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Adoption dynamics of natural farming in Himachal Pradesh: Insights into practices, profiles, and policy gaps

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Abstract

This study examines the adoption of Natural Farming in Himachal Pradesh, India, aiming to identify gaps and inform policy for sustainable agriculture. Data were collected from 384 farmers across twelve districts using a pre-tested questionnaire and a combination of purposive and multistage random sampling. Results indicate high adoption of Beejamrita and Jeevamrita (85.7%), but low uptake of Whapasa (16.7%) and crop rotation (3.1%), with 83.1% of farmers showing moderate adoption. Female farmers (63%) and marginal landholders predominate. Limitations include the study's quantitative focus and regional scope, which may limit generalizability. The findings underscore the need for enhanced training, policy support, and extension services to promote widespread adoption of Natural Farming practices.

Keywords: Adoption dynamics, Himachal Pradesh, natural farming, policy gaps, sustainable agriculture

Introduction

Agriculture forms the cornerstone of India's economy, intricately woven into its historical and cultural fabric. Blessed with varied climate, landscapes, and soil types, India sustains a broad spectrum of farming practices. This sector engages a significant portion of the population and accounts for 15.9 per cent of the nation's GDP, as reported by the Ministry of Finance, Government of India (2025) ^[12]. India's agricultural landscape is vibrant and varied, blending time-honored farming practices with contemporary agricultural innovations. The Green Revolution's technological advancements significantly increased crop yields and incomes compared to traditional practices (Panneerselvam *et al.*, 2011) ^[13]. However, the resulting intensive farming, reliant on chemical pesticides, fertilizers, and heavy irrigation, has led to environmental degradation and health risks from exposure to synthetic chemicals (Bhattacharyya *et al.*, 2015) ^[3]. In response, eco-friendly approaches like agroecology and sustainable intensification have gained traction as alternative production methods, better aligned with the United Nations' Sustainable Development Goals (SDGs).

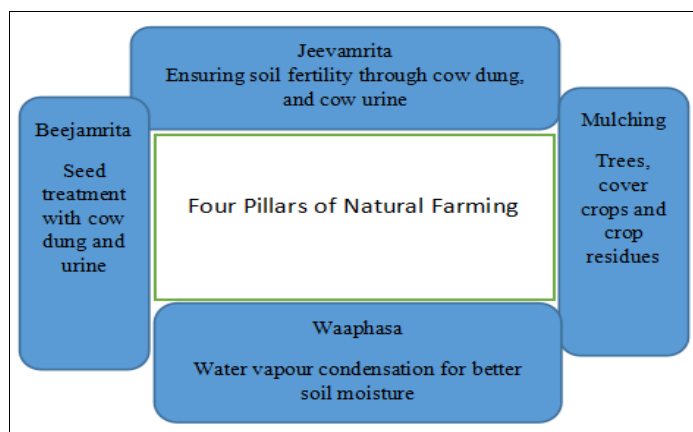
Organic farming contributes to poverty alleviation and food security by enhancing yields in low-input regions, preserving biodiversity, and protecting natural resources both on farms and in surrounding ecosystems (Masoodi *et al.*, 2022) ^[11]. According to Shanmuka *et al.* (2024) ^[14], natural farming, a type of regenerative agriculture, is distinguished by its unique practices and principles, setting it apart from other regenerative agricultural systems. Organic farming prioritizes environmental health, adopting an eco-friendly approach that serves as a natural mechanism for environmental protection and sustainable development (Bordoloi and Arunachalam, 2022) ^[4].

Duddigan *et al.* (2022) ^[7] conducted field experiments in Andhra Pradesh, comparing Natural Farming (NF) with conventional and organic systems, offering insights into NF's impact on crop yields across various districts and crops. Khan *et al.* (2022) ^[10] explored NF as a route to sustainable agriculture, emphasizing its ability to lower production costs and improve soil fertility through practices such as mulching and natural fertilizer use, which enhance soil health and minimize environmental harm. Natural Farming emphasizes on removing farmers'

dependence on outside supplies and credit markets to provide them autonomy by forbidding them to make any purchases from other parties, particularly businesses.

