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Impact of Organic Farming on Sustainable Agriculture Development – A Study on Mandya District

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Abstract

The study examines socio-economic aspects affecting organic agricultural adoption in Mandya, Karnataka, India. Using standardised questionnaires, 50 organic farms were surveyed about demographics, adoption, implementation, and economic outcomes. Percentage analysis and regression modelling are used to determine regional organic farming acceptance and economic viability factors. Organic agricultural implementation is examined in terms of certification, marketing channels, input access, government backing, and technical expertise. The methodology includes quantitative economic indicator analysis and farmers' ecological benefit perceptions. Two hypotheses are examined using regression analysis to evaluate whether socio-economic factors or organic farming techniques better predict practitioner economic success. The findings benefit agricultural extension services, policymakers, and farmers contemplating organic approaches. The report also makes evidence-based recommendations for developing a sustainable agricultural ecosystem in southern Karnataka and other Indian agroecological zones.

Keywords: Biodiversity, Climate Change, Greenhouse Gas Emissions, Organic Farming, Sustainable Agriculture

JEL Classification: Q01, Q12, Q15, Q57, O13, R58

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Introduction

Organic farming has gained popularity due to its sustainability compared to chemical-dependent agriculture. It focuses on ecological balance, conserving biodiversity, and soil fertility, avoiding the use of fertilisers and pesticides. (Reganold & Wachter, 2016). Organic farming improves soil structure and health through crop rotation, green manure, and compost applications, ensuring long-term productivity with minimal chemical intervention. Organic farming limits greenhouse gas emissions and enhances biodiversity, consuming less energy and polluting less than conventional systems. It also contributes to improved livelihoods in rural economies,

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particularly in India, providing small farmers with premium prices and better market opportunities, leading to increased income levels and food security. (Lotter, 2003) However, drawbacks include lower initial yields, lack of knowledge, and certification difficulties. These barriers may restrict its scaling up unless addressed through policy support and training programs. Organic agriculture aligns with sustainable development, promoting responsible exploitation of natural resources, good environmental practices, and long-lasting agriculture (Singh *et al.*, 2010). This study examines the role of organic farming in promoting sustainable environmental, social, and economic outcomes in agriculture and identifies specific transformations occurring at the grassroots level in different agricultural communities. (Scialabba & Müller-Lindenlauf, 2010).

Theoretical Background of the Study

Introduction to Agriculture and Sustainable World

Agriculture, a vital part of human life, has been industrialised, leading to environmental damage like soil erosion and water pollution. Sustainability in agriculture aims to balance ecological systems by reducing non-renewable inputs, preserving soil fertility, and promoting biodiversity. Activities like rotating crops and composting contribute to soil structure and carbon capture. The principle of it is as shown below,

1. **Optimal Use of Resources**: Prioritising natural resources (*e.g.*, solar energy, organic manure) over synthetic inputs.
2. **Ecosystem Conservation**: Preserving pollinators, soil organisms, and natural habitats to ensure ecological resilience.

Social Justice

Ensuring fair remuneration, secure working conditions, and equal access to markets for farmers.

Economic Sustainability

Balancing profitability with reduced environmental impacts through innovations like precision farming.

Emergence of Organic Farming

Organic farming is a sustainable approach to agriculture that uses closed-loop systems to avoid synthetic chemicals, enriching soil with compost and crop diversity, reducing chemical runoff, and increasing biodiversity. It contributes to reducing agriculture's carbon footprint and food security by addressing challenges like low yields and high labour costs. Sustainable agriculture balances present food needs with future ones, addressing productivity, environmental care, and social justice. Organic farming is an evolution of ancient practices and modern innovations, addressing ecological and socio-economic challenges. It has roots dating back to the 12th millennium when humans transitioned from hunting and gathering to cultivation. Advancements in crop rotation, fertile soil, and pest management practices have laid the foundation for organic farming principles.

Description of Organic Farming during the 20th Century

Albert Howard, Rudolf Steiner, and Eve Balfour were pioneers in the early 20th century, promoting soil health and composting (Heckman, 2006). J.I. Rodale introduced organic farming to the US (O'Sullivan, 2015), while Rachel Carson raised public support for

alternatives (Paull, 2007). The development of organic farming faced resistance from chemical companies and governments, but gained momentum with industry associations and consumer demand. Post-1990, legal frameworks like EU Regulation 2092/91 and USDA Organic standardised practices led to global growth in organic acres and retail sales.

