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Natural Farming to Boost Soil Fertility and to Manage Diseases and Pests for Sustainable crop productivity

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ABSTRACT

Natural farming adopts the philosophy of "work in harmony with nature" which prohibits the use of synthetic fertilizers, pesticides and other agrochemicals with aim to enhance soil fertility, manage diseases and insect pests through natural processes and ecological relationships. It encourages intercropping pattern, round-the-year soil cover, use of fermented products for land application viz. Bijamrita, Jeevamrita, Ghanajeevamrita for improving soil fertility and crop productivity. Furthermore, Neemastra, Agneyastra and Brahmastra also act as natural pesticide to control all sucking pests and diseases in plants. This type of farming utilizes natural inputs with zero cost of production and hence popularly known as "Zero Budget Natural Farming". Natural farming practice has been encouraged under Vikshit Krishi Sankalp Abhiyaan with the potential to make doubling of farmers' income. Therefore, stringent package of practice for natural farming to improve crop production should be developed and popularized among the farmers.

Key words: Natural Farming; Soil fertility; Pest and Disease management; Bijamrit; Jeevamrit

INTRODUCTION

Natural farming can be defined as "chemical free and livestock-based farming". It is a diversified farming system that integrates crops, trees, livestock and allowing the optimum use of functional biodiversity. Natural farming holds the promise of enhancing farmers' income while delivering many other benefits, such as restoration of soil fertility, environmental health and mitigating and/or reducing greenhouse gas emissions. Moreover, natural farming discourages the environmental exposure to pesticides and chemicals whereas it supports animal health or wellbeing. Natural farming builds on natural or ecological processes that exist in or around farms through recycling of on-farm generated biomass. Therefore, this farming practice promotes '*Bharatiya Prakritik Krishi Paddhati*' (BPKP) under the centrally sponsored scheme Paramparagat Krishi Vikas

Yojana (PKVY). BPKP aims at promoting traditional indigenous practices, which are largely based up-on on-farm biomass recycling with an emphasis on mulching and use of cow dung and urine formulations to enhance soil health and farm productivity. The dynamic movements of microbial matter repair the soil by replenishing nutrients, that was already lost with the chemical fertilizers. Natural farming is also popularly known as Zero Budget Natural Farming (ZBNF) eliminating the cost of production including the fertilizers, herbicides, insecticides and fungicides. The BPKP has been adopted in several state of India including Andhra Pradesh, Tamil Nadu, Kerla. Odisha, Chhattisgarh, Himachal Pradesh, Gujarat, Uttar Pradesh and Madhya Pradesh where the evidences of effectiveness of natural farming have been realized in terms of increase in production, sustainability, water conservation, improvement in soil health and farmland ecosystem. Therefore, natural farming is also considered as a cost-effective farming practice with scope for raising employment and rural development with no or minimal cost.

Pillars of Natural Farming

Non-judicious use of chemical fertilizers, agricultural residues burning and pesticide application deplete soil fertility, and reduce the ecological and faunal microbial diversity. Natural farming is an ecological farming approach which restores and promotes soil and environmental health using the natural inputs from indigenous cows which stimulates the growth of beneficial microorganisms and thereby, increases the soil enzymatic activities and microbial biomass. The natural farming is based upon the four principles or pillars viz. Bijamrita, Jeevamrita, Mulching/Acchadana and Waaphasa. Currently, this whole principle of natural farming is based on desi cow (*Bos indicus*) which plays a pivotal role for the supply of all the natural inputs used under natural farming. Moreover, the combinations of agro-forestry, intercropping, and microbial inoculation also enhance the activity of native soil micro-biota.

