March 2021 volume 23 no.1

20 YEARS LEISA INDIA
Promoting Agroecology

LEISA INDIA

Magazine on Low External Input Sustainable Agriculture

agri cultures NETWORK
INDIAN EDITION

Bio-inputs for agroecology

LEISA INDIA

March 2021 Volume 23 no. 1

Leisa India is published quarterly by AME Foundation

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Blustream Printing (India) Pvt. Ltd., Bangalore

COVER PHOTO

Biodegradable inputs are not only less expensive but also result in enhancing soil health
(Photo: S Jayaraj for AMEF)

The AgriCultures Network

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

Farming Matters (in English)

LEISA revista de agroecología (Latin America)

LEISA India (in English, Kannada, Tamil, Hindi, Telugu, Oriya, Marathi and Punjabi)

AGRIDAPE (West Africa, in French)

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www.leisaindia.org

Dear Readers

Agroecological approaches are based on principles of living in healthy communion with nature. Leveraging contextual diversity, they promote resilience, sustainable use of resources and safe environment. One of the most critical components for promotion of ecological/ organic/ LEISA farming is biodegradable inputs – awareness, availability, willingness to experiment so as to use them as substitutes for harmful and expensive chemical options.

Based on traditional and cultural knowledge, farmers and organic farming promoters have been constantly preparing and using biological alternatives with positive results. The mainstream institutions too have recognised the multiple benefits they offer not only to the farmer but also to the Planet. However, often, they are context dependent linked to factors like biodiversity availability and the willingness of farmers.

Interesting examples of way forward have been shared by LEISA enthusiasts in spite of COVID threats. Our authors are the backbone for continued knowledge sharing. We are highly thankful to them. Not only to those who share, we are also deeply grateful to all those who read, encourage and voluntarily contribute to the sustainability of this knowledge sharing effort.

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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Paderu women have proved that despite having access to fewer resources, it is possible to adopt agroecological methods of farming, with some initial assistance and training. Use of biologicals is only a small step towards a greener mode of farming, but has the potential to be scaled up on a larger scale especially through Farmer Producer Organisations (FPOs).

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Farmers dependant on rainfall are always vulnerable. But turning crisis into an opportunity requires determination and support from many. Sebastian is one such example who transformed into a role model, supporting farmers transition to organic farming methods.

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Bio-inputs for agroecology

India is naturally endowed with various types of naturally available organic form of nutrients. This considerably helps in organic cultivation of crops. The potential of biopesticides and biofertilisers for promoting sustainable agriculture has been known for many years. Recycling nitrogen on the farm by using manure and nitrogen fixing plants enhances soil quality, much neglected and least understood soil biology while providing nutrients to the plants. Plants use nutrients from organic sources through mineralization and billions of microorganisms are available in soil for this job. This is the predominant technique of organic and low external input agriculture.

There is enough scope for production of sufficient organic inputs in India from different sources like livestock crop residues, rural compost, vermi-compost and agricultural wastes. Bio-fertilisers are the low cost source of plant nutrients and are environment-friendly. There are wide varieties of biofertilizer in use, some of which are Rhizobium, Azotobacters, Azospirillum, Phosphate-solubilizing bacteria (PSB), Vesicular arbuscular mycorrhiza (VAM), Plant growth promoting rhizobacteria (PGPR), Blue Green Algae (BGA), azolla etc.

Promotion of bio-inputs needs extensive extension work. Firstly, regarding its need while convincing farmers about the need for enhancing soil health and crop productivity and to make them aavailable, accessible and self reliant. There is a need for paradigm shift in extension approaches; for instance from individual to community level, with active community participation. In one of the ICAR-CPSRI programmes, the critical component of the extension approach was the decentralized option for technology facilitation viz. capacity building of women farmer groups as master trainers, farm level producers of bio-inputs and targeting the 'potential and critical adopters' in the community for widespread adoption. Such specific extension approaches could increase the adoption of technologies, offer scope for refining them, evaluate their effectiveness and faster and wider technology dissemination. (Anitha Kumari P, p.6).

The formulation of inoculums, method of application and storage of the product are all critical to the success of a biological product. Short shelf life, lack of suitable carrier materials, susceptibility to high temperature, problems in transportation and storage are some of the bottlenecks that need to be solved in order to obtain effective inoculation. The storage and application of biofertilisers require special facilities and skills, which most producers and farmers do not possess. Hence capacity building in production and storage technology is key in popularizing and promoting use of bio-inputs.

Besides government, there are a number of civil society organisations and individuals too who are promoting production and application of bio-inputs. For example, farmers groups and Women's Self Help Groups in Maharashtra are trained in production of Enriched compost, Dashaparni Ark, Jeevamrut, Panchagavya etc. Also, many FPO's are working as a registered organic producer group. (Rohan Yogesh Raut, p.21). Similarly, Paderu women have proved that despite having access to fewer resources, have adopted bio-inputs, with some initial assistance and training. (Technoserve, p.16).

A number of government agencies, including the Ministry of Agriculture, are engaged in supporting research, production and application of these agents, through training, demonstration and supply of culture for production of bio-fertilizers. At the national level, institutions like MANAGE, Hyderabad and IIFSR, Modipuram are studying, collecting data, and promoting organic farming through their extension systems. Certified Farm Adviser (CFA) in organic farming is one of the innovative courses which is creating a force of organic consultants all around the country. (Rohan Yogesh Raut, p.21). Thus, these efforts are gradually increasing demand for bio inputs. This needs to increase substantially over next few years.

Governments can a play a very impactful role in promoting sustainable agriculture through use of bio-inputs. For example, in Srilanka, development of successful organic input production and marketing model with supportive policies has helped in widespread adoption of biologicals (Kandiah Pakeerathan and Gunasingam Mikunthan, p.11). Concerted efforts towards creating awareness on organic agriculture with necessary training, handholding and supportive policies is pushing Srilanka towards becoming a toxic free nation.

Skill building and support from the government can go a long way in encouraging farmers to take up production of bio-inputs at the community level. One such example is, Sebastian, from Tamil Nadu, a farmer-entrepreneur who got into bio-input production supporting farmers transition to organic farming methods (Victor I and Suresh Kanna K, p.33). And he attributes his success to the training and financial support received from the government.

With increased awareness of farmers and increased demand for organic produce, production of bio-inputs is slowly gaining momentum. However, use of bio-inputs is still prevalent in small pockets only. Unless the recommended package of practices include bio-fertilisers and bio-pesticides, supported by government subsidies, the takeoff is bound to be very slow.

Hope the experiences shared in this issue will motivate and trigger action towards sustainable bio-input promotion on a wider scale, benefitting in better recycling of resources, climate resilience and improved farm livelihoods.

Bio management of coconut pests

Social process for mass adoption

Anithakumari P

There is a need for paradigm shift in extension approaches from individual to community level, with active community participation. Such specific extension approaches could increase the adoption of technologies, offer scope for refinement of technologies, evaluation of effectiveness and faster technology dissemination.

Coconut is the crop of small and marginal farmers which is grown contiguously on their land holdings. Crop management is largely dependent on farmer to farmer extension as conventional extension system seldom looked into the contextual needs, need based delivery mechanisms for improving the efficacy of management in farmers gardens.

Black beetle, also termed as rhinoceros beetle owing to its horn like structure. is a major pest in coconut palms in all its growing stages. Rhinoceros beetle incidence in farmers field conditions is to the tune of 25 to 48 per cent in coconut seedlings and 23 per cent each in pre-bearing and bearing palms. The typical symptoms are the geometrical 'V' shaped cuttings in opened coconut fronds. The pest infestation results in loss of coconut seedlings and an yield loss of upto 10 percent in bearing palms. This calls for managing the pest over contiguous areas, involving community of farmers. Data indicated very low level of awareness and adoption regarding the bio control agents against the black beetle.

A participatory analysis with the communities, indicated that they prefer low cost, safer, environment friendly and bio-control practices to manage the pest, the reasons being as follows:

- In every coconut based homesteads this pest is ubiquitous in presence.
- Coconut trees are tall and require skilled coconut climbers for reaching the top, not only for harvest but also for cleaning the crown and adoption of plant protection measures.

- Existing extension mechanisms target only individual farmers as technology adoption units.
- Critical bio-inputs are not available and hence the knowledge and awareness is also limited among the farmers.

