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Review

Determinants of Blockchain Technology Adoption in the Australian Agricultural Supply Chain: A Systematic Literature Review

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Abstract: Blockchain technology (BCT) is emerging as a key enabler of sustainability in various sectors, including agriculture. This study explores the impact of BCT adoption on sustainability within the Australian agriculture sector. Through a systematic literature review (SLR) of studies published between 2015 and 2021, ten key themes influencing BCT adoption were identified: transparency, traceability, contract exchange, transaction efficiency, trade finance management, quality control, real-time information dissemination, security, trust, and legislative frameworks. The findings suggest that BCT adoption in agriculture can lead to improved sustainability outcomes. By enhancing transparency and traceability, BCT enables stakeholders to track the provenance of products, reducing the risk of fraud and ensuring compliance with environmental standards. The automation and efficiency gains afforded by BCT streamline supply chain processes, reducing waste and resource consumption. BCT enhances trust among stakeholders, fostering collaboration and information sharing to address sustainability challenges. This study contributes to the literature by highlighting how BCT can drive sustainability in agriculture through improved transparency, efficiency, and collaboration.

Keywords: blockchain technology; sustainability; agriculture; BCT; BCT adoption

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1. Introduction

Organizational operations in various aspects, including service delivery, customer care, and production management, have been greatly impacted by technology-driven disruptions [1]. The continued proliferation of Industry 4.0 technologies coupled with globalisation has necessitated most organizations to adopt effective and efficient strategies to remain competitive [2]. Among the key business operations segments, the supply chain has been the most affected by globalisation and technological advancements [3]. The integration of technologies such as blockchain in supply chain management offers potential to manage the complex global markets, reduce costs, increase efficiency, and enhance sustainability [2,4]. The attainment of global development goals, including food security, is highly dependent on the effective management of food supply chains through the adoption of technology [5].

The agricultural sector has remained one of the most critical segments in the economy to reduce poverty and promote shared global prosperity. The sector has the potential to feed approximately 9.8 billion people by the end of year 2050 [6]. It was estimated that in 2020, about 65% of adults in poor households globally were dependent on the agricultural sector [5]. Further, the sector plays a crucial in sustaining economic growth; in 2022, agribusiness accounted for 4.3% of the gross domestic product (GDP) globally [7].

The significance of the agribusiness sector necessitates investment in technology to enhance its sustainable growth [5].

Organizations continue to experience challenges in production planning and uncertainty related to predicting supply chain demand due to the dynamic nature of the external business environment [8]. Some companies have opted to adopt lean supply chain and operations management strategies to enhance efficiency, reduce waste, and optimise their logistics systems [9]. While blockchain technology (BCT) has emerged as a potential solution to enhance efficiency of supply chain operations, improve coordination, collaborations, transparency, and traceability of supply chain processes [8,10], there is limited insight into what motivates stakeholders to adopt BCT in the agricultural sector, particularly in Australia.

This study addresses this gap by performing a systematic literature review (SLR) of studies published between 2015 and 2021 and identifying key themes influencing BCT adoption, with a focus on the Australian agricultural sector, given the expected 46.8% CAGR growth in BCT spending from 2018 to 2025 [11]. Additionally, globally, it is projected that the market value of BCT in the food and agriculture sector would grow from USD 32.2 million in 2017 to USD 1.4 billion by 2028 [12].

Ensuring food safety, quality, and authenticity necessitates a high degree of transparency and traceability throughout the agriculture supply chain [13]. Tracking the production, processing, and distribution stages for food products has proven challenging with conventional centralized systems, which often lack the capability to provide real-time information visibility [13]. The opaque nature of current procedures renders them susceptible to unscrupulous practices such as fraud or mislabelling, posing potential risks to consumer health and safety. The adoption of blockchain technology (BCT) is expected to enhance the overall efficiency and effectiveness of the agriculture supply chain. The deployment of BCT in this sector is anticipated to help address issues of food safety and low trust among stakeholders [14]. Its application in agriculture is also expected to improve the efficacy and efficiency of data collection, storage, analysis, and usage. This would allow all stakeholders to readily obtain current information and make more effective decisions in their everyday agricultural operations [15]. Other essential benefits associated with BCT include reducing paperwork, enabling real-time information accessibility, and sharing, lowering administrative costs, improving efficiency in decision making, and promoting transparency and traceability [16,17].

Extant research on BCT adoption has predominantly emphasizes its benefits in improving supply chain efficiency [9]. For instance, Duan et al. [5] described how the transparency aspect of BCT is important in reducing cost and enhancing supply chain efficiency. However, these studies often overlook the challenges associated with BCT, such as perceived discomfort and insecurity, which can impact adoption in critical sectors like agriculture. This study addresses this gap by examining how negative aspects of BCT present challenges to its adoption.

There is extensive research on the effectiveness of BCT in supply chain management [18–22]. Most BCT research has focused on how the integration of BCT in the supply chain management (SCM) has provided better platforms for businesses to leverage the available technologies and eliminate bottlenecks in the acquisition, storage, inventorying, warehousing, and distribution of products [18,19,23,24]. Limited insight exists on what motivates stakeholders to adopt BCT in the agricultural sector, particularly in Australia. The majority of BCT research in previous studies have focused on nonagricultural sectors such as the real-estate [25]. The few studies that have examined the factors that influence the adoption of BCT in the agricultural sector have mostly been limited to nations such as the United States, China, and India [10,26–28]. There are few studies that have examined the drivers and challenges of BCT adoption with a specific focus on the Australian agricultural sector. This study aims to fill this gap by identifying the drivers of BCT adoption in the Australian agricultural sector, crucial given the anticipated growth in BCT spending in agriculture [15,22,29].

Agustina [30] questions whether adopting new technologies like BCT in agriculture will lead to expected benefits such as cost reduction and improved client satisfaction. It, however, limits its research on the antecedents (trialability) of new technology such as BCT and the accompanying challenges creating a research gap, which necessitated the current study. It differed in terms of how it restricted its research focus on the antecedents (i.e., trialability) and challenges (i.e., complexity) of BCT adoption. However, as a research gap, the study failed to examine how these antecedents and challenges of BCT adoption would influence the behavioural intention of stakeholders to integrate the technology in their supply chain networks. There are research studies that borrow from existing publications while focusing on other sectors such as the food industry, health, education, logistics, hospitality, manufacturing, and infrastructure [24,29,31–34]. There are significant market pressures that force businesses to adopt new technologies instead of implementing technologies to solve known supply chain challenges [35]. Therefore, it is vital for organizations to understand the determinants related to the adoption of BCT. There is limited evidence on how these factors, drivers, and challenges affect the adoption of BCT in the agricultural supply chains.

