Current Journal of Applied Science and Technology

41(13): 31-43, 2022; Article no.CJAST.86642
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Zero Budget Natural Farming: A way Forward towards Sustainable Agriculture

Mohammad Rafiq Khan [a], Waseem Raja [a], Tauseef A Bhat [a], Mohd Salim Mir [a*], Nasir Bashir Naikoo [b], Zakir Amin [c], Aijaz Nazir [d], Suhail Ahmad Mir [a], Idrees Mohammad [a], Aadil Akbar Wani [a] and Dhamni Patyal [a]

[a] Division of Agronomy, Faculty of Agriculture, SKUAST, Kashmir-193201, India.
[b] Division of Soil Science and Agricultural Chemistry, Faculty of Agriculture, SKUAST, Kashmir-193201, India.
[c] Division of Plant Pathology, Faculty of Agriculture, SKUAST, Kashmir-193201, India.
[d] Agromet Field Unit, SKUAST, Kashmir-190025, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2022/v41i1331712

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/86642

Review Article

Received 01 March 2022
Accepted 03 May 2022
Published 17 May 2022

ABSTRACT

Chemical fertilisers and insecticides have increased at an alarming rate in India since the green revolution. Excessive chemical use has a negative influence on the ecosystem, soil, human health, and Consumption of groundwater purity. To limit the usage of artificial fertilisers and pesticides in this situation, the Zero Budget Natural Farming technique was implemented. Agriculture is a significant industry in India. It is essential for the Indian economy's survival and expansion. The majority of farmers rely extensively on inorganic external chemical inputs like as fertilisers and pesticides, which pollute groundwater and other water-dependent ecosystems while also reducing soil fertility over time. The continued use of pesticides and chemicals poses a major threat to the health of Indian farmers.Zero-budget farming has the potential to significantly reduce production expenses. Mulching, soil protection measures, natural insecticides, and fertilisers are used by low-budget farmers. Jivamrita, Bijamrita, Acchadana (Mulching), and Whapasa are the four main pillars of natural farming on a low budget. Mulching, soil conservation measures, natural insecticides, and fertilisers are used by farmers on a low budget. The continual retention of crop wastes replenishes soil fertility and aids in soil health maintenance. Pest and disease management is an important part

**Corresponding author: E-mail: mirsalim@skuastkashmir.ac.in;*

of zero-budget natural farming crop production methods. Under the conditions of climate change, achieving food security would necessitate a holistic system approach that incorporates natural agricultural principles for a sustainable agriculture.In this paper, we have discussed about the concept, need, benefits, major pillars, principles of ZBNF, opportunities and challenges of adopting ZBNF and the factors to scale up zero budget natural farming.

Keywords: Ecosystem; food security; mulching; sustainable agriculture; zero budget natural farming.

1. INTRODUCTION

Wider ranges of climate and natural resources make India a country that relies heavily on agriculture to address the current demographic problem [1]. Natural resources must be conserved without depleting them, particularly in agriculture. The use of chemical fertilizers and pesticides in India has increased since the green revolution. Farmers' income is being reduced and their debt is being increased as a result of the excessive and expensive use of chemicals. Human health, the environment and the purity of ground water can all be negatively impacted by the excessive use of chemicals. Farmers are increasingly turning to zero-budget natural farming after learning about the numerous negative consequences of pesticide use in agriculture (ZBNF). It has grown in popularity across southern India, particularly in Karnataka, its birthplace [2]. A rapid expansion across India is now taking place as a result of its rapidity. This zero-budget natural farming method was pioneered in India in the 1990s by Mr. SubhashPalekar, a Padma Shri recipient [3]. ZBNF is an approach to farming that requires little or no investment in the form of outside resources. Often referred to as low-cost farming, ZBNF is gaining traction in the restoration of soil quality for long-term crop production through diversifying, microbial activities, nutrient recycling, and beneficial biological interaction. Bio-fertilizers play a significant role in plant growth and production, making them an essential part of organic and sustainable farming [4]. Low-input agricultural practices have proliferated around the globe, providing producers with potentially lower costs and improved yields as well as food that is free of chemicals for consumers and improved fertility for the soil. For farmers who want to avoid the use of synthetic fertilizers and pesticides in their agroecosystems for the long term by using local, low-cost inputs, ZBNF is the answer [4,5].

1.1 Zero Budget Natural Farming

The term zero budget refers to a financial situation in which there is no debt or expenditure, and no money is spent on agricultural inputs. Traditional Indian farming methods, known as "natural farming," are a form of chemical-free agriculture. Naturally farmed crops show how plant and animal products work together to improve crop establishment and build soil fertility, as well as microorganisms [7]. Ecological advantages of zero-budget natural farming have also been documented [8]. Tripathi et al. [9] found that zero budget natural farming is (2018) resource efficient because it reduces the use of financial and natural resources while increasing crop yield. Farming with nature's produce is called natural farming because the farmer is only there to serve as a facilitator and the real work is done by nature itself. Without the use of chemical fertilizers or pesticides this farming method is possible. Fukuoka started natural farming in Japan for the first time, and his results demonstrated the same level of productivity as chemical farming, but without the risk of soil erosion and a longer-lasting supply of nutrients in the soil [10]. His experiments use only locally sourced farm products and no other sources of input. Because of this, he was able to reap the benefits of cultivating his crops at a low or no cost. One straw revolution is a collection of his findings. Soil degeneration is minimized, microbial population is increased, and soil aeration and water retention are improved with natural farming [7] [11,12]. An alternative to the Green Revolution that was first implemented in India in the 1990s by Padma Shri recipient Mr. Subhash Palekar was this zero-budget natural farming system. For farmers in India, he claimed, the rising cost of these external inputs in farmland was a leading cause for debts as well as suicides because of their negative impact on the environment as well as long-term fertility. When it comes to farming, however, he focused on low-input technologies that could be sourced from farmland and that wouldn't harm the soil. Natural farming has been introduced to Karnataka for the first time. Around 50 lakh farmers have been converted to what he calls "Zero Budget Natural Farming" (ZBNF) in various Indian states under his guidance. There is no flooding or deep plowing tillage practice allowed in this method, which encourages soil aeration,