Several indigenous technologies were in existence and in practice among coconut farmers, since the crop and the black beetle are associated historically. The traditional practices like incorporating C*lerodendron infortunatum,* a weed plant in cowdung pits, compost units and coirpith heaps which are the breeding sites of rhinoceros beetle, hooking the beetle using a metal hook, applying mixture of equal quantities of crystal salt, ash and sand in the top most leaf axils, three times a year, were commonly practiced with good results as indicated by old generation farmers. These are no more practised presently. A need based social experimentation to evolve an efficient, feasible and up-scalable model of Area Wide Community Extension Approaches (AWCA) in bio-management of coconut rhinoceros beetle (*Oryctes rhinoceros* Linn.) was therefore designed by the Agriculture Extension scientists of ICAR Central Plantation Crops Research Institute (CPCRI).

Participatory Extension

Extension approaches for improving adoption of Green Muscardine Fungus (GMF) among coconut farmers was first initiated in 2007 in two panchayaths of Alappuzha district, but resulted in poor field responses and failure of FLP units. Hence in 2008, initiated Field Level Production (FLP) unit with a qualified person, but it did not sustain. An area wide campaign for treatment of breeding sites of the pest on 1500 ha was taken up, which proved to be time consuming and less efficient. Inadequate availability of bio agent and inability to achieve full coverage were the problems experienced.

Farm level production of Green Muscardine Fungus

Infected rhinoceros beetle grub from AWCA area

The three preliminary stages of the social process adopted were as follows:

I stage - Implementing participatory programme involving rural women farmers SHGs and introducing them to the technologies on IPM of rhinoceros beetle by field based off campus programmes. Convincing them on the visibility of technology impact was necessary for building confidence and making them voluntarily participate in the process. They were involved in all stages of technology demonstrations in coconut farmers fields.

II stage - Evolving workable model of decentralized Farm level Metarhizium production (FLP) involving rural educated women farmers was attempted in dialogue with peoples representatives which was facilitated by the Agriculture officer of the panchayath. The most valuable and critical contribution of the women SHG was the beautiful and simple refinement of the low cost multiplication procedure through participatory analysis, cross learning and practical thought process as women.

III stage - Production /multiplication of GMF under the facilitation and supervision of ICAR - CPCRI scientists. The leadership and supportive role played by Agricultural officer, women leaders and local self government added value for sustainability of this social model.

The area wide participatory extension programme was pilot tested in Edava grama panchayath in Thiruvananthapuram district of Kerala state involving 5465 coconut farmers in an area of 520 ha having 110143 numbers of palms. Mrs. Thejaswi Bhai, Agricultural officer of Edava Grama Panchayath, who contributed tremendously as a team, said *'Coconut is the nerve and steel of livelihood of this panchayath which was traditionally a coir village. The experience of being partnered in social research process with ICAR CPCRI make us proud and more knowledgeable in extension programme implementation. I can very confidently state that mutual learning and growing partnership with extension agencies elevate the efficiency and utilization of technologies developed in research institutions. The strong message of this participatory social research was that innovations are key to community development and women farmers are resourceful enough to refine technologies putting in simple modifications and thus contribute to faster and effective technology dissemination.'*

Interventions

The project interventions included community level awareness and actions, convergence of group efforts, linkage with extension agencies, decentralized production of bio agents, participatory monitoring and federating women farmers groups for improved technology access.

Social mobilization and awareness campaigns were organised. Panchayath wide campaigns for the GMF treatment of cow dung pits, vermicompost units, coir pith, degraded coconut logs which are the breeding sites, could effectively bring down the population of the pest. Different stages of grubs will be infested by the fungus within a week of its application and adults after a little longer time. The fungus will not affect the earthworms in vermicompost in any way. The non availability of sufficient quantities of GMF coupled with low level of awareness of the technology among the farming communities were the major obstacles in the adoption. The green muscardine fungus production was decentralized through farm level GMF multiplication units made operational by trained farm women groups. The capacity building and skill up gradation of the units was done as a continuous process of confidence building.

Another strategy was effective building up of network and linkage with relevant stakeholders like Department of Agriculture, coconut farmers clusters/ groups, Veterinary Department, Milk co-operative societies, livestock farmers, mass media, especially All India Radio, local self governments etc., for rapid spread of technology and multiple level of interventions.

Approximately, 2000 hectares of coconut area in three panchayaths were brought under the process in Thekkekara, Devikulangara and Edava panchayaths of Alappuzha and Trivandrum districts. Two to three women Self Help Groups (SHG) members, extension officials of the respective panchayath, coconut farmers clusters of 8-10 members in each ward were involved in technology transfer activities and treatment of breeding sites. Thus, a total of 150-200 women were mobilized to represent the panchayaths. This indicated that these technologies were very much women friendly, simple and adoptable.

Around 32 training programmes were organized for farmers and farm women. For midway corrections, video conference with experts was arranged. A low cost farm level GMF multiplication unit was set up by the women group for decentralized sustainable bio-input availability.

The initial cost of setting up of the unit is around Rs. 8000 - 10000/-. The basic items required are a pressure cooker (20 litres capacity), culture of Green Muscardine Fungus (GMF), Polypropylene covers, quality rice and other accessories like cotton, aluminum foil, thick candles, hand gloves etc. Ensuring hygienic conditions is the foremost requirement in farm level production (FLP) of the fungus. The application method is very simple. One packet (100g) of GMF is to be mixed with one litre of water and sprinkled over the cow dung pits, compost pits, decayed coconut logs etc. which are the breeding sites of rhinoceros beetles. The grubs die in 5-7 days.

While planning for area - wide community adoption programmes, all the potential breeding sites of rhinoceros beetles in each ward of the panchayath were mapped using GPS. The scattered breeding sites of rhinoceros beetle in the panchayath like livestock farmers (643 nos), vermicompost units (7 nos), coir processing sites with coir pith heaps (3 nos) were mapped in panchayath indicative of the locations in each ward. It was found

that 82 per cent of these potential/critical adopters were distributed in six wards. These sites were treated with GMF. It was a one week campaign with the active involvement of various stake holders. They were reached through coordinated efforts of peoples representatives, extension units of Department of Agriculture and Animal Husbandry, milk cooperative societies in which 85 per cent of livestock farmers are members and Women SHGs. Through this approach, more than 90 per cent of the potential adopters were reached within two months. Post intervention data indicated 75.8 per cent reduction in fresh pest infestation. Farmers revealed that grubs were infected by fungus after a week of treatment and infected grubs and beetles could be collected from all wards, indicative of reduction of pest.

Regular feedback was being received. The participating farmers gave feedback that frequency of breeding sites treatment should be once in a year for better results instead of two years, which was approved by the experts on further examination.

Outcomes

The programme reached 70 - 80 per cent of the potential adopters. There was reduction in fresh incidence of rhinoceros beetle, especially in the bearing palms, by 75 per cent.

It was noted that knowledge of coconut farmers was higher in intervention area (i.e. Edava grama panchayath, Thiruvananthapuram district) compared to non-intervention area (control farmers in Neendakara grama panchayath, Kollam district). More than 90 per cent farmers of both areas could identify adult beetles and 50-60 per cent knew common breeding sites and symptoms of infestation.

Integrated farm level value addition of coconut, jack, vegetables, tubers and cow dung, mushroom cultivation/ spawn production and processing and vermicomposting were taken up.

> With application of GMF, fresh incidence of rhinoceros beetle in the bearing palms, reduced by 75 per cent

Field level training

Farm level production technology of GMF was refined by the group, reducing the cost of production by 40 per cent with 30 per cent reduction in time.

Rural training centre was started wherein 2054 farmers from different districts were trained.

Lessons learnt

Technology package supported with appropriate extension mechanisms based on socio-economic situations and technical parameters, results in wide spread awareness and adoption and improved demand for technology.

Participation and functional linkages at grass root level could influence the technology utilization in a positive and effective manner. The model community extension approach evolved also underscores the role of linkages with peoples' representatives, farmer organizations, farmer leaders, co-operative societies of farmers and co-ordination with various extension departments and research institutions.

The critical component of the extension approach was the decentralized option for technology facilitation viz. capacity building of women farmer groups as master trainers and farm level producers of GMF and targeting the 'potential and critical adopters' (ie. livestock farmers having cow dung pits, coir pith units associated with the coir processing and compost units in farmers fields) of the bio control technology. The non adoption of the technology by the potential or critical adopters, render

Participants of field training

the community level adoption of the technology by other coconut farmers ineffective.