Four pillars of natural farming

- 1) **Beejamrita:** For generations, farmers have utilized a traditional practice of treating seeds with a blend of local cow urine, cow dung, and a small quantity of soil collected from the farm's bund or field. In Natural Farming, a comparable method is employed, where seeds are coated with a mixture crafted from cow dung, urine, and other locally sourced materials, proving equally effective in combating seed-borne diseases.
- 2) **Jivamrita:** This mixture, known as a fermented microbial culture, provides essential nutrients while primarily functioning as a catalyst to boost the activity of earthworms and other soil microorganisms. Additionally, this preparation, often called jivamrita, helps protect plants from bacterial and fungal diseases, promoting healthier crop growth.
- 3) **Mulching:** Mulching involves covering the soil surface with living crops or straw (decomposed plant residue) to retain moisture, regulate soil temperature around plant roots, prevent erosion, minimize runoff, and suppress weed growth, thereby enhancing overall soil health and productivity.
- 4) **Whapasa:** Whapasa refers to an optimal soil condition where the spaces between soil particles and plant roots contain a balanced mix of 50 per cent air and 50 per cent water vapor. This equilibrium improves water availability, enhances water-use efficiency, and strengthens crop resilience to drought, supporting sustainable agricultural practices.



Source: Sharma & Dhiman, 2024 ^[15]

Importance of natural farming

Natural Farming, as the name suggests, is the art, practice, and, increasingly, the science of working with nature to achieve much more with less. Various national and international authorities, the Food Safety and Standards Authority of India, and the European Union define maximum residue limits on multiple pesticides. Numerous Negative health effects have been associated with chemical pesticides, which is why promoting Natural Farming in India (Thakur *et al.* 2014) ^[17]. Therefore, an urgent strategic approach is needed to reduce the use of agrochemicals and implement sustainable practices. Moreover, current agriculture has to implement environmentally friendlier practices that pose fewer public health risks. Natural Farming has emerged to ensure food security by reviving Indian

agriculture in an environmentally safe manner. Hence, the present study has been proposed to identify the gaps and perception of farmers for inclusion in the policy and planning so that the farmers are encouraged to adopt Natural Farming and maximize their profit. Natural Farming has gained prominence as a sustainable approach to bolster food security while revitalizing Indian agriculture in an eco-friendly way. It encompasses a set of farming practices aimed at minimizing input costs through the use of natural inputs like Jeevamrita, Beejamrita, and Waaphasa, alongside techniques such as intercropping and mulching. Given the health risks associated with conventional farming, there is a pressing need to advocate for and enhance the adoption of Natural Farming.

Review of literature

The literature on Natural Farming highlights its significance as a sustainable agricultural practice in India, addressing environmental, economic, and health challenges posed by conventional farming. Panneerselvam *et al.* (2011) ^[13] demonstrated that Green Revolution technologies boosted yields but led to environmental degradation due to intensive chemical use, prompting a shift toward eco-friendly alternatives like Natural Farming. Bhattacharyya *et al.* (2015) ^[3] further emphasized the adverse health and ecological impacts of synthetic pesticides, underscoring the need for sustainable practices aligned with the United Nations' Sustainable Development Goals. Organic and Natural Farming are recognized for enhancing food security and reducing poverty, particularly in low-input regions, by preserving biodiversity and natural resources (Masoodi *et al.*, 2022) ^[11]. Bordoloi and Arunachalam (2022) ^[4] highlighted Natural Farming's role in environmental protection, noting its reliance on natural inputs like Jeevamrita and Beejamrita to improve soil health. Duddigan *et al.* (2022) ^[7] provided empirical evidence from Andhra Pradesh, showing that Natural Farming yields comparable outputs to conventional systems while reducing costs and environmental harm. Khan *et al.* (2022) ^[10] emphasized its economic benefits, such as lower input costs through practices like mulching and natural pest management. Shanmuka *et al.* (2024) ^[14] distinguished Natural Farming as a unique regenerative approach, characterized by practices like Whapasa, which enhance water-use efficiency. Thakur *et al.* (2014) ^[17] linked chemical pesticide exposure to health risks, advocating for Natural Farming to mitigate these issues. However, Thakur *et al.* (2023) ^[18] noted barriers to adoption, including limited awareness and policy support, suggesting the need for targeted extension services. This literature establishes Natural Farming as a viable solution for sustainable agriculture but highlights gaps in adoption dynamics, which this study aims to address. Recent studies, like Gupta *et al.* (2023) ^[9], underscore its potential to enhance soil microbial diversity, while Sharma *et al.* (2024) ^[16] noted its role in climate resilience through carbon sequestration. Tripathi *et al.* (2025) ^[19] identified barriers, including limited farmer training and market access, suggesting policy interventions. These studies collectively affirm Natural Farming's sustainability benefits but highlight adoption challenges, such as knowledge gaps and inconsistent extension services, which this study seeks to explore further.

