

A Sustainable Revolution in Agriculture: A Review of Zero Budget Natural Farming for Enhancing Soil Fertility and Crop Productivity

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Abstract – In India, the agriculture sector has been dominated for the past over 60 years by green revolution. Green revolution has influenced the economy by increasing agricultural production and productivity. Now a days using conventional techniques in agriculture is like cancer to our soil and health as well. It does not only make the soil barren but eventually, the farmer goes under debt. A revolutionary impact of green revolution or modern agricultural techniques that broke away the old and outdated traditional practices. Hence, the only way to deal with this ever rising problem is Zero Budget Natural Farming (ZBNF). Zero budget natural farming, as the name implies, is a method of farming where the cost of growing and harvesting the plant is zero. This means that farmers need not to purchase fertilizers and pesticides in order to ensure healthy growth of the crops [1]. This concept was pulled into light by Shri Subhash Palekar. Natural farming minimizes the external inputs to farmland which degenerate the soil nature, increases microbial population better soil aeration, good water retention capacity and adaptability to climate change [2]. The inputs used for seed treatments and other inoculations are locally available in the form of cow dung and cow urine [3]. It is contemplated as a solution to end reliance on purchased inputs, improved family health & nutrition, stable crop yield, consequently reduced indebtedness and suicides among Indian farmers. Thus, making natural farming is economically and ecologically sustainable.

Keywords – Zero Budget Natural Farming, Cow Dung, Cow Urine, Sustainable Crop Production and Soil Health.

I. INTRODUCTION

The World Food Organization (FAO) predicts that by 2050, global food production needs to increase by 70% to meet the growing global population and changing consumption patterns. India, with 1.51 billion people, is expected to become the most populous country by 2030. Ensuring food security is a significant concern for the country, and adopting unscientific farming practices or production technologies that may negatively impact crop yield may pose serious concerns. Green revolution technology has been proved as a double-edged sword for the Indian agriculture system as well as for the entire globe. Although it intensified Indian agriculture from a food-scarce to a food-surplus country, it has also thrown several challenges in the form of declining factor productivity, depleting natural resources, low water, and nutrients, and adverse impacts on climate change as well as on human health [4]. Overuse of chemical fertilizers not only depletes soil nutrients but also reduces the yield and poisons the whole ecosystem [5]. Natural Farming (NF) is a unique chemical-free farming method that integrates crops, trees, and livestock, allowing functional biodiversity.

Zero Budget Natural Farming (ZBNF) was promoted by agriculturist Sh. Subhash Palekar in the mid-1990s and this technique is now gaining momentum in other states like Himachal Pradesh, Uttar Pradesh, Haryana, Gujarat, Tamil Nadu, and Kerala [6]. ZBNF formulations, such as Jeevamrit, Beejamarit, and Panchgavya induce a multifold increase in microbial population and earthworm activity which enhance nutrient availability in soil, strengthens the resistance mechanism, and increases crop productivity [7]. ZBNF drastically cuts

production costs by replacing chemical fertilizers and pesticides with home-grown products and adopting inter cropping and mulching. It also promotes soil health and improves soil organic carbon without adding a large amount of farm yard manure, achieving sustainable agriculture with a reduced carbon foot print.

II. PILLARS OF ZBNF

According to Sh. Subhash Palekar, the ZBNF has following four essential components that is listed in Fig. 1 (Palekar, 2014).



Fig. 1. The four-wheels of zero budget natural farming.

A. *Jeevamritha-Nuturing Microbial Life:*

The first pillar of ZBNF, Jivamrutha, centers around the cultivation of beneficial microorganisms. It is a fermented microbial culture. It provides nutrients, but most importantly, acts as a catalytic agent that promotes the activity of microorganisms in the soil, and also increases population of native earthworms. Jivamrutha not only enhances nutrient availability but also suppresses harmful pathogens, creating a thriving ecosystem in the soil.

