Archives of Current Research International

Volume 25, Issue 10, Page 330-338, 2025; Article no.ACRI.146390
ISSN: 2454-7077

Socio-economic Analysis of SPNF Farmers in Solan District of Himachal Pradesh, India

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Authors' contributions

This work was carried out in collaboration between both authors. Authors DK and PR designed the study, Author DK performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author DK managed the literature searches. Both authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/acri/2025/v25i101571

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://pr.sdiarticle5.com/review-history/146390

Original Research Article

Received: 21/08/2025
Published: 22/10/2025

ABSTRACT

The shift from high-input chemical farming during the Green Revolution to sustainable practices like Zero Budget Natural Farming (ZBNF) or Subhash Palekar Natural Farming (SPNF) reflects growing concerns over soil degradation and environmental health. This study, conducted in Solan district of Himachal Pradesh, examined the socio-economic and behavioural characteristics of farmers adopting SPNF, a low-cost, eco-friendly alternative promoted under initiatives like the *Prakritik Kheti Khushhal Kisan Yojna*. Using a descriptive design and multistage random sampling, data from 90 SPNF practitioners revealed that the majority were middle-aged (74.44%), had secondary education (65.56%) and came from joint or large families. Most farmers (92.22%) had 4-5 years of SPNF experience and cultivated less than one acre of land. Behavioural analysis indicated that

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Cite as: *Deeksha Kumari, and Pratima Rana. 2025. "Socio-Economic Analysis of SPNF Farmers in Solan District of Himachal Pradesh, India". Archives of Current Research International 25 (10):330–338. https://doi.org/10.9734/acri/2025/v25i101571.*

most farmers exhibited moderate levels of information-seeking (77.78%), risk-taking (85.56%), leadership (81.11%) and decision-making ability (80%). These attributes suggest a stable foundation for scaling natural farming practices. The findings underscore SPNF's potential for promoting sustainable agriculture while enhancing rural livelihoods.

Keywords: Subhash palekar natural farming; sustainable agriculture; socio-economic.

1. INTRODUCTION

The Green Revolution was marked by the widespread use of chemical fertilizers and agrochemicals, which played a crucial role in ensuring food security across both developed and developing nations. In India, this approach led to a remarkable rise in food grain production from 115.6 million tonnes in 1960-61 (Praduman *et al.* 2016) to over 281.37 million tonnes in 2018-19 (Anonymous, 2019). Likewise, the annual usage of nitrogen (N), phosphorus (P), and potassium (K) fertilizers surged from just 0.07 million tonnes in 1951-52 to over 25.95 million tonnes by 2016-17 (Bagal *et al.* 2018). According to the Ministry of Agriculture and Farmers' Welfare Annual Report (2017-18), nearly 50 per cent of the increase in food grain output was attributed to higher fertilizer usage. However, this success came at a cost excessive reliance on chemical fertilizers led to severe imbalances in soil health (Patra *et al.* 2016), degrading beneficial soil microorganisms and reducing long-term productivity. In response to these challenges, including declining soil fertility and the pursuit of only short-term yield gains (Nadkarni, 1988), many farmers began exploring alternatives such as natural and organic farming. Recognizing this shift, the Government of Andhra Pradesh (GoAP) launched the ZBNF initiative in 2015-16 to promote environmental sustainability and improve farmer livelihoods. ZBNF encourages growing crops naturally without synthetic fertilizers, pesticides, or external inputs. The term zero budget signifies that the net cost of crop production is negligible, (Reddy *et al.* 2019; Ministry of Agriculture and Farmers' Welfare, 2020). ZBNF combines sustainable agricultural intensification methods with an emphasis on reducing production expenses. It began in Maharashtra in the early 2000s, pioneered by Mr. Subhash Palekar through extensive on-farm experimentation. According to Palekar, plants obtain only about 1.5 per cent of their nutrient requirements from the soil, while the remaining 98.5 per cent is derived from natural sources such as air, water and sunlight. He emphasizes that even the small fraction needed from the soil exists abundantly in all soil types but often in forms that plants cannot readily absorb. By enhancing the population of beneficial microorganisms using *desi* (native) cow dung, these nutrients become bioavailable, eliminating the need for chemical fertilizers and pesticides (Palekar, 2005; 2006; 2016; Devarinti, 2016; Bishnoi and Bhati, 2017). SPNF is founded on four essential practices, often referred to as its *"four wheels,"* which aim to improve soil fertility and crop productivity without external inputs or additional costs: (i) *Jiwamrita* (a microbial soil booster), (ii) *Bijamrita* (a natural seed treatment), (iii) *Acchadana* (mulching) and (iv) *Waaphasa* (soil aeration and moisture management). Jiwamrita serves as a microbial stimulant that revitalizes the soil by boosting microbial populations and enriching it with organic matter. It also suppresses harmful fungi and bacteria while promoting earthworm activity. *Bijamrita* protects seeds and seedlings from seed and soil-borne pathogens, particularly fungal infections. *Acchadana* supports humus formation and accelerates decomposition through enhanced microbial action (Palekar, 2006). *Waaphasa* refers to the ideal soil condition where both air and water coexist, ensuring better root respiration and nutrient absorption. SPNF also promotes minimal irrigation-recommending watering only during midday and in alternate furrows to conserve water. Additionally, it employs natural pest control formulations such as *Neemastra, Agniastra,* and *Brahmastra*-homemade organic solutions designed to effectively manage insect and pest infestations (Palekar, 2005).