intercropping, bunds, and crop residue mulching on top of the soil. According to research, ZBNF reduced debt for 97 farmers and their families by 30%, improved environmental conditions by 42%, and reduced cultivation costs by 38%, all while improving family health by 54% when especially in comparison to farmers who used other farming methods [13]. For sustainable crop production, ZBNF provides diversification, microbial activities, nutrient recycling, and beneficial microbes that interact with each other [14]. Another environmental benefit of ZBNF is that it reduces the amount of fertilizer needed to grow crops [15].

1.1.1 Need of zero budget natural farming

- Higher cost of inputs
- Higher Wages for labor
- Market price Fluctuations
- Weather extremities
- Suicide in farmers
- Rising Environmental concerns
- Change in Consumers preference towards safety food
- Combat climate change

1.1.2 Benefits of zero budget natural farming

- Farming in tune with nature
- Multi-crop cultivation methods for increased net income
- In ZBNF, there is no need for farmers to purchase inputs, so the cost of production is zero.
- This method uses only 10% of the water that crops use when grown in traditional ways. Approximately 10-12 kg of fresh dung is produced by a cow every day, enough to cover 30 acres of landin one month.
- There are no fertilizers or pesticides used on the farm, so input costs are nearly zero.
- Adding more crops and border crops to the same plot of land serves as a source of nutrients.
- External labor requirements are being reduced.
- Untainted food.
- It is suitable for all crops in all climates.

1.2 Govt. schemes and initiative to support Zero Budget Natural Farming

Natural farming is being promoted by the government of India as part of the government's commitment to double farmers' incomes by 2022, through programs such as Paramparagat Krishi Vikas Yojana (PKVY) and RashtriyaKrishiVikasYojana (RKVY). Addressing the United Nations Conference (COP-14) on Desertification, Prime Minister Modi estimated that India is concentrating on Zero Budget Natural Farming (ZBNF). NirmalaSitharaman, the Finance Minister, has frequently emphasized in her budget speeches how ZBNF will double farmers' incomes by going "back to basics." The AP government decided to reach 60 lakh (6 million) farming households to embrace "Climate Resilient Zero Budget Natural Farming (CRBZBNF)" as farming methods which asserts in the natural growth of crops without providing any other external inputs. Considering the food crisis and global food security, ZBNF may not fulfill the purpose in comparison to chemical based farming systems. However, the aim is to reduce the input costs and simultaneously boost the soil health vis-à-vis enhance the living standards of small and marginal farmers who donot have sufficient resources for utilizing high cost chemical inputs.

1.3 Pillars of Zero Budget Natural Farming

Soil microorganisms play a significant role in soil fertility, participating in nutrient cycles such as the C and N cycles, which are necessary for plant growth [16,17] (Fig.1).

1.3.1 Jivamrita/Jeevamrutha

It is basically a kind of bio-fertilizer which adds nutrients to the soil for plants' uptake. Further, this fermented microbial culture when applied to the soil, catalyses soil microbial and earth worms activities to make them do all the benefits. Mycorrhizal fungus and nitrogen-fixing bacteria are among the important microbes present in the product along with the PGPR, cyanobacteria, and soluble bacteria (PSB) [18]. Bacterial inoculums present in cow dung as well as in native soil during fermentation process to obtain nourishment from organic sources of nutrients and multiply. Even, the applied fermented culture attracts and enhances the activities of other beneficial micro-organisms already present in the soil [19]. On application, these microbes start to act and improve nutrient availability for the crop. Palekar [20] stated that there is actually no need for external application of fertilizers as the soil is a treasure box of all nutrients which is unlocked by micro-organisms when their activities get improved by application of *Jivamrita/ Jeevamrutha* (or 'nectar of life'). It is known to check various soil borne diseases also. In

situation of labour and water crisis, dry form of *Jivamrita/ Jeevamruthac*alled *Ghanajivamrita*is prepared which can be stored for one year [14]. In organic solutions, Sujana et al. [21] found that the Jeevamrit treatment had significantly higher growth attributes and quality attributes (2019) of chilli fruits, except for fruit length. To compare with the statistically equivalent 100 percent recommended dose of nitrogen applied via vermicompost + Jeevamrit, [22] found that the highest soybean grain yield was achieved with 100 percent RDN applied (2013) via vermicompost + Jeevamrit, while the lowest yield was achieved with control and Jeevamrit alone. Using Jeevamrit, Aulakh et al. [23] found that crop productivity was not affected, but the soil microbial population was continued to increase.

1.3.2 Bijamrita/Beejamrutha

Bijamrita/Beejamrutha is often used as a potential treatment of seed/seedling/planting material to decrease mortality rate as well as maintain a proper or strong crop stand in the field by assessing various seed and soil-borne diseases of younger plants. This product contains beneficial bacteria that are not only useful for plant protection but also for promoting plant growth. This is similar to Jivamrita/Jeevamrutha [24]. Seeds treated with Panchgavya and Beejamrit enhanced the microbial population, as per Shubha et al [25]. Chandrakala, [26] discovered that (2014) Beejamrut + Jeevamrit + Panchagavya accelerated (2008) chilli seed weight over control treatments. Shwetha and Babalad [27] reported an increase in soybean yield of 25 to 35 percent with the use of Beejamrit, (2008) Jeevamrit, and Panchagavya.

