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Exploring factors influencing circular economy adoption and firm-level practices in the agribusiness sector: an exploratory study of Indian firms

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Abstract
The adoption of circular economy practices in the Indian agribusiness sector has emerged as a significant area of interest due to its potential to promote sustainability and optimise resource utilisation. This exploratory study delves into the factors influencing the integration of circular economy principles in Indian agribusiness firms. The research's primary purpose is to unveil the driving forces behind the adoption of circular economy practices and firm-level strategies, given the increasing concerns about sustainability in agriculture. By conducting qualitative interviews with a diverse group of 17 managers and academicians from agribusiness firms and institutes, this study provides a comprehensive understanding of the factors and practices associated with circular economy adoption. The study's findings reveal a categorisation of influencing factors, encompassing socio-cultural, economic, technological, strategic, and organisational aspects, as well as supply chain dynamics. Furthermore, the research identifies key firm-level practices that contribute to the implementation of circular economy principles, such as collaborative partnerships, product design for durability, waste reduction and recycling, resource efficiency, and policy advocacy. In conclusion, this research contributes empirical evidence regarding the adoption of circular economy practices in the unique context of Indian agribusiness. The implications of these findings underscore the importance of supportive policies, knowledge dissemination, and capacity-building initiatives. These measures are crucial for promoting the widespread integration of circular economy practices among agribusiness firms. Ultimately, these efforts align with broader goals of environmental preservation and efficient resource utilisation, contributing to the advancement of sustainable agricultural systems and the promotion of resource circularity. This research adds valuable insights to the growing body of knowledge on circular economy practices, particularly within the Indian agribusiness sector.

Keywords Circular economy · Agribusiness · Resource efficiency · Supply chain · Food waste · Recycling · Sustainable practices · Circular design · Circular economy adoption · Firm-level practices · Circular economy implementation

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1 Introduction

The agriculture industry, which plays a crucial role in the economy, has substantial obstacles in terms of resource management and waste generation. It is imperative to prioritise efforts aimed at minimising the environmental consequences linked to disposal processes, while concurrently upholding the tenets of the circular economy to efficiently reduce detrimental environmental effects (Abbasi et al., 2022). To address these concerns, the circular economy framework has emerged as a possible option, promoting sustainable practices and the decrease of waste (Heshmati, 2017). Within the realm of agriculture, the concept of the circular economy involves the incorporation of principles that aim to maximise the efficient use of resources, minimise adverse effects on the environment, and develop a self-sustaining system that converts waste into valuable resources (Geissdoerfer et al., 2017). Agribusiness, as described by Cramer et al. (2001), involves a range of operations such as farming, food processing, distribution, and waste management. This sector is known for its significant resource consumption and the generation of substantial waste. The utilisation of conventional linear economic models frequently leads to inefficiencies and the deterioration of the environment (Stahel, 2016). However, the adoption of circular economy concepts provides agribusiness with the opportunity to reduce waste, improve the efficient use of resources, encourage sustainable production methods, and make a positive contribution to environmental preservation (Yang et al., 2021).

The field of agribusiness has undergone thorough examination, encompassing a wide range of subjects such as supply chain management, sustainable agriculture, waste management, and environmental sustainability. Rogelj et al. (2018) emphasised the need of sustainable practices in the field of agribusiness, specifically highlighting the requirement of adopting circular economy principles. In a study conducted by Kumar et al. (2017), an examination of waste management solutions in the food processing industry was undertaken, with a particular focus on the potential of circular economy concepts. Abbasi et al., (2022) identified the disruptions that have arisen in supply chains as a result of the global pandemic. In response, they put forth the circular economy as a more advantageous alternative to the linear economy. The agribusiness sector, which plays a crucial role in global food production, economic development, and job creation, faces various obstacles that extend beyond national borders. These challenges include limited resources, effective waste management, and environmental issues (Zylbersztajn, 2017). Since the initiation of the Kyoto Protocol in 2005, there has been a notable and swift growth in the global carbon trading market. Many countries worldwide have implemented various measures aimed at reducing greenhouse gas (GHG) emissions. Numerous studies conducted across different countries emphasise the necessity of adopting circular economy principles as a means to tackle these challenges. In a recent study conducted by Morseletto (2020), an examination of circular economy practices within the European agricultural sector was undertaken. The study aimed to shed light on both the advantages and obstacles associated with such practices. India, a prominent participant in the global agricultural sector, encounters unique obstacles in the field of agribusiness due to the rapid expansion of its population, constraints on available resources, and increasing concerns regarding the environment. Circular economy ideas have the ability to effectively overcome these difficulties. Several scholarly investigations, such as the research conducted by Kumar et al. (2017) and Murray et al. (2017), shed light on the potential of circular economy practices in the context of Indian agriculture, emphasising their relevance in promoting sustainable development. The inclusion of continuous

education (CE) in accountability frameworks within professional practise has arisen as a significant development over the last twenty years. Regulatory agencies frequently choose to engage in Continuing Education (CE) as the preferable approach for establishing accountability systems (Di Vaio et al., 2023).

A thorough analysis is required to identify the difficulties associated with policy design, development of new business models, formulation of strategies, and utilisation of tools for assessing sustainability and managing uncertainties during the implementation process. This examination should go beyond the environmental aspect of sustainability, as highlighted by Zhou et al. (2023). The growing interest in the application of circular economy principles to the field of agribusiness necessitates additional investigation into the factors that influence acceptance and the specific practices employed by firms to facilitate implementation (Silvestri et al., 2022). However, the existing body of scholarly study mostly focuses on the finding of linkages between environmental resources. The main objective of this study is to suggest alternative technical strategies that can improve the utilisation of these resources, such as reducing water and energy usage in the production of food (Di Vaio et al., 2020). With the increasing urgency of environmental concerns and the implementation of stricter rules, both individuals in the business sector and policymakers are more obligated to examine the environmental consequences of sustainability-related actions. In order to effectively address the complexities associated with policy design, business model development, strategy formulation, and the use of tools to assess sustainability and manage uncertainties during implementation, it is imperative to conduct a thorough analysis that goes beyond the environmental aspect of sustainability (Zhou et al., 2023). Silvestri et al. (2022) argues that despite the growing interest in the application of circular economy principles to the agricultural sector, there is a need for additional research to investigate the factors that influence adoption and the specific practices at the firm level that facilitate implementation. However, the existing body of literature mostly focuses on the exploration of relationships among environmental resources. The main objective of this study is to suggest alternative technical strategies that can improve the utilisation of these resources, such as reducing water and energy usage in the production of food (Di Vaio et al., 2020). With the increasing urgency of environmental concerns and the implementation of stricter rules, both individuals in the corporate sector and parliamentarians are increasingly motivated to examine the environmental consequences of sustainability-related actions. To bridge these gaps, this study aims to address the following research inquiries:

RQ1: What factors drive the adoption of circular economy practices in agribusiness firms?

RQ2: Which firm-level practices underpin the adoption of circular economy practices in agribusiness firms?

This study has significant consequences for scholars, policymakers, and industry stakeholders. The developing nations have been significantly affected by climate change and pollution resulting from industrial activities. These impacts are determined by various factors, including the lifestyles of the population, the types and quantities of waste produced, and the ways used towards waste management (Abbasi, 2023). Conducting an inquiry into the elements and practices at the firm level that impacts the adoption of circular economy principles in the agricultural sector would contribute to a deeper understanding of the drivers and obstacles associated with its implementation. The results of this study will provide policymakers with valuable insights that can be used to develop effective policies and interventions aimed at encouraging circular economy practices within the agriculture sector. Moreover, industry professionals will get essential knowledge from exemplary

methodologies and successful instances, thereby simplifying the incorporation of circular economy principles into their operations.

The paper's structure is as follows: Sect. 2 presents an exhaustive literature review on circular economy in agribusiness, highlighting pertinent studies and their findings. Section 3 delineates the research methodology. Sections 4 and 5 discuss explored themes and firm-level practices. Section 6 deliberates on study implications and concludes the paper and suggests avenues for future research.

