Farmer's perception towards adoption of Eco-Friendly Natural Farming System in Mandi District of Himachal Pradesh, India

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ABSTRACT

Over the past three decades, farming in India has become more and more unsustainable through the conventional farming system. The system had been set up for maximum output with little regard for the environment or the individual's existence. To overcome this, the best alternative is eco-friendly natural farming, which is economical and has been embraced by several Indian states. The objective of this research is to study the resource use efficiency, factors affecting adoption, and problems faced by farmers under the natural farming system in the Mandi district of Himachal Pradesh. Out of 12 districts, the Mandi district has been selected purposively due to a large number of farmers switching to the conventional farming system. A simple random sampling technique was used to select the farmers in the study area where a sample of 60 farmers was selected to analyse the Cobb-Douglas production function, Logit, Chi-square, and Garett ranking techniques were used. The study highlighted that out of the total cultivated area, the maximum area was under natural farming i.e., 64.83 per cent as compared to 35.17 per cent under a conventional farming system. The factor affecting the adoption of natural farming were chemical input cost, decreased pest attacks, health benefits, and quality yields with significant values of 0.006, 3.82, 4.16, and 3.94, respectively. It shows the rate of change in the adoption of natural farming systems with a 1 per cent change in the value of these factors. Besides this, there were some major constraints reported by farmers which hindered its widespread among farmers in the state.

KEYWORDS: Conventional farming, eco-friendly farming, resource-use efficiency and sustainable approach

1. INTRODUCTION

The agriculture sector is the most important sector of the Indian economy which provides employment to the majority of its population. With a wide range of agro-climatic zones with different types of weather conditions and soil types, India is capable of growing a variety of agricultural and horticultural crops. Even though agriculture's share of the GDP has dropped to around 18 per cent in the year 2021-22, the growth in agricultural production has increased significantly (Economic Survey, 2021). As a result, India has now become self-sufficient in food grain and net exporter of various agricultural and allied goods. As per the First Advance Estimates for 2022-23 Kharif, the total foodgrain production in the country is estimated at 149.92 million tonnes which was higher by 6.98 million tonnes than the average foodgrain production of the previous five years (Anonymous, 2022). From 1947 to 1960, the food grain production within India was insufficient in comparison to the growing population which could result in famine situation (Nelson et al., 2019).

To combat this situation, the Green Revolution was started in the 1960s to increase food production, reduce poverty in the nation, and feed millions of people. An effort was made to enhance the genetic makeup of traditional crops by introducing high-yielding varieties (HYVs) of rice and wheat (Nelson et al., 2019). Further, to maximize food grain production, the majority of farmers have shifted to a conventional farming system with an increase in the usage of fertilisers and pesticides (Le Campion, 2020) with monocropping patterns. Most of these pesticides used belong to the class of organophosphate, organochlorine, carbamate, and pyrethroid (Ogah et al., 2012). Indiscriminate pesticide use has led to several health effects on human beings in the nervous, endocrine, reproductive, and immune systems (John and Babu, 2021). The monocropping system, increased and frequent use of fertilizers and pesticides caused considerable damage to the soil's biological operation, crop diversity, increased cost of cultivation, deterioration of groundwater, loss of flora-fauna, and decreased soil fertility (Laishram et al., 2021).

To overcome these detrimental effects and to meet the demand of the growing population, there is a need for a sustainable agriculture farming approach. Natural farming is considered as the best approach for this which was introduced by Masanobu Fukuoka (1913-2008), a Japanese farmer and philosopher in his book 'The One-Straw Revolution'. Natural farming, as the name implies, is farming with nature with no ploughing, tillage, weeding, or plant protection (Brown, 2020). The aim of natural farming is to reduce the cost of production to almost zero and to come back to the 'pre-Green Revolution' style of agriculture (Khadse et al., 2017). It is considered as a cost-effective farming practice with scope for raising employment and rural development. (De LC, 2022). Recent years have seen the growth of alternative farming methods as a result of society's concern about the environmental issues brought on by conventional farming, as well as rising demand for agricultural sustainability and safe, high-quality meals (Parra-Lopez et al., 2007). (Rosenstock et al., 2020) stated that this natural farming has a positive impact on the environment and reduces up to 23 per cent of GHG emissions as compared to conventional farming.

