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Zero budget natural farming: A sustainable agricultural practice

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Abstract

Zero Budget Natural Farming (ZBNF) is an innovative and sustainable agricultural method that emphasizes the elimination of chemical inputs and reliance on natural processes. Developed by Indian agriculturalist Subhash Palekar, ZBNF is designed to minimize production costs and improve soil health through the use of locally sourced materials. The core principles of ZBNF include the use of bio-inoculants such as Jeevamrutha and Beejamrutha, which are fermented microbial cultures that enhance soil fertility and protect seeds. Mulching and the Waaphasa technique, which ensures adequate soil aeration, further support plant growth and resilience. By promoting biodiversity and natural resource conservation, ZBNF addresses critical environmental issues, such as soil degradation and water scarcity. This farming approach also fosters economic stability for farmers by reducing dependency on costly chemical fertilizers and pesticides, leading to improved crop yields and profitability. ZBNF's holistic framework aligns with global sustainable development goals by encouraging eco-friendly agricultural practices that support food security and rural livelihoods. As the agricultural sector faces increasing challenges from climate change and resource depletion, ZBNF offers a viable pathway toward sustainable farming, reinforcing the need for widespread adoption and policy support to enhance its scalability and impact.

Keywords: Zero budget natural farming, sustainable agriculture, bio-inoculants, soil health, economic stability

Introduction

Today, chemical-intensive agriculture has led to higher production costs and, in many cases, declining crop yields due to various factors (Intawongse & Dean, 2006; Ayansina & Oso, 2006; Sreenivasa *et al.*, 2010; Singh *et al.*, 2011) ^[11, 1, 20]. The repeated cultivation of the same commercial crops such as rice, wheat, cotton, and sugarcane has contributed to soil fertility depletion, degradation of topsoil, reduced soil vitality, groundwater depletion, and a significant decline in beneficial soil microbes.

The continuous use of chemical fertilizers, crop residue burning, and pesticide application has led to widespread environmental pollution. These practices reduce soil micro- and macrofauna, disrupting the carbon-nitrogen balance and nitrification processes (Jenkinson, 1982; Doran *et al.*, 1996; Shaikh & Gachande, 2015) ^[12, 7, 17]. Heavy pesticide and fertilizer application contaminates soil and can leach into groundwater, particularly with toxic heavy metals like Cadmium (Cd), Copper (Cu), Manganese (Mn), and Zinc (Zn). These heavy metals are absorbed by plants and accumulate in edible parts over time, posing severe health risks to consumers (Byrnes, 1990; Barabasz *et al.*, 2002) ^[4, 2]. Among these, cadmium and lead are particularly toxic, with crops like carrots, spinach, lettuce, radishes, and leafy vegetables tending to accumulate more heavy metals (Cobb *et al.*, 2000; Mattina *et al.*, 2003; Hough *et al.*, 2004) ^[6, 14, 10].

The root zone of soil hosts beneficial microbial communities such as Plant Growth-Promoting Rhizobacteria (PGPR), mycorrhizae, and cyanobacteria, which support plant growth and resilience against pathogens (Glick, 1995) ^[9]. However, repeated herbicide use, particularly with substances like atrazine and metolachlor, reduces these beneficial microbial populations.

Most Indian farmers have small landholdings, and investing heavily in inputs without achieving satisfactory yields due to pests, diseases, and unfavorable weather often

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increases production costs. This has led to an alarming rate of farmer suicides in India. Meanwhile, rising global populations and economic growth have spurred a higher demand for food, especially in developing countries like India. With a population constituting approximately 17.87% of the global total (world meter UNDESA, 2020) ^[21] and expected to reach 1.6 billion by 2050 (Smith *et al.*, 2020) ^[19], India must increase food production. In the past, India responded to these challenges by expanding cultivated land and increasing yields per unit area, supported by synthetic fertilizers and irrigation. However, these methods have led to inefficient resource use, especially in northern India, where nutrient use efficiency is particularly low (Bruinsma, 2003) ^[3].

