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Original Article

Pulse production system under natural farming- issues and management practices

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Abstract

Green revolution technology-led intensification of agriculture transformed India from food scarce to food surplus country. However, it also led to serious concern over national food security by adverse impacts on stagnation and decline in productivity of crops, soil degradation, poor soil health, biodiversity losses, resulting in reduced factor productivity and increasing production costs, leaving agriculture as an economically non-profitable enterprise. Sustainability of Indian agriculture is plagued with these ill-effects of Green revolution in India. Consequently, a large number of farmers falling into the debt trap, and distress in farming sector became extensive. In due course, Indian agriculture which may be benefitted by adopting natural and organic farming in those areas that are still not under modern high-intensive agriculture. The demand for organic food products is rising worldwide. The price of organic food products *vis-a-vis* conventional food is very high which makes it inaccessible to low income population. For successful crop production under organic farming a large quantity of FYM/organic fertilizers and costly certification processes makes it impossible for small farmers to adopt it.

Key words: Pulse Production, Natural Farming, Organic farming

Introduction

Natural Farming or Zero Budget Natural Farming is a farm practice addressing major concerns of farmers of the rising cost of production/cultivation. Contrastingly, Natural Farming (NF) is a unique that is considered to be an agroecology-based diversified farming system, which integrates crops, trees and livestock, allowing functional biodiversity (LVC, 2010; Rosset and Martinez-Torres, 2012). Natural farming is a chemical-free farming method and envisages ecological or regenerative agriculture approaches under which the application of any kind of chemicals to soil biosystems is prohibited. It relies more on soil biology than soil chemistry by encouraging multicropping, round-the-year soil cover, the addition of formulation made up of cow dung and urine to trigger the microorganisms in the soil system. It integrates crops, trees and livestock, allowing functional biodiversity (LVC, 2010; Rosset and Martinez-Torres, 2012). Zero Budget Natural Farming (ZBNF) was originally promoted by an agriculturist and agriculture graduate Sh. Subhash Palekar (Padma Shri awardee) in the mid-1990s (Khadse *et. al.,* 2017; Mishra, 2018; Niyogi, 2018; Economic Survey, 2019). It is considered to drastically cut down production costs by replacing the chemical fertilizers and pesticides with home-grown products like Jeevamritha, Beejamritha, Neemastra, etc, and adopting intercropping and mulching (Palekar, 2005). According to him, the method requires only one indigenous cow for 30 acres of land. It is also promote soil health, improves soil organic carbon even without the need of adding a huge quantity of FYM (farmyard manure) as in the case of organic farming and thus help in attaining sustainable agriculture with the reduced carbon footprint. Natural Farming may not be yield enhancing but helped in improving farmers' income by reducing cost of cultivation, and attracting better product price. Thousands of farmers across the states in India are using one or other components of the NF practices. According to NITI Aayog largest expansion of ZBNF is in Andhra Pradesh, Karnataka is the first adopted state and Maharashtra is the State with maximum farm distress reported. Zero Budget Natural Farming (ZBNF) is one of the alternative farming practices for improving the farmers' income, in the backdrop of declining fertilizer response and farm income (Economic Survey, 2019). Replacing the chemical fertilizers and pesticides with home-grown products like Jeevamritha, Beejamritha, Neemastra, etc, and adopting intercropping and mulching not only meet the requirements of crops but also result in improved crop yield and soil fertility and minimization of the incidence of insect-pests and diseases especially in pulses.

Sh. Subhash Palekar, conducts training programmes for the farmers at different locations in different parts of the country and suggests following:

- Since nothing to be purchased from the market under ZBNF practices, the production cost becomes zero. Therefore, it is named as 'Zero Budget'.
- Green Revolution technologies like chemical fertilizers and pesticides have destroyed these micro-organisms in the soil system.
- All the needed nutrients are available in the soil, but in unavailable form. These can be converted into available form by the microorganisms, which are available in plenty in the indigenous cow dung and uncultivated soil.
- One gram of cow dung contains about 300 to 500 crore beneficial microbes, thus Jeevamritha acts as culture.
- Only dung of local cow is effective. One can mix half cow dung and half the dung of bullock or buffalo, but not of Jersey or Holstein at any cost.
- For one-acre land, only 10 kg/month of cow dung is sufficient. Therefore, a farmer can cultivate 30 acres of land with only one indigenous cow.
- The micro-organisms available in cow dung decompose the dried biomass (mulch) on the soil and make the nutrients available to the plants. It also increases earthworm population in the field.
- Thus, Jeevamritha is perfect and complete solution for crop cultivation. There is no need to add FYM in bulk quantity.
- Organic farming is not suitable for poor Indian farmers, as it requires huge quantity of FYM, making their agriculture unremunerative. Besides, the worms *Eisenia foetida* used in vermi-composting convert considerable amounts of heavy metals into bio-available form, and the roots absorb these poisonous heavy metals which ultimately enter into the human food chain.

  Source: http://www.palekarzerobudgetspiritualfarming.org/zbnf.aspx

Soils contain more carbon than plants and the atmosphere combined. Losing carbon-rich organic matter from soils releases carbon dioxide (a greenhouse gas) causes global warming. By regenerating soils, we can sequester more carbon into the soil and reduce the risk of global warming. Cover crops take carbon out of the atmosphere as they grow and funnel it into the soil and are left to decompose and contribute to soil formation. While plants are the source of carbon for soils, microbes control its fate by using it as food, thus ensuring that at least some of it will remain in the soil (Wallenstein, 2017). Thus, it is believed that ZBNF or Natural Farming is based on the above hypothesis. With different interventions under it adding microbes, adding cover crop, minimum tillage, multi-cropping, etc. it helps in soil regeneration and ultimately would lead to sustainable agricultural growth.

Role of pulses in sustainable crop production

Pulses represent an important component of the human diet in several areas of the world, especially in the developing countries like in the diets of the Indian population where they complement the lack of proteins from cereals, roots, and tubers. Pulses have its economical and nutritional value and a wide variety of pulses grown globally. In some regions of the world, pulses are the only protein supply in the diet. It is also an important component of livestock in the form of palatable feed and fodder. Biological nitrogen fixation, carbon sequestration, soil amelioration, low water requirement and capacity to withstand harsh climate, pulses remain an essential component of sustainable production system, especially under rainfed areas are the some unique characteristics of pulses. Its adaptability to low-input management conditions makes opportunities for crop diversification and intensification especially in areas where Green revolution left various problems related to sustainability (Singh *et al*., 2005). Major pulses are largely cultivated under rainfed and monsoon dependent areas where soil moisture is the critical factor determining the productivity. The major constraints to realization of potential yield of pulses include biotic and abiotic stresses prevalent in the pulse growing areas besides socio-economic factors. Inclusion of pulse in cereal-based cropping system may enhance the sustainability of the system by improving soil health (Babu *et al*., 2016).

Constraints in pulses production in India

There are number of constraints in production of pulses in the country. Lack of quality seed supply and less or negligible pulse processing and storage facilities are available. Pulses are less remunerative crops than other crops and also lack of awareness among the farmers about the benefits of pulses. Therefore, farmers are not ready to grow pulse crops. Most of the pulses are cultivated on marginal soils of low fertility. They are also frequently affected by environmental vagaries. Low adoption of scientific production technologies by the farmers. Flower drop and poor

seed set due to heavy rainfall is common in some pulses. Late-sown urd bean is often affected by low temperature and moisture stress.

Comparison among chemical, organic and natural farming

Sr. No.	Farming practices	Specific inputs uses	Merits	Demerits
1	Organic Farming	• Farm Yard Manure (FYM) • Vermicomposting • Bio-fertilizers • Panchagavya • HYV/Hybrid seeds • Biological pest and diseases management	• Chemical free • Eco friendly • Assured market for contract farmers • Premium price	• Huge quantity of FYM • Yield reduction during conversion period • Stringent procedure • Expensive for consumers
2	Natural Farming	• Indigenous cow centric • Jeevamritha and FYM • Ghanajeevamritha • Beejamritha • Mulching • Inter/mixed/poly crops • Local cultivars seeds • Home made materials (Kasayams) for pests and diseases control- *Agneyastra*, *Neemastra* etc.	• Regular and better farm income from intercrop • Lower production cost • Less use of FYM/Inputs • Improved family health-non-use of pesticides and food diversity • Improved soil health • Chemical free produce	• Need of indigenous cow dung and urine • Possibility of lower yield • Cumbersome practices • More farm engagement • No established market certification
3	Chemical farming	• Synthetic fertilizers • Farm Yard Manure • Chemical pesticides, herbicides • HYV/Hybrid seeds • Heavy irrigation • Intensive tillage and farm mechanization • Mono-cropping system	• High yield potential • Convenience in farming • Less price for customers • Easy input availability • Well established market	• Rising cost of production • Health hazard for farmers and consumers both • Unsustainable system • Loss of biodiversity • Pests resurgence

