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REVIEW ARTICLE

Natural farming and its global adoption - A bibliometric analysis literature review

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Abstract

Natural farming, introduced by Masanobu Fukuoka, provides a sustainable alternative to traditional farming by tackling issues like soil damage, chemical use, and environmental harm. This study looks at global research on natural farming from 2018 to 2024, focusing on research trends, themes, and factors influencing its adoption. A review of 210 publications was conducted using Scopus, following PRISMA guidelines, with analysis done using R Studio and VOS viewer. India is the leader in natural farming research, with 135 publications, driven by government policies that support sustainability. Other key contributors include China, Italy, and the United States. The analysis identified three main themes: environmental sustainability, economic benefits, and adoption strategies. The citation analysis highlighted important researchers like Bharucha and Venkateshmurthy. The main reasons farmers adopt natural farming include better soil health, less chemical use, lower costs, and greater climate resilience. Techniques like Zero-Budget Natural Farming (ZBNF), which includes practices like Jeevamritha and organic mulching, are vital for improving soil fertility and cutting down on input costs. This study shows that natural farming can help balance the environment, improve farmer incomes, and encourage more sustainable practices. Future research should explore the role of digital technologies and cooperation between countries to expand natural farming worldwide.

Keywords

adoption strategies; environmental impact; global research trends; natural farming; sustainability; Zero-Budget Natural Farming (ZBNF)

Introduction

India's economy has always been based mostly on agriculture. More than half of the nation's population currently make their living from agriculture and related services (1). India's agriculture economy is well-known globally. Indian agriculture has come a long way since it first started, according to history. Given its status as the world's second most populous nation, India is under constant pressure to feed its rapidly growing population (2). Beginning in the 1960s, the Green Revolution placed a strong emphasis on boosting productivity through the extensive use of pesticides and high-yielding cultivars, while largely ignoring the sustainability of the environment and the soil. While this has aided in reaching the output goal, there have been several unfavourable consequences in recent years, including soil infertility,

declining water tables, greenhouse gas emissions, biodiversity losses, and rising production costs that have left farmers heavily in debt (3).

After the Green Revolution (GR) era, India's food production skyrocketed and it achieved self-sufficiency. These days are long gone, ship to mouth. Utilising GR technology such as chemical fertilisers, irrigation, mechanisation, high-yielding seed types, intensive cropping systems, and irrigation, the nation has become self-sufficient in food and is even exporting a variety of agricultural products (4-6). On the other hand, the primary cause of agricultural intensification is the careless use of chemical fertilizers and agrochemicals, which has led to the deterioration of soil, eutrophication of water systems, and global warming. Agroecosystems' primary limiting factor is their soil, which is difficult and takes a long time to replenish (7).

To save soil, water, biodiversity, and human health, worldwide governments are increasingly recommending organic farming and other sustainable agricultural projects. The majority of organic agricultural systems suggest substituting manufactured or industrial organic products for external chemical inputs (8). Natural and organic farming were used as novel solutions to the problems of agricultural yields and soil fertility (9).

Natural farming – An overview

The naturalist and philosopher Masanobu Fukuoka (1913–2008) developed the idea of natural farming in Japan (10). Global attention is now focused on sustainable agriculture, which aims to solve social, economic, and environmental issues while maintaining food security and agricultural production (11,12). Organic farming is practiced in various nations. A rising number of people in the Indian subcontinent and throughout the world are becoming aware of these important issues and are interested in using natural and organic agricultural methods and natural farming (13). Natural farming techniques are among the methods that can enhance food safety standards (14). Working with nature to create nutritious food, maintain our health, and maintain the health of the land is the idea of natural farming. Every element of nature has a function and a purpose in the larger scheme of things (15).

The goal of natural farming is to preserve the environment, communities, and public health by using it as an innovative strategy to advance traditional and modern agricultural practices (16). Several natural farming management techniques have been developed to achieve these goals, including the use of biofertilizers, crop rotation, intercropping, reduced tillage, mulching with plant waste, and eliminating agrochemicals. To promote microbial growth, seed health, and soil fertility, ZBNF mainly uses materials like Jivamrit, Bijamrit, and Acchadana (natural mulch). Despite this, it seems that ZBNF is making progress in protecting the environment (17,18). These methods resemble those used in organic farming, which has been suggested as a more sustainable approach to agricultural production than conventional farming (19-22).

