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Organic Farming and Food Security: A Sustainable Path Forward

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Abstract
Global agriculture has faced mounting challenges in recent decades driven by climate change, soil degradation, and unsustainable farming practices. In this context, organic farming has emerged as a viable and sustainable solution to address these pressing issues while enhancing food security. Food security, defined as the availability, access, and utilisation of safe and nutritious food, is a fundamental global concern. Organic farming, characterized by its reliance on natural processes, biodiversity, and limited use of synthetic inputs, has gained prominence as a strategy to foster food security while mitigating the adverse impacts of conventional agriculture. Organic farming represents a sustainable pathway toward achieving food security by promoting sound practices, enhancing soil fertility, preserving biodiversity, and reducing agriculture&39;s environmental footprint. The present study aims to explain food security and organic farming practices within the context of economic sustainability. While challenges exist, concerted efforts in policy support, research, education, and market development can pave the way for a more food-secure and environmentally sustainable future. Organic farming addresses global food systems' complex and interconnected challenges. Sustainable food systems must ensure enough safe and nutritious food while minimizing environmental degradation. Over the last 50–60 years, agriculture's continuous intensification and specialization have instigated many evil ecological effects. This questions the quality of the global food system to ensure food security while lingering below the environmental verges of sustainability, especially for an increasing population whose global food demand touches on calorie-rich diets. Organic agriculture is receiving wider consumer attention and growing policy support.

Keywords*: Economic sustainability, Food Security, Ecology, Organic Farming, Environmental Degradation*

Introduction

Food security in India, which safeguards everyone's relentless access to inexpensive and sufficient food, remains a pressing concern. Despite progress in agricultural productivity and technological advancement, a considerable portion of the population endures agonising from undernourishment, hunger, and food

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shortages. These issues are additionally wired by environmental degradation, climate change, and economic instability. Organic farming has come to light in this stimulating environment as a potentially effective means of enhancing food security. Organic farming improves soil health, biodiversity, and climate change resistance by replacing synthetic chemicalswith natural inputs and sustainable methods. These are factors that are critical to the production ofsustainably produced food. Furthermore, by plummeting their dependency on expensive chemicalresources and allowing them to command higher prices for their organic produce, organic farmingcan enhance the standard of living for small and marginal farmers. India is in a great position to use organic farming to ensure food availability because of its long history of natural agriculture and sizeable agrarian community. Farmers are financially motivated to embrace organic practicesby the growing demand for organic products from consumers both domestically and abroad. Actions and policies from the government are also aiding this transition to organic farming. As India tackles the complex challenge of ensuring food security for its vast population, organic farming offers a viable and sustainable solution. By addressing environmental, economic, and social aspects, organic farming meets immediate food security needs and aligns with long-term sustainable development goals

Literature

The role of organic agriculture in preserving natural resources is clear (Simon et al., 2020). Anotherstudy by C. Ume (2023) empirically examined how organic farming impacts food security in ruralNigeria using a multiple-treatment endogenous switching regression model. The findings suggestthat while adopting organic farming can effectively enhance the food security of smallholder farmers, it is most effective when supported by efficient organic markets. In addition to promotingmore sustainable agriculture, as supported by literature, these practices contribute to improved food security and nutrition when integrated with a robust marketing system that benefits smallholder farmers. Food security remains one of the most critical global challenges of the 21st century (Lashgarara, 2008). In Iran, research indicates that meeting the food needs of a growing population requires a significant increase in agricultural production (G. Dinpnah, 2014). Simultaneously, the importance of food security and the irreversible damage caused by the excessive use of agricultural chemicals has led to a focus on organic farming (B. Chaichi, 2009).

The studies by (Samal et al., 2022; Babu et al., 2022) predicted that the world population will reach 10 billion by 2050, demanding imperative agricultural technological and policy interventions to guarantee food security. Because “Food insecurity is a major challenge in front of developing countries” (Avinash et al., 2023). However, the present linear, economy-centered agricultural systems failed to meet the increasing food demands without compromising environmental degradation. To address these challenges, agricultural practices must develop towards intensified production to maximise agricultural output per unit of investment while minimising ecological effects (Yadav et al., 2020; Yadav et al., 2021a, b). With a population of about 1.4 billion, India faces critical food security challenges worsened by climate change and resource degradation (Das et al. 2020a). Despite efforts, agricultural yield growth has plateaued in recent years, posing significant concerns for food security (Yadav et al., 2018a). The present study aimed to address the following research question:

RQ: 1 Do the economic dimensions of organic farming improve food security?

To answer these questions and the abovementioned gap, the present study assesses the economic dimensions of organic farming and food security in developing economies like India (Kerala). It provides insights into whether the current food security status is sufficient for developing economies' food security dimensions.

