

Review Article

NATURAL FARMING: EMBRACING REGENERATIVE AGRICULTURE FOR SUSTAINABLE CROP PRODUCTION

ABSTRACT

Natural farming, a regenerative agriculture is advocated and promoted worldwide to produce safe and quality produce and to live in harmony with nature. It is a chemical free or do-nothing farming aims to improve the soil biological fertility without the addition of external inputs. Major strategy is continuous application of cow dung and cow urine-based concoctions beside following effective recycling of crop residues, leguminous intercrops as soil cover, pre- monsoon dry sowing, minimizing the irrigation and balancing the soil, air and moisture by irrigating at noon. The farmer is considered only to be a facilitator - the real work is done by Nature herself. No- tillage and farming without the application of herbicides, inorganic fertilizers and pesticides is practiced. Here, actual physical work and labor has been seen to reduce by up to 80% compared to other farming systems. The essence of natural farming is minimizing the external inputs to the farm land, which degenerate the soil nature and improving the crop yield.

Key words- *Natural farming, ZBNF, chemical free, natural resources, sustainable agriculture*

1. INTRODUCTION

Conventional agriculture, which gained momentum after the Green Revolution, has significantly increased crop yields to meet the demands of a growing population. However, the continuous use of chemicals in crop production has led to soil health deterioration and environmental hazards due to toxic residues. After 50 years of the Green Revolution, India faces second-generation challenges such as declining factor productivity growth, poor soil health, loss of soil organic carbon, pollution of ground and surface water, water-related stress, increased incidence of pests and diseases, rising input costs, reduced farm profits and the adverse impacts of climate change [1]. While chemical use is beneficial in the short term, it is detrimental to long-term sustainable agricultural production [2]. The harmful impacts of chemical fertilizers in intensive agriculture include the depletion of the carbon reserve pool and secondary and micronutrients, leading to soil productivity and fertility degradation [3]. According to the National Sample Survey Office (NSSO), over 70% of agricultural households spend more than they earn and more than half of all farmers are in debt due to rising costs of inputs like fertilizers and chemical pesticides.

To achieve the Central Government's goal of doubling farmers' incomes by 2022, it is crucial to reduce farming expenses and promote natural farming methods like Zero Budget Natural Farming (ZBNF). This approach minimizes farmers' reliance on costly external inputs like chemical fertilizers and pesticides, which are often unaffordable. The zero-budget farming model significantly reduces farm expenditure and dependence on farm loans. It also encourages the use of own seeds and locally available natural fertilizers, promoting farming in synchronization with nature [4].

In India natural farming is promoted as BharatiyaPrakritik Krishi Paddhati Program (BPKP) is a sub-mission under the Paramparagat Krishi Yojana (PKVY), which falls within the umbrella of the national Mission on Sustainable Agriculture (NMSA). BPKP aims at promoting traditional indigenous practices, which give freedom to farmers from externally purchased inputs. It focuses on on-farm biomass recycling with major stress on biomass mulching; use of cow dung–urine formulations and exclusion of all synthetic chemical inputs either directly or indirectly. The scheme has a total outlay of Rs 4645.69 crore for the period of six years (2019-20 to 2024-25). Under BPKP, financial assistance of Rs 12200/ha for 3 years is provided for cluster formation, capacity building and continuous handholding by trained personnel, certification and residue analysis with a vision of covering 12 lakh ha in 600 major blocks of 2000 hectare in different states [5].

2. NATURAL FRAMING

Natural farming, as the name suggests, involves farming with nature without using modern tools and technology like machinery, genetically modified seeds and soil testing. This method operates on the principle that soil contains all the essential nutrients for plant growth. Plants obtain 98-98.5% of their nutrition from air, water, and sunlight, with the remaining 1.5% from the soil. Thus, the system can sustain and flourish without nutrient supplementation, similar to a forest ecosystem [6]. Natural farming is a chemical-free, traditional farming method considered an agroecology-based diversified farming system integrating crops, trees, and livestock with functional biodiversity [7]. It emphasizes the synergistic effect of plant and animal products on crop establishment, soil fertility and microorganisms [8].