Himachal Pradesh is a mountainous state situated in the North Western Himalayan region of India. The State Himachal Pradesh falls under the High Hill Temperate Sub-zone under the agro-climatic zone- i.e., Western Himalayan Region where agriculture/horticulture is the main occupation of the people and provides direct employment to about 70 per cent of farmers (Economic Survey HP, 2021). Himachal Pradesh is the only State in the country where 89.96 per cent of the population (Census 2011) lives in rural areas. To increase the farmers income, Himachal Pradesh government has promoted natural farming in the state by providing financial assistance to the farmers. At present, 2,170 hectares of land are being cultivated under Subhash Palekar Natural Farming (SPNF) system (Anonymous 2021). This farming system is based on four pillars i.e., *Beejamrit, Jeevamrit, Acchadan,* and *Waaphasa* which are made from locally available inputs and have no residual and harmful effects on the environment (FAO, 2016). After that, many researchers and scientists also claimed that natural farming is a good alternative to chemical farming that directly or indirectly impacts sustainable development positively (Tripathi et al., 2018). Farmers' rationality on resource allocation is a major problem in agriculture output. If farmers utilize the resources efficiently then they can increase their yield and revenue. (Mahajan and Dev, 2023). Keeping in view the above background, the present study investigated the 'Resource Use Efficiency of Eco-Friendly Natural Farming System in Mandi District of Himachal Pradesh, India' with the objective to evaluate the resource use efficiency and factors affecting the adoption of natural farming underlying constraints.

2. MATERIAL AND METHODS

Himachal Pradesh is a hilly state that provides favourable environmental conditions for raising almost all types of agricultural and horticultural crops. The state comprises of 12 districts viz., Kangra, Mandi, Kinnaur, Bilaspur, Chamba, Hamirpur, Kullu, Lahaul & Spiti, Shimla, Sirmaur, Solan, and Una. Among these districts, Mandi district was selected purposively for the study as it has a high potential for agricultural growth. As a result, the study was carried out in 2 blocks of Mandi district where the survey technique was employed. A list of farmers who were actively involved in natural farming but also practicing conventional farming was procured from the Project director ATMA, Mandi. A Simple random sampling technique was used to select the ultimate sample of 60 farmers from the study area. The data were collected through personal interviews with sampled farmers with the help of a specially designed semi-structured schedule. The data collected during the period of investigation were carefully examined, compiled, and analysed by using different analytical tools. Functional analysis was carried out to examine the relationship between various inputs and output, to further analysed production functions, resource use efficiency, problems under natural farming, and various factors affecting the adoption of natural farming systems in the study area.

2.1 Cobb- Douglas Production

Production function analysis was employed to evaluate the resource use efficiency in crop production of natural farming. The Cobb- Douglas regression model was used in the present study.

$$Y = \beta_0 X_1^{\beta 1} \; X_2^{\beta 2} \; X_3^{\beta 3} \; X_4^{\beta 4} \; X_5^{\beta 5} \; X_6^{\beta 6} \; X_7^{\beta 7} \; U_t$$

Where,

Y = Gross Returns (Rs)
X_1 = Expenditure on Jivamrit (Rs.)
X_2 = Expenditure on Ghanjivamrit (Rs.)
X_3= Expenditure on Bijamrit (Rs.)
X_4 = Expenditure on Agniastra (Rs.)
X_5 = Expenditure on Neemastra (Rs.)
X_6 = Expenditure on Human Labour (Rs.)
X_7= Expenditure on seed (Rs.)
β_0 = Intercept
U_t= The error term
β_i = The elasticity coefficient (i =1, 2, 3.....)