Technology integration is the key. Indigenous technical knowledge (ITK) like incorporation of Clerodendron plants in breeding sites, leaf axil filling with salt/sand/ash mixture was integrated with recommended technologies.

The technology specific community extension interventions exert positive effect on the improvement of the knowledge of farming community irrespective of age, involvement and extent of farming systems practiced by the farmers. This leads to improved demand for technical knowledge for better output.

In area wide approaches mass media exposure plays larger role in creating awareness and dissemination of message to mass audiences. Social participation, extension contact, extension participation, mass media exposure and trainings attended, research and extension linkages significantly improved when compared before and after interventions, indicating the positive impact of the extension approach.

Even though livestock farmers are the potential adopters of the bio-control practices the community should know the associated bio management practices like leaf axil filling, mechanical destruction and prophylactic measures in positive impact creation, which was reflected in the relationship with extension contact and participation and mass media exposure.

Education and meaningful partnership in technology training programmes lead to positive dissemination facilitating adoption, refinement and improved access to technologies among coconut farmers.

Conclusion

Establishment of knowledge intensive area wide community based approaches to pest management and the utilization of integrated bio management technologies lead to acceptable solution to problem of pesticide misuse. AWCA proved to be not a passive process but involved interactions among and between stakeholders improving technology demand and utilization. Feedback and responses from extension officials indicated positive impact of spread to other farming communities also.

The focus on specific adopter categories and community extension approach in wider area could overcome the inefficiency of individual level technology adoption and wide variation of farmers' socioeconomic resource base. However, it requires continued efforts and components for sustainability and acceptability among coconut farming communities. Thu, research inputs for converting the farm level production units to village level enterprises with attractive product and shelf life, technical supervision and facilitation for quality control is needed. Otherwise, the success and sustainability of the units will be limited and they remain short term.

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Nurturing nature using nature's gift

A Sri Lankan Scenario

Kandiah Pakeerathan and Gunasingam Mikunthan

Concerted efforts towards creating awareness on organic agriculture with necessary training, handholding and supportive policies is pushing Srilanka towards becoming a toxic free nation.

The natural ecosystem is very well diversified, and does not need external biological inputs to sustain. When human's tradition transformed from hunter-gather culture to agricultural societies, anthropogenic activities collapsed the natural ecosystem, and the agroecosystem flourished. Beneficial micro and macro-organisms, such as *Trichoderma* spp, *Pseudomonas fluorescence*, Effective Micro-organisms (EM), Vesicular-Arbuscular Mycorrhiza (VAM), Basidiomycetes fungi, Entomopathogenic microbes, parasitic nematodes, earthworms etc., are nature's gift. They play a major role in the supply of essential nutrients. In the natural ecosystem, this is done through the decomposition of plant and animal wastes, protection via secretion of secondary metabolites which are toxic to plant pathogens.

Women were provided technical and material support to adopt organic practices

Since the 1960s, the green revolution mainly focused on increasing agricultural production (crop yield) by intensive mono-cropping of elite high-yielding varieties utilizing a lavish amount of external inputs. Consequently, a less diversified modern agro-ecosystem totally relying on synthetic inorganic fertilizers and harmful pesticides emerged, which totally ignored the importance of nature and nature's gift to develop a healthy society. In the post-publication of "Silent Spring" by Richel Carson in 1962, environmentalists raised their voice to emphasize the harmful effects of pesticides, the importance of environmental education, awareness on soil and human

health, and environment-friendly farming/ecological farming to conserve our nature.

Intensive training to farmers

Training farmers on how to produce, formulate, apply and market organic inputs, such as microbial inocula (such as rhizobia), composts, manures, biochars, and several preparations like jeevamrutha, panchagavya, neem decoctions, etc. is vital for a cleaner, safer, economically viable sustainable agriculture.

In Sri Lanka, training programs on intensive farm biological inputs production and application are being conducted by the experts in State Agricultural faculties of National Universities, and district agricultural training centers governed by the Department of Agriculture. Majority of the training programmes provide all the necessary practical skills and knowledge on how biological inputs can be produced at cottage level for their own needs as well as for commercial purposes.

Faculty of Agriculture implemented a pilot programme called "Development of sustainable integrated food production systems to enhance household food and nutritional security, economic growth and livelihoods of resource poor families in the Northern Region of Sri Lanka" through the National Thematic Research Programme (NTRP) from 2012 to 2018. The main objective is to promote organic gardens by using biological inputs of the war affected displaced and resource poor families. Selected farmers were educated through training, and were provided technical support as well as materials support, where necessary.

To train the farmers, a 2-hectare model home garden at the Faculty of Agriculture at Ariviyal Nagar, Kilinochchi, was established in 2014. The garden was developed to train the people who show interest in the establishment of a home garden, with eco-friendly technologies. A total of 284 men and women members of different farm families and women organizations were trained at the Faculty of Agriculture and in their villages on (1) establishing household level composting units, (2) mass production of organic liquid fertilizers and (3) biocontrol agents (Box 1).

Organic farms are solely dependent on the biological control agents, such as predators, parasitoids, and bio-pesticides includes entomopathogenic organisms (Beauveria bassiana, Metarhizium anisopliae, Lecanicillium, Paecilomyces, Nomouraea, Hirsutella, etc.), Trichoderma spp, P. flourescences, to manage the pest and diseases successfully. Due to the intensive agriculture with the use of inorganic broad spectrum

Training at Thampa Model Farm

Box 1: Technical Note 1 – Training content of various training events

1. All types of compost production training: where and how to collect different wastes such as garden wastes, agro-industries by-products, urban wastes, animal farm wastes, slaughterhouse wastes, distillery spent wastes, etc., and demonstration on how to set up and convert the waste into compost in heap method and pit method; on hand training on how to set up the vermicomposting units for small and large scale vermicompost production, how to select waste material for earthworms, how to set up beds for vermicomposting in bin based, pit based, and open type vermicomposting process, how to select the suitable earthworms species for quick vermicompost production, how to identify the compost ready for collection, how to collect the vermicompost without damaging earthworms, how farmers can enrich traditional garden compost and vermicompost by adding additional nutrients and biocontrol agents to make it super compost. How to store the composts for long term use, how to pack and marketing techniques, different types of compost application techniques, are mainly focused.

2. Training on liquid fertilizer production and application: Vermi-tea, vermi-wash, five-leaf solution, panchacowia, Gliricidia leaf solution, fermented cow urine decoction, fish emulsion, etc., are an excellent source of plant essential nutrients, antimicrobial compounds, secondary metabolites of beneficial microbes. This training mainly focused to provide technical and practical skills to farmers regarding how to set up each and every organic liquid fertilizer production unit, inputs needed, how to preprocess the inputs, in which ratio each and every input need to be mixed, how to and how often collect and apply to crops.

3. Mass production and field application of bio-control agents and bio-pesticides: Farmers from five districts Jaffna, Kilinochchi, Mullaitivu, Mannar and Vavuniya are invited by the respective district agriculture training centers where invited field-related experts from universities gave demonstration and techniques on how to identify, produce bio-agents at a small level and mass level, mode of applications, how to monitor the working performance of bio-agents, how to preserve the mother cultures, where they can get pure cultures or stock cultures if lost, how to pack and market if they produce in mass level, registration and label information, etc.

pesticides, these potential bio-agent's populations have been wiped-out, more or less. The outcome of the biological control is measurable, when enough quantity is existing in the environment. That's how continuous monitoring and timely field release/inoculation of bio-agents is highly recommended to maintain its existence. But, farmers did not have enough knowledge in identifying these bio-agents or how to produce these bio-agents at their home at a small or mass level.

The households in five districts (Jaffna, Kilinochchi, Mannar, Mullaitivu, and Vavuniya) established their ecological gardens through the active participation of their family members. Farmers set up their own compost unit at their homes. The sustainability of the home gardens was subsequently monitored. Later, the trained farmers who have set up their own units, were selected and honored by higher authorities, and invited as resource persons for the training of trainers.