In the agricultural world, natural farming practices are still in their infancy and are just now beginning to be accepted. According to data published by the Department of Agriculture & Farmers Welfare GOVT of India, there were 9.5 lakh hectares of natural farming in 17 states in India in 2022–2023. It is estimated that there are 20.08 lakh farmers in these states that practice natural farming. Numerous states have created effective models for natural farming and are already permitting it. Among the top states are Kerala, Uttar Pradesh, Gujarat, Himachal Pradesh, Karnataka, and Andhra Pradesh. Andhra Pradesh (2.9 lakh hectares) has the largest area under natural farming, followed by Gujarat (1.86 lakh hectares) (23)

Natural farming is essential to sustainable agriculture because it increases biodiversity, improves the health of the soil, and uses fewer chemicals, all of which have positive long-term effects on the environment and the economy. Research indicates that it increases the amount of organic matter in the soil and its ability to absorb water, so building strong agricultural systems and protecting ecosystems and biodiversity are essential for maintaining ecological balance and ensuring food security. There are more research publications on the subject of natural farming, which suggests that it is an important issue in academic discussions. It also highlights the importance and scope of this field's study.

The primary goal of this study is to trace the evolution and direction of research on the Adoption of natural farming and to Identify research gaps through bibliometric analysis, addressing a previously unexamined area. Specifically, this study aims to

- To examine the Country's scientific production in the adoption of natural farming studies,
- To assess the bibliographic coupling of documents related to natural farming and its global adoption,
- To examine the author citation network,
- To analyse the main reason for the adoption of natural farming practices.

Methodology

In this study, bibliometric analysis of Natural farming research is carried out using a methodological manner. Specific keywords related to natural farming elements were used to gather articles from academic databases such as Scopus. The chosen articles will be analysed using bibliometric approaches, and to study the trending topics, citation analysis, and Country collaboration networks visualised with a programme like R studio and Vos viewer. For the systematic review, this study used the Preferred Reporting Items for Systematic Reviews (PRISMA) approach. The keywords that were utilized for the literature searches from the database are given in Table 1. Inclusion and exclusion criteria were established for the initial screening of the publications listed in Table 2.

The literature was identified using Table 1. The total number of studies discovered in each database using the aforementioned search criteria is shown in Table 1.

Table 1. Combination of keywords used and the total number of publications from databases

Data-bases	Search terms	Numbers of articles
Scopus	"Natural farming" OR "ecofriendly farming*" OR "zero budget farming*" OR "Traditional farm*" OR "Eco friendly*" AND "uptake" OR "Adopt*" OR "Adoption"	5833

Table 2. The Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Time span	2018-2024	<2018
Document type	Article	Conference papers, Book chapters, review, Editorial
Languages	English	Non-English
Source type	Journal	Trade journal
Publication stage	Final	Press
Keywords	Sustainability, sustainable development, eco- friendly, environmental protection, environmental impact, sustainable agriculture, agriculture, water pollution, alternative agriculture, adoption, environmental sustainability, organic farming, environmental technology, natural farming	All other keywords
Open access	All open access	Restricted access
Screening		
Title and abstract	Existence of predefined keywords in the titles and abstracts were included in the study.	
Full text	The relevant papers that have been included in this study are those that discuss the predefined key words.	

A total of 5,833 records were retrieved from the Scopus database search.5598 were eliminated throughout the screening process using inclusion and exclusion criteria. 235 pieces of literature were retrieved via the automatic filters supplied by the databases. The number of literatures was reduced to 210 papers after skimming the relevant title and keywords. Based on screening, 210 well-researched publications were chosen for the review from the PRISMA flow diagram (Fig. 1). R studio and Vos Viewer were utilized to write systematic reviews.