1.3.3 Acchadana/mulching

Mulching is the practice of applying a layer of mulch to the top of the soil. Jivamrut's beneficial microorganisms require a specific microclimate for proper growth, multiplication, and activity, and there are three ways to create that microclimate. Mulching is a powerful tool for improving crop (2018) quality and yield by regulating soil temperature, maintaining moisture, and reducing soil evaporation [28].

a. Soil mulch
b. Straw mulch
c. Live mulch

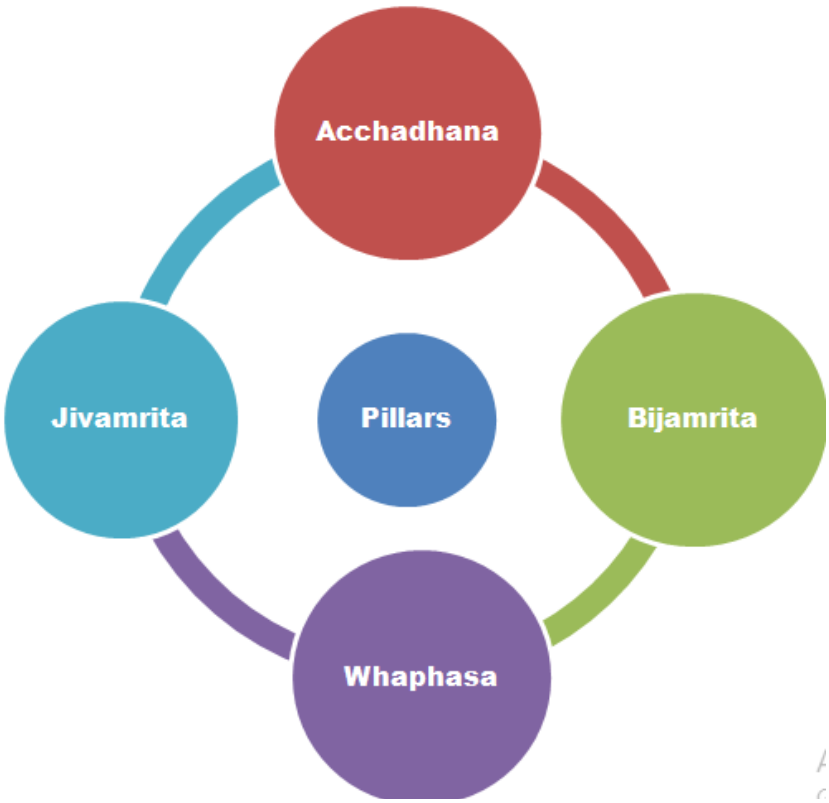

Fig. 1. Pillars of ZBNF system

Table 1. Major pillars of ZBNF [34]

Name	Preparation	Application
Jivamrita/Jeevamrutha	200 litres of water is poured in a barrel/container. 10 kg fresh local Indian bred cow dung and 5-10 litres of aged cow urine are put inside it. Then, 2 kg each of *jaggery*(brown sugar) and 2 kg pulse flour and a fist of soil from chemical less area are added in to it and mixed thoroughly. Mixture (*Jeevamrutha*) is kept further in shade for 48 hours for fermentation	In the soil, you can apply 200 liters of Jivamrita/Jeevamrutha in irrigation water to 1 acre of land twice a month, or you can apply 10% solution to the leaves.
Bijamrita/Beejamrutha	It is prepared similarly as *Jivamrita or Jeevamrutha*(local Indian-bred cow dung and urine, lime, water and soil). Specifically, 5 litres of urine and 5 kg of dung of local Indian bred cow are put inside a container containing 20 litres of water. 50 g of lime and a fist of native soil are then added into it and thoroughly mixed.	Coating and mixing the seeds by hand or leguminous seed dipping in *Bijamrita/Beejamrutha*solution followed by drying in shade and sowing
*Acchadana/*mulching	Three types of mulching are used viz. soil mulch (friable soil/dust coverage on top soil), straw mulch (dried resides of previous crops, dead materials of plants and/or animals) and live mulch (symbiotic mixed or intercrops preferably with monocot and dicot such as cereal-legume cropping).	Application of soil or straw mulch before sowing the seeds or sowing (cultivation) of crops to cover land spaces (live mulch)
Whapasa/moisture	It is making soil to provide water vapour to plant roots by reducing irrigation quantity and frequency	Irrigation during noon in alternate furrows to make air and water molecules to remain in soil

There are several benefits of covering the soil with dust or plant materials (Acchadana/ mulching). One of mulch's main advantages is that it helps to retain soil moisture [29]. It protects the soil from erosion. Besides, it improves soil aeration and conserves soil moisture by checking evaporation water loss. Weed emergence is to some extent checked through mulching. Mulching increased soybean seed yields, as well as plant biomass and nodule mass [30]. Soil physical qualities improved as mulching rates increased [31]. Further, Organic type of mulches such as dried plants additionally produces humus on decomposition, which supplies nutrients to the crop. An ideal microclimate for microbes and local earthworms can be established through using straw mulch. A review by Jalota et al. [32] shows that using straw mulch in Punjab (2007) improved crop yields. In soil, organic dry matter decomposes into humic substances when buried living organisms, including plants and animals. As mulching reduces the requirement of tillage (Deep ploughing is strongly avoided in ZBNF), labour shortages (in present days) can be compensated. Live mulch (using different plants) is helpful as different nutrients can be added in the soil (Monocots supply potassium, phosphorus etc. while dicots or legumes fix atmospheric nitrogen) [33].