Unlike previous survey articles focusing on nonagricultural sectors, the Technology Acceptance Model (TAM), and the Unified Theory of Acceptance and Use of Technology (UTAUT) [24,32], this study uses a systematic literature review to examine BCT adoption determinants specific to agriculture. It addresses sector-specific challenges such as traceability needs, and the diverse stakeholder landscape often overlooked in general technological adoption models.

This paper reports on a review of the literature on BCT from 2015 to 2021 to provide an understanding of the generalized approach to implementing the technology in the management of supply chains. Organizations in the manufacturing and production industry rely on BCT to revolutionize supply chain processes to attain competitive advantages and improve their overall business success [36,37]. The need for BCTs and other technologies stems from the changing business environment characterized by diversity in customer preferences, diversification of product portfolios, business scale expansion, geographically dispersed production locations, complex supply chain, and distribution systems [38]. Effective supply chain systems can assist manufacturing firms to attain timely delivery of products to physical and online retailing points [20,39]. The integration of BCTs in business models has saved over USD 400 billion in Europe [40,41]. Issa and Hamm [40] attribute the reduction in fraud and increase in product quality to the incorporation of BCT in supply chain management, thus saving companies costs related to litigations and reputational damage. In the United States, Australia, and other developed countries, BCT is estimated to reduce logistics and supply chain costs by around 0.7% [41].

BCT adoption is becoming a significant research area that will allow businesses to better understand its effective integration into core business processes such as supply chain management. By employing an SLR method, this study aims to analyse the determinant factors influencing BCT adoption based on the review of previous studies on the research topic. This review examines 33 current and credible research studies across different industries. The studies were found on online databases: Google Scholar, Science Direct, and Elsevier. The SLR findings indicate that the ten themes that influence BCT adoption include transparency, traceability, contract exchange, transaction efficiency, trade finance management, quality control, real-time information to involved parties, security, trust, and legislations. The study contributes to understanding BCT adoption factors and highlights areas for future research in Australia.

2. Theoretical Background and Key Studies

2.1. Blockchain Technology

Blockchain technology collates digital information that includes identifiers of a transaction such as time, amount, and date [38]. The technology stores information derived from entities participating in a transaction by creating a block for every transaction that is subsequently added to a chain of similar transactions. A unique code called the "hash" is used to identify each block of information [42]. Blockchain is publicly available, but the encryption prevents any alteration or deletion of the blocks. BCT operates on specific principles where a transaction must occur, be verified, stored in a block, and allocated a hash code [43]. It constitutes a decentralized ledger that allows the storing of information and data in blocks to create an incorruptible chain for all relevant processes and entities [44]. The use of blockchain technology in supply chain management (SCM) might have important ramifications such as increased transparency and transaction visibility [45]. Organizations that have been able to address transparency concerns due to the adoption of BCT are able to enjoy improved governance, consumption, and traceability of corporate information based on the available data [46].

The supply chain management system incorporates processes and resources that allow the movement and distribution of products among stakeholders in each sector [47,48]. In a typical agricultural supply chain, the key components include the procurement process, collation of correct and complete information, and product distribution [49]. The agriculture supply chain management (ASCM) in Australia is gradually seeking new and innovative technologies to improve the accuracy and efficiency of processes [30,50].

The Australian ASCM favours the adoption of information-driven systems that will allow the sector to minimize inventory costs, extend resources, add product value, retain clients, and accelerate time to market [51]. Blockchain technology is already providing the expected outcomes in a few organizations that have incorporated the technology in their supply chain processes [52]. The ultimate decision on whether to adopt or not adopt the BCT in the SCM will influence the eventual outcomes of the technology in the Australian agricultural sector [44]. Understanding the influence of BCT in a supply chain is pivotal to improving business processes and reducing unnecessary manufacturing, warehousing, and logistics costs [53].

BCT creates opportunities for the collection and storage of pertinent information such as product location, date, price, certification, and quality [54]. BCT has the capability to store information related to the production plans, the distribution channel, the sell-by date, storage locations, and recall information such as batch numbers [55]. The technology's feature that allows the selection of the people to share information gives the organization the ability to control and protect its sensitive information [54].

2.2. BCT Adoption

BCT adoption is a deliberate strategy that ultimately leads to the integration of blockchain technology in an organization's supply chain [45]. BCT adoption is influenced by the behavioural intention and attitudes towards the technology. Their attitudes and intention to adopt BCT tends to be influenced by its ease of use and usefulness [45]. The available studies on BCT adoption in supply chain management focus on its five main advantages in the sector, including collection and control of information, transparency, traceability, reduction in business cost, and elimination of production delays [56].

BCT adoption also results in transparency and the building of trust in organizations [45]. The perennial transparency and visibility problems in supply chains require new technologies that improve the process of recording business transactions [55,57]. BCT creates trusts and allows the sharing of personal details/information between two parties that do not know each other. Its transparency also entails the need to verify the history of transactions and guarantee nonmanipulation of such transactions [56]. This is achievable with BCT because it acts as a repository of all relevant information used in the supply chain.

BCT adoption is also associated with traceability benefits in the supply chain and payment transactions [45]. This is achieved through the implementation of ledger systems that keep track of products at different stages of the production process. The adoption of BCT not only improves products' traceability but also reduces cases of counterfeit products and improves manufacturing and distribution processes. With such potential benefits of BCT, many organizations that rely extensively on supply chain management are considering adopting this technology to streamline their production, warehousing, and logistics processes [54]. BCT is considered among the leading disruptive technologies in supply chain management [55].

The adoption of BCT in the supply chain is also expected to result in the reduction in business costs. The reduction in business process cost occurs due to the efficiency of BCT [45]. The technology automates business and supply chain processes, thereby enhancing their efficiency. It also makes auditing and reporting processes much easier [56,58]. Generally, the technology minimizes business costs by eliminating middlemen such as third-party service providers and vendors [59]. Business experts also agree that BCT has helped their institutions save on business costs because of its capacity to streamline operations.

