.208	0.172	0.240	**0.670**
INTEMA 15	0.372	0.360	0.452	**0.662**

All items are retained in the model because their loadings were either above the recommended threshold of 0.70 or if the loadings are between 0.40 and 0.70, their retainment did not impact on AVE. The AVE was above the recommended threshold of 0.50 (Hair et al., 2014). However, items SN 6 and SN 8 were removed, because they were not the highest values of the outer loading on the associated construct in cross-loading (Hair et al., 2014).

[82] Please see Appendix 1 for the complete survey instrument.

Table 4. 5 - Descriptive statistics, reliability and average variance extracted (AVE) statistics, and correlations from PLS model

Variable	Mean	Std.Dev	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)	Correlations			
						ATT	SN	PBC	INTEMA
ATT	4.4244	1.32347	0.796	0.876	0.620	**0.787**			
SN	5.2994	1.20157	0.937	0.950	0.761	0.729	**0.872**		
PBC	5.7326	1.23845	0.950	0.962	0.834	0.585	0.669	**0.913**	
INTEMA	5.0388	1.19163	0.939	0.947	0.544	0.454	0.402	0.471	**0.737**

AVE – average variance of extracted; ATT – behavioural-based attitude; SN – subjective norm; PBC – perceived behavioural control; INTEMA – intentions to adopt EMA practices.

Diagonal elements are the square roots of AVE, and off-diagonal elements are the correlations between the latent variables calculated in PLS (n = 91). All correlations above 0.20 are statistically significant ($p < 0.01$) (Hall, 2008).

4. 2 Tests of hypotheses

The study tests the three hypotheses developed in the previous section based on the PLS structural model (see Figure 4. 3). The structural model includes control variables, such as farm size, farm age and irrigation/rain-fed.[83] The PLS model creates potential statistical evaluations including path coefficiencts and their significance levels among the relationships. These evaluations are explained in the discussion section. When using PLS, R^2 is essentially used to evaluate the stability of the model (Chin, 1998). As shown in Table 4. 6, the R^2 value for intention to adopt EMA practices is 56.00 percent. The high value of R^2 shows the satisfactory stability of the model and its strong predictive capacity (Chin, 1998; Moulang, 2015).

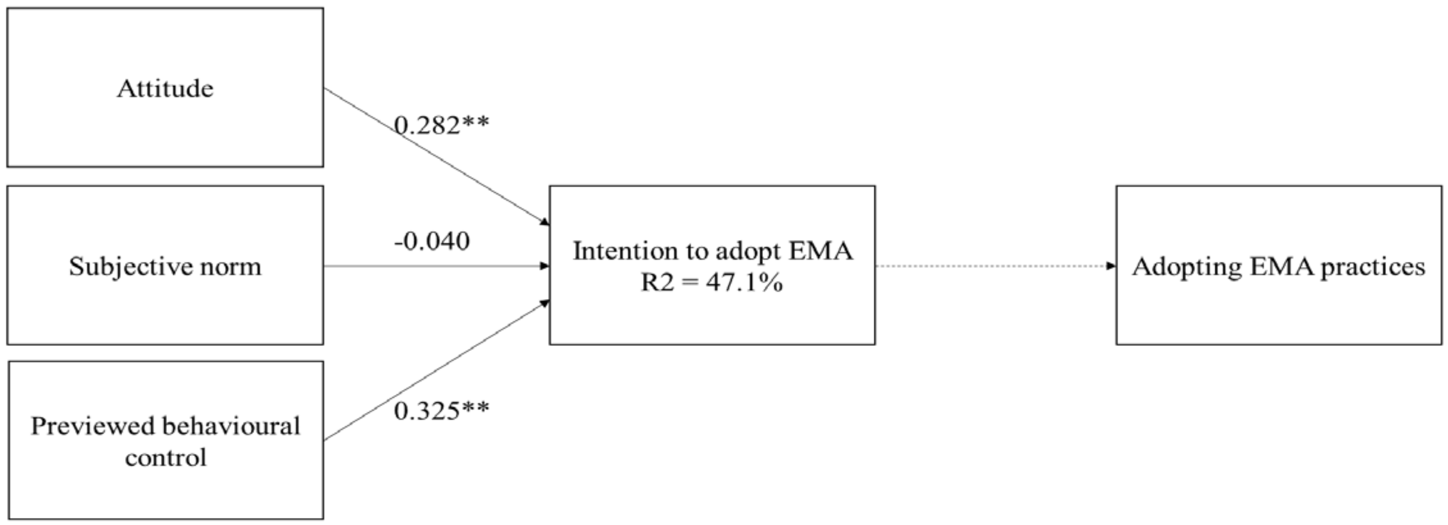
To examine the statistical significance of the path coefficients in the model, the study uses the bootstrapping sampling method with 500 sample replacement. Table 4. 6 presents the results from the PLS structural model. The study hypothesises that there is a positive relationship between farmers' attitude and their intention to adopt EMA (H1). The PLS results show a significant positive association between the two variables (β = 0.282, $p < 0.05$), and in the hypothesised direction. Thus, H1 of the study is supported.

Subjective norm is hypothesised to be positively associated with farmers' intention to adopt EMA (H2). However, the PLS results show that there is no significant association between subjective norms and the farmers' intention to adopt EMA (β = -0.040, p = 0.399). Thus, H2 is not supported.

H3 predicts that perceived behavioural control has a positive impact on farmers' intention to adopt EMA. As predicted, the results show that the association between the two variables is statistically significant (β = 0.325, $p < 0.05$), and in the direction of the hypothesis. Thus, H3 is also supported.

[83] The study does not include gender difference among farmers as a control variable in the PLS model, because the number of female farmers participating in the study was only 12 (13% = 12/91), which is not sufficient for a statistical analysis (Hulland, 1999).

Figure 4. 3 - PLS structural model with path coefficients



EMA – Environmental Management Accounting, *p < 0.1, ** p < 0.05, *** p < 0.01, n = 91

Table 4. 6 - PLS structural model: Path coefficients, *t*-statistics and R^2

Independent variables (paths from)	Intention to adopt EMA practices (INTEMA) (paths to)	T Statistics	P Values
Attitude (ATT)	0.282**	2.091	0.019
Subjective norm (SN)	-0.040	0.256	0.399
Perceived behavioural control (PBC)	0.325**	2.303	0.011
Farm size (SIZE)	0.218***	3.791	0.000
Farm age (FAGE)	-0.123*	1.656	0.049
Irrigation/Rainfed (IRRIRF)	-0.350***	3.962	0.000
R^2	0.471	6.444	0.000

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ (one-tailed) n = 91

4. 3 Additional analysis

This study undertakes two additional analyses to gain an in-depth understanding of farmers' intention to adopt EMA practices. Based on TPB and following prior studies (e.g. Han and Kim, 2010), the first additional analysis (*mediating effect*) is undertaken to examine whether subjective norm, which shows no direct association with intention to adopt EMA practices in the previous analysis, has an indirect association with the intention to adopt EMA practices through attitude and perceived behavioural control. For the purposes of the *mediating effect* analysis, the study develops the model shown in Figure 4. 4, using the same sample data (91 responses).

As per the original analysis, the study undertakes tests of reliability and validity. Table 4. 7 shows the measure of composite reliability by Fornell and Larcker (1981) and Cronbach's (1951) alpha test. The values of composite reliability and Cronbach's alpha for all used variables are above 0.70 endorsing acceptable composite reliability (Nunally and Bernstein, 1978). As shown in Table 4. 7, all variables in the model have an AVE value of higher than the 0.50 threshold indicating acceptable convergent validity (Chin, 1998; Hulland, 1999). Table 4. 7 also shows that the square roots of the AVE are larger than the relevant correlations between latent variables confirming acceptable discriminant validity. The above tests from the PLS measurement model endorse that the reliability (including individual item and composite) and validity (including convergent and discriminant) of the variables used in the measurement model are acceptable.

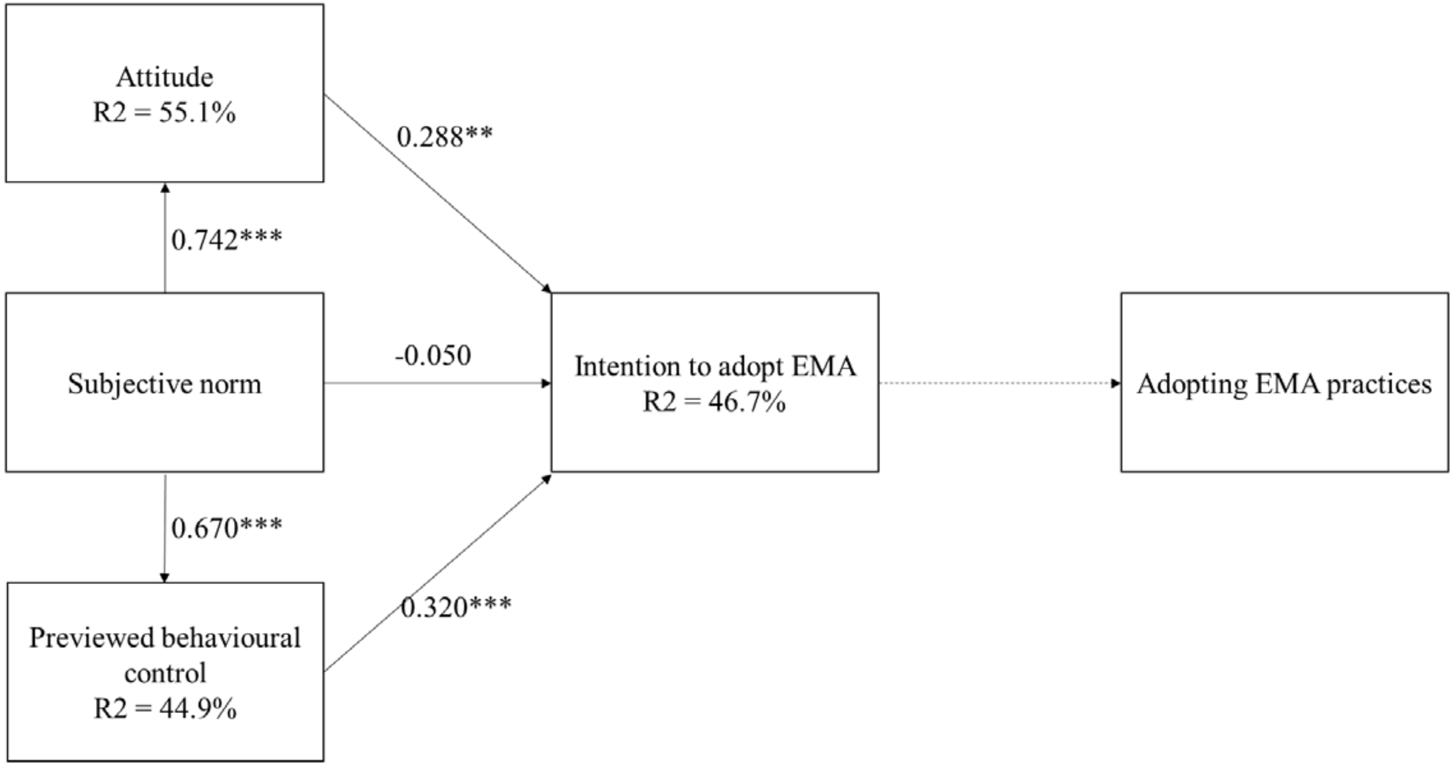
The *mediating effect* analysis shows that subjective norm positively and significantly influences intentions to adopt EMA practices through both attitude ($\beta = 0.742$, $p < 0.01$) and perceived behavioural control ($\beta = 0.670$, $p < 0.01$). This suggests that both attitude ($\beta = 0.742$, $p < 0.01$) and perceived behavioural control ($\beta = 0.670$, $p < 0.01$) fully mediate the association between subjective norm and the intentions to adopt EMA practices (see Table 8).[84] The high value of R^2 for both mediators (attitude 55.1% and perceived behavioural

[84] Full mediation is deemed to exist under three conditions: (1) the path between the independent and dependent variable is not significant; (2) the path between the independent and mediating variable is significant; and (3) the path between the mediating variable and the dependent variable is significant (Baron and Kenny, 1986). In this study, (1) the path between subjective norm (independent variable) and intention to adopt EMA practices (dependent variable) is not significant ($\beta = -0.050$, $p = 0.372$), (2) the path between subjective norm and attitude (mediating variable) is significant ($\beta = 0.742$, $p < 0.01$), and the path between subjective norm and perceived behavioural control (mediating variable) is significant ($\beta = 0.670$, $p < 0.01$). Finally, (3) the path between

control 44.9%), and the observed variable (intention to adopt EMA practices 46.7%) shown in Table 4. 8, indicate the satisfactory stability of the model and the strong predictive capacity of each variable (Chin, 1998; Moulang, 2015).

attitude and intention to adopt EMA practices is significant (β = 0.288, $p < 0.05$), and the path between perceived behavioural control and intention to adopt EMA practices is significant (β = 0.320, $p < 0.01$).

Figure 4. 4 - PLS structural model with path coefficients with mediating effect of attitude and perceived behavioural control *(mediating effect)*



EMA - Environmental Management Accounting, * $p < 0.1$, ** $p < 0.05$, ***, $p < 0.01$, n = 91

Table 4. 7 - Construct reliability and validity reliability and average variance extracted (AVE) statistics, and correlations from PLS model (*mediating effect*)

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)	Correlations ATT	SN	PBC	INTEMA
ATT	0.796	0.865	0.618	**0.786**			
SN	0.937	0.950	0.761	0.742	**0.872**		
PBC	0.950	0.950	0.836	0.592	0.670	**0.914**	
INTEMA	0.939	0.947	0.544	0.455	0.399	0.464	**0.737**

ATT – behavioural-based attitude; SN – subjective norm; PBC – perceived behavioural control; INTEMA – intentions to adopt EMA practices.

Table 4. 8 - PLS structural model: Path coefficients, *t*-statistics and R^2 *(mediating effect)*

Variables (paths)	Path coefficients	T Statistics	P Values
Attitude -> Intention to adopt EMA practices	0.288**	2.268	0.012
Subjective norm -> Intention to adopt EMA practices	-0.050	0.326	0.372
Subjective norm -> Attitude	0.742***	14.200	0.000
Subjective norm -> Perceived behavioural control	0.670***	8.106	0.000
Perceived behavioural control -> Intention to adopt EMA practices	0.320***	2.396	0.008
Farm size	0.217***	3.620	0.008
Farm age	-0.126*	1.628	0.052
Irrigation/Rainfed	-0.351***	3.752	0.000
R^2- Intention to adopt EMA practices	0.467	6.136	0.000
R^2- Attitude	0.551	7.230	0.000
R^2- Perceived behavioural control	0.449	4.241	0.000

EMA – environmental management accounting, * $p < 0.1$, ** $p < 0.05$, ***, $p < 0.01$, n = 91

The study undertakes the second additional analysis (*multi-group analysis*) to account for heterogeneity and to explore whether different groups of farmers are influenced by different belief-based factors when intending to adopt EMA practices. For the purpose of this analysis, the study uses the PLS *multi-group analysis* tool and identifies two groups with sample sizes of 44 and 47 farmers (original sample = 91 farmers) who were found to hold more environmentally friendly attitudes and less environmentally friendly attitudes, respectively.[85] Based on the recommendation of Goodhue et al. (2006), the sample size of the two groups is above the minimum sample size of 40 required for the PLS model. The PLS *multi-group analysis* presented in Table 4. 9 shows the path coefficients between the two groups and indicates that the two are significantly different.

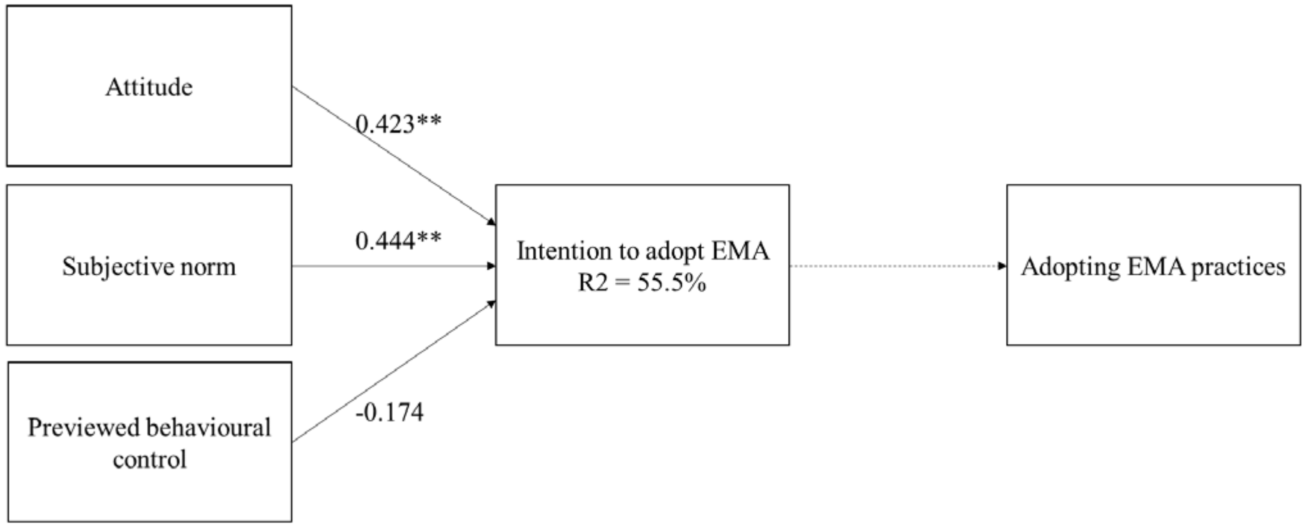
The study uses the bootstrapping procedure (with 1,000 sample replacement) based on the PLS *multi-group* technique to examine the statistical significances and coefficients of each path of the model for each group (see Table 4. 10). In contrast with the original analysis, for the more environmentally friendly group, the *multi-group analysis* shows that while there is a positive and significant association between subjective norm and the intention to adopt EMA practices (β = 0.444, $p < 0.05$), there is no evidence to support the link between perceived behavioural control and the intention to adopt EMA practices (β = -0.174) (see Figures 4. 5 and 4. 6). However, consistent with the original analysis for the same group, the *multi-group analysis* finds that attitude has a positive and significant association with the intention to adopt EMA practices (β = 0.423, $p < 0.05$). Moreover, for the less environmentally friendly group, only perceived behavioural control seems to have a significant and positive association with the intention to adopt EMA practices (β = 0.396, $p < 0.01$).

