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Natural Farming - A Mode of Exploiting Benificial Microbes For Sustaining Soil-Plant Health

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Abstract

Natural farming is a relatively new concept that is increasingly being recognized as a cost-effective solution for reducing the use of chemical fertilizers and pesticides in agriculture. The long-term use of chemicals has not only increased farming costs but has also posed a significant threat to soil and human health. Natural farming practices on the other hand, promotes the use of naturally available resources, primarilycow dung and cow urine to prepare organic manure and pesticides. One of the most significant benefits of natural farming is the promotion of beneficial microbes for sustaining soil and plant growth. Importantly, these microbes are found to have plant growth promoting traits, which can help plant nutrition and health in numerous ways.

Keywords: Zero budget natural farming (ZBNF), Natural Farming, Plant growth promoting rhizobacteria, Sustainability

Introduction and concept

Climate change creates critical risks for farmers, endangering the natural resources like soil water etc. on which the farmers depend. Rising temperature, irregular rainfall pattern has already created havoc making it harder for successful crop cultivation. In this regard, crops grown under natural farming practices can be a blessing to adverse climatic conditions. Few techniques like no/minimum tillage operations, mulching, crop diversification might impart positive results to farmers facing issues due to adverse climatic conditions.

The term, 'Natural farming' is becoming a popular term very recently. M. Fukuaka, a Japanese Agriculturist developed the concept for the 1st time as reported. In India, the concept was led by Mr. Subhash Palekar. He considered natural farming as a substitute to 'green revolution'. He belongs to Maharashtra and completed his bachelor's degree in the field of agriculture. Hebelieves that the increasing cost of chemical fertilizers and pesticides is a major cause of debt and suicide among farmers in India. He tried to develop low input use technologies which can beprepared from on-farm resources, available with the farmers themselves. Therefore, he started the concept of Zero Budget Natural Farming (ZBNF). Under his guidance, 523,000 farmers in Andhra Pradesh and 1 lakh farmers in Karnataka have converted their farming practices into natural farming. Later, Mr. Palekar received 'Padma Shri' for his contribution in the field of natural farming. Natural Farming practices improve soil bulk density, pH, electrical conductivity, urease activity, nitrate reductase activity etc.

Zero budget natural farming (ZBNF)

The word 'zero budget' mean no credit or no expenses. It refers toadopting farming practices without spending any expenditure on chemical fertilizers and pesticides. Briefly stating, natural farming, is a technique of chemical input-free agriculture portrayingits roots from traditional Indian agricultural practices. Scientifically, natural farming reveals the synergistic effect of both plant and animal products on crop establishment, to sustain soil fertility and microbial population.

The concept of ZBNFfocuses on four pillars mainly: jeevamrith, bijamrith, mulching, and soil aeration. These four pillarsof ZBNF help to sustain soil overall health, increase soil microbial population, and thus, enhanced crop yield. Further, speaking about pest management, there are also different astras used to control pest infestation in natural farming. In this chapter wewould discuss hownatural farming is important to sustain soil health by maintaining healthy microbial population in soil.

Zero budget natural farming (ZBNF) is a farming practice that involves adoption of chemical-free agricultural methods without incurring any expenses or taking credit. Essentially, ZBNF is a form of natural farming that draws on traditional Indian agricultural practices. This method of farming has been scientifically shown to reveal the synergistic effect of using both plant and animal products to sustain soi fertility and microbial population.

ZBNF is based on four pillars: jeevamrith, bijamrith, mulching, and soil aeration. These pillars help to sustain soil health, increase microbial population, and ultimately enhance crop yield. In addition, various astras are used in natural farming to control pest infestations.

Maintaining a healthy microbial population in the soil is crucial for sustaining soil health, and this is where natural farming plays a vital role. By avoiding the use of chemical fertilizers and pesticides, natural farming ensures that the soil is not damaged, and the micro organisms in the soil can thrive well.

