

20 LEISA
INDIA
YEARS
Promoting Agroecology

Magazine on Low External Input Sustainable Agriculture



LEISA INDIA



**Nurture plants
Save the planet**



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Rural women raising tree saplings in nurseries
(Photo: Grow-Trees.com)

The AgriCultures Network

LEISA India is a member of the global AgriCultures
Network. The network organisations provide
information on small-scale, sustainable agriculture
worldwide, and publish:

Farming Matters (in English)

LEISA revista de agroecología (Latin America)

LEISA India (in English, Kannada, Tamil, Hindi,
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The editors have taken every care to ensure
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however, for the content of individual articles.

The editors encourage readers to photocopy
and circulate magazine articles.

www.leisaindia.org

Dear Readers

It is being simply forgotten that the well-being of human kind is dependent on the well-being of the plants. Soil health is critical for growing healthy plants. Way too long we have been focusing on soil chemistry and greatly ignored the benefits of caring for soil biology. Indiscriminate use of chemicals has destroyed life in the soils as well as greatly polluted the air and water sources. Agroecological approaches are the answer for better use and recycling of resources. We need to value trees deeply and promote them widely – for a healthy environment, resilient livelihoods, favorable microclimate, and as a carbon sequestering measure. In this issue we have a mix of insightful scientific explanations and people led initiatives. This issue celebrates the year 2020-International Year of Plant Health.

We acknowledge deeply your overwhelming response to our reader's survey. Besides contributing regularly your experiences and wisdom, you have spared your precious time in responding to our survey. Your gesture and efforts reaffirms our relevance and is deeply motivating. We remain deeply indebted to you all for your commitment to promotion of LEISA. Together, let us celebrate **20th year of LEISA India**. We heartily wish you and your families **A Very Happy New Year 2020**. Hope some of you have received the 'gift' for your timely response to reader's survey....as promised delivered or being delivered!

The Editors

LEISA is about Low-External-Input and Sustainable Agriculture. It is about the technical and social options open to farmers who seek to improve productivity and income in an ecologically sound way. LEISA is about the optimal use of local resources and natural processes and, if necessary, the safe and efficient use of external inputs. It is about the empowerment of male and female farmers and the communities who seek to build their future on the bases of their own knowledge, skills, values, culture and institutions. LEISA is also about participatory methodologies to strengthen the capacity of farmers and other actors, to improve agriculture and adapt it to changing needs and conditions. LEISA seeks to combine indigenous and scientific knowledge and to influence policy formulation to create a conducive environment for its further development. LEISA is a concept, an approach and a political message.

AMEF is a member of AgriCultures Network, which is involved in co-creation and sharing of knowledge on family farming and agro ecology. The network is **locally rooted and globally connected**. Besides magazines, the network is involved in multi stake holders' engagement and policy advocacy for promotion of small holder family farming and agroecology. The network consists of members from Brazil, Ethiopia, India, Netherlands, Peru and Senegal. The secretariat of the network is located in IED Afrique, Dakar, Senegal.

MISEREOR founded in 1958 is the German Catholic Bishops' Organisation for Development Cooperation. For over 50 years MISEREOR has been committed to fighting poverty in Africa, Asia and Latin America. MISEREOR's support is available to any human being in need – regardless of their religion, ethnicity or gender. MISEREOR believes in supporting initiatives driven and owned by the poor and the disadvantaged. It prefers to work in partnership with its local partners. Together with the beneficiaries, the partners involved help shape local development processes and implement the projects. This is how MISEREOR, together with its partners, responds to constantly changing challenges. (www.misereor.de; www.misereor.org)

AME Foundation promotes sustainable livelihoods through combining indigenous knowledge and innovative technologies for Low-External-Input natural resource management. Towards this objective, AME Foundation works with small and marginal farmers in the Deccan Plateau region by generating farming alternatives, enriching the knowledge base, training, linking development agencies and sharing experience.

AMEF is working closely with interested groups of farmers in clusters of villages, to enable them to generate and adopt alternative farming practices. These locations with enhanced visibility are utilised as learning situations for practitioners and promoters of eco-farming systems, which includes NGOs and NGO networks. www.amefound.org

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T M Thiagarajan,
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and C Partheeban

More than genetic resistance of the plant, application of appropriate nutrients at the right time, in the right dose, based on the available form, plays a crucial role in plant health. Factors that influence the crop health is yet to be understood in a holistic manner.



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SankalpTaru Foundation

Innovatively integrating technology with nature, SankalpTaru enables people, with no time or space to plant trees, contribute their share towards the environment. The initiative is efficiently connecting individuals with nature and also helping rural communities in strengthening their livelihoods.



19 Green Festival *for Green India*

M N Kulkarni

The culture of planting trees with community participation is blended into the rural life styles through organizing planting festivals like *Hasiruhabba*.



34 Growing trees, strengthening livelihoods, protecting environment

Supriya Patil

Grow-trees, a social enterprise is providing a cost-effective service to individuals and companies globally to enable planting of trees. Through its web enabled services, the organization is giving every person an opportunity to do his/her bit in protecting the environment.



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Supriya Patil



Nurture plants Save the planet

The planet cannot survive without plants. Plants constitute majority of food sources and play an important role in providing clean air. But we seem to have ignored or forgotten this simple truth, in our journey towards building a modern, developed world. Every morning we hear about trees being felled or large areas of farmland being diverted for other uses, in the name of development. We are getting extremely callous about polluting soils and the water sources.

We believe that we nurture plants, but it is the plants that nurture humans by providing food, air and a clean environment to live in. We exploit to produce more, having little regard to the soil, water and the ecology. We have been using the most unsustainable practices producing unsafe food for both humans and animals. We need to therefore pause, understand plant health and reflect on how we could grow safe food without exploiting the natural resources and the prevailing ecology and environment.

In this issue, we can see a number of positive examples of ways of enhancing plant health, producing nutritious food that enhances health of the people and innovative ways of increasing the green cover on this planet.

Nurturing plant health

Like human health, often it is a reactive response to a pest or disease incidence, rather than a proactive approach to plant health. Understanding plant health is more important before suggesting ways of maintaining health. Plants are dependent on the soils they grow and hence soil health takes precedence over plant health. Mere understanding of the soils by conventional soil testing is no longer sufficient to keep the crops healthy. *We still do not test the soils for their health and more research is required to address this lacuna*, opine the scientists from SRMSIT. More than genetic resistance of the plant, application of appropriate nutrients at the right time, in the right dose, based on the available form, plays a crucial



Photo: AME Foundation

Land covered with crops and trees conserves soil and water while providing food and clean air

role in plant health. Factors that influence the crop health is yet to be understood in a holistic manner (T M Thiyagarajan et.al., p.11).

Beneficial micro-organisms can enhance the nutrient uptake and make nutrients more available by influencing root architecture. Scientists from SRMIST observed that VAM-infected *Lavendula* plant growth increased 8.5 times over non-infected plants. There is also some evidence that the soil bacteria can support in making phosphorous available to the plants by solubilizing the water-insoluble forms while mycorrhizal fungi help in mobilizing the immobilized nutrients from the soil. (T M Thiyagarajan et.al., p.11).

Pre-treatment of seeds with microbial agents has enormous potential in promoting healthy plants. Selective use of microbes for specific purposes can result in higher yields. Bio-priming is one of the techniques of integrated nutrient management to achieve sustainable yields in agriculture.(Deepranjan Sarkar et.al., p.22).

Another way of enhancing the microbial activity in the soils is by applying mulch. By way of mulching, scientists also observed better decomposition of fallen leaves and dead root mass, thereby increasing microbial population (Pradeep Kumar Sarkar et.al.,p.6). The root mass binds the soil, consequently, checking the soil erosion to a great extent.

Nurturing conducive microclimate will enhance plant growth. Many farmers have benefitted greatly by improving the microclimate on their farms. For instance, Madhu Ramakrishnan, a farmer in Pollachi, Tamil Nadu has been successful in reducing the temperature in his farm, owing to dense population of different plants and trees and also with live fencing. (Farmer's Diary, p.28). The congenial micro climate in the farm, also helps faster multiplication of microbes and earthworms. It also nurtures good and beneficial relationship between plants, pests and pathogens. However, microclimate has been poorly studied in relation to crop health and there is insufficient or inadequate research on microclimate management in relation to crop health (T M Thiagarajan et.al., p.11).

Kailash Murthy, another farmer in Karnataka, following a number of nature-friendly practices, has been able to maintain good soil and plant health on his farms (p.25). His farm which includes more than 138 species of herbs and trees, belonging to 28 families, is growing in harmony with nature, like a forest ecosystem by using only sunlight. "We don't get health security from super specialty hospitals, but from the **food diversity**. That's why, all these years, I have studied organisms under the ground and understood their ability to supply nutrients to soil." says Kailash Murthy.

Increasing tree cover

In an era where trees are cut either from forest areas or urban areas, planting trees wherever possible is another way of increasing green cover and harvesting the benefits that trees provide to the planet. Planting a sapling to mark special occasions has become a trend, but it is simply not enough. The way the air is getting polluted, it would probably be hard to live in a few years from now. Delhi is clearly moving towards it and many urban areas are following unsustainable models. We need to plant on a war footing.

Development organisations like BAIF are doing their bit in greening the rural areas. BAIF has been popularizing a cultural festival called *Hasiru Habba*, the Green festival, since 2001, in all its project locations. The culture of planting trees with community participation is blended into the rural life styles, by giving a traditional touch to the event. (M N. Kulkarni, p.19).

The Government of Karnataka is also promoting biofuel species in private lands and government lands through Karnataka State Biofuel Development Board. The species such as *Pongamia*, *Simaruba*, *Jatropha*, *Madhuca* etc., have been provided to the farmers through *Hasiru Honnu* and Baradu bangara project, where farmers are motivated to plant these species all along the field bunds and in the uncultivable lands (M N Kulkarni, p.19). However, we need to be extremely cautious with regard to purpose and choice of plant species.

Tree planting initiative is catching up with the new age organisations too. Innovatively integrating technology with nature, SankalpTaru Foundation (p.15) enables people, with no time or space to plant trees and contribute their share towards the environment. The initiative is efficiently connecting individuals with nature and also helping rural communities in strengthening their livelihoods. Working with various organisations and corporates, SankalpTaru Foundation has expanded its green footprint to over 18 Indian states reaching close to a million healthy tree plantations.

Grow-trees.com, another social enterprise is providing a cost-effective service to individuals and companies globally to enable planting of trees (Supriya Patil, p.34). Through its web enabled services, the organization has planted over 4.5 million trees across 20 states of India, generating approximately 370,000 workdays of employment for the rural communities.