- **Bijamrita:** It is a mixture of cow dung, lime (Chuna), cow urine and soil. It is used as a seed treatment where the microbial seed coating through cow urine and dung formulations eliminates the soil-borne and seed-borne diseases to protect the young seedlings in the soil.
- **Jeevamrita:** Jeevamrita is a fermented organic manure produced from cow dung, cow urine, Jaggery, gram flour and soil, which is commonly used as soil microbial enhancer to increase the soil microbial activity and mineralize soil nutrients. It is a rich source of food for bacteria, fungi, actinomycetes other beneficial microorganisms which promote soil health through microbial fermentation and make the availability of macronutrients and micronutrients needed for plant growth.
- **Achhadana or mulching**: Use of mulching is defined as covering of soil surface using both live crops and straw (dead plant biomass) to conserve moisture, lower soil temperature around plant roots, prevent soil erosion, reduce runoff and reduce weed growth. Live mulching is practiced by developing multi-cropping/inter cropping patterns of short durational crops in the rows of a main crop. It is suggested that the pattern should be of monocotyledons and dicotyledons in the same field, in order to provide all the essential nutrients. Monocots, like wheat and rice, supply nutrients such as potash, phosphate and sulphur, while dicots such as pulses provide nitrogen in soil for plants nutrition. The major advantage of mulching is retaining

of the soil moisture and controlling weed population. Mulching will also help the earthworms to bring more porosity and minerals available to the surface of soil. Mulching is also crucial to retain the optimal temperature (25-32°C) and moisture (65-72%) for stimulating microbial population and activity in the soil and reduce the irrigation requirements.

- **Waaphasa** is soil aeration method which is required to maintain the moisture-air balance and soil structure. Adopting whapasa is the most important methodology of natural farming. There is formation of monoclimate due to waaphasa which creates a balance of air and water molecules. It increases water availability, enhances water-use efficiency and builds resilience against drought.

Benefits of Natural Farming:

The benefits of natural farming are soil health improvement, water conservation, biodiversity conservation and climate change mitigation. The ecological intensification of natural farming will provide better cycling and recycling of nutrients for a positive nutrient balance in the soil. The significant benefits of natural farming are depicted as follows.

- Minimizes cost of production: Natural farming focuses on intercropping, multi-cropping and crop diversification. Cow dung and urine-based formulations are used for maintaining soil fertility which significantly reduce the high cost of chemical fertilizers and pesticides inputs. Therefore, it is considered as a cost-effective farming practice with better farm productivity.
- Nutrient and soil fertility management: Natural farming does not use any synthetic chemicals, instead of which it uses the natural inputs which encourages the soil carbon content and also make the easy availability of soil nutrients to the plants. Application of ghanjeevamrit + jeevamrit + mulching in wheat + gram intercropping system with alternate row under zero budget natural farming produced significantly highest available nitrogen (275 kg/ha) and NPK content and uptake, viable microbial count {bacterial (28.3 106 cfu/g soil), actinomycetes (22.0 105 cfu/g soil), fungi (8.5 103 cfu/g soil)} and highest seed yield {wheat (1767.3 kg/ha), gram (734.1 kg/ha)}. Moreover, the food has higher nutrition density and offers better health benefits.
- Disease and Insect Pest management: The primary strategy under natural farming is to control pests and diseases in crops. Neem leaves, butter milk, green chillies and garlic combined with cow dung and urine, popularly known as Neemastra, Brahmastra and Agneystra, are used as disease and pest control strategy.
- Soil and water conservation: The mulching and rain water harvesting play a key role to preserve soil moisture and reduce water requirements. The changes in soil structure with the help of organic carbon, no/low tillage and plant diversity are supporting plant growth under extreme situations like severe droughts, flood and cyclones.
- Environment conservation: It improves the soil quality, promotes agrobiodiversity and permits a more judicious usage of water with much smaller carbon and nitrogen footprints. It is expected that this kind of farming practice may reduce carbon foot print in the environment in due future.

- Livestock sustainability: The dairy farming has got a key role to promote natural farming practice in India. Cow dung contains 10,000 different species of micro-organisms such as bacteria, fungi and actinomycetes. When the cow dung is fermented with the cow urine, it triggers the multiplication of the population and activity of beneficial microorganisms. These microorganisms produce nutrients from organic carbon and make bioavailable in soil for plants. Therefore, the integration of livestock in the farming system plays an important role in natural farming in restoring the ecosystem. Moreover, natural farming not only improves soil fertility and productivity but also it provides profitable returns and health benefits to farmers.

