Sustainable Agricultural Practices and Agricultural Productivity: Government initiatives to promote SDG Goals in India

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Abstract: Sustainable agricultural practices (SAPs) play a crucial role in addressing India's growing food security challenges while ensuring ecological balance and rural prosperity. This study explores the current state of India's agriculture, the adoption of sustainable practices, the impact and the role of government initiatives aligned with Sustainable Development Goals (SDGs). By employing a descriptive and exploratory research design, primary data were collected through surveys and field visits involving 385 farmers and key stakeholders. The analysis, supported by time series analysis, regression, and structural equation modeling (SEM), highlights how practices such as crop rotation, organic farming, integrated pest management, and precision agriculture improve soil health, biodiversity, and farm profitability. Despite numerous government schemes like PMKSY, PKVY, and the Soil Health Card scheme, challenges such as high initial costs, limited awareness, and infrastructural constraints hinder widespread adoption. The findings underscore the significant positive impact of sustainable practices on farm income, while the effect of government policies and farmer awareness was found to be statistically insignificant. This research provides valuable insights for policymakers to strengthen support frameworks, incentivize adoption, and build farmer capacity towards resilient and sustainable agriculture in India.
Key words: Sustainable Agricultural Practices, Government initiatives and polices, agriculture productivity and SDG goals.

1. Introduction

Sustainable agricultural practices and improving agricultural productivity are essential to meet the growing global food demand, support rural livelihoods, and foster economic development. However, traditional approaches to boosting productivity such as intensive monoculture, heavy chemical use, and over-irrigation have often led to unanticipated adverse consequences. Sustainable Agricultural Practices (SAPs) such as Crop Rotation, Intercropping, Organic Farming, Integrated Pest Management (IPM), and Zero Tillage contribute to improved soil health, increased biodiversity, reduced dependency on chemical inputs, and enhanced resilience to climate change, all of which are essential for long-term agricultural productivity and environmental stewardship (Priya, & Singh, S.P., 2024). To enhance the welfare of cultivators and farm workers, reducing poverty, preserving ecosystems, slowing down the impact of global warming, and creating more robust, accessible, and ecologically sound food systems, sustainable agriculture should be the goal for all (Atapattu, A. J., Ranasinghe, C. S., Nuwarapaksha, T. D., Udumann, S. S., & Dissanayaka, N. S., 2024). In brief, sustainable agricultural productivity growth is an expansion of agricultural production that contributes to the goals of economic, social, and environmental sustainability in order to satisfy the demands of the present as well as the future for food and nourishment. This study is an attempt to understand the Sustainable Agricultural Practices that India's agriculture sector has adopted. (Srivastava, P., Singh, R., Tripathi, S., & Raghubanshi, A. S. 2016). It also seeks to learn about the programmes and policies that are being carried out by government organisations to support sustainable agricultural methods. The research will evaluate India's understanding, adoption, and cost-effectiveness of sustainable farming practices. The research will also look at the impact sustainable farming practices have on the agricultural industry and identify the barriers that keep farmers from adopting sustainable farming practices**.** To achieve the current research objectives, a qualitative research approach is used, involving the administration of an interview survey to farmers, academics, specialists in agriculture, and other relevant stakeholders to understand their viewpoints on this issue. Additionally, a thematic analysis is employed to examine the data.

1.1 Current State of Agriculture in India

The agricultural sector in India is a vital component of the country's economy, with a wide variety of crops and farming methods that differ greatly among its geographical regions. According to the Economic Survey Report 2024, agriculture provides a living for roughly 42.3% of the population and accounts for 18.2% of GDP at current prices. The sector is primarily made up of small-holder farmers, which results in significant variation in productivity levels across states. Recent developments show that crop production patterns have changed due to technological advancements and several government initiatives aimed at modernisation and sustainability. Additionally, the sector is being impacted by the effects of climate change, which have changed cultivation patterns, productivity, and risk management techniques throughout the country.

1.2 Challenges in Indian Agriculture

Indian agriculture is undergoing challenges like soil degradation, water scarcity, over-reliance on chemical inputs, small landholdings, farmer indebtedness, limited access to credit and technology, impacts of climate change, and infrastructural deficiencies like inadequate irrigation, poor storage, and limited market access (Lengai *et al.*, 2020).

1.3 Sustainable Agricultural Practices

Sustainable Agriculture practices refer to adoption of farming practices to safeguard food production, preserving the environment, public health, and the well-being of farmers and communities.