Methodology

This research was undertaken at Dr. Yashwant Singh Parmar University to fulfill part of the requirements for a PhD in Agribusiness Management. The study utilized a pre-tested questionnaire and was carried out in the rural regions of

Himachal Pradesh, India, which spans 55,673 square kilometers (Economic and Statistics Department, 2019) [8]. The study covered all twelve districts of Himachal Pradesh. A purposive sampling method was applied to select districts with significant Natural Farming activity. A multistage random sampling technique was used to choose farmers practicing Natural Farming. In the initial stage, one block with the highest proportion of Natural Farming practitioners was selected from

each district. In the second stage, panchayats with the largest number of farmers engaged in Natural Farming were chosen from each block. In the third stage, farmers practicing Natural Farming were deliberately selected from each village to gather primary data. The sample size for each panchayat was calculated using the relative proportion method, resulting in a total of 384 Natural Farming adopters, determined by Cochran's formula for a known population.

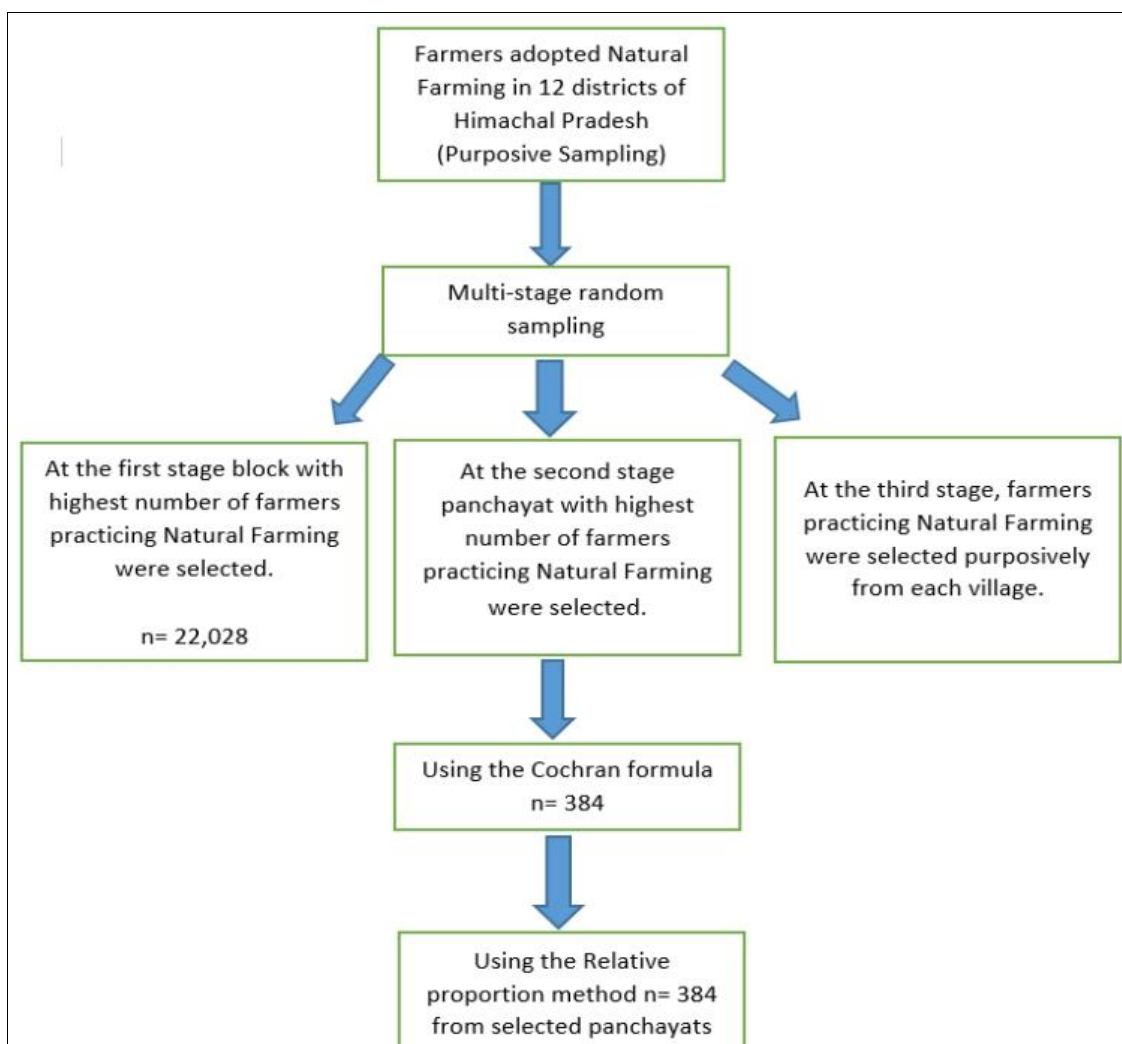


Fig 1: Schematic representation of sampled farmers practicing Natural Farming in the study area

Results

socio-demographic profile of the farmers practicing natural farming. The data presented in the table 1 provides a comprehensive overview of the demographic and socioeconomic characteristics of 384 farmers practicing Natural Farming in Himachal Pradesh, India. The findings offer valuable insights into the profile of farmers adopting this sustainable agricultural approach, highlighting key trends and variations across gender, age, education, income, family size, land use, and occupational patterns. The sample comprises 63 per cent female farmers (242) and 37 per cent male farmers (142). This indicates a significant female predominance in Natural Farming, suggesting that women play a substantial role in adopting sustainable farming practices in rural Himachal Pradesh. The relatively low standard deviation reflects moderate variability in gender distribution. The age distribution shows that the majority of farmers are middle-aged, with 37.5 per cent (144) aged 41-50 years and 33.3 per cent (128) aged 31-40 years. Younger farmers (21-30 years) constitute 8.6 per cent (33), while those under 20 years are