1.3.4 Whapasa/moisture

Whapasa/moisture focuses on improving water use efficiency by reducing the quantity and frequency of irrigation water applied as only a limited amount of water is needed (vapour form) for crop growth. Therefore, it provides resilience from drought. Ideal situation to mix up of air and water molecules renders suitable soil aeration and reduces 90% water use which is helpful in rainfed agriculture [33]. Nutrient composition of Beejamurtha, Jeevamurtha, local cow urine, local cow dung and pulse flour was found to be N (8.024.92,8.16,8.08,6.70): P (2.38,1.96,1.67,0.70,1.47):K(0.485,0.280,2.544,0 .231,0.910): Mg (ppm) 16,46,6.3,9.3,12.6 and Cu (ppm) 36,51,20,3.60,12.40 respectively [35].

2. PEST MANAGEMENT IN ZERO BUDGET NATURAL FARMING

Weeds cause the majority of yield loss, but pests and diseases also cause significant damage to crops. This loss is difficult to manage in natural farming as well. It is possible to use plant

extracts to create a compound that can be used to kill or control pests in the field. It's possible to make plant protections that include a mixture of neem seed, pepper powder, butter milk, and green chilli [36]. Farmers face an ongoing problem with pest control, but ZBNF's contribution to long-term pest management is significant [4,37]. Compounds that can only be obtained through natural means are used in ZBNF system.

2.1 Agriastra

Local cow urine (10 l), tobacco leaves (1 kg), green chili (500 g), local garlic (500 g), and pulverized neem leaves pulp in cow urine (5 l) are all that is needed to make this concoction. When using 100 liters of water, use 2 tablespoons of powder per 100 liters. Pests like Leaf Roller, Stem Borer, Fruit Borer, and Pod Borer are effectively halted by this of water. At a 10% concentration, a fermented buttermilk and cow urine mixture (1:1) was reported to prevent the pathogen [38].

2.2 Brahmastra

In natural farming, neem leaves (3 kg), custard apple, lantern camellia, guava, pomegranate, papaya, and white datura leaves are squashed and boiled with urine (10 ltr.) before making filtration. This is the second method for controlling pest populations. The extractant can be stored for longer periods of time after filtration. When it comes to sucking pests like pod borer and fruit borer, this is the most effective method of defense against them all.

2.3 Neemastra

For 24 hours, mix 5 l of cow urine, 5 kg cow dung, 5 kg neem leaves, and 5 kg neem pulp in an airtight container with 5 kg of neem pulp and 5 kg of neem leaves. Sucking pests and Mealy Bug are the primary targets.

3. PRINCIPLES OF ZERO BUDGET NATURAL FARMING

Following are the principles of ZBNF (Fig.2):

3.1 Low Input

The farmer's production costs are zero because no inputs are required. No need to add fertilizers because the plant takes only 1.5 to 2.0 percent of the nutrients in the soil (the rest is taken from the air, water, and solar energy). Nature provides these nutrients for free, as in the forest. Natural products collected by the farmer are used to protect the crop from pests and disease, avoiding the need to purchase whether chemicals or seeds. When it comes to the current agricultural crisis and farmers' heavy indebtedness and reliance on money lenders, natural farming is an ideal solution, as it is zero-cost.

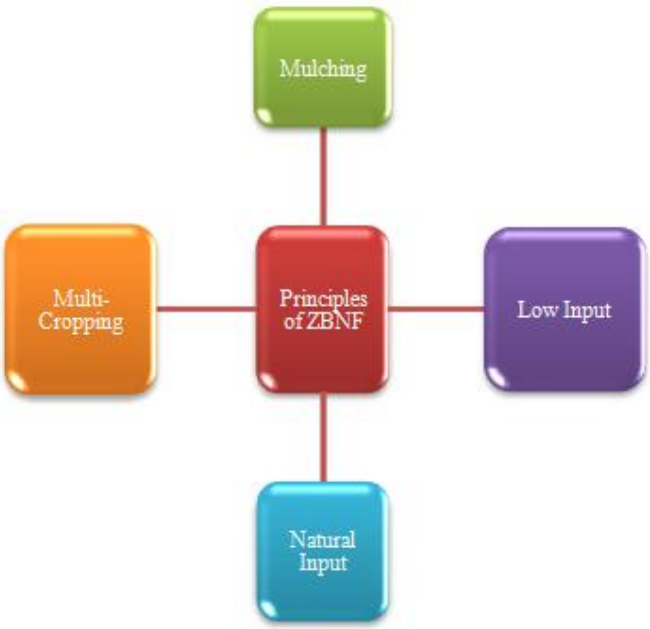

Fig. 2. Principles of ZBNFSource: [36]

3.2 Natural Inputs

In natural farming, no chemicals or organic compost like vermiculture are required but it encourages a natural catalyst of biological activity in soil and a natural defense against disease. Although the soil contains a variety of essential nutrients for plants, they are in inaccessible forms that prevent plants from utilizing them. Normally found in the soil, bacteria, fungi, and earthworms are needed to transform the materials into usable forms. Chemicals, on the other hand, have wiped out these microorganisms. S. Palekar estimates that 3 to 5 million beneficial microbes are contained in local cow dung and that this dung must be reintroduced naturally. Local cow dung (zebu) is more effective than town cow dung, according to his studies (Jersey, Holstein). The natural "catalytic agent" known as Jivamrit was developed by S. Palekar through observation of nature in order to promote the soil's humus formation by encouraging the proliferation of microbes that disintegrate the soil's dried biomass and turn it into nutrients for plants. Jivamrit is made from all-natural ingredients, including water, local cow dung and urine, sugarcane sugar, pulse flour, and soil. Without using any pesticides, his seeds were protected from numerous diseases and pests by a similar treatment formula. It is a mixture of water, local cow dung and urine, soil and lime that is naturally occurring. Some other natural pesticides and fungicides for controlling insects and pests include tobacco, green chili, garlic, neem, and various fruits, such as custard apple and guava as well as papaya, and white dhotara. All of these natural catalysts, safeguards, and treatments ensure that the soil, water, and crops are in top condition. Natural farming, therefore, can be compared to sustainable agriculture because it prevents environmental degradation and maintains a high level of productivity.