Results and Discussion

Country scientific production

A literature analysis of the Scopus database was conducted using R Studio. Fig. 2 highlights the global distribution of research on natural farming, with India leading with 135 publications. This reflects the country's strong policy focus on sustainable agriculture and the growing interest of researchers in addressing farmers' challenges.

China, with 87 publications, demonstrates growing interest in eco-friendly practices aligned with its environmental and food security goals. Italy, contributing 79 publications, underscores Europe's engagement, driven by its tradition of organic farming and sustainability.

The United Kingdom, Malaysia, and the USA contribute 50, 42, and 42 publications, respectively, The reflecting increasing interest in sustainable food systems and climate-resilient agriculture. South Korea with 34, Germany with 25, Iran with 23 and Portugal with 23 also show notable involvement, indicating a global recognition of natural farming's potential.

Document of bibliometric coupling

The bibliometric coupling network shown in Fig. 3 reflects the intellectual connections within the research field of natural farming adoption. The visualization, created using VOS viewer, categorizes documents into distinct clusters based on shared references. Each cluster is represented by a unique colour, signifying thematic groupings within the field. For example, the green cluster, which includes influential works such as (24,25), may represent studies focusing on the environmental benefits and strategies for natural farming adoption. Similarly, the purple and orange clusters likely signify other thematic areas, such as economic impacts or policy frameworks influencing the adoption process.

The size of each node represents the significance of the document in the network, often correlating with citation frequency or centrality in bibliometric coupling. Larger nodes, such as (26,27), indicate highly influential works that serve as key intellectual foundations for the research area. These documents are pivotal in shaping the understanding and development of natural farming practices globally. Nodes like (28,29) represent more recent contributions, suggesting ongoing research in emerging areas of interest within the domain.

The connections between nodes, represented by lines, denote the strength of bibliometric coupling, which highlights shared references among documents. Thicker lines, such as those between (27,30), indicate strong coupling, suggesting that these works share a significant intellectual base. In contrast, nodes like (31) in the red cluster exhibit relatively isolated connections, which may signify a distinct research focus, such as regional policy challenges or niche adoption strategies.

Network of author citation

Fig. 4 represents a network of author citations within the research domain of natural farming adoption, constructed using a VOS viewer. In this visualization, each node signifies an author, while the connections between nodes indicate citation relationships. The size and position of the nodes are indicative of the author's influence in the field, often based on the number of citations their work has received. Among the authors, "Bharucha, Zareen Pervez" is prominently central, suggesting that their research has had a significant impact on advancing knowledge about natural farming and its global adoption.