The R^2 of 55.5 percent is stronger for the more environmentally friendly group compared to the original analysis. The R^2 of 55.5 percent indicates the higher stability and robust predictive capacity of the model (Chin, 1998). The R^2 of 62.7 percent for the less environmentally friendly group is also stronger than the original analysis, indicating the

[85] Based on Läpple and Kelley (2013), the study uses a 12-item scale to measure farmers' attitude towards the environment (please see Appendix 1). Principal component analysis of this item (farmers' attitude towards the environment) shows a single factor, with the factor loading ranging from 0.473 to 0.820.

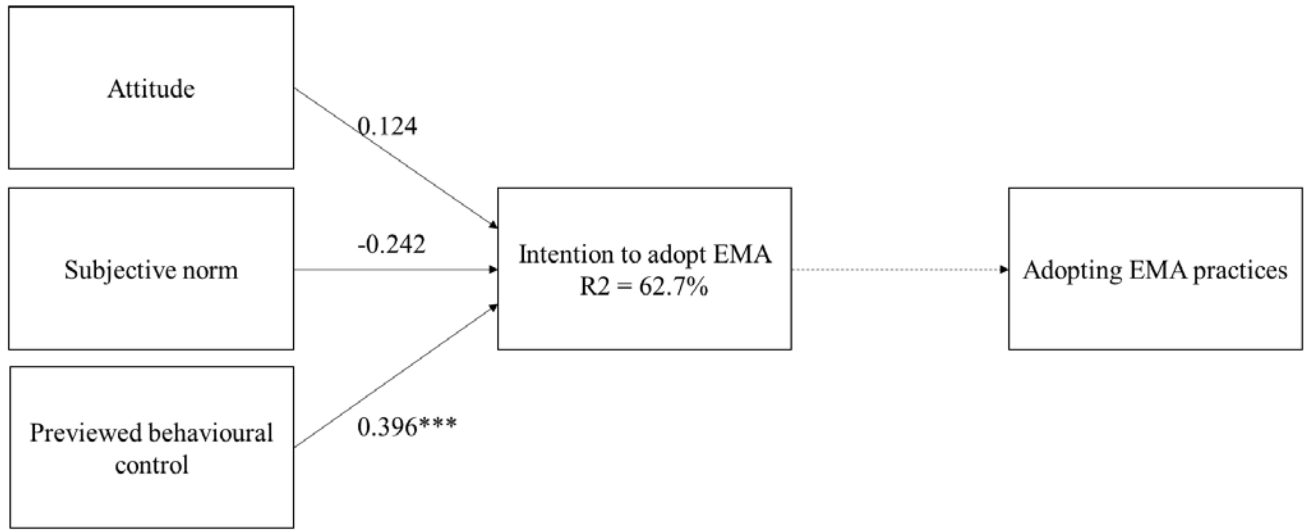
stability of the model. Further, these R^2s highlight the significance of the model's homogeneity.

Figure 4. 5 - PLS structural model with path coefficients with more environmentally friendly group *(multi-group analysis)*



EMA – Environmental Management Accounting, *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, n = 44

Figure 4. 6 - PLS structural model with path coefficients with less environmentally friendly group *(multi-group analysis)*



EMA – Environmental Management Accounting, $*p < 0.1$, $** p < 0.05$, $*** p < 0.01$, n = 47

Table 4. 9 – Group comparison (PLS parametric test, path coefficients differences, *t*-statistics and P values) (*multi-group analysis*)

Variables (path from > to)	Path coefficients-difference (More-less environmentally friendly)	*t*-statistics (More vs. Less environmentally friendly)	P values (More vs. Less environmentally friendly)
Attitude (ATT) > INTEMA	0.299	1.142	0.257
Subjective norm (SN) > INTEMA	0.686**	2.448	0.016
Perceived behavioural control (PBC) > INTEMA	0.570***	2.810	0.006
Farm (SIZE) > INTEMA	0.067	0.422	0.674
Farm age (FAGE) > INTEMA	0.181	1.179	0.241
Irrigation or Rainfed (IRRIRF) > INTEMA	0.232	1.711	0.091

INTEMA- intentions to adopt EMA practices, * p < 0.1, ** p < 0.05, *** p < 0.01

Table 4. 10 - PLS structural model for environmental attitude of subgroups: Path coefficients, *t*-statistics and R^2 (*multi-group analysis*)

Variables (path from > to INTEMA)	More environmentally friendly group N=44					Less environmentally friendly group N=47				
	Path coefficients Original sample	Path coefficients Sample mean	St Dev	*t*-statistics	P values	Path coefficients Original sample	Path coefficients Sample mean	St Dev	*t*-statistics	P values
Attitude (ATT) > INTEMA	0.423**	0.425**	0.203	2.082	0.038	0.124	0.090	0.172	0.719	0.472
Subjective norm (SN) > INTEMA	0.444**	0.406**	0.205	2.169	0.030	-0.242	-0.235	0.196	1.233	0.218
Perceived behavioural control (PBC) > INTEMA	-0.174	-0.104	0.147	1.184	0.237	0.396***	0.415***	0.143	2.770	0.006
Farm (SIZE) > INTEMA	0.227*	0.222*	0.122	1.864	0.063	0.160	0.149	0.106	1.501	0.134
Farm age (FAGE) > INTEMA	0.057	0.053	0.101	0.568	0.570	-0.124	-0.099	0.117	1.060	0.290
Irrigation or Rainfed (IRRIRF) > INTEMA	-0.356***	-0.337***	0.109	3.269	0.001	-0.587***	-0.571***	0.085	6.931	0.000
R^2	0.555	-	-	5.993	0.000	0.627	-	-	9.720	0.000

INTEMA – intentions to adopt EMA practices, * p < 0.1, ** p < 0.05, *** p < 0.01

Note: For brevity, the results of the measurement models are not presented in table format. The measurement model parameters and quality criteria for both subsamples are within acceptable levels.

5. DISCUSSION AND CONCLUSION

The environmental risks resulting from cotton farming activities in Australia are formidable. Previous studies note that cotton farming activities in the country have significantly deteriorated the quality of water, soil, air and ecological biodiversity (Antille et al., 2016; Hulugalle and Scott, 2008). Drawing on the theory of planned behaviour, this study examines the association between belief-based factors (attitude, subjective norm and perceived behavioural control) and farmers' intention to adopt EMA practices in Australian cotton farming. The results of PLS analysis based on data collected from 91 Australian cotton farmers strongly support the applicability of TPB in predicting farmers' behavioural intention towards the use of EMA practices.

This study finds that two factors suggested by TPB, namely attitude and perceived behavioural control, serve as powerful influences on farmers' intentions to adopt EMA practices. However, there is no evidence to support the association between subjective norms and farmers' intention to adopt EMA practices. These results suggest that while Australian cotton farmers as individuals are willing to do what they believe is right (attitude), their willingness to act is primarily driven by their financial ability (e.g. access to subsidies and loans) and the support available (perceived behavioural control), rather than by what they perceive others expect them to do. A possible reason for this finding is that it is easier and more acceptable for farmers to follow their moral beliefs and values and to utilise their ability (including knowledge, skills and financial ability) to adopt EMA practices rather than doing what others wish them to do. Also, it seems that knowledge, skills and financial ability are necessities and that without them it is difficult for farmers to adopt EMA practices.

An important finding emerging from the first additional analysis is that subjective norm which shows no direct relationship in the original analysis, has a strong indirect relationship with farmers' intention to adopt EMA practices through attitude and perceived behavioural control. A possible reason for this finding is that social pressure from referent groups, such as government and non-government agencies, influence farmers' attitude towards EMA practices (Beedell and Rehman, 2000). The findings related to the mediation role of subjective norm also suggest that the support (financial and non-financial) from individuals (family, contractors, employees) and organisations (subjective norm) are likely to increase farmers' resources (perceived behavioural control), and thus, positively affect farmers' intention to adopt EMA practices. Further, the findings of the first addition analysis indicate that farmers' behavioural intentions might be influenced by either attitudinal or normative control because their attitudes is associated with their subjective norms (Ajzen, 2005). The finding of the additional analysis thus contributes to very limited studies which examine indirect association between subjective norm and behavioural intention (e.g. Han et al., 2017; López-Mosquera and Sánchez, 2012).

This study is unique in its effort to use *multi-group analysis* based on two groups of farmers, namely more environmentally friendly and less environmentally friendly. Based on the *multi-group analysis*, the study investigates whether the relationship between the three factors of TPB and farmers' intention to adopt EMA practices differs between the two groups. Use of *multi-group analysis* minimises the possibility of both overstating the role of perceived behavioural control and understating the role of the subjective norm in the original model. It reveals that while attitudes and subjective norms are strong drivers of the intention to adopt EMA practices among farmers who are perceived to be more environmentally friendly, perceived behavioural control is the only driver among farmers who are perceived to be less environmentally friendly. This finding suggests that in the more environmentally friendly group, the farmers' individual beliefs towards the EMA (attitude) and the perceived opinion of significant people in the farmers' lives (subjective norm) encourage them to adopt EMA practices, regardless of the resources of their farms (perceived behavioural control). Subjective norm, which does not indicate a significant association with farmers' intention in the original analysis, however, shows a direct and significant relationship with farmers' intention to adopt EMA practices in the more environmentally friendly group. In contrast, among the less environmentally friendly group, the only factor encouraging EMA adoption is the farmers' access to resources (e.g. machines, equipment, expertise, and funds). A possible reason for this finding is that the intention of farmers who are less environmentally friendly is motivated by economic factors rather than by attitudinal or normative factors.

The findings of this study have important implications for policymakers in promoting EMA practices in farming activities. In particular, the three factors of TPB (attitude, subjective norm and perceived behavioural control), which are crucial in motivating people towards adopting EMA practices, could guide policymakers in designing policies to encourage cotton farmers and the wider community of farmers who are less environmentally friendly, to adopt sustainable farm practices. Such policies promoting the adoption of EMA practices could minimise environmental issues, such as water pollution, soil erosion and carbon emissions

(Antille et al., 2016; Bevilacqua et al., 2014; Hulugalle and Scott, 2008; Ismail et al., 2011). Previous studies also find that environmentally friendly practices such as EMA can be used as a competitive advantage (Albelda, 2011; Qian and Burritt, 2009; Visser et al., 2014) leading to the achievement of performance targets (Albelda, 2011; Ferreira et al., 2010).

The findings of this study have important policy relevance to the Australian context. Given the increasing environmental issues associated with cotton farming in Australia (e.g. water depletion, carbon emissions) (Ismail et al., 2011; Roth et al., 2013; Visser et al., 2014) this research suggests that by creating an atmosphere to shift farmers' attitude to a more sustainable mode, farmers could be motivated to use water more efficiently.[86] Given the Australian farmers are known to be among the world's least subsidised the findings also highlight the importance of government support and subsidies which could assist farmers with necessary resources required for environmentally friendly farm practices (ABC News, 2014).

The findings of this study highlight the importance of developing positive attitudes among employees and managers to encourage EMA practices. Attitudes can be shifted towards a more environmentally aware mode by creating a work environment that supports further learning about the benefits of EMA practices such as reducing the environmental harm and hence, minimising the potential health-related risk to the community (Brevik and Sauer, 2015; Oliver and Gregory, 2015). Development of positive attitudes could also increase environmental performance and transform farms towards a sustainable future.

Further research may address some of the limitations of this study. First, this study measures intentions only, not behaviour. A longitudinal study can be undertaken to further examine the actual behaviour of farmers, such as adoption of EMA practices. Second, the issue of social desirability bias may exist when surveys are used to collect data (Greaves et al., 2013). This study minimised this issue by ensuring the anonymity of the responses. However, due to the possibility of this form of bias, any conclusions drawn from this study should be interpreted with caution. Finally, although TPB might not be adequate to explain all of the behavioural intentions, it has provided a preliminary research step. While the study collected data from farmers located in two regions (NSW and QLD) which use the same water resources,

[86] Australia is the driest continent other than Antarctica (Vardon et al., 2007).

agricultural techniques, methods and climatic condition, behavioural intention of cotton farmers are likely to vary between regions depending on cultural and regional aspects (e.g. language and customs).

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APPENDIX 1 - Survey questions

Constructs used in the study

Intention to adopt EMA practices (1 = not at all; 7 = to a great extent)

Please indicate how likely or unlikely is that your farm to undertake each of the following in the next five years:

INTEMA 1) Identifying waste, emission (e.g. water, energy, fuel).

INTEMA 2) Measuring energy usage.

INTEMA 3) Measuring amount of water usage (e.g. megalitre).

INTEMA 4) Estimating cost of water usage.

INTEMA 5) Recognising recycling wastes (e.g. crop residue, fertilizers and pesticides leftover).

INTEMA 6) Measuring the cost of recycling waste.

INTEMA 7) Recognising recycling water.

INTEMA 8) Measuring the cost of recycling water.

INTEMA 9) Measuring quality of water released to the environment.

INTEMA 10) Recognising use of reusable/returnable packaging/containers.

INTEMA 11) Identifying air pollution.

INTEMA 12) Identifying soil pollution.

INTEMA 13) Identifying water pollution.

INTEMA 14) Estimating environmental contingent liabilities (e.g. fines).

INTEMA 15) Measuring environmental costs.

(Items 1–2 and 10 were taken from Frost and Wilmshurst (2000), items 3–9 were developed based on Frost and Wilmshurst (2000), items 11–13 were developed based on Ferreira et al. (2010), items 14–15 were taken from Ferreira et al. (2010))

Attitude (1 = strongly disagree; 7 = strongly agree)

Please indicate the extent to which you agree or disagree with the following statements:

ATT 1) If your farm produces cotton (e.g. GM /genetically modified/transgenic/technology variety/biotechnology) by using environmentally friendly practices (e.g. measuring amount of water usage, estimating cost of the water usage, measuring energy usage, identifying air pollution, identifying soil pollution, identifying water pollution) you will receive higher prices.

ATT 2) If your farm produces cotton by using environmentally friendly practices, you will increase the farm's income.

ATT 3) Producing cotton by using environmentally friendly practices on your farm will lead to more sustainable farming.

ATT 4) Producing cotton by using environmentally friendly practices on your farm will provide an environmentally friendly product that people like to buy.

(All items were taken from Läpple and Kelley (2013))

Subjective norm (1 = very unlikely; 7 = very likely)

Please indicate how likely it is that the following groups think you should produce cotton by using environmentally friendly practices on your farm within the next five years?

SN 1) Your family

SN 2) Other farmers

SN 3) Farm advisers

SN 4) Farm walks/information events

SN 5) Farming press/literature

SN 6) Government agencies

SN 7) Non-government agencies (e.g. Cotton Australia)

SN 8) General public

(Items 1–5 were taken from Lapple and Kelley (2013), items 6–8 were developed based on Ajzen (2005))

Perceived behavioural control (1 = strongly disagree; 7 = strongly agree)

Please indicate the extent to which you agree or disagree with each of the following statements:

PBC 1) You/your farm employees have the knowledge and the skills to produce cotton on your farm by using environmentally friendly practices. (e.g. measuring amount of water usage, estimating the cost of water usage, measuring energy usage, identifying air pollution, identifying soil pollution, identifying water pollution)

PBC 2) You/your employees have sufficient time to produce cotton by using environmentally friendly practices on your farm.

PBC 3) Conditions (resources) on your farm are suitable to enable you to produce cotton by using environmentally friendly practices.

PBC 4) It is possible for you/your farm employees to maintain good healthy cotton plants on your farm by using environmentally friendly practices.

PBC 5) It is possible for you/your farm employees to use the machines and equipment to produce cotton by using environmentally friendly practices on your farm.

(All items were taken from Läpple and Kelley (2013))

Attitude toward environment (1 = strongly disagree; 7 = strongly agree)

Please indicate the extent to which you agree or disagree with each of the following statements:

ATTENV 1) It is important to be mindful of the environmental impacts of farming by reducing environmentally harmful input on the farm.

ATTENV 2) The use of environmentally harmful inputs has a negative impact on the health of people and animals.

ATTENV 3) It is important to take the environment into consideration, even if it lowers profit.

ATTENV 4) Environmental problems resulting from agricultural activities are exaggerated by the media.

ATTENV 5) It is important to farm in an environmentally friendly way.

ATTENV 6) The impact of fertilizer runoff is worse than generally imagined.

ATTENV 7) Environmentally friendly farming is better for the environment than conventional farming.

ATTENV 8) The use of environmentally harmful inputs in agriculture makes sense as long as it leads to an increase in profit.

ATTENV 9) It is important to use environmentally harmful inputs cautiously.

ATTENV 10) Maximising profit is more important than protecting the environment.

ATTENV 11) Environmentally friendly farming is only a trend.

ATTENV 12) Chemical fertilizers have no harmful effects; they promote high-quality production.

Negatively phrased statements (4, 8, 10, 11, 12) were re-coded for the analysis.

(All items were taken from Läpple and Kelley (2013))

Control variables

a) How long has your farm been in use? …………………years
b) What is the approximate number of employees on your farm? (please specify full-time and part-time, casual and contractors) ……………………………………….employees

c) Is your farm: ☐ Fully irrigated ☐ Partly irrigated ☐ Rain-fed ☐ Other (please specify) ……………….. (If using both irrigation and rain-fed, please indicate the size of each) ……………….…………… Hectares irrigated …………..……………… Hectares rain-fed

(Item a was taken from Withers et al. (2011), item b was developed based on Läpple and Kelley (2013), item c was developed based on Antille et al. (2016))

CHAPTER FIVE

(PAPER 3)

EXPLORING THE ASSOCIATION BETWEEN ENVIRONMENTAL MANAGEMENT ACCOUNTING PRACTICES AND FARM PERFORMANCE: EVIDENCE FROM THE AUSTRALIAN COTTON FARMS

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(ABDC Rank A*).

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ABSTRACT

Purpose - This study examines whether the three contingent factors suggested by stakeholder theory, namely expected competitive advantage, perceived stakeholders' concern and farmers' environmental commitment are associated with the use of environmental management accounting (EMA) practices in Australian cotton farms.

Design/methodology/approach - The study uses partial least squares (PLS) structural model to analyse survey data collected from the Australian farmers.

Findings - The findings indicate that cotton farmers who expect to achieve competitive advantage through environmentally friendly initiatives and perceive that stakeholders are concerned about the sustainability of the natural environment, use EMA practices in their cotton farms. The study also finds that farmers' environmental commitment is associated with the use of EMA practices indirectly through expected competitive advantage and perceived stakeholders' concern.

Implications - The findings of this study have direct implications for practice and policy in designing EMA practices for sustainable cotton farming.

