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Determinants and Constraints for Adoption of Zero Budget Natural Farming (ZBNF) Practices

Sunil Kumar[1], Manjeet Singh Nain[2]*, V. Sangeetha[3] and Satyapriya[4]

[1]PhD Scholar, ICAR-Indian Agricultural Research Institute, New Delhi & SMS (Agricultural Extension) KVK, Kaneri, Kolhapur, Maharashtra, India
[2,3,4]Division of Agricultural Extension, ICAR-Indian Agricultural Research Institute, New Delhi-110012, India
*Corresponding author email id: msnain@gmail.com

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ABSTRACT

Zero Budget Natural Farming (ZBNF) follows agroecological principles and promotes chemical-free farming. It has emerged as cost-effective farming improving soil fertility and providing chemical-free food. For determining factors for the adoption of ZBNF practices in the purposively selected Wardha district of Maharashtra, conducted during 2022-23, Logit regression and for analyzing the constraints, factor analysis was used. The study revealed significant factors like integrated soil fertility management practices, adoption of ZBNF practices and IPM practices. The scarce raw materials for input preparation, management of weeds and pests were identified as input related whereas, lack of knowledge about liquid fertilizers, insect pest and weed management practices were reported as technology constraints, in case of the constraints related to labour and machinery, non-availability of the bullock, high demand of skilled labour and high labour wages were reported. In case of institutional constraints, higher conversion period, high demand of skilled labour, and high certification fee were found. The assurance of better prices, purchase agencies at distant places, and lack of proper market structure were reported as the marketing constraints. In the case of political and legal constraints, a lesser number of FPOs, the synergy of the ZBNF practices with mainstream agriculture, lack of globalized market, and the need for convergence were found significant.

INTRODUCTION

Declining crop productivity and uncertain market conditions has resulted in un-remunerative agriculture. Consequently, farmers have fallen into the debt trap due to the rising cost of crop production apart from health hazards due to serious exposure to harmful chemical pesticides (Kumar et al., 2023). These issues have led to the decreasing share of agriculture in productive economy; employment is taking place at different speeds and different challenges have been emerging across the regions (Chatterjee et al., 2022). The Farmer Field School (FFS) is a season-long training for farmers involving participatory activities and interactive learning with the doctrine of integrated pest management and agro-ecosystem analysis (Bhuiyan et al., 2022). In FFS, various other sustainable agricultural practices have a vital role to maintain sustainability of agriculture in the long run (Niranjan et al., 2023). These have facilitated the rise of Zero Budget Natural Farming (ZBNF) practices in several states throughout India, with the goal of creating a more effective and resource use agricultural system. Sh. Subash Palekar, an Indian agriculturists in the mid-1990s started ZBNF based on agro-ecological principles. Natural Farming (NF) is one-of-a-kind chemical-free farming approach that is regarded as an agro-ecological approach (Rosset et al., 2012). In other terms it can be discussed as a type of sustainable agricultural system, which is one such alternative to chemical fertilizer based agriculture and high input cost agriculture. It represents agro-ecological principles where the emphasis is on "enhanced soil conditions by managing organic matter and soil biological activity;

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diversification of genetic resources; enhanced biomass recycling; and enhanced biological interactions" (Khadse et al., 2018). In the last couple of years, the government of India has promoted natural farming in a big way to promote chemical-free farming. The Prime Minister of India in his address to the nation on the 76th Independence Day of India stated 'ZBNF is a promising tool to minimize the dependence of farmers on purchased inputs; it reduces the cost of agriculture by relying on traditional field-based technologies which also lead to improved soil health (Duddigan et al., 2022). The emergence of ZBNF in India has not been without its challenges in implementation. It has been facing several issues at different levels such as, awareness level among farmers, acceptability of good results in crops' yields, proper coordination with implementing agencies etc. Skeptics argue that transitioning from conventional farming to ZBNF requires a paradigm shift in the mindset of farmers, as well as significant investment in training and capacity-building. Furthermore, the adoption of ZBNF may initially lead to lower yields during the transition period as the soil and ecosystem adapt to the new farming techniques. The scaling up of NF may not only depend on the farming practices, but social factors such as social movements, public policies, markets, pedagogical processes, leadership, and discourse. Farmer-focused and farmer-led knowledge exchange is a key driver of the sustained spread of NF practice. Keeping this in mind, present study examines the different associated factors and constraints faced by farmers in adopting ZBNF practices.