In March 2018, the Himachal Pradesh (HP) Government launched the *Prakritik Kheti Khushhal Kisan Yojna* (PKKKY), inspired by the Gurukul SPNF model in Kurukshetra. The scheme promotes climate-resilient and low-cost farming practices to enhance farmers' incomes. The initiative gained traction after concerns about pesticide residues in fruits and vegetables surfaced in 2017. Since then, adoption of SPNF has steadily increased, with approximately 50,000 farmers initially participating and an ambitious goal of reaching 3.6 lakh farmers by 2022-23. As of March 2021, more than 1.16 lakh

farmers were engaged in natural farming across 6,377 ha (Gupta *et al.* 2021). Drawing inspiration from Andhra Pradesh's success, Himachal Pradesh is gradually transitioning to SPNF through awareness campaigns, *Kisan Goshtis* (farmer-scientist meetings) and infrastructure support such as cow sheds, pest management aids and cow urine collection under the *Prakritik Kheti Sansadhan Bhandar* scheme (ICAR, 2021; DoA, HP, 2019). The state-wise details of SPNF adoption (Table 1), showing the area under SPNF, its percentage of total agricultural land, and the financial support provided under PKVY (Pradhan Mantri Krishi Vikas Yojana) and RKVY (Rashtriya Krishi Vikas Yojana) schemes. This data highlights the uneven but growing uptake of SPNF across Indian states, with Andhra Pradesh, Chhattisgarh and Kerala leading in area coverage, while states such as Tamil Nadu and Jharkhand show limited adoption. The table underscores both the potential for expansion and the importance of targeted policy support, robust institutional mechanisms and adequate infrastructure to enhance the reach and impact of SPNF initiatives (Economic Survey 2021-22; Standing Committee on Agriculture, 17th Lok Sabha, 2020-21).

1.1 Problems and Prospects of Implementing SPNF

Despite the demonstrated ecological and economic benefits of SPNF, its large-scale adoption in India faces significant challenges that hinder a full transition from conventional agriculture. Farmers experience initial yield declines lasting up to three years, and the labour-intensive nature of SPNF limits its scalability, particularly for farms larger than five acres. Knowledge gaps remain substantial, requiring continuous support from Community Resource Persons (CRPs), while weak market linkages, limited certification and organic markets and dependency on intermediaries reduce incentives for adoption. Infrastructure constraints, including scarcity of native cows for bio-input preparation, insufficient Bio-input Resource Centres (BRCs), and inadequate extension services, further restrict widespread implementation. These challenges persist despite clear advantages such as a 50-60 per cent reduction in input costs, improved soil organic carbon, enhanced populations of beneficial microorganisms, better soil moisture retention and increased resilience to climate variability. Large-scale programmes in Andhra Pradesh and HP demonstrate the potential for SPNF to scale under strong institutional support. However, without addressing these systemic barriers through robust policy frameworks, market development, knowledge networks, participatory certification systems and infrastructure support the adoption of SPNF remains limited, constraining its potential as a pathway for sustainable agricultural transformation in India.