BCT adoption is also expected to eliminate production delays. This is because the technology eliminates middlemen and automates key business and supply chain processes. The implication is that BCT tends to complete transactions faster, although its speed might be affected by factors such as network traffic and the size of data. Nevertheless, experts still conclude that the technology is faster and efficient. The US retail giant Walmart adopted the technology and was able to trace the origin of its fruits and vegetables throughout its supply chain [60]. Therefore, the focus on BCT in the agriculture will be good in highlighting the determinants of its adoption and how the sector can benefit from the technology. The agriculture sector is one of the industries that have benefited considerably from the adoption of BCT [14,22,29].

2.3. Agriculture

Agriculture is defined as an activity that involves farming, cultivation, animal rearing, and fish harvesting [61]. The agricultural sector comprises establishments that are engaged in crop farming, raising animals, and harvesting fish to provide food for human sustenance. Advancements in technology and globalization have expanded the types of establishments that operate within the agricultural sector. Today, the sector comprises organizations that operate as large-scale farms, food processors, farm input suppliers, and groceries that benefit from BCT adoption in the supply chain. The few studies, which have examined the impact of BCT in the agricultural supply chain, provide evidence of its positive contribution to the sector [15,22,29].

The study by Prashar et al. [22] presented findings that highlighted how the adoption of BCT in the sector has improved traceability and productivity in the agro-food industry. The incorporation of BCT has also provided noticeable improvement in public health safety due to its transparency and traceability features. Lin et al. [15] also found that BCT can build efficient agricultural supply chains, thereby enabling farmers and other entities to lower their production costs. The technology has become a key enabler of product visibility in the agricultural supply chain. Rogerson and Parry [29] found that due to customers' preference for product visibility across the agricultural value chain, organizations that operate in the agricultural sector have begun to embrace the technology. These studies are important in highlighting the benefits of BCT adoption in the agricultural sector. However, they differ from this study because none has examined how the identified efficacies/benefits of BCT influence the behavioural intention and attitudes towards its adoption.

The agricultural supply chains across various countries exhibit distinct characteristics that significantly influence the adoption of blockchain technology. In Australia, the agricultural sector is marked by high production levels, strong export orientation, and reliance on international markets for critical inputs [62]. Supported by well-developed infrastructure and stringent regulatory measures, Australia's supply chain would benefit from enhanced traceability, transparency, and compliance when adopting blockchain technology [63,64]. These factors facilitate participation in global value chains and ensure high-quality products, although challenges remain in the timely delivery and high costs of imported inputs.

In contrast, many developing countries face hurdles such as underdeveloped infrastructure, local market focus, and regulatory restrictions, which impact the efficiency and cost-effectiveness of their supply chains [65,66]. A lack of digital infrastructure and connection impedes blockchain adoption in certain regions [67]. However, blockchain can still offer benefits by improving transparency, regulatory compliance, and climate resilience [67,68]. Blockchain enables improved tracking of environmental conditions and resource usage, allowing farmers to adapt to changing climates and improve sustainability practices, especially in less developed markets. Table 1 presents the characteristics of the agricultural supply chain in Australia in comparison to other countries.

Table 1. Characteristics of agricultural supply chain (Australia vs. other countries).

Characteristic	Australia	Other Countries
Market Focus	• High production levels and export orientation.	• Local market focus, direct sales.
Infrastructure	• Well-developed, supports blockchain adoption.	• Underdeveloped, poses significant hurdles.
Regulatory Environment	• Stringent biosecurity measures, ensures high-quality products.	• Varied regulatory and trade barriers, impacts efficiency.
Impact of Blockchain Technology	• Enhances traceability, transparency, compliance, and supply chain efficiency.	• Faces infrastructure challenges, improves transparency and regulatory compliance.
Climate and Environmental Factors	• Benefits from blockchain in tracking environmental conditions and resource usage.	• Supports climate resilience and sustainability practices.

3. Research Objectives

This review seeks to answer the following questions:

RO1: *What are the perceived determinants (i.e., drivers and challenges) of BCT adoption in the agriculture supply chain?*

RO2: *What is the influence of the determinants of BCT adoption on the behavioural intentions and attitudes of stakeholders in the agricultural sector?*

4. Methods

Systematic literature reviews (SLRs) are considered the most accurate secondary data source and provide ideal platforms for inquiries that do not require primary data [69]. The basic principle of systematic reviews is the synthesis and summarization of recent and exhaustive evidence regarding a particular phenomenon [70]. The PRISMA guidelines and checklist were also used in the selection of relevant evidence from the reviews [23,71].

4.1. Literature Search

Google Scholar, Science Direct, and Elsevier are the primary databases used in this review. The literature search topics included the adoption of BCT, drivers of BCT in the agriculture supply chain, and challenges in the adoption of BCT. While the study focuses on the Australian supply chain, studies from other regions were considered to provide diversity and comparative capability to the review. The abstracts for the chosen articles were used to determine their relevancy and suitability for this study. The reference lists for these articles also provided another source for relevant articles. Search terms used included the following:

"Blockchain Technology".

"Supply Chain".
"Supply Chain Management".
"Australian Agriculture Supply Chain".
"Impact of Blockchain technology".
"Effects of Blockchain technology".
"Considerations for Blockchain technology adoption".
"Influence of Blockchain technology".
"Factors for the adoption of Blockchain technology".
"Benefits of Blockchain Technology".

Boolean operators, "AND", "OR" were used to combine the above search terms to yield the desired search outcomes.

4.2. Eligibility Criteria

Journal articles included in this review mentioned the adoption or use of BCT in the supply chain. The articles met the following inclusion criteria: (1) The article was published in the English language, (2) the articles were published between 2015 and 2021, (3) the study showed extensive utilization of Blockchain technologies in supply chain management, (4) empirical studies including qualitative, quantitative, and mixed studies were included. The exclusion criteria were based on factors such as (1) the article was older than 2015, and (2) the article does not contain any relevant information related to BCT and agricultural supply chain (see Table S1).

4.3. Selection of Studies and Data Extraction

The researcher was involved in the evaluation of all studies. Inquiries identified from the investigation were independently evaluated by two investigators, A.S. and J.S. The abstract guided the researcher in establishing the eligibility of each study. The entire article was screened before including or excluding such studies where the abstract did not provide adequate information. Data extracted from each article included the name of the author(s), publication dates, the title of study, the title and name of the journal, methodology, study population and sample, processes using blockchain technology, the impact of BCT, and critical findings.