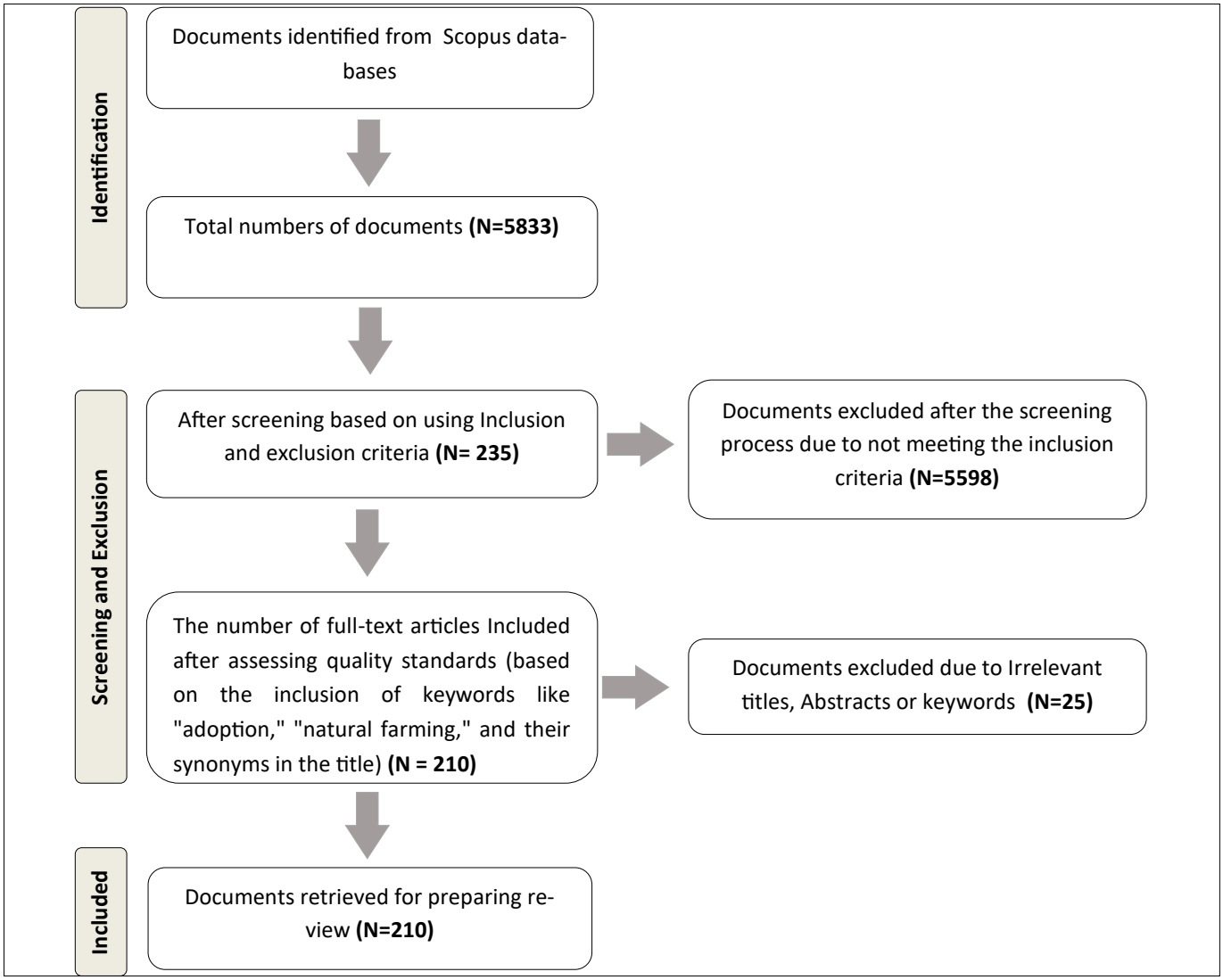

Fig. 1. PRISMA flowchart depicting the search literature for a systematic review of the Adoption of Natural farming.

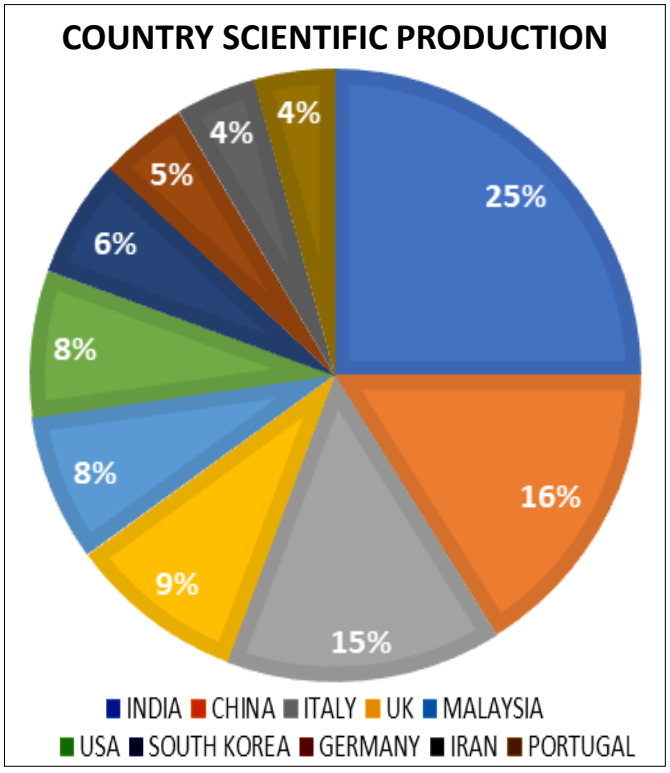

Fig. 2. The country Scientific Production.