Zero Budget Natural Farming (ZBNF), also known as Zero Budget Spiritual Farming (ZBSF), was introduced by Shri Subhash Palekar, who was honored with the Padma Shri in 2016. The term "Budget" refers to credit and expenses, so "Zero Budget" means farming without using credit, spending money on purchased inputs, or using chemicals [9]. ZBNF is a holistic agriculture practice that counters commercial expenditure and market dependency for inputs, with all necessary growth factors available around the plant's root zone [10]. The natural farming is resource-efficient, minimizing the use of financial and natural resources while increasing crop yield. By restoring soil and water-related ecosystems, it decouples agricultural productivity from ecosystem degradation and biodiversity loss [11].

3. HISTORY OF NATURAL FRAMING

3.1 The Emergence of Natural Farming Globally

3.1.1 Masanobu Fukuoka

Natural farming was established by Masanobu Fukuoka (1913–2008), a Japanese farmer and philosopher, and introduced in his 1975 book “The One-Straw Revolution.” Also known as the Fukuoka Method, The Natural Way of Farming, or Do Nothing Farming, this philosophy does not imply a lack of effort but rather the avoidance of manufactured inputs and equipment [12]. Fukuoka's philosophy focuses on working with nature to produce healthy food, maintaining the health of both people and the land, and is distinct from biodynamic agriculture. Fukuoka distilled the natural farming mindset into five principles: no tillage, no fertilizer, no pesticides or herbicides, no weeding, and no pruning [7].

Natural farming minimizes human labor and adopts nature's methods for producing cereals, fruits, vegetables, and ornamentals in biodiverse agricultural ecosystems. Seeds germinate without plowing on the surface, depending on microclimate conditions. Fukuoka observed that the ground remains covered by weeds, legumes, grains, vegetable crops, and orchards. Chickens roam freely in orchards, while ducks and fish populate rice fields. Ground cover enhances nitrogen fixation, and straw from previous crops mulches the topsoil. Each grain crop is sown before the previous one is harvested by broadcasting the seed among the standing crop, resulting in a denser, smaller, but highly productive and stronger plant [13].

3.1.2 Yoshikazu Kawaguchi's Natural Farming

Kawaguchi's principles, based on the philosophy of “Final Straw: Food, Earth, and Happiness,” restate the core values of natural farming:

- ✓ Do not plow the field.
- ✓ Weeds and insects are not considered enemies.
- ✓ There is no need to add fertilizer.
- ✓ Growing food is adjusted based on local climate and conditions.

3.2 The Emergence of Natural Farming in India

3.2.1 Subhash Palekar

The concept of natural farming in India was advanced by Subhash Palekar, a native of Amravati, Maharashtra [15]. Palekar earned a B.Sc. in Agriculture from Nagpur and dedicated himself to improving his village farm. After discovering that continuous use of chemicals rendered his farm barren, he sought an optimal solution. From 1986-88, Palekar researched forest vegetation and found that natural systems in forests could develop and nurture healthy ecosystems [4]

Through six years of dedicated research, Palekar revealed:

1. Dung from local Indian cows is particularly effective for re-enriching barren soil, unlike dung from Jersey and Holstein cows. In the absence of local cow dung, bullock or buffalo dung can be used effectively.
2. Dung and urine from the black-colored Kapila cow are believed to be miraculous.
3. Fresh cow dung and stale cow urine are most effective [5].
4. Ten kilograms of dung per acre per month is sufficient. An average cow produces 11 kg of dung per day, allowing one cow to fertilize 30 acres per month [16].
5. Urine, jaggery, and dicot flour can be used as additives.
6. Cows with lower milk production yield more beneficial dung for soil regeneration

Subhash Palekar, known as “Krishi ka Rishi” and the “Father of Zero/Low Budget Natural Farming” (LBNF), addressed two major issues in Indian agriculture: enhancing soil fertility through agro-ecological principles and freeing farmers from the cycle of debt by eliminating the need for high-cost external inputs [17].