METHODOLOGY

This study was conducted in the Wardha district of Maharashtra that was purposively selected. Two blocks, i.e., Wardha and Deoli, were selected, and two villages from each block and 30 farmers from each village were selected through a random sampling method. Thus, a total of 120 farmers were selected as respondents for this study. Data were collected from the respondents in structured interview schedule on different socio-economic characteristics. Logit regression was used for determining the factors for adoption of ZBNF practices in the farmer field school where Participation in Farmer Field school as dependent variable and other socio economic and personal variables as other independent variable as ordinal variable labeled as 1 and 0. For constraints, a 5-point likert scale, varying strongly agree to strongly disagree, was used to obtain the responses on six different categories of constraints, such as input constraints, technology constraints, labour and machinery constraints, institutional constraints, marketing constraints, and political and legal constraints.

Factor analysis was used to categorise and reduce the variables/ factor which were more prominent and was easy to group them for easy identification of constraints and Varimax rotation analysis was used to extract the factors. Data was analyzed using IBM-SPSS-29 package.

RESULTS AND DISCUSSION

The determining factors that were having a significant impact on the adoption of ZBNF practices facilitated through participation in FFS were analyzed. The Logit model regression was used to find out the determining factors for adoption of ZBNF practice. Here adoption of ZBNF practices is set of practices used in ZBNF so one or more practices. So practicing one or more practices has been considered as independent variable for measuring the adoption in participation to FFS.

From the Table 1, it is clear that some variables had positive effect like integrated soil fertility management practices, adoption of ZBNF practices and integrated pest management practices at 1 per cent of level of significance, use of live mulching and drip irrigation at 5 per cent level of significance.

Waste decomposer, and extension contact were found to be negatively associated with the adoption of ZBNF practices; however, not significantly influencing. The other factors like gender, ICT use, farm participation, education and livestock ownership were also found not significant. A study was conducted on impact of IPM practices in Jammu and reported similar result that IPM training programme impacted adoption of IPM practices in farmer field school (Sharma et al., 2015) which in line with our study.

The different types of constraints were listed through direct contact with farmers and through review of literature and grouped into different dimensions. Factor analysis method was used and their data reliability was tested using Kaiser-Meyer-Olkin Measure of sampling adequacy explains the strength of the partial correlation

Table 1. Determinants for practising sustainable agricultural practices/ZBNF practice in Farmer Field School

S.No.	Variables	Estimate	Std. error	Z	Sig.
1.	Age	.003	.008	.322	0.748
2.	Integrated Soil Fertility Management	2.975	.734	4.053	<.001
3.	Integrated Pest Management	2.016	.640	3.151	0.002
4.	Waste Decomposer	-.040	.189	-.213	0.832
5.	Drip Irrigation	.392	.203	1.936	0.053
6.	Gender	.285	.206	1.383	0.167
7.	ICT Use	.048	.266	.180	0.857
8.	Farm Participation	.067	.209	.319	0.750
9.	Livestock Ownership	-.053	.205	-.256	0.798
10.	Extension Contact	-.086	.196	-.441	0.659
11.	Education	.017	.111	.152	0.879
12.	Adoption of ZBNF	1.365	.281	4.857	<.001
13.	Live Mulching	0.785	.318	2.466	0.014

Table 2. KMO and Bartlett's test for constraints perceived by ZBNF farmers in Maharashtra