3.3 Mulching

Additionally, Zero Budget Natural Farming utilizes mulching as one of its four axes. A micro-climate of 25 to 32 °C temperature, 65 to 72 percent moisture and darkness and warmth in the soil is required for the best development of micro-organisms Mulching does conserve soil humidity, cools it, as well as prevents the soil's microbes, all of which reduces the need for irrigation.

3.4 Multi-cropping

While industrial and automated agriculture has implemented mono-cropping, the practice of growing multiple crops in close vicinity in the same field during a planting season is known as "intercropping," "multi- cropping," or "mixed cropping." It's based on the idea that plants work together in harmony. Because of the interdependence of the crops, natural farming makes better use of soil and its nutrients. The chikoo, coconut, and mango are examples of long-lived species that could be combined with short-lived species like different vegetables, leguminous, medicinal, and aromatic plants (like banana, papaya, custard apple). Crop diversification should be based on local and regional agro-climatic factors. When a farmer can count on a consistent crop year-round, multi-cropping is an excellent risk management strategy. If a crop fails, he has other crops to fall back on. Intercropping has other benefits, such as limiting pest outbreaks (some plants behave as biopesticides against other crops') whereas rotation protects against endemic pests; preserving biodiversity; and providing a more nutritious diet.

4. OPPORTUNITIES TO ADOPT ZBNF

The use of improved varieties, chemical fertilizers, and pesticides as part of the green revolution diminishes soil health by removing significant concentrations of nutrients from the soil, reduce population of beneficial microbes, and polluting the soil profile and groundwater. There is a negative environmental and human health impact from all of these. Soil organic matter content is reduced as a result of the burning of crop residues resulting in an increase in air pollution. We must ensure environmental sustainability, so that future generations can continue to enjoy the benefits of a healthy environment. Commercial farming has high input costs for farmers as well, despite the fact that they make little money from it. Using natural farming methods, these issues can be addressed more effectively.

4.1 Conserving Nature

Increasing microbial activity content and water - holding capacity allows drought-prone areas to consistently produce high yields thanks to this practice. To improve water quality and availability throughout weather extremes, less chemical fertilizer is applied to fields.

4.2 Reduces Health Risks from Chemicals

Reducing labor for women by providing them with easier access to clean water and animal feed, as well as lowering the number of illnesses caused by foodborne illness for all people, especially children. Natural farming manages to avoid this problem because of no use of chemical pesticides.

4.3 Reduction in Carbon Emissions and Carbon Capture

For every ton of residue burned, an additional 400 kilograms of carbon dioxide are released into the atmosphere [39] if the residues are retained on the surface or incorporated into the soil, both of which increase soil carbon content and yield.

4.4 Social Impact

As a result of lower input costs and more steady yields, farmers can more reliably sell a consistent volume of crops to make a living.

4.5 Net Economic Impact

According to some studies, a farmer who adopts ZBNF reaps a direct benefit of $13 for every $1 invested [40]. Diminished cultivation costs, higher yield, lower borrowing costs, revenue from intercrops, and a marginally greater selling price are the direct advantages. In addition to this, the social and environmental advantages include the safety of food, nutrition, and health, jobs, soil health, and water security, coastal ecosystem rejuvenation, climate - resilient, bio - diversity protection, and reduced risk etc.

5. CHALLENGES TO ADOPT ZERO BUDGET NATURAL FARMING

Natural farming is environmentally friendly and ecologically sustainable, maintaining soil, plant, and human health by enhancing beneficial microbial populations, providing plants with chemical-free nutrients, and providing consumers with toxic-free food (man and animals). Farmers, on the other hand, are unlikely to adopt this technology due to a number of shortcomings. Some of the challenges which we have highlighted are as:

5.1 Convincing the Scientific Community

It will be difficult for the scientific community to find a consensus if the scientific data and evidence are not generated by the research institutes. Stakeholders and farmers alike will be skeptical of the program's effectiveness in such an environment. Farmers would be in a state of confusion if a huge network of ICAR institutes/agricultural universities and KVKs had different viewpoints.

5.2 Adoption by Large-size Farm Holding

ZBNF practice necessitates frequent field inspections to check for pest and weed infestations, as well as nutrient deficiency. As a result, the demand for labor to prepare large quantities of Jeevamritha and apply it on a regular basis may increase the cost of crop cultivation. As a result, the practice may be better suited to small-scale farmers with only one or two members of their family working at home. As a result, large farm-sized holdings would face a monumental challenge in adopting the technology.

5.3 Doubtful in Case of High-input Mono-Cropping Region

In the ZBNF practice, agro-ecological farming is a must, with a variety of crops and farms. This practice may not provide a better or equal crop yield to current HYV and chemical fertilizer and pesticide application methods when large quantities of similar nutrients are used in mono-cropping. Consequently, farmers in the Indo-Gangetic Plains region, where farmers cultivate a single crop in the entire field during a single season, may not be interested in adopting this. If widely adopted by the majority of farmers, it could have a significant impact on the country's overall food supply. This was acknowledged in Smith et al. (2020)'s study [6], which found that ZBNF could be beneficial for low-input farmers. Increased input systems may suffer yield penalties if the maximum possible nitrogen supply is only 52-80% of the average fertilizer application rate. As a result, it is not recommended that farms in all sectors switch to ZBNF.