Expansion and collaboration

With rising population and more food requirements, nurturing healthy growth of plants is not a choice any more. Increasing urbanization, infrastructure development, increasing radiation and changing lifestyles are all leading us towards unsustainable living. Expanding lung spaces within cities, enhancing crop and animal diversity, adoption of sustainable practices in ecosystem management and food production and increasing tree cover across the nation are some of the ways to meet this impending challenge. It is a huge task which calls for a coordinated effort from citizens as well as various organisations, backed by supportive policies.



Healthy plant

Foundation for nutritional and environmental sustainability

Pradip Kumar Sarkar, M K Dhakar, Bikash Das, Priya Ranjan Kumar, Sudarshan Maurya, S S Mali, Reshma Shinde, J S Choudhary, S K Naik, Dharamjit Kherwar, Asit Chakrabarti, D K Raghav, A K Singh and B P Bhatt

Jharkhand farmers are showing increased awareness and responsibility towards efficient production systems as well as farm sustainability. With the support of ICAR scientists, farmers in Phusri village are reaping multiple benefits by reforming degraded mining lands into productive farm lands.

Mulching with Tephrosia candida is done around Bael plant for soil enrichment



Plant is the basic unit of agriculture. Individual plant lies in the centre of all endeavours and activities in the field of agriculture. The output of each and every input is expected to manifest itself in the form of a healthy, robust and productive plant, be it a mushroom or a mango tree. The civilization lives by the traits possessed by plants. Our diverse needs are met by the diverse kinds of plants we have around us. Diversity of flora contributes to the prosperity of a society and also determines the amount of self-dependence it can attain. For example, more diverse the kinds of microbes in the soil, higher the fertility and biological activity in the soil. Diversity of products that we can have is directly proportional to the diversity of flora and fauna in our ecosystem.

Plant diversity and their products are source of livelihood for forest dwellers and many village communities all over the world. Farmers at grass-root level have been maintaining homestead gardens which serve as a reservoir as well as cauldron of diversity. Homestead gardening is an important source of nutritional security at household level for rural poor with no capability to afford fruits from the markets. In addition to generating employment in rural hinter lands, they have come to hold a significant place in agrarian economy.

Women folk in rural areas are struggling to augment their income with limited options available in their socio-economic space. They are moving towards non-chemical methods. For instance, women in Palkot block of Gumla District of Jharkhand had produced imitable example in the field of plant protection by application of cultural practices and organic methods. Incidence of fruit flies in mango orchard was successfully managed by use of paper envelopes to cover the developing fruits and use of pheromone traps viz., Methyl eugenol, instead of toxic pesticides, since 2012. This technology has now been adopted over 1000 hectares of mango orchards.

Mine lands to productive lands

The State of Jharkhand has more than 180 coal mines. After years of mining, the land is rendered unsuitable for any use in general and agricultural use in particular. There are thousands of hectares of such lands waiting to be reclaimed.



Mango fruits are protected using paper envelopes from fruit fly infestation in Gumla district

Phusri is a tribal village situated near Charhi, Mandu, Ramgarh in Jharkhand. Quarrying and selling of raw coal to the nearest market has been the only livelihood option for these tribal households. In the lands they own, they have been cultivating rainfed lowland paddy during Kharif. Water gets collected in the abandoned mining pits during monsoons, which is used for washing and bathing, besides irrigating some crops. The pits get dried up after March. The village has very few trees too. Infact, only one tree each of mango, guava, mahua and a grove of sal (*Shorea robusta*) trees was seen in the village.

To ameliorate the degraded lands, ICAR Research Complex for Eastern Region, Farming System Research Centre for Hill and Plateau Region (ICAR-RCER, FSRCHPR), Plandu Ranchi, started working in Phusri from 2014 onwards.

Considering the deteriorated condition of the soil, some soil and water conservation measures (viz., construction of plastic lined dobhas, full moon terracing, half moon terracing, staggered contour trenching, mulching, etc.) were designed and applied for improvement of the site. Pattern of changes in soil moisture content in both the conditions under full moon and half moon terracing conservation measures for the plantation during extreme summer was recorded on daily basis to determine optimum irrigation requirement. In the beginning of the project (2014), it was observed that, after 24 hours of irrigation, the soil moisture content went down to approximately 6 - 8% and then gradually declined over the weeks. By 2018, water holding capacity of the soil

improved remarkably. It took more than 72 hours after irrigation, for the soil moisture content to reduce to 6 - 8%. This can be attributed to decomposition of crop residues leading to build up of organic matter, increase in microbial population and their activity. The soil bulk density has decreased from 2.3 g cm⁻³ to 1.1 g cm⁻³, whereas, available organic carbon content has increased from 0.23% to 0.58%. The soil pH and EC values have also shown an increase.

Raising plantations

A model of agri-horti-silvi-pastoral system has been developed for the coal mine affected areas in the village. This included planting of selected agroforestry species viz., *Aegle marmelos*, *Artocarpus heterophyllus*, *Citrus limon*, *Dalbergia latifolia*, *Mangifera indica*, *Melia azedarach*, *Pongamia pinnata*, *Psidium guajava*, *Punica granatum*, *Swietenia mahogany* and *Tectona grandis*. The species like Bamboos (*Dendrocalamus asper* and *D. strictus*) and *Tephrosia candida* were also introduced in the system for fodder as well as nutrient supplement purpose.

Fruit plants like mango, guava, lemon, bael (*Aegle marmelos*) are generally more susceptible to both biotic and abiotic stress as compared to forest trees like Bakain (*Melia azedarach*), Mahogany (*Swietenia mahagoni*) and Shisham (*Dalbergia sissoo*). Increased incidences of pest and diseases owing to climate change, were reported. Technologies like full moon terracing, half moon terracing, staggered contour trenching, mulching resulted in reduction of plant mortality. For example, under extreme dry spells, the plants grown at coal mine affected area respond differently to moisture regime and scheduling needs may vary from species to species.

Vegetable cultivation

To help farmers grow some vegetables, both for nutrition and income purposes, the project promoted vegetable cultivation. Villagers were not growing vegetables before. Various trainings were therefore designed and conducted, which covered a number of topics like cultural practices like nursery raising, planting techniques, pruning,



thinning, weeding, mulching, plant protection and several technologies related to soil and water conservation measures. The trainings were imparted during 2016-17 by experts of ICAR-RCER at KVK, Mandu. These were supplemented by need based on-farm demonstrations and field trainings too. The activities were closely followed up with the help of the staff of KVK, Mandu.

Seeds of different varieties were provided to farmers. For example, tomato variety *Swarna Lalima*, hybrid *Swarna Sampada*, brinjal var. *Swarna Shyamali*, bitter gourd var. *Swarna Yamini*, sponge gourd var. *Swarna Prabha*, water melon var *Arka Manik* were the major ones. Most of these varieties were developed by ICAR RCER. Vegetable crops are now being grown on farmlands as well as kitchen gardens. Vegetables like tomato, chilli, brinjal, cauliflower, cabbage, beans, okra, potato; and field crops like arhar, cowpea and mustard were cultivated during the year 2018-19.

Diversity is the engine of
sustainability.



Agroforestry at coal mine affected area

Results and impacts

Vast tracts of barren lands have been brought under cultivation. For the first time in Kharif 2019, the erstwhile mine lands were used for raising paddy nurseries, which were transplanted in rain-fed lowlands. Farmers are now producing fruits, vegetables, food grains, fuel wood, fodder, etc. All these have resulted in a number of benefits in terms of income, nutrition, fodder availability, and better employment opportunities.

Farmers received net returns of Rs. 42683/- per hectare from rainy season crops (like tomato, chilli and cucurbits) and Rs. 18293/- per hectare from winter crops (like mustard, groundnut, chickpea, arhar, cabbage, cauliflower and potato). Survey revealed that roughly 60.25% of vegetables and 22.34% of the fruits produced were sold in the market. Entire mustard produced was sold in the market. Households were able to obtain a marketable surplus of cowpea.

The impact on the nutritional status of the community was obvious and tangible. The vegetable intake of family (4 members) increased by approximately 30% due to vegetable cultivation. Also, the entire pigeonpea produced was consumed by households, improving their protein nutrition.

The reclaimed land also served as a good source of fodder for animals. Introduction of fodder species has become a major support for livestock farmers since their animals like cattle, goats and buffaloes mainly sustain on open grazing in lean months. Bakain (*Melia azedarach*), a multipurpose tree was grown as intercrop in field crops. Kans grass (*Saccharum spontaneum*) was grown for fodder as an intercrop between fruit trees and forest tree species. Bhoomi sudha (*Tephrosia candida*) was grown as a multipurpose species to serve as green manure, fodder as well as hedge. These fodder crops yielded around 628.05 kg per hectare. Green fodder which in addition to

Box 1: Success story

Mr. Sunil Murmu is a small farmer who benefitted from the project interventions. He cultivated different varieties of fruits, vegetables and fodder species on his farm. The family started harvesting considerable amount of fruits, vegetables from alleys, fodder for animals, pruned branches as fuelwood from the 3rd and 4th year onwards. The family harvested fruits like mango (168.68 kg), guava (273.34 kg), pomegranate (117.15 kg) and lemon (72.9 kg) from a holding of 0.82 ha. Almost everything was consumed at the household level.

In the year 2018-19, the family received net returns of more than Rs. 40000/- per hectare from vegetable cultivation during rainy season. During winter, Sunil earned more than Rs. 18000 per hectare from winter crops like mustard, groundnut, chickpea, arhar, cabbage, cauliflower and potato.

Mr. Sunil Murmu has expanded cultivating different crops to his remaining barren lands. He has also been motivating other farmers in the region to pursue crop and tree cultivation. People have taken interest in on-farm demonstrations and have been participating in training programs, as well. Now, he has become a role model and an inspiration for the rural youths in that area. For his excellent work and enthusiastic involvement, Mr. Sunil Murmu has been awarded with the "Best Farmer Award" by Shri. Radha Mohan Singh, Union Agriculture Minister on 22nd February, 2018.

roughage, supply good amount of vitamins, proteins and mineral nutrients to cattle and goats.

As a result of these efforts, lot of employment opportunities have been generated in the area. This further has reduced labour migration from the region.