The table below highlights the various agricultural systems and the sustainable agricultural practices:

System	**Practice**
Permaculture	Vermicompost
Organic farming	Drip irrigation/sprinkler
Natural farming	Crop rotation
System of rice intensification (SRI)	Intercropping
Biodynamic agriculture	Cover crops
Conservation agriculture	Mulching
Integrated farming system (IFS)	Contour farming
Agroforestry	Rainwater harvesting-artificial recharge of groundwater
Integrated pest management (IPM)	Floating farming
Precision farming	Plastic mulching
Silvipastoral systems	Shade net house
Vertical farming Hydroponics/Aeroponics	Alternate wetting and drying technique (for rice)
Crop-livestock-fisheries farming system	Farm pond lined with plastic film Direct seeding of rice Canopy management Mangrove and non-mangrove bio-shields

Source: Sustainable agriculture in India 2021. *Council on Energy, Environment and Water*.

Crop rotation, one of the simple SAPSs, is most popular across the country, covering about 30 million hectares and 15 million farmers. Practices like agroforestry and rainwater harvesting, which got significant attention in national programmes, also have higher coverage. Agroforestry is a land use management system that integrates trees with crops or pasture. It combines agricultural and forestry

technologies and covers a large area; the practice is mainly popular among large cultivators. National Agroforestry Policy (2014) encouraged wide adoption. It covers an area of about 20 million hectares.
Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) supported precision farming to improve efficiency in water-use. The National Mission on Micro Irrigation has significantly promoted micro-irrigation in the country. Integrated Pest Management uses biological control, resistant varieties, and cultural practices to reduce chemical pesticide use. This scheme is promoted by agricultural extension services and Krishi Vigyan Kendras. Intercropping is more common in the country's southern and western regions and covers nearly one million hectares. This method maximises the land use and income, enhances biodiversity and natural pest control.
Paramparagat Krishi Vikas Yojana (PKVY) supported organic farming. Currently it covers only two per cent of the country's total net sown area (140 million ha). India has about two million certified organic producers. Organic farming avoids synthetic inputs, enhances soil health, and supports premium markets**.** Biodynamic agriculture, a variant of organic farming, has an estimated coverage of 0.1 million ha (where biodynamic inputs are explicitly used along with organic farming practices). Natural farming has witnessed a faster rate of adoption in the last two to three years. Close to one million farmers practice natural farming, mostly in Andhra Pradesh, Karnataka, Maharashtra, and Himachal Pradesh.

1.4 Importance of Sustainable Agricultural Practices

Sustainable agricultural practices such as crop rotation, organic farming, conservation tillage, agroforestry, and integrated pest management contribute to improved soil health and water-use efficiency. It enhances soil fertility, reduces erosion, increases organic matter and adopts water conservation techniques to promote biodiversity and reduce reliance on chemical pesticides and fertilizers (Pawlak & Kołodziejczak, 2020).
Supporting small-holder and marginalized farmers through access to technology, credit, and markets, encourage inclusive participation, especially by women and indigenous communities, strengthen local food systems and reduce rural poverty (Dhanaraju *et al*., 2022). Increasing farm profitability without environmental trade-offs, foster innovation and resilient supply chains, create green jobs in agriculture and rural development.

1.5 Need for Sustainable Practices in India

The urgent necessity of adopting sustainable agricultural practices in India is to address the growing environmental, economic, and social challenges facing the agricultural sector. These practices play a critical role in ensuring long-term agricultural productivity, food security, and rural development. Sustainable practices mitigate adverse environmental impacts, enhance economic resilience for farmers, and promote social well-being by improving health and community stability (Zhang *et al*., 2021).

2. **Objectives of the study**

1. **To estimate the impact of adopting Sustainable Agricultural Practices (SAPs) on the profitability and productivity of farmers.**

   H1: There is no significant impact of Adoption of Sustainable Agriculture Practices on farmers' profit.
   H4: There is no significant impact of Adoption of Sustainable Agriculture on profit
   H6: There is no significant impact of Impact of Adopting Sustainable Agriculture practices on profit
2. **To evaluate the role of farmer awareness and understanding of sustainable agricultural practices in augmenting farm income.**
   H2: There is no significant impact of farmers awareness Regarding Sustainable Agriculture Practices on profit
3. **To examine the impact of government policies, initiatives, and adoption-related costs on the economic feasibility of sustainable agriculture.**

H3: There is no significant impact of Government Initiatives and Policies on farmers income

H5: There is no significant impact of Cost incurred in the Adoption of Sustainable Agriculture on profit

3. Methodology

The study adopted descriptive and exploratory research. Primary and secondary methods are employed for data collection. Secondary data is collected from the Economic survey report of 2023-24 and 2024-25, Ministry of Agriculture department reports, reports from the government websites. Simple random sampling is adopted for the study, with 385 sample size at 5% of confidence level. Farmers were interviewed to gather information on their knowledge of sustainable practices, including crop rotation, organic farming, and water conservation techniques. Additionally, field visits allowed researchers to observe current farming practices and assess the adoption of sustainable methods (Liliane *et al.*, 2020).