Heritage and Challenges

Organic farming, initially scepticism, has evolved into a sustainable agriculture method, reducing synthetic inputs, promoting biodiversity, soil health, and climate resilience, despite challenges like higher labour costs and knowledge gaps.

Environmental Benefits

Organic farming offers numerous environmental benefits, addressing ecological issues like soil degradation, water pollution, and biodiversity loss associated with conventional practices like synthetic chemicals, monoculture farming, and mechanised methods, which harmonise with natural processes.

Soil Health and Fertility

Organic farming improves soil health by using natural alternatives like compost and manure, enhancing soil fertility and structure. Practices like crop rotation, green manure, and reduced tillage increase organic matter, improving soil quality, water repellency, and microbe diversity, enabling better withstand ability in erosion, flooding, and drought conditions.

Pollution and Chemical Runoff Decrease

Organic farming reduces environmental pollution by reducing the use of synthetic pesticides and fertilisers. By adopting natural pest management techniques and biological controls like beneficial insects, crop rotations, and companion planting, organic farmlands contribute less to water body pollution and reduce pesticide exposure risks.

Conservation of Biodiversity

Organic farming promotes biodiversity by creating complex ecosystems, reducing species diversity due to monoculture farming systems. It involves intercropping, agroforestry, and maintaining natural habitats, ensuring ecosystem health and improving resilience to pests and diseases.

Reduction in Greenhouse Gas Emissions

Organic farming has a lower carbon footprints than conventional agriculture, as synthetic fertilisers and organic carbon inputs contribute to greenhouse gas emissions.

Socio-Economic Impacts

Organic farming offers socio-economic benefits, particularly for smallholder farmers, by reducing production costs, enhancing profitability, and preserving soil fertility. It also promotes economic resilience, especially in rural areas, as agricultural livelihoods are the backbone of the community. Organic farming also provides social benefits, providing local employment, fostering cooperation, and improving farmworker health. As these practices spread, they support local economies, reduce dependence on external agricultural implements, and strengthen sustainable food systems.

Need for the study

Agriculture in organic form poses considerable potential contrasts to conventional agriculture, becoming a development model with

significant potential impact on environmental sustainability, human health, and rural economic viability. However, a thorough assessment of its multidimensional impacts remains limited. This study aims to fill crucial research gaps by synthesising existing evidence regarding the contribution of organic farming to sustainable agricultural development. There has been a plethora of studies that have explored specific aspects of organic systems; this review uniquely integrates findings from the environmental, economic, and social realms to afford a holistic evaluation. The study also establishes knowledge gaps on the yield gap, climate resilience, and scaling barriers, which ought to inform agricultural policy. As global food systems are facing innumerable challenges from climate change, resource depletion, and population expansion, this all-encompassing analysis of organic farming's strengths and weaknesses will be crucial for working towards evidence-based mechanisms that seek an equilibrium of high productivity with sustainability in the long run.

Literature Review

This section provides the various works on organic farming carried out by various research scholars.

The Rise of Organic Agriculture in Global Food Systems

Organic farming has grown significantly globally, with the total area under organic management increasing from 11 million hectares in 1999 to over 74.9 million hectares by 2023. This growth is driven by consumer demand for healthier, environmentally friendly foods and increased policy support. Organic agriculture is defined by its principles of health, ecology, fairness, and care, aligning with the Sustainable Development Goals. This review synthesises current research findings to assess organic farming's contributions to agricultural sustainability.

Soil Health and Fertility: Building the Foundation of Sustainable Agriculture

Organic farming has been shown to significantly improve soil health, with long-term comparative studies showing significant improvements in physical, chemical, and biological properties. Organically managed soils contain 20-40% more microbial biomass, 30-40% more earthworms, and 90% greater microbial activity compared to conventional systems (Fließbach *et al.*, 2007). This enhances soil ecosystem functioning and resilience. Soil Organic Matter (SOM) typically increases under organic management due to greater inputs of organic amendments and more diverse crop rotations. Organic farms maintain 3.5% higher soil organic carbon concentrations and 12.8% higher carbon stocks compared to conventional farms, providing dual benefits for soil fertility and climate change mitigation (Lori *et al.*, 2017).

