CHAPTER 137

Sustainable Supply Chain Management in Agriculture

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ABSTRACT

This study evaluates the integration of sustainable practices into agricultural supply chains to enhance livelihoods, minimize environmental impact, and optimize resource utilization. By collecting primary data through surveys of producers, supply chain stakeholders, and agricultural specialists, it identifies challenges and opportunities for eco-friendly strategies. The findings emphasize the importance of sustainable practices to boost productivity, reduce pollution, and achieve ecological and economic goals, offering actionable recommendations for stakeholders. While limited by a small sample size, the study highlights the potential of sustainable supply chains to promote environmental conservation, community health, and equitable economic growth for farming communities, paving the way for long-term benefits.

Keywords: Supply chain management; Sustainable agriculture; Resource optimization; Environmental sustainability; Eco-friendly practices.

1.0 Introduction

Since it contributes to economic as well as environmental growth, Agriculture is essential to the growth of the nation or area. For most people across the globe, growing agricultural products is a daily activity and an occupation. Consequently, in most countries, agriculture is important in order to rise above poverty (Douillet, 2024). The agricultural supply chain has received much attention in recent times because of its link to social responsibility and environmental issues. Regulations that are more stringent and monitoring should be imposed on the planning as well as operation of the agricultural supply chain. This implies that to meet the growing demands of sustainability, traditional supply chain processes may be modified and altered. Knowing how a sustainable supply chain is helping agriculture is still in its infancy, even though the interest in sustainable supply chain management (SSCM) is growing in numerous directions (Toan, 2018). However, studies have shown that an SSCM's appearance is a key attribute in the agricultural sector. One of the most important problems facing the world today is sustainable agriculture as well as its supply chain. In some nations, they support the economy, society, and ecology.

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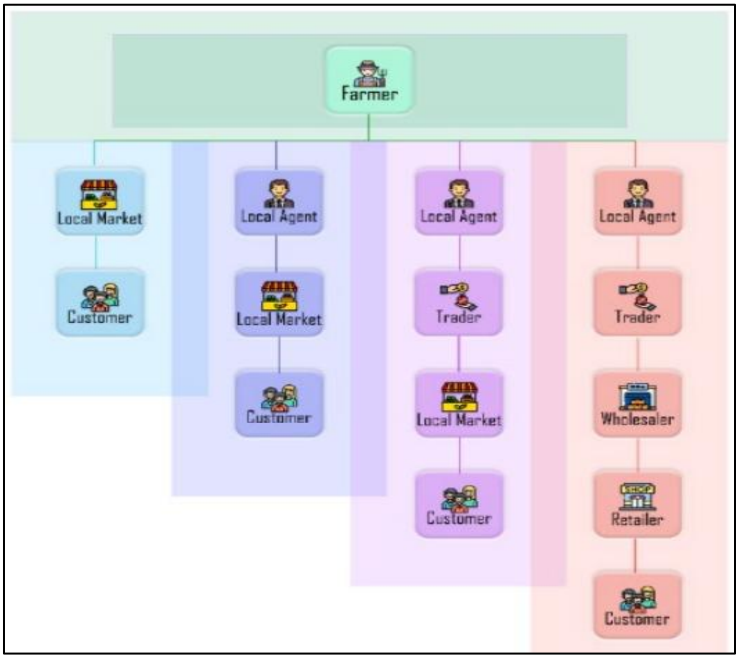
Figure 1: Traditional Agricultural Supply Chain



2.0 Sustainability & SSCM

From the viewpoints of corporations, governments, environmentalists, as well as social reformers, the term "sustainable development" may signify many different things. The term "sustainable" has no universally accepted meaning. "A development that satisfies current needs without jeopardizing the capacity of future generations to satisfy their own needs is referred to as sustainable development." Researchers' varying conceptions of sustainability concurrently emphasize three facets of social, environmental, as well as economic performance. Sustainability's capacity to lower long-term dangers associated with pollution, waste management, product liability, resource depletion, & energy price volatility (Kalva, 2017).