The structure of the network shows a radiating pattern, with multiple authors, including "Mohan, Sailesh," "Osbahr, Henny," "Jaacks, Lindsay M.," and "Venkatesh murthy, Nikhil Srinivasapura," forming connections with the central node. These connections represent shared research interests or overlapping citations, indicating collaboration or thematic alignment. For example, the link between "Bharucha, Zareen Pervez" and "Venkateshmurthy, Nikhil Srinivasapura" could highlight joint research efforts or a common focus on topics such as the environmental and socio-economic aspects of natural farming.

The variety of connections in the network illustrates the interdisciplinary nature of natural farming adoption research. It encompasses fields like agriculture, sustainability, policy, and socio-economics. Certain authors, such as "Collins, Chris D." and "Sizmur, Tom," addressing specific themes, such as soil health and ecological practices, while authors like "Pulugurtha, Karthik Teja" and "Shaw, Liz J." represent emerging contributors or focus on more specialized areas within the field.

The citation network highlights collaboration and intellectual connections among researchers in natural farming, identifying key contributors and emerging trends. It offers a clear overview for exploring studies and fostering future research.

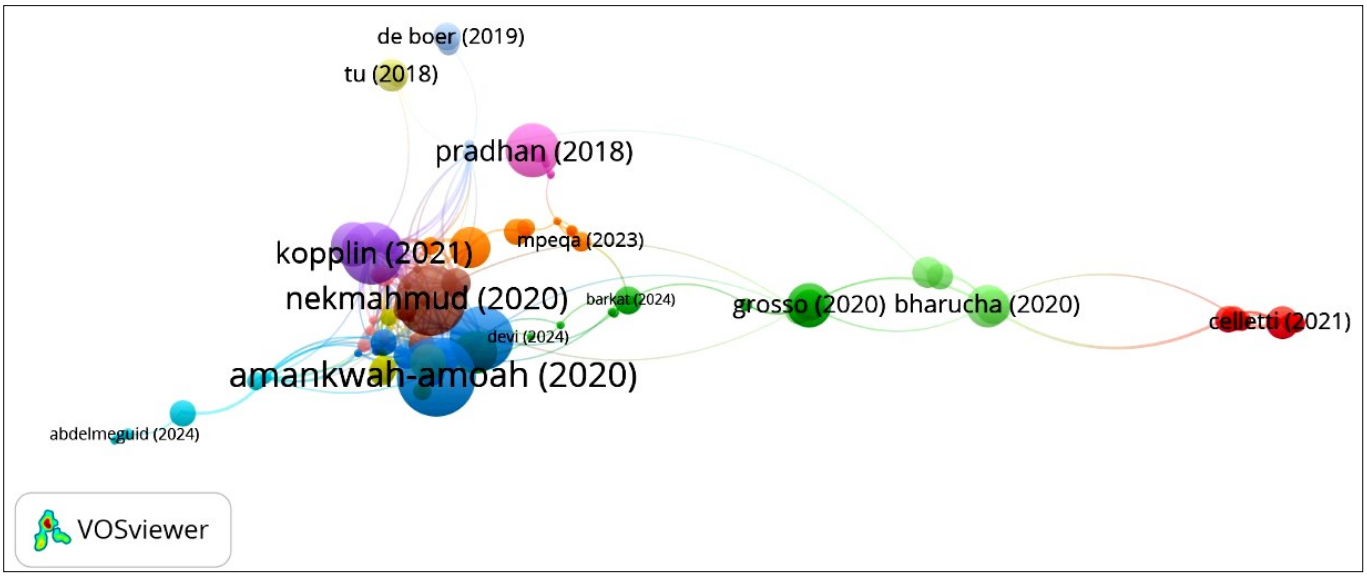

Fig. 3. The document of Bibliometric coupling.