Constraints	Input	Technology	Labour & Machinery	Institutional	Marketing	Political & Legal
Kaiser-Meyer-Olkin measure of sampling adequacy (KMO)	0.552	0.611	0.615	0.598	0.562	0.512
Bartlett's Test of Sphericity (Approx. Chi-square)	46.841	61.118	48.983	41.761	52.367	46.570
df	21	21	21	21	21	21
Sig.	<.001	<.001	<.001	0.005	<.001	0.001

(how the factors explains each other) between the variables and Bartlett's test of sphericity test he null hypothesis and a significant chi-square at 0.001% and 0.005% level of significance. The sample adequacy scale was also examined and its value was determined in a range of 0.5 to 0.6 which falls under acceptable tolerance range.

Table 2 indicated that KMO and Bartlett's test values of input constraints (BTS 46.841 and the significance point in P=<.001), technology constraints (BTS 61.118 and the significance point in P=<.001), labour and machinery constraints (BTS 48.983 and the significance point in P=<.001), institutional constraints (BTS 41.761 and the significance point in P=0.00), marketing constraints (BTS 52.367 and the significance point in P=<.001) and political and legal constraints (BTS 46.570 and the significance point in P=0.001) showed that all the constraints of the ZBNF farmers were suitable for analysis of principal component. Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) provided the values of input constraints (0.552), technological constraints (0.611), labour and machinery constraints (0.615), institutional constraints (0.598), marketing constraints (0.562), and political and legal constraints (0.512) which showed that the constraints of the ZBNF farmers had adequate items. Both tests favored the adequacy of principal component analysis.

From Table 3, it is revealed that input constraints were categorized into three components based on eigen values. Input constraints component 1 (levelled as scarce raw material for input preparation) had higher eigen value of 1.44, a variance percentage of 20.61, and a cumulative percentage of 20.61 and under this component non-availability of quality seeds (0.744) was the major constraint followed by scarcity of bio fertilizers and manures of 0.712, and Preparation of inputs is labour intensive and costly (0.538). The second component, levelled as crop management practices, comprise with difficulty in management of weeds, insect pest and disease, and non-availability of urine/dung of local/ indigenous cow having highest covariance values, and eigen value of 1.42, a variance percentage of 20.32, and a cumulative percentage of 40.94.

Rao et al., (2021), in his study found that the major constraints of ZBNF were non availability of Subhash Palekar Natural Farming

Table 3. Factor analysis following PCA (Varimax rotation) of constraints related to input and technology as perceived by the ZBNF farmers (N=100)

S. No.	Constraints related to input	Rotated component matrix: Component 1	2	3	Communalities (Sum of squared factor loadings for the variables denoted as R^2)
1.	Non-availability of urine/dung of local/indigenous cow	0.075	0.715	0.167	0.545
2.	Non-availability of biomass for compost preparation	-.127	0.326	0.809	0.776
3.	Difficulty in management of weeds, insect pest and disease	0.062	0.768	-.108	0.606
4.	Non-availability of quality seeds	0.744	-.070	-.029	0.559
5.	Preparation of inputs is labour intensive and costly	0.538	0.310	0.302	0.476
6.	Non-availability of liquid inputs in the market	0.261	-.327	0.696	0.660
7.	Scarcity of bio fertilizers and manures	0.712	0.089	0.016	0.515
	Eigen values	1.44	1.42	1.27	
	% of variance	20.61	20.32	18.15	
	Cumulative %	20.61	40.94	59.10	
	Constraints related to technology				
1.	Lack of Knowledge about insect and pest in ZBNF	0.053	0.773	0.174	0.631
2.	Lack of Knowledge about weed management practices in ZBNF	-.064	0.332	0.804	0.761
3.	Lack of capacity building regarding preparation of inputs in ZBNF	0.155	0.770	-.094	0.625
4.	Lack of Knowledge about use of liquid fertilizers in ZBNF	0.768	-.045	-.015	0.593
5.	Non availability of package of practices on ZBNF	0.569	0.253	0.335	0.500
6.	Less demonstration units for FYM/Compost/Liquid manure preparation	0.237	-.233	0.733	0.649
7.	Lack of soil & water testing facilities for ZBNF farmers	0.685	0.137	0.053	0.490
	Eigen values	1.469	1.440	1.339	
	% of variance	20.98	20.57	19.13	
	Cumulative %	20.98	41.55	60.69	