Table 1. Products of natural farming for growth promotion of crop plants

S.No.	Components	Methods of preparation	Advantage
1	Bijamrit	Mixture of cow dung, lime (Chuna), cow urine, and soil 5 kg cow dung + 5 L cow urine + 50 gm lime (Chuna) + 20 L water + 250 gm soil)	• Bijamrit is a fermented microbial solution, with loads of plant-beneficial microbes, and is applied as seed treatment. The beneficial microbes would colonize the roots and increase the germination capacity of the seeds. • It is effective in protecting young roots from fungus. • The beneficial microbial biomass present in Bijamrit helps to improve seed germination, seed vigour and seed length.
2	Jeevamrit	Mixture of cow dung, cow urine, Jaggery, gram flour and soil (200 L water + 10 kg fresh cow dung + 10 L fresh cow urine + 2 kg Jaggery + 2 kg gram flour + 250 gm soil) Mix it daily for 5-10 minutes and store for 4 to 6 days Ready for application in the field @ 500 L per hectare	• Jeevamrtt acts as a bio stimulant by promoting the activity of microorganisms in the soil. • It acts like a primer for microbial activity and also increases the population of native earthworms. Earthworm helps to keep soil quality porous which has a higher water holding capacity. • Improves pH of the soil. • Reduces costs of chemical fertilizers.

3	Ghan jeevamrit	Mixture of gram flour, cow dung, Jaggery, cow urine and soil 100 kg cow dung + 1 kg Jaggery + 1 kg gram flour + 2L cow urine + 500 gm soil) Mix it properly. It is ready on 10th day to be applied the field @ 80 kg per acre	• Ghanjeevamrit is the solid form of Jeevmaritha, which is prepared in areas where water availability is scarce. • The farmers prepare Ghanajeevamritha during the off-season and the dried product is stored in gunny bags before applying in the field.
4	Panchagavya	A traditional product prepared by fermenting the cow urine, cow dung, milk, ghee and curd. 2L cow milk + 2L curd + 3L cow urine + 500 gm ghee + 5 kg cow dung + 500gm Jaggery in 3L water + 3L coconut water + 12 ripened bananas Mix 2.5 Kg of Panchagavya in 100 L water and apply in the crops.	• The addition of cow dung increases the mineral status of soil, enhances the resistance of plant against pests and diseases • It also stimulates plant growth and other beneficial activities such as sulphur oxidation and phosphorus solubilization. • This can also be applied as seed and seedling treatment. • Panchagavya offer a variety of micronutrients to the soil, promotes plant development, deters insect and aids in developing disease resistance among the plant.

Table 2. Products of natural farming for plant protection

S.No.	Components	Methods of preparation	Advantage
1	Neemastra	Crush 5 kg Neem leaves in 100L water, Mix with 5L cow urine and 1 kg cow dung Store it for two days and Neemastra is ready to use @ 100 L per acre land	• Neemastra should be applied as a prophylactic measure, at every 15 days or 20 days interval. • Neemstra prevents egg laying and egg hatching among the sucking insects. • Neemastra is highly effective targeting jassids, aphids, whiteflies and small caterpillars.

2	Agneyastra	Mixture of neem leaves, chilli, garlic, cow urine. Make a paste by adding 500gm of tobacco leaves, 500 gm chilli, 500 gm garlic and 5 kg neem leaves. Add 20 L cow urine and mix properly. Stir the mixture clockwise and cover it while boiling until foam comes. Remove from heat and allow it to cool in shade. Store it for two days and agneyastra is ready to use. Dilute 2.5 to 3L Agneyastra in 100L water to be used as foliar spray in the field. Face mask is necessary during the application.	• 6-8 litre agneyastra in 200 litres of water is useful for spraying in 1 hactare area • Agneyasta is successfully applied to control leaf roller, stem borer, fruit borer and pod borer. • Spray of agneyastra at 25ml/L in pre-kharif crop gave reduction of leaf jassid population up to 65.84%.
3	Brahmastra	Brahmastra is prepared from 10L cow urine + 3 kg neem leaves paste + 2 kg custard apple leaves paste + 2kg castor leaves paste + 2 kg datura leaves paste + 2 kg Bael leaves Boil the solution till it foams out and keep in a cool dry place for 48 hours without opening the lid. Dilute 2.5 to 3L Brahmastra in 100L water to be used as foliar spray in the field	• For application, dilute 6-8 litres of Brahmastra in 200 litres of water for foliar spraying on crops. • Brahmastra is effective against all sucking pests and caterpillars due to the release of alkaloids from the leaves.
4	Dashaparni ark	Dashparni ark, a potent botanical pesticide, is prepared using a blend of natural ingredients where	• Dashaparni ark is useful to control patato cut worm Agrotis ipsilon very effectively.