Access to information and knowledge transfer

Readily available knowledge and information sources are really important to eliminate practical difficulties in agriculture. In the science and technology advanced era, digital agriculture is being promoted. Through this NTR projects, dissemination of information regarding organic gardening, understanding the nature and ecosystem, medicinal plants, role of microbes in maintaining the healthy life of plants, microbes to control diseases in crops, vermicomposting, recycling of organic wastes, minimize the use of inorganic pesticides and fertilizers, etc., were transferred to public through journal publications, conference proceedings, popular talks and theme seminars. Moreover, the information related to recommended biological inputs, new biological inputs invented and innovated, how to get this inputs, how to use these inputs, success and failure of the inputs, how to market these inputs if produced in mass level, how to get the certificate for the products produced organically using these biological inputs, how to get better price etc., is available in national and local languages in department of Agriculture websites (https://www.doa.gov.lk/ETC/index.php/en/programme, state agriculture faculties' extension websites, business websites (https://www.srilankabusiness.com/blog/organic-farming-sri-lanka.html) national and international television programme (Pon Vilaiyum Bhoomi), local radio

programme (Kalamum valamum, Yarl FM), local newspapers (Valampuri and Uthayan), monthly or yearly magazines released by the agriculture faculties (Pasunthokai, Ulavan), department of agriculture extension departments, well organized frequent meetings with farmers and agriculture instructors.

Advanced training opportunities to farmers

There are a lot of vocational training opportunities available in national agricultural faculties, private institutes, college of agriculture, department of agriculture, for young farmers who are below 45 years, in Sri Lanka. In these vocational training institutes (Eg: School of Agriculture, Vavuniya, Kundasale, Kandy; Institute of Agro-technology and Rural Sciences, University of Colombo), all kinds of training is given over a period of one-three years. After completion of diploma or graduation courses, they will become fully skilled entrepreneurs. They will be able to produce all varieties of biological inputs without others help and can act as consultants to other farms.

Gender role in production and use of biological inputs

The majority of the women labor force (58%) in Sri Lanka are unfit for heavy physical work. Therefore, women workers are being hired for soft works such as weeding, harvesting, collection of input materials for the compost production, maintenance of compost units, collection and packing of vermicompost with minimum wages. This earning helps them to support the family partially, and is a source of sole income for many women-headed families. Through this NTR project and NGOs (Eg: womens organization, ZOA, Sevalanka) funding, more than 500 women farmers, who were heading their households were selected, trained and financially supported to setup commercial vermi-compost production unit by providing exotic earth worms and necessary technical skills.

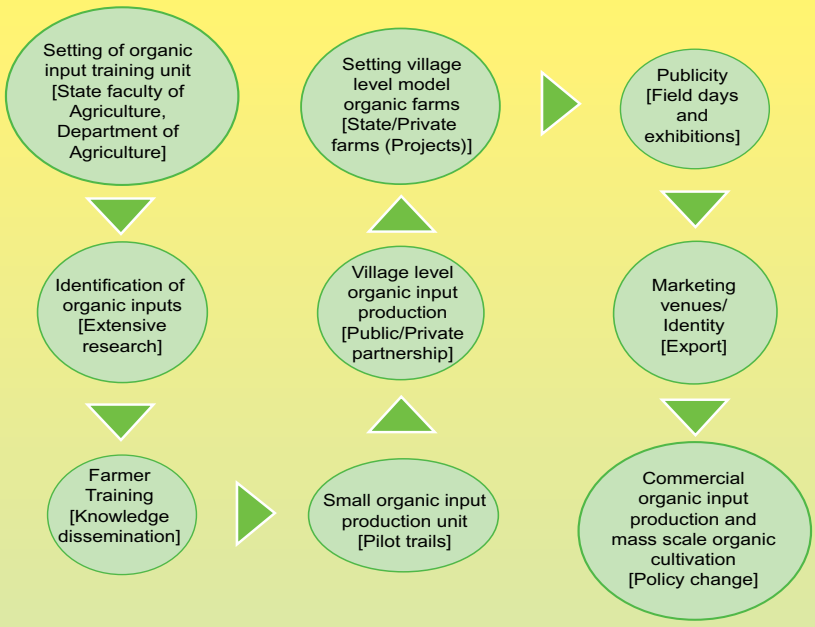
Agro-based institutions support

In Sri Lanka, women-headed farming families are higher in northern and eastern provinces. Governments, non-governmental organizations such as ZOA, IOM, UNDP, FAO, OXFAM, Servalanka, etc. financially support organising workshops, and also provide low-interest soft loans to establish own units, either small or on commercial scale.

A number of vocational training opportunities exist for young farmers

In the north, Thampa model farm plays a key role in motivating organic floriculture, and vegetable production. A private organization called "Thampa model farm" executed a project with the aim of poverty

Diagram 1: Model for organic input production



alleviation from rural community with the technical support of faculty of Agriculture, University of Jaffna. They financially supported few selected farmers who are getting Samurthi (financial livelihood support by the government from poverty alleviation) benefit from governments, to establish pure organic gardens. In this project, they have selected more than 1000 Samurthi beneficiaries in different villages, through rigorous screening process, and supported them financially and technically, to produce mass level of organic inputs and organic products. Farms are closely monitored by frequent visits.

Once the organic products are ready for marketing, the financial supporter, Thampa model farm, purchases all the products from the farmers and exports it to Europe. By doing so, farmers are receiving better returns on a regular basis. Consequently, many farmers are opting out from Samurthi scheme of the government.

Impact and way to go

There is a perceptible change in the farmers mind set owing to continuous intensive training programmes, brain storming, sessions, health awareness programs regarding increasing cancer and CKDU in Sri Lanka due to toxic pesticide and ferilizers. Many farmers have fully stopped using inorganic farm inputs and started pure organic agriculture by using local inputs. Moreover, with growing demand for organic farm products (Eg: fruits and vegetables), many export companies are buying the organic products at farm gates itself. This has motivated many farmers to produce organic inputs in bulk, which the commercial growers are ready to purchase at a higher price. COVID-19 pandemic has further pushed the organic input producers to expand their production. The "Thampa model farm" project, mentioned earlier, will be a huge success, and very soon Sri Lankan agriculture will be converted to organic agriculture with the aim of government's agriculture policy called "toxin free nation". Development of successful organic input production and marketing model (Diagram 1) with supportive policies will help in its success and sustainability.

Many export companies buy organic produce at farm gates itself, thus escalating demand for production of bio-inputs by farmers.

A classroom training session in progress

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Jeevamrut

The real liquid gold

Technoserve

Paderu women have proved that despite having access to fewer resources, it is possible to adopt agroecological methods of farming, with some initial assistance and training. Use of biologicals is only a small step towards a greener mode of farming, but has the potential to be scaled up on a larger scale especially through Farmer Producer Organisations (FPOs).

Tribal women of Paderu

Organic farming has been creating a buzz all around the world for the past few years. Started as a market for fruits and vegetables grown without the use of chemicals, it has now expanded to encompass food in every form, from milk and eggs to coffee and tea. With rising consciousness among consumers about the health and environmental benefits of organic food, particularly in urban areas, the market for organic foods is now one of the fastest growing in the world, with a forecasted growth rate of 16.4%, during the period of 2020-25.

The unique selling point of organic farming has always been the use of natural fertilizers and pesticides instead of chemicals, making it more environment friendly while simultaneously providing various health benefits. With this, a lot of attention has also gone into the use of biofertilizers and other microbiological inputs to make farming sustainable. However, there is a wide price difference between organic and non-organic food items, such that purchasing organic food is still considered a mark of privilege in urban centres. On the other end of the spectrum, farmers are forced to depend on expensive fertilizers, pesticides and other agricultural inputs to ensure a good crop yield. Even when it comes to organic farming, farmers need to depend on some form of inputs to keep pests at bay and produce a healthy yield. So how do people living in the geographically inaccessible tribal villages of India manage to grow their food in an organic way?

Minimuluru, a small tribal village sitting atop the hills of Paderu, is approximately 100 km from the sprawling

During the pandemic, the tribal women of Paderu emerged as self-sufficient, helping not just their own families but also their fellow villagers with vegetables grown right in their backyards.

Training by CRP

Application of jeevamrut

city of Visakhapatnam in Andhra Pradesh. In contrast to the city, Minimuluru is quiet and serene, home to people of the Paraja tribe, one of 33 tribes residing in the state. One often sees both men and women toiling away in their farms, usually 1-1.5 acres in size, where they grow paddy, turmeric and coffee. Tribal communities are known to depend extensively on nature for both their food intake as well as livelihood. But studies over time have shown that the nutritional intake of tribal communities, especially that of women, is far lower than what it should be.