Approximately 16% of India's land has agricultural potential, with the remainder unsuitable for cultivation. Increasing crop production efficiency will be essential to ensure food security in densely populated areas. However, NSSO data shows that almost 70% of agricultural households spend more than they earn, and over half are in debt, with indebtedness in states like Andhra Pradesh and Telangana as high as 90%, with average household debt around ₹1 lakh.

In response to these challenges, some farmers and institutions are exploring ancient farming practices for sustainable solutions, though these methods often lack scientific validation. NITI Aayog has recognized the need for alternative farming systems that reduce input costs while increasing productivity and profitability for small-scale farmers. These alternatives include Agnihotra Farming, Amrutpani Farming, Vedic Farming, Homeo Farming, and Zero Budget Natural Farming (ZBNF). Of these, ZBNF has gained popularity, especially in Karnataka, Andhra Pradesh, and Maharashtra, and is under consideration by the government of India. Nevertheless, before adopting or rejecting these methods, a comprehensive scientific evaluation of their efficacy, challenges, and potential impact on national food security is essential.

Zero budget natural farming

Zero Budget Natural Farming (ZBNF) is an agricultural method that requires no credit or major expenses on external inputs, relying instead on local resources. "Zero budget" refers to avoiding debt or costs, while "natural farming" focuses on chemical-free practices that draw from traditional Indian agriculture. ZBNF promotes a synergistic relationship between plants, animals, and soil to build fertility and support beneficial microorganisms (Smith *et al.*, 2020) ^[19].

Developed in the 1990s by Padma Shri recipient Subhash Palekar, ZBNF emerged as an alternative to the Green Revolution, which left many farmers in debt and degraded soil health. Palekar advocates minimal input costs, soil-friendly practices like aeration, crop residue mulching, intercropping, and limited watering. ZBNF discourages intensive irrigation and deep tillage, emphasizing natural methods for pest control. Palekar notably opposes vermicomposting, citing concerns that non-native worms may introduce toxic metals into the soil.

Initially gaining popularity in Karnataka in 2002, ZBNF has since expanded across states such as Andhra Pradesh, Kerala, Uttarakhand, and Himachal Pradesh. By 2019, Andhra Pradesh had converted 204,000 hectares to ZBNF across over 3,000 villages, aiming for full adoption by 2024.

The method has the endorsement of both state and central government bodies, with Prime Minister Narendra Modi expressing support for ZBNF as a sustainable future path for Indian agriculture. This approach is guided by four core principles designed to promote resilience and ecological health.

Pillars of ZBNF

The foundation of Zero Budget Natural Farming (ZBNF) rests on four main pillars that enhance soil fertility and promote sustainable agriculture. Soil microbes play a crucial role in nutrient cycles, such as the carbon and nitrogen cycles, which are essential for plant growth (Lazarovits, 1997) ^[13]. These pillars, as outlined by Subhash Palekar (2014) ^[15], work in synergy to support natural processes in the soil and maintain ecological balance in farming systems:

1. **Jeevamrutha:** Microorganisms play a crucial role in transforming unavailable nutrients into forms accessible to plants within the root zone. Jeevamrutha, a microbial-rich mixture, promotes this nutrient conversion in the soil. When applied, the microbes in Jeevamrutha such as Plant Growth-Promoting Rhizobacteria (PGPR), cyanobacteria, Phosphorus-Solubilizing Bacteria (PSB), mycorrhizal fungi, and nitrogen-fixing bacteria enhance nutrient availability and act as natural antagonists to pathogens, providing biological control against diseases (Glick & Bashan, 1997; Chen *et al.*, 1995) ^[8, 5].