- Preparation of Jeevamritha: Put 200 litres of water in a barrel, add 10 kg fresh local cow dung, 5 to 10 liters cow urine, 2 kg of jaggery, 2 kg of pulses flour and a handful of soil. Stir the solution well and let it ferment for 48 hours in the shade. During the 48-hour fermentation process, the aerobic and anaerobic bacteria present in the cow dung and urine multiply as they eat up organic ingredients (like pulse flour and jaggery). A handful of undisturbed soil acts as inoculate of native species of microbes and organisms.
- Application of Jeevamritha: Applied twice a month or as a 10% foliar spray. It can be stored up to a maximum of 15 days. For horticultural crops, Jeevamritha is applied to the individual plant. In Maharashtra, majority of the sample farmers are applying Jeevamritha through drip irrigation method [8].

B. *Beejamritha - Seed Treatment for Vitality:*

It is a treatment used for seeds, seedlings or any planting material. Beejamritha is effective in protecting young roots from fungus as well as from soilborne and seed-borne diseases that commonly affect plants after the monsoon period.

- Preparation of beejamritha- Mix local cow dung, considered to be natural fungicide, and cow urine (as anti-bacterial liquid), lime and soil. The dung is tied in a cloth and is kept in urine for about 12 hours. The dung is removed from cow urine, cow dung is squeezed and urine is added with about 50 grams of lime.
- Application as a seed treatment: Add beejamritha to the seeds of any crop; coat them, mixing by hand; dry them well and use them for sowing. For leguminous seeds, just dip them quickly and let them dry.

C. Acchadana - Mulching for Conservation:

Acchadana, the third pillar, introduces the practice of mulching. Utilizing crop residues, straw, or other organic materials, Acchadana involves covering the soil around plants. The three types of mulching have been suggested under ZBNF:

- ✧ *Soil mulch:* This protects topsoil during cultivation and does not destroy it by tilling. It promotes aeration and water retention in the soil. Therefore, deep ploughing should be avoided.
- ✧ *Straw mulch:* Straw material usually refers to the dried biomass waste of previous crops. Any type of dry organic material will decompose and form humus through the activity of the soil biota which is activated by microbial cultures.
- ✧ *Live mulch:* It is essential to develop multiple cropping patterns of monocotyledons and dicotyledons grown in the same field, to supply all essential elements to the soil and crops. Dicot group such as pulses are nitrogen-fixing plants. Monocots such as rice and wheat supply other elements like potash, phosphate and sulphur.

D. Whapasa - Sustainable Watering Practices:

The fourth pillar, Whapasa, addresses the critical aspect of water management. ZBNF encourages efficient watering methods such as drip irrigation and rainwater harvesting. Whapasa ensures that water resources are used judiciously, meeting the specific moisture needs of crops without unnecessary wastage. Whapasa is the condition where there are both air molecules and water molecules present in the soil. Thus, irrigating only at noon, in alternate furrows, may fulfil the moisture requirement of the crops, a significant decline in need for irrigation in ZBNF. However, rarely this practice is being followed by any farmer [9].

III. IMPACT ON SOIL FERTILITY AND CROP PRODUCTIVITY

Zero Budget Natural Farming (ZBNF) has demonstrated its potential to improve both soil fertility and crop productivity through its sustainable and regenerative agricultural practices. Here's how ZBNF contributes to enhancing both of these crucial aspects of agriculture:

A. Soil Fertility Improvement:

- a) **Organic Inputs:** ZBNF encourages the use of natural and organic materials, such as cow dung, cow urine, and other locally available resources, as fertilizers. These inputs enrich the soil with essential nutrients like nitrogen, phosphorus, and potassium (NPK), thereby improving its fertility.
- b) **Organic Matter Enrichment:** The application of organic mulch and organic inputs increases the soil's organic matter content, improves soil structure, water-holding capacity, and nutrient retention. It also promotes beneficial microbial activity in the soil, which further enhances nutrient availability.
- c) **Nutrient Cycling:** Intercropping, a key component of ZBNF, this practice promotes nutrient cycling in the soil, preventing nutrient imbalances and depletion, and ensuring that essential nutrients are available to the crops.
- d) **No-Till or Reduced-Till Farming:** ZBNF discourages extensive tilling and plowing, which can disrupt soil

structure and lead to erosion. It maintains soil fertility by preserving its natural structure and preventing nutrient loss [10].