Table1. Difference of Conventional farming, Organic farming and Natural framing[10]

Aspect	Conventional farming	Organic farming	Natural farming
Use of chemicals	Heavily relies on synthetic fertilizers and pesticides	Minimizes the use of synthetic chemicals, favoring natural alternatives	Prohibited the use of any chemical or organic fertilizers or pesticides.
Use of external resources	Depends on external sources for manures and fertilizers	Utilizes organic manures and fertilizer from external sources	Relies only on locally available and farm-based resources e.g., Beejamrita and Jeevamrutha
Soil preparation	Involves plowing, tilling and mixing of manures	Requires basic farming practices like plowing and tilling	Avoids plowing and tilling, instead supports the natural decomposition of organic matter on soil surface
Weed control	Uses chemical herbicide or mechanical weeding	Promotes natural weed control techniques like mulching	Considers weeds as essential, using them as living or dead mulch layer
Pest control	Relies on chemical pesticides	Uses natural pest control methods, including biological control and natural pesticides	Uses natural, farm made pesticides like Dashparni ark and Neem Astra
Cost	Can be expensive due to	May be expensive due to	Can be achieved with

	the cost of external inputs and machinery.	the cost of organic inputs and labour.	minimal budget, relying on locally available and farm-based resources.
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4. FOUR PILLARS OF NATURAL FARMING

4.1 Beejamrutha

Beejamrutha is a traditional seed treatment technique from ancient Indian agriculture. It involves preparing a nutrient-rich mixture applied to seeds before sowing. The name “Beejamrutha” comes from the Sanskrit words “Bheej” (seed) and “Amrutha” (nectar), highlighting its ability to revitalize and nourish seeds [18]. The preparation involves using local cow dung (a natural fungicide) and cow urine (an antibacterial liquid), along with lime and soil. The dung is tied in a cloth and soaked in urine for about 12 hours. Afterward, the dung is squeezed out, and 50 grams of lime are added to the urine. The seeds are then coated with Beejamrutha and dried thoroughly before sowing. Leguminous seeds can be quickly dipped and dried [19].

Beejamrutha contains general microflora and beneficial biochemical groups such as free-living nitrogen fixers, phosphorus solubilizers, bacteria producing plant growth-promoting substances, and bacteria with biological deterrent activities. The presence of such beneficial microbial biomass and nutrient content results in improved seed germination, seedling length, and seed vigor. Beejamrutha protects seedlings from seed or soil-borne diseases and young roots from fungus. It has been found to generate auxins (IAA) and gibberellins (GA₃), which promote plant growth [20].

Numerous experiments have evaluated the effectiveness of Beejamrit and Jeevamrit across various agro-ecological regions in vegetable crops. The seed weight of chilli increased compared to control treatments when Beejamrut, Jeevamrit, and Panchagavya were applied [21]. The Beejamrit was the most effective seed treatment, resulting in 92 percent seed germination in pea seeds compared to 56 percent in the control group. Beejamrit also acts as a potent antibacterial and antifungal solution [22]. 100% Beejamrita led to high germination, seedling development and seed vigor index in legume seeds [23]. Additionally, Beejamrita is known for root protection and strengthening during transplanting [24]. An increase in microbial population when seeds were treated with Panchagavya and Beejamrit [25]. The seed treatment with bijamrita in cucurbits and legumes significantly improved seed germination and seedling growth, promoting eco-friendly agriculture [26].

4.2 Jeevamrutha

Jeevamrutha is a fermented microbial culture, where “Jeeva” means a living organism and “Amrutham” signifies an elixir of life, indicating its ability to enhance the life of any living organism.

Jeevamrutha is prepared by mixing 10 kg of local cow dung with 10 liters of cow urine, 2 kg of local jaggery, 2 kg of pulse flour, and a handful of garden soil. This mixture is then diluted to 200 liters with water. The mixture is kept in the shade, covered with a wet gunny bag, and stirred clockwise three times a day, allowing it to incubate [27].

The benefits of jeevamrutha come from its high microbial load and growth hormones, which enhance soil biomass and sustain the availability and uptake of nutrients, leading to better crop growth and yield [28,29,30]. For instance, Jeevamrutha application increased the yield of capsicum [31] and the lycopene content of tomato fruit when combined with Panchagavya [32]. Additionally, applying jeevamrutha at 2000 liters per hectare significantly increased the green pod yield of French beans, and the yield improved further when supplemented with 6% Panchagavya [33].

4.2.1 Ghanjeevamrutha

Jeevamrutha can also be applied in solid form, known as Ghanjeevamrutha. It is prepared using 100 kg of air-dried cow dung, 1 kg of jaggery, 1 kg of pulse flour, 3 liters of cow urine and/or 2 liters of Jeevamrutha, and 250 grams of soil from undisturbed bunds or forests. These ingredients are mixed well and kept in the shade for 48 hours, turned 3-4 times a day. After 10 days, Ghanjeevamrutha can be used in fields at a recommended dose of 250 kg per hectare and is effective for up to 6 months when stored in a cool, dry place [34].

