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NATURAL FARMING: IT'S ROLE IN PLANT DISEASE AND INSECT PEST MANAGEMENT - A REVIEW

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ABSTRACT

Agriculture is the vital perception of Aatmanirbhar Bharat. The food security we relish nowadays, necessity to be supported via sustainable and viable agencies for forth coming generations. Natural Farming has developed anaxleopinion of conversation a mid the agricultural scientists, government, farmers and numerous other informal groups involved in agriculture. This is predominantly due to the reason that there are two diametrically opposite conservatories of thought on this topic co-existing in the country. About scientists promptly discard the attitude of Natural Farming. On the other hand, its promoters are appealing the method to be a solution for all problems causing distress in Indian agriculture, especially for smallholders. Though, at the same time, it also opens new outlooks for research with many key researchable questions that need to be systematically investigated to understand the destiny, sustainability and long-term impact of Natural Farming. It was shown that enrichment of soil occurs through propagation of beneficial soil microbes. It encourages the natural symbiosis of soil micro flora and crop plants. Mulching can maximize the moisture content in the soil, forms the cover for the earthworms and minimizes the weed propagation. This review paper the concepts of natural farming in the context of its role in plant disease and insect pest management.

Key words : Botanicals, Diseases, Eco-friendly, Insect-pest, Integrated, Natural farming.

Introduction

Agroecological practices are gaining importance across the globe aiming to address the contemporary issues in agriculture especially for achieving the sustainability without affecting the ecosystems. In this endeavor, Government of India is focusing on various alternate options to make agriculture self-sustainable. Natural farming is one such avocation and it is gaining importance among the farmers. Natural Farming (Zero Budget Natural Farming, ZBNF) is a chemical free traditional farming method. It is considered as an agroecology based diversified farming system which integrates crops, trees and livestock with functional biodiversity. According to Niti Ayog, Natural farming is a system where the laws of nature are applied to agricultural practices. This method works along with the natural biodiversity of each farmed area, encouraging the complexity of living organisms both plants and animals that shape each particular ecosystem (An ecosystem is a geographic area where plants, animals and other organisms, as well as weather and landscape, work together to form a bubble of life) to thrive along with food plants. Natural Farming builds on natural or ecological processes that exist in or around farms.

Chemical farming (the practice where chemicals such as pesticides, herbicides, fungicides, insecticides and fertilizers are used in agriculture to control pests and disease or control and promote growth) is facing either reduced production or increased costs or both (Ayansina and Oso, 2006; Intawongse and Dean, 2006; Sreenivasa *et al.*, 2010; Singh *et al.*, 2011). Farming monocultures (the cultivation or growth of a single crop or organism

especially on agricultural or forest land. A crop or a population of a single kind of organism grown on land in monoculture. Growth consisting of a single crop, plant or organism, such as rice (*Oryza sativa* L.), wheat (*Triticum aestivum*) and cotton (*Gossypium hirsutam*) etc., repeated on the same land results in the depletion of topsoil (it is being depleted by heavy tillage, use of agrochemicals and deforestation, to name a few).

The less topsoil you have, the more the lower, less fertile soil is exposed. Topsoil is the type of soil that has minerals and organic matter that plants need to grow), soil vitality (using biological, physical and chemical soil measurements, the vitality index gives an overall score, which is a guide to the yield potential. A higher soil vitality score means the soil will be able to support higher crop yields. Microbial activity, healthy soil has a high level of microbial activity), ground water purity (the state of water that is located beneath Earth's surface. Ground water can gather in cracks in subsurface rocks and in between soil particles. Since, many compounds can dissolve in water and others can be suspended in water, there is a potential for contamination with toxic compounds) and beneficial microbes (naturally occurring bacteria, fungi and other microbes that play a crucial role in plant productivity and health. Two types of beneficial microorganisms, mycorrhizal fungi and nitrogen-fixing bacteria are considered beneficial to plant health). It is finally making the crop plants vulnerable (weak and easy to hurt physically or emotionally) to parasites (A *parasite* is an organism that lives on or in a host and gets its food from or at the expense of its host. *Parasites* can cause disease in humans) and pathogens (an organism causing disease to its host, with the severity of the disease symptoms referred to as virulence. Pathogens are taxonomically widely diverse and comprise viruses and bacteria as well as unicellular and multicellular eukaryotes).