"The systemic coordination of key interorganizational business processes for the improvement of the long-term economic performance of the individual company and its supply chain, as well as the strategic, transparent integration and achievement of an organization's social, environmental, and economic goals." Because of concerns about income inequality, corporate social responsibility, and the rapid depletion of natural resources, sustainability has grown in importance for business and practical research over the last several decades. Therefore, it is possible to identify sustainable development as a process of structural change and economic growth that upholds human potential. The sustainable growth and balance of human capabilities,

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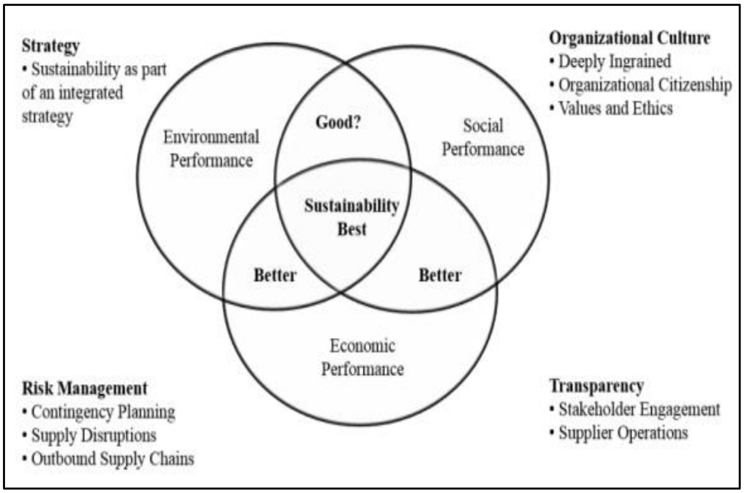
the capacity for social responsibility, and the future for future generations are so ways to approach sustainability (Carter & Rogers, 2008).

Figure 2: SSCM Objective of the Study



- To assess benefits of sustainability in agriculture.
- To identify challenges in adopting sustainable methods.
- To explore innovative solutions for sustainable agriculture.

3.0 Literature review

Sachin S. Kamble *et al.* (2020) highlighted that any solutions to these challenges should include social, environmental, and economic factors in addition to the food production process. New technologies are being used more often in agricultural supply chains. Blockchain, the IoT, and big data may enable sustainable agriculture supply chains. The agricultural supply chain is evolving into a digital, data-driven supply chain ecosystem thanks to these technologies (Kamble *et al.*, 2020). Rajabion *et al.* (2019) provide a framework for evaluating how farmers' knowledge, business practices, and urban ITS affect the effectiveness of GSCM systems for the urban distribution of agricultural products. The causal model is evaluated, and its validity and reliability are confirmed using the structural equation modeling approach. A structural equation model is also used to assess the model's consistency and validity. Smart PLS 3.0 is used for the analysis of the model and survey data (Rajabion *et al.*, 2019).

Touboulic *et al.* (2014) examine sustainable supply chain connections from a power perspective and critically evaluate buyer-supplier relationships using RDT. The RDT model is expanded using empirical data. A qualitative study of a multinational corporation and

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agricultural producers in the UK food business explores power dynamics in adopting sustainable practices. To determine how relative power influences sustainable supply-management strategies, several triadic interactions between a major client and its minor suppliers are examined (Touboulic *et al.*, 2014). Rohit Sharma *et al.* (2020) determined and evaluated the interruption-related ASC risks. FLQOWA was used to analyze these risks. The findings indicate that ASC is significantly impacted by supply, demand, financial, logistical, and infrastructure risks. Managerial and operational, policy, regulatory, biological, and environmental risks also play a crucial role depending on the organization's size and scope. Many strategies have been researched for a sustainable future, such as shared responsibility, Industry 4.0 technology adoption, and supply chain collaboration (Sharma *et al.*, 2020).

Kumar *et al.* (2021) highlighted that agricultural enterprises have begun to alter their business strategies due to growing globalization and digitization. Modern technologies are being employed by agribusinesses to create a more advanced, customer-focused, and sustainable supply chain. The circular economy (CE) concept and the development of related technologies have helped the industrial sector meet sustainability goals despite challenges. This report identifies the obstacles to Industry 4.0 (I4.0) and CE adoption in India's agricultural supply chain (Kumar *et al.*, 2021). Tsolakis *et al.* (2014) noted that the growing demand for upscale, value-added, and customized agrifood products is driven by globalization, demographic changes, and evolving regulations.

As a result, contemporary management science has gained more attention in the planning, creation, and administration of effective agrifood supply chains. These trends underscore the need for robust frameworks to optimize AFSC operations (Tsolakis *et al.*, 2014). Chartzoulakis *et al.* (2015) emphasized that water is the most crucial resource for sustainable agriculture. To meet increasing industrial and domestic water needs, more land will be irrigated, and fresh water extraction from agriculture will increase in the coming years. However, irrigation efficiency is currently low, with crops utilizing less than 65% of supplied water. Responsible water usage in irrigation is essential in arid environments (Chartzoulakis & Bertaki, 2015). Movahed *et al.* (2024) stated that the growing global population and food scarcity have led to new advancements in agriculture. To enhance efficiency, artificial intelligence and the Internet of Things are used for farmland management. Advanced industrialization in agriculture has resulted in improved product quality and quantity, optimized energy usage, reduced emissions, and fewer human interventions in the manufacturing process (Movahed *et al.*, 2024).