Subhash Palekar's Approach of ZBNF/NF

The main aims of Zero Budget Natural Farming/natural farming are to improve soil physical, chemical and biological properties by adding microbe inoculants and organic matter. It includes the addition of microbial cultures to enhance decomposition and nutrient recycling, integration of crops, trees and livestock (mainly cows of native breeds), use of local seeds, effective spacing of crops, agronomic measures to conserve water, intensive mulching, extensive intercropping and crop rotations. Mulching has positive effect on SOC content due to enhanced soil and water conservation, lower average and maximum soil temperatures under mulch than in unmulched soil surface, return of biomass to the soil, increase in soil biodiversity, and strengthening of the nutrient cycling mechanisms (Lal and Kimble, 2000).

Components of ZBNF/NF

According to Subhash Palekar, the ZBNF/NF has following 4 essential components

Sr. No.	Components	Description
1	Jeevamritha	Ensuring soil fertility through cow urine, cow dung, undisturbed soil, pulses flour & jaggery concoction
2	Beejamritha	Seed treatment with cow dung, urine and lime based formulations
3	Acchadana - Mulching	Using polycropping and different mulches with trees, crop biomass to conserve soil moisture & adding organic carbon
4	Whaspa	Water vapour condensation through activating available

		earthworms

Detail descriptions of the four major components of ZBNF/NF are as under

1. **Jeevamritha:** It is a fermented microbial culture which provides nutrients and acts as a catalytic agent that promotes the activity of microorganisms in the soil, and also increases the population of native earthworms.

***Preparation of Jeevamritha*:** Following materials are used for preparation of Jeevamritha

- Take 200 litres of water in a barrel
- Add 10 Kg fresh local cow dung (Desi cow dung only)
- Add 5 to 10 liters aged cow urine
- Add 2 Kg of Jaggery (a local type of brown sugar)
- Add 2 Kg of pulses flour (besan) and
- Add a handful of soil from the bund of the farm.

Stir the solution well and keep in the shade for 48 hours for fermentation. After 48 hours Jeevamritha is ready for application. During the fermentation process, the aerobic and anaerobic bacteria present in the cow dung and urine multiply as they eat up organic ingredients (like pulse flour and jaggery). A handful of undisturbed soil acts as inoculate of native species of microbes and organisms. Jeevamritha also helps to prevent the crop from fungal and bacterial diseases.

Application: The 200 litres of fermented Jeevamritha is sufficient for one acre of land. It should be applied to the crops twice a month with the irrigation water or as 10% foliar spray. The preparation is stored up to a maximum of 15 days. In Maharashtra, majority of the sample farmers are applying Jeevamritha through drip irrigation method.

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

***Preparation method of beejamritha*:** Mix local cow dung (considered to be natural fungicide) and cow urine (as anti-bacterial liquid), lime and soil. The cow dung is tied in a cloth and is kept in urine for about 12 hours. The dung is removed from cow urine, cow dung is squeezed and urine is added with about 50 grams of lime.

Application: It is used as a seed treatment. Add beejamritha to the seeds of any crop, coat them, mixing by hand, dry them well and use them for sowing. For leguminous seeds, just dip them quickly and let them dry.

3. **Acchadana-Mulching:** Generally, three types of mulching have been suggested under ZBNF i.e. soil mulch, straw mulch and live mulch:

   a. Soil Mulch: Soil mulch protects topsoil during cultivation and does not destroy it by tilling. It promotes aeration and water retention in the soil. Therefore, deep ploughing should be avoided in NF.

   b. Straw Mulch: Dry crop residue or waste of previous crops usually used as straw mulch. These organic materials will decompose and form humus through the activity of the soil biota which is activated by microbial cultures.

   c. Live Mulch: To supply all essential elements to the soil and crops, it is essential to develop multiple cropping patterns of monocotyledons and dicotyledons. Pulses are nitrogen-fixing plants and supply nitrogen to the soil and cereals such as rice and wheat supply other elements like potash, phosphate and sulphur.