Environmental pollution (the unfavourable alteration of our surroundings, wholly or largely as a by-product of man's actions, through direct or indirect effects of the changes in the energy pattern, radiation levels, and chemical and physical constitution and abundance of organisms) by chemical fertilizers (substances that are applied to soils or directly to plants in order to give nutrients that are optimal for their growth and development) and pesticides (*a chemical substance used to kill harmful insects, small animals, wild plants and other* unwanted organisms: The pesticides that farmers spray on their crops) is posing a serious threat (something unpleasant or violent will happen, especially if a particular action or order**)** Worldwide. Their continuous usage may destroy the beneficial soil micro flora (Microflora of soil is an integral part of soil organic matter. Soil bacteria and fungi are the start of the soil food web that supports other organisms. Bacteria constitute the most abundant groups of microorganisms in soil and the fungal population of soils constitutes a very heterogenous group of organisms (Doran *et al*., 1996; Jenkinson, 1982; Shaikh and Gachande, 2015). Nitrosamines the transformed products of nitrogen fertilizers (one of the most common types used to produce nitrogen in order to help plants flourish and grow strong. Common plant-based nitrogen sources include ammonium nitrates, urea, tetra amines and sodium nitrate or chloride) are dangerous ecological poisons (heavy metals found in water and food and other products (e.g. arsenic, lead and mercury), toxins found in homes or in building materials (*e.g.* asbestos, radon or volatile organic compounds) and air toxins found indoors or outside (*e.g.* carbon monoxide, cigarette smoke etc.).

Nitrosamines isolated from the soil exerted phytotoxic, mutagenic and carcinogenic effects (*a substance, organism or agent capable of causing cancer*) on plants, animals and humans (Byrnes, 1990; Barabasz *et al*., 2002). Intensive use of inorganic chemical fertilizers (manmade formulae that can be formulated for various speeds of release. Most common are urea, single super phosphate and murate of potash (NPK) and pesticides (substances that are meant to control pests or weeds) resulted in the contamination of soil surface and ground water with harmful chemicals (substances that can cause adverse health effects such as poisoning, breathing problems, skin rashes, allergic reactions, allergic sensitisation, cancer and other health problems from exposure). Many hazardous chemicals are also classified as dangerous goods and accumulation of heavy metals (disrupt metabolic functions in two ways: they accumulate and thereby disrupt function in vital organs and glands such as the heart, brain, kidneys, bone, liver, etc. They displace the vital nutritional minerals from their original place, thereby, hindering their biological function) (Colbourn and Thornton, 1978; Lena and Rao, 1997). Curiosity of heavy metals like Cd, Cu, Mn and Zn by plants is proportionate to the increasing level of soil contamination (Xian, 1989). People, who consume these plant products are at risk of adverse health effects (the causation, promotion, facilitation and/or exacerbation of a structural and/or functional abnormality, with the implication that the abnormality produced has the potential of lowering the quality of life, contributing to a disabling illness or leading to a premature death). Cadmium and lead are the elements of major concern due to their accumulation potential and toxic effects in the plants and

animals (Wolnik *et al*., 1983). Crops such as spinach, lettuce, carrot, radish and zucchini can accumulate heavy metals in their tissues (Sauerbeck, 1991; Hooda, 1997; Bahemuka and Mubofu, 1999; Cobb *et al*., 2000; Mattina *et al*., 2003; Hough *et al*., 2004).