		'Dasha' means 'ten' and 'Parana' means plant or tree leaf. 200L water + 20L cow urine + 2 kg cow dung + 500 gm turmeric powder + 200 gm ginger paste + 10 gm asafoetida, stirring clockwise and cover overnight followed by mixing of 1 kg tobacco leaves paste + 2 kg hot green chili paste + 500 gm garlic paste and furthermore addition of pastes made from any of the ten types of bitter leaves listed below**. Complete preparation needs 30-40 days. The prepared dashparni ark (6-8L) should be diluted in 200 L of water for spraying.	• More than 50% fungal growth inhibition from *Aspergillus niger* and *Pythium aphanidermatum* is achieved by the application of dashaparni ark.

** Specified list: 3 kg of Neem leaves (*Azadirachta indica*), 2 kg of Karanja leaves (*Pongamia pinnata*), 2 kg of custard apple leaves of (*Annona sqamosa*), 2 kg of Castor leaves (*Ricinus communis*), 2 kg of Datura leaves (*Datura metel*), 2 kg of Crown flower Leaves (*Calatropis procera*), 2 kg of Chaste tree leaves (*Vitex negundo*), 2 kg of Thorn apple leaves (*Datura stramonium*), 2 kg of Karavira leaves (*Nerium indica*), 2 kg of Gudhal leaves (*Hibiscus rosa*), 2 kg of Mango leaves (*Mangifera indica*), 2 kg of common Lantana leaves (*Lantana camara*), 2 kg of Panewar seed leaves (*Casia tora*), 2 kg of Guava leaves (*Psidium guava*), 2 kg of Pomegranate leaves (*Punica granatum*), 2 kg of Drumstick leaves (*Moringa oleifera*), 2 kg of Coffee leaves of (*Coffea arabica*), 2 kg of Mahua Leaves (*Maduca indica*), 2 kg of Coco leaves (*Theobroma cacao*), 2 kg of Babul leaves (*Acacia nilotica*), 2 kg of Babchi leaves (*Psoralea corylifolia*), 2 kg of Bitter Gourd leaves (*Momordica charantia*)

Fig 1. Preparation of products of natural farming

Fig 2. Application of natural farming's products in rice and millets crops

Improvement of nutrients and health of soil

Current practice of use of imbalanced farm inputs with aim to improve soil fertility and plant nutrition along with ignorance about conservation of native biodiversity species are the major threats to sustainable farming systems. The intensive and non-judicious application of NPK fertilizers has reduced the soil organic carbon significantly. The National Institution for Transforming India (NITI) Aayog has also emphasized practicing 'natural farming' to motivate farmers to adopt non-chemical farming by encouraging the Bhartiya Prakritik Krishi Paddati (BPKP). Moreover, enhancing long-term soil productivity and maintaining soil health is a key provision of the natural farming. The successful application of Bilamrita, jeevamrita and acchadhana in crop production supplement the nutrients through organic manures and green manures for increased availability of nitrogen and organic carbon than the conventional farming system. The organic compound prepared using the technique of using cow dung, cow urine, jaggery, pulse flour, plant leaf, water, and soil has proved to multiply the number of soil microbes.

Diversifying crop rotations induce more efficient recovery and physiological conditions of soil. The cover crops help to cycle soil nutrients and biologically fix atmospheric nitrogen. Adoption of cropping system usually by combination of deep rooted and shallow rooted crops (Groundnut + Pigeon Pea), crops of different duration (Pigeon Pea and maize) and hosting natural predators (Cotton + Black gram/ Green Gram, Cow Pea host Spiders and beetles) maintain nutrition balance of soil. Green manuring, legume cover crop/ intercropping, multi cropping, effective crop rotations and recycling of organic farm generated plant biomass through composting or mulching should form the basis of nutrient management under the natural farming. Farm waste can also be used as mulch which is helpful in restricting rainwater overflow on uncovered soil. Mulching also prevents evaporation of moisture from the soil and it allows water to percolate into the soil. Therefore, this protects topsoil during cultivation.