(SPNF) inputs. The third component (leveled as non-availability of biomass for compost preparation) had an Eigenvalue of 1.27, a variance percentage of 18.15, and a cumulative percentage of 18.15, the next major input constraint. The component consists of 3 items such as non-availability of biomass for compost preparation (0.809) major constraints followed by non-availability of liquid inputs in the market (0.696) and preparation of inputs is labour intensive and costly (0.302) were the major constraints. Similar results were also observed as ZBNF adoption include time and labor constraints found by Bhattacharya (2017) & Gupta et al., (2020) found the beejamrutham required the most labor out of all ZBNF inputs.

Technological constraints categorized into three components based on eigenvalues of more than one (Table 3). The first component (Lack of knowledge about different liquid fertilizers in ZBNF) was major technological constraint as it has a higher Eigenvalue of 1.469, a variance percentage of 20.989, and a cumulative percentage of 20.989 than the other two components. The component consists of three constraints; lack of knowledge about use of liquid fertilizers in ZBNF (0.768) was a major constraint followed by the lack of soil & water testing facilities for ZBNF farmers (0.685) and the non-availability of package of practices on ZBNF (0.569). Singh & Thakur (2022) found the similar result for ZBNF practicing farmers. The second component (Leveled as Appropriate knowledge about pest management) has an eigen value of 1.440, a variance percentage of 20.570, and a cumulative percentage of 41.559. The component consists of two constraints, lack of knowledge about insect and pest in ZBNF (0.773) was a major constraint, followed by lack of capacity building regarding preparation of inputs in ZBNF (0.770). The third component, leveled as knowledge about weed management practices had an eigenvalue of 1.339, a variance percentage of 19.133, and a cumulative percentage of 60.692, the next major technology constraints. The component consists of two constraints such as lack of knowledge about weed management practices in ZBNF with covariance value of 0.804 and less demonstration units for FYM/Compost/liquid manure preparation (0.733).

From Table 4, it is revealed that constraints related to labour and machinery were categorized into three components based on Eigen values. In labour and machinery constraints component 1 (levelled as non-availability of farm machineries) had higher eigen value of 1.408, a variance percentage of 20.110, and a cumulative percentage of 20.110 and under this non-availability of bullock/ tractor/power tiller at proper time (0.793) was the major constraints followed by less information about custom hiring services of 0.618. Das (2020) also found the similar constraints including farmers were less likely to adopt ZBNF due to labor and time constraints, as the increased costs to hire labor affected their profitability.

The second component, leveled as increased demand of skilled labour, had eigen value of 1.398, a variance percentage of 19.967, and a cumulative percentage of 40.077 and under this high demand of specialized/skilled labour (0.775) was major constraint followed by, non-availability of human labour (0.757). The third component

Table 4. Factor Analysis following PCA (Varimax rotation) of constraints related to labour/machinery and institutional issues as perceived by the ZBNF farmers (N=100)