Tools used for data analysis are - Time Series Analysis to study the trends over time regarding policy implementation and adoption, Regression Analysis to determine the impact of sustainable practices on agricultural output, yield, profitability and cost reduction, Exploratory Factor Analysis (EFA) to discover the underlying factors affecting adoption.

In data analysis, structural equation modeling, or SEM, has two main uses. It is first used to estimate the model's parameters, such as the covariances, variances, and factor loadings of the observable variables. Second, SEM evaluates whether the model accurately captures the relationships between variables by measuring how well the model fits the data. SEM's capacity to give a thorough grasp of the correlations between components and insightful information about how they relate to one another is one of its main advantages.

This study uses Structural Equation Modelling (SEM) to investigate the connections between theoretical constructs and the observed variables that go along with them. Three observable indicators are used to operationalise each of the latent constructs: Adoption of Sustainable Agricultural Practices, Awareness of Sustainable Agricultural Practices, Government Initiatives and Policies, Adoption of Sustainable Agriculture, Cost Incurred in Adoption, and Impact of Adoption on Profitability. SEM analysis, which allows for the identification and retention of items exhibiting statistically significant regression weights with their corresponding latent constructs, was used to build and improve these indicators. In the context of sustainable agriculture in India, this methodological technique guarantees the measurement model's construct validity and reliability.

4.1 Role of Government policies and initiatives for promoting sustainable agricultural practices to promote SDG goals.

Government initiated Pradhan Mantri Kisan Samman Nidhi (PM-KISAN), to provide financial support for small and marginal farmers, Kisan credit card (KCC) Scheme to provide easy and timely loan for agricultural and allied activities. Agriculture export policy to increase farmers income by promoting agricultural exports and spreading market to international level, To improve the public investment in agriculture and allied sectors and to support sustainable growth and rural development government introduced Rashtriya krishi vikasa yojana. To provide irrigation facilities and to encourage optimal utilization of water use for higher crop productivity Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) and National Mission on Micro-Irrigation were introduced. Focusing on soil health, water conservation, crop diversification and traditional organic farming, to promote climate resilient and sustainable farming practices National Mission on Organic Farming (NMOF) and National Mission for Sustainable Agriculture (NMSA), Paramparagat Krishi Vikas Yojana (PKVY) are employed. To provide information about soil nutrients for balanced fertilizers use, soil health card scheme was introduced.

Pradhan Mantri Fasal Bima Yojana (PMFBY) helps and support farmers by reducing income risk in case of crop failure because of natural disasters. Krishi Vigyan Kendras (KVKs): Offers extension services, training, and knowledge dissemination to farmers, encouraging the adoption of modern and sustainable agricultural practices. For the promotion of Technology and innovations to facilitate, the training and knowledge for the adoption of modern and sustainable agricultural practices, Krishi Vigyan Kendras (KVKs), ensuring better price for farmers through online trading, E-NAM (Electronic National Agriculture Market), to decrease import dependence and to increase oilseed production, National Mission on Oilseeds and Oil Palm (NMOOP), to reduce post harvesting losses and to create an extra income opportunities to farmers, government initiated for agro-processing industries. Animal Husbandry Infrastructure Development Fund (AHIDF) helps the livestock farmers to modernize and develop animal husbandry infrastructure.

4.2 Impact of Sustainable Agricultural Practices on Agriculture productivity

Sustainable agricultural practices, or SAPs, have become an essential strategy for raising agricultural output while preserving the environment. Through locally obtained organic amendments and integrated nutrient management, SAPs have been shown in numerous studies to be beneficial in increasing input efficiency, decreasing reliance on synthetic inputs, and promoting soil health (Kumari et al., 2024). Simultaneously, it has been demonstrated that the use of environmentally friendly methods like sustainable pest control, effective irrigation systems, and organic fertilisation can maintain and even increase the yield of staple crops like wheat, rice, maize, and soybeans while reducing environmental damage (Sari et al., 2024). Additionally, empirical data demonstrates that farmers who use SAPs often outperform traditional practitioners in terms of productivity and resource efficiency, suggesting that these techniques have the potential to revolutionise agricultural systems on a large scale (Reddy, 2024). The long-term benefits of SAPs, including improved soil quality, decreased environmental degradation, and increased resilience to climate-induced stress, have also been highlighted by foundational research. These benefits are mostly attained through methods like crop rotation and integrated pest management (Keeney, 2019). The compatibility of ecological stewardship with goals for food security is further supported by recent research showing that sustainable practices can increase biodiversity without sacrificing yields (Takola et al., 2025).