4.4. Quality of Studies

The STROBE checklist was used to evaluate the quality of all 33 studies [72]. This checklist's 15 key items were used: objectives, background, rationale, abstract, study design, variables, setting, quantitative variables, data sources/measurement, statistical method, main results, generalizability, key results, interpretation, limitations, and funding. Table S2 presents the quality assessment of each study using the STROBE checklist. Any potential biases in study selection were mitigated by using predefined inclusion and exclusion criteria and by cross-referencing with multiple databases. Despite these measures, we acknowledge that selection biases could arise from the predominance of English-language publications and the focus on specific agricultural contexts.

4.5. Data Synthesis

The identified studies showed significant diversity in methodologies, study designs, outcomes, and findings. Most studies relied on document analysis as data sources due to focusing on processes and institutions instead of human participants. The lack of uniformity in the study problems and findings indicates that meta-analysis and other reporting evaluations cannot be used for this project. Analysis of study characteristics was used to build a comparable pool of conclusions around the challenges and drivers of BCT in agricultural supply chains.

4.6. Data Analysis

The determinants of BCT adoption used in the studies were further analysed and grouped into homogenous themes. Table 2 provides a summary of the proposed themes based on the determinants of BCT adoption. The analysis is presented according to two dimensions: (1) BCT drivers and (2) BCT challenges.

Table 2. Grouping factors into themes.

Sources	Dimensions	Factors Used in Studies	Themes
[15,22,29]	BCT drivers	• Low trust in the technology • Fear of human error in implementation and use • Need to trace produce • Possible fraud cases • Governance issues • Threat to consumer data • Need for smart contracts	• Transparency • Traceability • Contract exchange
		• Need for quick transactions • Need to monitor and manage trade finances	• Transaction's efficiency • Trade finance management
	BCT challenges	• Need for quality food • Need for timely collection and communication of data	• Quality control • Real-time information to involved parties
		• Need for security of private information • Regulation of BCTs	• Security • Legislation

The BCT drivers include the need for product visibility and traceability, integrity and privacy of data, business trust, health safety, security of confidential data, and reduction in business risks, as well as partner and customer pressure. These determinants were grouped into the following themes: transparency, traceability, contract exchange efficiency, and finance management.

The BCT challenges include low organizational-level awareness, foreseeable scalability, integration, security problems, social influences, inadequate support from relevant stakeholders, legal consequences and concerns, costs, and organizational readiness, as well as the intentions and attitudes towards BCT. The BCT challenges were grouped into the following themes: quality control, real-time information, security, and legislation.

Table 3 below summarizes the ten themes that were derived based on the systematic literature review. The table captures the key themes, categorised into drivers and challenges of BCT adoption in the Australian agricultural supply chain.

Table 3. Themes developed in the study.

Source	All Factors (Drivers and Challenges)	Homogenous Themes
[29]	• Low trust in this technology • Fear of human error in implementation and use • Possible fraud cases • Governance issues • The threat to consumer data	
[15]	• Transparency • Quality control, • Contract exchanges • Transaction's efficiency • Food safety • Traceability • Trade finance in supply chain management • Provenance • Security and privacy • Real-time accurate information for parties involved	• Transparency • Quality control • Traceability • Contract exchange • Transaction's efficiency • Trade finance in supply chain • Security • Real-time information for parties involved • Trust • Legislation
[22]	• Encryption • Secret information. • Monitoring • Quality • Safety • Accountability	

5. Results

5.1. Identification of Studies

A total of 1641 peer-reviewed articles were accessed. Elsevier had 580, Science Direct had 533, Google Scholar had 327, and other databases had 116 articles. The sources were scaled down to 412 sources after screening all the studies to remove the duplicates. From the shortlist of 445 studies, 380 sources were excluded from the review because they were published earlier than 2015, not published in English, or did not focus on SCM. The remaining articles were evaluated for eligibility, including checking for discussion on the utilization of blockchain technology in supply chain, drivers, advantages, and challenges of BCT. After this screening, a further 32 articles were excluded. A total of 33 articles were deemed fit for the analysis and review after assessment for eligibility. At the final evaluation, the researcher ensured that the shortlisted studies reflected different countries and regions worldwide.

5.2. Study Characteristics

This article examines the characteristics of studies investigating the adoption of blockchain technology (BCT). The research settings of the selected studies spanned different regions, with eight studies conducted in multiple countries or regions. The distribution of studies by continent includes thirteen in Asia, seven in Europe, four in the United States, one in South America, and two in Australia. Methodologically, the studies employed qualitative (n = 13), quantitative (n = 16), and mixed methods (n = 4). The industries focused on in these studies were agriculture and the food industry (n = 11), business (n = 5), health (n = 4), education (n = 3), logistics and supply chain (n = 7), and tourism and hospitality (n = 3).

In the agricultural setting, seven out of eight studies that explored BCT adoption were qualitative. These studies commonly referenced theoretical frameworks to elucidate organizational and individual behaviour towards change and new technologies. The theories and models employed included the technology acceptance model (seven studies), technology readiness index (three studies), Theory of Planned Behaviour (five studies), Unified Theory of Acceptance and Use of Technology (three studies), Competitive Performance Model (one study), Grounded Theory (one study), and Technology–Organization–Environment framework (three studies).

6. Findings

This section summarizes the key themes that emerged from the systematic review of identified studies. Based on this review, 18 studies provided more relevance to the topic, including factors that influence and challenge the adoption of BCT in different sectors. These additional studies indicate that recent BCT adoption research has mainly focused on the agricultural sector. Most of these studies confirm that traceability is a key feature of BCT that can enhance resilience and sustainability of the agricultural and food produce supply chain [27,73]. Table 4 below summarizes the findings from the selected studies. The articles are summarized in terms of the research design, type of industry, and the findings.

Table 4. Summary of findings.