2 Literature review

To conduct a comprehensive review of the literature, a systematic search strategy was executed by combining relevant keywords. The databases Scopus and Web of Science were queried to retrieve pertinent articles. The search strategy involved employing a combination of keywords such as "Circular economy", "Agribusiness", "Resource efficiency", "Waste reduction", "Supply chain", "Food waste", "Recycling", "Sustainable practices", and "Circular design". Boolean operators (AND, OR) were utilised to refine search outcomes. The temporal scope of the search was delimited to articles published in English between 2001 and 2023, ensuring alignment with contemporary research. Furthermore, a manual scrutiny of reference lists of relevant articles was undertaken to identify additional studies that might have eluded the initial database query. This systematic search strategy aimed to comprehensively encompass studies at the nexus of circular economy and agribusiness.

Prior to delivering the tabulated summary of significant studies undertaken within the subject, it is imperative to establish a contextual background and offer a comprehensive viewpoint. The aforementioned studies serve as the basis for our present research, providing significant insights, approaches, and discoveries that enhance and contribute to the broader realm of knowledge. The purpose of this compilation is to recognise the contributions made by earlier researchers and to illustrate how our work aligns with the current body of research in this field. Additionally, it serves as a valuable resource for readers, offering a point of reference to comprehend the progression and fundamental concepts of study within the given discipline. Table 1 presents a concise compilation of the prominent and pertinent studies that have laid the foundation for our present inquiry. It offers a complete synopsis of their principal discoveries and ramifications.

From this extensive search, several thematic strands emerged, reflecting the multi-faceted discourse at the intersection of circular economy principles and agribusiness practices.

Theme 1: Circular Economy Principles in Agribusiness The literature consistently acknowledges the relevance of circular economy ideas in the agribusiness industry. The significance of this matter was clarified by Geissdoerfer et al. (2018) through a comprehensive analysis of circular economy frameworks, emphasising their suitability for the agri-food sector. The authors emphasised the importance of resource efficiency, waste reduction, and recycling as crucial components in the functioning of agribusiness operations. Geng et al. (2020) conducted a study that examined the integration of circular economy practices within the food supply chain. The investigation placed significant emphasis on the importance of circular design, resource recovery, and eco-innovation in augmenting the sustainability of agriculture.

Theme 2: Sustainable Agriculture and Circular Economy The integration of sustainable agriculture practices with circular economy ideas has attracted significant interest. Numerous empirical research and case analyses have extensively examined the mutually

Table 1 Major studies conducted in the field

Study	Findings	Research gaps
Geissdoerfer et al. (2018)	Explored frameworks for circular economy in the agri-food sector	Further investigation is needed into the factors driving the adoption of circular economy frameworks in agribusiness firms
		Further exploration is required into the firm-level practices that underpin the adoption of circular economy frameworks in agribusiness firms
		Further investigation into the practical implementation challenges of circular economy frameworks in agri-food contexts
Geng et al. (2020)	Examined circular economy practices within the food supply chain	Limited understanding of the potential barriers hindering the comprehensive adoption of circular practices throughout the entire food supply chain
		Further exploration is needed to identify the factors driving the adoption of circular practices in agribusiness firms within the food supply chain
Barros et al. (2020)	Investigated the interplay between sustainable agriculture and circular economy	Limited insights into the economic implications and trade-offs between sustainable agricultural practices and circular economy objectives in agribusiness firms
		Further investigation into the firm-level practices that underpin the adoption of circular economy practices in agribusiness firms engaged in sustainable agriculture
Schroeder et al. (2019)	Explored nutrient recycling and circular economy practices in agriculture	A need for a more in-depth analysis on the scalability and long-term viability of nutrient recycling practices in various agricultural systems within agribusiness firms
		Further exploration is required to understand the factors driving the adoption of nutrient recycling and circular economy practices in agribusiness firms
Mahmood et al. (2021)	Analysed circular supply chain practices in the agri-food sector	Further exploration is required into the role of technological advancements in optimising circular supply chain practices in agribusiness firms and minimising resource waste
		Further investigation into the factors driving the adoption of circular supply chain practices in agribusiness firms
Esposito et al. (2020)	Conducted a comparative analysis of circular economy policies in the agri-food sector	Limited understanding of how cultural and regional differences impact the successful implementation and adaptation of circular economy policies in diverse agribusiness contexts

Table 1 (continued)

Study	Findings	Research gaps
		Further exploration is needed to identify the firm-level practices that underpin the adoption and adaptation of circular economy policies in agribusiness firms in diverse cultural and regional contexts

beneficial association between sustainable agriculture and circularity within the realm of agribusiness. Merli et al. (2018) undertook a comprehensive systematic review to examine the relationship between sustainable agriculture practices and the dynamics of the circular economy. The investigation brought attention to the potential of circular methodologies in enhancing the sustainability of agribusiness, with a specific focus on agroecology, organic farming, and precision agriculture.

Theme 3: Closing the Nutrient Loop One crucial aspect of using circular economy principles in the agricultural sector involves the establishment of a closed nutrient loop. Prior studies have mostly focused on examining various approaches to effectively manage nutrients, such as the utilisation of organic waste recycling and the establishment of circular pathways to recover nutrients. In their study, Tukker et al. (2015) undertook a thorough examination with a specific emphasis on the use of nutrient recycling techniques within the agricultural sector. The conversation revolved around the capacity of circular economy paradigms to effectively extract nutrients from organic leftovers. The research emphasised the necessity of technical advancements and supportive regulations in order to effectively apply circular nutrient management systems.

Theme 4: Circular Supply Chains in Agribusiness Circular supply networks play a crucial role in promoting sustainability within the agribusiness sector. Academic inquiries have extensively explored approaches focused on waste reduction, efficient logistical operations, and the cultivation of collaborative partnerships among relevant parties. Pagoropolous et al. (2017) conducted an extensive investigation of the implementation of circular supply chain strategies in the agri-food industry. The investigation conducted by the researchers highlighted key factors that play a crucial role in the effective implementation of circular economy principles. Traceability, Collaboration, and information exchange have been identified as crucial elements for achieving circularity in agriculture supply chains.

Theme 5: Policy and Institutional Support for Circular Economy in Agribusiness The significance of legislative frameworks and institutional support in fostering circular economy practices within the agriculture sector is another important topic focus. Previous studies have examined various policy methods, regulatory procedures, and institutional frameworks that support the concept of circularity within the sector. Corona et al. (2019) conducted a comparative analysis to examine circular economy strategies in the agri-food sector across multiple nations. The investigation focused on the effectiveness of various policy instruments, including as economic incentives, laws, and stakeholder involvement, in promoting the adoption of circular economy principles in the agriculture sector.

This comprehensive review, characterised by systematic search methodologies and stringent inclusion criteria, illuminates the intricate tapestry of research encompassing the interface between circular economy principles and agribusiness dynamics. The identified thematic strands (Fig. 1) contribute to an enriched understanding of the diverse dimensions and implications of circular economy integration within the agribusiness realm.

Insufficient Understanding of Circular Economy Implementation in the Agribusiness Sector: Previous studies have highlighted the growing focus on circular economy concepts in many industries (Kumar et al., 2021; Sehnem et al., 2020). Nevertheless, there is a significant knowledge gap in understanding the factors that influence the adoption of circular economy practices within the agriculture sector. The current scholarly study largely focuses on the general aspects of adopting a circular economy or on individual industries, sometimes neglecting the unique problems and drivers that are inherent to the agriculture sector.

There is the insufficiency of empirical research on the implementation of circular economy practices at the firm level. Although scholars such as Malik et al. (2022) and Howard et al. (2022) have discussed the potential benefits of using circular economy principles in

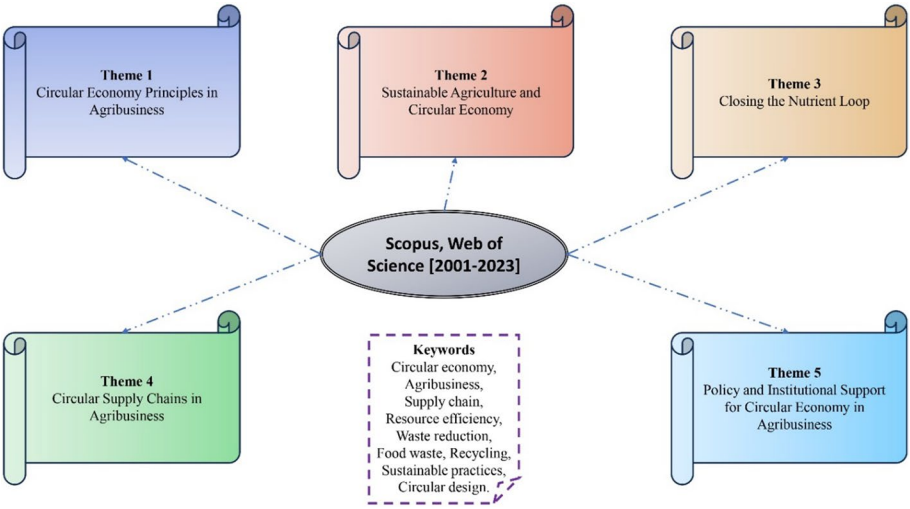

Fig. 1 Identified themes

agriculture, there is less empirical research available on the specific practices adopted by agribusiness firms in this regard. Gaining an understanding of the particular circular economy tactics employed by these companies, along with an analysis of the variables driving their adoption, is crucial for informing policy interventions and managerial strategic decision-making.