S. No.	Constraints related to labour and machinery	Rotated component matrix – Component 1	2	3	Communalities (Sum of squared factor loadings for the variables denoted as R^2)
1.	Non-availability of human labour	0.051	0.757	0.184	0.610
2.	High wages of labour	-.106	0.230	0.825	0.746
3.	High demand of specialized/skilled labour	0.129	0.775	-.100	0.628
4.	Non-availability of bullock/tractor/power tiller at proper time	0.793	-.117	-.015	0.643
5.	High charges of tractor/power tiller	0.538	0.292	0.324	0.479
6.	Lack of machinery bank at village level	0.279	-.165	0.692	0.584
7.	Less information about custom hiring services	0.618	0.211	0.044	0.428
	Eigen values	1.408	1.398	1.311	
	% of variance	20.110	19.967	18.725	
	Cumulative %	20.110	40.077	58.802	
	Institutional issues				
1.	Certification is difficult and time consuming	0.783	0.078	0.156	0.643
2.	Certification fee is high	0.197	-.264	0.774	0.707
3.	Conversion period from chemical to natural farming is longer	0.822	0.079	-.093	0.690
4.	Difficulty in fulfilling certification norms/rules	-.016	0.662	-.168	0.467
5.	Certification agencies are less and located at distant places	0.272	0.547	0.359	0.503
6.	Insufficient extension staff	-.182	0.348	0.626	0.546
7.	Lack of appropriate transfer of technology measures by extension organizations/Agriculture department/ private agencies	0.096	0.697	0.082	0.502
	Eigen values	1.444	1.428	1.188	
	% of variance	20.622	20.398	16.970	
	Cumulative %	20.622	41.020	57.990	

(leveled as high labour wages) had an Eigen value of 1.311, a variance percentage of 18.725, and a cumulative percentage of 58.802, the next major labour and machinery constraints. The component consists of 2 items such as high wages of labour of 0.825 major constraints followed by lack of machinery bank at village level (0.692). Laishram et al., (2022) reported that shortage of skilled labor, higher wage rate, non-availability at peak operation time were the major constraints in adopting ZBNF practices.

From Table 4, it is revealed that constraints related to institutional issues were categorized into three components based on eigen values. In institutional constraints component 1 (leveled as longer conversion period from chemical to non chemical/organic) had higher eigen value of 1.444, a variance percentage of 20.622, and a cumulative percentage of 20.622 and under this component conversion period from chemical to natural farming is longer (0.822) was the major constraint followed by certification is difficult and time consuming of 0.783. Devi et al., (2020) & Nain et al., (2020) also found the similar results. The second component, leveled as an lack of appropriate transfer of technology measures by extension organizations, has Eigen value of 1.428, a variance percentage of 20.398, and a cumulative percentage of 41.020 and under this lack of appropriate transfer of technology measures by extension organizations/Agriculture department/ private agencies (0.697) was major constraint followed by, difficulty in fulfilling certification norms/rules (0.662) and certification agencies are less and located at distant places (0.547). The third component (leveled as high certification fee) had an Eigenvalue of 1.188, a variance percentage of 16.970, and a cumulative percentage of 57.990, the next major institutional constraint. The component consists of 2 items such as certification fee is high of 0.774 major constraints followed by insufficient extension staff (0.626).

From Table 5, it is revealed that marketing constraints were categorized into three components based on Eigen values. In marketing constraints component 1 (levelled as lack of better prices assurance) had higher Eigen value of 1.657, a variance percentage of 23.66, and a cumulative percentage of 23.664 and under this component lack of assurance of better prices (0.796) was the major constraints followed by lack of robust supply chain network of 0.789. Similar result was also observed by Priya & Naidu (2019) that marketing is a major constraint. Vashishat et al., (2021), in his study reported that major constraints were non-availability of a specialized market and unfair price for produce in market.

The second component, leveled as at distant location of purchase agencies, has eigen value of 1.258, a variance percentage of 17.965, and a cumulative percentage of 41.629 and under this purchase agencies at distant places (0.777) was major constraint followed by lack of information for value addition and marketing (0.745). The third component (leveled as lack of market structure) had an eigen value of 1.197, a variance percentage of 17.098, and a cumulative percentage of 58.727, the next major constraint. The component consists of 2 items such as lack of proper market structure of 0.830 major constraints followed by high transportation charges (0.605).