Impact on environment and biodiversity

By promoting crop cultivation, there is a change in the soil and environmental condition. Introduction of various soil and water conservation measures like Dobha, full moon and half moon terraces, staggered contour trenching, mulching and zero tillage cultivation practices have led to establishment of vegetation, the root mass of which has had a binding effect on soil, consequently checking the soil erosion to a great extent. The rate of erosion measured as peak sediment discharge (concentration) reduced from 232 g m⁻³ to 181 g m⁻³. Because of mulching with dried vegetation, decomposition of fallen leaves and dead root mass, and agricultural activities, the microbial population as well as their activities increased. The diversity of weed species also increased from 7 in 2014 to 18 in 2017. Shanon index, a measure of weed diversity, increased from 0.34 to 0.79

in this period. Grey patches of lands are turning green. A concurrent increase in diversity of wild fauna like birds, honey bees, wild boars, reptiles, etc., has been observed.

Policy level measures

The project interventions have had a positive impact of availability of nutrition, spread of education, social stability, and employment opportunity for rural folks, including women. Farmers are showing increased awareness and responsibility towards efficient production systems as well as farm sustainability. Scientists are engaged in developing climate smart technologies. It is time for the government to formulate policies which encourage the efforts of farmers and are supportive to the implementation of technologies developed by research institutions. Since plant is the unit of production, farmers, scientists, industries and policy makers have to work in tandem to make sure that every single plant gets most congenial environment to give its potential production.



Pradip Kumar Sarkar, M K Dhakar, Bikash Das, Priya Ranjan Kumar, Sudarshan Maurya, S S Mali, Reshma Shinde, J S Choudhary, S K Naik, Asit Chakrabarti and A K Singh

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Photo: AME Foundation

Mulching helps in conserving soil moisture and enhancing biological activity in the soil

Understanding crop health

T M Thiyagarajan, S Rageshwari, L Ramazeame and C Partheeban

More than genetic resistance of the plant, application of appropriate nutrients at the right time, in the right dose, based on the available form, plays a crucial role in plant health. Factors that influence the crop health is yet to be understood in a holistic manner.

Healthy food for human beings can come only from healthy crops. Modern agronomy, plant breeding, agro chemicals such as pesticides and fertilizers, and technological improvements have helped in food sufficiency, but at the same time have caused widespread ecological damage and negative human health effects. Cultivated crops face several health issues with biotic and abiotic stresses which vary with weather, micro-climate, soil and ecology and the plant biochemistry.

A holistic understanding of the crop health in relation to the above-ground and below-ground environment and the plants' biochemical composition is essential to provide decisive healthcare to the crops.

Soil health is the key

A better soil health environment is a condition where there is good drainage with adequate air circulation for the roots to function without suffocation; nutrient supply to meet

crop needs throughout growing season which varies with the crop growth stage; favourable chemical status that does not affect the functioning of the roots and nutrient availability; soil biology that supports nutrient availability; soil organic carbon that forms the basis for the survival of microbes; and soil temperature.

Mere understanding of the soils by conventional soil testing is no longer sufficient to keep the crops healthy. We still do not test the soils for their health and more research is required to address this lacuna.

Microbial population in the rhizosphere is the greatest reservoir in this global ecosystem. Nearly 20 percent of the photosynthates are released into the soil as root exudates. The exudates mainly comprise of sugars, amino acids, flavonoids, aliphatic acids, proteins and fatty acids. They serve as a nutrient source for the plant as well as for microbiome near the rhizosphere. Pathogen activity increases, when the requirement goes from deficiency to sufficiency. Besides, soil edaphic and biological factors play a major role in deciding the amount and composition of root exudates. The soil bacteria are attracted towards the root zone and it converts ammonium nitrogen to nitrate. Phosphorous is sparingly soluble in most soils and is often the limiting nutrient in natural ecosystem. There is some evidence that the soil bacteria can support in making phosphorous available to the plants by solubilizing the water-insoluble forms while mycorrhizal fungi help in mobilizing the immobilized nutrients from the soil.

Beneficial micro-organisms can enhance the nutrient uptake and make nutrients more available by influencing root architecture. VAM-infected *Lavendula* plants growth increased 8.5 times over non-infected plants. The primary cause of mycorrhizal-enhanced growth appears to be enhanced uptake of nutrients, especially phosphorous. Plant health can be successfully improved by manipulating the rhizosphere by (i) increasing the suppressiveness of the soil, decreasing the suppressive of pathogens and by inflecting host immune system. A study on increased activity of microbiome in the rhizosphere soil carried out by De Boet and his co-workers in 2003, revealed that it directly increased the competition for iron, the limiting nutrient and thereby suppressed diseases such as fusarium wilt of carnation and radish, caused by soil borne pathogens. PGPF (Plant growth

promoting fungi) and PGPR (Plant growth promoting rhizobacteria) present in the rhizosphere has an ability to induce resistance to plants against pest and pathogens. Studies reveal that, plants selectively attract micro-organisms thereby increase the density of few species where, it also restricts different diversity of micro-organisms.

Microclimate influences crop health

Microclimate refers to the climate just above and within the crop canopy and in the soil root zone that can be influenced by management practices. The best crop microclimate is one that provides the most favourable growing environment and that maximizes crop productivity. Mulching produces new microclimate in the original soil, reduces transmittance of solar radiation; soil temperature and evaporation, helping in water conservation. The biological activity in the soil is also influenced.

The microclimate of a cropland is influenced by the moisture and temperature available in the soil and air; the presence of dew and frost; humidity; wind speed etc. This can affect the plant growth and germination, soil respiration, the vigour of soil biotic life, nutrient cycling, and the occurrence of pests and diseases. Microclimate management is well known in protected cultivation but is only to a limited extent in field crop cultivation.

Microclimate has been poorly studied in relation to crop health and there is no adequate research on microclimate management in relation to crop health.

Nutrients decide plant defense mechanism

Appropriate nutrient concentration of a plant has a high impact on improving the resistance of a crop while the surplus nutrients are responsible for inviting beneficial as well as harmful micro-organisms and insects. Nutrients serve as the first line of defence in a plant. Altering the

Mere understanding of the soils by conventional soil testing is no longer sufficient to keep the crops healthy.



Photo: AME Foundation

Improving soil organic carbon forms the basis for the survival of microbes

nutrients concentration in a crop can directly trigger the defense mechanism of the plants to pest and diseases.

Nutrients can directly alter the physiological and biochemical condition of the host including assimilation, nutrient uptake, cell wall integrity, and etc. There are many factors that affect the severity of plant disease such as, mineral nutrients, organic amendments, tillage, date of sowing, crop rotation, mulching, pH adjustment, etc. These factors decide the availability of nutrients to the plants and pathogens. For example, root rot caused by *Rhizoctonia* sp, wilt caused by *Fusarium* sp and club root diseases can be easily managed by altering the soil pH.

The plant defense mechanism is regulated by plant hormones like salicylic acid (SA), Jasmonates (JAs), and ethylene. These hormones impart resistance to plants against pests and diseases. SA plays a role in enhancing the systemic resistance against pathogens especially biotrophic and hemi-biotrophic pathogens, which colonizes living tissue. JAs and ethylene play a role against necrotrophs, and insects which rapidly kill plant cells to obtain nutrients.

Resistance against late blight of potato can be overcome by increased K application which increases the fungistatic compound arginine in leaves.

Plant nutrients and pest incidence

Nitrogen is one of the most important factors influencing the performance of herbivorous insects. Nitrogen has been found to affect the reproduction, longevity and overall fitness of certain pests. Application of synthetic nitrogenous fertilizer resulted in the more serious insect herbivores occurrence and crop damage by reducing plant resistance. The low nitrogen contents in the plants enhances the resistance of plants against pests, while high nitrogen content leads to vigorous growth along with consequent decrease in resistance. However, the high nitrogen rate resulted in the highest per leaf mean population of jassid, whitefly, and thrips. High nitrogen, increases the reproduction of cotton aphid and high population rate of whitefly. For example, the mustard aphid infestation increased with increasing level of nitrogen.

High phosphorus level shortened the development time of adult aphids (*Macrosiphum euphorbiae*). Recent reports showed that, the application of Phosphorus reduced the population densities and damage of pod sucking bugs and *Empoasca dolichi*.

Potassium fertilizer is negatively associated with occurrence of aphids (*Aphis glycines*), leafhoppers and

mites. Potassium nutrition has a profound effect on improving the attractiveness of plant for insects and pathogens as well as their subsequent growth and development.

Potassium deficiency on its own may not correlate with higher insect attack, but the subsequent impact of potassium deficiency on plants, makes plants more readily attacked by sucking insects. For instance, the increase in potassium level led to accumulation of more phenols which probably contributed to increased insect resistance in some rice cultivars. Moreover, potassium induced changes in rice plant had profound effect on insect- host interactions.

Abiotic stresses affecting crop health

Abiotic stresses that affect crop health include salinity, drought, flooding, metal toxicity, nutrient deficiency, high temperature and low temperature, shade, UV exposure photo-inhibition, air pollution, wind, hail etc. Effect of abiotic stresses on the plants and their management have been studied well.

Conclusion

Understanding the factors that influence the crop health has not been addressed in a holistic manner. Perfect manipulation of nutrient, plant and environment can reduce most of the pest and diseases. More than genetic resistance of the plant, application of appropriate nutrients at the right time, in the right dose based on the available

form, plays a crucial role in plant health. Sometimes the rhizosphere reaction can be negative too. Some chemical compounds attracts pathogens, hence, application of correct dosage of nutrients is highly crucial. Along with nutrients, crop amendments can help to improve the microclimate as well as, serve as food source for beneficial micro-organisms. Moreover, plants are capable of recruiting micro-organisms in there rhizosphere according to their genotype. The challenge lies in maintaining the density of microbiome high in rhizosphere.



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Enhancing green cover

The journey of SankalpTaru

SankalpTaru Foundation

Innovatively integrating technology with nature, SankalpTaru enables people, with no time or space to plant trees, contribute their share towards the environment. The initiative is efficiently connecting individuals with nature and also helping rural communities in strengthening their livelihoods.

This farmer in Maharashtra is earning better income by growing custard apple and guava trees on his farm



Photo: SankalpTaru Foundation

With an objective to reduce the carbon footprint of citizens by mobilizing them towards environmental conservation, SankalpTaru was born in the year 2011. Mr. Apurva Bhandari, an MBA graduate with many years of experience in the IT industry wanted to blend together his love for the natural world and the use of technology to better lives. The mission was to create a healthy, green and clean planet through tree plantation, while creating a repository for a rich ecological bio diverse planet and helping rural communities, in the process.

SankalpTaru website was launched in the year 2012, followed by its mobile application in 2013. By 2014, the organization expanded its footprints to 6 Indian states, including Leh Ladakh. Working with various organisations and corporates, SankalpTaru has expanded its green footprints to over 18 Indian states reaching more than half a million healthy tree plantations.