minimal at 2.1 per cent (8). Older farmers (51-60 years and above 61 years) represent 14.6 per cent (56) and 3.9 per cent (15), respectively. The standard deviation of 1.02 suggests moderate variability in age, indicating that Natural Farming appeals predominantly to farmers in their productive years, likely due to the physical and economic demands of adopting new practices. A significant 65.4 per cent (251) of farmers have completed senior secondary education, followed by 29.9 per cent (115) with graduate-level education. Only 2.1 per cent (8) hold diplomas, and 2.6 per cent (10) have postgraduate qualifications. The standard deviation of 0.66 reflects low variability, suggesting that most farmers practicing Natural Farming have at least a moderate level of formal education. This educational attainment likely facilitates their understanding and adoption of Natural Farming techniques. The majority of farmers (57.5 per cent, 221) earn an annual farm income of 0-2.5 lakhs, followed by 30.5 per cent (117) earning 2.5-5 lakhs. Only 7.6 per cent (29) earn 5-10 lakhs, and 4.4 per cent (17) earn above 10 lakhs. The standard deviation of 0.81 indicates

moderate income variability. The predominance of lower-income brackets suggests that Natural Farming is primarily practiced by smallholder farmers, possibly due to its low-input cost structure, which aligns with their economic constraints. Family size is evenly distributed, with 45.3 per cent (174) of farmers having 1-3 members and another 45.3 per cent (174) having 4-6 members. Only 9.4 per cent (36) have more than 6 members. The standard deviation of 0.64 reflects low variability, indicating that most farmers have small to medium-sized families. This may influence labor availability for Natural Farming, as smaller families may rely more on external or community support.

