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Green Farming Vol. **10** (6) **:** 661-667 ; November-December, 2019 **Research Paper**

Zero Budget Natural Farming - An empirical analysis

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ABSTRACT

Lately, there have been discussions around natural farming. This was reinforced when India's Finance Minister during the budget session in July 2019 responded to farmers' distress, thus: “we shall go back to basics on one count : zero-budget farming . It is not a new thing. We need to replicate this innovative model”. Zero Budget Natural Farming (ZBNF) with no external inputs of any sort, including finance, has been advocated for decades by Padma Shri awardee Subhash Palekar. The Government of Andhra Pradesh piloted it in select blocks of 13 districts since 2015-16, where rice is the staple food and it occupies 30% of the cropped area. Under ZBNF, Ghanamrutham and Jeevamrutham (liquid) are the two primary natural inputs that are considered substitutes for chemical fertilizers. Around 1.6 lakh farmers were practicing it by the end of 2018, and the government aims to bring about five lakh farmers under it by 2024. An estimated ₹ 15,000 crore is what it will take to scale it up to the entire state in the next few years. In this context, a study was conducted to assess whether the practice has reduced the cost of production and doubled farmer incomes. ZBNF was found to have partially improved soil health compared to lands of non-adopters possibly due to building the heterotrophic microbial communities and flora quickly. Many studies proved that the capacity to improve the soil microbes in N fixation and P solubalization was improved with the application of organic manures with cow urine. The ability to produce chemical-free food and reduce fertilizer and pesticide cost was cited by the farmers as the primary reason for the adoption of ZBNF. However, though there is acceptance of the technology, advocacy is possible only if the farmer's net returns and impact on the price paid by the consumer are well documented.

Key words : *Adoption, Ghanamrutham, Impact of adoption, Jeevamrutham, Paddy, ZBNF.*

INTRODUCTION

The Green Revolution saw the liberal application of inorganic fertilizers and chemicals and is believed to have significantly contributed to sustained food security in many developed and developing countries. Its strategies paid rich dividends in India, with a phenomenal increase in food grain production from 115.6 million tons in 1960-61 (Praduman *et al.,* 2016) to over 281.37 million tons in 2018-19 (Annon. 2019). Similarly, annual consumption of N, P and K fertilizers increased from 0.07 million tons in 1951-52 to more than 25.95 million tons in 2016-17 (Bagal *et al.,* 2018). According to the Annual Report 2017-18, Ministry of Agriculture and Farmers' Welfare, a 50% rise in food grain production can be attributed to increased fertilizer consumption. However, the Green Revolution brought with its excessive use of fertilizers causing an imbalance in soil health (Patra *et al.,* 2016) by destroying useful soil microflora.

To overcome the challenges of loss in soil fertility, health and short term gains in yields (Nadkarni, 1988), innovative methods like natural farming & organic farming were practiced by some farmers as an alternative to conventional agriculture.

In this context, the Government of Andhra Pradesh (GoAP) implemented a Zero Budget Natural Farming (ZBNF) Program in 2015-16 to enhance farmers' welfare and conserve the environment, ZBNF is a farming practice advocating the natural growth of crops without adding fertilizers and pesticides or any other foreign elements. Zero budget refers to the zero net cost of production of all crops.

Experts and farmers believe that even if ZBNF were to be adopted at a national scale, challenges and constraints associated with current farming practices, such as knowledge gap, availability of seed banks, price support, and marketing issues would remain unresolved. This calls for a critical and holistic examination of ZBNF. The current study focuses on the sustainability of ZBNF to arrive at definitive conclusions before it is advocated prospective farmers and policymakers.

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METHODOLOGY

The selection of mandals at district level is based on the inputs given by Joint Director of Agriculture (JDA) and one village from each mandal was selected with the help of Mandal Agricultural Officer (MAO). Adopters list of ZBNF is obtained from MAO and farmers are selected randomly.