Indian Contextual Neglect Most of the existing scholarly work on the dynamics of circular economy in the agriculture sector primarily originates from Western cultures, as noted by Fiksel et al. (2021). The Indian landscape, which has a significant impact in the global agricultural sector, has not received sufficient scholarly attention, as noted by Priyadarshini et al. (2020). The examination of circular economy integration and firm-level practices in Indian agribusiness enterprises presents an opportunity to gain a deeper understanding of the specific contextual intricacies, challenges, opportunities, and cultural factors that shape the implementation of circular economy principles.

Holistic Exploration of Research Inquiries Deficiency Previous academic research has explored many aspects of incorporating circular economy principles in the field of agribusiness (Sharma et al., 2020; Datta et al., 2021). However, there is still a lack of extensive investigation into the specific research questions presented in this paper. Remarkably, there has been a lack of comprehensive efforts to simultaneously investigate the underlying mechanisms driving the acceptance of circular economy principles and the practical implementation of these principles inside agribusiness organisations. The joint effort to address these inquiries holds the potential to narrow the existing knowledge deficit, resulting in a comprehensive understanding of the integration of circular economy principles in the agriculture sector.

3 Methodology

This research employs a qualitative research methodology to delve into the intricate factors influencing the adoption of circular economy practices within agribusiness firms. Interviews serve as the chosen method, allowing for an in-depth exploration of the subject matter, thereby enabling researchers to capture nuanced insights that might elude alternative

approaches (Young et al., 2018). Through open-ended inquiries and probing, interviews create an avenue for participants to share their perspectives, experiences, and insights, fostering a rich and comprehensive dataset (Kallio et al., 2016).

Interviews offer a high degree of flexibility and adaptability, enabling researchers to fine-tune their questions and follow-up probes based on participants' responses, thereby facilitating a thorough and multi-faceted understanding of the topic at hand. Furthermore, interviews possess the potency to render context-specific insights as participants can elucidate their experiences and challenges within their distinct organisational and social contexts (Adhabi et al., 2017).

The primary approach to data collection in this study involves semi-structured interviews conducted with 17 managers from a spectrum of agribusiness firms operating within India. The participant selection criteria were meticulously designed to ensure the representation of diverse agribusiness firms, accounting for factors such as size, sector, and geographical location. It is important to note that the participating firms varied in size, encompassing both small and large enterprises within the agribusiness sector. This variation in size allowed for a comprehensive understanding of the challenges and opportunities faced by agribusiness firms of different scales in adopting circular economy practices.

The data collection process encompassed face-to-face interviews with the selected participants. The data collection process spanned several months, commencing on 20 March and concluding on 15 May. Each interview typically lasted between 60 and 90 min, depending on the depth of discussion and the elaboration provided by the participants.

Participants were chosen based on their expertise and familiarity with circular economy practices within their respective organisations, particularly those with active involvement in sustainability and resource management decisions. The selection criteria ensured that the interviewed managers possessed a comprehensive understanding of the subject matter with a minimum experience of 7 years and were actively engaged in the adoption and implementation of circular economy practices within their organisations.

The interviews were recorded with participants' consent, and meticulous notes were taken during the sessions to capture both verbal and non-verbal cues. Subsequently, these interviews were transcribed verbatim to ensure precise data representation. The gathered interview data were reinforced by pertinent documents, reports, and publicly accessible information pertaining to the participating firms. This blended approach aimed to offer a comprehensive and holistic comprehension of the circular economy practices within these organisations.

The process of data analysis was guided by a thematic analysis methodology (refer to Fig. 1). The transcribed interviews and the attendant notes were subjected to meticulous scrutiny, leading to the identification of preliminary codes and themes. These codes and themes were developed both deductively, aligning with the research objectives, and inductively, emanating from the raw data itself. Subsequently, these coded data were organised into coherent categories and sub-categories, encapsulating the factors steering circular economy adoption, firm-level strategies, challenges, and opportunities.

The data analysis sought patterns, commonalities, and disparities within the data corpus, thereby unearthing recurring themes and engendering insightful conclusions. Throughout this analytical journey, a robust approach was adopted to secure the dependability and credibility of the findings. Multiple researchers were actively engaged in the analysis to bolster intercoder reliability. Consistent discussions and debriefing sessions were convened to ensure harmonious interpretation and to mitigate potential biases.

The interpreted findings were diligently cross-referenced against the original interview data to warrant accuracy and transparency in the analysis process. Direct quotations from

the interviews were interwoven into the findings to furnish firsthand evidence and buttress the articulated observations. These findings, coupled with the identified themes, were channelled (Fig. 2) to address the research objectives and the research inquiries, thus cementing the alignment between data and research outcomes.

In summary, this study employed a qualitative research methodology using semi-structured interviews with 17 managers from agribusiness firms and academicians. The selection criteria ensured a diverse representation of participants, and the data collection process involved face-to-face interviews supplemented by document analysis. Thematic analysis was employed to analyse and interpret the data, ensuring rigour and reliability in the findings.

4 Findings

4.1 Profile of respondents

The participants for the study were ten managers and seven academicians from agribusiness firms and academic institutes, respectively. They were full-time employees of their respective organisation. Their positions ranged from senior operations managers to project managers and associate professors. Their range of experiences in their respective field varied from a minimum of eight to a maximum of 27 years. Sample selection was convenience sampling. The breakdown of respondents is presented in the following (see Table 2).

In Fig. 3, the results of a comprehensive manual coding process using Atlas.ai are visually represented, highlighting six distinct factors that emerged as pivotal in the context of the research. These factors encompass a broad spectrum of considerations within the studied domain. Sociocultural factors underscore the importance of aligning circular initiatives with prevailing cultural norms and values, while environmental factors emphasise the foundational principles of sustainability and biodiversity conservation. Supply chain factors depict the significance of Collaboration with suppliers and the establishment of efficient reverse logistics systems. Strategic and organisational factors highlight the role of leadership involvement, fostering an organisational culture, and engaging employees in promoting circular economy adoption. The Technological factor showcases the enabling role of advanced technologies and digital solutions, particularly in aspects such as traceability and process efficiency. Lastly, economic factors indicate the driving force of economic considerations, with potential cost savings and market advantages emerging from circular practices. This visual representation serves to provide a concise overview of the multi-faceted

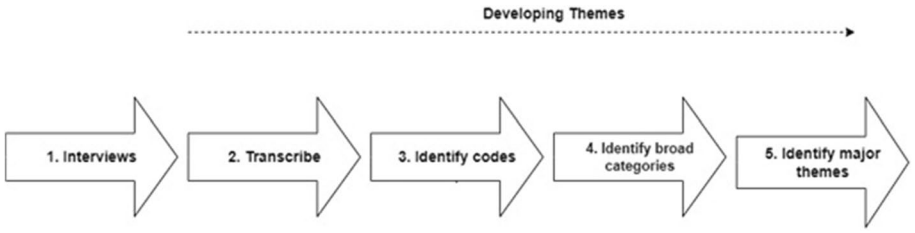

Fig. 2 Methodology flow chart

Table 2 Profile and experience of respondents

Industrialist/Academician	S. No.	Designation	Experience (years)
Academicians	1	Professor	25
	2	Associate professor	20
	3	Associate professor	20
	4	Associate professor	17
	5	Associate professor	15
	6	Associate professor	15
	7	Assistant professor	12
	8	Assistant professor	8
Industrialists	9	General manager	30
	10	General manager	27
	11	Project manager	11
	12	Project manager	8
	13	Operations manager	9
	14	Senior operations manager	8
	15	Departmental head	7