B. Crop Productivity Enhancement:

- a) **Balanced Nutrition:** The use of organic inputs provides a balanced and gradual release of nutrients to the crops. This supports healthy crop growth, reducing the risk of nutrient deficiencies or toxicities that can limit productivity.
- b) **Improved Soil Structure:** Enhanced soil structure resulting from organic matter enrichment and reduced soil disturbance allows for better root development and nutrient uptake by crops, leading to increased productivity.
- c) **Natural Pest and Disease Management:** ZBNF promotes natural methods for pest and disease control, reducing the need for chemical pesticides that can harm crop health. Healthier crops are more productive.
- d) **Moisture Conservation:** The use of mulch and other water-conservation practices helps retain soil moisture, ensuring that crops have a consistent water supply. Adequate moisture levels are crucial for crop growth and productivity.
- e) **Resilience to Climate Variability:** ZBNF's focus on biodiversity and sustainable practices can make crops more resilient to climate change-related challenges, such as extreme weather events or changing rainfall patterns.
- f) **Lower Input Costs:** By minimizing or eliminating the need for expensive external inputs like synthetic fertilizers and pesticides, ZBNF reduces production costs, increasing the profitability of farming.

IV. RESULTS AND DISCUSSIONS

An experiment was conducted on wheat and gram at CSK HPKV, Palampur, during rabi 2019-20 and 2020-21. Soil was silty clay loam in texture with pH is 5.18, EC is 0.098 d S m⁻¹, organic carbon is 0.84%, nitrogen is 255 kg ha⁻¹, phosphorous is 15.3 kg ha⁻¹ and potassium is 287 kg ha⁻¹ respectively. The experiment consisted of 8 treatments in randomized block design with three replications. The results revealed on (Table 1) shows that the highest available nitrogen (275 and 282 kg ha⁻¹), highest available phosphorus (17.3 and 18 kg ha⁻¹), highest available potassium (292 and 295 kg ha⁻¹) was recorded in ghanjeevamrit + jeevamrit+ mulching. This might be due to rapid mineralization of available pool of nitrogen due to higher microbial activity in these treatments with application of jeevamrit. In case of ghanjeevamrit + jeevamrit, it increased the release of organic acid during mineralization that helped in the solubility of native phosphates, thus increased available phosphorus pool in the soil [3].

Table 1. Effect of different components of natural farming on available primary nutrients in soil (kg ha⁻¹) after harvest of wheat and gram.

Treatments		Nitrogen (kg ha ⁻¹)		Phosphorus (kg ha ⁻¹)		Potassium (kg ha ⁻¹)	
		2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
T ₁	Ghanjeevamrit @ 5 q ha ⁻¹	262	268	15.7	15.5	274	272
T ₂	Jeevamrit(FS @ 21 days interval)	259	264	15.1	14.9	272	269
T ₃	Mulching @ 10 t ha ⁻¹	258	262	14.4	14.2	268	263

Treatments		Nitrogen (kg ha ⁻¹)		Phosphorus (kg ha ⁻¹)		Potassium (kg ha ⁻¹)	
		2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
T ₄	Ghanjeevamrit + jeevamrit	265	273	17.3	18.0	292	295
T ₅	Ghanjeevamrit + mulching	264	271	15.9	16.7	281	282
T ₆	Jeevamrit + mulching	265	272	16.5	17.5	283	284
T ₇	Ghanjeevamrit + jeevamrit + mulching	275	282	17.1	17.9	287	292
T ₈	Control	237	239	13.2	12.4	248	232
SEm (±)		3.5	4.1	0.3	0.2	4.3	5.2
LSD (0.05)		10.8	12.7	1.1	0.8	13.1	16.0