Originality/value - This study is novel because it is based on an inclusive approach encompassing three contingent factors of stakeholder theory (expected competitive advantage, perceived stakeholders' concern and farmers' environmental commitment) and EMA practices used in cotton farming.

Keywords: Environmental Management Accounting, Environmental Performance, Economic Performance, Expected Competitive Advantage, Perceived Stakeholders' Concern, Farmers' Environmental Commitment, Cotton Farming, Australia.

1. INTRODUCTION

The devastating environmental issues such as pollutions and emissions associated with the activities of the cotton industry are well documented in the literature (Antille et al., 2016; Braunack, 2013; Hulugalle and Scott, 2008; Maraseni et al., 2010).[87] These issues are known to be severely endangering the natural resources such as air, water and soil. Studies suggest that environmental issues need to be carefully managed to secure the sustainability of the industry. According to Antille et al. (2016, p. 1), "resources must be efficiently managed within increasingly sophisticated farming systems to enable long-term economic viability of cotton production".

Prior studies note that environmental management accounting (EMA) practices[88] can be used by managers to deal with the environmental issues of organizations (Chan et al., 2014; Latan et al., 2018; Qian et al., 2018). EMA practices have the potential to provide managers with environmental information, which is useful for organizational decision making. Such information could also help organisations to create competitiveness by minimizing environmental issues and thus increasing environmental performance. Studies note that increased environmental performance through EMA practices can also enhance economic performance (Chan et al., 2014; Gunarathne and Lee, 2015; Latan et al., 2018; Qian et al., 2018).

The effectiveness of EMA practices is primarily dependent on various contingent factors (see Adams and Larrinaga-González, 2007; Banerjee, 2001; Ervin et al., 2013; Hörisch et al., 2014; Lisi, 2015). According to stakeholder theory, there are three key contingent factors – expected competitive advantage, perceived stakeholders' concern and managers' environmental commitment – that could determine the effectiveness of EMA practices. *Expected competitive advantage* is managers' belief that the adoption of positive environmental initiatives such as EMA symbolizes a source of competitive advantage that increases the reputation and profitability of the organization (Lisi, 2015). *Perceived stakeholders' concern* is managers' perceptions that the organizations' stakeholders, such as employees, suppliers, lenders, local communities, government and media, have concerns

[87] The full references of all the citations in this paper are available in the reference list at the end of this paper on page 200.
[88] For example, recognizing recycling, estimating pollution prevention costs, measuring waste reduction costs, etc.

about the natural environment (Ervin et al., 2013). *Managers' environmental commitment* is managers' concerns for their environmental obligations (Bansal and Roth, 2000). Studies highlight that these factors are complementary and the combination of these factors may generate a broader view of EMA application (Banerjee, 2001; Bansal and Roth, 2000; Lisi, 2015).

However, prior studies have paid limited attention to the relationship between the three contingent factors suggested by stakeholder theory and the use of EMA practices. Prior studies have primarily focused on the non-accounting aspects of organizations. For example, while Plaza-Úbeda et al. (2009) examine the relationship between the three factors and managers' adherence to the win-win view of environmental investments, Harrison et al. (2010) examine the central concepts of stakeholder theory, such as competitive advantage, in relation to the firm's performance. This study differs from prior studies, in its aim to examine the association between the three factors (expected competitive advantage, perceived stakeholders' concern and farmers' environmental commitment) and EMA practices, in this case the EMA practices of Australian cotton farmers. The study also explores whether EMA practices are associated with both the environmental and economic performance of cotton farms. The study uses a survey method to collect data from a sample of 92 Australian cotton farmers. Partial Least Squares (PLS) as a Structural Equation Modelling (SEM) technique is used to analyse data.

The study makes several important contributions to the literature. First, this study makes a theoretical contribution to stakeholder theory as a response to calls for further empirical studies on stakeholder theory (Harrison et al., 2015). There is very limited knowledge about the association between the three factors suggested by stakeholder theory (expected competitive advantage, perceived stakeholders' concern and managers' environmental commitment) and EMA practices. In particular, little is known about links between the three factors of stakeholder theory, environmental performance and economic performance. Thus, this study extends prior studies examining these three factors in relation to other organizational variables, such as corporate environmental strategies (Banerjee, 2001) and environmental performance measurement systems (Lisi, 2015).

Second, this study develops a theoretical framework drawing on stakeholder theory. Prior studies on management accounting have primarily used theories from other fields, such as economics, psychology and sociology, and paid limited attention to stakeholder theory (e.g.

Appuhami, 2017; Hall, 2008, 2016; Jamil et al., 2015; Qian et al., 2011; Wickramasinghe and Hopper, 2005). For example, while Gibassier (2017) uses institutional theory to examine EMA practices used in French companies, Qian et al. (2011) use contingency theory to examine the use of EMA practices of local government in Australia, and Wickramasinghe and Hopper (2005) use mode of production theory and cultural anthropology to examine management control in a textile mill in Sri Lanka.

Third, this study contributes to the literature on agriculture by examining the relationship between the use of EMA practices and cotton farms' performance (environmental and economic). Prior studies examining environmental performance have mainly focused on other industries, such as finance, energy, chemical and pharmaceutical, capital goods, building and construction, and trade and logistics (Banerjee et al., 2003; Ervin et al., 2013; Qian et al., 2018) and paid limited attention to agriculture such as cotton farming.

Finally, this study contributes to the literature on cotton farming in Australia. Prior studies on Australian cotton farming have mainly focused on the management of environmental issues, such as water usage (Braunack, 2013), pest management and insecticides usage (Davies et al., 2011; Fitt et al., 2009), soil improvement (Antille, 2016) and carbon footprint (Maraseni et al., 2010; Visser et al., 2014) in isolation. In contrast, this study examines a bundle of EMA practices that could minimize environmental issues associated with Australian cotton farming.

The remainder of this paper is as follows. The next section discusses the relevant literature and develops hypotheses. Section 3 describes the research method, and Section 4 reports the findings of the data analysis. Section 5 presents conclusions and implications of the study.

2. THEORETICAL FRAMEWORK

2. 1 Environmental management accounting and cotton farming

EMA is "the management of environmental and economic performance through the development of appropriate environment-related accounting systems and practices" (Savage and Jasch, 2005, p. 19). According to The United Nations Division for Sustainable Development (UNDSD, 2001), EMA systems produce monetary and non-monetary information useful for internal decision making in organizations. Monetary information includes environment-related costs, earnings and savings, while non-monetary information includes the amount of water, energy and raw materials (including waste) used.

Monetary and non-monetary environmental information of the farms' activities are likely to be useful for farm owners in the Australian cotton industry. Such EMA information used in cotton farms can include the cost and amount of pesticides, air, water and soil pollution, wastewater, disposal of leftover pesticides, and penalties imposed on breaching environmental law. Prior studies note that 'merely' identification of waste is considered to be an EMA practice (Ferreira et al., 2010; Frost and Wilmshurst, 2000) which along with the other environmental costs are frequently not recorded and thus being overlooked by conventional accounting (Gale, 2006).

2. 2 Stakeholder theory

Stakeholder theory, introduced by Freeman (1984), considers all groups of stakeholders associated with organizational activities. The theory is derived from political economy theory, which is associated with "the social, political and economic framework within which human life takes place" (Gray et al., 1996, p. 47). Stakeholder theory as a management theory is based on the moral treatment of all stakeholders (Harrison et al., 2015), and considers the relationships between the organization and all other parties or individuals that could affect or be affected by the organization's activities. It also considers how these relationships influence the organizations' activities and decision making (Freeman, 1984). Guthrie et al. (2004, p. 283) note that based on stakeholder theory, "an organization's management is expected to take on activities expected by their stakeholders and to report on those activities to the stakeholders". Stakeholders include "any group or individual who can affect or is affected by the achievement of the organization's objectives" (Freeman, 1984, p. 46). More specifically, an organization's 'environmental stakeholders' include "individuals or groups [such as regulators, environmental interest groups, organizational members, investors, insurers, financial institutions, international trade partners, community members, and the media] that can affect or be affected by the achievement of a firm's environmental goals" (Banerjee et al., 2003, p. 107).

There are two branches of stakeholder theory, namely ethical (normative/moral) branch and managerial (positive) branch (Deegan, 2000; Ullmann, 1976). The ethical branch of stakeholder theory notes that all stakeholders are of equal importance in the organizational decision-making process. The managerial branch of the theory however, notes that the organization does not need to respond to all stakeholders equally; it can prioritize the interests of the most powerful groups of stakeholders, who have the higher degree of control over the resources required by the organization such as labour and finance (Deegan, 2000). The level of significance given to each group varies depending on the expected performance of the organization. For example, prioritizing economic performance implies that shareholders, employees and investors are perceived as the more significant group, whereas, building a good reputation and being perceived as an environmentally friendly organization indicates that environmental interest groups and the media are considered as more significant.

Drawing on the two branches, stakeholder theory, identifies three key factors, namely expected competitive advantage, perceived stakeholders' concern and environmental commitment (Banerjee et al., 2003).[89] These three key contingent factors can motivate managers to adopt certain management accounting practices to achieve specific organizational outcomes. Accordingly, the study develops a theoretical framework, presented in Figure 5. 1. The hypotheses development section below discusses links between the variables included in the framework.

2. 3 Hypotheses development

The study predicts that there are positive associations between the three factors (expected competitive advantage, perceived stakeholders' concern and farmers' environmental commitment) and the use of EMA practices. The use of EMA practices is also positively associated with environmental performance which, in turn, leads to improved economic performance. The relevant literature is reviewed to develop hypotheses for the relationships between the three factors and the use of EMA practices by cotton farmers (H1, H2, H3), and for the relationship between the use of EMA practices and farms' environmental performance (H4), which subsequently leads to improved economic performance (H5). Figure 5. 1 shows a summary of the hypotheses and the constructs used in this study.

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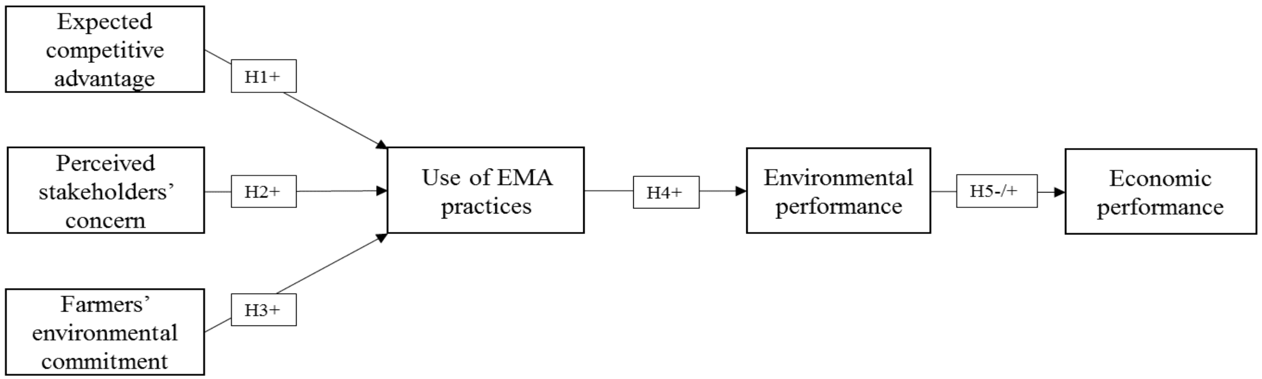
[89] Stakeholder theory used by Banerjee et al. (2003) is different from the framework used by Ullmann (1985). Ullmann (1985) had mainly focused on social disclosures and social performance.

Figure 5. 1 - Structural model: Expected competitive advantage, perceived stakeholders' concern, farmers' environmental commitment, use of EMA practices, environmental performance and economic performance



EMA – Environmental Management Accounting Practices

2. 3. 1 Expected competitive advantage and EMA practices

Expected competitive advantage is one of the factors identified by stakeholder theory as influencing the decisions of the managers of organizations. According to Švárová and Vrchota (2014, p. 688), competitive advantage "separates the enterprise from others and keeps it alive and growing". It includes, but is not limited to, the organizations' long-term relationships with customers and suppliers, its reputation, increased efficiency in its adaptation to external demands, product and service innovations, and noble ideas (Chenhall and Moers, 2015; Endrikat et al., 2014). Expected competitive advantage in this study refers to the expectation of managers in an organization to achieve an increase in long-term organizational profitability and good reputation through the application of environmentally friendly initiatives (Banerjee et al., 2003).

Organizations need to create competitive advantage over their competitors to increase sales and gain greater profit. In the globalized world of today, however, it is more difficult for organizations to maintain their competitive advantages (Yazdifar et al., 2018). Currently, there are more and more producers entering the market, thus competition is higher, and customers have greater choice (Švárová and Vrchota, 2014). While some organizations may create competitive advantage by possessing particular resources, which are exceptional, valuable, unique and non-substitutable achieved through specific learnings, management strategies and skills (Evans, 2016), others may create competitive advantage through intellectual capital leading to innovative behaviour, human capital and social capital growth (Liu, 2017).

One means of achieving competitive advantage is adopting environmentally friendly initiatives and meeting stakeholders' demands for responsible environmental performance (Arjaliès and Mundy, 2013; Bansal and Roth, 2000; Lisi, 2015; Paulraj, 2009). Organizations that create competitive advantage through environmentally friendly initiatives are more likely to adopt environmental management practices such as identifying waste, measuring recycling costs, measuring waste reduction costs and estimating pollution preventions costs (Sharma, 2000). The use of EMA practices could also help organizations to identify, measure, analyse and interpret information related to the environmental aspects of their activities (Burritt et al., 2002), thus creating competitive advantage. In the case of the cotton industry, cotton farmers could use the information generated by EMA to minimize environmental issues such as waste and pollution, and gain competitive advantage.

Prior studies in management, management accounting, hospitality and logistics management note that competitive advantage is one of the reasons for adopting various organizational practices, such as EMA (e.g. Beske, 2012; Endrikat et al., 2014; Evans, 2016; Journeault et al., 2016). For example, Fraj-Andrés et al. (2009), examining 235 industrial firms, find that competitive motivations are significant factors influencing managers to incorporate environmental issues into their strategic planning process including the management accounting system. The study of Liu (2017), which examines the role of competitive advantage in identifying a market opportunity and growth using a sample of 595 hotel managers, also provides strong support for the relationship between competitive advantage and organizational practices. Therefore, drawing on stakeholder theory and based on the above discussion, the study proposes the following Hypothesis 1:

H1: *Farmers are more likely to practice EMA if they believe it will provide them with a competitive advantage.*

2. 3. 2 Perceived stakeholders' concern and EMA practices

Perceived stakeholders' concern is the second factor identified by stakeholder theory as influencing the behaviour of managers in organizations. Perceived stakeholders' concern in this study refers to managers' perception that stakeholders are concerned about the natural environment (Ervin et al., 2013; Lisi, 2015). According to Freeman (1984), ongoing managerial attention to stakeholders' interest is critical to the success of any organization. In essence, the way managers respond to stakeholders' concern is a key determinant of organizational survival (Berman et al., 1999; De Villiers and Sharma, 2018; Donaldson and Preston, 1995).

Many groups of stakeholders, such as shareholders, employees, environmental advocates, banks, insurers, international trading partners and the general public increasingly demand improved environmental performance (Berry and Rondinelli, 1998; De Villiers and Sharma, 2018; Rodrigue et al., 2013). Different groups of stakeholders may act differently to "communicate satisfaction or dissatisfaction" through "direct engagement with managers" or indirect correspondence (Darnall et al., 2010, p. 1074). For example, Darnall et al. (2010) note that consumers and suppliers continue purchasing organization's products and renew selling agreements to show satisfaction with the organization's environmental strategies. In contrast, in order to show their dissatisfaction, commercial buyers, consumers and suppliers may take legal action against the organization (Darnall et al., 2010). Employees may also terminate employment or engage in public whistleblowing on an organization's non-compliance with environmental laws (Darnall et al., 2010). Thus, stakeholders' concern about the natural environment may influence an organization's management strategies and encourage managers to adopt management strategies including the adoption of environmentally friendly practices such as EMA that minimize the environmental impact of an organization (Al-Tuwaijri et al., 2004; Rodrigue et al., 2013).

Prior studies examine the role of perceived stakeholders' concern in relation to management practices in different industries (e.g. Banerjee et al., 2003; Fraj-Andrés et al., 2009; Judge and Douglas, 1998; Pondeville et al., 2013). The findings of previous studies indicate that there are positive associations between the role of perceived stakeholders' concern and various organizational practices such as environmental management systems, environmental performance and financial performance in organizations (e.g. Lisi, 2015; Banerjee et al., 2003). For example, based on 91 Italian firms, Lisi (2015) finds that there is a positive and significant relationship between managers' perception of stakeholders' concern and the adoption of environmental performance measurement systems. Similarly, Banerjee et al. (2003) find that stakeholders' concern has a positive and significant influence on corporate environmentalism. Therefore, drawing on stakeholder theory and based on the above discussion the study develops the following hypothesis 2:

H2: *Farmers are more likely to practice EMA if they believe that powerful stakeholders are concerned with environmental degradation.*

2. 3. 3 Farmers' environmental commitment and EMA practices

Stakeholder theory suggests that managers' environmental commitment is the third factor influencing managers' behaviour in an organization. Commitment can be defined as a pledge or promise by an individual to behave in a certain way (Terrier and Marfaing, 2015). Individual commitment could manifest in different area of decision making, such as promoting road safety, organic farming, cleaning local waterways and sustainable behaviours, such as reusing towels in the hotel industry to support pro-environmental initiatives (Buil-Fabreaga et al., 2017; Mzoughi, 2011; Rahman and Reynolds, 2016; Terrier and Marfaing, 2015). In the context of the environment, Rahman and Reynolds (2016, p. 109) note that "individuals committed to the environment who have a strong biospheric value orientation will be more willing to make sacrifices for the environment". Similarly, managers' environmental commitment refers to the concern that the managers of an organization have for their environmental responsibilities, including the wellbeing of plants and animals (Bansal and Roth, 2000; Rahman and Reynolds, 2016). According to Henriques and Sadorsky (1999, p. 88) what a manager is "actually doing or has done with reference to environmental issues can describe [their] commitment to the natural environment".

Managers can fulfil their environmental commitment through adopting various environmental practices, such as having a written document describing the environmental plan,[90] communicating the environmental plan to stakeholders, forming an environmental health and safety unit and having a board or management committee dedicated to dealing with environmental issues (Henriques and Sadorsky, 1999). Environmentally friendly practices adopted by organizations differ depending on managers' commitment to environmental responsibilities. Some managers who are less committed to environmental responsibilities tend to adopt environmentally friendly practices only to fulfil regulatory requirements. Managers who are more committed to meeting their environmental obligations go beyond the regulatory requirement to take voluntary initiatives to invest in resources and to design management accounting practices to minimize environmental impact (Nath and Ramanathan, 2016).

