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SUSTAINABLE AGRICULTURE - THE INDIAN WAY

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Abstract

If soil is dried so one ounce become one-quarter ounce,
Abundant yields will not require a single handful of fertilizer.

Thirukkural (Verse 1037)

The five natural elements (earth, water, fire, air, and sky), the sun and the moon, plants, trees, birds, and animals, came into existence much ahead of the human beings. In fact, man, as a part of nature, was the last creation in the universe. Though, we (human beings) have been created with the superlative degree of intellect, there is so much that can be learnt from nature; traditions of wisdom from the world teach us that a divine essence flows through all creations. Together with nature, man can co-create groundbreaking ideas that would help create wealth and well-being, for nature offers solutions for inclusive growth and sustainable development.

Food scarcity is the major issue concerning the developing countries these days; one out of every 8 person in the world goes to bed without food (FAO, 2012). Of the several hundred million hungry people in the world, 98 percent are in developing countries. There were several things done to alleviate this problem, but the consequences of those actions are even more costly. Usage of heavy machines, pesticides and chemical fertilisers in the soil created a lasting impact causing imbalance in ecosystem, degradation of soil, soil erosion and land degradation.

Natural farming is an ancient form of agriculture which follows the principles of nature to develop systems for raising crops, and livestock that are self-sustaining.

The present paper attempts to explicate the sustainable nature of natural farming, as against the quick fix solution agriculture of using fertilisers, and chemicals. This holistic learning outlook also tries to bring out the role of farm animals (and remain of farm animals, and farm produces), microorganisms in the soil, in creating food abundance, concerns about food loss and food wastage and its global impact.

Keywords: *Natural Farming, Inclusive growth, Sustainable Development, Ecosystem, Food Wastage*

Introduction

For centuries, human lived with nature and learnt a good deal about it for his sustenance. The knowledge he obtained from the plants and animals facilitated him to learn ways to approach them, and live with them. Even in this highly socialised and urbanised world, the behavior of plants, trees, birds and animals provide us a significant learning. The first instance of using animals, birds, plants and trees for the teaching-learning purpose is evident in '*Panchatantra*' written by Acharya Vishnu Sharma and the '*Jataka* tales', the Indian folktales that are infused with moralistic values.

Understanding the cognition, communication or the characteristics of nature might sound archetypal, but in its core, it can make man, an architect of the entire world, or if not, at least of his own. The instinctive and learned response of the animal and the plant kingdom encompasses their dynamic ability to adapt to various/ varying situations, reflex activities, directed movements or to frame action patterns.

Nature of the Nature

Being a part of the natural environment, the plants, birds and animals are linked to one another, and leaving behind one, in trying to understand the other, would not give a holistic understanding. The relationship between different species forms an integral part of ecology (the study of organisms and their interactions with the environment). The fundamental Law of Ecology ($L \geq C$) drives a crucial lesson to all constituents of the natural environment (i.e.) for any organism to survive, its rate of learning must be equal to or greater than the rate of change in its environment (Garrath, 1987).

Over the years, there has been a drastic change in the growth pace and dwelling pattern of the world. Though, its population

began in a small number, it is increasingly growing in the present scenario, and thus, bursting at the seams. The human population, which has seemingly outbalanced the overall living number on earth, uses/exploits nature to a great extent. Our habits have become unsustainable. Having touched the boundaries of natural tolerance, we are now hanging on to an important question, 'Can we realise such economic wealth creation to benefit all people while, at the same time preserve our planet?'

The answer to this question can be derived when we observe and learn the gestures of nature, co-create, not just with a few scattered organisms, but with the whole of the ecosystem. This paper sketches a few sustainable themes by emulating nature's time-tested patterns and strategies. Also, it reinforces the idea of learning from, and with nature, by repairing our bonding with the ecological world.

Balance of Nature

When we feel ourselves to be a part of the ecosystem, we will become interested in knowing how it has been created, how it has sustained over the years and how we act/react towards the system. This enables us to find the motive behind it. Without this understanding, we may adapt to the environment, but will use it for the wrong and selfish reasons and will not benefit others by our actions (Prime, 2002).