The combination of FYM (Farmyard Manure) 10t per hectare and Ghanjeevamrutha at 250 kg per hectare increases the yield, nutrient content, available nutrients, nutrient uptake and nodulation [35].

4.3 Acchadana/ Mulching

Mulching effectively changes the growing environment of crops by capturing and utilizing rainfall, reducing the risk of crop failure, increasing soil organic matter content, reducing soil moisture evaporation, and improving soil temperature. Three types of mulching are suggested under ZBNF:

- ✓ **Soil Mulch:** Protects topsoil during cultivation without tilling, promoting aeration and water retention. Deep plowing should be avoided.
- ✓ **Straw Mulch:** Uses dried biomass waste from previous crops. Any type of dry organic material will decompose and form humus through microbial activity. Straw mulching creates a physical barrier between the soil surface and the atmosphere, significantly reducing soil moisture evaporation and soil erosion, regulating soil temperature, and promoting plant growth. It directly affects the soil microenvironment, enhancing sustainability [37].
- ✓ **Live Mulch:** Involves multiple cropping patterns of monocotyledons and dicotyledons grown together to supply essential elements to the soil and crops. Dicot plants, like pulses, fix nitrogen, while monocots, such as rice and wheat, supply elements like potash, phosphate and sulfur [38]

Table 2. Season wise crop combination under natural farming [39]

Particulars	Kharif	Rabi
Vegetable	Tomato + Beans + Cucumber	Cauliflower + Pea + Radish
	Tomato + Beans	Cauliflower + Pea + Fenugreek
	Tomato + Beans + Capsicum	Cauliflower + Pea + Coriander
	Tomato + Beans + Chilli	Cauliflower + Pea + Spinach
	Tomato + Beans + Bottle Gourd	Cauliflower + Pea + Potato
	Tomato + Bean + Okra	Cauliflower + Pea + Onion
	Tomato + Beans + Brinjal	Onion + Pea + Fenugreek
	Capsicum + Beans	Cauliflower + Pea
Vegetables-Pulses	Tomato + Maize + Beans	Potato + Wheat + Pea
	Capsicum + Maize + Beans	Cauliflower + Wheat + Pea
	Bottle Gourd + Maize + Beans	Colocasia + Wheat + Pea
	Tomato +Maize + Beans	-
Vegetables-Pulses	Tomato + Soyabean	Cauliflower + Chickpea
	Tomato + Soyabean + Cucumber	Cauliflower + Kidney Beans + Potato
	Tomato + Soyabean + Chilli	Cauliflower + Chickpea + Coriander
	Okra + Beans	Cauliflower + Chickpea + Fenugreek
Vegetables-Oil seeds	-	Cauliflower + Mustard + Fenugreek
	-	Cauliflower + Mustard + Cabbage
	-	Cauliflower + Mustard + Coriander
	-	Cauliflower + Mustard + Radish
	-	Cauliflower + Mustard

4.4 Whapasa

Whapasa refers to the presence of a mixture of 50% air and 50% water vapor in the spaces between soil particles. According to Palekar, plant roots need water in the form of vapors rather than liquid. Whapasa creates a microclimate in the soil, allowing soil organisms and roots to thrive with sufficient air and essential moisture. This microclimate increases water availability, enhances water-use efficiency, and builds resilience against drought. Most soil microorganisms and root hairs, which absorb water and nutrients, are active in the top 10-15 cm of the soil layer. Maintaining Whapasa in this soil zone is crucial [36].