- **Climate Predispositions -** Extreme weather events, changing rainfall patterns, and temperature fluctuations increase risks for farmers experimenting with new sustainable methods (Priya & Singh, 2024).

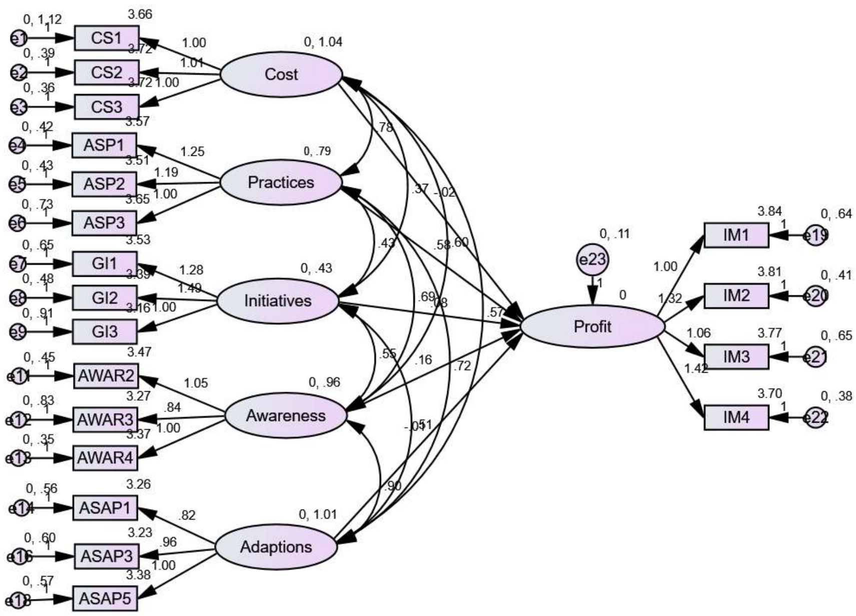
4.3 Challenges in adoption of Sustainable Agricultural Practices

- **High use of external mineral fertilizer and pesticides to improve agriculture productivity -** The increased crop productivity can be attributed to widespread use of external mineral fertilisers and chemical pesticides which has been a hallmark of modern agricultural practices since the Green Revolution. But these practices have resulted in the degradation of natural resources, reduced soil fertility, and diminished environmental resilience (Singh R., Singh H, & Raghubhanshi A. S., 2019). The sustainability of such input-intensive agriculture is increasingly questioned despite the short-term gains in yield. Moreover, the barriers to the adoption of Sustainable Agricultural Practices (SAPs) are attributed to the high costs associated with complex fertilisers and other agrochemical inputs specifically among the resource-constrained farmers.(Kadam R. L., Ahire R. D., Tadavi F. R., & Behera R. K., 2023).
- **Lack of awareness among the farmers for the adoption of advanced technology and innovation sustainable farming methods -** Most of the Indian farmers are illiterate and uneducated for the adoption of innovative farming methods and advanced technology(Bisht, I. S., Rana, J. C., & Pal Ahlawat, S. (2020). Declining attention of youth in agriculture, land-use challenges, inadequate storage facilities leading to wastage of agriculture production, is another challenge in India for the adoption of SAP (Priyadarshini, P., & Abhilash, P. C. (2020))
- **Limited financial access and high preliminary cost** - Implementation of organic farming, drip irrigation and other SAP need high initial investment. In India for small and marginal farmers accessing loan is the difficult task. (Pawlak & Kołodziejczak, 2020).
- **Small and Fragmented Land Holdings -** Small and fragmented land holdings are restricting the implementation of SAP like, crop diversification, agroforestry etc, (Zhang et al., 2021).

- **Market Hurdles -** Lack of infrastructure facilities and poor consumer awareness towards identifying, certifying and marketing of organic or sustainably produced products (Lengai et al., 2020)
- **Infrastructural Restrictions -** Inadequate irrigation infrastructure, poor storage and transport facilities, and limited access to agro-processing units reduce the benefits of sustainable production (Srivastava et al., 2016).

5. To examine the impact of government policies, initiatives, and adoption-related costs on the economic feasibility of sustainable agriculture.