Organic farming and natural farming

1. Organic farming practices can be expensive for many farmers in India due to requirement of bulk manures and biofertilizers in large quantities, whereas natural farming is an extremely low-cost farming method where farmers can produce their inputs in their own field.
2. Organic farming requires the basic agricultural operations viz. ploughing, tillage, weeding etc. whereas zero budget natural farming is free of these operations. Instead, growing of intercrops, crop rotation, mixed crop, mulching is some of the preferred activities.
3. Organic farming includes incorporation of organic products like vermicompost's, composts, FYM etc. which are added to crop field from external sources. Whereas, in natural farming decomposition of crop residues work as organic matter, enhancing soil microbial and indigenous earthworm population in soil, completely enriching with local biodiversity, which in turn gradually release nutrients to soil.
4. Vermicomposting is a component of organic farming can enhance soil physical, chemical and biological properties. But, Mr. Palekar does not support the concept of vermicomposting, as the worms like '*Eisenia foetida'* commonly called as European red wiggler was introduced to India from another place. These worms are reported to absorb toxic metals and pollute ground water and soil.

How does zero budget natural farming works?

As mentioned earlier, ZBNF works on four basic pillars are explained below:

1. Bijamrita: The seeds are treated with formulations prepared using cow dung and cow urine from native cow species. The native cow spp. has higher adaptability to our local climatic conditions and are easy to maintain by the small and

marginal farmers. Further, water, lime, and a hand full of soil are used in the concoction. This formulation is used for seed treatment. It contains soil beneficial microorganisms. Inoculating seeds with with bijamrith also helps to protect the seedling roots from soil and seed-borne diseases. It also aids in production of IAA.

2. Jivamrita/Jeevamrutha: Cow dung is a natural source which can be used to revive the fertility and nutrient value of soil. One gram of cow dung may have between 300 to 500 crore beneficial micro-organisms. These micro organisms assist in decomposing the biomass present in the soil and convert it into available/ready-to-use nutrients for crop.

Jivamrita is a mixture prepared by mixing of fresh cow dung, cow urine, jaggery, water and pulse flour. This culture is applied to soil as an alternative to chemical fertilizers. This mixture stimulates microbial activity in the rhizosphere. Micro organisms helps in the conversion of unavailable forms of plant nutrients to available form in root zone. The microbes present in jivamrita helps non-available form of nutrients to convert to dissolved available form when it is inoculated into the soil. It also has antagonistic properties i.e., biological control ofplant pathogens. Plant growth prompting rhizobacteria (PGPR), Phosphate Solubilizing Bacteria (PSB), arbuscular mycorrhizal fungi, Nitrogen-fixing bacteria- cyanobacteria etc. are some of the important microorganisms present in jivamrita.

3. Acchadana/Mulching: Mulching is the process of covering the top soil with crop wastes.Mulching of three types is followed in ZBNF viz. soil mulch, straw mulch, and live plant mulch. The growth of cover crops mighthelp to reduce weed infestation, increases water infiltration capacity of soil etc. Their root nodules help to fix atmospheric N into the soil which in turn provide N to crops. Retentionthe residues of these mulches, on the surface of soil accelerates microbial degradation of organic matter and liberation of available N by nitrification. Mulching procedure under ZBNF also supplies soil organic matter which contains various plant micro and macronutrients.

4. Whapasa aeration: Good aeration is required in the soil for plant growth and development. Whapasa refers toa micro environment where both water and air molecules are present in the soil. This micro environment is established by the use of the other three pillars of ZBNF.Due to the application of the two pillars of ZBNF viz., Jiwamrita and mulching, the soil aeration increases, thus improving humus content, and water holding capacity.

Again, in the field of natural farming, plant extractions are used to make various mixtures to controls the insect-pests of crops. The raw materials required are mainly- butter milk, cow dung, pepper powder, cow urine, neem seed and green chilli. few of the mixtures are: 1. Agriastra 2. Brahmastra and 3. Neemastra.

Can natural farming practices be claimed as advanced microbiology?

ZBNF is not simply a farming practice without the use of chemical fertilizers or externally produced organic fertilizers or pesticides. Rather it is an improved farming practice with the advantage of exploiting beneficial micro organisms which can enhance soil quality and soil health. It aims in the use of naturally and locally produced bio-inoculums instead of chemicals, which revives the soil microbiota thus improving soil health. Low fertilizer management is more favourable than using higher chemical fertilizers in determining the beneficial bacterial community structure to improve plant health and growth. This practice also increases the population of local earth worms and beneficial insects. Crops grown under natural farming practices harbours distinct root microbial population with Plant Growth-Promoting characters.