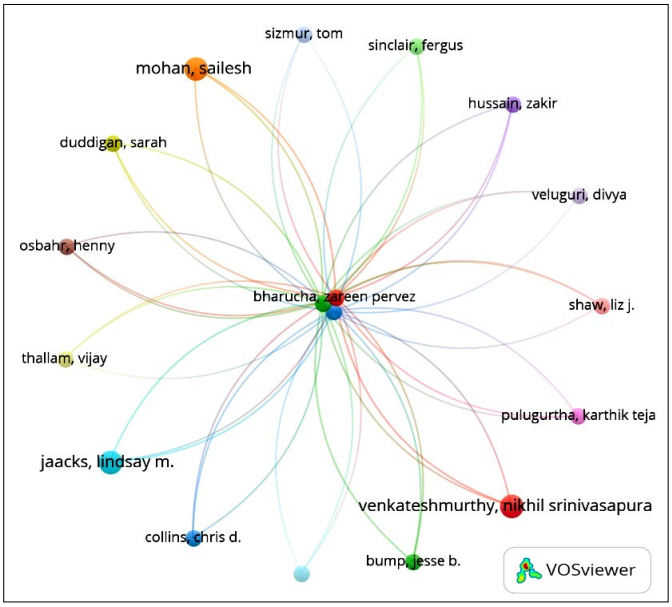

Fig. 4. The network of Author citation.

The main reason for the adoption of natural farming practices

The worldwide shift towards adopting natural farming practices is fuelled by a variety of factors, including environmental, economic, and socio-cultural considerations. These factors highlight not only the growing interest in sustainable farming methods but also a shift toward ecological stability, cost reduction, and resilience to climate fluctuations.

In India, (32) demonstrated that practices like intercropping, mulching, and using cow-based inputs were motivated by the desire to reduce reliance on chemical inputs, enhance soil health, and bolster ecological resilience. These techniques offer cost-effective solutions and are particularly significant for smallholder farmers facing high input costs. Likewise, (10) observed that farmers adopting Beejamrit, Jivamrit, and mulching for crops such as soybean, chili, and maize were primarily focused on minimizing input costs, maintaining soil fertility, and reducing pest incidences, further illustrating the financial benefits of adopting natural farming systems.

The adoption of practices that manage pest problems while boosting crop yields is also a key driver. In Kenya, (33) examined the use of Push-Pull technology, agroforestry, and legume intercropping in maize, sorghum, and bean cultivation. These strategies effectively controlled pests like the fall armyworm and stemborer, which significantly impact crop yields. The integration of pest control with sustainable farming methods highlights the multifunctionality of natural farming in promoting long-term sustainability and securing farmer incomes.

In India, (34) reported that the adoption of practices like Jeevamritha, Ghanajeevamritha, and bio-mulching for crops like paddy, sugarcane, and black gram was driven by the need to reduce dependency on synthetic chemicals, improve microbial health in the soil, and reduce farming costs. These findings emphasize a growing focus on soil health and sustainable farming as critical components in natural farming systems. Similarly, (25) found that practices like Bijamrita, Jivamrit, and mulching led to increased yields, enhanced soil health, and better resilience to extreme weather events, such as improved water retention during droughts, reduced soil erosion during heavy rains, and higher tolerance of crops to temperature fluctuations, highlighting natural farming's potential to address climate change impacts.

In terms of environmental considerations, conventional and organic tomato cultivation were compared using life cycle assessment (LCA) to demonstrate that organic farming significantly reduces greenhouse gas emissions and other environmental impacts (35). This reflects a larger global trend towards environmentally sustainable farming practices, which are motivating farmers to embrace natural farming, especially in areas that are vulnerable to climate-related challenges.

Kenya, emphasized eco-friendly farming practices, such as minimum tillage, crop rotation, and agroforestry, which improve yields, promote biodiversity and protect soil health (36). These practices were also seen as economically beneficial, further encouraging smallholder farmers to adopt them. The ability of these methods to promote climate resilience and conserve water resources further

underscores the importance of natural farming in addressing issues like water scarcity and biodiversity loss.