Figure no.5.1 – SEM Model



5.1 Maximum Likelihood Estimates

5.1.1 Regression Weights

			Estimate	S.E.	C.R.	P	Label
Profit	<---	Cost	-.015	.105	-.143	.886	
Profit	<---	Practices	.583	.188	3.097	.002	
Profit	<---	Initiatives	.078	.132	.589	.556	
Profit	<---	Awareness	.157	.177	.886	.376	
Profit	<---	Adaptions	-.009	.163	-.053	.958	
adaption5	<---	Adaptions	1.000				
adaption3	<---	Adaptions	.955	.059	16.200	***	
adaption1	<---	Adaptions	.822	.054	15.306	***	
AWAR4	<---	Awareness	1.000				
AWAR3	<---	Awareness	.843	.058	14.605	***	
AWAR2	<---	Awareness	1.053	.052	20.239	***	
GI_NMSA_GI3	<---	Initiatives	1.000				
GI_NMSA_GI2	<---	Initiatives	1.487	.138	10.770	***	
GI_NMSA_GI1	<---	Initiatives	1.279	.126	10.140	***	

			Estimate	S.E.	C.R.	P	Label
ADSP3	<---	Practices	1.000				
ADSP2	<---	Practices	1.191	.073	16.349	***	
ADSP1	<---	Practices	1.250	.075	16.642	***	
COSTI3	<---	Cost	1.000				
COSTI2	<---	Cost	1.013	.051	20.041	***	
COSTI1	<---	Cost	1.002	.067	15.053	***	
IMSPOI1	<---	Profit	1.000				
IMSPOI2	<---	Profit	1.319	.090	14.687	***	
IMSPOI3	<---	Profit	1.064	.085	12.557	***	
IMSPOI4	<---	Profit	1.423	.094	15.080	***	

Source: Primary Data

Cost → Profit: The relationship between Cost and Profit is negative (- 0.015) But the C.R is -0.143 and the P value is 0.886, which is not statistically significant that is (P>0.05) This suggests that cost does not have significant direct impact on farmer's profit.

Sustainable Practices → Profit: The relationship between Sustainable Practices and Profit is positive (0.583), and the C.R. is 3.097 with a p-value of 0.002, which is statistically significant ($p < 0.05$). This indicates that sustainable practices have a significant positive impact on Profit.

Government Initiatives →Profit: The relationship between Government Initiatives and Profit is positive (0.078), but the C.R. is 0.589 and the p-value is 0.556, which is not statistically significant ($p > 0.05$). This suggests that government initiatives do not have a significant effect on profit.

Awareness → Profit: The relationship between farmers Awareness and Profit is positive (0.157), but the C.R. is 0.886 and the p-value is 0.376, which is not statistically significant ($p > 0.05$). This indicates that farmers awareness does not have a significant direct effect on Profit.

Sustainable Practice Adoptions → Profit: The relationship between Sustainable Practice Adoptions and Profit is negative (-0.009), but the C.R. is -0.053 and the p-value is 0.958, which is not statistically significant ($p > 0.05$). This suggests that Sustainable Practice Adoptions do not have a significant effect on Profit.

5.1.2 Standardized Regression Weights

			Estimate
Profit	<---	Cost	-.021
Profit	<---	Practices	.694
Profit	<---	Initiatives	.069
Profit	<---	Awareness	.205
Profit	<---	Adaptions	-.012
adaption5	<---	Adaptions	.799
adaption3	<---	Adaptions	.777
adaption1	<---	Adaptions	.742
AWAR4	<---	Awareness	.855
AWAR3	<---	Awareness	.670
AWAR2	<---	Awareness	.837
GI_NMSA_GI3	<---	Initiatives	.567
GI_NMSA_GI2	<---	Initiatives	.817
GI_NMSA_GI1	<---	Initiatives	.721
ADSP3	<---	Practices	.722
ADSP2	<---	Practices	.850
ADSP1	<---	Practices	.865

			Estimate
COSTI3	<---	Cost	.861
COSTI2	<---	Cost	.856
COSTI1	<---	Cost	.695
IMSPOI1	<---	Profit	.683
IMSPOI2	<---	Profit	.837
IMSPOI3	<---	Profit	.701
IMSPOI4	<---	Profit	.865

Source: Primary Data

Profit ← Cost: The standardized estimate of -0.021 suggests that Cost has an extremely small and negative impact on Profit. However, this is a very weak relationship, evidence from Maximum Likelihood Estimates it was not statistically significant.

Profit ← Practices: The standardized estimate of 0.694 indicates that sustainable practices have a strong positive impact on Profit. This is the strongest predictor in the model, which aligns with the Maximum Likelihood Estimates finding that Practices had a statistically significant positive effect on Profit.

Profit ← Initiatives: Interpretation: The standardized estimate of 0.069 shows a very weak positive relationship between government initiatives and Profit, which was also statistically insignificant. This suggests that Initiatives have a minimal influence on Profit.