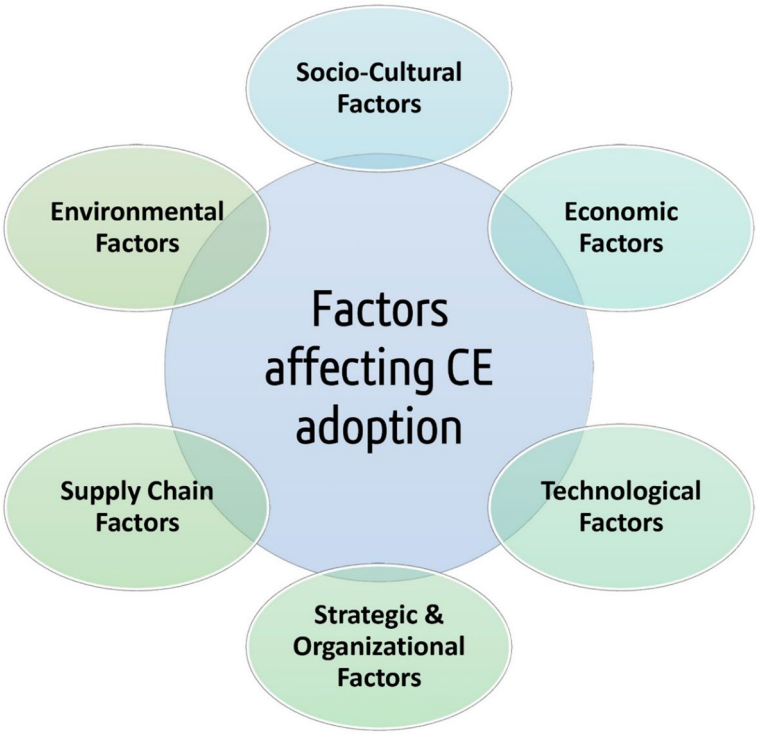

Fig. 3 Schematic representation of themes

dimensions influencing the integration of circular economy practices, offering a valuable reference point for readers to grasp the holistic scope of the research findings.

Table 3 provides a thorough summary of the coding procedure, categorisation, and frequency analysis that were undertaken as part of this research endeavour. By employing rigorous coding techniques, several categories were identified, providing insights into the prevailing themes present in the dataset. The frequency column serves to quantify the predominance of each category, so offering valuable insights into their respective levels of relevance. Moreover, the use of representative quotations enhances the depth of the research by providing explicit and illustrative instances from the data that substantiate the established categories. The table presented in this study serves as a beneficial tool, effectively summarising the research findings and providing readers with a well-organised and easily accessible reference to the primary themes and their frequency within the dataset.

4.2 Sociocultural factors (Theme 1)

Sociocultural aspects exert significant influence on the adoption of circular economy practices inside agriculture enterprises. These elements cover the cultural beliefs, attitudes, and behaviours that exert an influence on consumer demand, industry norms, and company tactics. The increasing recognition and apprehension over environmental matters have had a substantial impact on the implementation of circular economy strategies within the agro industry.

The adoption of circular economy practices in agribusiness enterprises has been influenced by sociocultural aspects, which have gained significance for many reasons (Sarala et al., 2016). According to Anggadwita et al. (2017), there is a growing trend among customers to prioritise environmental considerations and actively seek out products that are in line with their personal values. Consumers are becoming more cognizant of the ecological consequences associated with their purchasing decisions and are expressing a growing preference for sustainable and environmentally friendly goods. The alteration in consumer tastes has engendered a demand for products that adhere to the principles of the circular economy, hence compelling agribusiness corporations to embrace and implement such practices. One interview participant emphasised this by stating, **"Consumers today are more conscious of the environmental impact of their choices. They actively seek products that align with their values, including those that embrace circular economy principles".**

Societal values and attitudes towards sustainability have evolved, and there is a growing expectation for businesses to act responsibly and demonstrate environmental stewardship (Scholte et al., 2015). Agribusiness firms are recognising the need to align their practices with these societal values to maintain their social license to operate and enhance their brand reputation. One interviewee highlighted this by stating, **"Our customers are increasingly asking for sustainable products. They want to support companies that prioritize environmental stewardship. This has pushed us to adopt circular economy practices to meet their expectations".**

Furthermore, sociocultural factors influence industry norms and business practices. As more companies in the agribusiness sector adopt circular economy practices, it becomes a social norm and an industry-standard (Pearl et al., 2018). Peer pressure and benchmarking against competitors motivate firms to adopt circular economy practices to stay competitive and maintain their market position. A participant mentioned, **"We have noticed that more**

Table 3 Coding process

Code	Category	Theme	Frequency	Quotes
Consumer behaviour	Influencing behaviour	Sociocultural factors	10	"Consumers' growing awareness and demand for sustainable and eco-friendly products".
Cultural norms	Societal values	Sociocultural factors	6	"The cultural significance placed on preserving nature and traditional agricultural practices".
Cost-effectiveness	Financial considerations	Economic factors	12	"Implementing circular economy practices can lead to cost savings in resource management and waste reduction".
Financial incentives	External factors	Economic factors	8	"Government subsidies and tax incentives encourage agribusiness firms to adopt circular practices".
Innovation	Technological advancements	Technological factors	9	"Technological innovations in waste management and resource optimization drive circular economy adoption".
Automation	Operational efficiency	Technological factors	5	"Automated systems enable efficient monitoring and utilization of resources in circular agribusiness practices".
Leadership commitment	Internal factors	Strategic and organisational factors	11	"Leadership commitment is crucial for driving the adoption of circular economy practices within agribusiness".
Organisational culture	Work environment	Strategic and organisational factors	7	"A supportive organizational culture encourages employees to embrace circular practices and innovation".
Collaboration	Inter-organisational relationships	Supply chain factors	9	"Collaboration among stakeholders in the agribusiness supply chain is essential for implementing circular practices".
Traceability	Transparency and traceability	Supply chain factors	6	"Implementing traceability systems ensures transparency in the agribusiness supply chain and supports circularity".
Resource conservation	Resource management	Environmental factors	8	"Circular economy practices promote resource conservation and sustainable use in the agribusiness sector".
Waste reduction	Waste management	Environmental factors	7	"Efficient waste management systems minimize environmental impacts and support circular agribusiness practices".

and more companies in our industry are embracing circular economy practices. It has become an industry norm, and we don't want to be left behind".

Sociocultural factors exert a significant influence on the adoption of circular economy practices across various dimensions. According to Ketay et al. (2020), the emergence of a market demand for sustainable and circular products has prompted enterprises to implement circular economy practices to fulfil this need. Considering the growing emphasis placed by consumers on sustainability, agribusiness enterprises are acknowledging the significance of integrating circular economy principles into their operations to attract and retain environmentally concerned consumers (Camacho-Otero et al., 2018). Furthermore, these variables serve as motivators for companies to synchronise their ideals and practices with the expectations of society. Companies are under pressure from consumers and stakeholders to demonstrate responsible behaviour and actively engage with environmental issues. The pressure serves as a catalyst for agriculture enterprises to embrace circular economy practices to showcase their dedication to sustainability. One interview participant expressed this sentiment by stating, **"Sustainability has become a key consideration for our company. We want to show our customers and stakeholders that we are committed to addressing environmental issues through circular economy practices".**

Additionally, sociocultural elements contribute to the establishment of a positive feedback loop. The increasing adoption of circular economy practices by enterprises and their subsequent communication of sustainability efforts to consumers serves to enhance public knowledge and education of the advantages associated with circular economy techniques. According to Averill et al. (2015), this phenomenon subsequently strengthens the consumer's inclination towards circular products and motivates agribusiness enterprises to adopt circular economy practices. In summary, sociocultural factors play a significant role in influencing the adoption of circular economy practices inside agribusiness enterprises. The growing recognition and apprehension within society over environmental matters, combined with changing customer tastes and industry standards, have generated a significant drive for companies to embrace circular economy strategies. Agribusiness enterprises see the significance of harmonising their ideals and practices with social expectations and are actively adopting circular economy ideas in order to cater to consumer preferences for sustainable and environmentally friendly goods.

4.3 Economic factors (Theme 2)

Economic factors play a significant role in driving the adoption of circular economy practices in agribusiness firms. These factors encompass cost savings, revenue generation, and the overall financial benefits associated with adopting circular economy principles (Patwa et al., 2021).