2.1.1 Estimation of Resource use Efficiency:

Note that efficient production is represented by an index value of 1.0, while lower values indicate a greater degree of inefficiency. The following ratio based on the estimated regression coefficients was used to estimate the relative efficiency of resource use (r)

The marginal value product of a particular resource represents the expected addition to the gross returns caused by an additional unit of a resource, while other inputs were constant.

$$MVP_{xi} = MPP_{xi} * Py$$

Where,

MVP_{xi} = Marginal value product of its input
MPP_{xi} = Marginal physical product of the i^{th} input
P_y = Price of output

2.1.1.1Estimation of MVP-Factor Cost Ratio:

$r = \frac{MVP_{xi}}{MFC}$

Where,

r = Efficiency ratio

MVP_{xi} = Marginal value product

MFC = Marginal factor cost

If, r = 1 resource is efficiently used

r > 1 resource is underutilized

r < 1 resource is overutilized

2.2 Logit model for Adoption: The Logit model was used to specify the relationship between the probability of adopting Natural Farming (Feder et al., 1985). In addition, the Logit model maintains the estimated probability between 0 and 1.

Mathematically, the logit model is represented as :

$=\ln\left[\frac{P_i}{1-P_i}\right]=\beta_1 + \beta_2 X_i + UI$

Where;

X_i =Represents all the independent variables and β represents the effect of changes in X

L_i =Represent logit in the probability of adoption

Pi=Represent the probability of adoption

The model will be estimated by using the formula:

$Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6$

Where;

Y = If the producers have adopted Natural farming in their farms (0 if No, 1 if yes),

X_1 = Chemical fertiliser cost

X_2 = Gross returns

X_3 = Numbers of years of experience in farming

X_4 = Farm size in hectare

X_5 = A dummy variable indicating for a producer if pest attack decreasing (0 if No, 1 if yes)

X_6 = A dummy variable indicating for a producer if health increasing (0 if No, 1 if yes)

X_7 = A dummy variable indicating for a producer if the quality yield was high in natural farming (0 if No, 1 if yes)

2.3 Problems under natural farming

2.3.1 Production and marketing problem under natural farming

To test whether there was any significant difference among marginal, small, and medium farmers of Mandi for the problems faced by them. A chi-square test (Pearson, 1900) in (m x n) contingency table was applied where m and n are the number of problems faced by the farmers under natural farming in the Mandi district. The detail of the approximate Chi-square test is given as under:

$$\chi^2 = \sum_{j=1}^{L}\sum_{i=1}^{K}\frac{(O-E)^2}{E} \sim \chi2\ (L-1)(K-1)\ d.f.$$

Where,

O = Observed values

E = Expected values

K = number of problems

L = the number of farm size groups.

The Garret ranking technique was used to rank the constraints/problems (Garret and Woodworth, 1969) in practicing Natural farming. In Garrett's ranking technique, these ranks were converted into percent positions by using the formula:

$$\text{Percent position} = \frac{100\,(R_{ij}-0.5)}{N_j}$$

Where,
R_{ij} = Ranking given to the i^{th} problem by the j^{th} farmer
N_j = Number of problems ranked by the j^{th} farmer.

The constraint with the highest mean value has been considered as the most important one and the other followed that order (Karthick et al., 2013).

3. RESULTS AND DISCUSSION

3.1 Socio-economic status of sampled households:

The size and structure of the sampled households are considered to be an important factor affecting Natural Farming, as it is labour intensive. The sampled households are divided into three categories based on their land holding i.e., marginal, small, and medium. The demographic profile of farmers determined the socio-economic status of the family and plays a major role in production, farm business, and other marketing-related activities. Thus, the size and structure of sampled farmers have been presented in Table 1.

Table 1. Farm category-wise demographic profile of sampled households in the study area (Number)

Particulars	Farm category			
	Marginal	**Small**	**Medium**	**Overall**
Male	1.94 (35.79)	1.78 (32.66)	1.33 (33.25)	1.88 (35.14)
Female	1.94 (35.79)	2.11 (38.71)	1.67 (41.75)	1.95 (36.45)
Children	1.54 (28.42)	1.56 (28.63)	1.00 (25.00)	1.52 (28.41)
Average family size	5.42	5.45	4.00	5.35
Average no. of dependents (<15yrs to> 65yrs)	1.28	1.24	1.00	1.25
Dependency ratio w.r.t total workers	0.31	0.29	0.33	0.31
Dependency ratio w.r.t family size	0.24	0.23	0.25	0.23

*The figure in parentheses is the percentage of the average number of workers

The overall average family size was 5.35 persons, out of which 35.14 per cent were males and 36.45 per cent were females. The average family size of marginal, small, and medium farm categories was 5.42, 5.45, and 4.00, respectively. Additionally, those between the ages of 15 to 65 were identified as a working force since they were actively involved in productive economic activities. Medium farms had the greatest dependency ratio concerning workers and family size followed by marginal and small farms.