The Initiative

TechnoServe, a not-for-profit organization working towards poverty alleviation, started their Walmart Foundation funded program 'Sustainable Livelihoods for Smallholder Farmers in Andhra Pradesh' in the Paderu region. One of their goals was to enhance the nutritional intake of tribal women, while also increasing soil fertility in the region. Inspired by the Zero Budget Natural Farming model pioneered by Padma Shri awardee Shri Subhas Palekar, the Technoserve team decided to initiate Organic Kitchen Gardens training as part of the program, to support tribal women farmers to set up kitchen gardens in their backyards. This would ensure nutritional security to smallholder farming households, while also empowering women by increasing their involvement in economic activities and helping them generate an additional income.

Started in September 2019, the team began conducting trainings, distributing seeds and providing hand-holding support to roughly 1,000 tribal women farmers from 41 villages in the regions of Paderu and Chintapalli in Visakhapatnam district. A total of 8 varieties of vegetable seeds were distributed, including Brinjal, Tomato, Green Chillies, French Beans, Cowpea, Radish, Amaranthus and Spinach.

Jeevamrut, the organic liquid manure

Given the low-income levels of small-holder farming households, one major barrier was the lack of access to fertilizers and pesticides due to financial constraints. In response, the team decided to train women in preparing *jeevamrut,* an organic liquid manure solution that provides nutrients to the crops while also improving soil fertility.

Box 1: Ingredients for preparing 200 litres Jeevamrut

Local cow dung	10 kg
Cow urine	10 litre
Jaggery / gud	2 kg
Besan	2 kg
Soil from farm bund	2 Kg
Water	190 litre

The women were divided into groups of six by the Community Resource Persons (CRPs) and TechnoServe staff who provided hand-holding support throughout the training process. The main idea was to ensure that post-training, the women did not have to depend on any external markets for fertilizers. The biofertilizer prepared primarily using cow dung, cow urine, black jaggery, gram flour, water and soil (from farm bund) was both affordable and easily accessible at all times.

For the training, the team decided to provide jaggery and gram flour to the women as initial support. Each woman was given 200 grams of both jaggery and gram flour, enough to prepare 20 litres of *jeevamrut*. The cost for these materials came to approximately Rs. 11 per person.

The rest of the materials were locally available, and were sourced by the women themselves. The women formed sub-groups of two to three households each, wherein they collected cow dung, cow urine and soil together. This made it easier to distribute these materials among the rest of the women, who may not have had access to them.

Once all the materials were arranged for, the actual training process started. While *jeevamrut* can be made in cement tanks or earthen pots, most of the villages chose to prepare the mixture in plastic barrels, which was considered easier and more practical. Under the guidance of the CRPs and the team, the women began incorporating the components in the barrel.

The women first added water proportional to preparing approximately 20 litres of the biofertilizer. Cow dung and cow urine were added next, and mixed well. Post this, the rest of the ingredients, i.e., jaggery, gram flour and soil from the farm bund, were added and mixed well using a wooden stick.

Covering the mixture in the barrel with a jute bag, the participants kept the mixture in a shaded area to ferment.

The final product of *jeevamrut* could be applied directly to the root area of the plant in the soil. It could also be mixed in the ratio of 1:10 with water and sprayed on the crops in order to be used for foliar application.

The Impact

The resultant biofertilizer was then distributed among the participating women. While it's only been one season since the women farmers began using *jeevamrut*, the feedback has already been extremely positive. *"While I used to grow vegetables in my backyard previously, never before have they looked so fresh and healthy. I used jeevamrut as instructed to me by Lakshmi (the CRP) and it has completely removed the pest infestation that had always affected my crops,"* said a satisfied Mangamma, one of the tribal women farmers who participated in the training.

According to Vishal, a TechnoServe staff person overseeing the OKG program, women were eager to apply the biofertilizer once they started understanding its organic nature. *"Earlier, many farmers complained about how they were unable to access fertilizers and pesticides for the crops. When we told them about our plan to provide training for jeevamrut preparation, they were at first sceptical about its effects. But as they attended the training and started using the mixture on their crops, they realized how something organic, easy to make, and especially cheap, can be so effective!"* said Vishal.

Impact during Covid 19

The current pandemic has offered a new perspective on the intervention. Covid-19 and the ensuing country-wide lockdown resulted in more repercussions than immediately visible. Tribal farmers of Paderu not only underwent a loss of livelihood due to the shutdown of

Jeevamrut preparation

wholesale agricultural markets, but were also unable to access basic necessities like vegetables due to the interruption of the supply chain and restrictions on movement. This was when the importance of both, kitchen gardens and easily accessible biofertilizers became evident. While villagers were finding it difficult to purchase basics like vegetables, the tribal women of Paderu emerged as self-sufficient, helping not just their own families but also their fellow villagers with vegetables grown right in their backyards. "I usually harvest more than I need in one go so I can distribute some of it to others in my village. During the lock-down, given the restrictions and the distance of the market from our village, by the time we used to reach, not a lot used to be available for sale even there," said Mangamma. Since then, many women who have seen Mangamma's organic kitchen garden are now encouraged to set up their own gardens. *"People look at how healthy my vegetables are growing and I can tell them it is because of the jeevamrut. Given how we had no way of purchasing agricultural inputs during the lock-down, jeevamrut was not just an easily available alternative, but also extremely efficient as a fertilizer and pesticide!"*

Way ahead

Over the course of the program, a total of 708 women farmers from 32 tribal villages were trained on the preparation of *jeevamrut*. Almost all the women using the biofertilizer have reported seeing positive results in their yields. The exercise showed the team how, with some initial assistance and training, it is possible to inculcate agroecological methods of farming, even among people with fewer resources. While the preparation of *jeevamrut* may be only a small step towards a greener mode of farming, it has the potential to be scaled up, especially through Farmer Producer Organisations (FPOs) that have access to a wider farmer base as well as more resources.

One of the main reasons for the success of this intervention was the regular engagement of CRPs with the women farmers. Community Resource Persons who are part of the local community itself, often coming from the same or nearby villages, were instrumental in spearheading a more sustainable and community led model. While TechnoServe staff facilitated the intervention, it was the CRPs who ensured effective adoption of the practices by women farmers. And, one key learning – especially in cases of scant manpower – is to identify community embedded persons who can lead the initiative on the ground.

With the success of biofertilizer adoption in the region of Paderu, TechnoServe now plans to replicate this model not just in other regions under the program, but also across a range of programmes it currently has in operation, across the country.

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Transitioning towards organic farming

Bio-inputs replaced chemical inputs on farmers fields

Rohan Yogesh Raut

Farming is changing. From chemical to traditional again - but with a new touch, new perspective, and new challenges. Be it Organic, Regenerative or Zero Budget farming, what will matter most to farmers is its economic and environmental sustainability.

With 11 years of experience in organic farming and 5 years working with marginal paddy farmers (organic) at Gondeda, Tal. Chimur, Dist. Chandrapur, Maharashtra, last season of Kharif, we (Generous Technologies Pvt Ltd) tried our hands in the high pest pressure zone of paddy area in Village Asgaon, Bhandara district of Maharashtra. Changing existing practice in agriculture is not always easy. It wasn't for the 8 farmers too. After a series of discussions and field visits to successful organic paddy farmers, this group of farmers was ready to cultivate a minimum of one acre of each of their land adopting organic methods. Farmers mutually agreed on the Jai Shree Ram variety of rice which is fine, medium size rice.

Two tons of enriched compost per acre was used. It was prepared by culturing farm yard manure and farm waste with decomposing culture. After complete decomposition, 8 types of bacteria and fungus were added. Different biofertilizers were used for seed

treatment, Dhaincha/Boru was used as a green manure. Dashparni ark (10 leaves extract), *Neem leaf* extract, Agni Astra (Chilli Garlic Ginger extract) was used as pest repellent, and Parthenium extract, Jeevamrut, Vermiwash and Panchagavya were used as plant growth promoters for paddy cultivation.

It was our first time working in an intensive farming zone with high usage of inputs of fertilizer, pesticides, labour and capital on small sized lands. To our surprise, despite adverse climatic conditions, crops responded much more satisfactorily, compared to the neighbouring farmers' chemical fields. The farmers got very good results in terms of reduced pest infestation and increased disease resistance, ultimately improving productivity of paddy.