The incorporation of circular economy practices in agriculture enterprises is significantly influenced by economic aspects due to various compelling reasons. According to Sverko et al. (2020), significant cost reductions can be achieved by optimising resource utilisation and minimising waste. Agribusiness enterprises have the potential to achieve resource input minimisation, waste generation reduction, and operational efficiency improvement through the adoption of circular economy practices. The improvements in efficiency result in tangible financial benefits for the companies. One interview participant highlighted this by stating, **"By optimizing resource utilization and reducing waste, we have been able to cut down our operational costs significantly. This not only improves our bottom line but also contributes to our sustainability goals".**

Second, circular economy practices can unlock new revenue streams and business opportunities. By adopting circular economy principles, agribusiness firms can identify innovative ways to generate additional income (Khan & Haleem, 2021). For example, recycling agricultural waste can create value-added products that can be sold in new markets. One interviewee mentioned, **"Circular economy practices have helped us identify new revenue streams. For instance, by recycling our agricultural waste, we have been able to create value-added products and generate additional income".**

The adoption of circular economy practices has the potential to improve the overall financial stability and long-term sustainability of agriculture enterprises. Firms have the ability to manage the risks associated with resource scarcity and price volatility by lowering their dependence on limited resources and minimising waste. The strategic advantage mentioned by Hysa et al. (2020) plays a significant role in enhancing the long-term resilience and competitiveness of organisations. Various economic factors play a significant role in shaping the adoption of circular economy practices. The adoption of circular economy practices in agribusiness enterprises is strongly motivated by the potential for cost savings and enhanced profitability. Firms have the potential to enhance their financial performance by implementing strategies that focus on waste reduction, resource optimisation, and efficiency improvement within their operations. The aforementioned economic advantage is in accordance with the firms' primary financial goals and renders circular economy practices an appealing proposal. Circular economy practices have the ability to provide additional sources of revenue, hence presenting economic prospects for agriculture enterprises. Through the utilisation of waste materials, the implementation of recycling efforts, or the creation of creative goods, companies have the opportunity to access untapped markets and broaden their client demographic. The diversification of revenue sources improves the business's ability to withstand challenges and supports its long-term economic viability.

The implementation of a circular economy is supported by favourable economic conditions. The potential for cost savings and revenue generation resulting from the adoption of circular economy practices can be effectively conveyed to investors, shareholders, and other stakeholders, thus bolstering the firm's reputation and appeal within the financial community (Rehman et al., 2022). This enables the acquisition of financial capital and necessary resources for the implementation of circular economy initiatives. In summary, economic reasons are of significant importance in influencing the performance of circular economy practices inside agriculture enterprises. Firms are strongly motivated to adopt circular economy principles because to the potential benefits of cost savings, income growth, and enhanced financial stability. Agribusiness enterprises can achieve economic gains and promote sustainable and ecologically responsible practices by optimising resource utilisation, minimising waste, and exploring novel business prospects.

4.4 Technological factors (Theme 3)

Technological factors play a crucial role in driving the adoption of circular economy practices in agribusiness firms. These factors encompass advancements in technology, innovation, and the availability of tools and solutions that enable the implementation of circular economy principles (Rajput et al., 2019).

Technological elements play a significant role in facilitating the implementation of circular economy practices inside agriculture enterprises due to various compelling rationales (Rehman et al., 2022). Technological improvements have played a pivotal role

in enabling the emergence of novel processes, systems, and solutions that support the transition towards circular economy models. Emerging technologies have the potential to enhance resource allocation, optimise waste management infrastructure, and facilitate the development of value-added commodities derived from waste materials. The technology advancements offer the essential resources for agribusiness enterprises to effectively adopt circular economy strategies. One interview participant emphasised this by stating, **"Technological advancements have revolutionized our ability to adopt circular economy practices. We now have access to advanced waste management systems, smart farming techniques, and innovative processing methods that enable us to close the resource loop and reduce waste".**

Second, technology can improve the efficiency and effectiveness of circular economy practices. Automation, data analytics, and digital platforms can streamline processes, optimise decision-making, and enhance resource tracking and management (Bressanelli et al., 2018). For example, using sensor technology and Internet of Things (IoT) devices, agribusiness firms can monitor resource usage, track product lifecycles, and identify opportunities for waste reduction. These technological tools enable firms to make informed decisions and maximise the benefits of circular economy adoption. One interviewee mentioned, **"Digital technologies have been instrumental in our circular economy efforts. Through real-time monitoring and data analytics, we can identify areas for improvement and make informed decisions to optimize our resource utilization".**

Technological variables possess the capacity to stimulate creativity and cultivate collaborative efforts. The progress of technology promotes the exchange of knowledge, cooperation among various parties involved, and the creation of multidisciplinary solutions (De Jesus et al., 2018). Technological platforms and digital networks play a pivotal role in facilitating the exchange of ideas, best practices, and lessons learned within the agricultural sector. This enables enterprises to mutually benefit from shared knowledge and expedite the implementation of circular economy practices. The adoption of a collaborative approach serves as a catalyst for innovation and fosters a culture of ongoing improvement. One participant expressed this by stating, **"Technological platforms have connected us with other industry players and experts. We can learn from their experiences and collaborate on innovative solutions. This collective effort accelerates the adoption of circular economy practices and fosters continuous improvement".**

The implementation of circular economy practices in agribusiness enterprises is significantly influenced by technological variables. Technological breakthroughs provide the requisite tools and solutions for enterprises to efficiently apply concepts of the circular economy. The utilisation of modern waste management systems, smart agricultural technologies, and data-driven decision-making platforms facilitates enterprises in optimising resource utilisation, minimising waste, and enhancing operational efficiency. Furthermore, technology serves as a facilitator for both invention and Collaboration. Through the utilisation of technology, agribusiness enterprises have the capacity to investigate unexplored opportunities, generate innovative resolutions, and engage in cooperative efforts with stakeholders along the value chain. The implementation of this collaborative strategy serves to facilitate the flow of knowledge, expedite the integration of circular economy practices, and cultivate a climate conducive to innovation.

Moreover, the presence of technological components plays a significant role in enhancing scalability and replicability. With the increasing accessibility and affordability of technology, smaller agriculture enterprises are now able to adopt circular economy practices, hence facilitating their wider implementation within the industry. According to De Mattos

et al. (2018), the adoption of circular economy practices is made feasible for firms of all sizes through technological improvements, hence promoting democratisation.

Technological considerations significantly contribute to the facilitation of circular economy practices inside agriculture enterprises. Technological breakthroughs offer the required resources, resolutions, and prospects for enterprises to proficiently include circular economy concepts. Through the utilisation of technology, companies have the ability to enhance the allocation of resources, enhance operational efficiency, encourage innovation, and engage in collaborative efforts with stakeholders. The ongoing progress of technology plays a significant role in enhancing the scalability and replicability of circular economy practices, hence fostering sustainable and environmentally conscious agricultural methods.

4.5 Strategic and organisational factors (Theme 4)

Strategic and organisational factors play a critical role in driving the adoption of circular economy practices in agribusiness firms. These factors encompass the strategic vision, leadership commitment, organisational culture, and internal structures that support the integration of circular economy principles into business operations.

The incorporation of strategic and organisational aspects plays a crucial role in facilitating the implementation of circular economy practices within agribusiness enterprises due to various compelling justifications. The initial step involves establishing the strategic vision of the organisation, which serves as a guiding framework for sustainability endeavours, encompassing the implementation of circular economy practices (Buren et al., 2016). The integration of circular economy ideas into an organisation's strategic goals serves as a tangible manifestation of its enduring dedication to sustainability, while also offering a clear framework for the execution of these principles. One interview participant highlighted this by stating, **"Our organization has a clear strategic vision for sustainability, and circular economy practices are an integral part of that vision. It guides our decision-making and ensures that we prioritize sustainable practices throughout our operations".**

Second, leadership commitment is crucial for driving change and fostering a culture of sustainability within the organisation (Bertassini et al., 2021). When leaders champion circular economy practices, it creates a sense of purpose and motivates employees to embrace and implement these practices. Leadership support includes providing resources, empowering employees, and setting clear expectations for sustainability goals. One interviewee mentioned, **"Our leadership team is fully committed to sustainability and circular economy practices. They provide the necessary resources and support to implement these practices, and it trickles down to all levels of the organization".**

Furthermore, organisational culture plays a significant role in promoting circular economy adoption. A culture that values sustainability, innovation, and continuous improvement creates an environment conducive to the adoption of circular economy practices. When sustainability becomes an integral part of the organisational culture, employees are more likely to embrace and actively contribute to circular economy initiatives (Heyes et al., 2018). One participant expressed this by stating, **"Our organizational culture emphasizes sustainability and encourages employees to come up with innovative ideas. This culture of sustainability has paved the way for the adoption of circular economy practices and has generated enthusiasm among employees".**

The adoption of circular economy practices in agribusiness enterprises is significantly influenced by strategic and organisational considerations. The integration of

circular economy ideas into an organisation's strategic goals establishes a heightened level of importance and serves as a guiding force for decision-making across many divisions. The implementation of this strategic integration ensures the allocation of resources, design of procedures, and implementation of initiatives that are aimed at supporting circular economy practices.