The initial study sample targeted 65 respondents, five ZBNF farmers each from 13 districts in Andhra Pradesh, however, an additional 32 respondents were included in the sample given its response, bringing the total sample size to 97 (**Table 1**).

Table 1. Number of respondents in each district

District	Sample	District	Sample
Anantapur	6	Nellore	5
Chittoor	5	Prakasam	5
East Godavari	9	Srikakulam	10
Guntur	8	Vizianagaram	10
Kadapa	5	Vishakhapatnam	9
Krishna	7	West Godavari	8
Kurnool	10	**Total**	**97**

The major focus of the study assesses the impact of Jeevamrutham / Ghanamrutham on yield, cost of cultivation, and finally, the net returns.

The four samples of Ghanamrutham (two each from East Godavari and West Godavari districts) and two samples of Jeevamrutham (one each from East Godavari and West Godavari districts) are collected to analyze their chemical properties.

Similarly, four soil samples from treated plots and four from control plots where the principal crop is paddy and where Ghanamrutham has been applied were selected for analyzing the chemical properties. The soil is collected from the same villages of East and West Godavari where Ghanamrutham was collected and applied.

RESULTS AND DISCUSSION

Crops grown under ZBNF

The crops cultivated by farmers under ZBNF are shown in **Table 2**. A majority (67%) of the farmers cultivated paddy, followed by groundnut (9%). However, cotton, pigeonpea, chickpea, and horticultural crops like mango and banana were also observed to be cultivated using ZBNF methods. Since a majority of the respondents were paddy growers, the study focused on paddy to study the economics of ZBNF.

Table 2. Crops grown by farmers under ZBNF

Crops	Number of respondents	Crops	Number of respondents
Paddy	65	Black gram	1
Groundnut	9	Coconut + cocoa	1
Banana	3	Cotton	1
Pigeonpea/red gram	3	Onion	1
Jasmine	2	Palm oil	1
Mango	2	Finger millet	1
Turmeric	2	Sugarcane	1
Vegetables	2	Tomato	1
Chickpea	1	**Total**	**97**

Source : Primary survey.

Scale of ZBNF

A persistent debate in the literature on agro-ecological farming centers around scaling-out and scaling-up, meaning assessing the effectiveness of extension systems in reaching farmers in general (Freire, 1973), and more specifically for promoting ZBNF rather than new technologies. It is evident from the survey that farmers allocated almost 33% of their cropped area to ZBNF farming.

Loevinsohn *et al.* (2012) define adoption as “the integration of new technology into existing practice and is usually proceeded by a period of 'trying' and some degree of adaptation”.

Farmer's decisions on adopting new technologies depend on socio-economic, institutional and environmental factors, indicating that decision patterns can be very locality specific (Amare and Simane, 2017). It also involves resource allocation for the adoption process.

Fig. 1 provides insights into the crop-wise adoption of ZBNF by farmers. A comparison of the total area under cultivation shows that a majority of farmers did not allocate their land entirely to ZBNF, except in the case of chickpea, onion, and sugarcane. Only 30% of the area under mango, banana, and cotton was under ZBNF, whereas in the case of paddy, it was 38%. Mango had the least area (29%) under ZBNF.

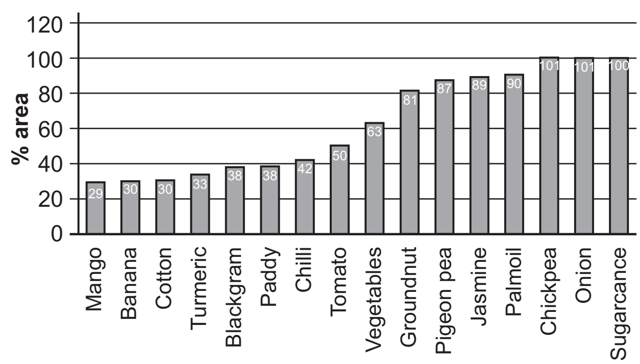
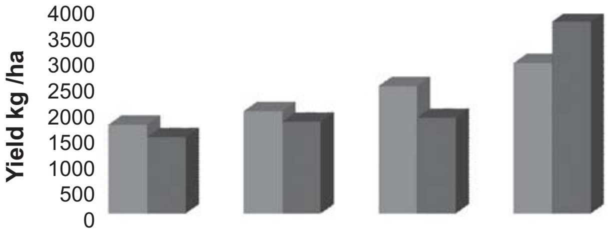