3.2 Literacy status

Education is one of the important factors affecting the overall growth and development of an individual. Educated persons are always better at decision-making than uneducated. They are most likely to adopt new technologies due to better understanding or interest and are more aware of the benefits and constraints in all production processes and marketing operations etc. The concept of natural farming is emerging, so education in terms of awareness is necessary for a proper understanding of the concept. The literacy status of sampled households has been presented in Table 2.

Table 2: Farm category-wise per cent literacy status of sampled households (%)

Particulars	Farm category					
	Marginal		Small		Medium	
	Male	Female	Male	Female	Male	Female
Illiterate	2.92	4.92	4.35	15.38	20.00	16.67
Primary	9.49	6.56	13.04	7.69	-	-
Middle	8.76	13.93	8.70	7.69	-	-
Matric	30.66	39.34	21.74	26.92	20.00	33.33
Senior Sec.	18.25	12.30	26.09	19.23	40.00	16.67
Graduation	21.90	15.57	21.74	11.54	20.00	16.67
Non-School going	8.03	7.38	4.35	11.54	-	16.67
Literacy Rate	96.83	94.69	95.45	82.61	80.00	80.00
Literacy Index	3.30	3.00	3.20	2.70	3.20	3.00

In all farm categories, the male literacy rate was higher as compared to the female literacy rate. The literacy index among the males varied between 3.20 to 3.30 and 2.70 to 3.0 in females. This indicates that the literacy rate in the study area is higher but the literacy index i.e., quality of education was poor.

3.3. Land use pattern of sampled household

Land use pattern refers to the way by which a particular piece of land is utilized and managed. In agriculture, land is an important asset for farmers, as it is the source of generating income among farmers for their livelihood. The land use pattern of the sampled households in the study area is presented in Table 3**.** It shows at an overall level, the average size of land holding was 0.80 ha out of which 64.81 per cent area was under cultivation. From the overall cultivated area, 63.75 per cent was under natural farming and 35.17 per cent area was under conventional farming. The average land holding in the marginal farm category was 0.58 ha out of which 65.55 per cent was under cultivation. From the average cultivated area of marginal farms, 68.65 per cent was under natural farming and 31.35 per cent was under conventional farming. The average land holding of the small farm category was 1.35 ha out of which 63.70 per cent was under cultivation. The per cent area under natural farming and conventional farming from the total cultivated area was 51.55 and 48.45, respectively in the small farm category. In the medium farm category, the average land holding was 2.93 ha out of which 56.31 per cent area was under cultivation. From the total cultivated area, the per cent area under natural and conventional farming was 43.55 and 56.45, respectively. The maximum area of natural farming was in the medium farm category followed by the small and marginal farm categories. The other land used for orchards is 5.00 per cent, pastures 21.25 per cent, and land under non- agriculture use i.e., 10.00 per cent. Table 4. concluded that natural farming was more practiced by marginal farms (68.65%) followed by small farms (51.55%) and medium farms (43.55%). More than 50 per cent of the area under natural farming indicates that farmers have started to adopt natural farming over conventional farming.