Management of diseases and insect pest

Bijamrita is a concoction of cow dung, urine, soil, lime and water. It is applied in seeds to improve germination, establishment, growth and yield. Furthermore, it provides protection to the plants against detrimental pathogens and other seed borne/soil borne diseases. The pathogenic phytophthora is controlled by beneficial Trichoderma present in the Bijamrita. The jeevamrita is a fermented microbial culture stimulates the microbial activity in the soil and enhances nutrient availability for the plants, protects the crops against soil pathogens and increases the carbon content in the soil. Damping off rot and vascular wilt are managed by jeevamrita.

Neemastra is a concoction of neem leaves, cow dung and urine which can be applied as a foliar spray to combat mealy bugs, sucking pests, jassids, aphids, white fly and small caterpillars. Brahmastra is a blend of leaves of neem, custard apple, castor and datura in water and cow urine. Brahmastra is a potential biopesticide against sucking pests, pod borer and fruit borers. Agneyastra is a complete natural pesticide prepared from using cow urine, cow dung, neem leaves, chili peppers, garlic, and tobacco leaves which has well established insecticidal and fungicidal properties to combat pests and diseases in crops. Antibacterial property of Dashaparni ark is noticed against pathogens like *Proteus vulgaris* and *Staphylococcus aureus* infestation. Mulching practice enhances the activities of biocontrol agents and also increases the activities of certain enzymes like cellulase and chitinase that suppress the occurrence of diseases. This technique is beneficial for growing vegetables and fruits such as tomato and brinjal. The application of organic inputs like Neemastra, Agneyastra and Brahmastra in the plants releases ammonia, which is quite effective for the control of nematodes.

Issues Related to Natural Farming

The initial yield and profit under natural farming is low, but the yield will be increased gradually over the years. The issues and difficulties with natural farming are listed below.

- Many farmers lack the knowledge about principles and techniques involved in natural farming. Therefore, stringent package of natural farming practices to improve crop yield and production should be developed and popularized among the farmers. This needs more research validation of frequency and quantity of application of natural farming products for improving crop productivity
- Shifting from conventional to natural farming practices requires a transition period. During this time, farmers may experience yield fluctuations and financial challenges, which can deter widespread adoption. Therefore, it needs incentives to counteract the loss incurred due to natural farming.
- The road map is also to be developed for adoption of natural farming in different agro-ecological regions in the country using local agro-ecosystem resources.
- Natural farming is an approach highlighting the importance of indigenous cows so that synergistic effects can be achieved to build soil fertility. Establishment and functioning of goshala and gouthans will be helpful for bulk preparation of natural farming components and their wider distribution to the farmers.
- Strengthening the supply chain and creating market linkages is crucial for the success of natural farming. Now-a-days the natural farming products are in demand in urban areas, therefore with suitable marketing facility and commercialization will definitely increase the farmers income in our country.

It is worthful to start with a portion of land under natural farming and when the farmer realizes the importance of low input cost involved with better farm produce, then large-scale implementation of natural farming for sustainable food production will be practically attainable.

CONCLUSION

Natural farming may not be a substitute for conventional farming for large scale food production, rather it is an ecological based agricultural system with the potential to boost employment and rural development. It promotes crop diversification, no use of synthetic agro-inputs, mulching, minimal tillage with application farm made bio-cultures viz. Bijamrit as seed treatment, Jeevamrit and Ghanjeevamrit as soil application to improve the soil microflora and nutrient accessibility to the plants and thereby enable plant growth. Further, farm made bio pesticides like Neemastra, Brahmastra and Dashaparni ark have effective potentiality to control diseases and pests in crops. The practice of whapasa and mulching in natural farming helps to increase the humus content in soil, thus increasing the soil aeration and intern the soil moisture retention benefitting the crops growth without any stress. The cost of production is believed to be very minimal and reduced to zero with natural farming as the entire farming practice is based on natural on farm produces only. Therefore, the Government of India’s vision for Viksit Krishi Sankalp Abhiyaan could be successfully accomplished though natural farming with a stringent action plan for larger adoption of natural farming practices in different parts of the country and creation of vast awareness among farming community through schemes and capacity building programmes.