4.0 Research Methodology

The research methodology is founded upon a primary data collection strategy whose objective is to acquire firsthand experience from the pertinent stakeholders. In a bid to ensure a comprehensive and relevant spectrum of opinions, purposive sampling was used in the selection of a sample comprising 100 respondents, namely farmers, supply chain managers, distributors,

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and policymakers. Structured questionnaires were used to collect data, which consisted of close-ended questions focused on essential sustainability factors such as maximizing resource use, minimizing waste, adopting environmentally beneficial technologies, and policy framework effects. To enable respondents' geographical dispersion, the questionnaires were conducted via web-based surveys. The information was examined with the help of statistical measures to find trends, correlation, and challenges involved in adopting sustainable practices within agricultural supply chains. In addition, qualitative answers gave contextual information on the drivers and barriers to sustainability. To ensure the credibility and integrity of the research process, ethical procedures were strictly followed, including the obtaining of informed consent and maintenance of respondent confidentiality.

5.0 Data Analysis

Table 1: Age

		Frequency	Percent
Valid	Under 20	54	54
	21-30	17	17
	31-40	18	18
	41-50	7	7
	Above 50	4	4
	Total	100	100

The age distribution of a sample of 100 people is indicated in the data. The highest number (54%) is below the age of 20, 18% fall in the age group 31 to 40, and 17% fall in the age group 21 to 30. Only 4% fall in the age group above 50, as well as the lower proportion, 7%, fall in the age group 41 to 50. This indicates that the sample includes people who are mostly young.

Table 2: Gender

		Frequency	Percent
Valid	Male	67	67
	Female	33	33
	Total	100	100

The gender distribution of a sample of 100 individuals is reflected in the data. The population consists of mostly males, 67%, and females, 33%. This shows that there is a greater proportion of males in the sample.

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Table 3: Education Level

		Frequency	Percent
Valid	High School	18	18
	Undergraduate	42	42
	Postgraduate	17	17
	Doctorate	23	23
	Total	100	100

The data provides the distribution of educational qualifications within a sample population of 100 individuals. Undergraduates are the largest percentage of the segment at 42%, followed by 23% who have a doctorate, 18% with an elementary high school level qualification, and 17% with a postgraduate qualification. This indicates that in the sample, the distribution is relatively level with a considerable percentage of respondents with higher education.

Table 4: The Adoption of Sustainable Practices in Agriculture is Essential for Long-term Growth

		Frequency	Percent
Valid	Strongly Disagree	6	6
	Disagree	10	10
	Neutral	23	23
	Agree	32	32
	Strongly Agree	29	29
	Total	100	100

The results are an indication of what the respondents feel towards a particular statement. Generally, the sentiments are positive as a larger number of respondents agree (32%), strongly agree (29%), or remain neutral. On the contrary, 23% of respondents remain neutral, and a smaller number of respondents disagree (10%) or strongly disagree (6%). Such an observation indicates minimal dissidence and general acceptability.

Table 5: Sustainable Supply Chain Management in Agriculture Enhances Environmental Protection

		Frequency	Percent
Valid	Strongly Disagree	4	4
	Disagree	9	9
	Neutral	24	24
	Agree	29	29
	Strongly Agree	34	34
	Total	100	100

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The attitudes of the respondents towards a statement are reflected in the data. Most of them, either strongly agreeing (34%) or agreeing (29%), reflect a positive bias. Although a quarter of the respondents (24%) are neutral, a lesser percentage (9%) or strongly disagree (4%). This reflects that there is overall agreement with little opposition.

Table 6: The Cost of Implementing Sustainable Practices in Agriculture is too High for Small-scale Farmers

		Frequency	Percent
Valid	Strongly Disagree	7	7
	Disagree	8	8
	Neutral	22	22
	Agree	27	27
	Strongly Agree	36	36
	Total	100	100

The opinions of the respondents on a statement are what are captured in the data collected. A general positive sentiment is seen in the fact that a large majority of the respondents either agree (27%) or strongly agree (36%). On the other hand, 22% of the respondents are neutral, while a minority disagree (8%) or strongly disagree (7%). This is an indication of a general consensus with minimal dissent.