All 8 farmers have got good yields ranging from 9-11 quintal paddy per acre in their first year of organic cultivation against 2-4 quintal per acre in chemically grown paddy. Point to be taken into consideration is that, in chemical farming fields, this year's production was very low due to adverse climatic conditions. Normally, chemically grown crops get 15-16 quintal per acre yield for fine rice variety in that particular area.

The farmers were happy not just because they got good yield compared to chemically grown crops, but they also could fetch a better price for their produce. Cost of production was reduced by upto 50% and in some cases even less. They saved more than last year, and also they gained more than last year.

This is a small example of how as agripreneur we are promoting organic farming.

Policy support

At district/Tehsil level, Agriculture Department and Agriculture Technology Management Agency (ATMA) is promoting organic farming through Participatory Guarantee Scheme (PGS). Farmers are trained to prepare all inputs required for organic farming. ATMA also has provision to provide required essentials like 200 liter drum, vermicompost units etc., at subsidised rate. Farmers groups and Women's Self Help Groups are also trained for HaNPV production, Tricho card preparation. With all these efforts, many FPO's are working as a registered organic producer group. In Nagpur district, agricultural departments are collectively working with Municipal Corporation to identify hot spots for

Farmers harvested better yields using bio-inputs

I always tell organic farmers- Convince your neigh-bouring farmer for Organic farming. Tell him the benefits you experienced. If he listens and follows you, you will be benefited in many indirect ways and you will be happy. If he doesn't listen, still you will be happy. Because of his chemical usage, pests and diseases will be attracted to his field first rather than your field – Author

selling farmers goods as a marketing initiative which is considered to be a weak link for the farmers.

At the national level, institutions like MANAGE, Hyderabad and IIFSR, Modipuram are studying, collecting data, and promoting organic farming through their extension systems. Certified Farm Adviser (CFA) in organic farming is one of the innovative courses which is creating a force of organic consultants all around the country. These CFAs will be helpful in extension of organic farming in future.

Initiatives from every tier of extension is definitely helping farmers to cultivate responsibly. Information flow to the farmer seems at par. Inputs like bio-fertilizers, are easily available in the market and when out of stock, it can be easily ordered.

Challenges

One must accept organic farming as a well planned activity. Organic farming is basically a preventive approach to agriculture. Commencing organic farming activity first requires patience to understand the whole system from production of crop to marketing of produce. And this has gone wrong in some cases.

While government system in adoption of organic farming is ample, following are the reasons for slow pace of farmers converting to organic farming: -

- Chemical farming has changed the mindset of farmers to "readymade and fast". In organic farming, farmers have to produce/process their own fertilisers, pest control inputs, and fungicides, for which many are hesitant.
- As organic farming is a preventive approach, in the initial stages of conversion to organic, one has to be proactive in spraying schedule. So ultimately the number of sprays (in some cases) may increase. This, many times, is not done by farmers. Once infestation gets beyond control, organic farming methods' name is at stake.
- Labour requirement is slightly higher than chemical methods. This is an issue where labour scarcity is there and acreage is more.
- Organic farming module is benefited by incorporation of animal husbandry with it. We must keep in mind that, "waste of one industry is best for another industry". Not all farmers own cattle. As many formulations require animal waste such as urine and dung for preparation of inputs, purchasing it from outside adds to the cost.

Way forward

Identifying the market for sale of produce should be done before selecting the crop. If a farmer wishes to sell crops in APMC, it is not advised to waste valuable efforts for farming organically. Deciding the target market first will win half the battle.

Before cultivation, farmers must understand the science of production through organic approach. Studying soil, crop, resources available is highly recommended. Copying the package of practice (POP) of some farmers is a big no. Farmers must make necessary changes in treatment as per their environment and resources available. Farmers should start organic farming with a small area after studying all these points.

Forming a group is always beneficial for exchanging knowledge and resources. It also gives power to purchase and sell.

Even if one ignores for a moment the indirect benefits like soil improvement, soil water improvement, human health effects etc., there are still large economic benefits of organic farming directly from high market value. First, the farmer must be assured of economics of organic farming. Indirect benefits are a bonus for him.

It is time to ignore fast and readymade approaches and appropriately respond to the changing needs of economic and environmental sustainability.

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Agri share in GDP hit 20% after 17 years: Economic Survey

Agriculture was the only sector to have clocked a positive growth at constant prices in 2020-21. The share of agriculture in gross domestic product (GDP) has reached almost 20 per cent for the first time in the last 17 years, making it the sole bright spot in GDP performance during 2020-21, according to the Economic Survey 2020-2021.

The resilience of the farming community in the face of adversities made agriculture the only sector to have clocked a positive growth of 3.4 per cent at constant prices in 2020-21, when other sectors slid. The share of agriculture in GDP increased to 19.9 per cent in 2020-21 from 17.8 per cent in 2019-20. Last time, the contribution of the agriculture sector in GDP at 20 per cent was in 2003-04. This was also the year when the sector clocked 9.5 per cent GDP growth, after the severe drought of 2002 when the growth rate was negative. Following 2003-04, the share has remained between 17 and 19 per cent.

"The growth in GVA (gross value added) of agriculture and allied sectors has been fluctuating over time. However, during 2020-21, while the GVA for the entire economy contracted by 7.2 per cent, growth in GVA for agriculture maintained a positive growth of 3.4 per cent," according to the survey. The continuous supply of agricultural commodities, especially staples like rice, wheat, pulses and vegetables, also enabled food security.

In 2019-20 (according to fourth advance estimates), total food grain production (296.65 million tonnes) in the country was higher by 11.44 million tonnes than 2018-19. It was also higher by 26.87 million tonnes than the previous five years' (2014-15 to 2018-19) average production of 269.78 million tonnes. The production also boosted allocation of food grains under the National Food Security Act (NFSA) that increased by 56 per cent in 2020-21, compared to 2019-20. The government allocated 943.53 lakh tonnes of food grains to states / Union territories till December 2020.

The survey also termed the new farm laws as a "remedy" and "not a malady" in a message to the farmer community opposing the laws. "The three agricultural reform legislations are designed and intended primarily for the benefit of small and marginal farmers who constitute around 85 per cent of the total number of farmers and are the biggest sufferers of the regressive Agricultural Produce Market Committee regulated market regime. The newly introduced farm laws herald a new era of market freedom that can go a long way in the improvement of farmer welfare in India," it said.

The survey gave a note of various consultations and reports on the need for agricultural reforms. "The reforms in the agricultural sector were more overdue than even the labour reforms as the existing laws kept the Indian farmer enslaved to the local Mandi (wholesale market) and their rent-seeking intermediaries," it said. It called for a paradigm shift in how agriculture was viewed, "from a rural livelihood sector to a modern business enterprise".

Source: https://www.downtoearth.org.in/news/agriculture/agri-share-in-gdp-hit-20-after-17-years-economic-survey-75271

Mass migration of blue earthworms in Meghalaya underlines sustainable land-use

Stone quarrying has affected population in some areas of East Khasi Hills district.

An army of blue earthworms, some measuring up to 1.6 feet, migrate about 300 metres up and down the steep slopes in Meghalaya's East Khasi Hills every year. Scientists of the Zoological Survey of India (ZSI) have for the first time prepared a report on the two-way mass migration in the district's Mawlyngot area. But the locals apparently beat them to observing these earthworms, scientifically called Perionyx macintoshi, and the role they play in enhancing the fertility of soil on their land to shift to ecologically sustainable organic farming.

Lethargic wrigglers

On the flip side, the scientist duo of Ilona Jacinta Kharkongor and Bhaskar Saikia found areas where "unsustainable land-use practices" have drastically reduced the population of earthworms to a few "lethargic

wrigglers". Much of the damage has been done by stone quarry and heavy earth-cutting for road connectivity and village expansion.

"The blue earthworms migrate twice annually — uphill in spring and downhill in autumn on inclines of up to 80-85 degrees to evade environmental factors that affect them. The research was done from 2011 to 2015 around the Mawlyngot plateau and the rivers Um Stew and Um Ñiuh around it," Bhaskar Saikia of ZSI's Shillong-based North East Regional Centre told *The Hindu* on Saturday.

The study he co-authored with Ms. Kharkongor was published in the latest issue of the journal, *Records of the Zoological Survey of India*.

The uphill migration starts in April-May coinciding with the onset of the monsoon when they emerge from the rivers and streams where they 'overwinter' under the rocks. Increased flow of water in such rivers and streams, signalling arrival of the rains, is said to trigger their emergence for the migration. The downhill migration happens during September-October when the vegetation begins to dry off and the temperature and humidity drop.