Managers' environmental commitment is a likely motivation for the adoption of EMA practices in organizations, including agribusinesses such as cotton farming. When managers are committed to environmental well-being, they tend to adopt management practices such as EMA to minimize the impact of organizational activities on the natural environment (Bouten and Hoozee, 2013; Han, 2015; Latan et al., 2018). Managers with stronger environmental commitment also seem to invest a significant amount of resources in designing management accounting practices such as EMA. According to studies, such practices could generate comprehensive information about the environmental impact of organizational activities (Bouten and Hoozee, 2013; Ferreira et al., 2010). For example, Bouten and Hoozee (2013) note that managers' environmental commitment motivates them

[90] An environmental plan describes "how an action might impact on the natural environment in which it occurs and set out clear commitments from the person taking the action on how those impacts will be avoided, minimized and managed so that they are environmentally acceptable" (Department of the Environment, 2014, p. 5). An environmental plan is a useful tool to consider and protect the wellbeing of the natural environment. The purpose of an environmental plan is to create sustainable communities to protect undeveloped lands.

to closely examine the use of water energy and raw materials in order to minimize waste. Han (2015) also notes that, unlike conventional business management strategies, which cause significant harm to the environment (e.g. excessive use of water, energy and disposal of waste and emissions into water, soil and air), the environmental commitment of managers drives them to actively adopt eco-friendly guidelines and environmental management practices such as EMA to improve the sustainability of their business strategies. Further, Latan et al. (2018) note that managers' environmental commitment motivates them to adopt a system such as EMA to help them to collect information about the environment.

Previous studies provide empirical evidence on the association between managers' environmental commitment and organizational practices such as EMA. While the organizational practices investigated in previous studies are not directly related to EMA, the finding of such studies provide a platform to develop the hypothetical relationship between managers' environmental commitment and EMA. For example, prior studies show the interplay between environmental commitment and the use of strategic environmental management practices, the environmental management system, and management disclosure practices (Albertini, 2014; Nath and Ramanathan, 2016; Plaza-Úbeda et al., 2009). Nath and Ramanathan (2016), examining 76 UK companies, confirm that organizations with some level of environmental commitment tend to use strategic environmental management practices to achieve their long-term pollution prevention objectives. Bouten and Hoozee (2013), examining the interplay between environmental reporting and management accounting change in four Belgian case companies, also highlight the significant role of top management environmental commitment. Therefore, drawing on stakeholder theory and based on the above discussion, the following Hypothesis 3 is proposed:

H3: *Farmers are more likely to practice EMA if they are personally committed towards the environmental wellbeing.*

2. 3. 4 Use of EMA and environmental performance

Environmental performance can be defined in a range, from narrow to broad. While narrow definitions only cover one aspect of environmental performance (Burnett and Hansen, 2008), broader definitions include many aspects of environmental performance, such as reductions in water consumption, emission of atmospheric pollutants, consumption of toxic materials, the production of solid waste and the number of environmental accidents (Stefanelli et al., 2014). Lisi (2015) defines improving environmental performance as the firms' increasing efficiency and effectiveness beyond fulfilling society's expectations and concerns in regards to the natural environment. Environmental performance indicators may include measurement of, for example, the amount of carbon emissions (CO_2), water and soil pollution and wastes disposals. Environmental performance in this study includes performance measurement of different aspects of the environment, such as number of environmental accidents (e.g. chemicals moved into the water stream due to water runoff), emission of atmospheric pollutants, consumption of dangerous/toxic materials, producing solid waste, compliance with environmental regulations, preventing and mitigating environmental crises (e.g. significant chemical use, significant water/soil/air pollution) and educating employees and the community about the environment.

Environmental performance in agribusinesses refers to minimizing impacts of agricultural activities on natural resources such as soil, water and air (Latan et al., 2018; Point et al., 2012). These impacts include but are not limited to emissions, pollutions, erosion and the depletion of these natural resources. Excessive use of water and depletion of water sources, as well as pollutions and waste such as the release of pesticides and other agricultural chemicals into water, air and soil, are some examples of these issues caused by agribusinesses. According to studies, agribusinesses impact on soil, water and air mainly through plantations, ploughing, irrigation, the use of pesticides and agricultural machinery (Antille et al., 2016; Bevilacqua et al., 2014; Hulugalle et al., 2015). For example, environmental impacts are significant in Australian cotton farming because of significant use of water and pesticides (Bevilacqua et al., 2014; Braunack, 2013; Maraseni et al., 2010; Roth et al. 2013). Highly mechanized agricultural activities in Australia also greatly contribute to carbon emissions due to large-scale use of fossil fuel. Prior studies highlight various areas of environmental performance in cotton farming in Australia that need immediate improvement, including water conservation and carbon emissions reduction (Agbola and Evans, 2012; Antille et al., 2016; Ismail et al., 2011; Roth et al. 2013).

The use of EMA practices is likely to increase the environmental performance of business operations (Chan et al., 2014; Latan et al., 2018). In particular, various EMA tools can generate environmental information needed to measure and improve environmental performance in organizations. For example, organizations can use Life-Cycle Costing (LCC) to measure and increase environmental performance by examining the total cost of the specific product over its full life cycle (Point et al., 2012). Such costing systems can also quantify the environmental impacts of raw material extraction, production and distribution, all the way down through the end-of-life stage of the product (Chan et al., 2014; Christ and Burritt, 2015). According to Lisi (2015), environmental performance measurement systems as a significant element of environmental management control systems can improve environmental performance. Point et al. (2012) also confirm that the use of Life-Cycle Assessment (LCA) as an EMA tool can be beneficial in quantifying inputs (including material and energy) and the relevant environmental emissions of the organizations' activities.

The use of EMA practices in agribusiness can measure and minimize environmental impacts associated with operational activities, including pesticides use and water pollution (e.g. Burritt et al., 2009). In cotton farming, the use of EMA practices can be helpful in minimizing environmental impacts such as soil erosions, soil and water pollutions, carbon emissions and water depletion, thereby increasing environmental performance. Various EMA practices used in cotton farming include, for example, the measurement of Greenhouse Gas (GHG) emissions, soil erosion prevention cost, and water and energy consumption (Hulugalle et al., 2015; Maraseni et al., 2014; Visser et al., 2014; Weaver et al., 2013).

Previous studies provide empirical evidence on the relationship between various EMA practices and environmental performance in business organizations. Some previous studies focus only on the relationship between specific elements of EMA and environmental performance. For example, Burnett and Hansen (2008) focus only on the measurement of carbon emissions (GHG emissions), while Point et al. (2012) explore the use of LCA in wine production. Other studies focus on a wide range of environmental indicators including air, soil and water pollution, compliance with regulations, educating employees, reducing waste, and recycling and the use of reusable containers in relation to environmental performance (e.g. Frost and Wilmshurst, 2000; Judge and Douglas, 1998; Lisi, 2015; Stefanelli, 2014). In essence, empirical evidence of such studies provides the platform to develop the relationship between EMA and environmental performance in cotton farming. Based on the above discussion and evidence the study formulates Hypothesis 4 as follows:

H4: *The use of EMA practices is positively associated with environmental performance in cotton farms.*

2. 3. 5 Environmental performance and economic performance

Economic performance of a business organization refers to the achievement of its goals in areas such as profits, assets, liabilities and market position. It includes factors related to money, wealth, debt and investment. Economic performance differs from financial performance as it broadly takes into account financial aspects and various other types of benefits such as reduction in material costs, increased productivity, improved quality of products and services, strong relationships with stakeholders and increased company reputation (Henri and Journeault, 2010).

Economic performance of agribusinesses involves minimizing farm related costs, minimizing waste and maximizing the quality of farm products (Buckley and Carney, 2013). Farm-related costs include water used for irrigations, fuel used for running agricultural machinery and energy used in drip irrigations. Similarly, the economic performance of cotton farms may include maximizing efficiency of inputs, such as irrigation water, fertilisers and pesticides. It could also include minimizing costs of pollution prevention or environmentally responsible disposal of leftover pesticides. Further, it may involve maximizing the quality of cotton yields with minimum irrigation (Cotton Australia, 2014).

Organizations are likely to use environmental performance in various ways to increase economic performance. Disclosures of environmental performance can be spread as good news that encourages investors to invest in business opportunities with the high economic return, thereby creating value over time (Burnett and Hansen, 2008; De Villiers and Sharma, 2018). Enhanced environmental performance can also increase economic performance by reducing risk and thereby reducing the cost of capital and increasing share prices (Burnett and Hansen, 2008; Feldman et al., 1997). Further, organizations can increase economic performance by minimizing environmental costs associated with pollution, emissions, wastes, pollution fines and penalties (Schaltegger and Synnestvedt, 2002).

Prior studies have examined the association between environmental performance and economic performance (Henri and Journeault, 2010; Journeault, 2016; Schaltegger and Synnestvedt, 2002) and are in agreement that environmental and economic performance are related. While some studies claim that improved environmental performance mainly causes extra costs and negatively impacts economic performance (Barbera and McConnell, 1990; Brännlund et al., 1995), others argue that environmental performance reduces costs and increases economic performance (Al-Tuwaijri et al., 2004; Burnett and Hansen, 2008; Endrikat et al., 2014; Schaltegger and Synnestvedt, 2002; Qi et al., 2014). Many other studies also find a moderate positive relationship between environmental performance and economic performance (Endrikat et al., 2014). In this regard, Wagner et al. (2002, p. 143) note that "it cannot be easily assumed that environmental and economic performance are independent of each other". Accordingly, the above discussion and evidence provide the basis for Hypothesis 5:

H5: *Environmental performance is associated with the economic performance in cotton farms.*

3. RESEARCH METHOD

3. 1 Sample selection and data collection

The study uses a sample of Australian cotton farms, including publicly listed agribusinesses, corporate farms and small family farms[91] (Cotton Australia, 2016). The initial sample of 1200 farms was reduced to a final population of 875 cotton farms after deducting subsidiary farms and considering one farm for each family farm. Of these 875 cotton farms, the 400 largest[92] were selected through a commercial mail list provider as the final sample for participation in this study (Table 5. 1). The study targeted the largest 400 cotton farms because large farms are more likely than small farms to use EMA practices (Beedell and Rehman, 1999; Läpple and Kelley, 2013). According to Van der Stede et al. (2005), this sample size is large enough to be representative of the population.[93]

Table 5. 1 - Sample selection

Steps	Numbers
Total number of surveys administered	400
Total responses received (31 %)	124
Number of incomplete questionnaires/deleted	(32)
Total number of responses used for analysis (23% response rate)	92

[91] Listed agribusinesses include businesses which are publicly owned by shares, corporate farms include private companies and family farms include small family owned farms, mainly owned by the farmers and their families. The majority of the farms in the sample consist of family farms.
[92] The study measures farm size by the number of employees including full-time, part-time, casual and contractors.
[93] The sample size of 400 is 45.71% of the populations (400/875) almost half of the population. The response rate is 31% (124/400), which is higher than most management accounting studies (e.g. Appuhami, 2017; Hall, 2008). Accordingly, the sample size is considered sufficient (Van der Stede et al., 2005).

The study collected data by using a survey administered to Australian cotton farmers. The study used survey method because of its advantages in collecting a large amount of data in a relatively short time and convenience for participants (Appuhami, 2017; Birnberg et al., 1990; Van der Stede et al., 2005). The study designed the survey questions using pre-tested survey questions and measurement scales used by prior management accounting and EMA studies (Banerjee et al., 2003; Ferreira et al., 2010; Frost and Wilmsurst, 2000; Judge and Douglas, 1998; Läpple and Kelley, 2013; Stefanelli et al., 2014; Walker and Boyne, 2006; Withers et al., 2011). The study also developed additional questions to reflect the current Australian cotton farming practices. The survey comprises multiple sections each containing multiple questions to capture data regarding expected competitive advantages of farm businesses, perceived stakeholders' concern, farmers' environmental commitment, the use of EMA practices, and the environmental performance and economic performance of cotton farms (see Appendix 1).

Consistent with Dillman (2000), the study followed three stages[94] in administering the survey: (1) telephone calls were made to check the accuracy of contact details of farmers (2) a survey pack containing cover letter, questionnaire,[95] reply-paid envelope and a pre-numbered postcard were mailed to all 400 farmers, and (3) follow-up reminders were mailed to the farmers three and eight weeks after the initial mail-out. To encourage participants to complete the questionnaire, the study provided each participant with incentives such as two movie tickets or a movie DVD of their choice (Appuhami, 2017). Participants were also ensured of the anonymity of their responses and promised a summary of the results. 124 of the 400 distributed surveys were returned indicating a 31% response rate, which is higher than most recent management accounting studies (e.g. Appuhami, 2017; Mahama and Cheng, 2013). After eliminating 32 incomplete surveys, 92 usable responses were available for analysis as the final sample of the study as detailed in Table 5. 1.

An independent sample *t*-test was undertaken for all constructs to compare early respondents (30%) to late respondents (30%) (non-response bias).[96] The results confirm no significant differences between the two groups (*p*-values range from 0.957 to 0.958 two-tailed test),

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[94] Step four follow up phone calls were not followed due to ethical limitations.
[95] Appendix 2 at the end of the thesis includes the participant information letter and the full survey instrument.
[96] Early responses represent participants who are willing to participate in the survey, while, late responses represent farmers who are less willing to participate in the survey (De Villiers and Van Staden, 2010).

with the similar mean size of the two groups of respondents including early respondents ($\bar{x}$ = 4.3766) and late respondents ($\bar{x}$ = 4.3568).

3. 1. 1 Descriptive statistics

Table 5. 2 presents demographic information[97] such as farm age and farm size, collected in this study (e.g. Läpple and Kelley, 2013; Withers et al., 2011). The average farm age (measured as the time that a farm has been in use) in the sample is 59 years. The youngest farm is ten years and the oldest farm is 180. The average farm size (measured as number of employees) has eight employees, with the smallest farm having only one employee (the farmer) and the largest farm 120.

Table 5. 2 - Descriptive statistics for demographic variables

Descriptive Statistics				
Variable	Minimum	Maximum	Mean	Std. Deviation
Farm size (no. of employees)	1	120	8.791	16.873
Farm age (years)	10	180	59.230	39.332

3. 2 Variable measurement

This study measures six latent variables, namely expected competitive advantage (ECA), perceived stakeholders' concern (PSC), farmers' environmental commitment (FEC), EMA practices (EMA), environmental performance (ENVP), and economic performance (ECONP) (Table 5. 3). The study measures all variables using measurement scales used in prior studies on EMA and management accounting. Using prior agriculture and farming studies the study designed further questions to capture more detailed information (e.g. Läpple and Kelley, 2013; Withers et al., 2011). A seven-point Likert scale used by the study ranges from '1' (disagreement/less likely/negative stance) to '7' (agreement/most likely/positive stance) with '4' serving as a neutral stance. Appendix 1 illustrates the details of questions and scales used in the study. To ensure clarity, the survey was also pilot tested on a group of 25 academics and PhD students. The results suggest no change to the established survey questions and a slight change to the graphic layout of the questionnaire.

[97] The sample includes 80 male (87%) and 12 female (13%) farmers. The majority of the farm businesses in the sample are small family farms, owned by farmers, aged between 50 to 60 years old and holding a diploma/TAFE degree.

Table 5. 3 - The summary of Observed, Latent and Control Variables

Observed Variable	Acronym
Use of EMA practices	EMA
Environmental performance	ENVP
Economic performance	ECONP
Latent Variables	
Expected competitive advantage	ECA
Perceived stakeholders' concern	PSC
Farmers' environmental commitment	FEC
Control Variables	
Farm size	SIZE
Farm age	FAGE

3. 2. 1 Expected competitive advantage

The study uses a four-item scale adapted from Banerjee et al. (2003)[98] to measure expected competitive advantage (ECA). Expected competitive advantage measures the level of advantages a farm business can gain compared to the other farm businesses by using EMA practices.[99] The results of the exploratory factor analysis show a single factor with an eigenvalue of greater than 1 and factor loading ranging from 0.667 to 0.879. Cronbach's alpha test shows 0.894 for this scale, well above the threshold of 0.70. This factor explains 76.11 percent of the total variance.

3. 2. 2 Perceived stakeholders' concern

The study uses a four-item scale adapted from Banerjee et al. (2003) to measure perceived stakeholders' concern (PSC). Perceived stakeholders' concern measures stakeholders' concern in relation to the impacts of the farm businesses' activities on the physical environment as perceived by farmers. The results of the exploratory factor analysis show a single factor with an eigenvalue of greater than 1, factor loading ranging from 0.667 to 0.879 and Cronbach's alpha test of 0.816. This factor accounts for 66.99 percent of the total variance.

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[98] These scales have also been used by Fraj-Andrés et al. (2009), indicating robustness.

[99] For understandability purposes the survey used in this study used the term "environmentally friendly practices" with examples for EMA practices within bracket. Because the term "environmental management accounting" (EMA), is not known to farmers, a statement was added to the survey to guide participants to see the survey section with more examples of EMA practices.

3. 2. 3 Farmers' environmental commitment

The study uses a three-item scale adapted from Banerjee et al. (2003) to measure farmers' environmental commitment (FEC). Farmers' environmental commitment measures the farmers' level of commitment and moral responsibility in relation to environmental harm. The results of the exploratory factor analysis show a single factor with an eigenvalue of greater than 1 and factor loading ranging from 0.848 to 0.905. Cronbach's alpha test shows 0.872 for this factor and it accounts for 80.52 percent of the total variance.

3. 2. 4 Use of EMA practices

The study uses a 15-item scale to measure the extent to which EMA practices (EMA) are used by cotton farmers. Five of the 15 items are adapted from Ferreira et al. (2010),[100] and ten additional items are designed based on Frost and Wilmsurst (2000) to capture more detail about EMA practices in cotton farming in Australia (see Appendix 1). The study revised the added questions based on Frost and Wilmshurst (2000) to increase the understandability of the questions for cotton farmers. The results of the exploratory factor analysis show a single factor with an eigenvalue of greater than 1 and factor loading ranging from 0.527 to 0.821. Cronbach's alpha test shows 0.908 for this scale, well above the threshold of 0.70. This factor explains 70.60 percent of the total variance.