Table 1. State-wise details of the spread of SPNF

States	Agricultural land/ cultivable land (2016-17) (thousand hectares)	Area under ZBNF (in '000 ha) as on 7.12.2021*	% age of agricultural area under ZBNF	Amount released under ZBNF (Rs. crore) *	Total amount released PKVY+RKVY since inception (in crores) #	% share of ZBNF in assistance under PKVY & RKVY
Andhra Pradesh	9047	100	1.11	7.50	1562.4	0.48
Chhattisgarh	5558	85	1.53	13.53	1102.4	1.23
Kerala	2584	84	3.25	13.37	666.0	2.01
HP	813	12	1.48	2.86	256.9	1.11
Jharkhand	4367	3.4	0.08	0.54	394.2	0.14
Odisha	6690	24	0.36	3.82	1683.0	0.23
Madhya Pradesh	17231	99	0.57	7.88	1810.8	0.43
Tamil Nadu	8110	2	0.02	0.32	1395.0	0.02

*Source: *Economic Survey 2021-22, Standing committee on agriculture, # 17th Lok Sabha, Demand for Grants (2020-21), 9th report Ministry of Agriculture*

The Prakritik Kheti Khushhal Kisan Yojna (PKKKY) provides incentives for farmers are as follows:

Farmers practicing SPNF receive significant government support under the PKKKY. This includes financial assistance covering 75 per cent of pest management expenses, subsidies for plastic barrels and 80 per cent of cow barn lining costs. To market SPNF produce, farmers are required to obtain certification from a third-party entity, which serves as an independent verifier that the produce has been cultivated according to SPNF standards. Such certification can be obtained through the Participatory Guarantee System (PGS-India) for domestic markets or through NPOP-accredited agencies for formal or export markets. Additionally, the government supports the establishment of new stores promoting SPNF with a grant of ₹50,000 over three years. The scheme also emphasizes raising farmers' awareness about the benefits of SPNF, including reduced pesticide use and improved soil fertility, thereby facilitating sustainable agricultural practices. (DoA, HP, 2019; Awasthi, 2020).

2. MATERIAL AND METHOD

The study was conducted in Solan district of HP. Solan was selected not only due to its reputation for early adoption and familiarity with innovative farming techniques among its farmers but also because of several other factors that enhance the relevance of the research. The district predominantly comprises small and marginal farmers who face economic challenges, making them more receptive to low-cost, sustainable farming practices like SPNF. Additionally, Solan has witnessed a notable uptake of SPNF, with a significant number of farmers adopting these methods, providing a rich context for studying benefits and challenges of natural farming. Empirical evidence suggests that SPNF practices in the district have improved soil health, enhanced crop yields and increased resilience to climate variability. The district also presents important insights into economic and market-related challenges, as farmers highlighting the need for interventions to improve direct marketing.

The study employed a descriptive design and a multistage sampling method by selecting specific development blocks (Solan, Kandaghat, Dharampur, Kunihar, and Nalagarh) within the district. A total of 90 farmers were randomly chosen from these five blocks using a Random Number Generator, with eighteen farmers selected from each block. A questionnaire with both open and closed-ended questions was developed and pre-tested on ten farmers (non-sampled) to ensure clarity and eliminate testing biases in a non-sampled area.

2.1 Percentage

The frequency of a specific cell was determined by dividing it by the total number of SPNF farmers in that category and then multiplying the result by 100.

$$\text{Percentage (P)} = \frac{\text{actual no.of respondents}}{respondents\ or\ score} \times 100$$

2.2 Frequency

The calculation includes summing up the total number of respondents within each specific category.

2.3 Mean

It was calculated to the average value of particular score. The formula is:

$$\text{Mean Score} = \frac{\text{total score on particular item}}{number\ of\ respondents}$$

2.4 Categorization

The mean and standard deviation were utilized for the categorization of respondents into different groups based on age, farming experience, family size and education.