Source	Type of Industry	Type of Research	Findings
[14]	Agriculture	Qualitative (case studies)	Examines the positive aspects (i.e., safety) and issues associated with the application of BCT in agriculture.
[15]	Agriculture	Qualitative	Blockchain technology ensures integrity and privacy of data, which in turn improves productivity. BCT also builds efficient supply chains, based on the trust among all stakeholders. The study also identifies challenges in scalability, integration, privacy, and security associated with BCT.
[22]	Agriculture	Qualitative	BCT led to better product traceability in the agro-food industry. There is a noticeable improvement in public health safety due to the deployment of BCT.
[23]	Supply Chain	Qualitative	BCT is an ideal technology that help companies reduce business risks. Most organizations are not ready for BCT, which means that there is need for organizational-level awareness.
[24]	Multiple Industries	Quantitative (cross-sectional survey)	Complex challenges related to integrity, confidentiality of data, and the unavailability of secure systems affect the BCT adoption.
[26]	Multiple Industries	Qualitative	BCT can facilitate information exchange in supply chains. However, confidentiality and privacy are key concerns of the technology.
[27]	Agriculture	Qualitative	Examines the broad adoption of BCT in the US fresh produce supply chain. The study found that BCT has a potential to enhance traceability in the fresh produce supply chain.
[28]	Agriculture	Qualitative	Examines the application of BCT in the organic agricultural supply. The study finds that in addition to its ability to enhance traceability, BCT can improve performance and lower supply chain costs.
[29]	Agriculture and Food	Qualitative	Blockchain technology is the leading enabler of product visibility in the food supply chains. Customers are ready to pay more to facilitate the adoption of BCT and improve the visibility and traceability of products

Table 4. *Cont.*

Source	Type of Industry	Type of Research	Findings
[31]	Business	Qualitative	Business is missing many functionalities in efforts to reap benefits from new technologies. BCT provides opportunities for the inclusion of tracking and monitoring capabilities, security, and time stamping of transactions.
[32]	Tourism and Hospitality	Quantitative (survey)	The adoption of any new technology is affected by the organizational strategic direction and the characteristics of individual managers/leaders. BCT adoption is also affected by innovativeness, self-efficacy, and social influences.
[33]	Education	Qualitative (24 interviews; 4 focus groups)	The significant challenges facing BCT adoption include security issues, usability, legal concerns, governance, and organizational conflicts.
[34]	Logistics	Qualitative	Factors affecting the adoption of BCT include performance and effort expectations, social influence, intentions, and attitudes.
[71]	Multiple Industries	Qualitative	Understanding the driving factors for new technology adoption is essential to help the organization develop effective implementation plans for BCT.
[74]	Multiple Industries	Qualitative (23 interviews)	Adoption of BCT in Australian organizations is affected by customer pressure, cost, leadership and government support, organizational readiness, perceived lack of awareness and perceived complexity of BCT.
[73]	Agriculture	Quantitative	The traceability feature of BCT is a key enabler of the agricultural supply chain performance.
[75]	Healthcare	Qualitative (15 interviews)	Barriers to the adoption of BCT result from lack of awareness, presence of legal issues, and inadequate support from top management.
[76]	Agriculture	Qualitative	The adoption of BCT can enhance sustainability of the agricultural supply chain and food production. However, the technology has various challenges, including scalability, privacy, and connectivity issues.

Table 4 shows that eight studies focused on BCT adoption in the agriculture sector: one study each focused on business, logistics, tourism, healthcare, education, and supply chain industries, while four studies focused on other (multiple) sectors. The studies identified different factors or drivers related to BCT adoption and challenges facing the adoption of this technology.

Further, the results in Table 4 indicate that there are only a few studies (i.e., two articles; Rogerson and Parry [29] and Malik et al. [74]) focusing on BCT adoption in the Australian agricultural sector and other industries. Most articles focused on BCT adoption in other advanced countries such as the US and the UK. The findings emphasise the need for more studies focusing on BCT adoption in the Australian agricultural sector. The adoption of BCT in the Australian agricultural sector is important for two main reasons. First, there is a need for studies on technology adoption in the Australian agricultural sector given the projected growth in BCT expenditure by 2025. These studies would highlight the specific benefits and challenges related to the implementation of this technology in the sector, thereby preparing stakeholders for the anticipated growth in BCT uptake. Second, there is need to focus on BCT adoption in Australia given that the country is expected to assume a global leadership role in terms of investment in blockchain technology [74].

This study identified ten themes that may influence BCT adoption in the Australian agricultural sector, including transparency, quality control, contract exchange, transactions efficiency, trade finance management, security, and real-time information for involved parties, trust, and legislation.

6.1. Transparency

Nathani and Singh [23] define transparency as the capability of a technology that allows each participant or stakeholder to see the changes in a transaction or data in the system. Transparency also enables participants to see any individual who makes changes to a transaction or data [67]. The theme of transparency emerged from three studies by Kosmarski [15,33] and Nathani and Singh [23]. The factors included in this theme include the need for food safety and management of sensitive business information. However, these were qualitative investigations that did not test empirically the statistical significance of these factors. According to these studies, there is a need for transparency in agriculture supply chains, leading to food safety and increased trust in business processes. Nathani and Singh [23] found out that there is minimal support on transparency and visibility values in organizations trying to adopt new technologies, which undermine the perceived usefulness and ease of using such technologies. These studies were conducted in the retail sector, with limited focus on the agricultural sector. Further empirical investigation into the importance of transparency in the agricultural industry is, thus, needed and may provide additional benefits such as enhanced food safety and increased trust in the SCM relationships.

6.2. Quality Control

Quality control refers to processes and mechanisms that recognize and remedy defects in finished goods [22]. Studies by Lin et al. [15] and Prashar et al. [22] found that organizations seeking to adopt BCT are driven by the need to attain and guarantee the quality of products. Two main factors that determined this theme include the need for food quality management throughout the supply chain process and provenance that guides organizations to verify their food products [76]. In the agriculture sector, quality control has become vital for businesses in their endeavour to build customer confidence and meet regulatory requirements. According to Lin et al. [15], organizations depend on BCT to trace the movement of food products from their source, processing, to the customer point. The analysed studies focused on food safety, which can be categorised as quality control, but the study focused on finished agricultural products failing to account for the supply chain. Furthermore, there is need for empirical research to assess how quality control can help the farmers.

6.3. Traceability

Prashar, et al. [22] defines product traceability as the ability of a technology to instantly track food products at every point of contact throughout the supply chain. Three studies by Nathani and Singh [23], Prashar et al. [22], and Rogerson and Parry [29] captured the theme of traceability as a driver of BCT adoption in supply chain, agriculture, and food industries, respectively. Rogerson and Parry [29] found that customers are willing to be charged extra for their food products to ensure that human errors are eliminated when sourcing such products. The additional resources have allowed businesses to consider the adoption of BCT to improve traceability and visibility of food products. Prashar et al. [22] and Nathani and Singh [23] supported these findings by suggesting that the adoption of BCT in the agro-food supply chain brings traceability, provenance, and visibility of products. Flores et al. [77] concluded that the traceability aspect is gaining momentum in the agriculture sector due to its ability to reinforce products' efficiency, safety, and credibility. The two studies were conducted in the agro-food industries, focusing on the food processing supply chain. Furthermore, empirical research is required to understand the importance of traceability not only to the farmer but to the ultimate consumer.