To prepare Jeevamrutha, mix 20 kg of cow dung, 5-10 liters of cow urine, and 2 kg of legume flour, adding this mixture to irrigation tanks every 15 days or spraying 200 liters twice a month until the soil becomes enriched. Jeevamrutha supplies essential nutrients, increases microbial populations, and helps protect plants from bacterial and fungal diseases. This treatment typically only needs to be applied for the first three years until the ecosystem becomes self-sustaining. Subhash Palekar advises that one indigenous ("desi") cow, with dung naturally containing 300 to 500 crore beneficial microbes, can support up to 30 acres of land, whereas dung from imported breeds, like Jersey or Holstein, may contain more pathogens and fewer beneficial microbes.

2. **Bijamrita:** Bijamrita is a natural seed treatment mixture prepared using 20 liters of water, 5 kg of cow dung, 5 liters of cow urine, 50 g of lime, and a handful of soil. This blend introduces beneficial microbes to seeds, protecting crops from harmful soil-borne pathogens and seed-borne diseases. Bijamrita also guards young seedling roots against fungal infections and helps stimulate the production of growth-promoting hormones like IAA and GA3 (Sreenivasa *et al.*, 2010) ^[20].

3. **Acchadana (Mulching):** Mulching in ZBNF uses three main types straw mulch, soil mulch, and live mulch. Cover crops, such as legumes, are grown to suppress weeds, enhance soil infiltration, and enrich the soil with nitrogen fixed by root nodules. Residue left on the soil surface promotes microbial activity, aiding in nitrogen release and providing organic matter rich in nutrients. Mulching improves seed germination without tilling, moderates soil temperature, conserves soil moisture by minimizing evaporation, and maintains water retention for longer periods.

4. **Whapasa (Aeration):** Whapasa focuses on precise water management by applying water only as needed for each crop. Alternate furrow irrigation is recommended, as younger horizontal and vertical roots absorb water and nutrients more effectively than older roots. Excessive watering can reduce soil aeration, leading to oxygen deficiency that may harm plants. Balanced water and air content in the soil are essential, and extending intervals between water applications helps maintain optimal aeration, crucial for plant health.

Benefits of Zero Budget Natural Farming (ZBNF)

- **Zero production cost:** ZBNF eliminates the need for purchased inputs, making production costs negligible.
- **Water efficiency:** It requires just 10% of the water used in conventional farming, significantly reducing water consumption.
- **Effective manure utilization:** A single cow can produce 10-12 kg of dung daily, enough to fertilize up to 30 acres monthly.
- **Increased crop yields:** ZBNF has demonstrated higher yields, such as 11% more in cotton and 40% more in finger millet (gulli ragi) compared to non-ZBNF practices.
- **Minimal input expenses:** With no need for fertilizers or pesticides, ZBNF keeps input costs near zero.
- **Climate resilience:** ZBNF farms show strong resilience, enduring better under droughts and floods.
- **Additional income from diverse crops:** Planting multiple crops, including border crops, on the same land brings extra income and natural nutrients to the soil.
- **Broader environmental and social benefits:** ZBNF promotes reduced water and energy use, healthier ecosystems, improved soil health, enhanced biodiversity, resilient livelihoods, and women's empowerment. It also avoids toxic residues, supporting overall sustainability and community well-being.

Pest management in Zero Budget Natural Farming (ZBNF)

Pests and diseases are significant contributors to crop yield loss, with weeds being the most prevalent cause, followed by pests and diseases. Managing these losses is a major challenge in natural farming. One method of pest control involves using plant-based extracts to create compounds that kill or repel pests. Some natural pest protection mixtures are made by combining ingredients like buttermilk, cow milk, pepper powder, neem seeds, and green chili (Palekar, 2016)^[16]. Research has explored various naturally extracted, chemical-free pest control compounds, as outlined below:

1. **Agriastra:** This solution is made by mixing 10 liters of local cow urine, 1 kg of tobacco leaves, 500 g of green chili, 500 g of local garlic, and neem leaf pulp crushed in 5 liters of cow urine. The mixture is stored in a cool place. To use, dilute 2 liters of this extract in 100 liters of water and spray it on crops. Agriastra effectively controls pests such as leaf roller, stem borer, fruit borer, and pod borer.
2. **Brahmastra:** Another method for pest control, Brahmastra is made by boiling a mixture of leaves from various plants such as neem, custard apple, guava, pomegranate, papaya, and white datura with cow urine. After boiling, the mixture is filtered and stored for

future use. This extract is particularly effective against sucking pests, pod borers, and fruit borers.