Table 3: Farm category-wise land use pattern of sampled households (ha)

Sr.		Farm category			
		Marginal	Small	Medium	Overall

No.	Particulars				
1)	**Average cultivated area**	0.38 (65.55)	0.86 (63.70)	1.65 (56.31)	0.51 (63.75)
a)	**Natural farming**	0.26 (68.65)	0.44 (51.55)	0.72 (43.55)	0.31 (64.83)
i)	Irrigated	0.12 (45.34)	0.26 (59.00)	0.45 (62.96)	0.16 (48.27)
ii)	Un-irrigated	0.14 (54.66)	0.18 (41.00)	0.27 (37.04)	0.15 (51.73)
b)	**Conventional**	0.12 (31.35)	0.42 (48.45)	0.93 (56.45)	0.20 (35.17)
i)	Irrigated	0.03 (26.06)	0.19 (44.68)	0.21 (22.86)	0.06 (28.69)
ii)	Un-irrigated	0.09 (73.94)	0.23 (55.32)	0.72 (77.14)	0.14 (71.31)
2)	**Orchard Area**	0.02 (3.43)	0.13 (9.62)	0.16 (5.47)	0.04 (5.00)
3)	**Pasture land**	0.11 (18.96)	0.25 (18.53)	0.88 (30.03)	0.17 (21.25)
4)	**Land put under non-agricultural use**	0.07 (12.06)	0.11 (8.15)	0.24 (8.19)	0.08 (10.00)
	Total land holding	0.58	1.35	2.93	0.80

*The figure in parentheses indicates the percentage of total landholding

3.4 Resource use efficiency in Natural farming system

One of the primary goals of a production unit is to maximize net returns through the optimum use of resources. The effectiveness of various resources or inputs used by the sampled farmers was assessed by using production function analysis to determine how certain inputs would affect the overall returns. The elasticity of the inputs used in natural farming was calculated using the Cobb-Douglas production function. The following experimental explanatory variables were used to identify the variables influencing the returns of natural farming systems i.e., biological fertilisers, plant protection products, labour, and seed.

Table 4. Cobb-Douglas Production function in the sampled household

Natural Farming			
Particulars	**Coefficient**	**Standard Error**	**t Stat**
Biological fertilisers	-0.08	0.07	-1.09
Plant protection solutions	-0.01	0.05	-0.28
Labour	0.62**	0.13	4.54
Seed	0.24*	0.09	2.59
R^2	0.80		
F	57.42		
∑bi	0.86		

*Significant at**1% and *5 % level of significance

Table 4 showed the calculated regression coefficient, standard error, and corrected coefficient of multiple determinations value. In this regression, R^2 was 0.80 indicating that the explanatory variable explained 80 per cent of the variation in the model. It was determined that both the computed labour and seed parameters were significant at the 5 per cent level of significance, showing that a 1 per cent increase in seed spending resulted in a 0.24 per cent increase in returns. Similarly, a 1 per cent increase in labour resulted in a 0.62 per cent rise in returns.

Resource use efficiency is the evaluation of efficient or inefficient utilization of resources. When a specific input is used to the point where the ratio of MVP to its marginal factor cost equals 1, then it is considered efficient utilization. If the MVP to MFC ratio is less than 1, the resource is being over-utilized; if the ratio is more than 1, the resource is being underutilized.(Zekeri and Tijjani, 2013)

Table 5 Marginal value products (MVP) and factor price ratio in the sampled households under Natural Farming.

Inputs	**Coefficients**	**App**	**Mvp**	**R**
Biological fertilisers	-0.08	41.63	-3.33	-3.33
Plant protection solutions	-0.01	54.36	-0.79	-0.79
Labour	0.62**	6.18	3.86	3.86
Seed	0.24*	15.41	3.84	3.84
***MIC and Py = 1**				

*Significant at**1% and *5 % level of significance

The analysed data have been presented in Table 5 showed that the ratio of MVP to MFC on seed and labour has a positive regression coefficient and is statistically significant at the 1 per cent and 5 per cent levels, respectively. Seed (3.84) and labour (3.86) both had ratio values greater than unity, indicating that both inputs were under-utilised. There is a need to increase its usage to optimize the returns. The value of r for biological fertilisers (-3.33) and plant protection treatments (-0.79) is less than unity, indicating these are overutilized and reduction in their usage would result in optimum returns.

3.5 Adoption of Natural Farming systems

In the last three to four years, Himachal Pradesh has embraced natural farming. The adoption of any farming depends upon the needs, interests, and knowledge of the farmers. The adoption of natural farming depends upon various factors which were studied using Logistic Regression Model.