6.4. Contract Exchange

Smart contract exchanges in agricultural supply chains are referred to as the execution of agreements between partners that have automated systems such that all parties reach an outcome simultaneously without time loss or the involvement of an intermediary [29,78]. Lin et al. [15] and Rogerson and Parry [29] investigated the contract exchange theme in the agricultural sector. According to Chang et al. [79], the adoption of BCT is expected to facilitate the introduction of smart contracts and also improve contract exchange, thus ensuring that employees, owners of the business, and stakeholders, are legally protected. Therefore, BCT is expected to popularize smart contracts in several industries, including programs that only run when specific conditions are present [79], informatively propagate, automatically negotiate, verify, perform, and enforce the terms of an agreement in a blockchain environment [78]. However, the current investigations on smart contracts in the agricultural sector mostly focus on legal and financial processes [26]. There are limited empirical studies, which have focused on the utilization of contract exchanges in agricultural supply chain management.

6.5. Transactions Efficiency

Lin et al. [15] introduces transaction efficiency as the capability of BCT to eliminate the requirement for intermediaries in critical business processes within the supply chain, thus leading to faster and safer transactions. This theme emerged from studies by Korpela et al. [31] as well as Lin et al. [15]. According to these studies, organizations incur huge costs when outsourcing third-party experts to run, monitor, and verify transactions. The need for digital signatures and timestamps for each transaction has necessitated the adoption of BCT to protect the transaction from modification and unnecessary denial [15]. Similarly, Korpela et al. [31] ascertained that businesses seek technologies that guarantee the security of transactions through time stamping and other forms of authentication. The cost-effectiveness, flexibility, and integration guaranteed by BCT contribute to transaction efficiency [31]. However, these studies do not establish a relationship between transaction efficiency, the need for BCT, and the improvement of supply chains in the agricultural sector. While the two studies hypothesize the impact of BCT on transaction efficiency, there is a need for empirical studies that show how the technology affects or influences transaction efficiency.

6.6. Trade Finance Management

Trade finance in supply chain management refers to the use of new technologies such as BCT to manage financial transactions with a view to increase the profits of farmers [80]. Farmers and small traders in the agricultural industry may face huge losses from different business risks, increased transaction costs, or expenses from accidental losses [81]. In most instances, these costs negate any returns from such businesses. Therefore, the adoption of BCT is geared towards helping these businesses become profitable. The adoption of BCT enables organizations to automatically predict risks and raise claims when such risks occur [15]. They can eliminate fraud risks while improving the efficiency of claim processing. Because trade finance management in the agricultural sector differs from other industries, there is a need for a technology that can facilitate automated payments, provide instant evidence of product delivery, and offer a platform to identify and manage disputes [28]. Ultimately, businesses can control their trade finances through the tracking of production and sales to balance risks and returns. Lin et al. [15] found that the comprehension of trade finance management in the agricultural supply chain was very critical in the use of BCT. However, there are no case studies from the Australian agricultural sector to support these viewpoints. Thus, there is need for empirical research on the importance of BCT in financial management in the Australian agricultural sector and how it can help farmers manage their finances with the aim of attaining profit.

6.7. Security

The adoption of BCT in the agriculture sector seeks to address the incidences of security gaps in business processes by improving data privacy, encryption, and protection of confidential information [59]. Kosmarski [33] explained that data security in supply chain management is concerned with protecting information systems, networks, and other platforms that cybercrime may threaten. This premise emerged from three studies that focus on the agriculture sector by Rogerson and Parry [29], Lin et al. [15], and Prashar et al. [22]. The premise resulted from the investigation of different factors, including information privacy, encryption of data, and the need for safety of both information and business processes. The findings from these studies indicate that the increasing adoption of new technologies in agricultural supply chain management may lead to a rise in insecurity concerns, vulnerabilities, and risks [15,22,29]. Organizations without adequate and effective security systems may experience breaches of data privacy and confidentiality.

The use of smart contracts, e-certificates, and other records that hold confidential information can open avenues for exploitation. Lin et al. [15] ascertained that many organizations turn to automated BCT tools to identify, reduce, and, if possible, prevent security risks by using enhanced security and privacy components. Rogerson and Parry [29] and Prashar et al. [22] also found that the use of multiple nodes in BCT guarantees higher security levels in managing data and in the authentication of business processes. Therefore, BCT ensures that businesses achieve expected levels of data integrity that gradually influence the levels of trust and productivity. The adoption of BCT in other sectors such as the financial and data management may help to understand the impact of security gaps in agricultural supply chain management. However, while such findings from the three studies are useful in understanding how BCT improves security in the agriculture supply chain, they are not sufficiently focused. The implication is that there is a need for studies that concentrate solely on security in the supply chains within the Australian agriculture sector.

6.8. Real-Time Information for Parties Involved

Lin et al. [15] found that there is increasing reliance on real-time data in agricultural processes and decisions. Availability of real-time information is facilitated by a digital token embedded in every product to enable instantaneous tracking. BCT seeks to create a balance between the need for correct real-time data and the maximization of transaction throughputs. Further, Lin et al. [15] found that reliance on real-time information improves stakeholders' decision making and eliminates unnecessary bureaucratic procedures. The increasing reliance on real-time data forces many organizations to adopt new technologies that allow the generation, management, and dissemination of such data (Collart and Canales [27]). However, few studies have focused on the importance and utilization of real-time information in the agriculture supply chain, as observed in the systematic literature review, where only one study focused on data. Also, the analysed qualitative study was not based on the Australian sector and, thus, lacked empirical evidence on how BCT adoption can help with real-time information management in the country's agricultural sector.