3. **Neemastra:** This pest control solution is made by mixing 5 liters of local cow urine, 5 kg of cow dung, and 5 kg each of neem leaves and neem pulp. The mixture is sealed in an airtight container for 24 hours to ferment. After fermentation, it can be used to control sucking pests and mealy bugs.

Challenges to adopting Zero Budget Natural Farming (ZBNF)

Zero Budget Natural Farming (ZBNF) is an eco-friendly, sustainable farming method that focuses on enhancing soil health, increasing beneficial microbial populations, providing chemical-free nutrients to plants, and producing toxin-free food. While ZBNF offers numerous benefits for the environment and human health, its widespread adoption remains a challenge due to several obstacles. Below are some of the major challenges faced by farmers and the broader adoption of ZBNF.

Increased labor requirements: ZBNF demands more labor compared to conventional farming practices. The manual preparation of microbial solutions and regular application of inputs like Jeevamruth and Bijamruth requires more time and effort from farmers, making it less appealing to those already struggling with labor shortages.

High demand for animal manure: ZBNF heavily relies on animal manure, particularly cow dung, for its inputs. However, the number of cattle in India is insufficient to meet the high demand for manure needed on a national scale. This scarcity limits the widespread adoption of ZBNF, especially in regions where livestock is not as abundant.

Changing consumer demand: The changing demand for high-value crops presents another challenge. As consumer preferences shift towards high-yield, high-value crops, ZBNF may not meet the productivity demands that conventional farming can achieve, making it difficult for farmers to compete in the market.

Limited technology and high investment needs: ZBNF requires better farming technologies that emphasize manual and organic methods, unlike the mechanized tools used in conventional farming. The lack of suitable heavy machinery and implements that can be used without harming the soil poses a barrier. Additionally, significant investment in land preparation and manual labor is required, which many farmers cannot afford.

Weak agricultural market infrastructure: There is limited market infrastructure to support and value ZBNF products on a large scale. The price of natural, chemical-free products is often not significantly higher than that of conventionally grown produce, making it economically unviable for many farmers.

Lack of scientific validation: Despite its growing popularity, there is limited scientific validation of many key components of ZBNF, such as the microbial composition and effectiveness of Jeevamruth, Bijamruth, and other natural pest control methods. Without scientific data supporting these practices, farmers may be hesitant to fully adopt them.

Restrictions on hybrid varieties: ZBNF does not permit the use of hybrid seeds, which are commonly used to increase crop yields. With a growing global population and limited food supply, hybrids are considered necessary to meet food production targets, making their exclusion a major hindrance to ZBNF adoption.

Political and scientific challenges: The promotion of ZBNF on a large scale without scientific validation, often driven by political motives, can create skepticism among farmers. Furthermore, there is insufficient data on crop yields, making it difficult for farmers to trust the system's efficacy in producing substantial yields.

Pest and disease management: Effective pest management in ZBNF is challenging. Although natural products like Agriastra and Brahmastra are used to control pests, they are often less effective than chemical pesticides. The difficulty in controlling specific crop pests and diseases can deter farmers from adopting ZBNF.

Availability of indigenous cows: ZBNF emphasizes the use of indigenous cows, which are considered to have pathogen-free dung rich in beneficial microbes. However, the non-availability of these indigenous cows in certain areas limits the practice.

Lack of policy support: A well-structured policy framework and specific standards are crucial for the success of ZBNF. However, these are often lacking, which creates confusion and inconsistency in implementation.

Limited availability of commercial formulations: The growth stimulants and pest control solutions used in ZBNF are not available on a commercial scale, and their shelf life is limited, further hindering large-scale use.