Ecosystem being a community of all living and non-living things, everything in the natural world is connected. Food chain/ food webs/ food cycle show how plants and animals (including human beings) are connected to each other for their existence. Food chains and food webs are representations of predator-prey relationships between species within an ecosystem or habitat. The relationship between the predator – prey species is in an essentially static balance with predators never excessively consuming their prey populations. Trees, for instance produce acorns for insects, which successively are the food to snakes and birds. As they lurk around, these birds are eaten up by hawks and owls. When they die, they are consumed by scavengers, decomposers and fungi. Therefore, all the species are subsumed to one another. Even if one constituent is missing, it will make the cycle incomplete. A slight discrepancy may affect the existence of the entire ecological system. The way plants and animals subsist; preach the philosophy of 'co-existing or living together.'

A sequential incidence of the impact of imbalanced food chain on the ecosystem was observed in the early 1950's. The World Health Organization held a campaign for the prevention and control of malaria in Borneo, Africa. Because of the increased spread of the disease, DDT was sprayed aerially. The synthetic pesticide sprayed, remained on the thatched roofs of the houses leading to unintended consequences. While the mosquitoes were quickly wiped out, DDT was stored in the bodies of the roaches, which were eaten by the lizards. This slowed down the activities (movements) of the lizards, making it easy for the cats to get hold of them. The cats ate the poisoned lizards and died. Since there were no cats, the rat population increased, which led to the spread of rabies. The roofs of the thatched houses started decaying due to the increase in termite population (due to the decrease in lizard population).

The concept/ theory of 'Balance of Nature' thus states that 'a small change in some particular ecological parameter will have an impact on the other parameter of the ecosystem'. There are three key elements in relation to food chain, namely: sustainability, durability, and balance. A combination of these elements ensures effective interaction and connection among the species in the ecosystem (Sznajdar, 2006).

Industrial/ Modern Agriculture

National security being the major concern, most of the food produced was offered to army people during the Second World War; import of food and food crops also became difficult due to the war. After the WWII, scarcity of food emerged as a major concern to the entire world. So, with the help of industrial revolution, industrial farming was promoted to improve productivity. This initiated the extensive usage of chemical fertilisers and pesticides. Though it improved the yield it was offset by the negative impacts such as panoptic usage of water, ground water pollution, and eutrophication. The reason for the presence of persistent organic pollutants in air, water, soil and food is majorly due to industrial farming (Lichtfouse & Eglinton, 1995; Lichtfouse, 1997a; Lichtfouse et al., 1997, 2005a).

Impact of Fertilisers and Pesticides

It is said that one-third or one half of the nitrogen fertiliser applied to the soil is utilised by the plant, rest of the fertiliser either stays in the soil and destroys the soil fertility or goes to the rivers as runoff and disturbs the water ecosystem (Tilman,1998). Also, the fertilisers that are washed away affect the humans by contaminating the local water supplies. Major disease that is caused by usage of fertilisers is blue baby syndrome (WHO, 1998). Only 0.1% of the pesticides applied attack the target pests, leaving 99.9% to impact the environment. Impacting the environment includes: loss of biodiversity, water pollution, and soil contamination (Piemental D. Greiner, Bashore T., 1991). Agriculture accounts for about 38% of total green house gas emissions (usage of heavy equipment, fossil fuel energy consumption).

Increased pesticide usage is due to the practice of monocropping (growing only one crop in same area of land). Usage of fertilisers and pesticides results in soil degradation, soil infertility and also causes imbalance in the ecosystem

by killing the organisms that are good for agriculture. These pesticides not only kill the pests but also kill the human beings who consume it; hence they must be termed as "biocides".

Usage of fertilisers and biocides has led to the new lifestyle diseases. As mentioned earlier, blue baby syndrome is a serious disease regarding the usage of fertilisers. Pesticide causes cancer, disrupts the reproductive system and weakens the immune system. Some pesticides get accumulated in the farm animals and when humans consume that food it improves the risk of exposure. It is found that 10,000 deaths occur every year (UN), because of the use of fertilisers and biocides.