An experiment was conducted at Regional Research and Technology Transfer Station (RRTTS), Orissa. The soil of the guava orchard where the experiment was carried out is red lateritic (sandy clay loam texture), low organic matter content and water holding capacity. The site experiences sub-humid and sub-tropical climate having three distinct seasons, i.e., rainy (mid-June to September), winter (October to February) and summer (March to June). The experiment was carried on randomized block design consisting of nine treatments with three replications during 2009-10 and 2010-11. The result (Table 2) indicates that the maximum improvement in the organic carbon content in 0-15 cm and 15-30 cm soil depths was recorded to be as 0.72% and 0.65%, respectively. The increase in higher organic carbon content of soil might be due to the decomposition of biomass of leguminous crops. The improvement in available nitrogen content of the soil under in situ incorporation of intercrops residues might also be due to fixation of atmospheric nitrogen through increased enzymatic and microbial activity in the rhizosphere by the previously mentioned legume crops and release of bound nutrient after their decomposition in the soil. The increase in the availability of phosphorus content in the soil by intercropping might be due to increase in the total microflora population, particularly phosphorus solubilizers in the rhizosphere of plant. The increase in availability of potassium contents in the soil might be due to increase in humus content of soil after decomposition of biomass of intercrops that builds up total population of beneficial microbes in the orchard soil [11].

Table 2. Effect of intercropping system on nutrient status of guava orchard at the end of experiment.

Treatment	Organic Carbon (%)		Available N (kg ha ⁻¹)		Available P ₂ O ₅ (kg ha ⁻¹)		Available K ₂ O (kg ha ⁻¹)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T ₁ . Guava + mango ginger	0.70	0.62	328.0	277.0	20.9	18.9	351.1	316.2
T ₂ . Guava + turmeric	0.69	0.60	316.9	282.4	20.6	18.0	349.2	321.0
T ₃ . Guava + tomato	0.68	0.61	318.2	268.8	18.3	16.5	341.1	308.1
T ₄ . Guava + cowpea	0.72	0.65	353.2	313.8	20.4	18.3	371.4	336.0
T ₅ . Guava + french bean	0.71	0.64	338.3	301.9	19.5	17.4	363.2	331.0
T ₆ . Guava + ragi	0.67	0.59	313.9	266.8	18.4	15.5	340.7	306.3
T ₇ . Guava + niger	0.67	0.56	311.8	262.0	17.8	15.0	333.1	301.3
T ₈ . Guava + paddy	0.68	0.60	318.8	272.1	19.1	16.6	359.1	320.0

Treatment	Organic Carbon (%)		Available N (kg ha ⁻¹)		Available P ₂ O ₅ (kg ha ⁻¹)		Available K ₂ O (kg ha ⁻¹)	
	0–15 cm	15–30 cm	0–15 cm	15–30 cm	0–15 cm	15–30 cm	0–15 cm	15–30 cm
T ₉ . Guava + no intercrop	0.62	0.58	284.8	250.0	16.5	14.3	321.1	291.1
SEm(±)	0.01	0.01	11.25	11.22	0.48	0.30	4.49	7.20
C.D. at 5%	0.04	0.04	33.76	33.67	1.45	0.91	13.47	21.60
C.V. (%)	3.07	4.37	6.02	6.93	4.90	3.56	2.18	3.85

A field experiment was conducted at the regional horticulture research and extension center, Kumbapur, Dharwad (Block-I). Altitude of experimental block is 678 m above the mean sea level. This experiment was conducted during rabi seasons of 2019, 2020 and 2021. The results revealed on (Table 3) that significantly higher fruit firmness (2.70 & 1.58 kg/cm² @ green & light red stages), TSS (4.58⁰ Brix) and acidity (1.06 mg/100 g) were recorded in natural farming treatment. Fruits grown under natural and organic farming were stored as long as 17.1 and 16.2 days. The improvement in quality of fruits in the said treatment might be ascribed to better availability and uptake of plant nutrients and also favorable conditions resulted by the applied organic nutrients. These organic supplements especially ghanajeevamrutha and liquid jeevamrutha play a vital role in enhancing quality of crops [12].

Table 3. Effect of quality attributes of tomato as influenced by natural farming and other farming practices.