The rhizosphere (*a diverse reservoir of culturable microorganisms that can be exploited to benefit mankind*, many rhizosphere microbes benefit crop) contains diverse microbes with beneficial effects on crop productivity. The plant growth promoting rhizobacteria (PGPR-*bacteria that colonize the roots of plants (rhizosphere) that enhance plant growth*), mycorrhiza (*a symbiotic association between a green plant and a fungus*. The plant makes organic molecules by photosynthesis and supplies them to the fungus) and cyanobacteria promote plant growth (cyanobacteria produce numerous secondary metabolites that can be useful for plants *e.g.* they can have growth promoting effects or increase resistance to plant diseases. The effects of biotic and abiotic stress as well be reduced by many secondary metabolites) and also protect them against pathogens (Glick, 1995). It was shown by (Ayansina and Oso, 2006), who commonly used herbicides atrazine and metolachlor decreased the microbial counts of the soil. Increased cost of production of crop lead to the suicides of the farmers in India. Monoculture of rice crop, commercial crops (which are very benefits and return the desired products for farmers which is grown for sale to return a profit are known as commercial crops. Examples are cotton, sugarcane, jute etc. The most important commercial crop of India is sugarcane) posed a threat to biodiversity and increased the scope for invading pathogens (the invading microbe or pathogen is called an antigen). It is regarded as a threat by the immune system (the immune system is a complex network of organs, cells and proteins that defends the body against infection, whilst protecting the body's own cells. The immune system keeps a record of every germ (microbe) it has ever defeated so it can recognise and destroy the microbe quickly if it enters the body again) and is capable of stimulating an immune response. Antigens are proteins that are found on the surface of the pathogen). Total annual losses in agriculture produce are given below in Fig. 1.

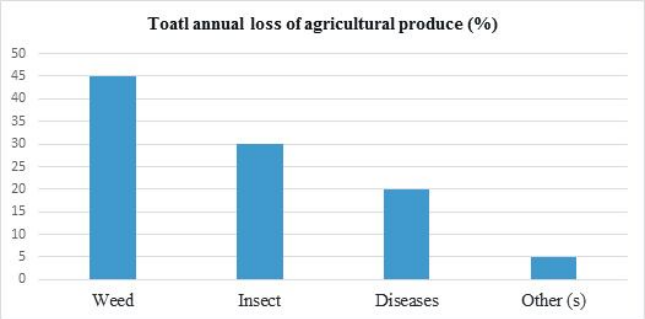

Fig. 1 : Crop yield losses due to pest infestation (Santosh Korav *et al*., 2020).

Natural farming

Way of life

India has a rich heritage of traditional farming practices which are environment friendly and less resource intensive. Vrikshayurveda also known as "*The Science of Plant Life*". VRIKSHAYURVEDA was systematically compiled by SURAPALA a *Royal Physician in the court of King* approximately 1000 years ago in the form of 325 Sanskrit slokas. The methods of plant health management, classification of plants physiology, plant diseases and disease management including pest control etc. are systematically explained in this book. However, due to the various factors including colonization, these practices were not prominent or in the front lines of Indian agriculture for a long period. The roots of natural farming practices currently practiced in India can be traced back to this ancient treatise.

Natural farming way of life is working with nature to produce healthy food to keep ourselves healthy and land healthy. Everything in nature is useful and serves a purpose in the web of life. Also termed 'Do Nothing Farming', because 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. Now, actual physical work and labour has been seen to reduce up to 80% compared to other farming systems. Natural farming differs from organic farming by not using any organic manure like farm yard manure and vermicomposting. In Japan, Fukuoka started Natural farming by experimenting with the Nature and following the natural ways of crop propagation (when plants grow and develop naturally without any human interference. Natural vegetative propagation can be enabled by the development of adventitious roots (plant roots that form from any non-root tissue and are produced both during normal development (crown roots on cereals and nodal roots on strawberry) and in response to stress conditions, such as flooding, nutrient deprivation and wounding). Thus, new plants may emerge from the roots, stem and leaves of the parent plant). He achieved yields similar to those of chemical farming, but without soil erosion (Fukuoka, 1978; Andow and Hidaka, 1998; Neera *et al*., 1992). The spirit of natural farming is minimizing the external inputs to the farm land, which degenerate the soil nature. At first, because there was no habitat for

many of the insects, he had to make natural insecticide like pyrethrum which comes from chrysanthemum roots and he had to spray that on his vegetables in order to keep pests like cabbage worm and cabbage moths away. When, we follow nature without destruction, nature takes care of us. Zero Budget Natural Farming is proposed by Shri Subash Palekar in India, with the same philosophy but with the indigenous supplements (Palekar, 2014). In ZBNF, soil is supplemented with the microbial inoculums like Beejamruth and Jeevamruth to accelerate the propagation of soil micro flora, beneficial to soil enrichment. Indigenous pesticide decoctions of leaves with cow urine Neemastram and Bramhastram etc., are introduced. The way of the natural farming is to nurture the growth of these beneficial microorganisms without using external manure and chemical pesticides.