Nutrient cycling in organic systems relies on biological processes rather than synthetic inputs, creating qualitative differences in nutrient availability patterns. Organic systems retain nitrogen more efficiently within the soil-plant system, reducing nitrogen leaching by up to 64% compared to conventional systems (Drinkwater *et al.*, 1998). Soil physical properties also improve under organic management, with increased aggregate stability, water infiltration rates, and water holding capacity. These improvements are particularly significant in climate change adaptation, as enhanced water retention can buffer against drought conditions and reduce erosion risk during intense rainfall events.

Biodiversity Conservation: Supporting Ecosystem Services in Agricultural Landscapes

Organic farming has been shown to have a significant positive impact on biodiversity conservation, with an average 30% increase in species richness compared to conventional operations (Bengtsson *et al.*, 2005). This is particularly significant for pollinators and predatory insects, which provide essential ecosystem services like pollination and natural pest control. The benefits of organic farming are attributed to the absence of synthetic pesticides, diverse crop rotations, and management practices like reduced tillage intensity and mixed farming (Hole *et al.*, 2005). The landscape context also plays a significant role in biodiversity outcomes, with organic farming's benefits most pronounced in homogeneous, intensively farmed landscapes. Soil biodiversity also shows significant responses to organic management, with microbial biomass and enzyme activities being 59% and 30% higher in organic systems. This enhanced biodiversity not only supports agricultural productivity but also improves pollination, natural pest control, and soil fertility (Crowder *et al.*, 2010).

Water Quality and Resource Management: Reducing Agricultural Pollution

Organic farming systems offer significant water quality protection by prohibiting synthetic pesticides and limiting soluble fertilisers, reducing agricultural pollutants entering ground and surface waters. Nitrogen leaching rates are 31% lower in organic systems compared to conventional agriculture, and nitrate leaching reductions range from 40-64%. Organic-approved pest management substances, such as copper-based fungicides, have lower water quality impacts than synthetic alternatives due to reduced persistence and lower application rates. Water use efficiency in organic systems varies depending on regional context and management specifics. In arid regions, improved soil structure and higher organic matter content can enhance water retention capacity by 20-40%, reducing irrigation requirements during dry periods (Gomiero *et al.*, 2011). The relationship between organic farming and water resource management becomes increasingly important in the context of climate change, with more frequent droughts anticipated in many agricultural regions. Watershed-level studies show potential landscape-scale benefits of organic agriculture for water quality, particularly when strategically implemented in high-leaching risk zones.

Climate Change Mitigation and Adaptation: Organic Farming's Carbon Footprint

Organic farming has the potential to contribute to climate change mitigation through various pathways, including increased soil carbon sequestration and reduced greenhouse gas emissions. Organic farms sequester an average of 3.5 metric tons of CO_2-equivalent per hectare per year more through soil carbon storage, with the greatest gains observed in arid regions. However, organic systems may produce higher emissions of certain gases under certain conditions, such as nitrous oxide and methane (Grandy, 2006). Life Cycle Assessments (LCAs) reveal system- and product-specific patterns, with organic products generally having lower carbon footprints per unit area but not necessarily per unit product due to the yield gap. Organic systems also have climate adaptation capacity, with enhanced soil

organic matter, improved water retention, and greater biodiversity, conferring greater resilience to extreme weather events. Research by Lotter *et al.* (2003) shows that organic corn and soybean systems have 28-33% higher yields during drought years due to better water retention and greater resilience to flooding in organic systems with well-developed soil structure (Gomiero *et al.*, 2011).