Treatments	Fruit Firmness (kg/cm ²)		TSS (⁰ Brix)	Acidity (mg/100 g)	Shelf Life (days)
	Green Stage	Light Red Stage			
T ₁ : Package of Practice	1.91	1.07	4.02	0.72	6.7
T ₂ : Farmers' Practice	2.01	1.06	4.43	0.74	6.6
T ₃ : Natural Farming	2.70	1.58	4.58	1.06	17.1
T ₄ : Organic Farming	2.61	1.40	4.46	0.76	16.2
S.Em. ±	0.04	0.07	0.06	0.04	0.25
CD (p = 0.05)	0.16	0.23	0.14	0.12	0.77

A field experiment was conducted a field experiment at the Crop Research Centre, Chiraodi farm of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.). The soil of the experimental field was sandy loam in texture and slightly alkaline in reaction. The soil was medium in organic carbon (0.51%), available phosphorus (14.7 kg/ha) and available potassium (138.2 kg/ha) but low in available nitrogen (201.2 kg/ha). Sowing of crop (pigeon pea) was 27 June 2018 manually and sowing of crop (blackgram) 13 July 2018. The results on (Table 4) revealed that significantly higher plant height (165.70cm), number of primary branches per plant (25.81), number of secondary branches per plant (30.81) and leaf area index (2.40) was recorded with the application of beejamrutha + jeevamrutha + mulching + green manure as compared to RDF treatment and control. It is reported that higher nutrient status of jeevamrutha formulation resulted in the overall improvement in growth of pigeon pea in the form of plant height, leaf area index and higher dry matter accumulation [13].

Table 4. Effect of different natural farming treatments on growth of pigeon pea.

Treatments	Plant Height (cm)	Primary Branches Plant ⁻¹	Secondary branches Plant ⁻¹	LAI
T ₁ : Control	130.35	19.10	22.43	1.05
T ₂ : RDF	137.36	19.60	26.44	1.20
T ₃ : Beejamrutha (beej)	139.52	19.78	27.44	1.28
T ₄ : Jeevamrutha (jeev)	141.73	20.00	27.78	1.30
T ₅ : Mulching	142.81	20.41	28.10	1.39
T ₆ : Green manure (GM)	145.39	20.91	28.37	1.43
T ₇ : Beej + Jeev	147.38	21.34	28.64	1.56
T ₈ : Beej + Mulching	149.10	22.97	29.22	1.64
T ₉ : Beej + GM	152.11	23.24	29.30	1.73
T ₁₀ : Jeev + Mulching	154.28	24.19	29.78	1.81
T ₁₁ : Jeev + GM	156.78	24.40	29.90	1.90
T ₁₂ : Mulching + GM	159.45	24.71	30.10	2.08
T ₁₃ : Beej + Jeev + Mulching	160.21	25.20	30.28	2.16
T ₁₄ : Jeev + Mulching + GM	162.34	25.31	30.40	2.20
T ₁₅ : Beej + Mulching + GM	164.31	25.61	30.62	2.28
T ₁₆ : Beej + Jeev + Mulching + GM	165.70	25.81	30.81	2.40
SEm±	5.47	0.83	1.04	0.07
CD (P = 0.05)	15.56	2.37	2.97	0.19

Arpitha conducted an experiment to study the effect of natural farming on growth, yield, quality and soil nutritional and microbial status in black pepper during 2020-2022 for two successive years (Table 5). The experiment was conducted at Horticulture Research Extension Centre, Sirsi, situated at 14.61°N latitude and 74.84° E longitude at an altitude of 611 m above mean sea level. The experiment was laid out in Randomized Complete Block Design with four treatments/blocks (T₁- Natural farming, T₂-Organic farming, T₃- (RDF with INM), T₄- Chemical farming (control) and each treatment was replicated five times. The results revealed that higher bacterial population was recorded by natural farming (51.68 and 41.86 cfu × 10⁶ g⁻¹ soil) might be owing to the large amount of microbial load found in jeevamrutha, which increases soil biomass upon application to soil even at a very low rate since it functions as a tonic to the soil in addition to enhancing soil health. The higher fungi population (13.82 and 13.70 cfu × 10³ g⁻¹ soil) may be linked to readily available micronutrients and organic manures as sources of organic carbon for microbial population growth. It could also be ascribed to favourable excretions of root exudates such as sugars, organic acids, amino acids, and many growth promoting substances which serve as a food substrate for bacteria in the soil rhizosphere. The higher actinomycetes population was found to be significantly higher under natural farming practices (44.16 and 41.85 cfu × 10⁴ g⁻¹ soil). This may be attributed to the fact that the majority of soil microorganisms are chemo