5.4 Lack of Mechanization

Farmers can only reap the benefits of ZBNF when they grow multiple crops together as inter-crops or mixed crops, allowing them to be harvested at various times. Sowing, harvesting, and other farm management practices are all hampered as a result of this. In this case, achieving economies of scale and farm efficiency may always be a concern.

5.5 Continuous Improvement in Crop Yield

Harvesting the crops is the first step in realizing the farmers' output. ZBNF practice prohibits the use of improved cultivars/ hybrid seeds and GMOs, so farmers may lose interest in growing crops with this method if yield plateaus are imminent as a result. ZBNF/NF practices must be tested on a variety of cultivars in order to keep improving yields. In addition to above factors others are as:

No scientific validation- jivamrith and bijamrith and bramhastra's microbial composition, efficiency, and impact have not yet been tested and there is no scientific data on them. Weakened agricultural market infrastructure-natural products have no value in large scale areas even though their price is similar to chemically produced products.

Promotion of ZBNF without scientific validation and under the influence of politics - no scientific data on crop yield.

Insecticides, weed killers, and other natural products aren't enough to control crop-specific weeds, diseases, and pests, which can have a devastating effect on a crop.

The state universities, government institutions, and extension workers should be concerned about the lack of a particular package of practices for crops grown under natural farming.

6. PUBLIC POLICIES NEED TOWARDS ZERO BUDGET NATURAL FARMING

A shift in public policy is needed, according to Ramanjaneyulu, a scientist at the Center for Sustainable Agriculture, to correct inappropriate resource use in agriculture through the adoption of diversified, biological resource integrated models. Instead, implement crop rotations that take into account intercropping as well as other methods such as multiple cropping systems. Land use and farming systems must be carefully planned in light of ecological intensification challenges. Support systems (prices, subsidies, research, and institutions) should be re-configured from current subsidies on external inputs to support ecosystem service. Ecosystem-specific agronomic diversity must be maintained at all costs. Agricultural practices that benefit wetland, rain-fed, and hill regions, among others, require assistance. The current unsustainable models of agriculture must be replaced by more decentralized and diverse approaches. Instead of using the same cropping system, use safe food like millets, pulses, oilseeds, and a variety of locally grown fruits and vegetables. Follow regulations to the letter and limit the use of technologies with biosafety implications, such as agrochemicals and GMOs. Pollinators are under threat, and this has the potential to have a negative impact on productivity and yields across a wide range of crops. No formal knowledge systems require their own space. Spend 10 to 15 percent more of the union budget on ZBNF to better support agriculture. Inspire farmers to make more informed decisions rather than relying on institutions that have a vested interest in their success. Farmers are supported by their own labor, resources, and knowledge. Ecosystem services are being supported. Farmers Income Commission should ensure statutory commission of balancing decisions that impact cost of production, subsidization and support living costs as well as prices of produces. An agroecological perspective is needed when establishing the research and training agenda for agricultural research. Farmers and farm workers should be actively involved in the development of new technologies, with researchers taking a more participatory approach. Agro-ecosystem health can only be restored through the application of collective, site-specific approaches to extension. It is imperative that more money be invested in agricultural research. Sustainability and ecosystem health should be included in agricultural research performance standards. There should be bio-products with a low production volume and a long shelf life in place.

A move from an informational to a knowledge-based system and the use of experienced farmers as resource people should be made starting with agricultural extension work at the block level. Farmers Participatory Organizations (FPOs) should have access to technical support, quality management, access to financing, and markets through the development of a state-level commodity board. Storage and processing units are supported by the infrastructure.

7. FACTORS TO SCALE UP ZERO BUDGET NATURAL FARMING PRACTICES

7.1 Removing negativity around ZBNF/NF

At the moment, society is divided between two opposing ideologies that are both powerful and

diametrically opposed. In order to discredit the agricultural scientific community and institutions, advocates of natural farming are spreading several falsehoods. Green revolution technologies and associated scientific institutions are also blamed, according to these theories, for the high number of farmer suicides and other forms of hardship. Antagonizes the scientific community, who vehemently oppose the ZBNF practices, saying they are unscientific and untested. National Academy of Agricultural Sciences (NAAS), has requested that the PMO stop supporting ZBNF practices. As a result of this conflict, Indian farmers are unsure of the veracity of information provided by both sides. Deliberation based on facts and evidence would help build trust in the new practices. However, there is currently little evidence to back up or deny the claims. Such conditions necessitate the collection of evidence from the experimental fields to determine whether the ZBNF practices can increase farmers' income by reducing the cost of cultivation and/or increasing crop yield.

7.2 Institutional Arrangement for Capacity Building and Awareness Creation among the Farmers

Compared to current farming methods, the new approach advocated by ZBNF is radical. Most of India's smallholder farmers are semi-literate. In order for them to adopt the new practices, they require a steady stream of information. Several farmers have been observed using Jeevamritha as an additional input. At this point of time, they do not fully believe in its efficacy. Scientific evidence must be obtained before large-scale capacity building initiatives can take place. For each village, all of the KrishiVigyanKendras (KVK) could work together to train one forward-thinking farmer who can then influence other farmers by putting his or her training into practice in the fields where they work.

7.3 Farmers Producers Organizations (FPOs) Formation and Recognition as Niche Products

In the absence of strong scientific evidence, it may be up to farmers to implement ZBNF practices. However, the formation of an FPO for ZBNF practices may be encouraged, and the yield may be classified as a niche product. Because no chemicals are used in ZBNF practices, the cultivation can be certified as PGS-Green under the Participatory Guarantee System. Adopter farmers would benefit from higher consumer demand and higher prices.