4. **Whapasa-moisture:** ZBNF does not over-reliance on irrigation in green revolution farming. Whapasa is the condition where there are both air molecules and water molecules present in the soil. Thus, irrigating only at noon, in alternate furrows, may fulfill the moisture requirement of the crops, a significant decline in the need for irrigation in ZBNF. However, this practice is not followed by farmers.

Pest control solutions

According to the farmers who adopted ZBNF, when chemical fertilizers are applied to the crops, the vegetative growth of the crop is very good and lush green. This attracts the insects/ pests to the crops. When use Jeevamritha, the leaves colour is not that much green, limited pests are observed. However, when infestation occurs, the farmers prepare different types of formulations called Kashayam made up of locally available plant materials to control the pests. Some of these are:

1. Neemastra: Neemastra is prepared by the farmers and is the most commonly used for pest control. It is prepared by cow dung, cow urine, neem leaves, and water. For neemastra, the neem leaves are grinded into paste and added with water and directly applied to plants without any further dilution. For this, 5 kg of neem paste is added with around 2-3kg of dung, 10-20 litres of cow urine, handful of soil. The solution is fermented for about 48 hours.

2. Brahmastra: It is prepared from five types of bitter leaves such as neem, custard apples and chilli etc. Neem leaves are used along with the other bitter-tasting leaves. For this around 20-30

litres of cow urine is boiled for about 2-3 hours. The solution is cooled for about 12 hours and is filtered using fine cloths. The solution is further diluted with about 15 litres of water for every 1 litre of Brahamastra.

3. Agniastra: It is prepared by adding 5 kg of neem paste with 1 kg of tobacco leaves, 0.5 kg of chillies and 0.5 kilo of garlic paste and further added in about 25-30 litres of cow urine and is cooled down for about 24 hours. The solution is then filtered and used. The solution is diluted before applying in the field for every half litre of Agniastra about 15 litres of water is added. Agniastra is considered to be effective against insects like Leaf Roller, Stem Borer, Fruit borer, Pod borer. The pest controlling solutions were also made available to the farmers at NPM (Nutrients Pest management) shops in Andhra Pradesh.

4. Tutikada rasam: It is prepared from datura leaves and cow urine. The leaves are boiled in cow urine for 2-3 hours and is cooled then it is filtered using a cloth.

5. Dashparini Kashyam: Dashparini means ten leaves and is prepared from ten types of plant leaves. The leaves of Neem, *Agele marmelos*, Calotropis, *Senna auriculata*, Papaya, Custard apple, Gauva, *Vitex negundo*, castor, Pomegranate, Nerium, Ocimum, *Aloe vera*, Tobacco, Datura, *Lantana camara* and *Pongamia pinnata* are used in preparing the solution. Green chilli and garlic are also crushed and added and mixed with 20 litres of cow urine. It is kept up to 45 days for fermentation. The solution is filtered and sprayed after dilution. In about 8-10 litres of solution 100 litres of water is added for dilution.

Conclusion

Natural farming or Zero budget natural farming replaces the chemical fertilizers and pesticides with home-grown products and provides food security with least negative impacts on the environment. It also offers solutions for sound rural development, provides healthy food and employment opportunities to the resources-poor farmers of India. There is an urgent need to specify the various approaches for growing of pulses under natural farming condition to reduce the risk of the resource-poor farmers in the country. The crop yield in natural farming (NF) is not higher as compared to conventional farming. However, when supplemented with FYM/Ghanajeevamritha, crop yield improved significantly. It was also evident that there is substantial reduction in input cost in NF as compared to non-NF due to non-use of expensive agro-chemicals and external inputs resulted into better profitability (B:C ratio) for NF farmers. Thus, Natural Farming may not be considered as yield enhancing farming practices, but definitely increases farmers' income through reduction of cost of cultivation.

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