6.9. Trust

Lin et al. [15] define trust in the agricultural supply chain as the levels of reliability and dependence that stakeholders build around a process, product, or technology. The theme of lack of business trustworthiness emerged from three studies by Rogerson and Parry [29], Lin et al. [15], and Alazab et al. [24]. Lack of trust in new technologies is among the significant challenges that affect data access for both management and customers [29,82]. Lin et al. [15] identified BCT as the most suitable technology to address business trust issues by integrating cryptographic and computational techniques in processes that rely entirely on computer technology. Building a trustworthy platform is a win for all stakeholders in the agricultural supply chain, including farmers, producers, distributors, and customers [15]. Further, Alazab et al. [24] found that organizational trust is a critical consideration that influences the intention to adopt BCT. Lin et al. [15] concluded that the adoption of BCT for agricultural supply chain management sought to solve many trust issues arising from the relationship among customers, businesses, partners, and regulators. However, there are still gaps in the understanding of how BCT can resolve the increasing cases of fraud and business malpractices in the Australian agriculture supply chain. Furthermore, the three studies that were analysed lacked empirical evidence on the importance of trust to the Australian agricultural industry.

6.10. Legislation

The challenge of legislation in BCT adoption emerged from two studies: Kosmarski [33] and Sharma and Joshi [75]. According to Kosmarski [33], there are no clear legal and regulatory procedures for adoption and use of technologies that rely on BCT. Sharma and Joshi [75] found that there is minimal awareness of the legal issues involved in organizations seeking to use BCT to improve business processes. The above studies only mention legislation as a challenge related to the adoption of new technologies in supply chain management. Therefore, it is essential to investigate how legislation requirements affect the adoption and implementation of BCT in the agricultural sector.

The results indicate that there are 10 key factors (determinants) of BCT adoption in the Australian agricultural sector. These include transparency, traceability, contract exchange, transaction efficiency, trade finance management, quality control, real-time information to involved parties, security, trust, and legislation. These themes include positive aspects (drivers) and negative aspects (challenges) that influence BCT adoption in the Australian agriculture sector. The drivers (transparency, traceability, contract exchange, transaction efficiency, trade finance management, quality control, and real-time information to involved parties) positively influence the attitude and behavioural intentions of stakeholders in the Australian agricultural sector to adopt these technologies. However, negative aspects such as issues related to BCT security present challenges in the BCT adoption among the Australian agricultural sector stakeholders.

7. Gaps in Literature

The analysis of the above themes provides a foundation on the drivers and challenges affecting the adoption of BCT in the agricultural sector. Based on the above findings, at least one gap was identified for each theme on the determinants of BCT. From the perspective of BCT determinants related to transparency, it was established that the accuracy of information input by sensors or people is not guaranteed, which meant that transparency may not be achieved completely. The procedure of developing, verifying, adopting, and implementing smart contracts is limited by the availability of frameworks that could support smart contracts efficiently.

Despite the increasing number of inquiries on traceability in the agriculture sector, a limited number of empirical studies focus on traceability and visibility in Australian agriculture supply chains. In terms of achieving transaction efficiency and trade finance management, it is still not clear whether the use of BCT and its alternatives could provide greater efficiency benefits compared to other centralized systems.

From the perspective of challenges, previous studies failed to identify how third-party activities could be detected using BCT. This means that future innovators should be committed to address this gap, otherwise trust and security of the technology may be compromised. From the aspects of achieving real-time information and legislation, a lot still needs to be achieved to protect key stakeholders from the risk of false information and other technological risks. Where possible, new studies should focus on organizations and businesses that have adopted BCT in their agricultural supply chains to understand the suitability, benefits, and drawbacks of this technological innovation.

8. Discussion

This systematic review emerged with ten themes related to the adoption of BCT in the agricultural sector and other industries. The themes relate to the drivers of BCT and the challenges in the adoption of this technology. The key drivers of BCT identified in this study are the need for transparency, quality control, traceability, contract exchange, transaction efficiency, security, trade finance management, and the need for real-time data. On the other hand, the main challenges related to the adoption of this technology include legislation and legal issues, lack of trust, awareness, and minimal support from relevant stakeholders.

Successful BCT adoption hinges on factors such as transparency, traceability, quality control, transaction efficiency, security, finance management, and real-time data. These factors significantly influence consumer attitudes and behavioural intentions towards BCT, acting as both drivers and obstacles. Organizations must balance the benefits and challenges of BCT to ensure value addition to business processes, necessitating a shift in organizational culture. Failure to manage adoption obstacles can adversely affect specific business processes [15].

These findings emphasize the critical role of transparency and traceability in decisions regarding the adoption of BCT. By enabling stakeholders to track the provenance of products from farm to consumer, BCT reduces the risk of fraud and ensures compliance with environmental standards and sustainable practices. Increased transparency empowers consumers to make informed decisions and holds producers accountable for their actions, driving sustainable behaviour. Organizations are also looking for technologies that can guarantee the required product quality and transaction efficiency [15]. An increase in business losses is attributed to the ineffectiveness of systems supporting business transactions, and the inability to manage trade finances compels institutions to consider the adoption of BCT to guarantee efficiency and eventual business returns [15,31]. The need to incorporate smart contracts through contract exchanges as well as the desire for real-time data has also influenced decisions to adopt BCT.

The need for technologies that can guarantee secure systems and processes is becoming a vital consideration for business functions such as supply chains that use considerable volumes and require numerous approvals. Rogerson and Parry [29] and Prashar et al. [22] highlight that the adoption of BCT is driven by the need for secure systems and platforms that can guarantee customer and organizational data protection. BCT enables stakeholders to share information and work together to address sustainability challenges. This increased trust and cooperation can facilitate the adoption of sustainable practices, as well as the development and implementation of policies and regulations that promote environmental stewardship. However, lack of trust and legal obstacles impede BCT adoption. According to Kosmarski [33] and Sharma and Joshi [75], the legal requirements for adopting BCT and subsequent governance issues prevent many organizations from considering the adoption of new technologies despite the projected benefits associated with such technologies. Since BCT is still a developing technology with limited adoption, decisions on governance and legislation have not been universally incorporated in the use of this technology [33]. Further, attempts to integrate BCT with a view to improve specific business processes have received substantial opposition from stakeholders who do not understand the immediate and future value of these new technologies and developments.

8.1. Theoretical Implications

The study contributes to the theory on agriculture. The theory of change in agriculture is concerned with the statement of mini steps which will result in the desired goal. Having identified the determinants of BCT adoption in the agricultural supply chain, mini steps that will be undertaken include understanding of the needs, identification of relevant framework needed, developing legislation framework, and selection of the best technology that will provide the desired solution. For instance, research has established the need for transparency in the supply chain; therefore, a new technology (BCT) is needed to address the problem. The BCT requires supporting frameworks such as systems of compiling quality data.