Fig. 1. Percentage of area devoted to ZBNF, crop-wise



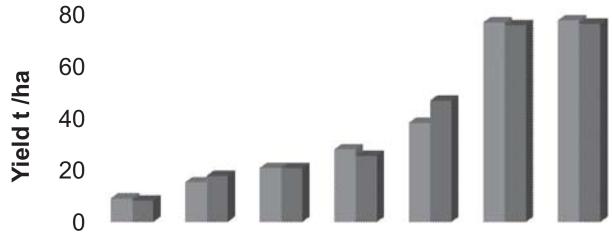


Fig. 2 and 3. Change in yield of different crops before and after ZBNR implementation

While this could be due to many reasons, a majority of farmers cited the risk of fall in yields, which is evident from **Fig.'s 2 and 3**. A before and after scenario of ZBNF adoption shows that except for a few crops like cotton, chilies and tomato, yields of the remaining crops declined marginally. As the sample size for these crops was very small, the results could be statistically invalid.

Products used under ZBNF and their application

Khadse and Rosset (2019) believe that 'Zero budget' does not mean that costs are 'zero', but rather that the need for external financing is zero. This is evident from **Table 3** which shows products that are mainly used as alternatives to fertilizers and pesticides (Ruchi and Akshaya, 2017).

Two hundred and fifty liters of Jeevamrutham sufficient for one hectare of land were applied at three stages: before sowing, 20 days after sowing (DAS) and 45 DAS. Ghanamrutham is a dry form of Jeevamrutham recommended for dryland/rainfed areas where there is shortage of water. It is applied during ploughing or before final ploughing. For every hectare, 500 kg of Ghanamrutham is required and applied as basal application. Panchagavya, which acts as a plant growth regulator, is recommended as foliar spray at 30% level for all the crops and contains substances such as IAA (Indole Acetic Acid), GA, Cytokinins, essential plant nutrients, and effective micro-organisms like lactic acid bacterium, yeast and actinomycetes (Brar *et al.,* 2019). Agniastra, Bramhastra, and Neemastra are used for plant protection and made of locally available materials.

From Table 1 shows the cost of various ZBNF products, it is evident that the cost of their application does not exceed ₹ 2500/ha, compared to ₹ 15,000/ha incurred by farmers on chemical fertilizers and pesticides for paddy. This nearly 15% difference in cost is roughly equivalent to 8 quintals of paddy if its Minimum Support Price (MSP) is ₹ 1600/quintal. So the adoption of ZBNF technologies is still a value proposition.

Table 3. ZBNF products used as alternatives to fertilizers and pesticides, their ingredients, uses and cost

Products	Ingredients	Uses	Cost of own preparation, excluding labor cost (₹)	Cost in the open market (₹)
Jeevamrutham	Cow dung (10 kilograms (kgs]), cow urine (10 liters (L), jaggery (2 kgs), pulse flour (2 kgs), fine soil (1 kg), water (100 L)	Promotes microorganism activity in the soil, increases earthworm activity	₹ 200-300	-
Ghanajeevamrutham	Cow dung (100 kgs), cow urine (10 L), jaggery (4 kgs), pulse flour (2 kgs), fine soil (as required)	Used as manure	₹ 300	₹ 6/kg
Panchagavya	Cow milk (2 L), cow yogurt (2 L), clarified butter/ oil (1/2 kg), cow urine (5 L), cow dung (10 kgs), coconut water (2 L), bananas (2 kgs), ash gourd (1), jaggery (2 kgs)	Promotes growth and provides immunity in plant	₹ 400-500	₹ 150/L
Agniastra	Tobacco (1 kg) , neem leaves (5 kgs), green chillies (0.5 kg), garlic (0.5 kg), cow urine (10 L)	Effective against leaf roller, stem borer, fruit borer, pod borer	₹ 100-200	₹ 80/L
Bramhastra	Cow urine (10 L), neem leaves (3 kgs), custard apple leaves (2 kgs), papaya leaves (2 kgs), pomegranate leaves (2 kgs), guava leaves (2 kgs), Lantena Camella leaves (2 kgs)	Used to control all sucking pests, pod borer, fruit borer	₹ 50-100	₹ 40/L
Neemastra	Water (100 L), cow urine (5 L), cow dung (5 kgs), neem leaves (5 kgs)	Used for sucking pests and mealy bug	Free	₹ 50/L