Endosulfan incident that happened in Kerala will help us to realise the deadly effect of the biocides used in India. Endosulfan, a highly toxic pesticide, was sprayed aerially in Kerala to improve the productivity of cashews from 1976. By 1979, the calves that born during that time suffered from stunted growth and deformed limbs. In 1990s children were found to be worst affected with mental retardation, physical deformation, epilepsy. Men and women were also found to suffer from cancer and reproductive disorders.

Farmer's Friends

Earthworm, farmer's friend, will not grow in the farm where fertilisers and pesticides are used. Presence of earthworm indicates the fertility of the soil. It converts the minerals into the form that plants can take. Honeybees are important for pollination. They are decreasing as a result of pesticides usage. Honeybees become weak after consuming the pesticides sprayed on plants that will disrupt their reproduction. Spiders act as a natural pest controller by building their webs in the farm to capture the pest that attacks the soil. When pesticides are applied, these webs get destroyed.

Soil Degradation

Chemical fertilisers increase the acidity of the soil. Nitrogen fertilisers when applied releases H^+ ions to the soil which decreases the pH thereby increasing the acidity of the soil. When soil becomes acidic, the microbes and bacteria that supply nutrients to the soil will get suppressed and also the minerals available to the soil become insoluble. Industrial farming uses heavy machinery for ploughing which destroys the soil structure by compacting it. Modern irrigation methods leave behind salts that will decrease the soil productivity. The excess salt content in the soil affects the absorption capacity of the soil by making it non-porous. FAO estimates that 13% of the world's irrigated land is either water-logged or excessively salty (FAO, 2002). All these components lead to food scarcity and food shortage.

Lifestyle Diseases

Though industrial farming is found to improve the productivity in quantities it failed to satisfy the quality aspect. It is approximated that 868 million people remain undernourished in terms of energy consumption and 2 billion people lack one or two micronutrients (FAO, IFAD and WFP 2012). 26% of all children at the age of 5 are stunted and 31% suffer from vitamin A deficiency. 1.4 billion People in the world are overweight of whom 500 million are obese (WHO, 2013a).

According to UN secretary general, Ban-Ki-moon, six million children die of hunger every year, which is 17,000 per day (Gupta & Gupta, 2013). Also, rich-poor-division in urban societies refuses fair access to food, thus aggravating the problem of food security. The production, distribution, consumption and effective management of food generated, must be used in the sustained manner so as to ensure that the future generations are not compromised.

Wisdom from Nature

A unique way of establishing an association between nature and mankind is to learn nature's ways for sustenance. Studying and understanding the relationships and interdependencies found in the communities and ecosystems is a beneficial way to overcome the struggle for survival on earth. Man is only a member in the biotic community. He needs to be nurtured and shaped by the characteristics of the land. Wisdom from nature derives many factors which can be simulated by man to understand the various strategies of the ecosystem and develop measures for a productive living.

Bio-Mimicry

Bio-mimicry as an upcoming stream of science attempts to connect people, planet and technology and it studies nature's best ideas and then imitates these designs and industrial processes to solve human problems (Benyus, 1997). The term 'Bio-mimicry' has its root in Greek (*bios* means life, and *mimikos* means imitation). Thus, bio-mimicry literally refers to *imitation of life*. It creates possible new innovations and helps in developing a more sustainable and regenerative environment. Bio-mimicry introduces an era based on what we can learn from the ecosystem.

This way of approach toward nature, prefaces a realm for sustainability that can impart not only innovative designs and solutions but also awakens people to the importance of conserving the bio-diversities on earth for the generations to come. Major international corporations such as Proctor & Gamble, Nike etc learn from nature's designs to develop truly sustainable solutions. In addition to its contribution

to technology innovation, design and development, construction industry etc, the application of bio-mimicry to land management and agriculture is yielding significant whole of system benefits. Using natural processes, studying the principles of ecology and the food chain opens the door to natural or sustainable agriculture / farming.