3. 2. 5 Environmental performance

The study uses an eight-item scale including five adapted from Stefanelli et al. (2014) and three adapted from Judge and Douglas (1998)[101] to measure farms' environmental performance (ENVP). The results of the exploratory factor analysis for this variable show a single factor with an eigenvalue of greater than 1, factor loading ranging from 0.638 to 0.857, Cronbach's alpha of 0.845, which is above the threshold of 0.70 and accounting for 69.01 percent of the total variance.

[100] Only five items were adapted from Ferreira et al. (2010) as other questions were not suitable for farmers because they were designed for large corporations with management accountant positions and use formal EMA practices, such as Life Cycle Assessments (LCA) and environment-related key indicator performance (KIP) etc.

[101] These scales have also been used by Lisi (2015), indicating robustness.

3. 2. 6 Economic performance

The study uses an eight-item scale adapted from Walker and Boyne (2006) to measure farms' economic performance (ECONP). The results of the exploratory factor analysis show a single factor with an eigenvalue of greater than 1 and factor loading ranging from 0.780 to 0.914. Cronbach's alpha test shows 0.942 for this scale, well above the threshold. This factor explains 72.22 percent of the total variance.

3. 2. 7 Control variables

The study controls for farm age (measured as a number of years a farm had been in use), because the early, medium and late adopter of EMA practices might be different (Läpple and Kelley, 2013). The physical impact of a farm in use for a longer period is also greater than a farm in use for a shorter period. The study further controls for farm size (measured as the number of employees) because larger farms are more likely to impact on the natural environment (Beedell and Rehman, 1999). The support of employees in the farm also motivates the use of EMA practices (Läpple and Kelley, 2013; Withers et al., 2011), and the use of EMA practices by farmers can minimize harmful impacts and improve environmental performance.

4. RESULTS

This study uses the partial least squares (PLS) technique to test the hypotheses. PLS technique as a form of structural equation modelling (SEM) has been increasingly used in recent management accounting studies (e.g. Appuhami, 2017; Hall, 2008; Mahama and Cheng, 2013) due to its advantages such as analysing reflective models (Lowry and Gaskin, 2014), applying minimal data assumptions and analysing small sample sizes (Wold, 1985; Hair et al., 2014),[102] and the ability to analyse predictions such as competitive advantage and success drivers (Hair et al., 2014). PLS uses the latent variable modelling technique, which integrates multiple dependent constructs and identifies measurement error using covariance structure analysis (Fornell, 1982; Hall, 2008). PLS uses bootstrapping resampling technique

[102] Unlike other structural equation modelling techniques (e.g. LISREL), PLS does not need normally distributed data (Hall, 2008). As a regression based technique, PLS needs ten cases for the most complex regression (Chin, 1998). The most complex regression in this study, is the economic performance (ECONP) (as the dependent variable), with seven variables, suggesting a minimum sample size of 70 cases.

to indicate the significance of the factor loadings and the path coefficients by generating R^2. The R^2 generated in bootstrapping resampling is used to measure the stability of the model. To analyse the measurement model and structural model the study uses SmartPLS (v. 3.2.7).

4. 1 Measurement model

The PLS measurement model demonstrates the likely associations between observed variables (EMA, ENVP, ECONP) and latent variables (ECA, PSC, FEC). Prior to the analysis the study examines the reliability and validity of all the variables used in the measurement model, by undertaking different reliability (individual item and composite) and validity (convergent and discriminant) tests. To ensure the reliability of individual items, the study examines the factor loadings for each variable. All items loading on their relevant constructs with factor loadings above 0.70 were retained (Hair et al., 2014), and items with loadings lower than 0.40 were removed from the model. Items with loadings between 0.40–0.70 were checked for possible impact on average variance extracted (AVE). If the retention of such items did not cause the AVE to fall below the threshold of 0.50 they were retained and if deletion of the item caused AVE to increase to or above the threshold of 0.50 such items were deleted (Hair et al., 2014). Deleted items include EMA 3, EMA 5, EMA 10, ENVP 6 and ENVP 7. The factor loadings from the PLS measurement model are presented in Table 5. 4. In order to test the reliability of each variable, the study also uses Fornell and Larcker’s (1981) measure of composite reliability and Cronbach’s (1951) alpha test of reliability. Table 5. 5 presents the values of composite reliability and Cronbach’s alpha for all used variables which are above 0.70 endorsing satisfactory composite reliability (Nunally and Bernstein, 1978).

Further, the study undertakes convergent validity test by using the AVE statistics to measure the correlations between scale items for each variable (see Table 5. 5). All variables in the model show the AVE value higher than the required threshold of 0.50, which demonstrate satisfactory convergent validity (Chin, 1998; Hulland, 1999). Moreover, the study undertakes a discriminant validity test by comparing correlations between the latent variables with the square root of the AVE statistics for each variable (Chin, 1998). The discriminant validity test identifies whether a latent variable shares more variance with its measures than it shares with other latent variables. As presented in Table 5. 5, the square roots of AVE are larger than the relevant correlations between latent variables, which endorse the acceptable level of discriminant validity. The reliability (both individual item and composite) and the validity (both convergent and discriminant) of the variables used in the measurement model are endorsed by all the above tests from the PLS measurement model and confirmed to be satisfactory.

Table 5. 4 - Factor loadings from PLS measurement model

Variables[103]	ECA	PSC	FEC	EMA	ENVP	ECONP
Expected competitive advantage (ECA)						
ECA 1	**0.745**	0.287	0.196	0.238	0.284	0.071
ECA 2	**0.887**	0.491	0.303	0.365	0.445	0.331
ECA 3	**0.953**	0.513	0.316	0.415	0.490	0.394
ECA 4	**0.888**	0.497	0.356	0.400	0.459	0.378
Perceived stakeholders' concern (PSC)						
PSC 1	0.429	**0.880**	0.496	0.384	0.431	0.347
PSC 2	0.232	**0.799**	0.384	0.249	0.323	0.341
PSC 3	0.667	**0.706**	0.239	0.308	0.445	0.360
PSC 4	0.363	**0.871**	0.388	0.326	0.413	0.355
Farmers' environmental commitment (FEC)						
FEC 1	0.288	0.340	**0.886**	0.130	0.361	0.277
FEC 2	0.265	0.457	**0.963**	0.270	0.448	0.469
FEC 3	0.427	0.446	**0.829**	0.142	0.411	0.465
Use of EMA practices (EMA)						
EMA 1	0.222	0.249	0.170	**0.647**	0.348	0.386
EMA 2	0.232	0.218	0.236	**0.622**	0.420	0.401
EMA 4	0.120	0.201	0.157	**0.622**	0.395	0.384
EMA 6	0.429	0.337	0.194	**0.818**	0.531	0.433
EMA 7	0.162	0.222	0.125	**0.619**	0.319	0.459
EMA 8	0.190	0.174	0.037	**0.723**	0.311	0.311
EMA 9	0.281	0.310	0.092	**0.801**	0.520	0.358
EMA 11	0.393	0.331	0.137	**0.766**	0.422	0.184
EMA 12	0.441	0.416	0.230	**0.668**	0.419	0.161
EMA 13	0.396	0.397	0.284	**0.839**	0.536	0.297
EMA 14	0.263	0.122	0.019	**0.664**	0.386	0.137
EMA 15	0.292	0.290	0.187	**0.702**	0.430	0.232
Environmental performance (ENVP)						
ENVP 1	0.272	0.410	0.285	0.428	**0.732**	0.407
ENVP 2	0.238	0.392	0.313	0.417	**0.752**	0.511
ENVP 3	0.441	0.340	0.344	0.516	**0.880**	0.490
ENVP 4	0.414	0.312	0.335	0.487	**0.899**	0.499
ENVP 5	0.433	0.377	0.244	0.394	**0.719**	0.321
ENVP 8	0.476	0.485	0.580	0.515	**0.601**	0.368
Economic performance (ECONP)						
ECONP 1	0.279	0.253	0.357	0.283	0.461	**0.846**
ECONP 2	0.308	0.239	0.281	0.343	0.460	**0.861**
ECONP 3	0.398	0.460	0.471	0.435	0.514	**0.792**
ECONP 4	0.315	0.341	0.421	0.437	0.474	**0.832**
ECONP 5	0.332	0.410	0.457	0.328	0.459	**0.862**
ECONP 6	0.293	0.409	0.524	0.326	0.541	**0.911**
ECONP 7	0.266	0.387	0.252	0.410	0.513	**0.829**
ECONP 8	0.256	0.396	0.372	0.364	0.434	**0.860**

EMA 3, EMA 5, EMA 10, ENVP 6 and ENVP 7 were removed from the model because their loadings were lower than the recommended threshold and by removing them, EVA was kept above the acceptable threshold 0.50 (Hair et al., 2014).

[103] Please see Appendix 1 at the end of the paper for the complete survey instrument.

Table 5. 5 - Descriptive statistics, reliability and average variance extracted (AVE) statistics and correlations from PLS model

Variable	Mean	Std.Dev	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)	Correlations					
						ECA	PSC	FEC	EMA	ENVP	ECONP
ECA	4.3434	1.3671	0.894	0.926	0.759	**0.871**					
PSC	4.9505	1.1194	0.831	0.888	0.667	0.526	**0.816**				
FEC	5.9231	1.1462	0.878	0.923	0.800	0.344	0.468	**0.894**			
EMA	4.4535	1.1296	0.910	0.924	0.507	0.417	0.395	0.223	**0.712**		
ENVP	4.9863	0.9602	0.858	0.896	0.594	0.493	0.499	0.459	0.601	**0.770**	
ECONP	5.4500	0.9729	0.945	0.950	0.722	0.361	0.428	0.464	0.432	0.570	**0.849**

AVE – average variance of extracted; ECA – expected competitive advantage; PSC – perceived stakeholders' concern; FEC – farmers' environmental commitment; EMA – use of EMA practices; ENVP – environmental performance; ECONP – economic performance.

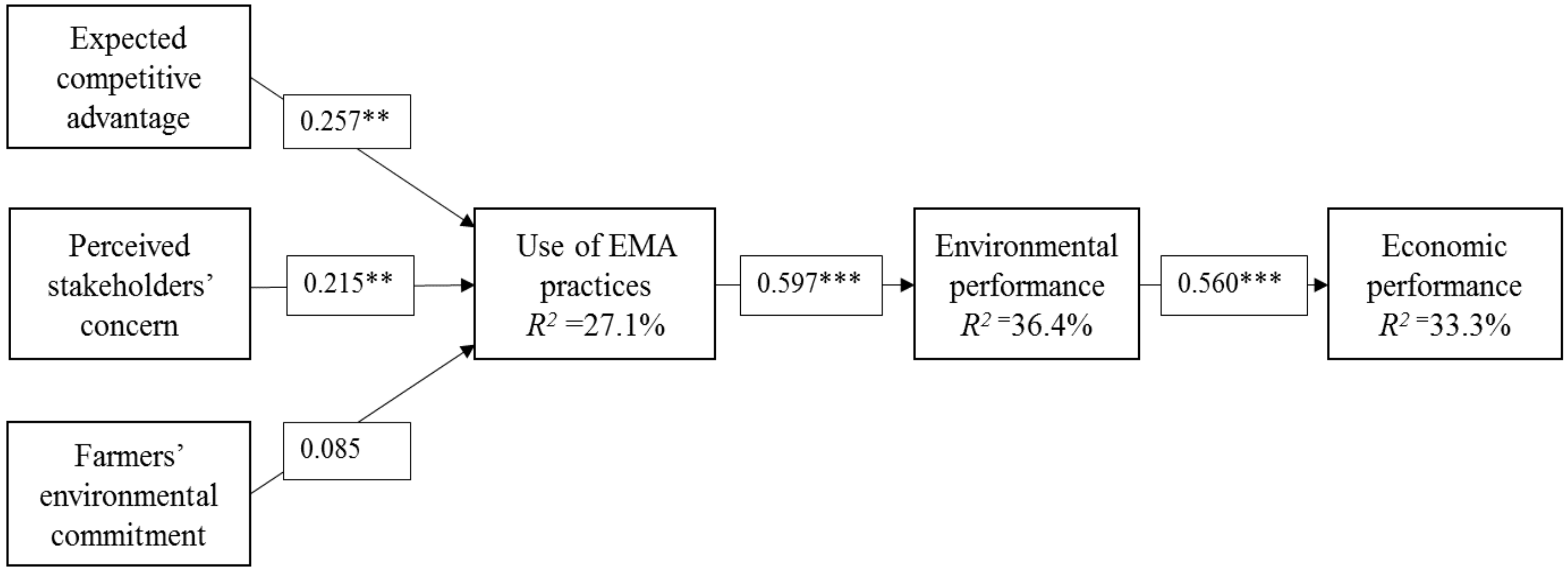
Diagonal elements are the square roots of AVE, and off-diagonal elements are the correlations between the latent variables calculated in PLS n = 92. All correlations above 0.20 are statistically significant ($p < 0.01$) (Hall, 2008).

4. 2 Tests of hypotheses

The study tests the five hypotheses based on the PLS structural model (see Figure 5. 2). Following previous studies, in order to minimize the impact of endogeneity, the study incorporates two control variables into the structural model (Appuhami, 2017; Hall, 2008). The model includes control variables such as farm age and farm size, which can have an impact on the use of EMA practices, as well as the environmental and economic performance of the cotton farm businesses. The PLS model generates path coefficients and their significance levels among the relationships, which are further demonstrated in the discussion section. R^2 is used in PLS to estimate the stability of the model (Chin, 1998). As presented in Table 5. 6, the R^2 value for the use of EMA practices, environmental performance and economic performance are 27.1%, 36.4% and 33.3%, respectively, indicating the stability and robustness of the model (Chin, 1998; Moulang, 2015).

The study uses the bootstrapping sampling method with 500 interactions to examine the statistical significance of the coefficients of the path in the model. The results from the PLS structural model are presented in Table 5. 6. The study hypothesizes that there is a positive relationship between the expected competitive advantage, perceived stakeholders' concern, farmers' environmental commitment and the use of EMA practices by farmers (H1, H2, H3). The PLS results show a significant positive association between the two variables, namely expected competitive advantage, perceived stakeholders' concern ($\beta = 0.257$, $p < 0.05$ and $\beta = 0.215$, $p < 0.05$) and the use of EMA practices, respectively and in the hypothesized direction. Thus, H1 and H2 of the study are supported. However, the PLS results do not show a significant association between the farmers' environmental commitment and the use of EMA practices ($\beta = 0.085$, $p = 0.480$). Thus, H3 is not supported. The study also predicts that there is a positive association between the use of EMA practices and environmental performance in the cotton farm businesses (H4), which in turn leads to economic performance (H5). The PLS results indicate a significant positive association between the two variables in both hypotheses 4 ($\beta = 0.597$, $p < 0.01$) and 5 ($\beta = 0.560$, $p < 0.01$), respectively. Thus, H4 and H5 of the study are also strongly supported.

Figure 5. 2 - Structural model: Expected competitive advantage, perceived stakeholders' concern, farmers' environmental commitment, use of EMA practices, environmental performance and economic performance



EMA Environmental Management Accounting Practices; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ (one-tailed) $n = 92$ (significant paths for farms' size and age not shown).

Table 5. 6 - PLS structural model: Paths coefficients, *t*-statistics and R^2

Independent variables (paths from)	Use of EMA practices (EMA) (paths to)	Environmental performance (ENVP) (paths to)	Economic performance (ECONP) (paths to)	*t* Statistics	*p* Values
Expected competitive advantage (ECA)	0.257**	-	-	2.105	0.036
Perceived stakeholders' concern (PSC)	0.215**	-	-	1.916	0.050
Farmers' environmental commitment (FEC)	0.085	-	-	0.707	0.480
Use of EMA practices (EMA)	-	0.597***	-	7.508	0.000
Environmental performance (ENVP)	-	-	0.560***	6.599	0.000
Farm size (SIZE)	0.241***	-	-	2.861	0.004
Farm size (SIZE)	-	-0.011	-	0.196	0.845
Farm size (SIZE)	-	-	0.003	0.063	0.950
Farm age (FAGE)	-0.063	-	-	0.746	0.456
Farm age (FAGE)	-	-0.048	-	0.605	0.545
Farm age (FAGE)	-	-	--0.081	0.933	0.351
R^2	0.271	-	-	3.525	0.000
R^2	-	0.364	-	4.101	0.000
R^2	-	-	0.333	3. 357	0.001

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ (one-tailed) $n = 92$

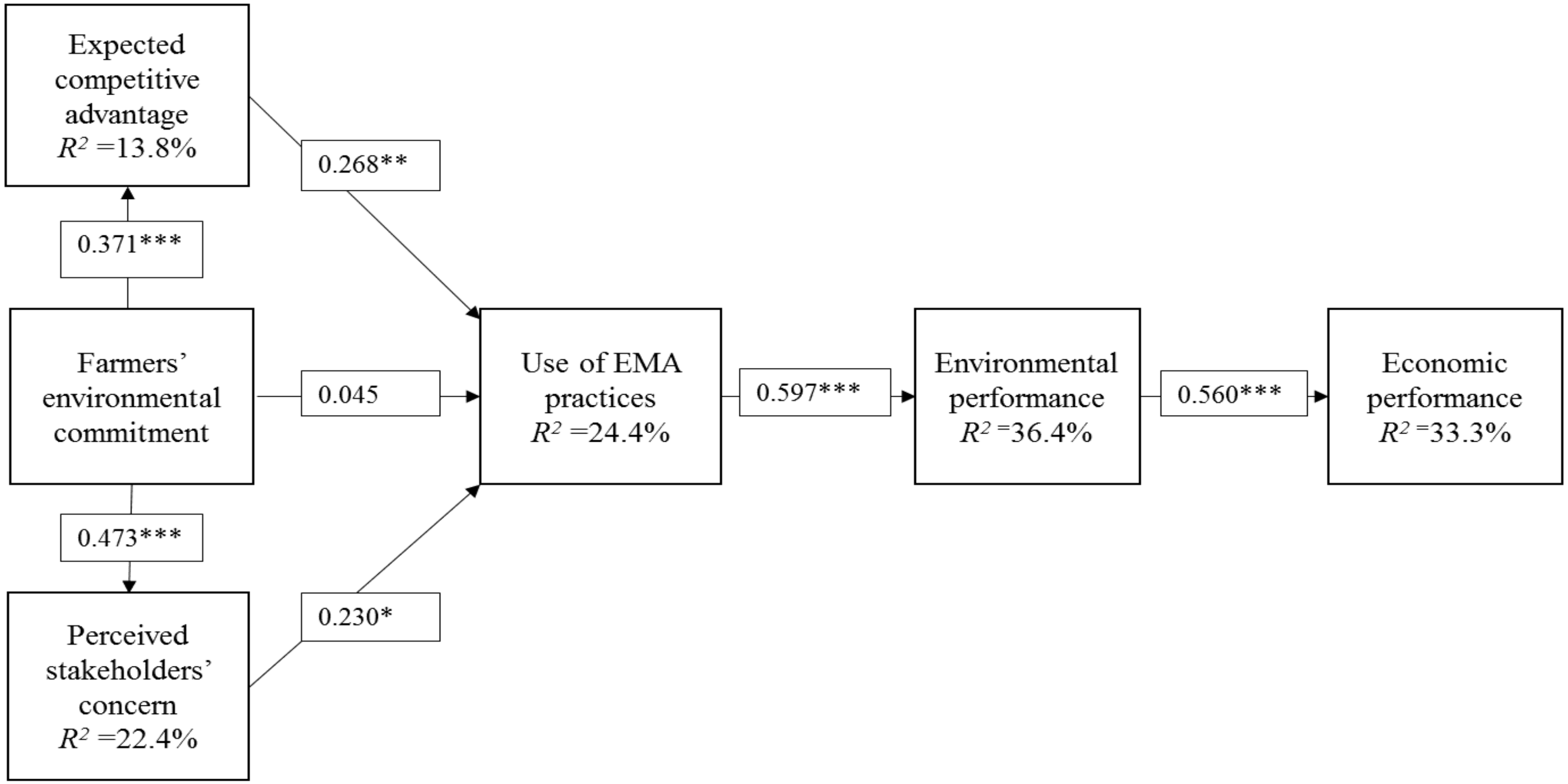
4. 3 Additional analysis (mediating effect)

In order to gain a deeper understanding of farmers' use of EMA practices in managing farm businesses, the study undertakes an additional analysis. Following prior studies (e.g. Banerjee et al., 2003), the additional analysis on mediating effect aims to examine whether farmers' environmental commitment, which shows no direct association with the use of EMA practices in the original analysis, has indirect association with the use of EMA practices through expected competitive advantage and perceived stakeholders' concern. The study develops the model shown in Figure 5. 3 and uses the original sample (92 responses) to examine total and specific indirect effect using SmartPLS (v. 3.2.7).