5. PEST MANAGEMENT IN NATURAL FARMING USING ASTRAS

Sl. No.	Astras	Preparation	Control	Reference
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1	Neemastra	The mixture is prepared by crushing 5 kg of neem leaves in water, then adding 5 liters of cow urine and 2 kg of cow dung. This mixture is fermented for 24 hours, with occasional stirring. After fermentation, the extract is filtered and diluted to 100 liters and can be applied as a foliar spray over an acre	Mealy bugs and sucking pests	[40]
2	Brahmastra	The formulation includes 10 liters of cow urine, along with 3 kg of neem leaves, 2 kg each of custard apple, papaya, pomegranate, and guava leaves. These ingredients are mixed together and boiled five times at intervals, allowing the contents to cool after each boiling session. After a resting period of 48 hours, the extract is filtered. Dilute 2 litres of extract in 100 litres of water for one acre.	It is effective against sucking pests and pod/fruit borers.	[41]
3	Agniastra	Mix 10 liters of local cow urine with crushed tobacco leaves, green chili, and garlic in an earthen pot. Add 5 kilograms of neem leaves pulp and boil the mixture thoroughly five times. Allow the solution to ferment for about 24 hours before straining it.	Aphids, sucking pests, stem borer, fruit borer and insects.	[42]
4	Dashparni	Neem leaves, Jatropa leaves, Heart-leaved moonseed leaves, Custard apple leaves, Karanja leaves, Castor leaves, Nerium leaves, oak leaves, green chilli, Garlic, Cow dung, Cow urine are the ingredients.	Controlling a wide range of insect pests and diseases.	[40]

6. OTHER LIQUID FORMULATION TO IMPROVE THE FERTILITY

6.1 Panchagavya

Panchagavya, a fermented organic product known for its ability to enhance plant growth and immunity, was introduced and popularized in Tamil Nadu by Natarajan. Derived from cattle waste and by-products, Panchagavya improves soil fertility by increasing organic matter, macro and micronutrient levels, and nutrient uptake in plants. It also promotes the growth and reproduction of microorganisms, thereby maintaining soil health [43].

To prepare Panchagavya, specific cow by-products are used: 7 kg of cow dung, 10 liters of cow urine, 3 liters of cow milk, 1 kg of cow ghee, and 2 liters of cow curd. Additional ingredients include 3 liters of tender coconut water, 3 kg of jaggery, 12 well-ripened poovan bananas, and 10 liters of water. These materials are mixed in proper proportions in an earthen pot, placed in a shady area, and covered. The mixture is stirred twice daily in both directions. After 30 days, the solution is filtered and collected for use [44].

An increase in growth and yield parameters at low concentrations of Panchagavya [45]. Similarly, An increase in the microbial population in post-harvest soils of cauliflower crops, with higher populations of bacteria, fungi, and actinomycetes (64.2×10^6 , 26.8×10^4 , and 34.9×10^4 cfu/g, respectively) observed with a 3% panchagavya spray [46]. Additionally, the application of panchagavya as a seed treatment led to a notable reduction in Phytophthora blight and anthracnose in capsicum and early blight in tomato [47,48].

6.2 Dasagavya

Dasagavya is prepared using the healthy leaves of various plant species, including *A. indica* (Kohomba), *C. gigantia* (wara), *V. negundo* (nika), *T. purpurea* (pila), *J. curcas* (edaru), *D. metel* (aththana), *P. pinnata* (magulkarada) and *A. vasica* (adathoda). The collected leaves are thoroughly cleaned before extracting their essence. For each species, 1 kg of mature leaves is soaked in 1 L of cow urine for ten days. After soaking, the extracts are filtered, and 1 L of each extract is added to 5 L of the Panchagavya preparation. This mixture is then fermented for another 25 days, during which it is stirred regularly to ensure proper mixing of the Panchagavya and the eight plant extracts [49]. Before applying Dasagavya to plants, it should be thoroughly filtered. A 3% concentration is recommended for use as a foliar spray and for seed treatments. Seeds should be soaked in Dasagavya for 20 minutes before sowing.

Dasagavya is a growth promoter while it has the potential in boosting immunity against pests and diseases in plants [50]. Dasagavya is enriched with fermentative bacteria, including Lactobacillus, and produces various beneficial metabolites such as organic acids, hydrogen peroxide, and antibiotics that effectively combat pathogenic organisms. Dasagavya has the potential to enhance the shelf life, quality, quantity and taste of numerous fruit and vegetable varieties, demonstrating high biological efficiency in crops [51]. Dasagavya is a growth promoter while it has the potential in boosting immunity against pests and diseases in plants [50].

6.3. Aattottam

To create an effective plant growth promoter, start by soaking goat dung in water overnight. The next day, add goat urine to the mixture and blend well. Incorporate all the remaining ingredients green gram, curd made from goat milk, banana, coconut water, and sugarcane juice. Let this mixture sit for 24 hours in a shaded area. When the mixture is ready, use a 2% solution during the branching stage, before the flowering period, and before the fruit starts to set. This natural formula enriches the soil with essential nutrients, boosts chlorophyll production, enhances branching, leafing, flowering & fruiting and serves as an excellent promoter of overall plant growth[52].