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Conceptual Development and Hypothesis Setting

Organic agriculture is a method that intensifies agricultural production sustainably and economically while also focusing on social engagement. This approach addresses various dimensions of food security, including sustainability, availability, accessibility, and food utility. Proponents of organic agriculture argue that organic food and fibre systems can alleviate poverty and enhance food security (Manorjan et al., 1998; Kotschi et al., 2003).

Production optimisation capability of organic farming and food Security

Food security is attained by organic farming production optimisation, which expands agriculturaltechniques' resilience, sustainability, and efficiency. Crop rotation, intercropping, cover crops, organic fertilisers, and insect control techniques help organic farming to maximise yield. Over time, these methods lead to better and more consistent yields because they strengthen the health ofthe soil, boost biodiversity, and strengthen crops' resistance to pests and diseases. Organic farming guarantees crops obtain the nutrients they prerequisite for optimal growth by preserving and enhancing soil fertility. This increases agricultural productivity and lowers the likelihood of crop failures. Furthermore, by reducing reliance on a single crop, the diversification of crops in organicsystems also lessens the impact of unfavourable weather and market changes... Furthermore, maximising productivity in organic farming frequently entails implementing water-saving strategies and effectively using available resources, both of which are essential in areas with a water shortage and environmental stress. In addition to ensuring food production in the here and now, this sustainable method protects the environment for agricultural endeavours in the future. Ultimately, organic farming's production optimisation guarantees a steady supply of wholesome food by boosting farming systems' resilience and productivity. This consistency is necessary to feed expanding populations and provide long-term food security. ***H1: The production optimisation capability of organic farming has a positive effect on Food Security***

Economic benefit Capability of organic farming and Food Security

The economic benefits capability of organic farming pointedly enhances food security by fostering a steady and sustainable agricultural production system. Organic agriculture often harvests higher profit margins due to premium prices for organic products, which boosts farmers' incomes and empowers them to capitalise on better farming practices and technologies. Moreover, the abridged reliance on expensive synthetic inputs lowers production costs, permitting farmers to assign resources more efficiently. This financial stability, coupled with the conception of more labour-intensive production techniques, reinforces rural economies and upsurges the purchasing power offarming households. Expanded income sources from diverse crops and livestock further mitigate market fluctuations and crop failure risks, confirming a consistent food supply. Furthermore, government subsidies and incentives for organic farming lessen the initial costs of transitioning to sustainable practices, making it more reachable for farmers. Together, these economic advantages

Support a robust food production system, safeguarding farmers and communities to have dependable access to nutritious food, thus significantly contributing to long-term food security.

H2: The economic benefit capability of organic farming has a positive effect on food security

Income creation capability of organic farming and Food Security

The income generation capability of organic farming directly improves food security by giving farmers more reliable and better incomes. Organic produce recurrently charges higher prices because consumers are

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increasingly interested in eco-friendly and contamination-free products. Farmers benefit financially from this premium, which they may use to invest in enhanced farmingequipment, facilities, and technology to raise crop yields and productivity. Farmers can subordinate crop and market failure risks by fluctuating agricultural production and getting more financial returns. Improved economic and financial stability also permits agricultural households to pay for healthcare, education, and nutritious food, raising living standards and buildingresilience against food insecurity

By assuring that farmers have the monetary resources to sustainably accomplish their farms and support their families, income creation in organic farming plays a vibrant role in reaching long-term food security.

H3: The income creation capability of organic farming has a significant impact on food security

Food security means a "situation in which every individual in society has access toenough safe, nourishing f curity". It is a multifaceted idea with many unified d es:stability of food, availability of food, accessibility c upported by the prior study developed by Avinash a conomic dimension of sustainability in the context c