Productivity and Yield Comparisons: Addressing the Yield Gap

Organic agriculture's productivity comparison is a contentious issue, with studies showing that organic yields are generally 25% lower than conventional yields. However, this difference varies by crop type and management context (De Ponti *et al.*, 2012). Diversification practices like multi-cropping and crop rotations can help overcome the yield gap. Long-term systems trials show that organic systems can achieve 80% of conventional yields while using less fertiliser and energy. Theoretical modelling suggests that the current yield gap could narrow significantly with further research and innovation. Organic agriculture could potentially feed the global population without expanding agricultural land area, but only if combined with strategies to reduce food waste and shift dietary patterns. The yield gap discussion should be contextualised within broader sustainability goals (Reganold & Wachter, 2016).

Economic Viability: Farm Profitability and Market Development

Organic farming offers economic sustainability through improved farm profitability, market stability, and economic resilience. Despite lower yields, organic farms often achieve equal or greater profitability compared to conventional operations (Crowder & Reganold, 2015). A meta-analysis found that organic agriculture is 22-35% more profitable than conventional agriculture, with a benefit/cost ratio 20-24% higher. Price premiums are the primary economic driver offsetting lower yields, with average premiums varying across regions. Organic production costs show different patterns than conventional agriculture, with higher expenses for labour, organic inputs, and certification. The global market for organic food has grown significantly, but market infrastructure limitations create barriers for farmers transitioning to organic production. Organic farms typically implement more diverse crop rotations, resulting in more stable incomes and less vulnerability to input price volatility (Delbridge *et al.*, 2017).

Social Dimensions: Health, Employment, and Rural Development

Organic farming has significant social sustainability impacts, including improved human health, employment opportunities, and rural community development. It reduces the occupational hazard of pesticide poisoning, as organic farming eliminates synthetic pesticide use. Employment effects are positive but context-dependent, with organic farms employing 15% more workers per hectare than conventional operations (Boedeker *et al.*, 2020). Consumer health impacts are ongoing, with organic food containing higher antioxidant concentrations and lower levels of cadmium and pesticide residues (Finley *et al.*, 2018). Organic farming also fosters social capital development in rural areas through direct marketing, agritourism, and value-added processing (Jansen, 2000). The educational aspect of organic farming extends to consumers, with farm visits and direct marketing creating opportunities for public

engagement (Baudry *et al.*, 2018). However, equity considerations in organic agriculture remain complex, with participatory guarantee systems and group certification models emerging to address challenges (Beuchelt & Zeller, 2011).

Organic agriculture policy support has evolved significantly over the past few decades, with key mechanisms such as financial incentives, maintenance payments, and market development support being effective in promoting organic transitions. Europe has the most supportive policies, with the EU aiming to convert 25% of agricultural land to organic by 2030. The economic rationale for public support of organic agriculture is partly due to its provision of public goods and positive externalities, such as enhanced ecosystem services and rural employment. However, tensions between original organic principles and regulatory minimums have emerged, leading to the participatory guarantee systems movement. Research and extension policies tailored to organic systems remain underdeveloped in most regions, with less than 1% of published agricultural research specifically addressed (Lockeretz & Anderson, 1993).

Research Design

The study uses a quantitative research approach to evaluate the impact of organic farming on sustainable agriculture development, using a descriptive survey design to analyse farmers' experiences, production methods, economic outcomes, and environmental impacts in the study area.

Statement of the Problem

Even though the harm to the environment and side effects of using chemicals in farming have become more widely known, organic methods are still not widely used in agricultural areas specific to the Mandya region. Farmers encounter issues relating to declining soil fertility, heavy dependence on rain due to lack of irrigation facilities, fewer types of crops and rising input prices. All these factors impact the continuous and sustainable success of agriculture. The claim that organic farming is environmentally friendly and efficient lacks empirical evidence specific to the Mandya region. This study aims to find out if organic farming helps the local economy, protects the environment and boosts the lives of farmers in Mandya and what challenges or drivers affect people's ability to adopt it.

Objectives of the Study

(i) To analyse the socio-economic profile of organic farmers in the Mandya district.

(ii) To identify determinants influencing their adoption of organic farming practices.

(iii) To measure the economic viability of organic farming by comparing production cost, yield pattern, and income generation with those of conventional farming in the area under study.

(iv) To identify the major challenges and constraints faced by organic farmers in Mandya district in terms of production, certification, and market access.

(v) To study the relationship between different characteristics of farmers and farms with the economic success of organic farming enterprises using regression modelling.