Furthermore, the commitment of leadership is of utmost importance in facilitating change and surmounting opposition towards the implementation of circular economy practices. The demonstration of authentic dedication to sustainability by leaders engenders a heightened feeling of urgency and serves as a catalyst for employees to wholeheartedly adopt the concepts of the circular economy. Leadership support plays a crucial role in enabling the distribution of resources, the formation of cross-functional teams, and the integration of sustainable practices across the entire organisation.

An organisational culture that places importance on sustainability cultivates a shared mentality and motivates employees to actively participate in activities related to the circular economy. According to Ormazabal et al. (2018), the provision of empowerment and assistance to employees to foster innovation and the implementation of sustainable practices results in increased levels of engagement and ownership in the promotion of circular economy adoption. The cultural transformation serves to strengthen the incorporation of circular economy principles inside routine company practices (Salvioni & Almici, 2020). The adoption of circular economy practices in agribusiness enterprises is significantly influenced by strategic and organisational considerations. The direction and implementation of circular economy projects are influenced by the strategic vision, leadership commitment, and organisational culture. The successful adoption and implementation of circular economy practices can be facilitated when an organisation's strategy incorporates circular economy principles, is guided by committed leadership, and is embraced by the organisational culture.

4.6 Supply chain factors (Theme 5)

Supply chain factors play a significant role in driving the adoption of circular economy practices in agribusiness firms. These factors encompass Collaboration and coordination among stakeholders, reverse logistics, product life cycle management, and sustainable sourcing practices.

The significance of supply chain elements in facilitating the implementation of circular economy practices within agriculture enterprises is noteworthy due to multiple reasons. The establishment of Collaboration and coordination among stakeholders is necessary in order to effectively close the resource loop and mitigate waste across the supply chain (Govindan et al., 2018). The facilitation of efficient communication, Collaboration, and information sharing among stakeholders allows for the identification of potential avenues for waste reduction, optimisation of resources, and the implementation of circular product design. One interview participant emphasised this by stating, **"Collaboration with our supply chain partners has been crucial in adopting circular economy practices. By working together, we can identify opportunities for waste reduction, promote recycling initiatives, and optimize resource utilization across the entire supply chain".**

Second, reverse logistics plays a vital role in facilitating the return, recovery, and recycling of products and materials. Efficient reverse logistics systems enable the collection, sorting, and processing of waste materials, ensuring their proper handling and diversion from landfills. By implementing robust reverse logistics practices, agribusiness firms can

maximise the value and lifespan of products, minimise waste generation, and support circular economy principles. One interviewee mentioned, **"Our focus on reverse logistics has allowed us to recover valuable materials from our products. By implementing efficient collection and recycling processes, we contribute to the circular economy by closing the loop and reducing waste".**

Furthermore, effective product life cycle management is crucial for adopting circular economy practices. It involves designing products for durability, reparability, and recyclability, as well as managing their end-of-life stages (Zeng et al., 2017). By considering the entire life cycle of a product, from raw material extraction to disposal, agribusiness firms can make informed decisions that promote circularity. One participant expressed this by stating, **"Product life cycle management is key to our circular economy efforts. We design products with a focus on durability and recyclability, and we also ensure that they can be easily repaired and recycled at the end of their life. This comprehensive approach allows us to minimize waste and maximize resource efficiency".**

The adoption of circular economy practices in agriculture enterprises is significantly influenced by many aspects within the supply chain. According to Barrick et al. (2015), the establishment of collaborative endeavours among various stakeholders in the supply chain facilitates the exchange of knowledge, promotes innovation, and enables the identification of potential for waste reduction. Through Collaboration, agribusiness enterprises have the potential to devise and execute circular economy strategies that encompass the entirety of the value chain, encompassing activities ranging from sourcing to distribution.

The implementation of robust reverse logistics systems facilitates the effective gathering, categorisation, and treatment of discarded items, thereby guaranteeing their appropriate management and diversion away from disposal sites. The implementation of efficient reverse logistics practices enables agribusiness enterprises to optimise resource retrieval, minimise waste production, and actively participate in the circular economy by facilitating the closure of material cycles (Centobelli et al., 2020). Furthermore, the incorporation of product life cycle management factors, such as the intentional design of items for enhanced durability and recyclability, assumes a crucial role in the widespread acceptance of circular economy principles. According to Franco (2017), the incorporation of circularity concepts in product design and end-of-life management by agribusiness enterprises can result in several benefits. These include the extension of product lifespan, reduction in resource extraction requirements, and the promotion of material recycling and reuse. The adoption of circular economy practices in agribusiness enterprises is significantly influenced by supply chain dynamics. The promotion of circularity within the supply chain necessitates the presence of Collaboration and coordination among stakeholders, the implementation of efficient reverse logistics systems, and the adoption of effective product life cycle management. Through Collaboration, efficient resource allocation, and the adoption of sustainable methodologies, agribusiness enterprises have the potential to reduce wastage, improve resource efficiency, and make valuable contributions towards the development of a circular and sustainable agriculture industry.

4.7 Environmental factors (Theme 6)

Environmental factors encompass the ecological aspects and considerations that drive the adoption of circular economy practices in agribusiness firms. These factors include the preservation of natural resources, reduction of greenhouse gas emissions, waste management, and sustainable land use practices (Andrews et al., 2015).

The significance of environmental concerns in facilitating the implementation of circular economy practices inside agriculture enterprises cannot be overstated, owing to various compelling justifications. Primarily, agriculture enterprises are strongly dependent on natural resources, including water, land, and energy, to facilitate their operational activities. By implementing circular economy strategies, these companies have the potential to make a positive contribution towards the conservation of natural resources and the reduction of their environmental footprint. One interview participant highlighted this by stating, **"Our organization recognizes the importance of environmental conservation. By adopting circular economy practices, we aim to reduce our resource consumption and minimize our ecological footprint, contributing to a more sustainable future".**

Second, circular economy practices play a significant role in reducing greenhouse gas emissions and mitigating climate change. Through practices such as recycling, waste reduction, and energy efficiency, agribusiness firms can minimise their carbon footprint and contribute to the transition towards a low-carbon economy. One interviewee mentioned, **"Climate change is a pressing global issue, and as an agribusiness firm, we acknowledge our responsibility to reduce emissions. Circular economy practices allow us to reduce emissions and upgrade recycling and durability of the product".**

5 Firm-level practices

Before delving into the detailed firm-level practices, it is essential to provide an overview of the key strategies and actions that agribusiness firms can undertake to embrace circular economy principles. These firm-level practices (Table 4) represent a proactive approach to sustainable and responsible business operations in the agribusiness sector. From collaborative partnerships that foster knowledge exchange to product design for durability aimed at minimising waste generation, these practices underscore the potential for positive environmental and economic impacts. Resource efficiency techniques, such as precision agriculture, aim to optimise resource utilisation, while policy advocacy endeavours can drive systemic change by influencing supportive regulations and public awareness. The following table offers a comprehensive summary of these practices, their key features, and their contributions to advancing circular economy principles within agribusiness. It provides a valuable reference for stakeholders seeking to enhance sustainability and circularity in this vital sector.

5.1 Collaborative partnerships

Collaborative partnerships play a crucial role in promoting circular economy principles in agribusiness by fostering alliances and close cooperation with stakeholders across the value chain (Baldini et al., 2018; Bloom et al., 2015). Through Collaboration, agribusiness firms can leverage shared knowledge, resources, and best practices to drive sustainable practices and innovation (Masi et al., 2018). As one interviewee stated, "Collaboration is essential for advancing circular economy in agribusiness as it allows us to pool our resources and expertise, leading to more impactful and efficient solutions".