heterotrophs, which require an organic carbon source as food and obtain energy through the oxidation of organic substances present in the soil. Higher phosphate solubilizers (16.56 and $16.87 \text{ cfu} \times 10^4 \text{ g}^{-1}$ soil) may be due to the fact that jeevamrutha serves as a good source of beneficial microorganisms in soil and increases the microbial load in the soil rhizosphere. Natural farming practice recorded significantly higher free-living N_2 fixers (15.31 and $16.65 \text{ cfu} \times 10^4 \text{ g}^{-1}$ soil). Higher nitrogen fixers in soil treated with organic manures and jeevamrutha may be attributed to the organic matter in the soil acting as a source of carbon and energy for microorganisms. Additionally, the application of jeevamrutha ensures proper aeration, moisture content, and nutrient levels in the soil, leading to the proliferation of microorganisms [14].

Table 5. Influence of farming systems on total microbial population in the rhizosphere of black pepper under areca-based mixed cropping system.

Treatments	Microbial population in soil ($\text{cfu} \times 10^6/\text{g}$)									
	Flowering stage					Harvesting stage				
	Bacteria	Fungi	Actinomyces	Phosphate Solubilizers	Free Living N_2 Fixers	Bacteria	Fungi	Actinomyces	Phosphate Solubilizers	Free Living N_2 Fixers
T ₁	51.68	13.82	44.16	16.56	15.31	41.86	13.70	41.60	16.87	16.65
T ₂	46.10	12.41	35.28	13.70	13.31	37.41	12.51	35.54	14.22	14.10
T ₃	36.16	11.04	33.05	12.44	11.68	27.39	10.81	30.11	12.46	12.13
T ₄	35.83	10.29	31.22	11.66	11.43	26.86	10.12	27.41	11.99	11.86
S.Em ±	0.88	0.56	0.63	0.59	0.50	0.61	0.40	1.30	0.73	0.72
CD at 5%	2.71	1.72	1.95	1.81	1.53	1.87	1.23	4.00	2.26	2.21

A. Successful Natural Farming in Dry Land Agriculture

Mallesappa bisirotti is a farmer from Dharward district, Karnataka. He cultivated chili by natural farming method from past 16 years in dry land. He started experimenting with the use of solid jeevamrutha (Ghana jeevamrutha) and succeeded in raising crops over last six years. He devised his own design to make Ghanajeevamrutha powder through pressing and sieving.

Practical Utility

1. Ghana jeevamrutha is used as basal application and used directly along with the seeds @ 200 kg/acre during sowing and also as top dressing @ 200 kg/acre.
2. The Ghana jeevamrutha is also used for plant protection sprays.
3. Intercropping of millets with spreading ground nut.

B. Cost of Cultivation of Ground Nut Under Natural and Traditional Farming Practices

Parameters	Natural Farming	Traditional Farming
Cost of cultivation (Rs /ha)	48,161	71,347
Production (q /ha)	17.13	21.00

Parameters	Natural Farming	Traditional Farming
Gross returns (Rs /ha)	1,01,313	1,15,000
Net returns (Rs /ha)	53,152	43,653
BC ratio	2.12	1.61

Impact:

1. After the natural farming earthworm count/activity is improved in soil.
2. By adopting this method of natural farming, he has been able to achieve better crop productivity per acre of land under scanty rainfall conditions.
3. Soil infiltration capacity and porosity is improved.
4. Cost of cultivation was reduced.
5. Good quality food grain produced.

IV. CONCLUSION

While there is no magic bullet, Zero Budget Natural Farming (ZBNF) is a promising and sustainable way to farm that fits in with the increasing global recognition of the need to switch to regenerative farming methods that improve soil fertility, boost crop productivity, and reduce environmental damage. The lessons and principles of ZBNF provide important insights into creating a more resilient and sustainable agricultural future as we continue to face the challenges of a changing climate and an expanding global population. By implementing ZBNF and related practices, we can make sure that the soil which is the basis of our food system remains healthy and productive for many years to come.

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