Ms. Kharkongor said the timing is crucial during downhill as the worms fail to reach their favoured destination if there is any deviation in the ecological factors. For instance, they had in October 2013 observed hundreds of earthworms having died of desiccation before they could reach the water body from 800 metres above sea level to a gorge 300 metres downhill. *"The rain had stopped abruptly in September-end that year after a short burst of showers,"* she said.

Organic practices

Mr. Saikia said the worms help enrich the soil. The local farmers had the wisdom to observe them and adopted organic practices, shifting from broomstick cultivation to grow organic tea that has gained in brand value abroad.

But the scientists observed the earthworm population dwindling in areas where human interference in the form of stone quarrying and earth-cutting has increased. "As in the case of other animals, factors like developmental activities, predation, erratic weather patterns and climate change pose risks to successful migrations of earthworms," he said.

Source: https://www.thehindu.com/news/national/other-states/mass-migration-of-blue-earthworms-in-meghalaya-underlines-sustainable-land-use/article33889798.ece

Biopesticides Industry in India to 2024 - Government impetus to improve soil health further supported by flexible registration process

The "India Biopesticides Market Outlook to 2024 - Government impetus to improve soil health further supported by flexible registration process expected to pose healthy growth" report has been added to ResearchAndMarkets.com›s offering.

The report titled India Biopesticides Market Outlook to 2024 - Government Impetus to Improve Soil Health Further Supported by Flexible Registration Process Expected to Pose Healthy Growth provides a comprehensive analysis of Biopesticides market in India.

The report focuses on market size, market segmentation by unorganized and organized sector, By Origin (Microbial, Biochemical Biopesticides and PIPS), by India Biofungicides Market Segmentation (Trichoderma Viride and Harzianum, Pseudomonas Fluorescens, Bacillus Subtilis/ Pumilus, Ampelomyces Quisqualis, Fusarium Proliferatum), by India Bioinsecticides Market Segmentation (Bacillus Thuringiensis Variant Kurstaki, Beauveria Bassiana, Verticillium Lecanii, Metarhizium anisopliae, Paecilomyces lilacinus and Others), by By Target Pests (Sucking Insects, Soil Insects, Caterpillars, Nematodes), by Crops, by Imported and Indigenous Biopesticides, Biopesticides Consumption by Regions and States.

The report also covers the competitive landscape, government role and regulations, growth restraints, drivers. The report concludes with market projections highlighting opportunities and caution.

For more information about this report visit https://www.researchandmarkets.com/r/os6ldt

Source:https://www.globenewswire.com/news-release/2020/12/11/2143867/0/en/Biopesticides-Industry-in-India-to-2024-Government-Impetus-to-Improve-Soil-Health-Further-Supported-by-Flexible-Registration-Process.html

Women organising agroecology for resilience in the Sahel

Tsuamba Bourgou and Peter Gubbels

The COVID-19 situation has exacerbated the existing crises in the Sahel. Just before the pandemic broke out, an innovative approach to strengthen people's resilience through agroecology was starting to bear fruit in Burkina Faso, Ghana, Mali and Senegal. At the centre of this are women, who have pioneered agroecological farming practices with a strong focus on better nutrition and decision making. New economic relations and power balances are emerging between men and women, providing a basis for long-lasting resilience.

Photo: ANSD

In Burkina Faso, women in over 80 communities started using agroecological methods

Burkina Faso and other countries in the Sahel are currently facing a multitude of crises. Over 12 million small scale farmers and their families in the dryland areas of the region are *chronically* vulnerable to food and nutrition insecurity. This is the result of the degradation of fragile ecosystems, population growth, and a low capacity to adapt to climate shocks, such as major droughts. To survive, an ever-increasing percentage of families are taking desperate measures. They sell their harvest to pay back loans, eat their seed stocks, borrow money from loan sharks, cut down on the number of daily meals or sell their physical assets. This makes them even more vulnerable. On top of that, millions of people have had to flee their homes on the run from extreme violence from jihadists and other armed groups. They are living in terrible circumstances, often without a roof over their heads, and facing a shortage of water, food and medical care. The COVID-19 pandemic is making this crisis worse, particularly for women. After terrorist attacks, many rural services such as schools, hospitals and police stations were shut down, services sorely needed during the pandemic. Forced market closures and restrictions on gatherings have also hit rural communities hard.

In the regions where we work, these restrictions hampered income-generation activities for women, such as selling garden produce and artisanal products, or undertaking petty commerce. It also affected the ability of women's groups to carry out collective activities such as market gardening in the dry season (February to May), conduct their groups' savings and credit sessions, and participate in trainings and knowledge building activities.

Agroecology as a response

Before COVID-19, an increasing number of women in the Sahel had already started to experiment with agroecological practices, including soil and water conservation, agroforestry, intercropping with legumes, use of short cycle local seeds, and dry season vegetable production. They were attracted by these practices because they recognised their potential to increase soil fertility, productivity, sustainability of the natural resource base, nutrition, resilience, income and autonomy. In Burkina Faso, women in over 80 communities in Eastern Region, near Fada N'Gourma, started to use these practices with the support of a local NGO called 'Association Nourrir sans Détruire' (ANSD) and Groundswell West Africa. They bolstered their knowledge on agroecological practices that served their needs, such as protecting tree shrubs and dry season gardening, as this gave them healthy food all year round. As explained by Mrs Bilana OUOBA, Kokouogou village, between 60 and 70 years old, this implied overcoming some cultural obstacles:

> *"There has always been the attitude in our traditional way of farming, that you have to be crazy to let the trees smother the crops in the field. So I used to cut down all the trees and shrubs and even sweep away every twig and set fire to all this in my field. When we heard about a farming strategy to let the trees grow [Farmer Managed Natural Regeneration], this caused a lot of controversy in our community. But I started to do some tests and protected small trees that were growing in my field. I also improved the soil. I now harvest pods from the philiostigma trees from my field. It has become a major source of income and healthy food for me. Today, this is a common practice for women in the village."*

The women also engaged in credit and savings groups. This not only allowed them to gain access to vitally needed credit, but also bolstered their leadership,

solidarity, and self-confidence. Moreover, the women negotiated with village leaders and the rural municipality to secure access to land and water for dry season gardening. Village leaders also agreed to support women in the poorest households in accessing seeds, through a popular system of credit based on cooperative grain storage (locally referred to as *warrantage)* and revolving loans to obtain poultry, goats or sheep. One of the many things we can learn from these women is that improving livelihoods requires not just technical knowledge and access to productive resources, but also strengthened organisational and leadership capacities.

This became very clear from the case of the Lanpugini Women's Group from the village of Bassieri, Burkina Faso, which consists of 44 members of whom only two are literate. The group's main activity is market gardening, but since 2011 they have also been running their own savings and credit scheme, with a special solidarity facility for women in emergency situations. The Lanpugini's Women's Group meets once a week. During these meetings, the women have an opportunity to hear news from each other, discuss their concerns (including on farming) and share other ideas about how to improve their living conditions. It has now become common for women in this area to come together in a group and to obtain and control funds for farming and animal-raising. After some time, these women started to discuss gender relations with men. Building their own collective group has strengthened the women's leadership and organisational capacities. It has also enabled them to have a stronger voice in decision making - both within their family and in the village and to improve their livelihoods.

New roles and responsibilities

These experiences are significant, because in the Sahel, men and women have increasingly come to realise that women's participation in the transition to agroecology is essential for a resilient, sustainable and productive

solution for improved livelihoods. However, measures to foster women's engagement in agroecology can easily lead to further increasing their already heavy workloads. The domestic work, agricultural work *and* childcare that they have to take on are often referred to as women's triple work burden.

Even within initiatives to promote agroecology in the Sahel, rural women often remain economically marginalised and vulnerable – sometimes with an increased workload. Agroecology is often celebrated for its strong emphasis on human and social values, such as dignity, equity, inclusion and justice. Yet there is still much for practitioners of agroecology to learn about how to foster more equitable (economic) relations within families and within communities. This experience provides useful insight on how to do this.