Source - Primary survey

Economics of production

A major concern in natural/organic farming has been low yields, which calls for more land to produce the same amount (Sreejith 2014). The current study revealed a negative trend in yield (**Fig. 4**); the mean yield was 5335 kg/ha before ZBNF and 4746 kg/ha after adoption (**Fig. 5**), a decline of 12%. This has been a major concern raised by researchers across the globe (Stanhill 1990 ; Penning de Vries *et al.,* 1997; Badgley *et al.*, 2007; Kirchmann *et al.,* 2008) who reported that yields could fall by 9-50% because of excluding chemical fertilizers.

Also, the interquartile range (1163 with ZBNF) suggests high variability in yield across the geographical spread, which may be a cause for concern in terms of food security of the region (Timsina, 2018). Anderson test for normality shows that the yield levels of pre-ZBNF are not normally distributed (p >0.05). However, in the post-ZBNF scenario, the null hypothesis for normality was accepted, with wide yield changes observed across the districts. Finally, with 95% confidence, it can be stated that yield levels ranged between 5163 kg/ha and 5507 kg/ha with pre-ZBNF adoption and between 4517 kg/ha and 4976 kg/ha with ZBNF. This is high and is a major concern for farmers, researchers, and policymakers.

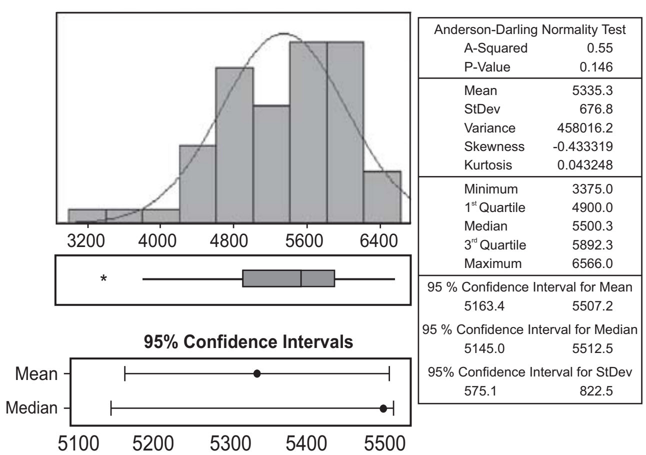


Fig. 4. Distribution of yield before adoption

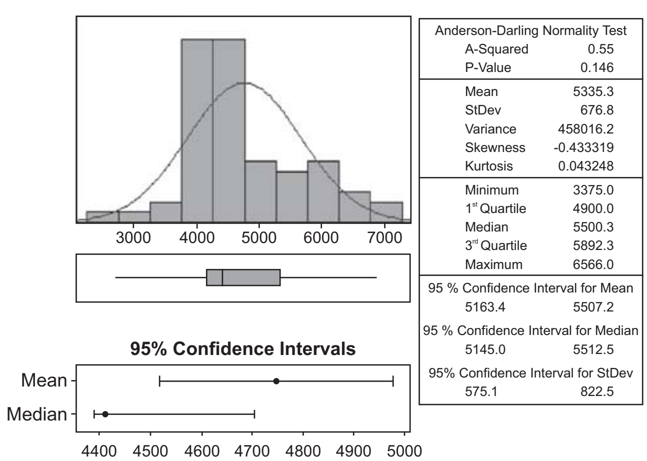


Fig. 5. Distribution of yield after adoption

A disaggregation of input and output components (**Fig. 6**) shows that higher prices (32%) and improved farm management practices (reduction in the cost of fertilizers by 83% and of pesticides by 87% resulted in higher net gains (92%). The results emphasize that ZBNF has gained consumer confidence and approval, which was reflected in consumer readiness to pay for higher prices for the ZBNF produce. The average difference in the cost of cultivation (COC) between pre- and post-ZBNF is ₹ 13,000/ha. This is equivalent to the money saved from adopting ZBNF practices *i.e.*, the average cost of fertilizer and pesticide in pre-ZBNF is ₹ 14,800/ha compared to ₹ 2200/ha in post ZBNF. This clearly shows that the loss due to yield can be compensated with premium prices and a reduction in cost of cultivation.