The data shows a near-equal split, with 49.2 per cent (189) of farmers considering Natural Farming their primary activity and 50.8 per cent (195) not doing so, with a standard deviation of 0.50. This balance suggests that while Natural Farming is a significant practice, many farmers engage in it alongside other income-generating activities, reflecting a diversified livelihood strategy. Among those not solely focused on Natural Farming, 47.6 per cent (91) identify farming as their primary occupation, followed by 30.9 per cent (59) in salaried jobs, 13.1 per cent (25) in business, and 8.4 per cent (16) in other activities. The

standard deviation of 1.06 indicates moderate variability, highlighting the diverse occupational backgrounds of Natural Farming practitioners. This diversity may contribute to the resilience of rural households adopting sustainable practices. A striking 92.9 per cent (357) of farmers operate on marginal land (less than 12.3 bigha), with only 5.5 per cent (21) on small land (12.3-24.7 bigha) and 1.6 per cent (6) on semi-medium land (24.7-49.52 bigha). No farmers reported medium or large landholdings. Additionally, 47.9 per cent (184) of the land is irrigated, while 52.1 per cent (200) is rainfed, with a low standard deviation of 0.33. These findings underscore that Natural Farming is predominantly practiced by marginal farmers, likely due to its suitability for small-scale, resource-constrained agriculture. The near-equal split between irrigated and rainfed land suggests adaptability to varying agroecological conditions. All farmers (100%, 384) own their land, with no instances of leased land reported. This complete ownership indicates that Natural Farming is practiced by farmers with secure land tenure, which may facilitate long-term investment in sustainable practices like mulching and soil fertility management.

Table 1: Socio-personal profile of farmers (n=384)

S No.	Particulars	Category	Frequency	Std. Deviation	Percentage
1.	Gender			.48	
		Male	142		37.0
		Female	242		63.0
2.	Age			1.02	
		Under 20 Years	8		2.1
		21-30 Years	33		8.6
		31-40 Years	128		33.3
		41-50 Years	144		37.5
		51-60 Years	56		14.6
		Above 61 Years	15		3.9
3.	Educational Status			.66	
		Senior Secondary	251		65.4
		Graduate	115		29.9
		Diploma	8		2.1
		Post Graduate	10		2.6
4.	Annual Farm Income			.81	
		0-2.5 Lakhs	221		57.5
		2.5-5 Lakhs	117		30.5
		5-10 Lakhs	29		7.6
		More Than 10	17		4.4
5.	Total Number of Family Members			.64	
		1-3	174		45.3
		4-6	174		45.3
		More than 6	36		9.4
6.	Is Natural Farming primary activity			.50	
		Yes	189		49.2
		No	195		50.8
7.	What is your Primary Activity			1.06	
		Farming	91		47.6
		Business	25		13.1
		Salaried	59		30.9
		Others	16		8.4
8.	Agriculture Land use Pattern			.33	
		Marginal (less than 12.3 Bigha)	357		92.9
		Small (12.3-24.7 Bigha)	21		5.5
		Semi-Medium (24.7-49.52)	6		1.6
		Medium (49.52-123.5 Bigha)			
		Large (More than 123.5 Bigha)			
		Irrigated	184		47.9
		Rainfed	200		52.1
9.	Does a farmer Own or Lease Land				
		Own	384		100.0
		Lease			

Adoption of different components and practices of Natural Farming among farmers

The analysis of Table 2 presents the adoption levels of various components and practices of Natural Farming among respondents, based on mean scores, adoption categories (High, Moderate, and Low adoption), and overall ranking. The findings indicate that the highest level of adoption is observed for Beejamrit and Jeevamrit, both with a mean score of 2.85 and an adoption level of 85.7 per cent, ranking first. These results suggest that seed treatment and soil enrichment practices are widely accepted among natural farmers. The second most adopted component is natural pest management, with a mean score of 2.75 and a high adoption level of 75 per cent, indicating

that farmers recognize the importance of chemical-free pest control methods. Astras rank third, with a mean score of 2.61 and a high adoption rate of 71.1 per cent, highlighting moderate acceptance among farmers. Intercropping (ranked fourth), with a mean score of 2.28 and 64.1 per cent high adoption, suggests that many farmers integrate multiple crops to enhance biodiversity and soil fertility. Mulching, with a mean score of 2.46 and 57.3 per cent high adoption (ranked fifth), indicates a moderate level of acceptance. Whapasa ranks sixth, with a mean score of 1.77 and only 16.7 per cent high adoption. The lowest ranked component is crop rotation, with a mean score of 1.13 and only 3.1 per cent high adoption, suggesting that most farmers (90.1 per cent) have a low adoption level of this practice.