Profit ← Awareness: The standardized estimate of 0.205 indicates a moderate positive impact of farmers awareness on Profit, but this effect was not statistically significant. Still, the size of the coefficient shows that it has a more noticeable effect compared to government initiatives and sustainable practice adoptions.

Profit ← Adoptions: The standardized estimate of -0.012 suggests that sustainable practice adoptions have an extremely weak negative relationship with Profit, which aligns with the Maximum Likelihood Estimates result that this path was not statistically significant.

5.1.3 Intercepts

	Estimate	S.E.	C.R.	P	Label
adoption5	3.379	.064	52.753	***	
adoption3	3.226	.063	51.269	***	
adoption1	3.257	.057	57.430	***	
AWAR4	3.369	.058	57.719	***	
AWAR3	3.273	.063	52.145	***	
AWAR2	3.470	.063	55.311	***	
GI_NMSA_GI3	3.161	.059	53.505	***	
GI_NMSA_GI2	3.395	.061	55.659	***	
GI_NMSA_GI1	3.527	.059	59.363	***	
ADSP3	3.655	.063	58.094	***	
ADSP2	3.512	.064	55.206	***	
ADSP1	3.566	.066	54.348	***	
COSTI3	3.719	.061	61.447	***	
COSTI2	3.719	.062	60.343	***	
COSTI1	3.657	.075	48.670	***	
IMSPOI1	3.839	.056	68.821	***	
IMSPOI2	3.813	.060	63.531	***	
IMSPOI3	3.771	.058	65.251	***	
IMSPOI4	3.699	.063	58.998	***	

Source: Primary Data

Adoption of sustainable practices - The intercepts for Adoptions are quite high (around 3.25 to 3.38) and are statistically significant ($p < 0.001$), indicating that the baseline value for Adoptions is significantly different from zero.
Awareness of sustainable agricultural practices - The intercepts for Awareness are similarly high (around 3.27 to 3.47) and are statistically significant ($p < 0.001$), indicating that Awareness also has a strong baseline value.
Government initiatives such as NMSA - The intercepts for GI_NMSA variables range from 3.161 to 3.527, all being statistically significant ($p < 0.001$), indicating a strong baseline for this set of variables as well.
Adoption of Sustainable agriculture practices - The intercepts for Adoption of Sustainable Agriculture Practices are between 3.512 and 3.655, all being statistically significant ($p < 0.001$), suggesting a strong baseline effect for these variables. Sustainable agriculture practices are not feasible for farmers with limited financial resources.
Cost - Cost serves as a major barrier to the adoption of sustainable agriculture. The intercepts for cost are quite high (around 3.657 to 3.719) and are statistically significant ($p < 0.001$), suggesting a strong baseline level for Cost as well.
Impact of Adopting Sustainable Agriculture - The impact of Adopting Sustainable Agriculture on farmers is that it increases their overall income. Sustainable agriculture adoption results in the improvement of crop yields, reduced costs of chemical fertilizers. The intercepts for IMSPOI variables range from 3.699 to 3.839, all being statistically significant ($p < 0.001$), indicating a strong baseline for these variables.

5.1.4 Covariance's

			Estimate	S.E.	C.R.	P	Label
Adaptions	<-->	Awareness	.905	.084	10.749	***	
Adaptions	<-->	Initiatives	.507	.065	7.796	***	
Adaptions	<-->	Practices	.719	.077	9.320	***	
Cost	<-->	Adaptions	.571	.073	7.865	***	
Awareness	<-->	Initiatives	.552	.066	8.335	***	
Awareness	<-->	Practices	.694	.072	9.567	***	
Cost	<-->	Awareness	.595	.070	8.522	***	
Initiatives	<-->	Practices	.428	.057	7.484	***	
Cost	<-->	Initiatives	.371	.055	6.779	***	
Cost	<-->	Practices	.784	.079	9.942	***	

Source: Primary Data

Policy Adoptions and Awareness: This strong positive covariance suggests that as farmers awareness increases, policy adoptions also will increase. The critical ratio (C.R.) of 10.749 is very high, indicating a statistically significant relationship. The p-value (***, less than 0.001) it is significant.
Policy Adoptions and Government Initiatives: This covariance (0.507) is moderately strong and significant, indicating that Initiatives are related to policy adoptions, but not as strongly as awareness. The critical ratio of 7.796 recommends a solid statistical association, implying that policy adoptions within farmers may lead to more government initiatives.
Adoptions and Practices: This is another strong relationship, indicating that when organizations or individuals adopt, they also evolve their Practices. With a high C.R. (9.320), this association is statistically significant, showing that adopting to change goes hand-in-hand with evolving practices to remain competitive or effective.
Cost and Policy Adoptions: The positive covariance (0.571) suggests a moderate relationship between Cost and policy adoptions. As costs increase, farmers may need to adopt the sustainable, or perhaps policies adopting leads to cost changes (either increases or savings). The relationship is statistically significant, but the moderate value suggests that cost alone is not the only driver of policy adoption.