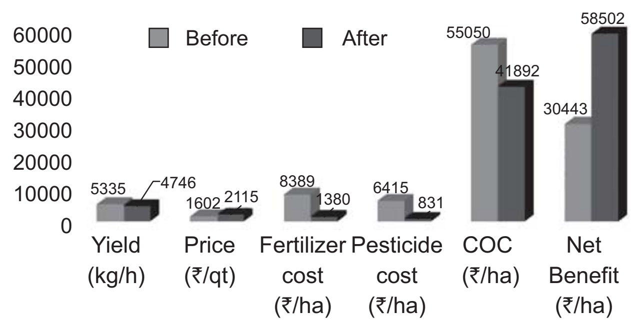


Fig. 6. Change in production parameters ZBNF technologies

Comparing ZBNF and non-ZBNF fields

To attain higher production it is necessary to improve both soil health and the use efficiency of nitrogenous and phosphatic fertilizers (Naresh *et al.,* 2018). Results shows the improved soil health in a mango field (**Fig. 7**), where farmers had been practicing natural farming for the past 15 years. A comparative analysis of soil samples from farmers' fields (ZBNF and non-ZBNF) (**Table 4**) reveals that soil organic carbon (OC) and total N in fields of adopters were higher (52% and 70% respectively) than those in non-adopters fields. There is no significant difference in other nutrients between the two

Fig. 7. The improved soil health in the mango orchard (R) following the use of earthworm pellets

Table 4. Chemical properties of soil samples

Particulars	pH	OC (%)	Total N (PPM)	Total N (%)	Available P (PPM)	Available P (%)	Exch-K (PPM)	Available K (%)	Available Zn (PPM)	Available B (PPM)	Available S (PPM)
ZBNF Farmer 1	5.56	0.75	926	0.09	30.9	0.003	79	0.008	1.12	0.52	3.94
Control 1	4.61	0.46	421	0.04	44.3	0.004	75	0.008	1.23	0.35	4.23
ZBNF Farmer 2	7.20	0.31	339	0.03	16.3	0.002	82	0.008	0.80	0.62	2.30
Control2	6.75	0.25	311	0.03	20.2	0.002	93	0.009	1.10	0.73	2.13
ZBNF Farmer 3	5.45	0.62	870	0.09	40.4	0.004	90	0.009	2.42	1.82	5.24
Control 3	4.35	0.40	457	0.05	42.5	0.004	72	0.007	2.53	1.65	5.53
ZBNF Farmer 4	6.35	0.42	549	0.05	34.0	0.003	92	0.009	1.56	1.38	3.06
Control 4	4.78	0.27	389	0.04	36.0	0.004	88	0.009	1.86	1.49	2.89
Average of ZBNF	6.14	0.53	671	0.07	30.4	0.00	86	0.01	1.48	1.09	3.64
Average of Control	5.12	0.35	394	0.04	35.7	0.00	82	0.01	1.68	1.06	3.70
% change	19.8	52.1	70	62.50	-14.95	0.00	4.48	3.03	-12.20	2.84	-1.62

pH = Potential of Hydrogen, N = Nitrogen, P = Phosphorous, K = Potassium, Zn = Zinc, B = Boron, S = Sulphur, ppm= parts per million

treated and control plots. However, available P and Zn tended to decline under ZBNF practice (in all the four soil samples).