Study Area

The research was conducted in Mandya district, Karnataka, due to its significant organic farming activities and diverse agro-ecological conditions. The district, known for its canal irrigation systems and cultivation of crops like rice, sugarcane, and vegetables, is an ideal location to study various aspects of organic agriculture implementation.

Sampling Procedure

The study used a purposive sampling technique to select 50 farmers in Mandya district who have been practising organic farming for at least three years, ensuring substantial experience and a sample size based on research objectives, available resources, and statistical requirements.

Data Collection

The study used a structured questionnaire to gather information on farmers' socio-economic characteristics, organic farming practices, production inputs, yields, marketing channels, income, challenges, and perceived benefits of organic farming. Field assistants were available for clarification, and questionnaires were completed and reviewed. Secondary data was sourced from government reports, Karnataka State Department of Agriculture, local agricultural extension offices, organic certification bodies, and published literature to complement the primary data.

The collected data was analysed using both descriptive and inferential statistical techniques.

Descriptive Statistical Analysis

Percentage analysis was employed to examine the distribution of respondents across various categories, including demographic characteristics, farm size, types of organic crops grown, certification status, marketing channels utilised, and perceived benefits of organic farming. Results are presented using frequency tables, charts, and graphs to facilitate easy interpretation and comparison.

Regression Analysis

The regression analysis revealed that factors such as farm size, education, farming experience, access to credit, and market access significantly impact the productivity and profitability of organic farming systems.

Independent Variables (IVs)

Age, education level, farming experience, and land holding size.

Dependent Variable (DV)

Economic success of organic farming operations (measurable through: "Organic farming has improved the overall economic viability of my farm operation", and "Percentage premium price received").

Hypotheses of the Study

H1: There is a significant relationship between farmers' socio-economic characteristics (age, education, farm size, and farming experience) and the economic success of their organic farming operations.

H2: Organic farming practices significantly improve the economic viability of agricultural operations compared to conventional farming methods in the Mandya district.

Data Analysis

From Table 1, we can analyse that

(i) Middle-aged farmers participate more in organic farming, potentially due to experience and sustainable practices, while younger and elderly farmers participate less, indicating age-specific hurdles.

(ii) Organic farmers in Mandya district have moderate literacy, with secondary education being the majority, which may limit their access to organic agricultural information.

(iii) Organic farmers typically have 11-20 years of experience, with a lower percentage under 5 years, suggesting perceived hazards may deter adoption.

(iv) Marginal farmers benefit most out of organic farming practices compared to landholders

(v) Mandya's traditional agricultural profile includes rice as the dominant crop, while diversification into vegetables reflects market demand for organic produce in high-value crops.

(vi) Organic farmers have a local market orientation, limiting integration with specialised value chains, with producer organisations acting as intermediaries and export market access being limited.

(vii) The majority of the farmers lack specialised credit facilities for organic farming, limiting investment in infrastructure due to reliance on general agricultural loans or difficulties accessing tailored finance.

(viii) Organic farming practices lead to cost reduction due to decreased dependency on chemical inputs. However, some may experience increased costs during transition years.

(ix) Most organic farmers in Mandya have modest price premiums, suggesting limited market differentiation or consumer willingness to pay for organic products in accessible markets.

The analysis of regression results for organic farmers in Mandya (Table 2) reveals that the amount of variation in economic success explained by the chosen characteristics (age, education, farming experience and landholding

Table 1. Demographic and Other Categorical Responses of the Respondents

Age	41-50 years	21%
Education	Secondary (6-10 standard)	19%
Farming Experience	11-15 years	34%
Land holding	1-2 hectare	46%
Crop type	Rice	74%
Marketing channel	Direct sales	74%
Authentication	Organic farming certification	36%
Access to credit	Short-term loan (Crop loan- unsecured)	38%
Economy	Lower production cost	38%
Price premium	Modest price premium	34%

Source: Desk Research

size) is quite low. Overall, less than 3% of the change in economic performance is connected to the independent variables included, as indicated by R-squared.