Table 7: Farmers in My Region are Aware of the Benefits of Sustainable Farming Practices

		Frequency	Percent
Valid	Strongly Disagree	5	5
	Disagree	8	8
	Neutral	24	24
	Agree	29	29
	Strongly Agree	34	34
	Total	100	100

The findings are a portrayal of the views of the respondents on a specific statement. A positive trend is indicated by the fact that most either strongly agree (34%) or agree (29%). On the dissent, 24% of the respondents are neutral and a lesser proportion disagrees (8%) or strongly disagrees (5%). This shows that there is a general assent with little dissent.

The "Case Processing Summary" reveals that the analysis had 100 valid cases, which represented 100% of the data. The study did not exclude any cases, as a 0% exclusion rate indicates. Therefore, the dataset was represented by a sum total of 100 cases that were integrated

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into the analysis. This summary suggests that the analysis is based on the whole dataset, with no data omitted or discarded.

Table 8: Scale - All Variables

Case Processing Summary			
		N	%
Cases	Valid	100	100
	Excluded[a]	0	.0
	Total	100	100

Table 9: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.901	.894	18

The results of the reliability analysis of the data are shown in the "Reliability Statistics" table. From the Cronbach's Alpha of 0.901, it is evident that the items on the scale have a high level of internal consistency, meaning that they are highly correlated and reliable. A standardized item value of 0.894 shows that the internal consistency is strong even when the items are standardized. Examining 18 items established the reliability of the scale, which shows that it is a valid measure of the construct in question.

Table 10: ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
The adoption of sustainable practices in agriculture is essential for long-term growth.	Between Groups	23.074	4	5.768	4.863	.001
	Within Groups	112.686	95	1.186		
	Total	135.760	99			
Sustainable supply chain management in agriculture enhances environmental protection.	Between Groups	26.278	4	6.569	6.258	.000
	Within Groups	99.722	95	1.050		
	Total	126.000	99			
The cost of implementing sustainable practices in agriculture is too high for small-scale farmers.	Between Groups	31.455	4	7.864	6.426	.000
	Within Groups	116.255	95	1.224		
	Total	147.710	99			
Farmers in my region are aware of the benefits of sustainable farming practices.	Between Groups	26.655	4	6.664	6.091	.000
	Within Groups	103.935	95	1.094		
	Total	130.590	99			

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Long-term development requires the usage of sustainable farming practices: The hypothesis is accepted since the p-value is 0.001, which is lower than the significance level of 0.05. Sustainable agricultural supply chain management enhances environmental conservation: The hypothesis is embraced since the p-value is 0.000, which is lower than the significance level of 0.05. Small-scale producers cannot fund the costs involved in implementing sustainable farm practices: The null hypothesis is rejected since p = 0.000 is less than the significance level of 0.05. The farmers in my area see the benefits of sustainable agriculture: The null hypothesis is rejected, since the p-value 0.000 is smaller than the significance level 0.05. In all cases, the p-values are smaller than 0.05, indicating that there are large differences among the groups. The null hypotheses are therefore rejected. The alternative hypotheses are therefore accepted.

6.0 Findings

The ANOVA results confirm that consumers demonstrate significant differences in their willingness to pay a premium for agricultural produce that is sourced ecologically, reflecting strong support for sustainability in their shopping habits (p-value = 0.000). However, there is no significant difference in views about the focus on minimizing waste and maximizing resources in the agricultural supply chain (p-value = 0.087), nor is there a significant difference in views about the lack of awareness and training in SSCM for agriculture (p-value = 0.143). These results suggest that customers value sustainability in consumption; however, there is less consensus when it comes to the operational aspects and the need for education in sustainable agriculture.

7.0 Conclusion

In conclusion, agricultural SSCM is fundamental for the long-term development of economic stability, environmental conservation, and social health. The report emphasizes how important sustainable farming methods are, including the application of innovative technologies, enhancement of resource optimization, and minimization of waste in the enhancement of the overall efficiency as well as sustainability of the agricultural supply chain. While there is widespread consumer acceptance of agricultural produce that is sourced sustainably, there is limited agreement on the operational areas of focus, such as resource maximization and minimization of waste. In addition, to ensure the universal application of these practices, it is crucial to solve the major education and awareness problems of SSCM. In building a resilient and accountable agricultural system, it will be crucial to have sustainable supply chain practices since the agricultural sector will continue to grapple with the impacts of climate change, resource depletion, and rising global demand.

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