One practical example of a collaborative partnership firm practice is the establishment of a recycling and waste management consortium. This initiative brings together multiple agribusiness firms, waste management companies, and other stakeholders to collectively address the challenges of waste generation and disposal (Bogers et al., 2018). Through

Table 4 Identified firm-level practices

Firm-level practice	Key features and examples	Contributions to circular economy
Collaborative partnerships	Foster alliances and cooperation with stakeholders	Leverage shared knowledge and resources
	Example: Recycling and waste management consortium	Identify opportunities for recycling and repurposing
	Promote sustainable practices and innovation	Achieve economies of scale and cost savings
	Facilitate knowledge sharing and technology transfer	Engage external stakeholders for additional support
	Reduce waste management costs and enhance efficiency	Demonstrate commitment to sustainability
Product design for durability	Create long-lasting, repairable products	Extend product lifespans and minimise waste generation
	Example: Modular design for agricultural machinery	Enable easy disassembly and component replacement
	Provide resources and training for customer repairs	Establish take-back or buy-back programmes for refurbishment
	Promote resource efficiency and circularity	Align with principles of sustainable production and consumption
Resource efficiency	Optimise resource use through advanced technologies	Maximise resource utilisation and minimise waste generation
	Example: Precision agriculture techniques	Monitor and analyse factors influencing crop growth
	Minimise resource wastage and environmental impact	Implement data-driven resource allocation
	Utilise predictive analytics for crop management	Reduce water, fertiliser, and pesticide usage
	Incorporate innovative techniques like vertical farming	Conserve resources and promote sustainability
Policy advocacy	Engage policymakers and advocate for supportive regulations	Drive systemic change and create an enabling environment
	Example: Lobbying for legislation incentivising circular practices	Collaborate with industry associations and NGOs
	Promote extended producer responsibility (EPR) schemes	Advocate for waste management regulations prioritising recycling
	Support recycling infrastructure development	Raise public awareness and mobilise public support
	Educate consumers and stakeholders about circular practices	Shape the regulatory landscape and establish a supportive framework

Collaboration, agribusiness firms can identify opportunities for recycling, repurposing, and reusing agricultural by-products, packaging materials, and other waste streams (Baldini et al., 2018). An interviewee emphasised the benefits of Collaboration, stating, **"Through our recycling and waste management consortium, we have been able to develop innovative solutions for waste reduction and explore new recycling technologies that we wouldn't have been able to do alone".**

The consortium facilitates knowledge sharing, technology transfer, and best practices exchange among the participating firms, enabling them to implement circular economy principles throughout their operations (Govindan et al., 2018). By collaborating, the firms can achieve economies of scale, share risks and costs, and negotiate favourable contracts with service providers, leading to reduced waste management costs and increased efficiency (Hemmert et al., 2016). According to an interviewee, **"Our collaborative approach has allowed us to negotiate better contracts with recycling facilities, which has significantly lowered our waste management expenses".**

Furthermore, the consortium may engage with external stakeholders such as governmental agencies, research institutions, and non-profit organisations to tap into additional resources, funding opportunities, and regulatory support Barrick et al., (2015). This Collaboration strengthens the consortium's impact and enhances the adoption of circular economy practices in the agribusiness sector (Chadwick et al., 2015). One interviewee highlighted the importance of external Collaboration, stating, **"Working with research institutions and non-profit organizations has provided us with access to cutting-edge research, funding for pilot projects, and regulatory guidance, all of which have been instrumental in advancing our circular economy initiatives".**

By adopting collaborative partnership firm practices such as a recycling and waste management consortium, agribusiness firms demonstrate their commitment to sustainable practices and environmental stewardship (Ode et al., 2020). These partnerships not only drive cost savings and operational efficiency but also create opportunities for innovation, improved resource utilisation, and enhanced environmental impact reduction in the agribusiness sector (Bartik et al., 2020). As one interviewee emphasised, **"Collaboration is the key to transforming agribusiness into a more sustainable and circular industry".**

5.2 Product design for durability

Product design for durability focuses on creating products that are long-lasting, robust, and able to withstand wear and tear. By designing products with durability in mind, agribusiness firms can extend the lifespan of their products, reducing the need for frequent replacements and minimising waste generation. Durable products contribute to the circular economy by maximising resource utilisation and reducing the overall environmental impact. Additionally, designing products for easy repairability further enhances their longevity and promotes circularity (Crifo et al., 2015).

One example of a product design for durability firm practice in the context of the circular economy is the implementation of modular design principles. Modular design involves creating products that can be easily disassembled and repaired, allowing for the replacement of specific components rather than the entire product.

For instance, an agribusiness firm specialising in agricultural machinery can adopt modular design principles when manufacturing their equipment. Instead of producing machines with welded or permanently attached parts, they design their products with easily removable and replaceable components. This allows for quick and cost-effective repairs, reducing

the need for frequent product replacements (Banks et al., 2015). By incorporating modular design, the firm enables its machinery to have a longer lifespan. If a specific component of the equipment becomes faulty or worn out, it can be easily replaced with a new one, extending the overall usability of the machine. This practice reduces the amount of waste generated and promotes resource efficiency. Moreover, the firm can provide training and resources to their customers, such as instructional manuals or online tutorials, to empower them to perform minor repairs or component replacements themselves. This approach not only strengthens the durability of the product but also enhances customer satisfaction and builds long-term relationships.

Additionally, the firm can establish a take-back or buy-back programme, where customers can return their used machinery to the company after a certain period. This allows the firm to disassemble and refurbish the returned equipment, replacing any worn-out components and preparing them for resale or redistribution. By actively participating in the product's lifecycle, the firm reduces waste and promotes a circular approach to resource utilisation. By embracing product design for durability through modular design principles, agribusiness firms can create products that are longer-lasting, easier to repair, and more resource-efficient. This approach aligns with the principles of the circular economy by reducing waste generation, extending product lifecycles, and minimising the need for new resource extraction. Ultimately, this practice contributes to sustainable production and consumption patterns within the agribusiness sector.

5.3 Waste recycling

Product design for durability is a key strategy in promoting the circular economy within agribusiness, as it focuses on creating long-lasting, robust products that can withstand wear and tear (Rauch et al., 2016). By designing products with durability as a core principle, agribusiness firms can reduce the frequency of product replacements and minimise waste generation. This approach maximises resource utilisation and contributes to environmental sustainability.

Modular design is an exemplary firm practice that embodies product design for durability in the context of the circular economy (Bender et al., 2018). Agribusiness firms, such as those manufacturing agricultural machinery, can adopt modular design principles to facilitate easy disassembly and repair of their products. Rather than producing machines with welded or permanently attached parts, they design products with interchangeable and replaceable components.

For instance, an agricultural machinery manufacturer can adopt modular design principles in the production of their equipment. By using easily removable and replaceable components, the firm enables swift and cost-effective repairs instead of requiring the replacement of entire machines (Bogers et al., 2018). The incorporation of modular design extends the lifespan of the machinery, reducing waste generation and promoting resource efficiency.

To further support durability and circularity, the firm can provide resources and training to customers, such as instructional manuals or online tutorials, empowering them to perform minor repairs or component replacements themselves. This not only enhances the longevity of the product but also fosters customer satisfaction and loyalty. Furthermore, the firm can establish a take-back or buy-back programme, allowing customers to return used machinery after a certain period. Through this programme, the firm can disassemble and refurbish the returned equipment, replacing worn-out components and preparing them for

resale or redistribution (Franco, 2017). By actively participating in the product's lifecycle, the firm promotes a circular approach to resource utilisation and reduces waste.

By embracing product design for durability, particularly through modular design principles, agribusiness firms contribute to the circular economy by creating products that are long-lasting, easily repairable, and resource-efficient (De Mattos et al., 2018). This approach aligns with the principles of sustainable production and consumption, as it reduces waste generation, extends product lifecycles, and minimises the need for new resource extraction. Ultimately, product design for durability in agribusiness supports the transition towards a more sustainable and circular agribusiness sector.

5.4 Resource efficiency

Resource efficiency is a crucial aspect of the circular economy in agribusiness, focusing on optimising resource use to minimise waste generation and improve productivity. Agribusiness firms can adopt various practices, such as precision agriculture, efficient irrigation techniques, and energy-efficient technologies, to reduce resource consumption and promote sustainability. An example of a resource efficiency firm practice within the circular economy is the adoption of precision agriculture techniques. By utilising advanced technologies and data analytics, agribusiness firms can optimise the allocation of resources such as water, fertilisers, and pesticides in their agricultural operations (Scholte et al., 2015).