Total nitrogen which is a measure of all organic and inorganic forms of nitrogen in soil can be determined with soil testing. Total nitrogen could only be used as an index of soil quality indicator and it helps in maintaining soil fertility and pedo-environment (Pal *et al.,* 2000). A soil sample analysis showed that the N supplying power of soils where ZBNF had been adopted was comparatively higher than that in non-adopters' fields. This supports the theory of application of dung/FYM/organic matter will improve the organic content of the soil, only after decomposition or carbon sequestration.

Soil pH was slightly higher in ZBNF adopters than non-adopters' fields, indicating that the use of ZBNF products led to a reduction in soil acidification which shows a positive response to higher nitrogen doses, which in turn inhibits assimilation or storage of soil organic matter (Khan *et al.*, 2017).

However, more soil samples need to be collected and analyzed to obtain a holistic understanding of soil nutrient status as well as nutrient dynamics in the soil-plant system, particularly in ZBNF farms. This will help in better nutrient management to improve crop yield, a major criticism of the non-adopters.

Chemical properties of ZBNF products

ZBNF product Jeevamrutham is being promoted by the Government of Andhra Pradesh (Tripathi *et al.,* 2018) as a substitute for chemicals. According to Krishan Chandra (2005), fresh cattle dung contains 0.4-0.5% N, 0.3-0.4% P, and K and paddy require 100 kg N/ha, 50 kg P/ha and 50 kg K/ha to realize effective yields. The results of Ghanamrutham and liquid Jeevamrutham sample show that Ghanamrutham has 1.08 - 1.94% total N, 0.3 -0.4% available P, 0.008 - 2.055% available K, 5.31 - 12.22 ppm available zinc (Z), 3.3 - 7.62 ppm available boron (B) and 138.28 - 493.3 ppm available Sulphur (S) (**Table 5**).

Palekar's ZBNF uses a new biodynamic formulation termed Jeevamrutham, a plant growth-promoting substance containing beneficial microorganisms providing the necessary nutritional needs for growth and yield of a crop (Vanaja *et al.,* 2009). Many studies on microbial activity in jeevamrutham and ganamrutham found a high incidence of naturally occurring beneficial microorganisms, predominantly bacteria, yeast, actinomycetes and certain fungi in organic liquid manures (Devakumar *et al.,* 2014a). The beneficial microbial in the soil are broadly N fixer (Bacteria - Azatobacter sp., *A. chroococcum*, Bacillus sp., *Beijerinckia* sp., Actinomycetes - Streptomyces sp) P-solubiliser fungi (*Aspergillus* sp.,

Table 5. Chemical properties of Ghanamrutham and liquid Jeevamrutham

Particulars	OC (%)	Total N (PPM)	Total N (%)	Avail-P (PPM)	Avail-P (%)	Exch-K (PPM)	Avail-K (%)	Avail-Zn (PPM)	Avail-B (PPM)	Avail-S (PPM)
Ghanamrutham 1	8.72	10805	1.08	288.87	0.029	10412.00	1.041	5.31	6.32	492.00
Ghanamrutham 2	14.76	15279	1.53	238.56	0.024	2976.00	0.298	11.46	3.30	138.28
Ghanamrutham 3	15.69	19437	1.94	673.00	0.067	20547.00	2.055	6.61	7.62	493.30
Ghanamrutham 4	15.79	17251	1.73	408.80	0.041	13428.00	2.055	12.22	4.06	139.04
Average	**13.74**	**15693**	**1.57**	**402.31**	**0.004**	**7340.75**	**0.007**	**8.90**	**5.30**	**315.60**
Liquid Jeevamrutham 1	4.56	5667	0.57	165.96	0.017	2925.00	0.293	1.12	2.74	117.60
Liquid Jeevamrutham 2	4.05	4327	0.43	44.00	0.004	4767.00	0.477	0.48	1.89	98.00
Average	**4.305**	**4997**	**0.50**	**104.98**	**0.010**	**3846.00**	**0.380**	**0.80**	**2.32**	**107.80**

Penicillium sp., Bacteria like- *Bacillus* sp., *Pseudomonas* sp.,) and he states that the jeevamrutham is an enriched mix of native soil microorganisms (Devakumar *et al.,* 2014a).