Table 6 Logit regression model for Natural farming

Adoption	**Coefficient (β)**	**dy/dx**	**Standard Error**
Chemical Input Cost	0.006*	0.0071	0.0033
Experience	-0.065	-0.072	0.09917
Farm Size	-3.02	-0.034	0.21
Decrease Pest Attack	3.82**	0.72	0.25
Quality output	3.94*	0.70	0.29
Health Benefits	4.16**	0.63	0.22
Constant	-5.32	-	2.25

*Significant at**1% and *5 % level of significance

From Table 6 it was observed that chemical fertiliser cost, health benefits, quality output, and reducing insect attacks were all significant explanatory variables, implying that these variables have a substantial impact on the adoption of natural farming. The cost of fertiliser has a positive relationship with the adoption of natural farming. If the cost of chemical fertiliser rises by 1per cent, there is a 0.006 per cent probability that farmers will switch to natural farming. If the cost of chemical fertiliser rises, farmers will switch to natural farming over conventional farming. Natural Farming produces chemical-free goods, which contributes to improved health. If farmers' health improves, there is a 4.16 per cent probability that they will switch to natural farming.

Natural farming produces better quality output than conventional farming. If the output quality in natural farming improved by 1 per cent, then there is a 3.94 per cent probability that farmers will switch to natural farming. Pest attacks also exhibit a positive indicator, indicating that if pest attacks decrease by 1 per cent, there is a 3.82 per cent probability that farmers would switch to natural farming. Natural farming adoption is unaffected by experience and farm size.

3.6 Problems faced by farmers under Natural Farming

Every development process is bound to some constraints/limitations. Farmers in the Mandi district also faced similar constraints when practicing natural farming. The data collected through personal interview method revealed that lack of premium price, lack of consumer awareness of natural farming produce, labour-intensive farming, low yield, and Incidence of disease pest were problem are faced by the farmers in practicing natural farming systems in the study area.

To test the significance of the problem, the chi-square test was used, with Garrett ranking technique to rank the problems in the study area. The results of chi-square analysis presented in Table-7 revealed that among various categories of constraints, lack of premium price (13.50), lack of consumer awareness of NF produce (14.79), labour-intensive farming (24.74) and scattered land (6.87) were found to be different among selected farmers by their statistically significant chi-square values. The main problem faced by farmers with rank I was determined to be natural farming as labour-intensive farming followed by lack of premium price (II), lack of consumer awareness for NF produce (III), and scattered land (IV) with chi-square value of 24.74, 14.79, 13.50 and 6.87, respectively which were significant at 5 per cent level of significance. It shows that these problems vary from farmer to farmer in the study area.

Table 7. The problem faced by the farmers in Natural Farming

Sr. No.	Problems	Chi-square	Garrett means	Rank
1	Lack of premium price	13.50*	34.44	II
2	Lack of consumer awareness of NF produce	14.79*	29.53	III
3	Labour-intensive farming	24.74*	35.16	I
4	Low yield	4.97	26.76	V
5	Incidence of disease and pest	4.68	26.50	VI
6	Scattered Land	6.87*	27.61	IV

*Significant at *5 % level of significance

4. CONCLUSION

The study concluded that men participated in the natural farming system to a greater extent than women with higher levels of education. Natural farming does not require specialised knowledge or skill, but understanding its principles and concept is crucial to understanding its long-term benefits. The average area under cultivation for natural farming was greater than that for conventional farming, demonstrating the growing adoption rate in the region. The resource use efficiency of natural farming was also assessed, and the results showed that under natural farming systems, farmers were either over-utilizing the resources or under-utilizing the resources, which resulted in decreasing returns to scale. The efficient utilization of these resources not only improves the health of the soil but also begins to provide them with escalating returns over time. Farmers are concerned about health problems that have been affected due to shift for a cost-intensive conventional farming system. Additionally, the whole transition is limited by developmental constraints. With proper government support the widespread adoption of natural farming is feasible in the long run.

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