Supporting rural livelihoods

Rural farmers are assisted in improving their livelihoods by planting fruit and fodder-bearing trees. These trees help in promoting women's empowerment and independence, increasing biodiversity in the region, alleviating poverty, and improving green cover in some of the most arid places. The selected regions where plantations are carried out are geographically deprived of greenery. The objective is to increase the green cover, while also supporting rural farmers in strengthening their livelihoods supported with fruit-bearing saplings.

In 2015, in partnership with the Government of India in the Thar Desert plantation programme, SankalpTaru Foundation started working in the districts of Barmer and Jaisalmer. The aim was to support the livelihoods of poor farmers by growing trees of varied plant species like pomegranate, ber, lemon and many more. This initiative not only created greenery in this arid region but has also gone a long way in providing livelihoods to the poor farmers. Also, associating with Greenlam Laminates a total of 5,002 saplings of pomegranate were planted on the lands of 5 farmers from Dhaka village in Rajasthan. Also, trees were planted in community lands and schools located in the region.

Under the Project Sanjeevani, a Rural Livelihood Support Program, a total of 16,000 trees of several fruit-bearing, shade and fodder giving trees were planted on community

lands and on the fields of several farmers in the cold desert of Leh Ladakh and in the arid Thar desert of Rajasthan. Community members were involved in nurturing the foliage around them, with the theme of "*Gaanv ka jungle, gaanv ke liye*" (i.e. a forest by villagers, for the village). Since its initial plantation, the project has come a long way in revamping the living of the natives and empowering women.

In the south, the Foundation worked in Talupula village in Anantapur district of Andhra Pradesh. The village suffers from frequent droughts and adverse weather conditions for growing crops. The region faces a high agricultural related suicide rate because of failed crops and drop in the market prices. More than 50000 trees were planted to improve the villagers' livelihoods and provide a sustainable income for their families through the agroforestry approach. Similarly in Satara and Buldhana districts of Maharashtra, more than 12,500 trees were planted on the lands of identified farmers.

Enhancing urban greenery

Trees are planted in residential societies and schools to combat air pollution, and mobilize city residents to reduce their carbon footprints by increasing green cover. The plantation campaign had a sole aim of combating striking pollution levels of India's rapidly developing cities by rooting a total of 25,000 trees in several residential societies. The mission was to mobilize city dwellers about environment conservation, while fostering environmental stewardship within them to nurture plants regularly. Our enthusiastic initiative is successfully creating green lungs in the respective cities to sequester high carbon from the atmosphere.

More than 50000 trees were planted in Talupula village in Anantapur district of Andhra Pradesh to provide a sustainable income for the farm families.



Photo: SankalpTaru Foundation

School students in Panchgaon, Haryana plant trees as part of the Clean and Green School Program.

Highly conscious towards sustainable development of the environment, NEC Technologies associated with SankalpTaru Foundation to make Earth more greener and cleaner through their Project Protect Earth. Thus, the teams carried out plantations of 600 fruit-bearing and native trees at Nirashrithara Parihara Kendra (NPK), a destitute center in Bangalore. Since its initial plantation, the project has come a long way in developing a self-sustainable and self-enthusiastic model for the inmates of NPK, while revamping environmental conditions of India's Garden City.

In Pune, 85 trees of several native plant species were rooted in a residential society. Enthusiastic residents, including kids and women participated in the plantation drive and pledged to nurture the saplings regularly.

Educating students

The vision of Clean and Green School programme is to sensitize children about growing environmental degradation and its repercussions and help them grow into environmentally conscious citizens of the country. Students and teachers are involved in plantation activities and cleanliness drives by holding workshops, screening educational movies, and giving them practical training to achieve a thriving ecosystem within their communities.

Collaborating with Teach for India, a holistic environmental education program was introduced in their

MCD schools across the NCR region. Joining hands with TATA Power, around 5,000 trees were planted in various schools across 8 Indian states, involving around 6,000 students in the campaign. With every tiny sapling planted, the students are being educated about different ways of nurturing plants to grow into trees, while keeping their school vicinity clean and green.

SankalpTaru Foundation and Cairn India organized a workshop with students of State High Primary School in Barmer. Under their Clean & Green School program, the teams educated students about water harvesting through science kit, where the enthusiastic kids also participated actively to learn about environment conservation techniques.

Restoring community lands

By planting trees on barren community lands, we create green pastures and develop an ecosystem which engages community members in growing and nurturing trees.

The Aravallis are a vital 'Recharge Zone' for Delhi NCR which are being aggressively exploited to create concrete jungles, while its green foliage is being tarnished into barren land. Perturbed by the destructive plight of Aravallis, Rio Tinto and SankalpTaru Foundation collaboratively initiated Project Bhavnam to restore the greenery by creating green-lungs in this eco-sensitive region. Two thousand saplings of varied native plant species have been rooted on the rugged mountains of the Aravallis Range to strengthen the natural infrastructure around Delhi NCR.

To compensate for the forest fires that took place in Uttarakhand in 2016, native trees were planted. This program was designed to address the locals' needs, while preserving and growing trees suitable to protect and increase biodiversity. Ever since its execution, the project has come a long way in revamping the natural aura of the Himalayan region and has also enlightened the natives to prevent incidents of forest fires.

Way forward

Presently, SankalpTaru is leading the way in using the latest technology to better serve the planet. Beejyaan 1 is the organisation's first drone that uses the seed-bombing method to plant tree saplings in toughest terrains, like the Tehri belt. With increasing awareness and the need

Box: Project Green Leh Ladakh

The mystical mountains of Leh Ladakh which are located at an altitude of 3500m are undoubtedly scenic but they have sparse greenery. To revive its barren lands with healthy fruiting trees and increase groundwater levels, SankalpTaru Foundation, an IT-enabled tree plantation NGO operating across 18 Indian states, initiated 'Project Green Leh Ladakh' in the region during 2014. The team transports saplings during October and November and stores them in bunkers to preserve the plants from extreme snowfall. After the snow has cleared, trees are planted during April with the support of native villagers.

The plantations are carried out under two operational models: The Rural Livelihood Support Model, which undertake plantations of apple and apricot trees on the lands of rural farmers, and the Community Plantation Model under which fodder-bearing trees are rooted on vacant community patches. The NGO's effective impact is measured through its 95% tree survival rate in this area despite adverse weather conditions, where not only growing the plants but even the act of planting them in the first place is a tough challenge. By reaching out to more than 800 rural farmers and 50 schools in the region, SankalpTaru has developed a self-sustainable and biodiverse ecosystem through the addition of thousands of blooming green trees in the cold deserts of Leh Ladakh. These fruits are sold in the market and are a reliable source of income for farmers. The fruits also meet their nutritional needs and the roots bind the soil to prevent against flooding.

Having covered around 12 village clusters of Leh Ladakh with more than 30,000 flourishing trees, the organisation has also planted trees at the Indo-China border in Nyoma village. One thousand popular and select saplings were planted with the Indian Army to generate oxygen for them at high altitudes. SankalpTaru also planted trees in the flood affected villages of Tia and Vanla to prevent recurrent flood incidents in a flood-prone region.

for expanding green covers, the programme is being taken up as employee engagement programmes in the urban areas. As an employee engagement campaign, the aim is to reduce carbon footprints of the corporate officials, while enlightening them about the importance of trees through their green contribution.

With its aim of reaching more than a million healthy trees and expanding to global locations, the programme has come a long way in the last seven years, with its own share of challenges. Initially, arranging a seed capital funding was a challenge. Unlike for-profit ventures which have better access for funding from venture capitalists, non-profits find it challenging to arrange seed funding.

Another main challenge was to expand the operational network in a country like India, which is geographically, culturally and linguistically diverse. It was quite challenging to reach out to remotely located rural places in various program states. Since most of the program states spoke different regional languages, conversing with farmers and convincing them to adopt the program was quite a challenge.

With more than 95% survival rates, the plants are growing healthily, enhancing the green cover in many locations. While the programme is improving livelihoods in the rural areas, it is increasing the green cover and the lung spaces in the urban regions. In future, the full grown trees will help in cleaning the environment by filtering pollutants from the atmosphere. Most importantly, the programme is inculcating a sense of responsibility in communities towards maintaining a healthy environment. Innovatively integrating technology with nature, SankalpTaru allows people with no time or space to plant trees and contribute their share towards the environment. The initiative is efficiently connecting individuals with nature and also helping rural communities in strengthening their livelihoods.



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Photo: Author

Tree based farming system – A view

Green Festival *for Green India*

M N Kulkarni

The culture of planting trees with community participation is blended into the rural life styles through organizing planting festivals like *Hasiruhabba*.

Among 123 special days that are celebrated across the world for various issues every year, three days are reserved for the soil and plant life on the earth, namely, World Forestry Day (March-21), World Earth Day (April-22) and World Environment Day (June-05). Besides celebrating these occasions, there isn't much discussion among the general public on plants and their benefits for human beings.

Planting trees is the duty of all citizens, as all need clean air and environment to be healthy. However, planting is done as a token, to mark occasions like World Environment Day. It is the plants that provide food to the entire living beings on the earth, it is plants that absorb harmful gases and makes the air clean. A country needs to have at least 33% land under forest cover. But as per the latest estimates, forest cover in India is below 20%. Hence, planting and protecting the trees gains great significance.

Hasiru Habba, the green festival

BAIF, after putting in three decades in the extension and implementation of tree based development programmes such as watershed development, agro forestry, agri-horti-forestry etc., has reached to a conclusion that planting of trees has to be made part and parcel of the farming communities and general public. The culture of planting trees with community participation is to be blended into their life styles in such a way that, it should become a festival like other festivals in the villages and towns.

In order to popularize tree plantation on a large scale involving rural communities, BAIF Institute for Sustainable Livelihoods and Development-Karnataka, has been popularizing *Hasiru Habba*-Green festival, since 2001, in all its project locations. It is an effort to give religious touch and recognition to the planting of trees by involving people of all sections in the village - religious heads, politicians, social workers, government departments etc. Late Sri Sri Balagangadharanath Swamiji of Adichunchanagiri math, late Sri. Sri. Siddalingeswar Swamiji of Tontadarya math, Dambal, local MLAs, environmentalists and political leaders have participated in the events organized and motivated the community on the importance of planting and protection of trees. Other NGOs, farmer

Box 1: The Hasiruhabba oath

"Trees are an integral part of agriculture. We, the villagers, in the name of village Goddess, hereby take an oath that we will celebrate *Hasiruhabba* in our village every year, plant and protect as many trees as possible with community participation. We will also involve all family members, relatives, friends and neighbouring villagers in this Habba".

organizations, self help groups and village level organizations have replicated the concept.