6.4 Farmers effective microorganism's

To prepare Farmer's Effective Microorganism (FEM), the required ingredients are 3 kg of pumpkin, 1 kg of banana, 3 kg of papaya, 3 kg of jaggery, and 5 eggs. Begin by chopping the fruits and vegetables into small pieces and placing them in a plastic container. Dissolve the jaggery in 10 liters of water, then add the eggs and mix all the ingredients thoroughly. Seal the container with an airtight lid and leave it for 10 days, releasing the air after this period. Mix the contents well and allow the mixture to incubate for an additional 45 days.

After 45 days, the container will have three distinct layers. The top layer will be a thin, white layer indicating successful fermentation. The middle layer will consist of a pure brown liquid, while the bottom layer will be a semi-solid mass formed from the dissolved vegetables. To collect the semi-solid portion, open the tap at the bottom of the container and transfer it to one container. The top and middle layers should be collected in a separate container. Once ready, the FEM can be used as a foliar spray in a 2-5% concentration, serving effectively as both a herbicide and pesticide[52].

7. Conclusion

Natural farming is a system where the laws of nature are applied to agricultural practices. ZBNF has been emerged as a farming model for small and marginal farmers to overcome the farming distress and sustaining the livelihood. It reduces farmer's costs through eliminating external inputs and utilising in-situ resources to rejuvenate the soil, simultaneously increasing incomes, restoring ecosystem/soil health and climate resilience through diverse multi-layered cropping systems.

Reference

1. Naresh RK, Vivek, Kumar M, Kumar S, Chowdhary U, Kumar Y, et al. Zero budget natural farming viable for small farmers to empower food and nutritional security and improve soil health: A review. *Journal of Pharmacognosy and Phytochemistry*, 2018; 7(2): 1104-1118.
2. Biswas S, Jana K, Agrawal RK, Puste AM. Effect of integrated nutrient management on growth attributing characters of crops under various oat-lathyrus intercropping system. *The Pharma Innovation Journal*. 2019; 8(9): 368-373.

3. KhambalkarPA, TomarPS, Verma SK. Long term effects of integrated nutrient management on productivity and soil fertility in pearl millet (*Pennisetum glaucum*)-mustard (*Brassica juncea*) cropping sequence. Indian Journal of Agronomy. 2012;57(3): 222-228.
4. KumarA, Kumari S. A review on zero budget natural farming: A path towards sustainable agriculture. The Pharma Innovation Journal. 2020; 9(4): 236-239.
5. SharmaHH, Paul A, DasO, Goswami A, Hazarika P, BorkotokyB, et al. (2023). The ABCs of natural farming: Principles, components and features: A review. The Pharma Innovation Journal. 2023; 12(11): 564-568.
6. SharmaS, Ravisankar N, Jain N, Sarangi S. Natural farming: current status, research and case studies. Indian Journal of Agronomy 68. 2023; (XXII Biennial National Symposium Special issue)S1-S15
7. DeLC. Natural Farming- A sustainable Ecological Approach. Research Biotica. 2022; 4(1): 05-20.
8. Smith J, Yeluripati J, Smith P, NayakDR. Potential yield challenges to scale-up of zero budget natural farming. Nature Sustainability. 2020; pp. 1-6.
9. BadwalDPS, Kumar M, Singh H, Simran, Kaur S. Zero budget natural farming in India- A review. International Journal of Current Microbiology and Applied Sciences. 2019; 8(12): 869-873.
10. Korav S, DhakaAK, Chaudhary A, Mamatha YS. Zero budget natural farming a key to sustainable agriculture: Challenges, opportunities and policy intervention. Indian Journal of Pure & Applied Biosciences. 2020; 8(3): 2582-2845.
11. TripathiS, NagbhushanS, Shahidi T. Zero budget natural farming for the sustainable development goals, Andhra Pradesh, India. 2018.
12. Mevada K, MakwanaBD. Efficiency of plant nutrient enhancer for sustainable agriculture in diverse agroecosystem. Journal of Agriculture and Ecology. 2023;16:99-104.
13. Fukuoka M. The natural way of farming: The theory and practice of green philosophy. Japan Publications. 1987; (ISBN 978-0-87040-613-3).
14. HardikN, Lakhani RK., Jalu RK, ParmarKJ, Patoliya JU, Kasandra MM. Natural farming: New horizon of the agricultural sector. International Journal of Current Microbiology and Applied Sciences. 2020; 9(6): 774-780.
15. PawarVR, 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): 865-868.
16. PalekarS. 2014. Retrieved from <http://www.palekarzerobudgetspiritualfarming.org/>
17. RossetP, TorresM. Rural social movements and agroecology: Context, theory, and process. Ecology and Society. 2012; 17(3): 1-17.
18. Devarinti SR. Natural Farming: Eco- Friendly and Sustainable? Agrotechnology. 2016; 5(2)