Climate-Smart Agriculture (CSA) practices, such as watershed development and the use of Soil Health Cards (SHC) examined in India, which are aimed at enhancing productivity, improving water management, and addressing the vulnerabilities posed by climate change. These practices reflect a growing trend to integrate natural farming methods with broader climate resilience strategies, particularly in regions prone to droughts and erratic weather patterns (37).

The impact of reduced, zero, and conventional tillage practices in rice and wheat cultivation explored in India by (38). These methods are intended to conserve water, reduce labour costs, and enhance soil fertility, demonstrating how natural farming practices are also driven by economic considerations. By making farming more efficient and profitable, these techniques are gaining popularity, especially in water-scarce regions.

In Malaysia, natural farming techniques like crop rotation, mulching, and natural weed control benefited marginalized rural communities by increasing household incomes, lowering food expenses, and ensuring sustainable livelihoods (39). These benefits are key for regions where economic stability is heavily dependent on agriculture, showing that natural farming methods can improve both the economic and social well-being of farmers.

The adoption of conservation agriculture practices such as no-tillage, crop diversification, and soil-covering techniques in China were examined by (40). These methods are designed to prevent environmental degradation, reduce agrochemical use, and enhance soil quality. This trend reflects a broader global movement toward reducing the environmental impacts of traditional agriculture through more sustainable farming practices.

In Morocco, emphasized the implementation of agroecological techniques like crop rotation, manure application, and intercropping, helps in reducing chemical inputs, enhancing crop resilience, and maintaining soil fertility. These methods not only support eco-friendly farming practices but also play a crucial role in sustaining agricultural productivity over time (41).

Zero-Budget Natural Farming (ZBNF) practices, including seed coating, soil microbe enhancement, and cover cropping, are gaining traction in India, as noted by (42). These techniques are being adopted to reduce input costs, promote soil health, and decrease reliance on external inputs. ZBNF represents a growing alternative to conventional farming methods, particularly in areas where cost reduction and sustainability are of utmost importance.

In India, the impact of Zero Budget Natural Farming (ZBNF) on crops like aubergine, chili, groundnut, and tomato, and utilizing practices such as organic mulching, Bijamrita, and Jeevamritha were studied. The findings revealed that ZBNF enhanced soil moisture retention, promoted biodiversity, and reduced input costs by replacing chemical fertilizers with organic alternatives. Moreover, these practices ensured more consistent yields even under varying climatic conditions, establishing ZBNF as a sustainable and cost-effective farming approach (43).

The development of certification tools, such as the Certified Evaluation Tool for Agriculture Resource Analysis of Natural Farming (CETARA-NF) discussed by (44), is also supporting the widespread adoption of natural farming by lowering certification costs and improving market access for farmers. These tools help build consumer trust and encourage sustainable practices, further facilitating the adoption of natural farming methods on a larger scale.

In the Chittoor district of Andhra Pradesh, India, A Study (45) examined how participatory system dynamics promote climate-resilient agriculture, leading to reduced groundwater use, improved soil productivity, and better financial stability. This approach highlights the growing recognition of the need for climate-adapted, sustainable farming solutions that not only ensure environmental benefits but also strengthen the economic position of farmers.

CSA methods like ZBNF, conservation agriculture, and the System of Rice and Wheat Intensification (SRI), were investigated which focus on improving water-use efficiency, reducing greenhouse gas emissions, and combating the adverse effects of climate change (46). These practices reflect a growing global interest in adopting farming systems that are both resource-efficient and climate-resilient.

Use of natural farming inputs like Ghanajeevamritha, Jivamrit, and Beejamrit in rice and wheat cropping systems examined (47). These practices were shown to improve soil nitrogen uptake, boost soil microbial health, and support sustainable yields, further emphasizing the importance of soil health in the global adoption of natural farming techniques.