For instance, using sensor-based technologies, satellite imagery, and real-time data collection, a firm can monitor and analyse factors that influence crop growth, such as soil moisture levels, nutrient levels, and pest infestations (Alam et al., 2022). By leveraging this data-driven approach, the firm can make precise interventions, applying resources only where and when they are needed. Implementing precision agriculture techniques enables the firm to minimise resource wastage and achieve greater efficiency in resource allocation. For example, by using sensors to detect areas that require irrigation and applying water only to those specific areas, water consumption can be significantly reduced. Similarly, by applying fertilisers and pesticides based on crop needs and pest infestation levels, the firm can minimise excess usage and reduce potential environmental contamination (Balaj et al., 2021).

Furthermore, the firm can utilise predictive analytics and modelling tools to optimise crop rotations, planting schedules, and harvesting practices (Alam et al., 2022). By analysing historical data and climate patterns, informed decisions can be made regarding the most suitable crops to grow, the timing of planting, and harvesting practices, maximising resource efficiency and yield. Incorporating innovative techniques like vertical farming, hydroponics, or aquaponics can further enhance resource efficiency by maximising space utilisation and reducing resource requirements. These methods allow for year-round production in controlled environments, minimising water usage, land requirements, and the need for synthetic fertilisers (Rauch et al., 2016). According to an interview with an industry expert, "Precision agriculture has revolutionized the way we utilize resources in agribusiness. We can reduce waste and achieve higher resource efficiency by using real-time data and targeted interventions. This benefits the environment and enhances our operational efficiency and competitiveness in the market".

Through the adoption of resource efficiency practices like precision agriculture, agribusiness firms can minimise resource waste, optimise resource allocation, and reduce their environmental impact (Alam et al., 2022). This practice contributes to sustainable agriculture

practices, conserving resources for future generations and promoting a more circular approach to resource management in the agribusiness sector.

5.5 Policy advocacy

Policy advocacy is crucial in promoting the circular economy within the agribusiness sector. By actively engaging with policymakers and advocating for supportive policies, agribusiness firms can drive systemic change and create an enabling environment for circular economy practices (Bocken et al., 2019).

An example of policy advocacy firm practice is engaging in lobbying and advocacy efforts to promote favourable legislation and regulations that incentivise circular economy practices (Masi et al., 2018). Agribusiness firms can collaborate with industry associations, NGOs, and other stakeholders to advocate for policies that encourage sustainable agricultural practices, waste reduction, and resource efficiency. According to an interview with a sustainability manager at an agribusiness firm, **"Policy advocacy is an essential part of our sustainability strategy. By actively engaging with policymakers, we can influence the development of supportive regulations and frameworks that encourage circular economy practices. This creates a level playing field and helps drive systemic change across the industry".**

Agribusiness firms can advocate for the implementation of extended producer responsibility (EPR) schemes, which hold manufacturers accountable for the entire lifecycle of their products (Bocken et al., 2019). This includes the collection, recycling, and proper disposal of products. By advocating for EPR, agribusiness firms promote closed-loop product management and incentivise producers to design products with end-of-life considerations in mind. Additionally, agribusiness firms can support the development and implementation of waste management regulations that prioritise recycling and the use of recycled materials in agricultural packaging and products (Rauch et al., 2016). They can advocate for the establishment of recycling infrastructure and facilities to facilitate proper disposal and processing of agricultural waste. The interviewee further emphasised the importance of policy advocacy, stating, "By collaborating with NGOs and academic institutions, we generate research and data that supports the need for policy changes. This evidence-based approach helps policymakers understand the benefits of circular economy practices and provides a strong foundation for policy reforms".

Moreover, agribusiness firms can engage in public awareness campaigns to educate consumers and stakeholders about the importance of circular economy practices and the role of supportive policies in driving sustainable change (Bocken et al., 2019). By mobilising public support, they can create a favourable environment for policy reforms and encourage consumers to make informed choices that align with circularity. Through policy advocacy, agribusiness firms can shape the regulatory landscape and establish a supportive framework for circular economy practices. This practice provides clarity, incentives, and a level playing field for sustainable practices, ultimately encouraging the adoption of circular economy principles throughout the agribusiness sector.

6 Conclusion

The results obtained from the conducted interviews provide valuable insights into the key aspects that substantially impact the incorporation of circular economy principles inside agriculture enterprises. These criteria encompass a range of dimensions, each having a crucial role in influencing the implementation of circular efforts.

The primary considerations are the sociocultural factors. The interviews revealed that the alignment of circular economy practices with current cultural norms and values is of utmost significance. Furthermore, a notable focus was placed on the need of consumer education and awareness initiatives in promoting the implementation of circular practices within the agriculture industry. The implementation of circular practices was also influenced by economic factors. Businesses were highly motivated by the potential cost savings and market benefits that could be achieved via the use of circular techniques.

Moreover, the significance of financial incentives in promoting the adoption of circularity by agriculture enterprises was emphasised. Technological factors have played a pivotal role in facilitating the implementation of circularity within the industry. The utilisation of advanced technology and digital solutions has been recognised as crucial instruments in domains such as traceability and process efficiency, aiding agribusinesses in maximising their operational effectiveness while minimising wastage. The study also identified the significant impact of strategic and organisational factors. The active participation of leaders in promoting circular practices, cultivating an organisational culture that prioritises sustainability, and involving employees in the path towards a circular economy were identified as crucial factors in facilitating the adoption of such practices. The vital role of supply chain factors in the circular approach was acknowledged. The need of collaborating with suppliers and implementing efficient reverse logistics systems was emphasised as crucial elements for the effective adoption of circular practices in agro enterprises. Environmental factors have significantly influenced the acceptance of circular practices, playing a fundamental role in influencing their implementation. The fundamental importance of sustainability and biodiversity conservation was emphasised as the central focus of circular approaches, which aim to link agribusinesses with wider environmental objectives and obligations.

In summary, the knowledge obtained from the interviews highlights the complex array of factors that impact the incorporation of circular economy principles in agriculture enterprises. The aforementioned findings offer a thorough perspective on the various factors that need to be considered to achieve successful acceptance and implementation of circular initiatives within the agricultural sector.

6.1 Discussion

The results of this study highlight the complex array of factors that impact the incorporation of circular economy practices in agriculture companies. The adoption of circular initiatives is influenced by various aspects, including sociocultural, economic, technological, strategic, supply chain, and environmental dimensions. These elements are significant in shaping the implementation and acceptance of circular initiatives. The significance of integrating circular practices with cultural norms and values underscores the crucial role of local environment and consumer acceptance. The economic benefits and cost reductions linked to circular strategies provide a strong rationale for firms, hence increasing the economic necessity of implementation. The unquestionable significance of technology in augmenting efficiency and resource management is widely recognised, with organisational elements like as leadership participation and staff engagement serving as crucial catalysts. The alignment of agribusinesses with broader ecological goals is facilitated via Collaboration across the supply chain and a steadfast commitment to environmental sustainability.

The aforementioned observations collectively contribute to a full comprehension of the changing landscape of circular economy adoption within the farming sector.

6.2 Implications

This study's findings have ramifications relevant to both the academic and managerial spheres. The study aims to fill important research gaps pertaining to the agribusiness sector, focusing on the factors that influence the adoption of circular economy practices and the practices implemented by firms at the organisational level. This research provides vital insights for academicians in this field. This statement underscores the importance of conducting research tailored to unique contexts within different industries and countries to enhance the comprehension of the adoption of circular economy principles. In addition, the research findings propose potential directions for future academic inquiry. These include doing longitudinal studies to evaluate the enduring effects of circular practices and undertaking comparative assessments across various locations to uncover problems and best practices specific to particular contexts.

The study provides valuable insights for agriculture organisations aiming to adopt circular economy practices from a managerial standpoint. This statement underscores the need of aligning circular activities with cultural values and highlights the potential economic advantages that can be derived from such alignment. Moreover, it highlights the significance of incorporating technology, fostering a leadership-driven sustainability culture, cultivating collaborative partnerships across the supply chain, and prioritising environmental responsibility. These insights can enhance strategic decision-making and resource allocation within agricultural enterprises, facilitating the effective implementation of circular economy practices and promoting sustainability sand efficiency within the sector.

Data availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors do not have any conflict of interest.

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