7.4 Establishment of Demonstration Plot in Each Village Panchayat

Learning by doing is one of the best ways for peasant movements to succeed. It's difficult to convince farmers of the validity of your claims unless you show them a working model. To ensure the success of ZBNF practices, at least one demonstration plot should be established either through a local NGO or at a more advanced farmer's field. Word of mouth and peer-to-peer communication could help the practice spread to a larger area in a short period.

7.5 Linking ZBNF farmers to Mid-Day Meal and Anganwadi Scheme

The ZBNF farmers' morale may be boosted by policy changes in the state that encourage the acquisition of chemical-free yield for the Mid-Day Meal Scheme and Anganwadi Centers. Chemical-free produce would be in high demand as a result of this development.

7.6 Setting up of Institutions for Recognizing ZBNF Produce

Products made with ZBNF technology are clearly superior to those made in the traditional manner. Premium prices for ZBNF products will be difficult to achieve without some sort of mechanism for positioning this product as a niche product on the market. In order to produce, aggregate, certify, and bring the final consumer closer to the final product, a new institutional mechanism and policy change will be necessary. It's possible that encouraging farmers to pursue this practice in a group setting would be an effective way to reduce costs across the board.

8. DISCUSSION

With its roots purely of Indian Origin, Zero Budget Natural Farming shows the purpose driven base for an environment friendly ecosystem. However the newer approaches like Integrated farming system [41], Resource conservation based cropping systems, circular agriculture based farming systems, vertical farming [42] and climate smart agriculture are also focusing on the judicious utilization of chemical inputs so as to cover the aspects of food production with special emphasis on disease and pest management as well as weed management. Though the Natural farming assures a chemical free produce, but it cannot

sustain the global food crisis and food security under changing population dynamics. Therefore, it becomes imperative to cover the aspects of global food crisis so as to boost the food production in ZBNF.

9. CONCLUSION

Zero budget farming is both cost-effective and eco-friendly. Crop protection chemicals and fertilizer costs are reduced as a result. Maintaining soil health is aided by the constant retention of crop residues. In addition, pest and disease management is critical in zero-budget natural farming systems. Regardless of the debates and criticisms, the fact that ZBNF was developed with a very positive mentality to benefit the farming community cannot be disputed. Many small-scale farmers across the country have benefited from it. For researchers, scientists, and extension workers, possibilities are two factors that show the gaps in the system and the benefits to adopters, and policy intervention is required to make success. However, a thorough scientific evaluation or validation of the claim is required before it can be recommended. There is a need to conduct multi-locational trials to study ZBNF's effects on the soil nutrient content, land and environment health as well as the economic status of farmers and national food security.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Pinipilli CS, Kudumula VR. Zero Budget Natural Farming: A New Avenue In Entrepreneurship (An Exploratory study on Management students of aselect Public Universityin Visakhapatnam district). International Journal of Research and Analytical.:1.
2. Kumar N. SubashPalekar's zero budget no-till rice farming. 2012.
3. Korav S, Dhaka AK, Chaudhary A, YS M. Zero Budget Natural Farming a Key to Sustainable Agriculture: Challenges, Opportunities and Policy Intervention. Ind. J. Pure App. Biosci. 2020;8(3):285-95.
4. Upadhyay H, Mirza A, Singh J. Impact of Biopesticides in Sustainable Agriculture. In Advances in Plant Microbiome and Sustainable Agriculture 2020 (pp. 281-296). Springer, Singapore.
5. Upadhyay H, Shome S, Choudhary S. Effect of certain medicinal plant extract on insect pest management of watermelon cultivation. Plant Archives. 2019; 19(2):1159-62.
6. Smith J, Yeluripati J, Smith P, Nayak DR. Potential yield challenges to scale-up of zero budget natural farming. Nature sustainability. 2020;3(3):247-52.
7. Andow DA, Hidaka K. Yield loss in conventional and natural rice farming systems. Agriculture, ecosystems & environment. 1998;70(2-3):151-8.
8. Pawar VR, Tambe AD, Patil SP, Suryawanshi SU. Effect of different organic inputs on yield, economics and microbial count of Sweet Corn (*Zea mays Var. Saccharata*). Eco. Environ. Conser. 2013; 19(3):865-8.
9. Tripathi S, Nagbhushan S, Shahidi T. Zero Budget Natural Farming, for the Sustainable Development Goals. Andhra Pradesh, India. 2018;1-6.
10. Devarinti SR. Natural farming: eco-friendly and sustainable. Agrotechnology. 2016; 5:147.
11. Fukuoka M. The One-Straw Revolution.(Translated from the Japanese by Chris Pearce, Tsune Kurosawa and Larry Korn, originally published in Japan as Shizen Noho WoraIppon No Kakumei). Other India Press, Mapusa. 1978;403:507.
12. Neera P. Rice culture under nature farming in Japan. Proc. Fac. Agric. Kyusyu Tokai Univ.. 1992;11:67-74.
13. Khadse A, Rosset PM, Morales H, Ferguson BG. Taking agroecology to scale: The zero budget natural farming peasant movement in Karnataka, India. The Journal of Peasant Studies. 2018;45(1):192-219.
14. Khadse A, Rosset PM. Zero Budget Natural Farming in India–from inception to institutionalization. Agroecology and Sustainable Food Systems. 2019;43(7-8):848-71.
15. Gupta N, Tripathi S, Dholakia HH. Can Zero Budget Natural Farming Save Input Costs and Fertiliser Subsidies?. Report. The Council on Energy, Environment and Water. 2020;1-30.
16. Lazarovits G, Nowak J. Rhizobacteria for improvement of plant growth and establishment. Hort Science. 1997; 32(2):188-92.