Natural (Nature's Way of) Farming

"An ideal agricultural system is sustainable, maintains and improves human health, benefits producers and consumers both economically, and spiritually, protects the environment, and produces enough food for an increasing world population."

– Dr. Teruo Higa

Agriculture is a human activity in which the farmer attempts to integrate certain agro-ecological factors for optimum crop and livestock production. The excessive use of chemical fertilisers and pesticides adversely affects food safety and quality, health (human beings and animals) and the environment. Natural farming is an ideal solution for cultivation without destroying the natural resources. It is one of the ways of establishing a regenerative environment. 'Natural farming', 'No-till farming', 'Do-nothing farming' or 'Organic Farming' was popularised by Masanobu Fukuoka of Japan in the 1940s. Natural farming and organic agriculture, which conform to the principles of natural ecosystem, are possible alternatives to chemical-based agriculture. Natural farming minimizes human labor and facilitates practical, natural ways to cultivate land.

In India, Fukuoka's method of farming is referred to as *'rishi kheti'*, meaning *'agriculture of the sages'*. Using the natural farming practices / natural techniques, depleted soils can be rejuvenated and deserts can be reforested. The decayed plant and organic content in the soil makes the soil richer, facilitating manure for the plant community. The vegetation further, holds the soil in its place, slowing down the process of erosion. Moreover, grass is grown on the ground surrounding the trees so that it prevents soil erosion, holds moisture, propagates microorganism and produces organic fertilisers.

In natural farming, microorganisms like earthworms are allowed to do the work of tilling the land, instead of machines; earthworms can dig up to seven meters, whereas, machines can plough only up to 20 centimeters (Fukuoka, 1978). Furthermore, chemical fertilisers are substituted with natural farming inputs which are highly effective. The animal bones are sources of phosphoric acid, eggshells provide calcium and decayed leaves serve as manure for the plants. These inputs are much cheaper, degradable and easily available, than the man-made fertilisers. The owners of housing complex in Manhattan, for instance, use ladybirds as an ingenious solution to deal with the pests in the gardens and grass. These lady birds consume around 50 pests a day, keeping about 50cm^2 clear (Readers Digest, July 2011).

Natural farming is an efficient farming practice yielding to sustainable food production (Benyus, 1997) by replacing conventional mono-cultural agriculture system to perennial poly-cultural agriculture system. Instead of a monotonous cycle of the same plant being grown, year after year, the Nutritive Cycle Theory is adopted. Here, the farmers follow the principle of Nature and produce what is needed. By doing so, the soil remains fertilised for ages. *Nutritive Cycle theory* is a theory that enables us to read the changing growth stages of a plant or animal. Just like human beings, crops and livestock also need nitrogen when young, phosphoric acid during adolescence and calcium after maturity. Also the amount of food they need to take in will constantly change, just as a baby cannot consume an adult's food. Understanding these principles enable human to co-exist and co-create with the Nature.

Natural farming thus is an ecological farming approach, which observes the law of nature; it reduces (rather eliminates) the dependence on off-farm input materials thereby maintaining ecological balance. Through this approach, crops are raised naturally without the use of any chemical fertilisers and pesticides. As a sustainable agricultural philosophy and practice, natural farming helps meet the needs of the present generation, without compromising the ability of future generation to meet their own needs. It is an economically viable, environmentally safe, and socially fair agriculture.

Best Practices in Natural Farming

The crops are allowed to grow naturally in the farm without any external factors such as fertilisers and pesticides. Crops are sown in mixed or inter dependent category depends on the geographical location and season. In natural agriculture the idea is to grow crops independently were animal life cycle is not affected in any diagonal. When a bad bug is in the farm it is eaten by the good bug which becomes pray for frog and the cycle continues on. Thus the problem of pesticides never comes as natural resistance occurs. In a condition where natural farming is to be started it is best to prepare the soil first along with the environment. Soil may be prepared by various methods using animal manure and weed for mulching. This method gives higher profitability for farmers but not instantly. In natural farming animals are given importance as they grass in farm where ever they need were theoretically it shows loss of crop but practically maintains natural yield of crops including healthier animals (goat, sheep, duck, pigeon, hen, fishes, cow, buffalo, horse, pig, rabbit). Farming naturally gives more comfort to the farmer in terms of maintenance, irrigation process.