Practice notillage : Annual tillage chemical fertilization and pesticide use consistently affect populations of earthworms. While, tillage is avoided, soil moisture content is increased, augment the propagation of earthworms. Earthworms are known to make the soil porous (the amount of pores or open space, between soil particles. Pore spaces may be formed due to the movement of roots, worms and insects; expanding gases trapped within these spaces by ground water; and/or the dissolution of the soil parent materials) and enrich the soil with their castings. Seeds are scattered and covered by straw before harvesting the previous crop. Seeds are germinated by the arrival of next favourable season (Palekar, 2016).

Mulching : Grain crops, healthy orchard trees are grown with a ground cover of vegetables, weeds and white clover. Mulching with straw improves soil moisture content and conducive to the growth of microorganisms and earthworms (Paoletti, 1999). It also improves seed germination without tillage. Growth of the covering plants like white clover holds back weeds effectively (Fukuoka, 1978). Growth of covering crops like legumes increases the nitrogen fixation in the soil. Harvesting weed before flowering and covering the open land reduces the area for the crop weed and improves the organic matter content in the soil. With this practice usage of herbicides can be avoided.

Beejamruth : Application of Beejamruth is followed in ZBNF. It is a seed treatment mixture prepared from cow dung, cow urine, lime and a handful of soil (Palekar, 2014). Naturally occurring beneficial microorganisms are found in cow dung (Swaminathan, 2007). These microorganisms are cultured in the form of Beejamruth and applied to the seeds as inoculum. It is reported that seed treatment with beejamruth protects the crop from harmful soil-borne pathogens (a disease-causing agent, which lives both in soil and in a plant host and which will tend to infect undiseased plants which are grown in that soil. Common soil borne pathogens include *Fusarium, Pythium, Rhizoctonia, Phytophthora, Verticillium, Rhizopus, Thielaviopsis* and nematodes including *Meloidogyne*) and also helpful in producing Indole Acetic Acid (IAA- *is an essential plant hormone produced by different types of soil borne bacteria e.g. Erwinia, Rhizomonas* and *Streptomyces*. Pathogens in the *Pseudomonas* and *Xanthomonas* groups usually persist in the soil for only a short time and among the different microbial groups) and Gibberellic Acid (GA-*a gibberellin found in both higher plants and fungi*, is commercially available for horticultural and home gardening uses) (Sreenivasa *et al.*, 2010).

Jeevamruth : Soil microorganisms play an active role in soil fertility as they involve in the cycle of nutrients like carbon and nitrogen, which are required for plant growth (Lazarovits, 1997). They are responsible for the decomposition of the organic matter entering the soil and therefore in the recycling of nutrients in soil. PGPR, cyanobacteria and mycorrhiza constitute soil microorganisms (Suslov, 1982; Kloepper, 1994). They participate in decomposition (the process by which dead organic substances are broken down into simpler organic or inorganic matter such as carbon dioxide, water, simple sugars and mineral salts), mineralization (the decomposition of the chemical compounds in organic matter, by which the nutrients in those compounds are released in soluble inorganic forms that may be available to plants. Mineralization is the opposite of immobilization) and nutrient supply to the plants. Phosphate solubilizing bacteria (PSB) and mycorrhizal fungi can also increase the availability of mineral nutrients (phosphorus) to plants (Katznelson *et al*., 1962; Raghu and MacRae, 1966; Khan and Bhatnagar, 1977; Rodriguez and Fraga, 1999). Nitrogen fixing bacteria can transform nitrogen in the atmosphere into soluble nitrogenous compounds useful for plant growth. These microorganisms, which improve the fertility status of the soil and contribute to plant growth. They may also show antagonism (biological control) to pathogens (Kloepper, 1993; Chen *et al*., 1995; Glick and Bashan, 1997). Soil is saturated with all the nutrients, but these are in the non available form to the roots of the plants. Beneficial micro-organisms in Jeewamruth convert the nutrients in non-available form into dissolved form, when it is inoculated to the soil. Jeewamruth is either sprayed/sprinkled on the crop field or added to the irrigation tank in regular interval of 15 days until the soil