17. Palekar, S; 2014. Available:http://www.palekarzerobudgetspiritualfarming.org.
18. Chen C, Bauske EM, Musson G, Rodriguez kabana R, Kloepper JW. Biological control of Fusarium wilt on cotton by use of endophytic bacteria. Biological control. 1995;5(1):83-91.
19. Münster D. Zero budget natural farming and bovine entanglements in South India. RCC Perspectives. 2017;1(1):25-32.
20. Palekar S. The Philosophy of Spiritual Farming. Zero Budget Natural Farming Research. Development & Extension Movement, Amravati (Maharashtra);2006.
21. Sujana S, Kohale VS, Gawali K, Khadse A, Nagmote AV. Effect of FYM and organic solutions on yield and Quality of chilli (*Capsicum annum* L.). Journal of Pharmacognosy and Phytochemistry. 2019;8(5):251-4.
22. Laharia GS, Patil DU, Damre PR. Effect of organic sources on soil fertility, nutrient uptake and yield of soybean. Crop Research. 2013;45(1to3):155-9.
23. Aulakh CS, Singh H, Walia SS, Phutela RP, Singh G. Evaluation of nutrient sources for organic production of rice (*Oryza sativa*)-wheat (*Triticumaestivum*) cropping system in north-west India. Indian Journal of Agronomy. 2018;63(2):137-44.
24. Sreenivasa MN, Naik N, Bhat SN. Beejamrutha: A source for beneficial bacteria. Karnataka Journal of Agricultural Sciences. 2010;22(5).
25. Shubha S, Devakumar N, Rao GG, Gowda SB. Effect of seed treatment, Panchagavya application and organic farming systems on soil microbial population, growth and yield of maize. InProceedings of the 4th ISOFAR Scientific Conference.'Building Organic Bridges', at the Organic World Congress 2014 (Vol. 23483).
26. Shwetha BN. Effect of nutrient management through the organics in soybean-wheat cropping system. M. Sc (Agri.) Thesis. 2008.
27. Chandrakala M. Effect of FYM and fermented liquid manures on yield and quality of Chilli (*Capsicum annuum* L.). M. Sc.(Agriculture Chemistry). University of Agricultural Sciences, Dharwad. 2008 Aug 5;85.
28. Chakraborty D, Nagarajan S, Aggarwal P, Gupta VK, Tomar RK, Garg RN, Sahoo RN, Sarkar A, Chopra UK, Sarma KS, Kalra N. Effect of mulching on soil and plant water status, and the growth and yield of wheat (*Triticumaestivum* L.) in a semi-arid environment. Agricultural water management. 2008;95(12):1323- 34.
29. Mulumba LN, Lal R. Mulching effects on selected soil physical properties. Soil and Tillage Research. 2008;98(1):106-11.
30. Sekhon NK, Hira GS, Sidhu AS, Thind SS. Response of soyabean (*Glycine max* Mer.) to wheat straw mulching in different cropping seasons. Soil Use and Management. 2005;21(4):422-6.
31. Jordán A, Zavala LM, Gil J. Effects of mulching on soil physical properties and runoff under semi-arid conditions in southern Spain. Catena. 2010 Apr 15;81(1):77-85.
32. Jalota SK, Khera R, Arora VK, Beri V. Benefits of straw mulching in crop production: a review. J Res Punjab Agric Univ. 2007;44(2):104-7.
33. Palekar S. The principles of spiritual farming II. 2nd ed. Amravati: Zero Budget Natural Farming Research, Development & Extension Movement, Amravati, Maharashtra, India; 2006.
34. Via Campesina L. Zero Budget Natural Farming in India. Family Farming Knowledge Platform of Fao; 2016.
35. Devakumar N, Shubha S, Gowder SB, Rao GG. Microbial analytical studies of traditional organic preparations beejamrutha and jeevamrutha. Building organic bridges. 2014;2:639-42.
36. Palekar, S. Zero Budget Natural Farming. 2016. Available:http://palekarzerobudgetspiritual farming.org
37. Chakraborty A, Singh J, Upadhyay H. Fungal Diversity and Ecology: Major Challenges for Crop Production in Present Climate Scenario. InRecent Trends in Mycological Research 2021 (pp. 89-107). Springer, Cham.
38. Rana D, Paul YS, Upmanyu S. Organic management of paddy blast using indigenous technical knowledge based organic inputs. Plant Disease Research. 2016;31(1):15-8.
39. Gupta N. Paddy Residue Burning in Punjab: Understanding Farmers. Perspectives and Rural Air Pollution', Council on Energy, Environment and Water (CEEW), March;2019.
40. Korav S, Dhaka AK, Chaudhary A, Mamatha YS. Review- Zero Budget

Natural Farming a Key to Sustainable Agriculture: Challenges, Opportunities and Policy intervention, Indian Journal of Pure & Applied Biosciences (IJPAB). 2020;8(3):285-295. DOI:http://dx.doi.org/10.18782/2582-2845.8091

41. Mir MS, Naikoo NB, Kanth RH, Bahar FA, Bhat MA, Nazir A, Mahdi SS, Amin Z, Singh L, Raja W, Saad AA. Vertical farming: The future of agriculture: A review. The Pharma Innovation Journal. 2022;SP-11(2):1175-1195.

42. Mir MS, Naikoo NB, Amin Z, Bhat TA, Nazir A, Kanth RH, Singh P, Raja W, Singh L, Fayaz S, Ahngar TA. Integrated Farming System: A Tool for Doubling Farmer's Income.Journal of Experimental Agriculture International. 2022;44(3):47-56.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/86642