19. MishraS, ChaubeyAK, GaurAS, TripathiKM, PrajapatiD,Sahu S. Effects of zero-budget natural farming on yield, earthworm populations, microbiological activity, and the requirement for public policy: A review. *International Journal of Environment and Climate Change*. 2023;13(10):3378-3391.
20. SreenivasaMN, Naik NM, Bhat SN. Beejamruth: A source for beneficial bacteria. *Karnataka Journal of Agricultural Sciences*. 2010; 17(3): 72-77.
21. Chandrakala M. Effect of FYM and fermented liquid manures on yield and quality of chilli (*Capsicum annuum* L.) (Master's thesis). University of Agriculture Science, Dharwad. 2008.
22. Chadha S, Rameshwar, Ashlesha, Saini JP,Paul YS. Vedic Krishi: Sustainable livelihood option for small and marginal farmers. *Indian Journal of Traditional Knowledge*. 2012; 11(3): 480-486.
23. VyankatraoNP. Effect of Bijamrutha and other organic liquid treatments on seed germination and seedling growth of legume crops. *Online Int. Interdiscipl Res J*. 2019; 9(3)
24. Nene YL. A critical discussion on the methods currently recommended to support organic crop farming in India. *Asian Agri-Histor*. 2017;21(3): 267-285.
25. ShubhaS, Devakumar N, RaoGGE,Gowda SB. Effect of seed treatment, Panchagavya application and organic farming systems on soil microbial population, growth and yield of maize. *Proceedings of the 4th ISOFAR Scientific Conference. 'Building Organic Bridges', at the Organic World Congress 2014, 13-15 Oct., Istanbul, Turkey(23483)*.
26. JhaBK, KumarO, NaikSK, Sarkar PK, ChoudharyJS, ShindeR. (2021). Efficacy of seed treatment with Bijamrita and Bavistin on seedling growth of cucurbits and legumes. *An International Quarterly Journal of Life Sciences*. 2021;16(2): 123-128.
27. Devakumar N, ShubhaS, GowderSB, RaoGG E. Microbial analytical studies of traditional organic preparations Beejamrutha and Jeevamrutha. *Building Organic Bridges*. 2014; 2: 639-642.
28. Palekar S. 2006. *The principles of spiritual farming II* (2nd ed.). Amravati: Zero Budget Natural Farming Research, Development & Extension Movement, Amravati, Maharashtra, India.
29. VasanthkumarHHR. Jeevamrut slurry preparation. *SiriSamruddhi*, 2006; 4-5.
30. Devakumar N, RaoGGE, ShubhaS, Imrankhan, Nagaraj, GowdaSB. 2008. *Activities of Organic Farming Research Centre*. Navile, Shimoga, Univ. Agri. Sci., Bangalore, Karnataka.
31. BoraiahB, Devakumar N, Shubha S, Palanna, KB. Effect of Panchagavya, Jeevamrutha and cow urine on beneficial microorganisms and yield of capsicum (*Capsicum annuum* L. var. *grossum*). *International Journal of Current Microbiology and Applied Sciences*. 2017; 6(9): 3226-3234.
32. PandaD, Padhiary AK,Mondal S. Effect of Panchagavya and Jeevamrit on growth and yield of tomato (*Solanum lycopersicum* L.). *Annals of Plant and Soil Research*. 2020;22(1): 80-85.
33. Kumber B,Devakumar N. Influence of different levels of Jeevamrutha and Panchagavya on yield and quality parameters of organic French bean (*Phaseolus vulgaris* L.). In Rahman *et al.* (Eds), *Proceedings of the Scientific Conference on "Innovative Research for Organic Agriculture 3.0"*, 19th Organic World Congress, New Delhi, India, November 9-11, 2017;pp. 459-462.