Awareness and Government Initiatives: A positive covariance of 0.552 indicates a strong link between Awareness and Government Initiatives. This proposes that as farmers become more aware they are more likely to utilise the government initiatives. The relationship is significant, with a C.R. of 8.335, reflecting that awareness can be a precursor to taking new government initiatives.

Awareness and Sustainable Practices: This strong positive covariance indicates that Awareness is strongly related to sustainable practices. As farmers become more aware, they are likely to refine their sustainable practices. The significant C.R. of 9.567 supports the idea that awareness drives changes in sustainable practices.

Cost and Awareness: A moderate positive covariance between Cost and Awareness advises that farmers who are more cost-conscious may also be more aware of other factors. The significant relationship could indicate that managing costs requires greater awareness.

Government Initiatives and Sustainable Practices: The covariance (0.428) is moderate, indicating a meaningful but not overwhelmingly strong relationship between government initiatives and sustainable practices. This recommends that as new initiatives are undertaken, they lead to some changes in sustainable practices.

Cost and Government Initiatives: This is one of the weaker relationships in the model, with a covariance of 0.371. It proposes a moderate positive relationship between Cost and government Initiatives, sense that as costs change, there may be some influence on the number government initiatives undertaken, but it's not as strong as other relationships. The relationship is still significant (C.R. of 6.779), but cost alone may not be a primary driver of government initiatives.

Cost and Sustainable Practices: This strong positive covariance (0.784) indicates that Cost and Sustainable Practices are closely linked. As costs increase, farmers are likely to change their Sustainable practices to address these financial pressures. The high critical ratio (9.942) indicates that this relationship is statistically significant. It advises that cost control or cost changes are a major factor in driving changes in sustainable practices.

5.1.5 Correlation

			Estimate
Adoptions	<-->	Awareness	.923
Adoptions	<-->	Initiatives	.770
Adaptions	<-->	Practices	.806
Cost	<-->	Adaptions	.557
Awareness	<-->	Initiatives	.859
Awareness	<-->	Practices	.797
Cost	<-->	Awareness	.596
Initiatives	<-->	Practices	.733
Cost	<-->	Initiatives	.553
Cost	<-->	Practices	.863

Source: Primary Data

Policy Adoptions and Awareness (0.923) - This correlation is extremely strong and close to 1, indicating that when farmers awareness increases, policy adoptions increase almost perfectly in tandem. The high correlation state that awareness plays a crucial role in driving policy adoption.

Policy Adoptions and Government Initiatives (0.770) - This strong positive correlation indicates that the policy adoptions and government initiatives are closely related. It directs that as farmers adopt the policies, they are likely to undertake more government initiatives. However, the correlation is not as high as the one between policy adoptions and awareness, which may imply that while government Initiatives are strongly linked to policy adaptions.

Adoptions and Practices (0.806) - The strong correlation between Adoptions and Practices (0.806) suggests that as organizations adopt to changing conditions, they also evolve their operational or

strategic practices. This could indicate a feedback loop where adoptions and best practices inform one another, with one driving changes in the other.
Cost and Policy Adoptions (0.557) A moderate positive correlation between Cost and policy adoptions suggest that as costs increase, adoptions are also likely to increase, but not as strongly as other relationships. This could indicate that while cost pressures encourage farmers to adopt the policies relationship is not as critical as those with farmer awareness.
Awareness and Government Initiatives (0.859) is another very strong correlation, indicating that as Awareness increases, government initiatives rise significantly. It proposes that heightened awareness prompts farmers to take more government initiatives.
Awareness and Sustainable Practices (0.797) The strong correlation recommends that as Awareness increases, sustainable Practices will be followed by the farmers. This relationship emphasizes the importance of continuous learning and situational awareness in improving follow the sustainable practices
Cost and Awareness (0.596) - This is a moderate correlation, suggesting that as Cost rises, Awareness also increases, though not as strongly as the other relationships. One interpretation might be that farmers facing higher costs are more likely to become aware of the sustainable.
Government Initiatives and Practices (0.733) - A strong positive correlation indicates that government initiatives increase, sustainable practices also will be followed by farmers. This suggests that taking government initiatives often leads to improvements in farmers sustainable practices.
Cost and Government Initiatives (0.553) - This moderate correlation suggests that as Cost increases, government Initiatives may increase as well. However, the relationship is weaker than other correlations. It may suggest that rising costs push farmers to follow more government initiatives to reduce the costs, but costs are not the primary driver behind these government initiatives.
Cost and Sustainable Practices (0.863) This is a very strong correlation, implying that cost and sustainable practices are tightly linked. As costs increase, there's a significant shift in sustainable practices. This could mean that farmers facing cost pressures are highly motivated to refine and adjust their sustainable practices, possibly by adopting more cost-efficient practices.