Usually during June-July months, a date for *hasiruhabba* is fixed in consultation with the community. Project participants from nearby villages, school children, people's representatives and religious heads are invited to participate in the event. Transport of seedlings, seeds of fast growing plants, pit excavation in the selected land and other arrangements will be ensured on the previous day. The community gathers in the morning, goes to the plantation area in a procession, performs pooja to the seedlings and takes the *Hasiruhabba* oath (see box 1), before planting the seedlings.

Diverse species and their impact

Planting neem trees around the school premises and educational institutions will help in prevention of diseases. Planting of *Anthocephalus* sps (Kadamba), *Bilwara* and *Albezia lebbek* in towns and cities will help in controlling air pollution. Planting of *Michelia*, *Millingtonia* sps (Akash mallige) and *Nyctyanthse* sps (Parijatha) plants

Inaugurating Hasiruhabba at Mylanahalli village in Karnataka.



Photo: Author

around the garbage heaps and drainage lines have the capacity to mask the bad odour coming out in such places. The species such as *Ficus religiosa*, *Ficus glomerata*, *Ficus bengalensis* etc., can be planted in parks and temple premises as these plants have the capacity to clean the air. A study conducted by the Banaras Hindu University suggests to go for planting of species like *Caesalpinia sappan*, *Dalbergia sissu*, *Psidium guava* and *Albazia lebbek* in towns and cities as these are air pollution tolerant species.

Live hedge fences help in carbon sequestration and thus act as mitigation against climate change. Live hedge fence around the orchards and field boundaries can be established by planting cuttings of *Glyricidia*, *Erythrina*, *Lantana* etc., in rainy season. Also seeds of fast growing species like *Sesbania*, *Subabul* and *Glyricidia* can be drilled along the boundary. These will get established soon. From the second year onwards, fence starts providing large quantity of biomass which can be used for making compost. Over a period of time, native species start growing all along the fence.

The plants like *Glyricidia*, *Subabul*, *Erythrina* and *Sesbania grandiflora* are fast growing species and can be established through direct seed dibbling during rainy season. These will cater to the fodder needs as well as biomass that can be incorporated into the soil. Farmers need seeds and motivation to adopt this low cost practice.

The Government of Karnataka is also promoting biofuel species in private lands and government lands through Karnataka State Biofuel Development Board. The species such as *Pongamia*, *Simaruba*, *Jatropha*, *Madhuca* etc., have been provided to the farmers through *Hasiru Honnu* and *Baradu bangara* project. Farmers can be motivated to plant these species all along the field bunds and in the uncultivable lands. Apart from seed production, there will be lot of biomass and leaf litter. This can be converted into compost and applied to the field so as to reduce application of chemicals and fertilisers in the climate change context.



Photo: Author

Communities planting trees during Hasiruhabba

Wider outreach

Tree plantation need to be promoted in common lands, school premises, temple premises, fallow lands, roadside plantations, etc., Planting trees needs to be imbibed as a culture and not be enforced. This requires strong community mobilization. In villages, involving self help groups, youth clubs, school children will go a long way in sustaining plantation activities. Farmers in dry lands need to be supported to take up agro forestry and tree based farming systems. Depending on the availability of space, at least one or two plants can be planted in the backyards. Planting at least 200 to 300 trees per acre should be made mandatory for availing benefits of any government schemes. Ultimately, it is the trees that are going to sequester carbon from the atmosphere and help in mitigating climate change effects.



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Bio-primed plants

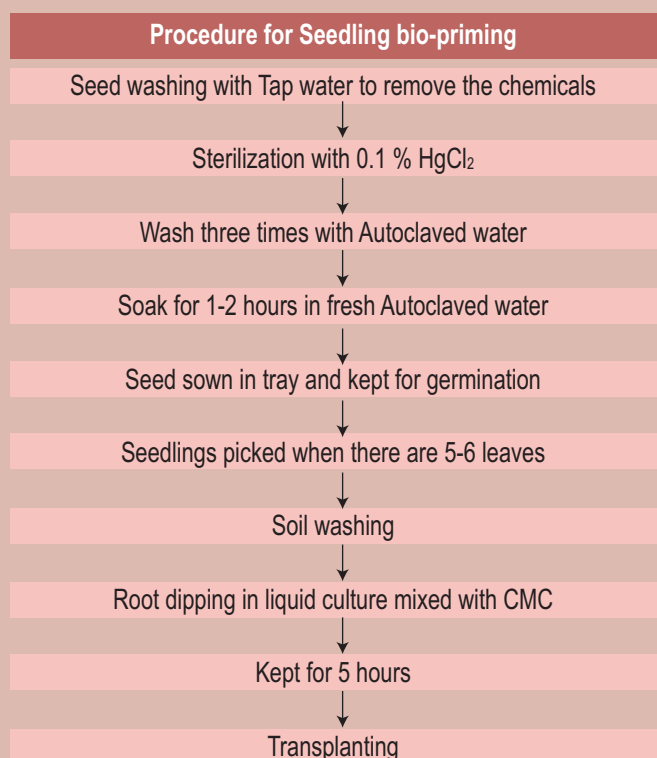
The future of food and nutrition security

Deepranjan Sarkar, Sonam Singh,
Ardith Sankar and Amitava Rakshit

Meeting the food demands along with nutritional security, without exploiting the natural resources is the biggest challenge that we are facing today. It is necessary to adopt alternative strategies that enhance resource use efficiency, without damaging the environmental quality.

Indian agriculture is facing big challenges in terms of depleting soil organic matter, imbalance in fertilizer use, emerging multi-nutrient deficiencies particularly of secondary and micronutrients, declining nutrient use efficiency, negative soil nutrient balance, etc. As all these problems can be well linked with fertilizer application in soil, the issues becomes more stringent when farmers pay double prices for these energy related inputs, viz., fuel and fertilizers. It's high time to change our production plans with new energy conservation methods substituting the existing energy intensive and costly production system.

The increasing demand of qualitative and varietal foods by the consumer society demands energy production. Utilisation of that energy in a judicious manner for sustainable management of resources is a big challenge in the future. The depleting resources warrant farming communities to adopt alternative strategies to enhance the input use efficiency as well as the environmental quality.



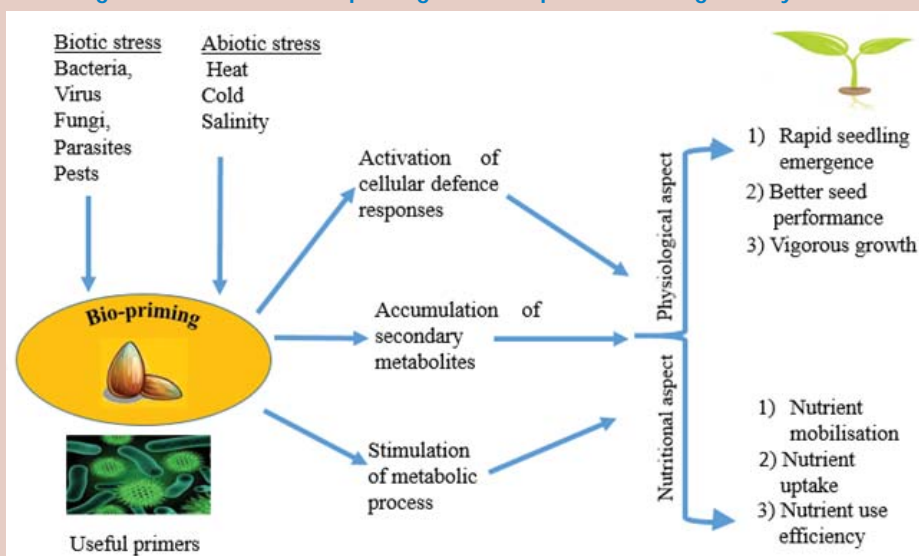
Adaptability of microbes to thrive in different environments has attracted scientists to introduce microbial intervention in the agricultural processes. Bio-priming has the potential to fulfil many objectives of the modern production system with the use of beneficial microorganisms in an eco-friendly manner.

The technique

Bio-priming is a technique of biological seed treatment combining a variety of physiological and biological aspects related to seed and plant growth promotion together in one process (Fig 1). A controlled seed hydration is carried following beneficial microbial seed inoculation under warm and humid conditions. Microbial coating of seeds is done by taking eligible species of fungi and bacteria such as *Trichoderma*, *Pseudomonas*, *Bacillus*, *Rhizobium*, *Azospirillum*, *Glomus*, *Azotobacter*, *Agrobacterium*, etc. During seed imbibition, partial germination is allowed which triggers numerous physiological and biochemical processes (cell repairment, metabolism of reserves, DNA repairment, protein synthesis, ROS detoxification) in seeds, and before the emergence of plumule and radicle, the water treatment is terminated.

Bio-priming is an advanced seed treatment process in this era to empower the plants function effectively in all

Fig 1: Mechanisms of bio-priming mediated processes in agroecosystems



conditions. The bio-innovative system will work as growth enhancer, disease controller, and quality maintainer along with increased production. The performance of bio-primed seeds is noticed under diverse agroecological systems because of rapid germination, uniform seedling emergence, reduced seed dormancy, improved nutrient uptake, and greater tolerance to environmental stresses (pests and diseases).

Field experiment

Farmers of Indo-Gangetic Plains of Uttar Pradesh are involved in seed bio-priming before sowing for numerous crop species including rice, wheat, maize, and pulses. However, seedling bio-priming is recommended for

Non-primed plants (RDF @ 120:60:60)



Primed plants [75% RDF (90:45:45) + *T. harzianum* + *P. fluorescens*]



Photo: Author

Table 1: Effect of bio-priming and NPK fertilisation on nutritional quality of red cabbage (mean of 2 years)

Treatment	N (%)	P (%)	K (%)
Absolute control N:P ₂ O ₅ :K ₂ O @ 0:0:0 kg ha ⁻¹	1.89	0.43	2.36
RDF of N:P ₂ O ₅ :K ₂ O @ 120:60:60 kg ha ⁻¹	2.70	0.52	2.63
75% RDF + <i>Trichoderma harzianum</i>	3.12	0.53	2.85
75% RDF + <i>Pseudomonas fluorescens</i>	3.19	0.56	3.39
75% RDF + <i>Bacillus subtilis</i>	3.01	0.53	3.43
75% RDF + <i>T.harzianum</i> + <i>P.fluorescens</i>	3.38	0.57	3.38
75% RDF + <i>P. fluorescens</i> + <i>B. subtilis</i>	3.33	0.61	3.61
75% RDF + <i>T.harzianum</i> + <i>B. subtilis</i>	3.26	0.58	3.50
75% RDF + <i>T.harzianum</i> + <i>P.fluorescens</i> + <i>B. subtilis</i>	3.06	0.55	3.43

vegetables (cabbage, cauliflower, or brinjal). A high nutrient requiring crop (N:P₂O₅:K₂O @ 120:60:60kg ha⁻¹), viz., red cabbage was selected for bio-priming. Healthy seedlings were transplanted in 4 × 2 m² plots at a spacing of 50 cm × 50 cm. Three priming agents (*Trichoderma harzianum*, *Pseudomonas fluorescens*, and *Bacillus subtilis*) singly and in combination were used with 75% recommended dose of fertilizers (NPK). Field experiments were conducted at Vegetable Research Farm, Banaras Hindu University during *rabi* seasons of 2016 and 2017.