Studying the effect of Jeevamrutham on field crops, observed that microbes present in it are devoid of specific characteristics of nitrogen fixation, phosphorous solubilization and sulphur uptake. Other studies (Chandrakala, 2008 ; Manjunatha *et al.,* 2009 ; Tapke *et al.*, 2017) found that Jeevamritham combined with manure, Panchakayava and Ghanamrutham produced better results than as a standalone application.

Many researchers in their trials on liquid organic inputs with and out cow urine (Boraiah *et al.,* 2017 ; Swetha, 2008 ; Yadav and Mowade, 2004) observed that application of liquid organic inputs helps in building the heterotrophic microbia and flora quickly. This is because liquid organic inputs increase the organic carbon content of the soil which acts as carbon and energy source for microbes (Yadav and Mowade, 2004).

Hence, it is advised to conduct research on Jeevamrutham / Ghanamrutham and its impact as it is the main source of microbes that supplies nutrients to the plant.

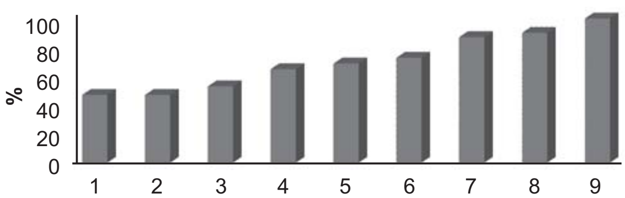
To adopt or not to adopt – Tenant's dilemma

Among the many dilemmas facing tenant farmers in the adoption of ZBNF are fear of crop failure and drop in yield or price of produce which could lead to major economic losses and straight into a debt trap. Also, when tenant farmers are exposed to climate vagaries, it serves as a deterrent to the adoption and consequent diffusion of ZBNF practices.

The adoption of the practice could be improved through a regulatory authority for ZBNF products and an efficient marketing system.

Reasons for adoption - Farmer perception

When asked about the factors that influenced the adoption of ZBNF, a majority of the respondents seem to have been influenced by the relative advantage of technology. All the respondents unanimously stated the production of chemical-free food as the primary advantage (**Fig. 8**). Healthy food, the initial push by the government, and less expenditure on fertilizers and pesticides were other drivers. The results suggest that as in any other technology's dissemination, ZBNF too needs a good extension system for its effective diffusion.



1. Increase in net returns
2. Assistance from Government
3. Input materials are readily available
4. Ease of preparation of material (inputs)
5. Availability of extension staff
6. The plants will be healthier (more panicles, sturdy tillers and bigger...
7. Initial push by the government
8. Fertilizer and pesticide cost was reduced
9. Chemical- free food

Fig. 8. Farmers' reasons for adopting ZBNF

Suggestions

Among the suggestions, farmers came up with (**Table 6**) for a wider spread of natural farming practices included certification by a competent authority (100%) followed by the provision of marketing facilities (85%).

Table 6. Suggestions by adopters

Parameter	Responses (%)
Certification or authentication of their produce	100
Government provision of marketing facilities	85
Machinery to prepare ZBNF products	65
Technical support from the department	30

Overall, the farmers opined that if the government wishes, it could encourage ZBNF farming on a broader scale. It should initially come up with guidelines for certification. They cited instances where ZBNF products had failed to control pests and diseases (particularly in fruit crops), forcing them to use chemicals. The farmers also sought technical support, particularly in pest and disease management.

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