Table 2: Adoption level of different components and practices of Natural Farming

Adoption of Different Components and Practices of Natural Farming	Mean	S.D	High Adoption	Medium Adoption	Low Adoption	Total weighted Score	Adoption Level	Rank
I use Beejamrit in Natural farming	2.85	0.35	329 (85.7)	55 (14.3)	0	1097	85.7	I
I use Jeevamrit in the production process	2.85	0.35	329 (85.7)	55 (14.3)	0	1097	85.7	I
I use and have knowledge about Astras in Natural Farming	2.61	0.64	273 (71.1)	76 (19.8)	35 (9.1)	1006	71.0	III
I use Whapasa in the Natural Farming process	1.77	0.71	64 (16.7)	171 (44.5)	149 (38.8)	683	16.7	VI
I have adopted crop rotation in Natural Farming	1.13	0.41	12 (3.1)	26 (6.8)	346 (90.1)	434	3.1	VII
I have adopted intercropping in Natural Farming	2.28	0.95	246 (64.1)	3 (0.8)	135 (35.2)	879	64.1	IV
I have adopted Natural pests in Natural Farming	2.75	0.43	288 (75)	96 (25)	0	1056	75.0	II
I have adopted Mulching in Natural Farming	2.46	0.68	220 (57.3)	122 (31.8)	42 (10.9)	946	57.3	V

An analysis of Table 3 categorizes the adoption levels of natural farming practices among farmers based on their scores, divided into three groups: Low Adoption, Moderate Adoption, and High Adoption. The majority of farmers (83.1%) fall under the Moderate Adoption category, with scores ranging between 1.91 and 2.77, indicating that most farmers have adopted some components of natural farming. This suggests that while there is significant interest in natural farming, full implementation is still a challenge for most. A smaller proportion (14.1%) is categorized under Low Adoption, with scores below 1.91. These farmers have minimal engagement with natural farming practices. On the other hand, only 2.9 per cent of farmers fall into the High Adoption category, with scores above 2.77,

demonstrating that very few farmers have fully embraced all components of natural farming. The mean adoption score is 2.34, with a standard deviation of 0.42, indicating moderate variability in adoption levels across the surveyed population. A few reasons for the moderate adoption of these components and practices are that some farmers are not fully aware of the benefits and methodologies associated with natural farming (Thakur *et al.* 2023) [18]. While initiatives are promoting natural farming, inconsistent policy support and a lack of institutional backing hinder widespread adoption. Farmers require assurance through support, subsidies, and technical assistance to confidently adopt natural farming practices.

Table 3: Adoption index

Adoption Categories	Score Range	Frequency	per cent
Low Adoption (Mean-S.D)	Below 1.92	54	14.1
Moderate adoption (Mean $\pm$ S.D)	Between 1.92 to 2.76	319	83.1
High Adoption (Mean+ S.D)	Above 2.76	11	2.9
	Total	384	100.0
Mean = 2.34	S.D= 0.42		

Discussion

The findings of this study provide critical insights into the adoption of Natural Farming in Himachal Pradesh, highlighting both its potential and challenges. The socio-demographic profile reveals a predominance of female farmers (63%), aligning with trends showing women's increasing role in sustainable agriculture (Agarwal, 2018) [1]. The concentration of middle-aged farmers (70.8% aged 31-50) suggests that Natural Farming appeals to those in their productive years, possibly due to its labor-intensive nature and economic viability (Duddigan *et al.*, 2022) [7]. The high educational attainment (65.4% senior secondary, 29.9% graduates) indicates that literacy facilitates the adoption of complex practices like Beejamrita and Jeevamrita, which require technical knowledge (Shanmuka *et al.*, 2024) [14]. The prevalence of marginal landholdings (92.9%) and low-income farmers (57.5% earning 0-2.5 lakhs) underscores Natural

Farming's suitability for resource-constrained smallholders, as its low-input model reduces financial burdens (Khan *et al.*, 2022) [10].