The adoption of BCT can drive sustainability in agriculture by enhancing transparency, efficiency, and collaboration. Transparency ensures that all stakeholders can access accurate and reliable information about the supply chain, leading to better decision making and accountability. Efficiency gains from BCT streamline processes, reduce costs, and minimize waste, contributing to more sustainable practices. Furthermore, BCT fosters collaboration among stakeholders by creating a trusted and secure platform for information sharing and contract execution. By addressing these key areas, BCT can significantly advance sustainability in the agricultural sector, promoting responsible and efficient resource use. The Australian context presents unique challenges and opportunities for BCT adoption, driven by its vast geography, diverse agricultural products, and stringent biosecurity measures. Unlike other countries, Australia's agricultural supply chain must address the complexities of long-distance transportation, varied climate conditions, and the need for robust traceability systems to meet international export standards. These factors necessitate innovative solutions like BCT to enhance supply chain integrity and competitiveness on the global stage.

This study contributes to the body of knowledge on BCT by investigating the adoption process. These findings also impact the food security theory of change. This theory is concerned with ensuring sustained and healthy meals for children from vulnerable families, particularly the most susceptible communities. The study finding on the potential benefits associated with the usage of BCT, especially the achievement of efficient agriculture, will contribute considerably to the achievement of the theory's goal. The traceability of agricultural produce will enable experts to reach out to the farmers with a view to train them on good farming practices. Ultimately, the production of healthy agricultural produce will lead to the supply of healthy products to consumers. This will ensure that the customers are able to consume healthy agricultural products.

8.2. Practical Implications

The results extend the extant knowledge on BCT adoption by highlighting a comprehensive set of factors that influence the integration of this technology in the Australian agricultural sector. Contrary to existing evidence, the study findings indicate that there are two broad and opposing set of factors that contribute to BCT adoption. The key drivers that positively influence attitudes and intentions towards BCT adoption are its unique features/attributes, including traceability, transparency, real-time aspect, and transaction efficiency [22]. For instance, AgriDigital, Australia's leading independent digital grain software, executes real-time settlement of a physical commodity on a blockchain, eliminating counterparty risk and proving the feasibility of real-time transactions in the agriculture supply chain [83]. Another example is the implementation of a blockchain-based multisignature approach to enhance governance and transparency in multitier supply chains, demonstrating potential for digitally transforming supply chain governance through trustworthy information sharing [84]. However, certain aspects of BCT, including its trust, security, privacy, cost, and confidentiality, can have a negative influence on attitudes and behavioural intentions towards its adoption [24]. This study contributes to the current research discussion by highlighting to key stakeholders in the Australian agricultural sector the drivers and obstacles to BCT adoption in the country.

Organizations in Australia that prioritise transparency are more likely to adopt BCT due to its ability to reduce information asymmetry and enhance traceability, especially important in agriculture and supply chain management [85]. BCT promises to improve transaction efficiency for Australian companies by streamlining processes, real-time information sharing, reducing intermediaries, and lowering costs. The perceived risks related to data security, regulatory compliance, and business disruption influence BCT adoption decisions in Australian organizations [86].

Further, the insight from the systematic review revealed that, recently, there are more studies focusing on BCT adoption in the agricultural sector. We found that eight of the eighteen studies (44.4%) described the factors that contribute to BCT adoption in the agricultural sector. This insight has important implication for stakeholders in the Australian agricultural sector. While interest in BCT is growing in Australia, particularly in the agricultural sector, more research is needed to understand the long-term impacts and challenges across different Australian industries.

Policy Recommendations for BCT Adoption in Australia's Agricultural Supply Chain

BCT holds significant potential to transform Australia's agricultural supply chain by enhancing transparency, traceability, and efficiency. However, its adoption faces several challenges that need to be addressed through targeted policy interventions. Based on findings from various studies, key policy recommendations include enhancing digital infrastructure by improving internet connectivity in rural and remote areas and providing grants or subsidies for technological upgrades [87]. Establishing a clear regulatory framework and standardizing data protocols are essential to ensure compliance and interoperability between different blockchain systems [88,89]. Education and training programs for stakeholders, including incorporating blockchain into agricultural education curricula, are crucial for overcoming perceived behavioural control issues and ease-of-use concerns [88]. Financial incentives such as subsidies, tax breaks, and funding for pilot projects can encourage investment and showcase successful use cases [90]. Promoting collaboration through public–private partnerships and international cooperation can drive innovation and harmonize blockchain standards [91]. Addressing security and privacy concerns with robust security measures and a legal framework for data protection is vital to protect data integrity. Tailored support programs and access to shared resources can help small and medium enterprises (SMEs) overcome high initial costs and complexity [92]. Implementing these policy recommendations can address the challenges of blockchain adoption in Australia's agricultural supply chain, enhancing efficiency, transparency, and global competitiveness.

9. Conclusions

This study has established the critical determinants that influence the adoption of BCT, including assessing transparency, traceability, contract exchange, transaction efficiency, trade finance management, quality control, real-time information, security, and legislation. This study concludes that the need for product traceability drives the adoption of BCT. Process transparency, the need for quality controls, and the necessity for smart contracts in business engagements also motivate businesses to implement BCT. Further, this study concludes that the need for transaction efficiency, business trusts, real-time data, security, and trade finance management are critical drivers that influence BCT adoption. On the other hand, challenges such as legal uncertainties, low readiness and awareness levels, lack of trust, and inadequate support prevent or slow down decisions on BCT adoption. Overcoming these obstacles through education, collaboration, and supportive policies is crucial for realizing the full potential of BCT in driving sustainability in the Australian agriculture sector.

This analysis finds that when it comes to determining whether to adopt BCT in business processes, firms tend to consider certain aspects. The agricultural supply chain is being pushed to embrace BCT due to a loss in production and performance, as well as issues in ensuring product quality. BCT adoption is also necessitated by the need to eliminate fraud and security concerns in supply chain management. As the adoption of BCT in agriculture continues to grow, it is essential to address the challenges identified in this study to ensure that its implementation contributes to a more sustainable and resilient agricultural sector in Australia.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su16135806/s1, Figure S1: PRISMA Flowchart; Table S1: Search Log; Table S2: Methodological Quality Assessment and Depth of Reporting.

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