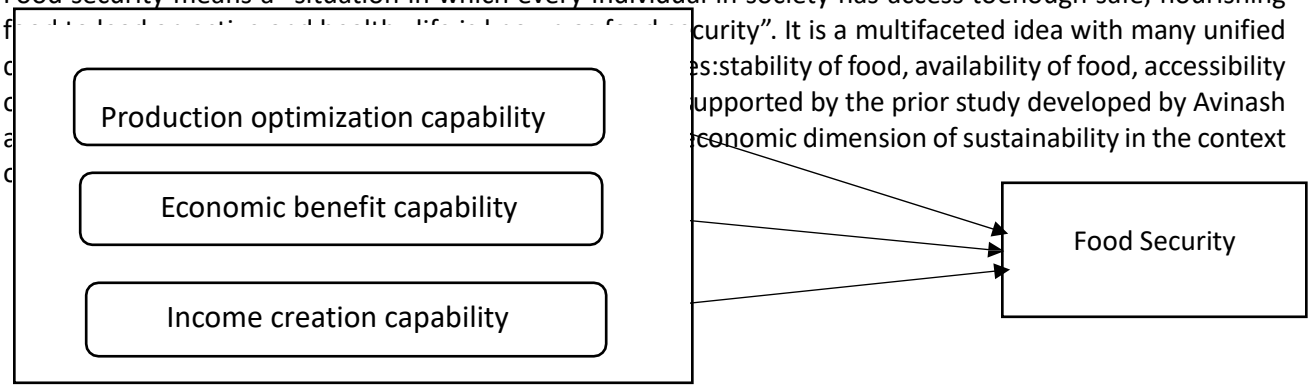

Figure 1: Conceptual model

Economic Dimensions of Organic Farming

Methodology

***Sample selection*:** This study was descriptive and was conducted among a sample of organic farmers registered in FPOs. Data were collected using self-report questionnaires administered to respondents selected through purposive sampling. Of 300 distributed questionnaires, 231 usable responses were obtained for final analysis.

Measures: The economic dimensions of organic farming encompass three capabilities: production optimisation (OP), economic benefit (EB), and income creation (IC). Morshedi et al. (2017) identified these dimensions of economic sustainability of organic farming sustainability, with an 18-item scale assessing OP (4 items), EB (7 items), and IC (7 items), with Cronbach's alpha values of $\alpha = 0.789$, $\alpha = 0.944$, and $\alpha = 0.915$, respectively. Food security was measured using the Food Insecurity Experience Scale (Food and Agriculture Organization of the United Nations, 2020), which comprises eight questions. Respondents' responses are scored based on their understanding of accessing food due to financial or resource constraints. We asked

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respondents the following question on the scale regarding the past 12 months: "Was there a time when, because of lack of money or other resources, you could not access food?" The number of positive responses to these eight questions specifies the level of food insecurity experienced. These questions were converted into statements, forming an 8-item scale (α = 0.898) for data collection.

Analysis Result

Analysis Design

The data were analysed using IBM SPSS 23.0. Descriptive statistics were employed to detail the respondents' profiles and summarise the variables. Cronbach's alpha coefficients were calculated to assess the reliability of the scales measuring OP, EB, IC, and FS. A PLS-SEM analysis was directed to examine the effects of OP, EB, and IC on FS.

Results

Demographic profile of the respondents

The demographic data gathered from the farmer respondents indicated that most were male, agedbetween 31 and 55 years, engaged in a full-time farming activity, educated, and had a monthly income between 10,000 and 50,000. All farmers under the study are semi and marginalised farmers.

Common Method Bias: In the present study, the researchers studied the possibility of standard method bias by evaluating the variance inflation factor (VIF), as Kock (2015) recommended. The recommended limit for VIF values is 3.3 (Kock, 2015). However, the highest VIF value in the model was 1.184 (OP). Thus, standard method bias is no longer a concern for the present model.

The correlations show significant positive relationships among the variables, with EB and OP being perfectly correlated (r = 1.000), indicating they likely measure the same underlying factor. EB, OP, and FS all show moderate positive correlations with YC, suggesting that economic benefit and production optimisation improvements are associated with income creation and food security increases. The most substantial relationship is between YC and FS (r = 0.663), indicating that foodsecurity will likely improve as income creation increases. All correlations are statistically significant at the 0.01 level, underscoring the reliability of these associations.

Inter-construct- correlation

		EB	OP	YC	FS
Economic Benefit	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	242			
Production optimisation	Pearson Correlation	1.000**	1		
	Sig. (2-tailed)	.000			
	N	242	242		
Income create	Pearson Correlation	.394**	.394**	1	
	Sig. (2-tailed)	.000	.000		.

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on	N	242	242	242	
Food security	Pearson Correlation	.446**	.446**	.663**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	242	242	242	242

Source: The Authors

Note(s)=**. Correlation is significant at the 0.01 level (2-tailed).

Multiple Regression Analysis between Food security and the independent variables

Model	***R***	***R2***	***Adjusted R2***	***Std. error of the estimates***	***sig***
1	0.693	0.480	0.476	0.58438	0.000

Source: The Author

The multiple regression analysis shows that the model is statistically significant (p-value = 0.000),indicating a strong positive relationship between the independent and dependent variables (R = 0.693). The model explains 48% of the variance in the dependent variable (R^2 = 0.480), and afteradjusting for the number of predictors, it explains 47.6% of the variance (Adjusted R^2 = 0.476). The standard error of the estimate is 0.58438, indicating the average prediction error. Overall, themodel appears to be a good fit for the data, explaining the variability in the dependent variable.