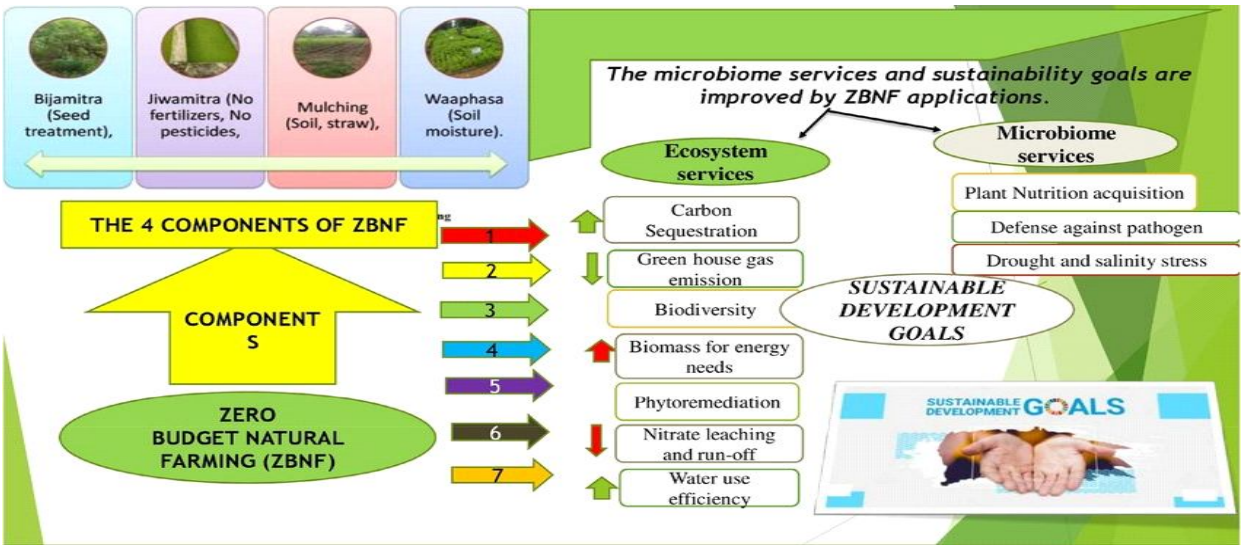

Fig. 2 : The different components of ZBNF (zero budget natural farming) directed towards theenhancement of microbiome services and sustainability goals (source: www.google.co.in)

is enriched.

Composition of Jeevamruth

Water 200 litre, cow dung 10 kg, cow urine 5-10 liter, Jaggary 1-2 kg, flour of the pulses 1 kg, a handful of soil. This mixture is well stirred for few days and sprayed on crop for every fortnightly.Application of Jeevamruth facilitated the growth of beneficial soil microorganisms and improved crop yield (Shaikh and Gachande, 2015; Nileema and Sreenivasa, 2011; Shubha, 2014).

Modules used in plant diseases and insect pest management

Neemastra : Neemastra is used to prevent or cure diseases and kill insects or larvae that eat plant foliage and suck plant sap (soft scales or coccidae feed on phloem sap and directly injure plants in much the same way as do aphids. Soft scales can be mobile as nymphs and adults until the female settles down and begins to produce eggs). This also helps in controlling the reproduction of harmful insects. Neemastra is very easy to prepare and is an effective pest repellent [a substance applied to the skin, clothing or other surfaces to discourage insects (and arthropods in general) from landing or climbing on that surface] and bio-insecticide for Natural Farming.

Inputs needed : 200 litre water, 2 kg cow dung, 10 litre cow urine, 10 kg fine paste of neem leaves.

Preparation of Neemastra

Phase 1 : Take 200 litre of water into a drum and add 10 litre of cow urine. Then add 2 kg of local cow dung. Next, add 10 kg of fine paste of neem leaves or 10 kg neem seed pulp.

Phase 2 : Then stir it clockwise with a long stick and cover it with a gunny bag. Keep it in shade as it should not be exposed to either sunlight or rainfall. Stir the solution every morning and evening in clockwise direction.