Statistical analysis in Tables 3 and 4 indicates that the selected socio-economic variables are not linked to economic success. The F-statistic at 1.4441 indicates the goodness of fit of the model. However, the significance value of 0.241 indicates no significant impact of socio-economic variables on the economic success of organic farming.

Table 2. Regression Statistics

Regression Statistics	
Multiple R	0.17
R Square	0.0289
Adjusted R Square	0.0089
Standard Error	0.519
Observations	50

Source: Desk Research

Discussion and Conclusion

The analysis makes it clear that we need policies to foster an excellent environment for organic farming. If the market is better linked, services could be improved, access to certification is made easier, and credit facilities are established, people will be more likely to take up and succeed with new technologies. Structural reforms can streamline the support mechanisms provided to farmers adopting organic farming. The change would play a big role in reaching the main objectives for sustainable farming in India.

The study reveals obstacles and potential in organic farming in the Mandya district. The majority of the farmers considered as sample respondents for the study practice organic farming. They have a secondary education as their background. The land distribution is similar to broader agricultural patterns, with small and marginal farmers making up 64% of practitioners. Only 38% of select respondents have an official organic farming certification.

Table 3. ANOVA

	df	SS	MS	F	Significance F
Regression	4	0.7781	0.1945	1.4441	0.241
Residual	45	6.0689	0.1349		
Total	49	6.847			

Source: Desk Research

Table 4. Coefficient Statistics

	Coefficients	Standard Error	t Stat	p value	Lower 95%	Upper 95%
Intercept	1.5541	0.2037	7.6275	0.0000	1.1497	1.9585
Age	-0.1199	0.1006	-1.1919	0.2362	-0.3197	0.0798
Education level	0.0635	0.0546	1.1629	0.2477	-0.0449	0.1719
Farming experience	0.045	0.0600	0.7500	0.4560	-0.0760	0.1660
Land holding size	0.08	0.0700	1.1429	0.2580	-0.0610	0.2210

Source: Desk Research

Technical constraints include input accessibility and pest management facilities. They have limited exposure to market opportunities. The majority depend on unsecured short-term agricultural loans and lack access to institutional loans. Despite these hurdles, farmers claim increased soil quality, biodiversity, cost reductions, and economic viability as advantages of organic farming. Government support is low, suggesting improving institutional support, market growth, and access to organic inputs could improve the adoption rates.

The success of organic farming is not primarily determined by socio-economic factors but by the comprehensive application of organic practices. The study suggests holistic policy interventions to create an enabling ecosystem for organic farming, such as strengthening market linkages, enhancing extension services, and developing specialised credit facilities.

Since socio-economic factors only partly explain economic success among organic farmers. Future studies can include factors such as the use of organic products, training and policy support from the government, water conservation techniques, membership in cooperative societies, *etc*. In addition, researchers can adopt focus group interview methods and case studies that can help understand the qualitative factors that shape success that cannot be measured with numbers. Furthermore, dividing farmers into small and large groups or new and experienced organic farming participants could uncover information that is not present when all farmers are analysed as a single group. This method enables us to customise support services for each type of farmer.

In addition, time-series research can help us monitor the long-term economic changes caused by organic agriculture. With the current cross-sectional information, it is not possible to account for seasonal or yearly differences in income, yield or access to the market. The government must concentrate on making the market, storage systems, certification and training better for organic farmers. Programs for farmers that teach them about recent organic farming technologies and sustainability would be beneficial too. Researchers can apply logistic regression, path analysis or structural equation modelling to obtain better analysis.

The challenges in organic farming are closing the yield gap that can be improved by breeding programs, enhanced biological pest management strategies, and precision organic technologies. Climate change adaptation is another challenge, with research focusing on developing drought-resistant systems and climate-adaptive crop varieties. Ensuring equitable access to organic markets globally is another challenge, with producers in developing regions often facing barriers. Participatory guarantee systems and digital technologies can help build local organic markets while minimising certification costs. Integrating traditional agricultural knowledge with modern organic science can enhance productivity and cultural relevance in developing regions (Scialabba & Müller-Lindenlauf, 2010). Technology adoption in organic agriculture presents trade-offs between efficiency and adherence to core principles, with debates surrounding new breeding techniques like CRISPR gene editing. (Baars, 2011)

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