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Path Coefficient in the Model

Model		Unstandardised Coefficients		StandardisedCoefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.630	.188		3.356	.001
	OP	.206	.048	.218	4.296	.000
	YC	.545	.048	.577	11.374	.000

Source: The Author

Note(s): Predictors: (constant), OP, EB, YC.Dependent variable: FS.

The multiple regression model suggests that OP (Production Optimization) and YC (Income Creation) are significant predictors of the dependent variable. The intercept is 0.630, indicating the expected value of the dependent variable when OP and YC are zero. The unstandardised coefficient for OP is 0.206, indicating that a one-unit increase in OP is associated with a 0.206 increase in the dependent variable. The unstandardised coefficient for YC is 0.545, indicating thata one-unit increase in YC is associated with a 0.545 increase in the dependent variable. The standardised coefficients reveal that YC has a more robust relative impact on the dependent variable than OP. All coefficients are statistically significant, with p-values less than 0.01,indicating robust relationships between the predictors and the dependent variable.

Discussion and Implication

India will prerequisite approximately 311 million tons of food grains (including cereals and pulses)by 2030 to feed around 1.43 billion people, with this requirement projected to rise to 350 million tons by 2050 as the population reaches about 1.8 billion. To guarantee food security in the economy, efforts should expand agricultural land and increase crop productivity (Kumar et al., 2020). Exponents of organic agriculture argue that organic food and fibre systems help reduce poverty and improve food security (Manorjan et al., 1998; Kotschi et al., 2003). However, some studies have shown that organic cultivation may be less productive. This study concurs with advocates of high-external-input technology, proclaiming that increases in agricultural productivity are indispensable for long-term food security; otherwise, the economy will struggle to meet public food demand.

The productivity of organic farming aligns with the Neo-Malthusian perspective on food production. Regarding the economic dimensions of organic farming's three capabilities— production optimisation (H1) (0.628), Economic benefits (H2) (0.403), and income creation (H3) (0.574)—these showed enhancements in food security and predicted income generation. Farmers' satisfaction with the economic benefits of organic farming is the primary predictor of economic benefits capability. Additionally, reducing costs allied with purchased external inputs is a crucial outcome of the income-creation capability of organic farming. Subsequently, farmers' standpointson the economic aspects of organic agriculture highlight the lessening of external input costs and the production of higher-value, marketable products, eventually enhancing their income and subsidising long-term food security.

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These conclusions align with earlier studies by Pour et al. (2014), Ward et al. (2013), Bahramian (2011), and Peramaiyan (2011), as well as conclusions drawn by Chhabrah (2012), Khaledi (2011), Saedi (2011), Rundgren (2016), and Hoffmann (2017). However, this study indicates that the income-creation capability of organic farming only knowingly influences food security. This weak relationship recommends that organic agriculture in India could be more viable and economically feasible, with farmers mainly fetching in it for environmental sustainability and personal satisfaction. A complete and coordinated policy approach is required to endorse organic agriculture within the food security background. The government should implement solid strategies, including clearly defined objectives, feasible national organic standards, streamlined certification processes, a ban on pesticide imports, reliablemarkets, premium pricing for organic products, and identifying critical areas requiring organic involvement. Adopting these strategies makes attaining food and nutritional security and sustainable agriculture possible rather than relying on conventional farming methods. Integrating organic agricultural practices or natural farming practices can yield more balanced food security outcomes regarding agricultural intensification, economic specialisation, and social mobilisation,thus efficiently progressing food security through organic agricultural practices.

Limitations, future directions and conclusion

The economic sustainability dimension of organic farming (OP, EB, and YC) plays a vivacious role in enhancing food security, proposing a pathway towards a more buoyant and impartial agricultural system. By converging on sustainable practices, organic farming conserves natural bio-resources and boosts farmers' livelihoods through sophisticated profit margins and reduced.

Input costs. The labour-intensive nature of organic practices generates job opportunities, contributing to rural development and economic stability. Furthermore, the augmented demand fororganic produce enables market access for smallholder farmers, permitting them to secure fair prices for their produce and improve their economic well-being. Moreover, the holistic approach of organic farming nurtures biodiversity, augments soil health, and indorses climate resilience, which is crucial for safeguarding consistent food production in the face of environmental hurdles.By investing in research, infrastructure progress, and education related to organic farming, thegovernment and policymakers can generate a supportive outline that stimulates sustainablepractices while addressing food insecurity. In summary, the economic sustainability of organic farming not only augments food availability and accessibility but expands nutrition and health outcomes for society as a whole. By assimilating organic farming into more comprehensive food security approaches, societies can pave the way for a healthier, more economically sustainable future. This ratifies that all individuals have access to safe, nutritious food while enhancing the environment for future generations.

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