In Table 5 it is depicted that, political and legal constraints were categorized into four components based on Eigen values. In

Table 5. Factor analysis following PCA (Varimax rotation) of constraints related to marketing and political concerns as perceived by the ZBNF farmers

S. No.	Constraints related to marketing	Rotated component matrix: Component 1	2	3	Communalities (Sum of squared factor loadings for the variables denoted as R^2)
1.	Lack of robust supply chain network	0.789	0.252	0.000	0.685
2.	Lack of information for value addition and marketing	0.081	0.745	-.228	0.614
3.	Lack of assurance of better prices	0.796	-.120	-.016	0.649
4.	Lack of proper market structure	-.045	-.074	0.830	0.696
5.	Low level of marketable surplus	0.490	-.052	0.200	0.283
6.	Purchase agencies at distant places	-.066	0.777	0.225	0.658
7.	High transportation charges	0.384	0.114	0.605	0.527
	Eigen Values	1.657	1.258	1.197	
	% of variance	23.664	17.965	17.098	
	Cumulative %	23.664	41.629	58.727	

S. No.	Constraints related to Political and legal concerns	1	2	3	4	Communalities
1.	Subsidy on input such as seeds, fertilizers, machinery etc.	0.843	-.082	-.044	0.037	0.721
2.	Government support through different scheme (PMFBY, Support to Agri MSMEs)	-.072	0.475	0.098	0.636	0.644
3.	Less public investment on research and development	0.162	-.685	0.449	0.061	0.701
4.	Lack of globalized market and integrated market intelligence approach	0.014	0.084	0.898	-.001	0.813
5.	Need of convergence between different departments and NGOs	0.130	-.220	-.051	0.834	0.763
6.	Effort to enline the ZBNF practices with mainstream agriculture	0.107	0.755	0.315	-.029	0.681
7.	less number of FPOs/ farmer based organization	0.850	0.061	0.106	0.046	0.739
	Eigen values	1.493	1.331	1.132	1.107	
	% of variance	21.328	19.014	16.164	15.820	
	Cumulative %	21.328	40.342	56.506	72.326	

political and legal constraints component 1 (levelled as appropriate number of FPOs) had higher Eigenvalue of 1.493, a variance percentage of 21.328, and a cumulative percentage of 21.328 and under this component less number of FPOs/farmer based organization (0.850) was the major constraint followed by subsidy on input such as seeds, fertilizers, machinery etc. of 0.843. The second component, leveled as mainstreaming of ZBNF practices, has Eigenvalue of 1.331, a variance percentage of 19.014, and a cumulative percentage of 40.342 and under this effort to enline the ZBNF practices with mainstream agriculture (0.755) was major constraint. The third component (leveled as lack of global market structures) had an Eigenvalue of 1.132, a variance percentage of 16.164, and a cumulative percentage of 56.506, the next major constraint. The component consists of 2 items such as lack of globalized market and integrated market intelligence approach of 0.898 major constraint followed by less public investment on research and development (0.449). The fourth component (leveled as need of convergence based approaches) has an Eigenvalue of 1.107, a variance percentage of 15.820, and a cumulative percentage of 72.326, and under this, need of convergence between different departments and NGOs (0.834) was the major constraint followed by government support through different scheme (PMFBY, Support to Agri MSMEs) (0.636).

CONCLUSION

The factors such as integrated soil fertility management practices, integrated pest management practices, adoption of ZBNF practices, use of live mulching and drip irrigation were found significant factors for practicing sustainable agriculture/ZBNF practices for the participants of Farmer Field School. ZBNF practicing farmers faced constraints like, scarce raw material for input preparation, lack of weed management practices, lack of appropriate pest and disease management practices and non-availability of biomass for compost preparation, knowledge about use of liquid fertilizers, lack of specialized labour, high labour wages, higher conversion period and several others. Farmers showing interest in adopting ZBNF should be fully aware of basic ZBNF practices and they need to be trained on the aspects constrained by them. Beside these technical and other constraints the number of farmers in ZBNF is increasing due to intervention of government of India and different state specific schemes. These constraints need to be overcome for sustaining the yield and income through natural farming practices.

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