Enriching soil can be made using a method where 1 litre of each of cow dung and urine are mixed along with 100gms of jaggery in 10 litres of water and stirred and kept idle for a day, 24 hours. This mixture is sprinkled in soil for about two months which makes the soil extremely good for cultivation.

Preparation of seed is started right from the end of previous season. Seeds are soaked in cow dung for at least 24 hours where they are treated well with micro organisms which give them high pest resistance. While soil and seeds are ready there is something to wait for is that the climate. If the natural farming is done for first time it is must to wait for the rainy time for sowing and on continuation water level increases gradually which when reaches at a point, crop can undergo heavy drought conditions. To prevent pests naturally there are natural plants from which we can prepare higher preventive liquids by squashing and diluting it in water. By spraying this solution on plants insects are prevented. After the cultivation of crops the remaining parts are again left over the soil for decaying. The whole process of natural farming can be made in any type of land.

Natural farming ensures farmers not relying on one crop and gives more profit than the other methods. Higher the natural way of cultivating the higher the longevity of people. Sustainable agriculture is not just a way of farming but also to make the economy sustainable. Maintaining natural way in every aspect leads to a sustainable growth of mankind.

Food Shortage

While modern/ industrial agriculture is driven almost solely by productivity and profit, sustainable agriculture integrates biological, chemical, physical, ecological, economic and social sciences in a comprehensive way to develop/ reinstate farming practices that are safe and do not degrade our environment (Lichtfouse, 2009).

With the world population expected to double by the end of the century, the need for food will become increasingly urgent as rising temperatures force nations to retool their approach to agriculture, create new climate-resistant crops, and develop additional strategies to ensure an adequate food supply for their people. Globally, food prices are near their historic peaks, and food price volatility is widely seen as the "new normal." Managing this volatility and feeding a rapidly growing population will require sustained commitment, co-ordination, and vigilance from the international community to help governments put policies in place to help people better cope

Majority of the food producers (farmers) move to urban areas in search for other employment opportunities since cultivable land area is decreasing at an alarming rate due to urbanisation. By 2050, when 80 percent of the world's population is expected to reside in urban areas, it will face a huge challenge to feed this population in a sustainable way. Several Countries are addressing this issue by adopting "Urban Farming" (eg. Plan NYC 2030 in New York to create rooftop gardens). Various programmes and techniques pertaining to Urban Farming are gaining momentum, thereby utilizing the so-called developed urban areas for agricultural production.

Sustainable Development and Agriculture

The term 'sustainable development' was first used by Brundland Commission in the year 1987. Brundland commission, formally the World Commission on Environment and Development, solicited by the United Nations defined sustainable development as:

"Sustainable Development is the development that meets the needs of the present generation, without compromising the ability of future generation to meet their own needs."

It implies the need to develop a way that doesn't affect the needs of the future generation. Thus it is essential to adopt sustainable agricultural practices to produce food crops and products to satisfy the food requirements of the present and the future population both quantitatively and qualitatively. Sustainable agriculture may be defined as "*agriculture that is economically viable, environmentally safe and socially fair for a long period of time*".

MacRae et al. (1989) proposed the following framework based on three strategies: **E**fficiency; **S**ubstitution; **R**edesign (**ESR**).

Level 1: Substitution Strategy

This strategy involves usage of bio fertilisers and pesticides as a substitute for chemical fertilisers. Toxic chemicals and mineral fertilisers (NPK) can be replaced by less harmful compounds. Instead of nitrogen fertilisers, nitrogen fixing bacteria and fungi can be utilised. These micro organisms grow on the root nodules of legumes such as beans, peas, potatoes etc. This will reduce the usage of chemicals in the soil to an extent. This strategy will provide only a short term solution because of the development of pest resistance to the biological pesticides applied.