The results of mediating effect analysis indicate that farmers' environmental commitment positively and significantly influences the use of EMA practices through the two variables, namely expected competitive advantage ($\beta = 0.371$, $p < 0.01$) and perceived stakeholders' concern ($\beta = 0.473$, $p < 0.01$). As presented in Table 5. 7 and Figure 5. 3, this relationship confirms that expected competitive advantage ($\beta = 0.371$, $p < 0.01$) and perceived stakeholders' concern ($\beta = 0.473$, $p < 0.01$) serve as full mediators[104] in the relationship between farmers' environmental commitment and the use of EMA practices (Hair et al., 2016). The relatively high value of R^2 for both mediators expected competitive advantage 13.8% and perceived stakeholders' concern 22.4% and the observed variable use of EMA practices 24.4% presented in Table 5. 7 indicate the acceptable level of stability and robust predictive capacity of the model (Chin, 1998; Moulang, 2015). The specific indirect effect of farmers' environmental commitment towards the use of EMA practices mainly through expected competitive advantage ($\beta = 0.099$, $p < 0.1$) and less so through perceived stakeholders' concern ($\beta = 0.109$, $p = 0.102$ very close to 0.1) also shows a significant specific indirect effect of this variable.

[104] Full mediation exists when there is no direct relationship between an independent and dependent variable, however, there is an indirect relationship between the same independent and dependent variables through a mediator and both on the same direction (Hair et al., 2016). In specific, there is a significant relationship between the independent variable and the mediator, and between the mediator and the dependent variable (Hair et al., 2016).

Figure 5. 3 - Structural model: Expected competitive advantage, perceived stakeholders' concern, farmers' environmental commitment, use of EMA practices, environmental performance and economic performance



EMA – Environmental Management Accounting Practices; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ (one-tailed) $n = 92$ (significant paths for farms' size and age not shown).

Table 5. 7 - PLS structural model: Paths coefficients, direct effects, total indirect effects, specific indirect effect, t-statistics and R^2 *(mediating effect)*

Variables (paths)	Path coefficients	*t* Statistics	*p* Values
Expected competitive advantage -> Use of EMA practices **(Direct effect)**	0.268**	2.070	0.039
Perceived stakeholders' concern -> Use of EMA practices **(Direct effect)**	0.230*	1.923	0.055
Farmers' environmental commitment -> Use of EMA practices **(Total indirect effect)**	0.208***	2.375	0.002
Farmers' environmental commitment -> Expected competitive advantage **(Direct effect)**	0.371***	4.063	0.000
Farmers' environmental commitment -> Perceived stakeholders' concern **(Direct effect)**	0.473***	4.746	0.000
Farmers' environmental commitment -> Expected competitive advantage > Use of EMA practices **(Specific indirect effect)**	0.099*	1.776	0.086
Farmers' environmental commitment -> Perceived stakeholders' concern > Use of EMA practices **(Specific indirect effect)**	0.109*	1.652	0.102
Use of EMA practices -> Environmental performance **(Direct effect)**	0.597***	7.628	0.000
Environmental performance -> Economic performance **(Direct effect)**	0.560***	6.311	0.000
Farm size -> Use of EMA practices	0.230**	2.487	0.013
Farm age -> Use of EMA practices	-0.062	0.681	0.431
Farm size -> Environmental performance	0.127	1.389	0.165
Farm age -> Environmental performance	-0.085	0.919	0.358
Farm size -> Economic performance	0.074	0.843	0.399
Farm age -> Economic performance	-0.128	1.163	0.245
R^2- Expected competitive advantage	13.8%	2.078	0.039
R^2- Perceived stakeholders' concern	22.4%	2.392	0.017
R^2- Use of EMA practices	24.4%	3.176	0.002
R^2- Environmental performance	36.4%	4.174	0.000
R^2- Economic performance	33.3%	3.070	0.002

EMA - Environmental Management Accounting, * $p < 0.1$, ** $p < 0.05$, ***, $p < 0.01$, n = 92

5. DISCUSSION AND CONCLUSION

Cotton farming activities in Australia are known to damage natural resources such as water, air and soil (Antille et al., 2016; Hulugalle and Scott, 2008; Maraseni et al., 2010). This study examines the association between three contingent factors suggested by stakeholder theory (expected competitive advantage, perceived stakeholders' concern and farmers' environmental commitment) and the use of EMA practices in Australian cotton farms. The study also investigates whether the use of EMA practices is associated with both environmental performance directly and economic performance indirectly in Australian cotton farms. The study uses PLS structural model to analyse the data collected from 92 Australian cotton farmers.

The findings of the study provide strong support for the applicability of stakeholder theory in explaining farmers' motivation to use EMA practices. The findings of this study reveal that the two factors of the theory, namely expected competitive advantage and perceived stakeholders' concern, are strong motivators for cotton farmers to adopt EMA practices. The findings suggest that farmers who believe that farms can achieve competitive advantages through environmentally friendly initiatives and perceive that stakeholders concern about the natural environment, use EMA practices in their cotton farms. This finding is consistent with prior studies that find a significant role of competitive advantage in managers' environment-related decision-making process (e.g. Banerjee et al., 2003; Fraj-Andrés et al., 2009; Lisi, 2015; Liu, 2017). Further, the study reveals that the use of EMA practices by cotton farmers in the study's sample strongly improves the environmental performance of cotton farms, which in turn, enhances the economic performance of their farm. The findings suggest that the use of EMA practices helps cotton farmers to minimize environmental costs related to waste and pollution and enhances their farms' image and reputation leading to economic performance. This finding is also in line with prior studies on the relationship between the environmental and economic performance of non-farming business organizations in various industries, such as coal mining, pharmaceutical products, chemical fibre and rubber products (e.g. Al-Tuwaijri et al., 2004; Endrikat et al., 2014; Henri and Journeault, 2010; Qi et al., 2014). The findings of the study, however, do not provide evidence on the direct relationship between the farmers' environmental commitment and the use of EMA practices. A possible reason for this finding is that farmers are likely to prioritize shareholders and employees' concern and potential profit-making objectives (competitive advantage) in using EMA practices above their personal commitment towards the natural environment.

The novelty of this study is also evident in the additional analysis (mediating effect analysis). The mediating effect analysis proves that while farmers are willing to address stakeholders' expectations and increase farm profit, they also value their ethical commitment towards the natural environment. The use of mediating effect analysis aims to minimize the possibility of overstating both the role of expected competitive advantage and perceived stakeholders' concern, and understating the role of the farmers' environmental commitment in the original model. The additional analysis shows that the farmers' environmental commitment is indirectly associated with the use of EMA practices through mediators, namely expected competitive advantage and perceived stakeholders' concern. The findings suggest that the two motivators (expected competitive advantage and perceived stakeholders' concern) are significantly driven by farmers' commitment towards the natural environment. The findings also indicate that farmers who are committed to improving the natural environment are likely to achieve competitive advantage based on environmentally friendly initiatives and address stakeholders' environmental concerns by using EMA practices. Further, consistent with previous studies (Banerjee et al., 2003; Lisi, 2015), the findings of the additional analysis prove that the three factors suggested by stakeholder theory are complementary and that one cannot be considered without the others.

The findings of this study have direct implications for farm owners, managers and regulators. The findings suggest that by using EMA practices, as a novel and innovative approach in farm businesses, farm owners and managers can create competitive advantage and increase farm performance. By using EMA practices, farm owners and managers can also satisfy stakeholders such as regulators, environmental activists, neighbouring farms and the community who are concerned about protection of the natural environment. Further, the use of EMA practices could also help farm owners and managers fulfil their ethical values of protecting the natural environment and increase the sustainability of their farms. Moreover, the findings of this study provide valuable implications for regulators and policymakers in supporting EMA practices in farm businesses. In particular, the key motivating factors (expected competitive advantage, perceived stakeholders' concern and farmers' environmental commitment), can assist regulators in designing guidelines to encourage cotton farmers to use EMA practices in their farming activities. Such guidelines could also include educational programs to educate and internalize ethical values towards the natural environment among farmers and the larger community.

There are a number of limitations to this study. First, the use of surveys may involve the issue of social desirability[105] (Greaves et al., 2013). While the study minimized this issue by ensuring the anonymity of responses, any conclusions should be cautiously drawn. Second, this study focuses on farming stages of the supply chain mainly undertaken in Australia. Other stages of the supply chain undertaken abroad are not examined in this study. Third, this study focuses on the Australian context only. Therefore, while the application of the findings of the study in other contexts with similar settings and technology could be feasible, the generalizability of the findings of the study should be done cautiously. Finally, the study examines the association of the three internal and external factors as perceived by cotton farmers. The perceptions of the farmers are based on their individual understanding.

Future studies may address some of the limitations of this study. This study primarily focuses on the farming stage of the cotton supply chain which is mainly undertaken in Australia, and thus it does not provide insights into the EMA practices used in other stages of the cotton supply chain such as weaving, knitting and dying. A future study could examine the EMA practices used in other stages of the supply chain which are mainly undertaken in emerging economies[106] including China, Indonesia, Pakistan and Bangladesh (FAO, 2015). Such study could provide insights into the changes in EMA practices between the various phases of the cotton supply chain undertaken in emerging economies. While this study finds insignificant association between the farmers' environmental commitment and the use of EMA practices, a further study can also be undertaken to examine cotton farmers' environmental commitment in relation to EMA in other developed countries such as the USA. According to prior studies the level of pollution associated with cotton farming, as well as the legal and political environment influencing cotton industry are likely to be different and thus the level of farmers' commitment can vary between countries (Bevilacqua et al., 2014).

[105] Social desirability reflects the individuals' need for acceptance by others by responding in a way which is culturally appropriate (Zemore and Ajzen, 2014).
[106] Other stages of cotton supply chain are undertaken in emerging economies, such as China and Bangladesh (FAO, 2015) due to reasons, such as cheaper labour and overhead costs (Wang et al., 2016).

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APPENDIX 1 - Survey questions

Constructs used in the study

Expected competitive advantage (1 = strongly disagree; 7 = strongly agree)

Please indicate the extent to which you agree or disagree with each of the following statements:

ECA 1) Being environmentally conscious can lead to substantial cost advantages for your farm.

ECA 2) Your farm can attract new buyers by adopting environmentally friendly practices (e.g. measuring the amount of water usage, estimating the cost of water usage, measuring energy usage, identifying air pollution, identifying soil pollution, identifying water pollution).

ECA 3) Your farm can increase sales by making your cotton more environmentally friendly.

ECA 4) Reducing the environmental impact of your farm's activities will lead to quality improvement in your cotton yield and/or farming activities.

(All items are taken from Banerjee et al. (2003))

Perceived stakeholders' concern (1 = strongly disagree; 7 = strongly agree)

Please indicate the extent to which you agree or disagree with each of the following statements:

PSC 1) Your stakeholders (e.g. suppliers, customers, community, lenders) feel that environmental protection is a critically important issue facing the world today.

PSC 2) The public is very concerned about environmental destruction.

PSC 3) Your customers are increasingly demanding environmentally friendly cotton.

PSC 4) Your stakeholders expect your farm to be environmentally friendly.

(All items are developed based on Banerjee et al. (2003))

Farmers' commitment towards the environment (1 = strongly disagree; 7 = strongly agree)

Please indicate the extent to which you agree or disagree with each of the following statements in relation to your farm:

FCOM 1) Your farm owner in the farm is committed to environmental preservation.

FCOM 2) Your farm's environmental efforts receive full support from your farm owner.

FCOM 3) Your farm's environmental practices are driven by your farm owner.

(Items 1 – 3 were adapted from Banerjee et al. (2003))

The extent of EMA practices used (1 = not at all; 7 = to a great extent)

Please indicate the extent to which your farm is currently undertaking each of the following:

EMA 1) Identifying waste, emission (e.g. water, energy, fuel).

EMA 2) Measuring energy usage.

EMA 3) Measuring amount of water usage (e.g. megalitre).

EMA 4) Estimating cost of water usage.

EMA 5) Recognizing recycling wastes (e.g. crop residue, fertilizers and pesticides leftover).

EMA 6) Measuring the cost of recycling waste.

EMA 7) Recognizing recycling water.

EMA 8) Measuring the cost of recycling water.

EMA 9) Measuring quality of water released to the environment.

EMA 10) Recognizing use of reusable/returnable packaging/containers.

EMA 11) Identifying air pollution.

EMA 12) Identifying soil pollution.

EMA 13) Identifying water pollution.

EMA 14) Estimating environmental contingent liabilities (e.g. fines).

EMA 15) Measuring environmental costs.

(Items 1 – 2 & 10 were taken from Frost and Wilmshurst (2000), items 3 – 9 were developed based on Frost and Wilmshurst (2000), items 11 - 13 were developed based on Ferreira et al. (2010), items 14 – 15 were taken from Ferreira et al. (2010))

Environmental performance (1 = strongly disagree; 7 = strongly agree)

Please indicate the extent to which you agree or disagree with each of the following statements in relation to your farm:

ENVP 1) Your farm has reduced its water consumption per hectare in the past three years.

ENVP 2) Your farm has reduced its number of environmental accidents in the past three years (e.g. chemicals moved into the water stream due to water runoff).

ENVP 3) Your farm has reduced its emission of atmospheric pollutants in the past three years.

ENVP 4) Your farm has reduced its consumption of dangerous/toxic materials in the past three years.

ENVP 5) Your farm has reduced its quantities of solid waste in the past three years (e.g. crop residue).

ENVP 6) Compliance with environmental regulations.

ENVP 7) Preventing and mitigating environmental crises (e.g. significant chemical use, significant water/soil/air pollution).

ENVP 8) Educating employees and the community about the environment.

(Items 1 – 5 are taken from Stefanelli et al. (2014) and items 6 – 8 are taken from Judge and Douglas (1998))

Economic performance (1 = very poor; 7 = excellent)

Please indicate the performance of your farm business compared to the other farms in relation to the following aspects:

ECONP 1) The quantity of your farm cotton product (e.g. number of bales)

ECONP 2) The quality of your farm cotton product

ECONP 3) The implementation of new environmental practices/procedures (e.g. recycling water)

ECONP 4) Your farm's water use efficiency (saving water)

ECONP 5) Your farm's cost efficiency

ECONP 6) The efficiency of your farm's operations as a whole

ECONP 7) Your farm's sales

ECONP 8) Your farm's business performance as a whole

(All items are developed based on Walker and Boyne (2006))

Control variables

a) How long has your farm been in use? …………………years
b) What is the approximate number of employees on your farm? (please specify full-time and part-time, casual and contractors) ………………………………………employees

(Item a was taken from Withers et al. (2011), and item b was developed based on Läpple and Kelley (2013))

CHAPTER SIX

CONCLUSION

1. INTRODUCTION

The aim of the thesis is to examine whether the use of environmental management accounting (EMA) practices can increase the environmental and economic performance of cotton farms in Australia. This study achieves this aim through the three specific objectives included in three self-contained papers. Paper 1 is an integrative literature review that identifies the current critical environmental issues associated with the cotton industry. Paper 2 examines the influence of the belief-based factors suggested by the TPB, namely attitude, subjective norm and perceived behavioural control, on the farmers' intention to adopt EMA practices. Paper 3 examines the association between the three contingent factors suggested by stakeholder theory, namely expected competitive advantage, perceived stakeholders' concern, farmers' environmental commitment, and the use of EMA practices. Paper 3 also examines whether the use of EMA practices is associated with the environmental performance and the economic performance of cotton farms.

This chapter is organised as follows. Section 2 presents the findings and contributions of this thesis to the literature. Section 3 discusses the implications of the thesis to practice. Section 4 identifies the limitations of the thesis and Section 5 provides suggestions for future research.

2. FINDINGS AND CONTRIBUTIONS

The findings of this study are classified under three sub-headings: (1) the current critical environmental issues caused by the Australian cotton industry; (2) the influence of belief-based factors on farmers' intention to adopt EMA practices; and (3) the association between the use of EMA practices, and the environmental and economic performance of cotton farms.

2. 1 Contribution to the literature on cotton farming in Australia

This study is one of the limited number of studies that examines and integrates the current environmental issues caused by cotton farming in Australia. Previous studies have mainly examined each issue separately. For example, while some studies have examined the problems related to soil pollution (Hulugalle and Scott, 2008),[107] others focused solely on

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[107] The full references of all the citations in this chapter are available in the reference list at the end of this chapter on page 224.

the issues related to the greenhouse gas (GHG) emissions caused by the excessive use of energy and fossil fuels in this industry (Ismail et al., 2011; Maraseni et al., 2010).