Phase 3 : After 48 hours, it is ready for use. It may be stored for use up to 6 months. It should not be diluted with water.

Phase 4 : Filter the prepared solution with a muslin cloth and apply directly on the crop through foliar spray.

Management : All the sucking pests, jassids, aphids, white fly and small caterpillars are controlled by Neemastra.

Brahmastra

This is a natural insecticide prepared from leaves which have specific alkaloids to repel pests. It controls all sucking pests and hidden caterpillars that are present in pods and fruits.

Inputs needed : 20 litre cow urine, 2 kg neem leaves, 2 kg karanj leaves, 2 kg custard apple leaves and 2 kg datura leaves.

Preparation of Brahmastra

Phase 1 : Take 20 litre of cow urine in a vessel and add 2 kg of fine paste of neem leaves, 2 kg of paste prepared from leaves of karanj, 2 kg paste of custard apple leaves, 2 kg paste of castor leaves and 2 kg paste of datura leaves into it.

Phase 2 : Boil it on a small flame, till one or two foams (overflow level). Stir in clockwise direction, then cover the vessel with a lid and keep on boiling it.

Phase 3 : After formation of second foam, stop boiling and allow it to cool for 48 hours so that the alkaloids present in the leaves are released into the urine. After 48

hours, filter solution using a muslin cloth and store it. It is better to store in pots (earthen pots) or plastic drums under shade. The solution may be stored for use up to 6 months.

Application : Dilute 6-8 litre of Brahmastra in 200 litre of water can be used as the foliar spray on the standing crop. This ratio may be changed depending upon the severity of pest attack as follows:

100 litres of water + 3 litres of Brahmastra

15 litres of water + 500 ml of Brahmastra

10 litres of water + 300 ml of Brahmastra

Agniastra

It is used to control all sucking pests and caterpillars.

Inputs needed : 20 litre cow urine, 2 kg pulp of neem leaves, 500 gm tobacco powder, 500 gm green chilli, 250 gm garlic paste and 200 gm turmeric powder.

Preparation of Agniastra

Phase 1 : Add 200 litre cow urine to a container. Then add 2 kg neem leaves paste, 500 gm tobacco powder, 500 gm green chilli paste, 250 gm garlic paste and 200 gm turmeric powder.

Phase 2 : Stir the solution in clockwise direction and cover it with a lid and allow it for boiling till we get foam.

Phase 3 : Remove from fire and keep the vessel under shade, away from direct sunlight for cooling up to 48 hours during this fermentation period stir the components twice a day.

Phase 4 : After 48 hours, filter with a thin muslin cloth and store it. It can be stored for 3 months.

Application : 6-8 litres of agniastra should be taken and diluted in 200 litres of water for spraying. The following ratio is to be followed based on the infestation of pest attack.

100 litres of water + 3 litres of agniastra

15 litres of water + 500 ml of agniastra

10 litres of water + 300 ml of agniastra

Dashaparni Ark or Kashaya

Dashaparni ark acts as substitute for Neemastra, Bramhastra and Agniastra. It is used to control all types of pests and used depending on the level of infestation.

Inputs needed : 200 litre water, 20 litre cow urine, 2 kg cow dung, 500 gm turmeric powder, 10 gm Asafoetida, 1 kg tobacco powder, 1 kg chilly pulp, 500 gm garlic paste, 200 gm of ginger paste, any 10 leaves.

Preparation of Dashparni

Phase 1 : Take 200 litres of water in a drum; add 20 litres of cow urine and 2 kg of cow dung. Mix it well and cover with the gunny bag and keep aside for 2 hours.

Phase 2 : Add 500 gram of turmeric powder, 200 gram of ginger paste, 10 grams of Asafoetida into the mixture. Mixing it well in the clockwise direction; cover with gunny bag and keep overnight.

Phase 3 : Next morning, add 1 kg of tobacco powder, 2 kg of hot green chilli paste and 500 gram of garlic paste and mixing it well with wooden stick in the clockwise direction, cover with gunny bag and leave for 24 hours under shade.

Phase 4 : Next morning, add paste of any 10 types of leaves.