3. RESULT AND DISCUSSION

The socio-economic characteristics of farmers practicing SPNF were assessed to gain a holistic understanding of their demographic and livelihood profile. The analysis revealed that the majority of farmers (74.44%) fell within the middle-age group of 40 to 56 years (Table 2), while 13.33 per cent belonged to the old age group (above 56 years), and 12.23 per cent to the young age group (below 40 years). These results resonate with earlier studies by Badhe (2012), Agahi *et al.* (2011), and Sadati *et al.* (2010), which observed that SPNF is most commonly practiced by middle-aged farmers. In terms of farming experience, most of the respondents (92.22%) had moderate experience ranging between four to five years, while 4.45 per

cent had less than four years and only 3.33 per cent had more than five years of SPNF experience (Table 2), a trend consistent with findings from (Sadati *et al.* 2010), who noted that most SPNF farmers had experience ranging from three to five years. Marital status data showed that a vast majority (93.33%) were married, and only 6.67 per cent were widows or widowers, with no representation from unmarried or divorced categories. Family type analysis indicated a slight dominance of joint families (53.33%) over nuclear families (46.67%), reflecting the prevalence of extended family systems in rural areas. Family size analysis further showed that more than half of the farmers (53.33%) belonged to large families with more than seven members, followed by 46.67 per cent with medium-sized families of five to seven members, while no respondents had small families with fewer than five members (Table 2). These findings are aligned with observations by (Sadati *et al.* 2010), suggesting the influence of traditional joint family norms. Educational background data revealed that a majority of farmers (65.56%) had completed secondary education (up to 12th grade), followed by 14.45 per cent graduates, 13.33 per cent with primary-level education (up to 5th grade), 4.44 per cent who were illiterate, and only 2.22 per cent who held postgraduate degrees (Table 2), aligning with (Agahi *et al.* 2011) who also observed a dominance of secondary-level education among farmers. Regarding occupation, the majority (67.78%) were primarily engaged in farming, while others pursued multiple livelihoods: 18.89 per cent combined farming with government employment, 16.67 per cent with labour, and 15.55 per cent with private jobs (Table 2). These results echo the findings of (Agahi *et al.* 2011), who reported agriculture as the main occupation among farmers. Housing data revealed that 54.44 per cent of farmers lived in permanent (*pucca*) houses, 35.56 per cent in mixed houses, and 10 per cent in *kutcha* houses, with none living in huts, rentals or without shelter, suggesting an improved economic condition likely attributable to the adoption of SPNF. Landholding patterns showed that the majority (72.22%) had less than one acre under SPNF, 17.79 per cent held one to five acres, 4.44 per cent had five to ten acres, 3.33 per cent had ten to fifteen acres, and only 2.22 per cent owned fifteen to twenty acres. This contrasts with Khadse *et al.* 2018, where most farmers were classified as semi-medium to large-scale (Table 2).

In terms of irrigation sources (Table 3), 57.77 per cent of farmers depended on rainfall, while 42.22 per cent had access to other sources. A diverse set of irrigation methods was used, with 70 per cent relying on water pipes, 68.88 per cent on motor pumps, and 31.11 per cent utilizing irrigation channels. Additionally, traditional systems like *Kulhs* and river-fed canals were employed in Himachal Pradesh, echoing findings from Khadse and Rosset (2019) and Khadse *et al.* 2018, who noted that the majority of farmers had access to varied irrigation resources.

Table 2. Socio-economic status of the SPNF farmers

Parameters	No. of respondents (n=90)	Percentage
Age (in years)		
Young (Less than 40)	11	12.23
Middle-age (40 to 56)	67	74.44
Old-age (More than 56)	12	13.33
Farming experience (in years)		
Low (less than 4)	04	4.45
Medium (4 to 5)	83	92.22
High (more than 5)	03	3.33
Family size (No. of family members)		
Small (Less than 5)	00	00
Medium (5 to 7)	42	46.67
Large (More than 7)	48	53.33
Education		
Illiterate	04	4.44
Primary education	12	13.33
Secondary education	59	65.56
Graduate	13	14.45
Post graduate	02	2.22

Parameters	No. of respondents (n=90)	Percentage
Occupation		
Farming + Labourer	15	16.67
Farming	61	67.78
Farming + Government employee	17	18.89
Farming + Private sector	14	15.55
Type of house		
Kutcha house	09	10
Pucca house	49	54.44
Mixed house (*kutcha +pucca)*	32	35.56
Land holding		
Less than 1 acre	65	72.22
1 to 5 acres	16	17.79
5 to 10 acres	04	4.44
10 to 15 acres	03	3.33
15 to 20 acres	02	2.22