This study contributes to the literature on the environmental issues in cotton farming by exploring the critical environmental issues caused by the cotton farming activities. By undertaking an integrative literature review, this study discloses that water-related issues, including water depletion and water pollution, are the most critical issues caused by the Australian cotton industry (Darbas et al., 2008; Roth et al., 2013). In particular, water depletion is the most critical issue because, except for Antarctica, Australia is the driest continent (Vardon et al., 2007) and as over two-thirds of cotton farmers grow irrigated cotton, it makes Australia more susceptible to the issue of water depletion. The integrative literature review also reveals that Greenhouse Gas (GHG) emissions are the least critical issue of concern in this industry. By highlighting the critical environmental issues, the review also lays the foundation for further research in areas where there is a lack of knowledge and that need urgent attention.

Further, this study is one of the few EMA studies examining the cotton industry in Australia. Previous studies were undertaken in European countries (e.g. Italy, Germany, Greece, and the UK), Philippine, and Canada, which differ from Australia in terms of climate and the regulatory framework. These studies have also mainly focused on other industries, such as rice (Burritt et al., 2009), paper and pulp (Gale, 2006), forestry (Papaspyropoulos et al., 2012), chemicals, pharmaceuticals, energy, printing (Bartolomeo et al., 2000), and the wine industry (Christ, 2014). Thus, this study extends the literature by focusing on the performance of cotton farms in Australia. The findings of this study contribute to the literature on cotton farming in Australia by examining the association between the use of EMA and cotton farms' performance. The analysis reveals that the use of EMA practices on cotton farms helps cotton farmers to significantly improve the environmental and economic performance of their farms.

2. 2 Contribution to the literature on the theory of planned behaviour (TPB)

Ajzen's (2005) TPB claims that the three belief-based factors (attitude, subjective norm, and perceived behavioural control) are strong predictors of individuals' behaviour. Prior TPB studies have mainly examined the influence of these three factors on various behavioural intentions in areas such as waste paper recycling, environmental activism, organic farming (Cheung et al., 1999; Fielding et al., 2008; Lapple and Kelley, 2013).

However, prior studies paid very limited attention to the belief-based factors in relation to farmers' intentions to adopt certain management accounting practices. Therefore, due to the limited knowledge it is not clear whether the belief-based factors such as attitude, subjective norm and perceived behavioural control influence the farmers' adoption of EMA practices. Thus, as the first study to examine the influence of the belief-based factors on farmers' intentions to adopt certain management accounting practices, this study fills the gap in the literature by examining the association between the three belief-based factors and the cotton farmers' intention to adopt EMA practices.

The findings provide strong support for the applicability of the TPB in predicting farmers' behavioural intentions. The findings reveal that attitude and perceived behavioural control (suggested by TPB) are the two factors that strongly influence farmers' behavioural intentions. The findings also indicate that there is a strong indirect influence of the subjective norm on the farmers' behavioural intention through farmers' attitude and perceived behavioural control. Further, the findings indicate that attitudes and subjective norms are the primary factors that influence the more environmentally friendly farmers to adopt EMA practices, while perceived behavioural control is the only driver to influence the less environmentally friendly farmers to adopt EMA practices.

2. 3 Contribution to the literature on stakeholder theory

Stakeholder theory suggests that the managers of an organisation need to be aware and concerned about all the other stakeholders who may be affected by the activities of the organisation in adopting business practices (Freeman, 1984). The theory notes that three contingent factors, namely expected competitive advantage, perceived stakeholders' concern, and managers' environmental commitment, are likely to influence managers to use certain management practices (Banerjee et al., 2003). Prior studies on stakeholder theory have mainly focused on these three factors in relation to corporate environmentalism in various industries including services, food, pharmaceuticals, utilities, and manufacturing (Banerjee et al., 2003; Berman et al., 1999; Harrison et al., 2010).

However, prior studies have paid limited attention to the links between the three factors and the EMA practices in agricultural business. Therefore, little is known about whether the contingent factors encourage farmers to use EMA practices in cotton farms. Thus, by examining the association between the contingent factors suggested by stakeholder theory and the use of EMA practices on the Australian cotton farms, this study fills the gap in the literature and provides evidence regarding the applicability of stakeholder theory in examining the use of EMA practices in cotton farming.

The findings of this study suggest that expected competitive advantage and perceived stakeholders' concern are the two strong motivators for the farmers to use EMA practices. The study also reveals that the use of EMA practices significantly improves the environmental performance of cotton farms, which, in turn, significantly improves the economic performance of cotton farms. Further, the findings suggest that the farmers' environmental commitment has an indirect association with the use of EMA practices through expected competitive advantage and perceived stakeholders' concern.

2. 4 Contribution to the literature on environmental management accounting (EMA)

This study contributes to the literature on EMA. EMA studies emerged about three decades ago, and, in recent years, have increased to their highest number[108] (e.g. Chan et al., 2014; Ferreira et al., 2010; Qian et al., 2018). Whereas most EMA studies have focussed on one or two EMA dimensions, such as water (e.g. Christ, 2014; Moore and McPhail, 2016), carbon emissions (Bowen and Wittneben, 2011), or waste (Qian et al., 2018), this study examines a range of EMA dimensions. These dimensions include water, energy, pollution, waste, recycling, carbon emissions, biodiversity and soil thereby providing empirical evidence to support the benefits of the EMA practices. The findings suggest that the use of EMA practices can significantly increase the environmental and economic performance of the businesses, and, thereby, increase the sustainability.

3. IMPLICATIONS

The findings of this study have direct implications for policymakers, Cotton Australia, cotton farmers and academics, as described in the following subsections.

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[108] EMA studies during the last decade (2009-2018) have reached 43, which is the highest number compared to the first decade (1989-1998) (4 studies) and second decade (1999-2008) (16 studies).

3. 1 For policymakers and Cotton Australia

The findings of the study provide important implications for policymakers. This study combines all the key environmental issues caused by the Australian cotton industry over the past twelve years. It highlights the areas of concern that need the immediate attention of the policymakers and standard-setting bodies, and provides the foundation for further steps for creating sustainable cotton production. For example, it draws the attention of the policymakers to the most critical issue – the water crisis in the Australian cotton industry – that needs urgent action. It also clarifies that while carbon emissions might be the most critical issue in other cotton-producing countries (Bevilacqua et al., 2014), it is the least critical in Australia.

In particular, the findings of the study are related to the recent TAFE courses[109] funded by the New South Wales (NSW) Government with Cotton Australia (Cotton Australia, 2018b). These courses aim to guide and equip farmers with book-keeping, agricultural, and management skills, for example, EMA required for running farm businesses, such as cotton farming. The findings suggest that promoting such courses would increase the environmental commitment of farmers to increase the usage efficiency of scarce resources, such as water and land. Thus, the findings of the study with EMA practices, could help develop such courses and degree programs to provide farmers and managers with insights into environmentally friendly business practices leading to sustainable farm performance.

The findings of the study could also provide important insights into government programs that aim to promote cotton farming. For example, the finding about perceived behavioural control, which suggests that funding assistance influences the intention of farmers to adopt EMA practices, could directly encourage the NSW Government to implement new subsidies, such as the $500 million Drought Assistance Package[110] for farmers (Cotton Australia, 2018a). The findings of the study indicate that the provision of financial assistance

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[109] Technical and Further Education (TAFE) is an educational institution which provides vocational education and training, and nationally recognised throughout Australia. The courses include On-Farm Business Management and Agribusiness Solutions and Skills (Cotton Australia, 2018).

[110] The package includes $190 million for drought transport subsidies, $150 million to boost the Farm Innovation Fund infrastructure program, and $110 million to reduce farming costs by waiving fees and charges (Cotton Australia, 2018a). As part of the least subsidised group (ABC News, 2014), the Australian cotton farmers can significantly benefit from this new subsidy, since the findings of this study (paper 2) show that perceived behavioural control, which includes funding assistance, influences farmers to adopt EMA practices.

from various sources including subsidies from the Government encourages farmers to introduce environmentally friendly farm practices.

3. 2 For cotton farmers and managers

The findings of this study provide important implications for all farmers and farm managers in general and for cotton farmers in specific. The findings of this study highlight the current critical environmental issues caused by cotton farming including the most critical and the least critical. These findings could help cotton farmers to design and implement environmentally friendly farming practices, including EMA practices, to minimise the environmental issues caused by cotton farming. The findings of the study can benefit farm managers in implementing workshops or training programs to improve positive attitudes among farm employees towards environmentally friendly farm practices such as EMA. Creating a work environment that supports EMA practices can help shift the attitudes of employees towards a more environmentally aware mode.

3. 3 For researchers

The findings of the study provide useful information for researchers to undertake future studies. The two theoretical frameworks developed for paper 2 and paper 3 (see Figure 4. 2 on page 124 of paper 2 and Figure 5. 1 on page 174 of paper 3) would guide researchers to undertake similar studies in other farming businesses, such as wine and rice. In particular, the critical environmental issues identified by paper 1, would help researchers to focus their studies on the areas of concern in the Australian cotton industry that require in-depth investigation. Thus, this study provides specific implications for researchers by laying the foundation for additional empirical studies that focus on finding solutions to the environmental issues that threaten the sustainability of the cotton industry.

4. LIMITATIONS OF THE STUDY[111]

There are several limitations associated with this study. First, the scope of this study is the cotton farming stage of the supply chain. This stage is the first stage of the cotton supply chain undertaken in Australia. Over 99% of Australian cotton is exported to other countries,

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[111] The limitations of each study have been mentioned in the conclusion section of each paper in detail.

such as China, Indonesia, Thailand, South Korea, Bangladesh, and Japan, where other stages of the supply chain take place (Bradburn, 2015; Cotton Australia, 2014; 2016; FAO, 2015). Thus, this study does not examine the EMA practices and the environmental issues associated with the other stages of the supply chain.

Second, drawing on the TPB, paper 2 of the thesis examines the intention of farmers to perform a specific behaviour only. The study does not examine the actual behaviour. Even though the theory claims that the intention is a strong predictor of the behaviour (Ajzen, 2005), since this study does not examine the actual behaviour, any interpretation needs to be made with caution. A longitudinal study can be undertaken to examine the actual behaviour. However, due to the time limit of this PhD thesis undertaking a longitudinal study was not possible.

Finally, the study uses the survey method to collect data. Despite the advantages of the survey method, such as the ability to collect data from large sample sizes in a limited time, there are certain issues involved, such as the issue of social desirability bias[112] (Greaves et al., 2013; Grimm, 2010). This study minimised this issue by ensuring the anonymity of the responses. However, any conclusions drawn from this study should be interpreted cautiously, due to the possibility of this form of bias.

5. SUGGESTIONS FOR FUTURE RESEARCH

5. 1 Environmental issues in other cotton-producing countries

The study highlights a number of areas for future research. The integrative literature review approach used in this thesis can also be used to integrate the current environmental issues associated with the cotton production in the other stages of the supply chain, such as weaving, knitting, and dying, in the other cotton producing countries. The different climatic conditions and technology used by the farmers in other countries may result in different findings. Future research may also focus on the critical environmental issues found in the integrative literature review in this study. The water crisis in the cotton industry in Australia is found to be the one that needs the serious attention of researchers.

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[112] Social desirability bias may lead participants to choose responses that sound socially acceptable rather than responses that reflect their true feelings (Grimm, 2010).

5. 2 The theoretical frameworks used in the study

The theoretical frameworks developed based on stakeholder theory, TPB, and EMA literature can be used for future studies (see Figure 1. 2 in the introduction chapter). The framework can be used to investigate the similar relationships that are shown in the frameworks in other cotton-producing countries (e.g. China, India, the US, Pakistan, Brazil, Uzbekistan, and Turkey) and in other industries (e.g. rice and wine), as the cultures and socioeconomic backgrounds can vary between industries and cultures. The frameworks can also be used to investigate similar associations in other stages of the cotton supply chain, such as weaving, knitting, and dying. Future studies on TPB can provide empirical evidence concerning the most significant factors influencing individuals' behavioural intention in different settings. Future studies on stakeholder theory may examine the relationship between farmers' environmental commitment and the use of EMA practices in other developed countries (e.g. the US), since this study did not find a direct relationship between these two variables. As the regulatory requirements relating to the cotton industry and environmental pollution caused by the industry vary between countries, the level of farmers' commitment may also be different (Bevilacqua et al., 2014; Rieple and Singh, 2010).

5. 3 Longitudinal study to examine the actual behaviour

This study examines farmers' behavioural intention not the actual behaviour. Although the TPB claims that individuals' behaviours are predicted by their intentions, an intention may differ from the actual behaviour due to some unknown factors. A longitudinal study can be undertaken to compare the behavioural intention and the actual behaviour.

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APPENDIX 1

APPROVAL FROM ETHICS REVIEW COMMITTEE

Appendix 1 of this thesis has been removed as it may contain sensitive/confidential content

APPENDIX 2

PARTICIPANT INFORMATION LETTER

AND

SURVEY QUESTIONNAIRE

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MACQUARIE University SYDNEY·AUSTRALIA

Day/Month/Year
Title Name Surname
Street name
Suburb, State, Postcode

Dear Participant

The Role of Environmental Management Practices in the Australian Cotton Industry

You are invited to participate in a study on Cotton Farming in Australia. The aim of this study is to explore the influence of farmers' belief-based factors such as attitude and social norm on the intention to adopt Environmental Management practices in the Australian cotton industry. The study is being conducted by Shamim Tashakor [Department of Accounting and Corporate Governance at Macquarie University, NSW, Australia, [redacted]] in order to meet the requirements of a Doctor of Philosophy (PhD), under the supervision of Dr Ranjith Appuhami, [(61-2) 9850 7295, ranjith.bala-appuhamilage@mq.edu.au] and Associate Professor Rahat Munir [(61-2) 9850-4765, rahat.munir@mq.edu.au] of the Department of Accounting and Corporate Governance, Macquarie University.

Participation in this study is entirely voluntary, and you are not obliged to participate. If you decide to participate, you will be required to complete questions on the attached questionnaire. The questionnaire should take approximately 10-15 minutes to complete. Return of the questionnaire will be regarded as consent to use the information for research purposes. Upon receipt of the completed survey, you will receive **two movie tickets** or **a movie DVD** as a token of my appreciation for your time taken to complete the survey.

Any information gathered in the course of the study is confidential, except as required by law. No individual will be identified in any publication of the results. If you would like a copy of the results of the study, please indicate so on the postcard. Access to the data will only be granted to the researchers and will not be used for any other purposes. The results of this study will be incorporated into my PhD thesis, which will be available at the Macquarie University Library for public access.

Thank you for your assistance.

Yours Sincerely,

Shamim Tashakor

The ethical aspects of this study have been approved by the Macquarie University Human Research Ethics Committee. If you have any complaints or reservations about any ethical aspect of your participation in this research, you may contact the Committee through the Director, Research Ethics (telephone (02) 9850 7854; email ethics@mq.edu.au). Any complaint you make will be treated in confidence and investigated, and you will be informed of the outcome.

A Survey on Cotton Farming

As a token of my appreciation for your help in completing this survey, I would like to offer **two movie tickets OR a movie DVD to each participant** following the completion of the survey.

If you wish to enquire about the survey or if you need any assistance in completing the survey, please contact Ms. Shamim Tashakor at Department of Accounting and Corporate Governance, Faculty of Business and Economics, Macquarie University, Sydney or on 0403 611 936 or via email – shamim.tashakor@hdr.mq.edu.au

A Please provide answers to the following questions.

a) Please indicate your gender: □ Male □ Female

b) Which one of the age categories best describes you? □ 20-30 years □ 31-40 years □ 41-50 years □ 51-60 years □ 61-70 years □ Other (please specify) ....

c) Which one of the following best describes your highest education level? □ High school certificate □ TAFE Certificate/Diploma □ Undergraduate □ Postgraduate □ Doctoral Degree □ Other (please specify).........

d) How long has your farm been in use? ....years

e) What is the approximate number of employees within your farm? (please specify full-time, part-time, casual and contractors/employees) ....employees

f) Is this farm owned or leased? □ Owned by farmer □ Leased

g) How do you describe your position? □ A farmer □ An employee (please specify)..........................

h) How do you describe the nature of your farm business? □ Family business □ Partnership □ Private limited company □ Public limited company □ Other (please specify)....................

i) Is your farm: □ Fully irrigated □ Partly irrigated □ Rain-fed □ Other (please specify)................... (If using both irrigation and rain-fed please indicate the size for each) .... Hectare irrigated .... Hectare rain-fed

j) Please indicate the type of cotton grown in your farm: □ Genetically Modified (GM) with insecticidal proteins □ Herbicide resistant □ Other (please specify)......................................

B Please indicate the extent to which you agree or disagree with each of the following statements:

		Strongly disagree			Neutral			Strongly agree
a)	You/your farm employees have the knowledge and the skills to produce cotton in your farm by using environmentally friendly practices (e.g. measuring amount of water usage, estimating cost of water usage, measuring energy usage, identifying air pollution, identifying soil pollution, identifying water pollution) (please refer to section K for more examples).	□1	□2	□3	□4	□5	□6	□7
b)	You/your employees have sufficient time to produce cotton by using environmentally friendly practices in your farm.	□1	□2	□3	□4	□5	□6	□7
c)	Conditions (resources) on your farm are suitable to enable you to produce cotton by using environmentally friendly practices.	□1	□2	□3	□4	□5	□6	□7
d)	It is poss ble for you/your farm employees to maintain good healthy cotton plants on your farm by using environmentally friendly practices.	□1	□2	□3	□4	□5	□6	□7
e)	It is poss ble for you/your farm employees to use the machines and equipment to produce cotton by using environmentally friendly practices on your farm.	□1	□2	□3	□4	□5	□6	□7
f)	Technical knowledge derived from interactions with the local clients/suppliers/other farmers is important for your farm.	□1	□2	□3	□4	□5	□6	□7
g)	Skills gained from collaborations with the local clients/suppliers/other farmers is important for your farm.	□1	□2	□3	□4	□5	□6	□7
h)	Procedures/methods learned from cooperation with the local clients/suppliers/other farmers are important for your farm.	□1	□2	□3	□4	□5	□6	□7

C

Please indicate the extent to which you agree or disagree with the following statements:

		Strongly disagree			Neutral			trongly agree
a)	If your farm produces cotton (e.g. GM /genetically modified/transgenic/technology variety/biotechnology) by using environmentally friendly practices (e.g. measuring amount of water usage, estimating cost of water usage, measuring energy usage, identifying air pollution, identifying soil pollution, identifying water pollution) (please refer to section K for more examples) you will receive higher prices.	□1	□2	□3	□4	□5	□6	□7
b)	If your farm produces cotton by using environmentally friendly practices, you will increase farm's income.	□1	□2	□3	□4	□5	□6	□7
c)	Producing cotton by using environmentally friendly practices on your farm will lead to more sustainable farming.	□1	□2	□3	□4	□5	□6	□7
d)	Producing cotton by using environmentally friendly practices on your farm will provide an environmentally friendly product that people I ke to buy.	□1	□2	□3	□4	□5	□6	□7

D

Please indicate how likely it is that the following groups think you should produce cotton by using environmentally friendly practices on your farm within the next five years?