Phase 5 : Stir thoroughly and cover with the gunny bag. Keep it for 30-40 days for fermentation so that the alkaloids present in the leaves will get dissolve in the mixture. Stir twice a day.

Phase 6 : Filter this after 40 days with a muslin cloth and use it.

Application : The prepared kashayam of 6-8 litres should be diluted in 200 litres of water for spraying.

Leaves of neem (*Azadirachta indica*) - 3 kg, leaves of Indian beech (*Pongamia pinnata*) - 2 kg, leaves of custard apple (*Annona sqamosa*) - 2 kg, leaves of castor (*Ricinus communis*) - 2 kg, leaves of datura (*Datura metel*)- 2 kg, leaves of giant milkweed (*Calatropis procera*) - 2 kg, leaves of chinese chaste tree (*Vitex negundo*) - 2 kg, leaves of (thorn apple) *Datura stramonium* - 2 kg, leaves of nerium (*Nerium indica*) - 2 kg, leaves of *rose of china* (*Hibiscus rosa-sinensis*) - 2 kg, leaves of mango (*Mangifera indica*) - 2 kg, leaves of lantana (*Lantana camara*) - 2 kg, leaves of *sickle senna* (*Casia tora*) - 2 kg, leaves of guava (*Psidium guava*) - 2 kg, leaves of pomegranate (*Punica granatum*) - 2 kg, leaves of drumstick (*Moringa oleifera*) -2 kg, leaves of coffee (*Coffeaarabica*) - 2 kg, leaves of mahua (*Maduca indica*) - 2 kg, leaves of coco (*Theobroma cacao*) - 2 kg, leaves of babul (*Acacia nilotica*) - 2 kg, leaves of babchi (*Psoralea corylifolia*) - 2 kg and leaves of bitter gourd (*Momordica charantia*) - 2 kg.

Fungicide

Fungicide prepared with cow milk and cow curd is found to be very effective in controlling the fungus.

Preparation : Take 3 litre milk and prepare curd from it. Remove the creamy layer and leave for 3 to 5 days till the formation of a grey layer of fungus. Churn it well, mix it with water and spray on infected crops after

filtering.

The universalethics that manage Natural farming are mentioned below:

- A healthy soil microbiome is critical for optimal soil health and plant health and thereby animal health and human health.
- Animals should be incorporated into farming. Integrated farming systems are critical for promoting Natural farming.
- Healthy soil microbiome is the key to retaining and enhancing soil organic matter. Bio stimulants are necessary to catalyze this process. There are different ways of making bio stimulants. In India, the most popular bio-stimulants are based on fermentation of animal dung and urine and uncontaminated soil.
- Increasing the amount and diversity of organic residues returned to the soil is very important. These include crop residues, cow-dung, compost etc.
- Minimal disturbance of soils is critical; hence no till farming or shallow tillage is recommended.
- Pest management should be done through better agronomic practices (as enshrined in Integrated Pest management) and through botanical pesticides (only when necessary).
- Soil may be covered with crops for maximum period of the year.
- The soil across a farm or larger field/collection of fields should have diverse crops, a minimum of 8 crops over the year. The greater the diversity, the better.
- Use of synthetic fertilizers and other biocides is harmful to this process of regeneration and is not allowed.

Conclusion

Natural farming is environmentally friendly. Savings on the cost of seeds, fertilizers and plant protection chemicals have been substantial. Because of continuous retention of crop residues replenishment, the soil fertility, it helps to maintain the soil health. Other thing is that management of pest and diseases is a key component in zero budget natural farming crop production systems. Successfully control pests in ZBNF, it is essential to understand the interactions of different components in a specific ecosystem. The new system of farming has free debt trap of farmers and it has instilled in them a renewed sense of confidence to make farming an economically viable venture. The challenges and opportunities are two parameters that show the systems lacunas to researchers, scientists and extension workers and benefits to adopters, and policy intervention is necessary to make success. However, these studies are in preliminary stage, several investigations need to be conducted to validate the benefits in all crops, efficacy of indigenous pesticides like Neemastram, Brahmastram etc., and the time needed for the enrichment of the polluted soil.

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Conflict of interest

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