Results

Bio-priming enhanced the nutrient uptake of red cabbage crop both in terms of macronutrient (N, P and K) and micronutrient (Fe, Mn, Zn and Cu). Based on the nutrient content (N, P and K), combined application of *T.harzianum* and *P.fluorescens* resulted in highest N%, whereas combined application of *P.fluorescens* and *B. subtilis* resulted in highest P% and K% (Table 1). Microbial consortium performed better than single species priming. However, dual consortium surpassed triple consortium. Economical yield and energy use efficiency was higher in bio-primed treatments. These might be due to increased microbial activity in soil releasing enzymes, hormones and organic acids. The growth of primed plants was higher than non-primed plants. Rhizospheric interactions due to bio-priming have modulated the root architecture of crop, mobilized nutrients and improved the nutrient use efficiency. Strategic nutrient management has expedited the process of mineral element acquisition by plants from the soil.

Conclusion

Growing concerns among public about thoughtful health hazards (both environment and human) urge the requirement of eco-friendly, economical, and sustainable agriculture. Bio-priming is a simple tool that can be adopted even by small farmers. These sort of interventions besides reducing the level of fertilizer application will also improve the nutrient use efficiency of crops. Also, the use of agrochemicals is uneconomical leading to ecological disruptions. Pre-treatment of seeds with microbial agents

has enormous potential in modern times. Selective use of microbes for specific purposes can further yield in high results. Bio-priming must therefore be integrated in to the existing technology of integrated nutrient management to achieve sustainable yields in agriculture.

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No fertilisers, no pesticides

This Karnataka farmer uses only solar energy

Kailash Murthy's experiment with natural farming stands out as a model for every small and marginal farmer in the country.

Ecology can survive without economics but economics can't survive without ecology. M K Kailash Murthy had learnt this the hard way. A banker-turned-farmer in Doddinduvadi village of Chamarajanagar district has turned a farmland of 22 acres into a mini forest in one of the most drought-prone regions in the state. At a time when states like Punjab are calling for reducing use of pesticide and chemical fertilisers, Murthy's experiment with natural farming stands out as a model for every small and marginal farmer in the country.

Murthy began practising chemical farming in 1984. Within a span of four years, he realised the ill-effects of biodiversity loss. Soil fertility started depleting and plants started demanding more water and fertilisers.

"Farmers must understand that pests are natural occurrences. Left alone, the crops develop a resistance to them. Merely spraying crops with pesticides will not put a check on pests. Initially, it may seem to work, but in the long run the pests become immune. That's what happened to me in the initial years," says Murthy. "Pests in my farms developed resistance to all pesticides and the plants started demanding more NPK, urea, potash and water," says Murthy.

The Beginning

Inspired from Masanobu Fukuoka, a pioneer in natural farming in Japan, Murthy switched to natural farming in 1988. Almost 30 years have passed since then and Murthy hasn't ever used chemical fertilisers or pesticides. Even today, he follows no-tilling and no-weeding approach. "For cultivation, I don't even use organic manure like *panchagavya* and *jeevamrita*. I am only using photosynthesis," he says, while substantiating his claim of practicing zero-input farming.

His farm now has a total of about 3069 trees, including beetle nut, mango, banana, val beans, papaya and a wide number of herbs.

If Murthy is not using pesticides, how is he tackling pests? "It is elementary science that teaches us how plant produces its own food and develops resistance for pests. Moreover, nature will never allow one species to rule the world," answers Murthy. Explaining the benefits of crop diversity, he adds, "When you grow different types of vegetables, plants and fruits, each crop becomes less susceptible to pests because the latter will have more natural enemies to check their growth," says Murthy, while referring to a phase of his life when he identified

trees that are harmful for banana cultivation and introduced “enemy trees” to kill those trees so that banana plantation can thrive.

In his banana plantation, the banana canopy covers the area underneath, and in the process, protects, promotes and supports soil microbes. The organic matter falls from banana-supporting plants, which becomes food for the microbes. Moreover, water evaporation is avoided because the surface of the soil is covered. Thus, soil moisture is retained.

Murthy has also established the Academy of Natural Farming near Kollegal taluk with the sole objective of bringing awareness about ill-effects of fertilisers and benefits of going back to natural farming. He, along with Prof M D Nanjundaswamy, is working towards popularising zero-input farming in and around Karnataka by showing people how natural farming helps fighting climate change and maintaining genetic stock. He is also perhaps the only one in the country to run a solar-powered food processing plant near his farm.

If you kill biodiversity with “deadly inputs”, you are practicing ‘agri-criminology’

Straight from the scientists’ mouth

Few years back, he invited experts from agricultural universities and research centres across the country to study his farm and identify its merits and demerits. They found the plants healthy with no visible symptoms of any deficiency or disease. M N Ramesh of University of Agriculture Science, Bangalore, acknowledged that all the horticultural plants in Murthy’s farm are free from pests, bearing lots of healthy fruits and nuts.

More than 138 species of herbs and trees, belonging to 28 families, are growing in harmony like a forest ecosystem by using only sunlight. According to the

Inspired from Masanobu Fukuoka, a pioneer in natural farming in Japan, Murthy switched to natural farming in 1988.



Photo: M K Kailash Murthy

Types of bacteria found in Murthy's farm and their benefits

Bacteria	Benefits
Bacilli	fixes nitrogen and brings about organic matter decomposition and heavy metal transformation
Mucor	brings about nitrogen transformation, organic matter decomposition and biodegradation of hydrocarbon in the environment
Bacillus	brings about phosphate solubilisation
Arthobacter sp	brings about organic matter decomposition of soil
Pseudomonas	fixes N ₂ , C, P, S

scientists who studied his farm, a thick layer (about 9 inches) of leaf litter produced by the weeds and falling leaves and twigs from the tree species is very efficient for mulching and preventing soil erosion. Moreover, the weeds and fallen leaves go through natural recycling by soil organisms like earthworms, insects and fungi found in the soil.

Rainwater trickles down to the roots and recharges ground water aquifer. Carbon sequestration, according to experts' estimate, is about 1085 tonnes annually by trees species. According to the soil analysis by Dr N Nandini, Reader and Principal Investigator, Department of Environmental Science, Bangalore University, samples from his land showed that the soil has high NPK (nitrogen, phosphorus and potassium) content apart from adequate quantity of micronutrients like nickel, zinc, iron, copper and magnesium.

Over 300 horticulture trees and timber trees in his farm prevent raindrops from directly falling and checking soil erosion.

But, is his farm insulated from impact of climate change?

"You see, a mango tree is an indicator of changing climate. From flowering to pollination and maturation of fruit, every transition used to be predictable in the past. We knew that mango trees will start flowering from mid-January and we will harvest fruits by May. But this year, the flowering took place in December. Moreover, a mango tree needs moderate temperature to grow. For the last few years, I have been noticing long spell of excess heat, which burns the flowers. Climate change is making it



Photo: M K Kailash Murthy

The organic matter falling from banana-supporting plants becomes food for the microbes.

increasingly difficult for farmers to predict the fruit's lifecycle.'

While talking to him, one can realise that he is not just concerned about his mango trees, but also the microbes and insects dependent on mango trees. "You can imagine what these tiny creatures have to go through to adapt to these changes. They have to undergo a complete lifecycle change to survive and help the next generation grow," he rues.

"We don't get health security from super specialty hospitals, but from the **food diversity**. That's why, all these years, I have studied organisms under the ground and understood their ability to supply nutrient to soil."

Adopting natural farming becomes relevant in present times because marginal farmers are increasingly looking to reduce their input cost and is not incurring any loss but making profit all these years.



This article was originally published in Down to Earth. You can find the link at: <https://www.downtoearth.org.in/news/agriculture/karnataka-farmer-hasn-t-used-fertilisers-pesticides-for-three-decades-now-57443>

Plant is everything for life on the planet

Every living being needs food to eat, water to drink and air to breathe. There is no exemption for this natural law. Of course, sun light and space are also necessary for a healthy life. But these two items are just taken for granted.

Plants provide the humanity with food. They are central for the rainfall we receive and very important for purifying the air we breathe. Only when the plant is healthy, can we get healthy food. Also, plants absorb the carbon-dioxide from the atmosphere to prepare glucose and release oxygen, which is so basic for the survival of other living beings. As such, all the basic needs of a living being are supplied by plants only. Not only food, water and air, plants provide economic, environmental and ecological support too.

One thing we have to remember is, that the most valuable thing in our life is SOUL. Nothing is more valuable than this. To protect the soul, we need a healthy body. To gain a healthy body, we need good and nutritious food. We can get good food, only from plants. Though meat and fish could be other forms of food, yet the primary link in the food chain is plant or its products. So it is clear that without plants, no food is available for any living being.

Mr. Masanobu Fukuoka, the father of Natural Farming, from whom I took training on Natural Farming, used to say *“I don't believe that rain comes from sky or sea. It comes from TREES only. So, we have to understand, that water is also given / brought by plants only.”*

In my farm, I have five tier system of well placed and well spaced plants, to utilise the natural resources to the maximum. Coconut is the major crop. Below this, I have arecanut, cocoa, nutmeg, bread fruit and some medicinal plants like aloe vera, pepper etc. It is carefully planted so that no one plant suffers from lack of sun light. The farm is a Natural Farm, and so, all the plants support each other and give better yield. The problems of water utilization, weed control, pest management are all solved without any difficulty. From my experience I understood that the right choice in mixed plants guarantee the growth and

multiplication of predators also, in addition to the development of healthy soil.

The extent of my farm is 50 acres. And in all the 50 acres, mixed cropping pattern is followed. Value addition of agricultural produce is done to get more income from my farm. Women in this farm are engaged throughout the year, as they have some work to do daily. If it is a mono crop or seasonal crop, there will be big intervals often.