Absence of crop-specific practices: A comprehensive package of practices tailored to different crops grown under ZBNF is still missing. State universities and government institutions must develop and promote such practices to ensure consistency and success.

Overall, while ZBNF offers promising ecological benefits, its adoption faces numerous challenges. Addressing these barriers requires collaborative efforts from the government, researchers, and extension workers to provide scientific validation, infrastructure, and support to farmers.

Opportunities to adopt Zero Budget Natural Farming (ZBNF)

The traditional farming methods associated with the Green Revolution, which rely on high-yielding varieties, chemical fertilizers, and pesticides, have led to significant degradation of soil health. These practices deplete soil nutrients, reduce the population of beneficial microbes, and lead to the accumulation of toxic substances in the soil. Furthermore, the overuse of chemicals pollutes groundwater, creating negative impacts on both the environment and human health. In addition, the burning of crop residues reduces soil organic matter and contributes to air pollution. Given the growing concerns surrounding environmental sustainability and the increasing costs associated with commercial farming, ZBNF offers a promising alternative to address these issues. Below are key opportunities that come with the adoption of ZBNF:

- **Conservation of nature:** ZBNF practices significantly improve the microbial content and water retention capacity of soils. This is especially beneficial for drought-prone areas, as it helps maintain consistent yields despite water scarcity. The reduced application of chemical fertilizers leads to less runoff, which in turn improves water quality by preventing contamination of rivers and wetlands. Additionally, the availability of water is increased during extreme weather events, making the practice highly resilient to climate change.
- **Reduction of health risks:** ZBNF reduces the risks associated with chemical pesticide exposure. By avoiding the use of harmful chemicals, especially those found in fruits and vegetables, the practice helps reduce illnesses caused by the consumption of toxic residues. This is particularly beneficial for vulnerable groups like children, who are more susceptible to pesticide-related health issues. Furthermore, natural farming maintains ecosystems on farms and reduces the drudgery faced by women, who benefit from easier access to clean water and animal feed.
- **Reduction in carbon emissions and carbon capture:** The practice of burning crop residues releases significant amounts of carbon into the atmosphere, with one tonne of residue burning producing approximately 400 kg of carbon. ZBNF promotes the retention or incorporation of these residues into the soil, which not only helps sequester carbon but also improves soil fertility and promotes higher yields. As more farmers shift to natural farming, such practices can significantly contribute to reducing carbon emissions and enhancing carbon capture.
- **Social impact:** ZBNF reduces the cost of cultivation by eliminating the need for expensive chemical inputs, thus improving the financial security of farmers. With stable yields and lower input costs, farmers can consistently produce crops, which ensures a more reliable income. The shift to natural farming also contributes to the overall well-being of farming communities by creating more sustainable and resilient livelihoods.
- **Economic benefits:** Studies show that every 1 USD invested in ZBNF yields direct benefits equivalent to 13 USD. These benefits include reduced cultivation costs, higher yields, lower borrowing costs, income from intercropping, and better selling prices. In addition, ZBNF offers broader social and environmental advantages such as improved food security, better nutrition, enhanced soil and water health, climate resilience, and biodiversity protection. It also reduces the overall risk for farmers and communities.
- **Government support and financial investments:** The Indian government has begun to recognize the value of natural farming and has allocated funds to promote it. In the 2020-21 budget, the Finance Minister announced 687.5 crore INR for the development of organic and natural farming. International organizations, including the United Nations Environment Programme (UNEP), BNP Paribas, and the World Agroforestry Centre (ICRAF), are also supporting ZBNF through the Sustainable India Finance Facility (SIFF). Their efforts, in collaboration with state governments like Andhra Pradesh, aim to scale ZBNF adoption to millions of farmers. For instance, Andhra Pradesh has committed to

becoming the first state to implement natural farming on a large scale, with an estimated budget of 17,000 crore INR.