Level 2: Agro Ecological Strategy

This strategy involves application of ecological principles to the design, development and management of sustainable agricultural practices. Biodiversity can be promoted by cultural practices like intercropping, mixed cropping, crop rotation, composting and green manuring. The productivity of the farming systems can be increased by developing ecological principles and concepts.

Intercropping is a method in which two or more crops are cultivated on the same land so that the entire land is used effectively. The planted crops support one another by nature and coexist together. Mixed cropping is another method which involves cultivation of multiple crops which are inter-related and depended grows on same duration. The main idea is to grow fishes/animals along with the crops. Mixed cropping is profitable and needs less care.

Crop rotation ensures soil fertility and to reduce weeds and insects. It makes good quality cultivation in terms of minerals and nutrition. It is planted in an order of root, legume, leaf and fruiting plants. This helps the soil to attain balance and to fix more nitrogen for the future crop. Crop rotation period may be in years.

Level 3: The Global Strategy

This strategy involves facing agricultural issues in a global level, by rethinking its relation to society. This strategy involves the reexamining the role of agriculture in our society. This approach acknowledges that sustainability cannot be solely reached by farming alone i.e., it also deals with the relation between the food and food consumption.

Vedic Ecology and Inclusive Growth

'The world has enough for everyone's need but not enough for everyone's greed'

– Mahatma Gandhi.

The ecological system is a combination of human beings along with other components. During Vedic times the nature *(Prakriti)* or the elements of nature like air, water, land, fire, birds, animals and the human being *(Purusha)* were interconnected and interdependent who co-existed and co-evolved. Vedic ecology as a discipline primarily emphasize on the benefit for the greater good (*sarva sukhinah bhavantu* – Let all beings be happy) (Prime, 2002).

The *Isa Upanishad* says it very clearly: *take only what you need that is set aside for you. Do not take anything else, for you know to whom it belongs.* The concept of Inclusive Growth, as stated by the Management Guru C.K. Prahalad, also talks about the same. He says that an equitable allocation of resources which would benefit all sections of the society is a handy tool for economic development. In ecological sense, when man utilises Nature only to the extent of what is needed inclusive growth can be accomplished. Thus, being an inseparable part of the life support system, deterioration in one will affect the other (Khosboo, 1985).

It is believed that, a truly empowered person is the one whose actions match with the art of nature (including divinity, spirituality). The concept of Integral Management of Sri Aurobindo (like the Triple Bottom Line) also affirms that men need to rise above the economic bottom line to an evolutionary line, embracing environmental and human concerns. Thus, learning/inspirations from nature enable drafting strategies for mankind. Some of the great lessons taught by nature in simple terms can be well – observed in some of its following species.

Endnote

'We do not inherit the land from our ancestors. We borrow it from our children.'

– Haida proverb

Some of the major concerns that the world share in today's living:

- Emotionally disconnected life
- Increasing prevalence of lifestyle diseases
- Increasing food needs (demand for food), and rising food prices

All the above concerns can be addressed by bringing a small change at a rudimentary level. Nurturing saplings was found to be one of the simplest ways to foster social, emotional, and physical well-being in an individual. From an economic point of view, ever growing population demands an increasing level of food production (over 70% by 2050 to meet the world's food needs) to satisfy the hunger needs.

As a universal principle, each constituent of nature has a unique role to play and each one is responsible for the harmony of the world. Nature is not just for admiration and application, but it can also act as a catalyst for human reflection and learning. When we learn to appreciate it, an individual/ organisation can never feel alienated. Nature opens up the gates of trust, compassion and wisdom, by connecting us with our higher consciousness. Wisdom from nature inspires, educates, invigorates, enlivens and unites the entire ecosystem. It presents a great deal of understanding and matching of our inner needs with external responsibility to serve the planet with generosity and gratitude.

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