Society is benefited, by effective micro climate created in this area. The temperature inside my farm is reduced to a great level, because of the dense population of different plants and trees and also with live fencing. The effect of micro climate is such that my Solar Dryer, which I use to dry coconut, cocoa, pepper etc., has rendered useless owing to cool temperature within the farm. While my farmer friend uses the solar dryer all through the year, I am able to use it only in hot summer and not in other seasons.

The congenial micro climate in the farm helps faster multiplication of microbes and earthworms. It also nurtures good and beneficial relationship between plants, pests and pathogens. The expenditure for the pest and disease control is minimum, which increases the net income of this farm.

“Turn to Nature, otherwise, you will be turned”, said Masanobu Fukuoka many decades ago, which applies to the present even more than before.



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India plants 220 million trees in a single day

By Sophie Lewis, August 9, 2019 / 6:30 PM / CBS News

In just one day, more than a million people in India planted 220 million trees. It's all thanks to a government campaign to combat climate change and improve the environment, according to The Associated Press.

The trees were planted in the country's most populous state, AP reports. The saplings were all planted by 5 p.m. Friday in northern Uttar Pradesh, which has a population of more than 200 million people.

Forest official Bivhas Ranjan said students, law makers, officials and other residents planted dozens of species of saplings along roads, railroad tracks and in forests. The goals are to increase forest cover and absorb carbon dioxide from the atmosphere.

Chief Minister Yogi Adityanath tweeted a plea to young people to "save Mother Earth" and improve the environment for future generations. "We set the target of 220 million because Uttar Pradesh is home to 220 million people," he said.

"The whole process is online," state government spokesman Awanish Awasthi said. "The pits are geo-tagged and the saplings carry a QR code. So we can record how many saplings are planted and where."

India has pledged to have trees cover at least one-third of its land area, but its efforts are complicated by its population and rapid industrialization.

According to a recent study, scientists say planting a trillion trees globally could be the single most effective way to fight climate change. Since trees absorb carbon dioxide, which contributes to global warming, a worldwide planting initiative could remove a substantial portion of heat-trapping emissions from the atmosphere.

But rather than adding trees, in many parts of the world, they're being cut down on a massive scale. Deforestation is a major concern in the Amazon, where acres of rainforests are being cut down every day to make room for agriculture.

So while reforestation may be the best solution, halting deforestation and reducing animal agriculture would also provide immediate benefits.

Source: <https://www.cbsnews.com/news/climate-change-india-plants-220-million-trees-in-a-single-day-to-save-the-planet/>

China and India help make planet leafier

By Roger Harrabin BBC environment analyst

China and India, two of the world's biggest polluters, are making it leafier - for now, a report says.

The greening effect stems mainly from ambitious tree-planting in China and intensive farming in both countries. There are now more than 2 million sq miles of extra leaf area per year, compared with the early 2000s - a 5% increase. Extra foliage helps slow climate change, but researchers warn this will be offset by rising temperatures.

What exactly is happening?

Satellite data from the US space agency NASA shows that over the last two decades there has been an increase in leaf area on plants and trees equivalent to the area covered by all the Amazon rainforests. The greening was first detected in the mid-1990s.

Scientists first assumed plants were being fertilised by the extra CO₂ in the atmosphere and boosted by a warmer, wetter climate. But they didn't know whether changes in farming and forestry were contributing to the changes. Thanks to a NASA instrument called Modis, which is

orbiting the Earth on two satellites, they can now see that both are clearly playing a direct part, too.

Why are China and India in the lead?

China's contribution to the global greening trend comes in large part (42%) from programmes to conserve and expand forests. The policies were developed to reduce the effects of soil erosion, air pollution and climate change. Another 32% of the greening there – and 82% of the greening in India – comes from intensive cultivation of food crops, thanks to fertilisers and irrigation.

Production of grains, vegetables, fruits and other crops has increased by 35% to 40% since 2000, so both nations can feed their large populations.

The future of the greening trend may change depending on numerous factors. For example, India may run short of groundwater irrigation.

On the global picture, scientists recently warned that CO₂ in the atmosphere could reach record levels this year as a result of heating in the tropical Pacific which is likely to reduce CO₂ uptake in plants.

Does this affect predictions of climate change?

Rama Nemani, from NASA's Ames Research Center, a co-author of the work said: "Now that we know direct

human influence is a key driver of the greening Earth, we need to factor this into our climate models.

"This will help scientists make better predictions about the behaviour of different Earth systems, which will help countries make better decisions about how and when to take action." The scientist who first spotted the warming trend, Prof Ranga Myneni from Boston University, reiterated a previous warning to BBC News that the extra tree growth would not compensate for global warming, rising sea levels, melting glaciers, ocean acidification, the loss of Arctic sea ice, and the prediction of more severe tropical storms.

But it's acknowledged that although carbon uptake from plants was factored in to Intergovernmental Panel on Climate Change (IPCC) models, it remains one of the main sources of uncertainty in future climate forecasts.

The research comes as a UK-based think tank IPPR warned that governments should not focus narrowly on any single environmental problem, but recognise the slew of environmental issues facing the world, including the loss of soil which is already reducing fertility in many areas.

Source: <https://www.bbc.com/news/science-environment-47210849>

Ambala farmers skip burning, sow wheat on paddy residue

Nitish Sharma, Tribune News Service, Ambala, December 1

The burning of crop residue has been a major issue in the region and different measures, including incentive, fine and legal action, are being taken by the government to stop farmers from burning stubble. But scientists of Krishi Vigyan Kendra, Tepla, have managed to persuade farmers to sow wheat on nearly 500 hectares in Tepla, Racheri, Rattanheri, Sapeda and Samlehri villages in Ambala without removing and burning the paddy residue.

The first trial was done last year on 200 acres and after getting success, more farmers have started showing interest in Ambala. The scientists had made some changes in the Happy Seeder (new-generation planters) to sow wheat in the residue. The scientists, during their study, found that the nutrients in the residue may reduce fertiliser requirement, weed density was less, crop lodging did not

occur in the crop residue management plots during the last irrigation and farmers harvested qualitative grain yield.

Guru Prem Grover, Subject Matter Specialist (Soil and Water Management), said, "Residue burning is a fast and cheap option for farmers to clear their fields. The challenge is to change the mindset of farmers as they don't want to change their conventional methods of farming.

"We have been organising visits of farmers at the demonstration plots and to the plots of farmers who have sown wheat without removing the residue. They are being told that the cost of cultivation can be reduced by adopting newer methods and that it can also save water by 20-25 per cent," he added.

The scientists claim the burning of residue also results in the loss of plant nutrients and organic carbon of the soil, deteriorating the soil health.

About 70 per cent quantity of fertiliser remains in the residue. Mixing the residue back into the soil decreases the requirement of fertiliser for the next crop.

<https://www.tribuneindia.com/news/haryana/ambala-farmers-skip-burning-sow-wheat-on-paddy-residue/868954.html>

FAO launches 2020 as the UN's International Year of Plant Health

2 December 2019, Rome

The Food and Agriculture Organization (FAO) today launched the United Nations' International Year of Plant Health (IYPH) for 2020, which aims to raise global awareness on how protecting plant health can help end hunger, reduce poverty, protect the environment, and boost economic development.

Plants make up 80 percent of the food we eat, and produce 98 percent of the oxygen we breathe. Yet, they are under constant and increasing threat from pests and diseases. Every year, up to 40 percent of global food crops are lost to plant pests and diseases. This leads to annual agricultural trade losses of over \$220 billion, leaves millions of people facing hunger, and severely damages agriculture – the primary income source for poor rural communities. This is why policies and actions to promote plant health are fundamental for reaching the Sustainable Development Goals.

“Plants provide the core basis for life on Earth and they are the single most important pillar of human nutrition. But healthy plants are not something that we can take for granted,” said FAO Director-General Qu Dongyu who launched the Year on the sidelines of the UN agency's Council meeting.

Climate change and human activities are altering ecosystems, reducing biodiversity and creating conditions where pests can thrive. At the same time, international travel and trade has tripled in volume in the last decade and can quickly spread pests and diseases around the world causing great damage to native plants and the environment.

“As with human or animal health, prevention in plant health is better than cure,” stressed the FAO chief.

Protecting plants from pests and diseases is far more cost effective than dealing with full-blown plant health emergencies. Plant pests and diseases are often impossible



INTERNATIONAL YEAR OF
PLANT HEALTH

2020

to eradicate once they have established themselves and managing them is time consuming and expensive.

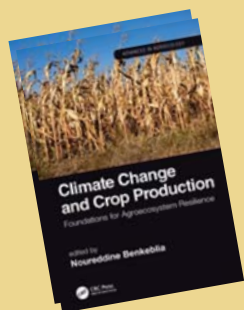
Qu Dongyu also urged for prompt action, pointing out that much still needs to be done to ensure plant health.

“On this International Year and throughout this Decade of Action to deliver the Sustainable Development Goals, let us dedicate the necessary resources and increase our commitment to plant health. Let us act for people and planet,” said António Guterres, UN Secretary-General in a message read out at the event.

The following ministers also spoke at the event: Edward Centeno Gadea, Minister of Agriculture and Livestock, Nicaragua; Andrew Doyle, Minister of State at the Department of Agriculture, Food and the Marine, Ireland; Jaana Husu-Kallio, Permanent Secretary of the Ministry of Agriculture and Forestry, Finland; and Tamara Finkelstein, Permanent Secretary of Department for Environment, Food and Rural Affairs, UK.

In his opening remarks, the FAO Director-General Qu Dongyu commended the Government of Finland for taking the lead in proposing a year dedicated to plant health and coordinating efforts to have the year declared.

Source: <http://www.fao.org/news/story/en/item/1253551/icode/>



Climate Change and Crop Production Foundations for Agroecosystem Resilience, 1st Edition

Nouredine Benkeblia (Ed.), 2019, *CRC Press*, 206 p., £43.39, ISBN: 9780367895921

Presenting an overview of agroecology within the framework of climate change, this book looks at the impact of our changing climate on crop production and agroecosystems, reporting on how plants will cope with these changes, and how we can mitigate these negative impacts to ensure food production for the growing population. It explores the ways that farmers can confront the challenges of climate change, with contributed chapters from around the world demonstrating the different challenges associated with differing climates. Examples are provided of the approaches being taken *right now* to expand the ecological, physiological, morphological, and productive potential of a range of crop types.

Giving readers a greater understanding of the mechanisms of plant resilience to climate change, this book provides new insights into improving the productivity of an individual crop species as well as bringing resistance and resiliency to the entire agroecosystem. It offers a strong foundation for changing research and education programs so that they build the resistance and resilience that will be needed for the uncertain climate future ahead.