5.1.6 Variances

	Estimate	S.E.	C.R.	P	Label
Adaptions	1.006	.111	9.026	***	
Awareness	.956	.094	10.142	***	
Initiatives	.431	.077	5.618	***	
Practices	.792	.099	7.991	***	
Cost	1.042	.103	10.118	***	
e23	.111	.021	5.262	***	
e1	1.122	.091	12.306	***	
e2	.389	.043	9.061	***	
e3	.365	.041	8.881	***	
e4	.416	.040	10.265	***	
e5	.431	.040	10.781	***	
e6	.728	.058	12.658	***	
e7	.651	.059	11.068	***	
e8	.476	.056	8.461	***	
e9	.909	.072	12.678	***	
e11	.452	.043	10.500	***	
e12	.833	.065	12.761	***	
e13	.352	.036	9.901	***	
e14	.556	.047	11.709	***	
e16	.603	.054	11.133	***	

	Estimate	S.E.	C.R.	P	Label
e18	.570	.054	10.651	***	
e19	.637	.050	12.651	***	
e20	.414	.039	10.533	***	
e21	.652	.052	12.520	***	
e22	.380	.040	9.617	***	

Source: Primary Data

The variance of policy adoptions is 1.006, which indicate there is a fair amount of variability in how much policy adoption occurs across the farmers. The high critical ratio (C.R. = 9.026) indicates that this estimate is highly statistically significant.

Awareness has a variance of 0.956, indicating relatively high variability in how much famers awareness is present across the sustainable practices. The high critical ratio (10.142) shows that the variance is statistically significant.

The variance for government initiatives is lower (0.431), which shows that government initiatives vary less than policy adoptions or awareness. The lower variance suggests that there is less diversity in how many government initiatives are undertaken across by the farmers. The C.R. (5.618) still indicates that this variance is statistically significant.

The variance of sustainable practices is 0.792, indicating a reasonable amount of variability in how practices are implemented or evolved across the farmers. This variability is statistically significant with a high C.R. of 7.991.

The variance for Cost is 1.042, showing a relatively high amount of variation in the cost-related aspects of the model. This high variance implies significant variability in cost pressures across the farmers. The C.R. of 10.118 indicates that the estimate is statistically significant.

Error Terms (e1, e2, e3, ... e22), The e terms represent the variances of error terms in the model, reflecting the unexplained variance in the observed data for each factor. Each of these error variances is statistically significant ($p < 0.001$) as indicated by the C.R. values; shows they are important in capturing the portion of variability that the model does not account for.

5.1.7 Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	72	451.133	137	.000	3.293
Saturated model	209	.000	0		
Independence model	38	4947.897	171	.000	28.935

Source: Primary Data

The above table depicts the default model with 72 parameters, where the Chi-square value is 451.133 with 137 degrees of freedom, yielding a significant p-value (P = 0.000). The Chi-square to degrees of freedom ratio (CMIN/DF) of 3.293 suggests that the model is acceptable.

6. **Conclusion:**

This study is undertaken to study government policies and initiatives towards Sustainable Agricultural Practices and Agricultural productivity. Sustainable agricultural practices have a strong and significant positive impact on farmers' profitability and long-term productivity in India. Practices like crop rotation, organic farming, and precision irrigation not only enhance yields and reduce dependence on chemical inputs but also contribute to better soil and water resource management. However, the adoption of these practices remains uneven due to barriers such as high implementation costs, inadequate infrastructure, and limited farmer awareness. Although various government policies and programmes such as PM-KISAN, PMKSY, PKVY, and KVKs aim to promote sustainable farming and support farmers financially and technically, the direct effect of these policies on farm profitability was found to be statistically insignificant in this study. This highlights a critical gap between policy design and on-ground impact. Moving forward, there is an urgent need to bridge this gap through improved awareness campaigns, capacity-building initiatives, and robust extension services. Policies must focus on lowering adoption costs, providing targeted subsidies, improving market access, and ensuring technology transfer to smallholders. Strengthening institutional support and farmer participation will be key to realizing India's commitment to the SDG targets of zero hunger, poverty reduction, and environmental sustainability.

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