The adoption analysis reveals strong uptake of Beejamrita and Jeevamrita (85.7% high adoption), reflecting their simplicity and effectiveness in seed treatment and soil enrichment (Bordoloi & Arunachalam, 2022) [4]. Natural pest management (75% high adoption) indicates farmers' awareness of chemical-free alternatives, driven by health and environmental concerns (Thakur *et al.*, 2014) [17]. However, lower adoption of Whapasa (16.7%) and crop rotation (3.1%) suggests knowledge gaps or practical challenges, possibly due to limited extension services or agroecological constraints (Thakur *et al.*, 2023) [18]. The moderate adoption index (83.1%) highlights that while interest in Natural Farming is widespread, full implementation remains limited, likely due to inconsistent policy support and inadequate

training (Masoodi *et al.*, 2022)^[11]. The complete land ownership (100%) facilitates long-term sustainable practices, as secure tenure encourages investments in soil health (Panneerselvam *et al.*, 2011)^[13]. These findings align with global trends promoting agroecology to achieve Sustainable Development Goals, particularly in reducing poverty and enhancing food security (Bhattacharyya *et al.*, 2015)^[3]. However, the study's reliance on quantitative data limits exploration of farmers' motivations and barriers, which qualitative methods could address.

Policy implications

- **Develop Targeted Training Programs:** Implement comprehensive training initiatives to enhance farmers' understanding of low-adoption practices like Whapasa and crop rotation, focusing on practical demonstrations to bridge knowledge gaps.
- **Promote Gender-Sensitive Support:** Design policies that provide women-specific resources, such as access to training and financial aid, to leverage the high female participation (63%) in Natural Farming.
- **Introduce Financial Incentives for Smallholders:** Offer subsidies and low-interest loans tailored for marginal farmers (92.9% of the sample) to reduce economic barriers and encourage adoption of Natural Farming practices.
- **Strengthen Extension Services:** Establish robust agricultural extension networks, including mobile units and local workshops, to deliver ongoing technical support and increase awareness among farmers.
- **Facilitate Market Access for Natural Farming Products:** Create dedicated market channels and certification programs to ensure fair pricing and economic viability, motivating farmers to fully embrace Natural Farming.

Future research & limitations

Future research should adopt a mixed-methods approach, integrating qualitative interviews with farmers to uncover motivations, barriers, and perceptions influencing Natural Farming adoption, complementing quantitative findings (Creswell & Plano Clark, 2017)^[6]. Expanding the geographical scope beyond Himachal Pradesh to other Indian states with diverse agroecological conditions would enhance generalizability (Kumar, 2019). Longitudinal studies tracking adoption trends over time could assess the sustainability and economic impacts of Natural Farming, addressing gaps in long-term data (Duddigan *et al.*, 2022)^[7]. Policy-oriented research should evaluate the effectiveness of existing support mechanisms, such as subsidies and extension services, to recommend targeted interventions (Thakur *et al.*, 2023)^[18]. Investigating the role of gender in adoption, given the high female participation, could inform gender-sensitive agricultural policies (Agarwal, 2018)^[1]. Additionally, studies should explore the low adoption of practices like Whapasa and crop rotation, identifying specific agroecological or knowledge-related barriers (Shanmuka *et al.*, 2024)^[14]. Collaboration with agricultural institutions to develop tailored training programs could bridge knowledge gaps and promote wider adoption.

This study, while comprehensive, has several limitations. The reliance on quantitative data limits insights into farmers' motivations and barriers, which qualitative methods could address. The purposive sampling method, although strategic, may introduce selection bias by focusing only on districts with high Natural Farming activity. The study's scope is restricted to

Himachal Pradesh, potentially limiting generalizability to other agroecological regions. Additionally, the lack of longitudinal data hinders understanding of long-term adoption trends. Finally, the absence of detailed criteria for selecting blocks and panchayats reduces methodological transparency, potentially affecting replicability.

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