Food waste composting in rural China and found it to be a beneficial practice for sustainable agriculture (48). The key advantages of composting include reducing the use of chemical fertilizers, improving environmental sustainability by recycling organic waste, and mitigating health risks associated with chemical residues in crops. Additionally, composting helps lower production costs by eliminating the need for purchased fertilizers. Overall, the study highlights food waste composting as an eco-friendly, cost-effective solution that promotes healthier farming and environmental conservation.

The compiled studies demonstrate varying levels of adoption influenced by geographic, socio-economic, and cultural contexts based on their reasons for adoption. A synthesis of these findings highlights the percentage of the reasons for adopting natural farming practices globally which was mentioned in Fig. 5.

From Fig. 5, the percentages of various reasons cited for adopting natural farming practices, highlight its multifaceted Appeal across environmental, economic, and social dimensions. The most significant reason for adoption is its ability to promote soil health, accounting for the highest percentage. This underscores the importance of

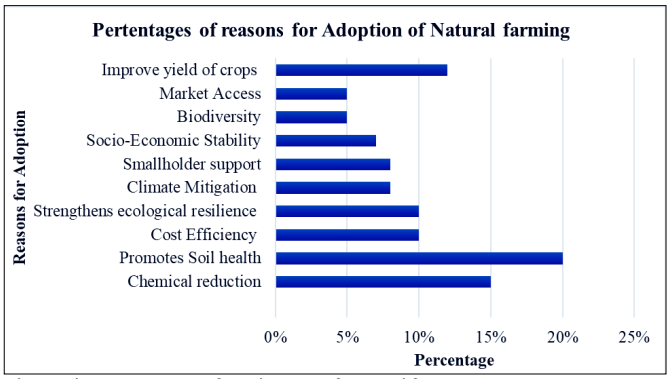

Fig. 5. The major reason for Adoption of Natural farming.

sustainable soil management practices as a cornerstone of natural farming, ensuring long-term agricultural productivity. The second most prominent reason is the reduction of chemical inputs, reflecting widespread concerns about the adverse impacts of synthetic chemicals on the environment, human health, and ecosystems. This aligns with the global trend toward eco-friendly agricultural approaches.

Cost efficiency emerges as another key driver, emphasizing the economic viability of natural farming, particularly for resource-constrained farmers seeking to reduce expenses on chemical fertilizers and pesticides. Some other factors, like making ecosystems more resilient and reducing climate change, are also pretty important. This shows how natural farming can help people adapt to changing weather and make ecosystems more resilient overall. Socio-economic stability and support for smallholder farmers are also notable reasons for adoption. This shows that natural farming has social and political benefits by reducing reliance on outside inputs and ensuring livelihood security.

While improving crop yields and accessing markets are relatively less prominent motivations, their presence indicates that natural farming is valued not only for its ecological benefits but also for its potential to enhance productivity and commercial viability. Lastly, biodiversity conservation is mentioned by a smaller proportion, reflecting a growing awareness of the role of natural farming in preserving biological diversity and supporting ecosystem services. Overall, the chart reveals that the adoption of natural farming is driven by a combination of environmental, economic, and socio-political factors. These insights are crucial for shaping global strategies to promote natural farming by addressing the primary concerns and motivations of adopters effectively.

Conclusion

Natural farming provides a sustainable solution to global agricultural challenges by enhancing soil health, protecting biodiversity, and minimizing reliance on chemical inputs. This study underscores India's prominent role in adoption and research, while highlighting the increasing global interest, due to its importance in food security, ecological balance, and socio-economic growth. Despite its potential, research gaps remain, including a limited understanding of challenges faced by farmers, socio-economic effects, and scalability across varied regions. Future research should investigate long-term environmental and economic outcomes, develop region-specific approaches, and strengthen supportive policies. Leveraging digital tools, knowledge-sharing platforms, and inclusive markets can further promote widespread adoption.

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Authors' contributions

HN carried out the survey, analysed the data, and formulated the manuscript, CFC assisted in data collection and Analysis as part of the research study, KC contributed by developing ideas, reviewing the manuscript, and assisting with procuring research grants, TSP helped in summarizing and revising the manuscript, MS contributed to summarizing and JRA provided additional support and contributions to the research study

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None

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