Food Security Policy, Evaluation and Impact Assessment 1st Edition

Sheryl L. Hendriks (Ed.), 2019, *Routledge*, 240 p., £36.99, ISBN: 9781138497092

This book offers an essential, comprehensive, yet accessible reference of contemporary food security discourse and guides readers through the steps required for food security analysis.

Food insecurity is a major obstacle to development and achievement of the Sustainable Development Goals. It is a complex issue that cuts across traditional sectors in government and disciplines in academia.

Understanding how multiple elements cause and influence food security is essential for policymakers, practitioners and scholars. This book demonstrates how evaluation can integrate the four elements of food security (availability, access, nutrition and resilience) and offers practical tools for policy and programme impact assessment to support evidence-based planning.



Biological Diversity Balancing Interests Through Adaptive Collaborative Management, 1st Edition

Louise E. Buck, Charles C. Geisler, John Schelhas, Eva Wollenberg (Eds.), 2019, *CRC Press*, 504 p., £54.99, ISBN: 9780367455224

We live in a world of wide pendulum swings regarding management policies for protected areas, particularly as they affect the involvement of local people in management. Such swings can be polarizing and halt on-the-ground progress. There is a need to find ways to protect biodiversity while creating common ground and building management capacity through shared experiences. Diverse groups need to cooperate to manage forests in ways that are flexible and can incorporate feedback.

The book addresses the problem of how to balance local, national, and global interests in preserving the earth's biological diversity with competing interests in the use and exploitation of these natural resources. This innovative book examines the potential of adaptive collaborative management (ACM) in reconciling a protected area's competing demands for biodiversity conservation, local livelihood support, and broader-based regional development. It clarifies ACM's emerging characteristics and assesses its suitability for a variety of protected area situations.





People-Plant Relationships Setting Research Priorities, 1st Edition

Raymond P Poincelot and Joel Flagler, 2019, *CRC Press*, 466 p., £38.49
ISBN: 9780367449582

Presenting the latest research on cross-cultural people-plant relationships, this volume conveys the psychological, physiological, and social responses to plants and the significant role these responses play in improved physical and mental health. With chapters written by field experts, it identifies research priorities and methodologies and outlines the steps for developing a research agenda to aid horticulturalists in their work with social scientists to gain a better understanding of people-plant relationships. This resource covers a wide array of topics including home horticulture and Lyme disease, indoor plants and pollution reduction, and plants and therapy.

Farmers and Plant Breeding Current Approaches and Perspectives, 1st Edition

Ola Tveitereid Westengen, Tone Winge (Eds.), 2019, *Routledge*, 332 p., £120.00
ISBN: 9781138580428

Plant breeding is essential to food production, climate-change adaptation and sustainable development. This book brings together experienced practitioners and researchers involved in collaborative breeding programmes across a diversity of crops and agro-ecologies around the world. Case studies include collaborative sorghum and pearl millet breeding for water-stressed environments in West Africa, participatory rice breeding for intensive rice farming in the Mekong Delta, and evolutionary participatory quinoa breeding for organic agriculture in North America. While outlining the challenges, the volume also highlights the positive impacts, such as yield increases, farmers' empowerment in the innovation and development processes, contributions to maintenance of crop genetic diversity and adaptation to climate change. This collection offers a range of perspectives on enabling conditions for farmer-breeder collaboration in plant breeding in relation to biodiversity agreements such as the Plant Treaty, trade agreements and related intellectual property rights (IPR) regimes, and national seed policies and laws.



Connecting Indian Wisdom and Western Science Plant Usage for Nutrition and Health, 1st Edition

Luisella Verotta, Maria Pia Macchi, Padma Venkatasubramanian (Eds.), 2019, *CRC Press*, 470 p., £54.99, ISBN: 9780367377700

A truly integrated collection of research, *Connecting Indian Wisdom and Western Science: Plant Usage for Nutrition and Health* compares Ayurvedic and Western conceptions of wellness, healthy lifestyle, and diet. It includes approximately 40 selected monographs on fruits, vegetables, spices, nuts, and seeds, complete with Ayurvedic and traditional uses as nutritional ingredients.

The book focuses on how plants can be employed as both aliments and adjuvants, able to improve health and the quality of life. It does so by comparing the Indian Ayurvedic tradition with the Mediterranean diet. Chapters written largely by Indian authors trace the early history of Ayurveda and the basic principles and dietetics of the Ayurveda, Siddha, and Unani systems of medicine. Chapters written by western scientists and nutritionists discuss the global focus on nutrients, nutraceuticals, and, importantly, the Mediterranean diet.



Building on this foundation, the book opens what will, no doubt, be a long and continuing journey of mutual exchange and dialogue. The authors create an integrated perspective for understanding India's health traditions through the lens of modern science.

Growing trees, strengthening livelihoods, protecting environment

Supriya Patil

Grow-Trees.com, a social enterprise is providing a cost-effective service to individuals and companies globally to enable planting of trees. Through its web enabled services, the organization is giving every person an opportunity to do his/her bit in protecting the environment.

Rural communities are involved in various activities during the plantation process

The rural communities in India have long lived in deprivation. They not only lack the basic amenities to survive but they also find it challenging to make ends meet without access to resources like water, food and regular income. Most of these communities reside in regions with low soil fertility, minimal employment opportunities and polluted water bodies.

Grow-Trees.com, a social enterprise, with an aim to uplift the socio-economic conditions of the rural and tribal communities promoted tree



Photo: Grow-Trees.com

Box 1: Story of Mrs. Devi

The project has brought a significant change in life of 35 years old Mrs Devi, belonging to the Irula tribal community of Villupuram, who has three sons to look after in her family. Earlier, working as a day labourer with about 13 hours of rigorous work, she could neither spare any time to look after her family nor contribute to her children's health, education or wellbeing.

After being engaged and employed as a nursery worker for the plantation project, Mrs. Devi feels dignified to work in an organizational atmosphere, and is now also able to contribute to her children's education, health and is living a fulfilled life with her family. Her work is also looked-up by many others in her community.

plantation initiatives across India in 2010. The goal is to reconnect these community members to the basics of life.

In the last 10 years, the organisation has expanded to 20 states across India, namely, Odisha, West Bengal, Maharashtra, Jharkhand, Madhya Pradesh, Karnataka, Andhra Pradesh, Rajasthan, Bihar, Arunachal Pradesh, Uttar Pradesh, Chhattisgarh, Gujarat, Tamil Nadu, Sikkim, Telangana, Uttarakhand, Delhi, Puducherry, and Punjab. The recent afforestation project in Cherangani Hills, Kenya has taken it on to the global level.

The process

Grow-Trees, with the help of its Project coordinators, planting partners and environmental researchers, selects community lands in need of reforestation and/or afforestation and initiates plantation activities. The trees are planted only on public lands to ensure maximum benefit being provided to the inhabitants of the region.

Awareness drives are organized to involve the rural communities in the plantation process. Meetings are held at the village level educating the Panchayat and the community members about the benefits of the trees,

important measures to keep in mind for their upkeep and the plantation process. During these meetings, it is made sure that the value from the trees is conveyed to the community members. Community members are sensitized about the value of trees which keeps them away from overexploiting the land or using it for grazing purposes.

The tree species planted are chosen after long research and consultation with experts and the community members, based on the latter's needs. Often, plants species that hold ethnic, ayurvedic as well as economic value to the local rural communities are planted to preserve the local biodiversity. Based on the features of the soil, rain patterns in the region and economic, medicinal and social needs of the rural communities and the wildlife, the suitable tree species are sourced and bred in local nurseries. For eg., mangroves are planted in the periphery of Sundarbans National Park, West Bengal as a measure towards disaster management from the impending cyclones that frequently hit the Bay of Bengal. In recent studies, it has also been highlighted that due to the shield of trees in and around the Sundarbans National Park, massive damages from natural calamities have been prevented in Kolkata.

In order to achieve higher survival rate, saplings are first raised in the nurseries and then transported to the plantation sites upon maturity. The rural communities are involved in various activities during the plantation process, i.e., raising saplings in the nursery, transporting of saplings to the plantation site, site clearance and pit-digging, plantation of saplings and watering the field etc. This has generated employment to the tribal-rural communities, especially for women on a daily-wage basis.

Since the trees belong to the community, they are the sole recipients of all the socio-economic benefits from

Over 4.5 million trees have been planted across 20 states of India, generating approximately 370,000 workdays of employment for the rural communities.

Box 2: Greet with Trees®

Grow-Trees.com offers a unique Greet with Trees® feature, wherein individuals can plant a tree online and greet their loved ones with an eTreeCertificate®. Via its Plant Monthly, Greet Anytime!® Subscription, Grow-Trees.com is attempting to imbibe the habit of tree plantation in every household of India. These eTreeCertificates® can be used to gift family and friends on birthdays, festivals, anniversaries and other special occasions. Each tree that you plant with them, provides for the sustenance of the rural communities. This is their attempt of re-greening the country and providing equal opportunities to every citizen of India.

those trees. Communities decide whether they need to consume or market the harvest from fruit trees and the NTFPs (Non-Timber Forest Produce) in the local markets. Once mature, the NTFPs also provide sustainable sources of income to the members throughout their lives.

Results and impact

Gifted to the nation on the World Environment Day of 2010, this organisation has planted over 4.5 million trees across 20 states of India, generating approximately 370,000 workdays of employment for the rural communities.

They have aided in generating alternative sources of income by inculcating rural employment during the plantation process and by providing non-timber forest produce that can be utilised for both consumption and sales. *“Even when my sons have left us, these trees will stay with me, forever, to take care of me and my wife in our old age”*, shares one of the members involved in the plantation.

Through their projects, Grow-Trees have succeeded in providing water to the deserted villages of Rajasthan and Gujarat. For instance, in the region of our plantation site near Sariska Tiger Reserve, the water table has come to 40ft as opposed to 400 ft, the latter being the depth at the time of initiating the plantation project. Over 400,000 trees have been planted in the region in the last 4 years, benefitting not only the rural communities, but also improving the tiger habitats.

Affecting lakhs of lives positively, Grow-Trees has always ensured to generate maximum impact through its projects.



Photo: Grow-Trees.com

Raising tree saplings has generated lot of employment for women

By initiating large scale tree plantation initiatives in the unimaginable parts of the country, it has reached out to those who have often been ignored widely. They are also exploring ways to increase incomes for rural communities from allied activities.

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*Wishing all our readers a
Happy New Year 2020*