Public policies needed for Zero Budget Natural Farming (ZBNF)

To foster the adoption and success of Zero Budget Natural Farming (ZBNF), there is a need for a shift in public policy frameworks that support sustainable agricultural practices. This can be achieved through rethinking the current models of farming, redirecting investments, and implementing measures to ensure the economic and environmental viability of ZBNF. Below are key policy recommendations:

Shift in public policy framework

As highlighted by Ramanjaneyulu, a scientist at the Centre for Sustainable Agriculture, it is essential to transition towards diversified and biological resource-integrated agricultural models. The focus should be on correcting the inappropriate use of resources through:

- **Intercropping and crop rotation:** Policies should encourage the use of intercropping, multiple cropping systems, and appropriate crop rotations to enhance soil health and biodiversity.
- **Integration of crops and animals:** The integration of crop and livestock systems should be promoted for better nutrient cycling and ecosystem balance.
- **Planning for ecological intensification:** Public policies must support farming systems based on ecological principles, with attention to specific regions like wetlands, rainfed areas, and hilly terrains, which require tailored farming practices.
- **Reconfiguring subsidies:** Current subsidies on external inputs such as chemical fertilizers and pesticides should be redirected to support ecosystem services, promoting sustainable farming practices. This shift is critical for reducing reliance on monoculture-based farming systems.
- **Regulating harmful technologies:** Policies should strictly regulate the use of agrochemicals, GMOs, and other technologies with biosafety risks. This will help safeguard pollinators and preserve crop productivity.

Increasing investments in agriculture

Public investments in agriculture must be substantially increased to support the transition to ZBNF. The union budget should allocate 10-15% to ZBNF, with a focus on:

- **Informed farmer choices:** Providing farmers with better access to knowledge and support for making informed choices, rather than being influenced solely by large corporations.
- **Supporting ecosystem services:** Investment should go toward practices that promote ecosystem health, such as organic farming techniques, water conservation, and biodiversity preservation.

Ensuring income security for farmers

To address the economic challenges faced by farmers, the creation of an Income Security Commission is recommended. This body would

- Balance decisions affecting the costs of production, subsidies, and living costs.
- Ensure that the prices of products are fair and supportive of farmers' income.

Agricultural research and training

Agricultural research must evolve to adopt an agroecological perspective. Key strategies include:

- **Participatory research:** Involve farmers directly in the research process to ensure that new technologies and methods meet their needs.
- **Location-specific extension:** Extension services should focus on context-specific, community-based approaches to restore agroecosystem health.
- **Investing in agroecological research:** More funds should be directed toward research that enhances sustainability, ecosystem health, and the development of bio-based products with longer shelf lives.

Agricultural extension services

Extension services should be restructured to focus on community-managed systems. This can be achieved by:

- **Knowledge-based system:** Shifting from a mere information-based system to a knowledge-sharing system, involving experienced farmers as resource persons to facilitate peer learning.
- **Local level empowerment:** Block-level extension services should be converted into community-managed units to increase farmer engagement and self-sufficiency.

Marketing support for farmers

Support for farmers in accessing markets is critical for the success of ZBNF. Key recommendations include:

- **Commodity boards:** Develop state-level commodity boards that support Farmer Producer Organizations (FPOs) with technical guidance, quality management, financial access, and market linkages.
- **Infrastructure development:** Build infrastructure for storage, processing, and distribution to ensure that farmers can sell their products at fair prices and minimize post-harvest losses.

Conclusion

Zero Budget Natural Farming (ZBNF) offers a sustainable and economically viable alternative to conventional farming. It significantly reduces costs related to seeds, fertilizers, and chemicals while promoting soil fertility and maintaining ecosystem health. The management of pests and diseases in ZBNF also requires a holistic understanding of the interactions within the farming ecosystem. By addressing the challenges and leveraging the opportunities of ZBNF, policies can help farmers escape the debt trap and enable them to make farming a profitable and environmentally friendly venture. A comprehensive policy framework, focused on ecological sustainability, income security, and farmer empowerment, will be essential to making ZBNF a success on a larger scale.

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