34. Vishnupandi, S., &Thangaselvbai, T. (2019). Effect of different nutrient formulations on growth and yield of *Cordyline fruticosa* grown in soilless culture system. Journal of Agriculture and Ecology, 8, 24-29.
35. Sharma T, Singh J, Singh A, SharmaR, Chauhan G. Effect of organic nutrient sources on the yield, nutrient uptake and nodulation in cowpea (*Vigna unguiculata*) under mid-hill conditions of Western Himalayas. Environment Conservation Journal. 2022; 24(2): 250-256.
36. Mandla I, Sharma S. Subhash Palekar Natural Farming: Introduction and its four pillars. Just Agriculture. 2022; 3(1): 1-5.
37. DuC, LiL, Effah Z. Effect of straw mulching and reduced tillage on crop production and environment: A review. Water. 2022; 14(6): 2471.
38. SaiVM, KumarMS, Reddy BM. Natural Farming Need for Future Prospects, research gate, 2022; Chapter 2: 29- 46.
39. LaishramC, VashishatRK, SharmaS, RajkumariB, Mishra N, BarwalP, et al. Impact of natural farming cropping system on rural households- Evidence from Solan District of Himachal Pradesh, India. Frontiers in Sustainable Food Systems. 2022; 6: 878015.
40. CharapaleST, GaikwadDK, JagtapR, Sonawane KD. Antibacterial activity of Dashparni, Agniashtra, Bramhastra and Neemastra the organic formulations. Bioinfolet Quarterly Journal of Life Sciences. 2021; 18(2): 262-263.
41. Badiyala A, Sharma GD. Pest management under natural farming. Indian Farmer. 2021; 8(3): 253-258.
42. Devapatni MK, PrasharJ, SinghM, MenonS, SinghG. ITK based organic formulations in crop production: A review. Eco. Env. Cons. 2023; 29: 124-129.
43. Komal KB, Chavhan V, Raut NA, Gurav S. Panchagavya: A precious gift to humankind. Journal of Ayurveda and Integrative Medicine. 2022; 13(100525).
44. ChakrabortyB, Sarkar I. Quality analysis and characterization of Panchagavya, Jeevamrutha and Sasyamrutha. International Journal of Current Microbiology and Applied Sciences. 2019; 8(5): ISSN: 2319-7706.
45. RakeshS, Poonguzhali S, Saranya B, SugunaS, Jothibasuk. Effect of Panchagavya on growth and yield of *Abelmoschus esculentus* cv. Arka Anamika. International Journal of Current Microbiology and Applied Sciences. 2017; 6(9): 3090-3097.
46. Diwaker P, Lakhawat S, Sharma S, Jain H, Jat G, Pilania S, et al. Soil properties and microbial population after harvesting of cauliflower (*Brassica oleracea* L. var. *botrytis*) cv. Pusa Snowball K-1 as influenced by organic manures and liquid formulations. Annals of Agri-Bio Research. 2022; 27(1): 66-70.
47. Ashlesha PY. Antifungal bioefficacy of organic inputs against fungal pathogens of bell pepper. Paripex-Indian Journal of Research. 2014; 3(6): 4-9.

48. RameshG, Ajithkumar K, Savitha AS, PatilSG. Integrated influence of organic manures in addition to inorganic fertilizers on growth, yield parameters and early blight disease of tomato (*Lycopersicon esculentum* L.). International Journal of Biological & Pharmaceutical Research. 2015; 6(6): 478-483.
49. ChandrashekharaiiahM, SannaveerappanavarVT, ChakravarthyA, Verghese A. Biological activity of select plant and indigenous extracts against diamondback moth, *Plutellaxylostella* (L.) (Lepidoptera: Plutellidae) and cowpea aphid, *Aphis craccivora* Koch (Hemiptera: Aphididae). Current Biotica.2013; 7(3): 134-144.
50. Pathak RK, RamR A. Bio-enhancers: A potential tool to improve soil fertility, plant health in organic production of horticultural crops. Progressive Horticulture. 2013; 45(2): 237-254.
51. SarmaHH, Talukdar N. Dasagavya and Panchagavya: Elixirs of organic Farming. Indian framing, 2024; 11(06): 198-202.
52. Inbavijayan SN, Ravi S. Compendium of organic farm inputs. Kovise Foundation