Table 3. Distribution of respondents based on sources of irrigation

Sources of irrigation	No. of respondents (n=90)	Percentage
Rainfed	52	57.77
Irrigated	38	42.22
Irrigation channels	28	31.11
Motor pumps	62	68.88
Water pipes	63	70

Multiple response analysis: The findings presented in Table 4 illustrate the behavioural analysis of farmers reveals that the majority consistently fall into the medium category across all key attributes assessed. In terms of information-seeking behaviour, 77.78 per cent of farmers access information from multiple sources, including personal contacts, media and institutional channels. This aligns with (Agahi *et al.* 2011), who found TV, agricultural programmes, model farmers and farm consultants to be the most preferred sources of information. Similarly, risk-taking ability is predominantly moderate, with 85.56 per cent of farmers showing a medium level of willingness to adopt uncertain or new practices. The assessment of leadership ability indicates that 81.11 per cent of farmers possess a medium capacity to motivate and lead others towards agricultural goals. Lastly, decision-making ability is also concentrated at the medium level, with 80 per cent of farmers demonstrating a reasonable capacity to select optimal solutions for improving farm profitability. These findings highlight that most farmers operate with moderate levels of engagement, adaptability, leadership and decision-making, which may play a crucial role in the adoption of agricultural innovations.

Table 4. Distribution of farmers of SPNF based on behavioural characteristics (n=90)

Sources of Information		No. of farmers	Percentage
Low	Less than 75	11	12.22
Medium	75 to 84	70	77.78
High	More than 84	09	10
Information Seeking Behaviour			
Low	Less than 15	12	13.33
Medium	15 to 18	68	75.56
High	More than 18	10	11.11
Risk taking ability			
Low	Less than 17	10	11.11
Medium	17 to 22	77	85.56
High	More than 22	03	3.33

Sources of Information		No. of farmers	Percentage
Leadership ability			
Low	Less than 7	11	12.22
Medium	7 to 12	73	81.11
High	More than 12	06	6.67
Decision making ability			
Low	Less than 4	16	17.78
Medium	4 to 8	72	80
High	More than 8	02	2.22

4. CONCLUSION

The study highlights the transformative impact of SPNF practices on farming communities, particularly in Solan district of HP. Triggered by the limitations and ecological concerns of the Green Revolution model, these natural farming approaches have emerged as sustainable alternatives that reduce input costs, preserve soil health, and enhance long-term productivity. The socio-economic profile of SPNF farmers reveals that the majority are middle-aged, married, literate and belong to large joint families, with agriculture as their main occupation. Most farmers have moderate experience in SPNF and cultivate less than one acre of land, using diverse traditional and modern irrigation methods. Behavioural analysis indicates that farmers exhibit moderate levels of information-seeking, risk-taking, leadership and decision-making abilities, which are vital traits for the adoption and scaling of sustainable practices. The increasing adoption of SPNF in HP, supported by government initiatives like PKKKY and awareness campaigns, reflects a positive shift towards climate-resilient and low-cost agriculture. The findings suggest that natural farming, when implemented with institutional support and farmer engagement, holds significant promise for improving rural livelihoods while ensuring ecological sustainability.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of this manuscript. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology.

Details of AI usage are given below:

1. Name and source of AI tool: ChatGPT, developed by open AI (https://chat.openai.com).
2. Version/model used: GPT-5, open AI's generative pre-trained transformer model (as available on ChatGPT, October 2025).
3. Purpose and extent of use: the AI tool was employed only for language refinement, grammatical correction, improvement of sentence structure, and formatting of references according to the Chicago manual of style (17th edition).

ACKNOWLEDGEMENT

I express my sincere gratitude to Dr. Pratima Rana, my supervisor, for her invaluable guidance, constructive feedback and constant encouragement throughout this research. Her expertise and support have been instrumental in shaping the quality of this work. I am thankful to Shoolini University for providing the necessary facilities and a supportive academic environment that enabled me to carry out this study effectively. My heartfelt thanks go to my family for their unwavering love, patience and encouragement, which have been my greatest source of strength. I also extend my appreciation to my friends for their support and companionship during this journey. To all who have contributed, directly or indirectly, to the completion of this work I am deeply grateful.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://pr.sdiarticle5.com/review-history/146390