Plant Growth Promoting Rhizobacteria (PGPR)

The term “plant growth promoting bacteria” refers to a group of bacteria that colonize the roots of plants (rhizosphere) which has the capacity to enhance plant growth. Rhizosphere is the soil environment, where plant roots are available. It is a

zone of maximum microbial activity.

Importance of PGPR for sustaining soil and plant health

1. Nitrogen fixation

The atmospheric nitrogen is converted into plant available forms by the process of biological nitrogen fixation (BNF), which changes nitrogen to ammonia by nitrogen fixing microorganisms. Here, a complex enzyme system known as nitrogenase is used. BNF represents an economically beneficial and environmentally sound alternative to chemical fertilizers. Nitrogen fixing organisms are generally categorized as (a) symbiotic N2 fixing bacteria (family rhizobiaceae - which forms symbiotic relationship with leguminous plants (e.g. rhizobia) and non-leguminous trees (e.g. Frankia)) and (b) non-symbiotic (free living, associative) - cyanobacteria (Anabaena, Nostoc, *Azospirillum, Azotobacter, Gluconoacetobacter.*

2. Phosphate solubilization

Phosphate-solubilizing bacteria (PSB) are well-thought-out as promising biofertilizers because they can supply plants with available P from poorly available sources. Bacterial genera like *Azotobacter, Bacillus, Beijerinckia, Burkholderia, Enterobacter, Erwinia, Flavobacterium, Microbacterium, Pseudomonas, Rhizobium* and *Serratia* are the most significant phosphate-solubilizing bacteria. They can solubilise inorganic P and thus can enhance growth and yield of crop plants. Phosphate solubilizers associated with agricultural crops like potato, tomato and radish are *Azotobacter chroococcum, Bacillus circulans and Cladosporium herbarum, Bradyrhizobium japonicum, Enterobacter agglomerans, Pseudomonas chlororaphis and Pseudomonas putida*.

3. Production of Phyto-hormones

Plant hormones are chemical messengers that influence the plant's ability to react to its environment. These are naturally organic compounds that are effective at very low concentration and are mostly synthesized in certain parts of the plant and transported to another location. It influences processes like plant growth, differentiation, and development.Since these phyto-hormones stimulate or inhibit plant growth, they are also referred to as plant growth regulators,which are produced from PGPR. A few notable plant hormones such as auxins, ethylene, gibberellins, abscisic acid (ABA), and cytokinin's may well regulate plant growth and development.

4. Production of Siderophores

Siderophores are low molecular weight iron binding protein compounds involved in the process of chelating ferric iron (Fe3+,) from the environment. When Fe is limited, microbial siderophores provide plants with Fe, enhancing their growth. PGPR can enhance the plant-growth producing extracellular siderophores which allow control of several plant diseases by depriving the pathogen of iron nutrition, thus resulting in increased crop yield.

5. Production of Enzymes

PGPR can promote plant growth by controlling phytopathogenic agents, primarily by the production of metabolites contributing to the antibiosis and antifungal properties. This mechanism involves the production of hydrolytic enzymes, examples - chitinase and glucanase. Major fungal cell wall components are made up of chitin and beta-glucan, thus bacteria which produce chitinases and beta-glucanasescan inhibit fungal growth. The *Sinorhizobiumfredii* and *Pseudomonas fluorescens* produce chitinase and beta-glucanases and control the fusarium wilt produced by *Fusariumudum*.

Natural farming a approach of exploiting beneficial microbes for sustaining soil-planthealth

A higher abundance and greater diversity of the root micro organismsare found under nature farming conditions compared to soil where chemical fertilization is done. The application of chemical fertilizers and pesticides reduce the microbial diversity of some beneficial microbes, which are otherwise important for plant growth and health.