		Very unlikely			Neutral			Very likely
a)	Your family	□1	□2	□3	□4	□5	□6	□7
b)	Other farmers	□1	□2	□3	□4	□5	□6	□7
c)	Farm advisers	□1	□2	□3	□4	□5	□6	□7
d)	Farm wa ks/information events	□1	□2	□3	□4	□5	□6	□7
e)	Farming press/literature	□1	□2	□3	□4	□5	□6	□7
f)	Government agencies	□1	□2	□3	□4	□5	□6	□7
g)	Non-government agencies (e.g. Cotton Australia)	□1	□2	□3	□4	□5	□6	□7
h)	General public	□1	□2	□3	□4	□5	□6	□7

E

Please indicate the extent to which you agree or disagree with each of the following statements in relation to your farm:

		Strongly disagree			Neutral			Strongly agree
a)	Your farm owner in the farm is committed to environmental preservation.	□1	□2	□3	□4	□5	□6	□7
b)	Your farm employees in the farm are committed to environmental preservation.	□1	□2	□3	□4	□5	□6	□7
c)	Your farm's environmental efforts receive full support from your farm owner.	□1	□2	□3	□4	□5	□6	□7
d)	Your farm's environmental efforts receive full support from your farm employees.	□1	□2	□3	□4	□5	□6	□7
e)	Your farm's environmental practices are driven by your farm owner.	□1	□2	□3	□4	□5	□6	□7
f)	Your farm's environmental practices are driven by your farm employees.	□1	□2	□3	□4	□5	□6	□7

F

Please indicate the performance of your farm business compared to the other farms in relation to the following aspects:

		Very poor			Neutral			Excellent
a)	The quantity of your farm cotton product (e.g. number of bales)	□1	□2	□3	□4	□5	□6	□7
b)	The quality of your farm cotton product	□1	□2	□3	□4	□5	□6	□7
c)	The implementation of new environmental practices/procedures (e.g. recycling water)	□1	□2	□3	□4	□5	□6	□7
d)	Your farm's water use efficiency (saving water)	□1	□2	□3	□4	□5	□6	□7
e)	Your farm's cost efficiency	□1	□2	□3	□4	□5	□6	□7
f)	The efficiency of your farm's operations as a whole	□1	□2	□3	□4	□5	□6	□7
g)	Your farm's sales	□1	□2	□3	□4	□5	□6	□7
h)	Your farm's business performance as a whole	□1	□2	□3	□4	□5	□6	□7

G

Please indicate the extent to which you agree or disagree with each of the following statements:

		Strongly disagree			Neutral			Strongly agree
a)	Being environmentally conscious can lead to substantial cost advantages for your farm.	□1	□2	□3	□4	□5	□6	□7
b)	Your farm can attract new buyers by adopting environmentally friendly practices (e.g. measuring amount of water usage, estimating cost of water usage, measuring energy usage, identifying air pollution, identifying soil pollution, identifying water pollution) (please refer to section K for more examples).	□1	□2	□3	□4	□5	□6	□7
c)	Your farm can increase sales by making your cotton more environmentally friendly.	□1	□2	□3	□4	□5	□6	□7
d)	Reducing the environmental impact of your farm's activities will lead to a quality improvement in your cotton yield and/or farming activities.	□1	□2	□3	□4	□5	□6	□7

H

Please indicate the extent to which you agree or disagree with each of the following statements in relation to your farm:

		Strongly disagree			Neutral			Strongly agree
a)	Your farm has reduced its water consumption per hectare in the past three years.	□1	□2	□3	□4	□5	□6	□7
b)	Your farm has reduced its number of environmental accidents in the past three years (e.g. chemicals moved into the water stream due to water runoff).	□1	□2	□3	□4	□5	□6	□7
c)	Your farm has reduced its emission of atmospheric pollutants in the past three years.	□1	□2	□3	□4	□5	□6	□7
d)	Your farm has reduced its consumption of dangerous/toxic materials in the past three years.	□1	□2	□3	□4	□5	□6	□7
e)	Your farm has reduced its quantities of solid waste in the past three years (e.g. crop residue, ginning waste).	□1	□2	□3	□4	□5	□6	□7

I

Please indicate the extent to which you agree or disagree with each of the following statements:

		Strongly disagree			Neutral			Strongly agree
a)	It is important to be mindful to the environmental impacts of farming by reducing environmentally harmful input on the farm.	□1	□2	□3	□4	□5	□6	□7
b)	The use of environmentally harmful inputs has a negative impact on the health of people and animals.	□1	□2	□3	□4	□5	□6	□7
c)	It is important to take the environment into consideration, even if it lowers profit.	□1	□2	□3	□4	□5	□6	□7
d)	Environmental problems resulting from agricultural activities are exaggerated by the media.	□1	□2	□3	□4	□5	□6	□7
e)	It is important to farm in an environmentally friendly way.	□1	□2	□3	□4	□5	□6	□7
f)	The impact of fertilizer run-off is worse than generally imagined.	□1	□2	□3	□4	□5	□6	□7
g)	Environmentally friendly farming is better for the environment than conventional farming.	□1	□2	□3	□4	□5	□6	□7
h)	The use of environmentally harmful inputs in agriculture makes sense as long as it leads to an increase in profit.	□1	□2	□3	□4	□5	□6	□7
i)	It is important to use environmentally harmful inputs cautiously.	□1	□2	□3	□4	□5	□6	□7
j)	Maximizing profit is more important than protecting the environment.	□1	□2	□3	□4	□5	□6	□7
k)	Environmentally friendly farming is only a trend.	□1	□2	□3	□4	□5	□6	□7
l)	Chemical fertilizers have no harmful effects; they promote high-quality production.	□1	□2	□3	□4	□5	□6	□7

J

Please indicate the extent to which you agree or disagree with each of the following statements in relation to your farm:

		Strongly disagree			Neutral			Strongly agree
a)	You enjoy finding solutions to problems associated with farm activities.	□1	□2	□3	□4	□5	□6	□7
b)	You enjoy creating new procedures/methods/techniques to undertake farm activities.	□1	□2	□3	□4	□5	□6	□7
c)	You enjoy improving existing procedures/methods/techniques/ products/services in the farm.	□1	□2	□3	□4	□5	□6	□7
d)	You suggest new ways to improve environmentally friendly farming.	□1	□2	□3	□4	□5	□6	□7
e)	You come up with new and practical ideas to improve environmentally friendly farming.	□1	□2	□3	□4	□5	□6	□7
f)	You search out new technologies, processes, techniques, and/or product ideas to improve environmentally friendly farming.	□1	□2	□3	□4	□5	□6	□7
g)	You develop adequate plans and schedules for the implementation of new environmentally friendly farming practices.	□1	□2	□3	□4	□5	□6	□7

K

Please indicate the extent to which your farm is currently undertaking each of the following:

		Not at all			Neutral			To great extent
a)	Identifying waste, emission (e.g. water, energy, fuel).	□1	□2	□3	□4	□5	□6	□7
b)	Measuring energy usage.	□1	□2	□3	□4	□5	□6	□7
c)	Measuring amount of water usage (e.g. megalitre).	□1	□2	□3	□4	□5	□6	□7
d)	Estimating cost of water usage.	□1	□2	□3	□4	□5	□6	□7
e)	Recognising recycling wastes (e.g. crop residue, fertilizers and pesticides leftover).	□1	□2	□3	□4	□5	□6	□7
f)	Measuring the cost of recycling waste.	□1	□2	□3	□4	□5	□6	□7
g)	Recognising recycling water.	□1	□2	□3	□4	□5	□6	□7
h)	Measuring the cost of recycling water.	□1	□2	□3	□4	□5	□6	□7
i)	Measuring quality of water released to the environment.	□1	□2	□3	□4	□5	□6	□7
j)	Recognising use of reusable/returnable packaging/containers.	□1	□2	□3	□4	□5	□6	□7
k)	Identifying air pollution.	□1	□2	□3	□4	□5	□6	□7
l)	Identifying soil pollution.	□1	□2	□3	□4	□5	□6	□7
m)	Identifying water pollution.	□1	□2	□3	□4	□5	□6	□7
n)	Estimating environmental contingent liabilities (e.g. fines).	□1	□2	□3	□4	□5	□6	□7
o)	Measuring environmental costs.	□1	□2	□3	□4	□5	□6	□7
p)	Compliance with environmental regulations.	□1	□2	□3	□4	□5	□6	□7
q)	Preventing and mitigating environmental crises (e.g. significant chemical use, significant water/soil/air pollution).	□1	□2	□3	□4	□5	□6	□7
r)	Educating employees and the community about the environment.	□1	□2	□3	□4	□5	□6	□7

L

Please indicate the extent to which you agree or disagree with each of the following statements:

		Strongly disagree			Neutral			Strongly agree
a)	Your stakeholders (e.g. suppliers, customers, community) feel that environmental protection is a critically important issue facing the world today.	□1	□2	□3	□4	□5	□6	□7
b)	The public is very concerned about environmental destruction.	□1	□2	□3	□4	□5	□6	□7
c)	Your customers are increasingly demanding environmentally friendly cotton.	□1	□2	□3	□4	□5	□6	□7
d)	Your stakeholders expect your farm to be environmentally friendly.	□1	□2	□3	□4	□5	□6	□7

M

Please indicate how likely or unlikely is that your farm to undertake each of the following in the next five years:

		Very unlikely			Neutral			Very likely
a)	Identifying waste, emission (e.g. water, energy, fuel).	☐1	☐2	☐3	☐4	☐5	☐6	☐7
b)	Measuring energy usage.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
c)	Measuring amount of water usage (e.g. megalitre).	☐1	☐2	☐3	☐4	☐5	☐6	☐7
d)	Estimating cost of water usage.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
e)	Recognising recycling wastes (e.g. crop residue, fertilizers and pesticides leftover).	☐1	☐2	☐3	☐4	☐5	☐6	☐7
f)	Measuring the cost of recycling waste.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
g)	Recognising recycling water.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
h)	Measuring the cost of recycling water.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
i)	Measuring quality of water released to the environment.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
j)	Recognising use of reusable/returnable packaging/containers.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
k)	Identifying air pollution.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
l)	Identifying soil pollution.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
m)	Identifying water pollution.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
n)	Estimating environmental contingent liabilities (e.g. fines).	☐1	☐2	☐3	☐4	☐5	☐6	☐7
o)	Measuring environmental costs.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
p)	Compliance with environmental regulations.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
q)	Preventing and mitigating environmental crises (e.g. significant chemical use, significant water/soil/air pollution).	☐1	☐2	☐3	☐4	☐5	☐6	☐7
r)	Educating employees and the community about the environment.	☐1	☐2	☐3	☐4	☐5	☐6	☐7

N

Please indicate the extent to which your farm is currently undertaking each of the following:

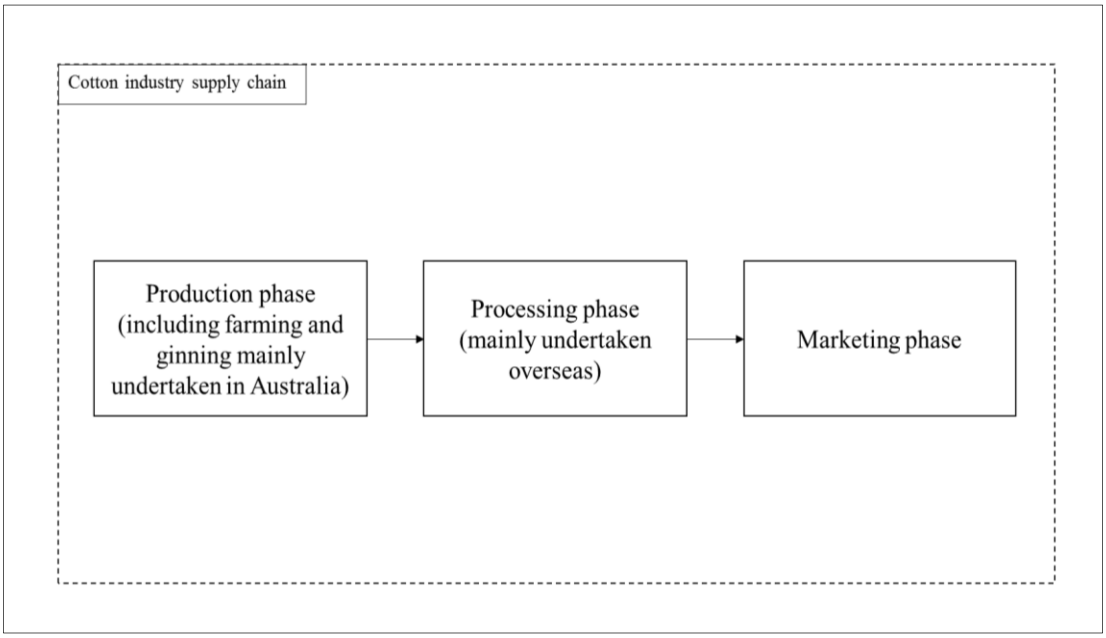
		Not at all			Neutral			To great extent
a)	Complying with water-related regulations (e.g. emissions, waste disposal).	☐1	☐2	☐3	☐4	☐5	☐6	☐7
b)	Limiting water impact beyond compliance.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
c)	Preventing and mitigating water crises (e.g. significant spills).	☐1	☐2	☐3	☐4	☐5	☐6	☐7
d)	Educating employees and the community about the importance of water.	☐1	☐2	☐3	☐4	☐5	☐6	☐7

Thank you for taking time to complete the survey. Please return your completed survey in the enclosed envelope. Please also return the enclosed postcard separately in the mail. The receipt of the postcard will alert me that you have returned the survey and thus, I can make arrangements to post your movie tickets/DVD.

APPENDIX 3

COTTON SUPPLY CHAIN

Cotton supply chain

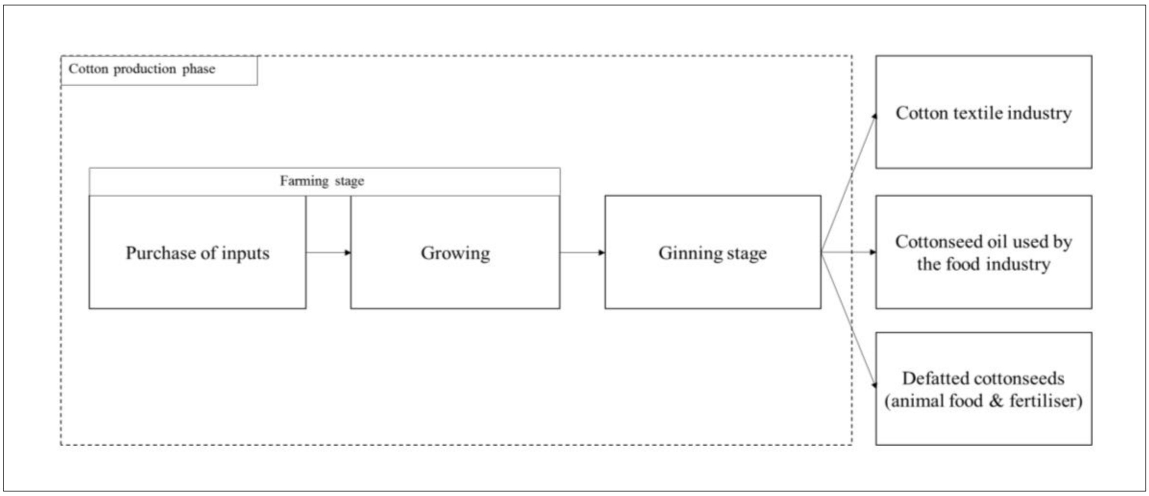


Adapted and modified from FAO (2015, p. 7)

APPENDIX 4

DIFFERENT STAGES OF COTTON PRODUCTION

Different stages of cotton production industry and its outputs



Adapted and modified from FAO (2015, p. 7)

APPENDIX 5

HISTORY OF COTTON IN AUSTRALIA

History of cotton in Australia

Australia's modern cotton industry began in the 1960s mainly in the Namoi Valley in New South Wales (NSW) (CottonInfo, 2015). There are two types of cotton species planted in Australia namely *Gossypium barbadense,* and *Gossypium hirsutum. Gossypium barbadense* (known as Pima, Egyptian, Peruvian, and Sea Island) has a very high fibre quality and is only used for production of fine garments and it is very expensive to process. The production of this species (Pima) is only limited to the western NSW areas such as Bourke, Hillston, and Tandou, because of the lower yield and stricter climate requirements (CottonInfo, 2015). *Gossypium hirsutum* is the commercial cotton (also called 'Upland') represents about 90% of the Australian and global cotton, because of its productive nature and suitability for modern textile production (CottonInfo, 2015). *Gossypium hirsutun* is planted in about 200,000 ha, mostly in the Gwydir, Namoi, Macquarie and Lachlan Valleys of NSW, and in the St George, Darling Downs, Theodore-Biloela and Emerald districts of Queensland (QLD) (CottonInfo, 2015).

APPENDIX 6

LEADING COTTON PRODUCING COUNTRIES

Leading cotton producing countries worldwide in 2014/2015.

Country	Production Volume (tons)	$ Amount (billion)*
China	6,532,000	14.6
India	6,423,000	14.3
US	3,553,000	7.9
Pakistan	2,308,000	5.2
Brazil	1,524,000	3.4
Uzbekistan	849,000	1.9
Turkey	697,000	1.6
Australia	501,000	1.1
Others	629,000	1.4
Worldwide	23,016,000	51.4

(Statista, 2016)

*The figures are calculated based on the total value given by FAO (2015) and the proportion of cotton production by each country. E.g. China $14.6 b = (6,532,000/23,016,000) * 51.4. The figures are rounded.

APPENDIX 7

LEADING COTTON EXPORTING COUNTRIES

Leading cotton exporting countries worldwide in 2013/14

Country	Production Volume (tons)
US	2,250,000
India	2,100,000
Australia	1,100,000
Francophone Africa	750,000
Uzbekistan	650,000
Brazil	500,000
Pakistan	100,000
Turkey	50,000
Others	1,600,000
Worldwide	9,100,000

(FAO, 2015)