Some of the beneficial microbes found in soil where nature farming is practices are mentioned below:

1. Bradyrhizobum: It is known as PGPR and is able to fix atmospheric nitrogen.

2. Soil where nature farming is practiced is also enriched with the bacterial genera Betaproteobacteria - *Curvibacter* and *Piscinibacter*. Most Betaproteobacteria have been reported as PGPR.

3. Haliangium: It produces haliangicin as an antifungal compound that can inhibit the growth of a wide spectrum of fungi.

4. Fe - reducing bacteria: A greater abundance of iron-reducing bacteria, including the *Sideroxydans, Acidibacter* and *Anaeromyxobacter* genera, are found under soil where nature farming conditions is maintained.

5. Relatively greater abundances of *Curvibacter* and *Anaeromyxobacter*are found in soil where natural farming is practiced.

Culturable Bacteria Relatedwith Nature Farming Systems and their PGP Characteristics

1. Soil where natural farming is practised harbours bacterial isolates that have PGP traits and are able to promote rice growth under low nutrient conditions.

2. The genera *Pseudomonas, Bacillus*, and *Paenibacillus*are the most predominant groups found under nature farming eco-systems under Rice cultivation.Actually, Pseudomonas and Bacillus are also as the dominant genera found in soils where from organic farming is practiced.

3. Burkholderia, Bacillus and *Rhizobium* as the most dominant genera of diazotrophic bacterial isolated from naturally grown sugarcane crops.

4. The *Pseudomonas* genus were able to yield positive results in all the PGP tests conducted. These isolates possessed traits like IAA production; phosphorus solubilization and ammonia production. *Pseudomonas*are known to exhibit siderophore production and possess antifungal activity against fungal phytopathogens. *Pseudomonas* isolated from naturally managed maize crop, owned siderophore production activity and antifungal activity against *Ralstonia solanacearum.*

5. Isolates like*Bacillus, Paenibacillus* and *Lysinibacillus*, can exhibit IAA production activity which might aid in plant growth, viz. cell elongation and rooting.

*6. F. acidificum*can have a good P- and K-solubilizing capacity found in soils where natural farming is practiced. Phosphorus/potassium-solubilizing bacteria play a crucial role in converting insoluble phosphate/potassium into their soluble form for uptake by plant.

Beneficial microbes with respect to major crops

Plant Growth Promoting characters of micro organismsunder naturally cultivated Rice rhizosphere -Rice is one of the principal food crops in India. It is the basic food crop of the country's population. These soil microbes promote different growth parameters of rice seedlings. Soils enhanced with microbes through natural farming contributes a greater increase in rice seedling. Same is the case for enhancing the growth of various other crops, including sugarcane and vegetable crops. The production of biosurfactants by *P. koreensis* suppressed *Pythium ultimum* in tomato and *Phytophthora infestans* in potato.

Natural Farming Improves soil quality and alters Microbial Diversity in a Cabbage Field in Japan. Natural farming practices improves soil physical, chemical, and biological properties and leds to a distinct microbial population in soil. *Pedomicrobium* and *Solirubrobacter*, improves soil conditions in naturally managed ecosystem. Taken together, this study indicates NF beneficially alters the soil environment and ecosystem and could be regarded as an appropriate management for sustainable agricultural production.

Challenges to adopt ZBNF

1. Convincing the farmers who are already lying their faith on chemical fertilizers might get worried about the yield of the crops specially in the initial years of natural farming practices.

2. Disparity between demand and supply.

3. Shortage of desi cow among the present farming community.

4. Shortage of locally available seed varieties for cultivation.

Conclusion

Natural farming practices, including zero budget natural farming, is very important for the sustainability and resilience of agriculture. Natural farming practices have significant benefits for soil health and microbial activity, which are essential for healthy crop growth and long-term sustainability.

In addition to the benefits for soil health, natural farming practices also have positive impacts on the environment and human health. By avoiding the use of chemical fertilizers and pesticides, natural farming practices help reduce soil and water pollution. Further, the use of natural pest management methods using astras can help reduce the risk of harmful chemicals entering the food chain.It is very important that we continue to promote and support the adoption of these practices to ensure the long-term sustainability of agriculture and the health of human.

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