Changing governance

For several years now, we have accompanied communities in Burkina Faso, Ghana, Mali and Senegal in their efforts to combine agroecology with equity. While teaching each other the most relevant agroecological practices, communities have reformed governance at the community and municipality levels, strengthening the position of women in the process, including those from the most vulnerable families. At the community level, representative Village Development Committees that include women leaders have been established. These committees lead the planning, implementation and oversight of the promotion of agroecology in the community. At the rural municipality level, or 'Commune', the mayor and elected Councilors, having seen the benefits of agroecology through field visits and discussions with villagers, agreed to include the promotion of agroecology in their Communal Development Plans and budgets. These plans now include specific activities to strengthen the position of women.

The pathway to equity

In our experience, the pathway towards building more equitable (economic) relations between men and women through agroecology is based on the following set of main principles:

- Engagement of women farmers as trainers of other farmers. This fosters the development of women leaders who serve as role models in their communities. Women prove that they are as capable as, and sometimes better than, men in ensuring the transmission of knowledge to others. These women leaders gain respect, develop a stronger voice in decisions, and are listened to and consulted with more both within their households and their wider communities.
- A combination of strategies can strengthen women's ability to make an income with agroecology. Women's struggles for land, market gardening and their credit & savings activities enable them to make a substantial financial and material contribution to household expenses, as well as improving food security and nutrition. This in turn changes (economic) relations within their households: Women report that they are consulted more often by their husbands in family decision making, including farming.
- Women must be involved in planning and decision making on agroecology. Women's involvement in decision making, at both family and village level, helps to improve their mobility and creates and reinforces the new norm that women can and do participate in meetings, both within and outside their villages.

These developments are already bearing fruit. For example, it has become common for men to help

Women's credit groups bolster leadership, solidarity, and self-confidence.

or replace their wives in the planting of beds and the watering of crops if required, for example in instances of illness or pregnancy. Another indicator is that in many villages, men have contributed their own resources to the fencing of market gardening sites that are reserved for women. While in large compounds of many family members, grandmothers often take care of the children when women are out of the house to farm or sell, in smaller compounds it can now be seen more often that men are taking on these care duties. Finally, in some cases, male elders and traditional village authorities have agreed to provide secure land access to women groups for market gardening or collective farming. These are major socio-cultural changes for rural families in the Sahel.

Lessons from our experience in the Sahel

We have seen that it is essential that women are able, in a culturally sensitive way, to directly address gender relations and the division of resources and responsibilities within the family. As they gain in self-confidence, organisation, solidarity, leadership and economic means through their women's groups and agroecological activities, it is important that they do not become overburdened, or that childcare is compromised. Changes in the division of roles and tasks are necessary and possible, as we have seen.

Within the social and cultural context of the Sahel, the short term benefits of agroecology to addressing women's specific needs can eventually bring about wider change. Improvements in income, food and nutrition security, self-confidence, organisational capacities and economic wellbeing lay the foundations to instigate shifts in gender relations, women's status and decision-making roles within families and communities. It is important to recognise that this takes time. The process can be accelerated through the support of civil society organisations, for example with facilitation of dialogues and through local capacity building. We do realise that as outside agents we can play a facilitation role, but in the end the women themselves must negotiate these things within their families and communities. It is our strong conviction that these insights illuminate the most promising pathway to a real and equitable renegotiation of roles and responsibilities between men and women in the context of agroecology in the Sahel.

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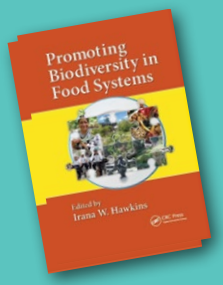
NEW BOOKS

Agroecology Now! Transformations Towards More Just and Sustainable Food Systems.

Anderson, C.R., Bruil, J., Chappell, M.J., Kiss, C., and Pimbert, M.P., *2021, Palgrave MacMillan,* 199 p., ISBN 978-3-030-61315-0

This open access book published by Palgrave develops a framework for advancing agroecology transformations focusing on power, politics and governance. It explores the potential of agroecology as a sustainable and socially just alternative to today's dominant food regime. Agroecology is an ecological approach to farming that addresses climate change and biodiversity loss while contributing to the Sustainable Development Goals. Agroecology transformations represent a challenge to the power of corporations in controlling food system and a rejection of the industrial food systems that are at the root of many social and ecological ills.

In this book the authors analyse the conditions that enable and disable agroecology's potential and present six 'domains of transformation' where it comes into conflict with the dominant food system. This book will be a valuable resource to researchers, students, policy makers and professionals across multidisciplinary areas including in the fields of food politics, international development, sustainability and resilience.



Promoting Biodiversity in Food Systems

Irana W. Hawkins (Ed.), *2020, CRC Press*, 384 p. ISBN 9780367732974, Paperback £52.99, Hardback £150.00, eBook £135.00

Biodiversity of the food system is crucial for food production and loss of biodiversity is a pressing issue. This book focuses on biodiversity's crucial role in food systems, health and well-being, and fate of the natural environment. It provides practical recommendations on how proper food systems can sustain a healthier planet and protect biodiversity. Sections provide a comprehensive understanding of the urgent need for promoting biodiversity-promoting food systems that help maintain planetary boundaries that are at risk; mimic the natural processes of highly integrated ecosystems; and improve human/planetary health while providing a wholesome and sufficient food supply.

Agricultural Development: New Perspectives in a Changing World

Keijiro Otsuka and Shenggen Fan (Ed), 2021, International Food Policy Research Institute, 766 p., ISBN-10 : 0896293831

Agricultural Development: New Perspectives in a Changing World is the first comprehensive exploration of key emerging issues facing developing-country agriculture today, from rapid urbanization to rural transformation to climate change. Top experts offer the latest research in the field of agricultural development, addressing topics such as nutrition and health, gender and household decision-making, agrifood value chains, natural resource management, and political economy. The book also covers most developing regions, providing a critical global perspective at a time when many pressing challenges extend beyond national borders. With its unprecedented breadth and scope, this textbook will be an indispensable resource for the next generation of policymakers, researchers, and students dedicated to improving agriculture for global wellbeing.

SOURCES

Biofertilizers and Biopesticides in Sustainable Agriculture

B. D. Kaushik, Deepak Kumar, Md. Shamim (Eds.), *2020*, Apple Academic Press, 482 p., ISBN 9781771887939, Hardback £131.00, eBook £37.79

This new volume, *Biofertilizers and Biopesticides in Sustainable Agriculture*, presents strategies for the management of soil and crop diseases. Microbes have attracted worldwide attention due to their role in disease management and remediation of polluted soils. Taking a sustainable approach, this book explores the means of integrating various microbial management approaches to achieve the desired levels of crop yield under both conventional soils and neglected soils through the use of biopesticides and other botanicals as well as biomolecules. This book also presents a broad and updated view of molecular nitrogen fixation and phosphate-solubilizing and sulphur-transforming microbes for nutrition of crops in relation to the role of metal tolerant microbes in providing protection to plants grown in metal-contaminated soils.

The preparation and application of biofertilizers, utilization of household waste materials, and use of genetically modified microorganisms (GMOs) in plant growth and development are also well discussed in the volume.

The Soil-Human Health-Nexus

Rattan Lal (Ed.*) 2021, CRC Press*, 350 p., ISBN 9780367422134, Paperback £66.99, Hardback £150.00, eBook £60.29

The term "soil health" refers to the functionality of a soil as a living ecosystem capable of sustaining plants, animals, and humans while also improving the environment. In addition to soil health, the environment also comprises the quality of air, water, vegetation, and biota. The health of soil, plants, animals, people, and the environment is an indivisible continuum.

One of the notable ramifications of the Anthropocene is the growing risks of decline in soil health by anthropogenic activities. Important among these activities are deforestation, biomass burning, excessive soil tillage, indiscriminate use of agrochemicals, excessive irrigation by flooding or inundation, and extractive farming practices. Soil pollution, by industrial effluents and urban waste adversely impacts human health. Degradation of soil health impacts nutritional quality of food, such as the uptake of heavy metals or deficit of essential micro-nutrients, and contamination by pests and pathogens. Indirectly, soil health may impact human health through contamination of water and pollution of air.

Part of the *Advances in Soil Sciences* series, this informative volume covering various aspects of soil health appeals to soil scientists, environmental scientists and public health workers.

Microbes in Agriculture and Environmental Development

Chhatarpal Singh, Shashank Tiwari, Jay Shankar Singh, Ajar Nath Yadav (Eds.), 2021, CRC Press, 318 p., ISBN 9780367524135, Hardback £115.00, eBook £40.49

The collection of essays in Microbes in Agriculture and Environmental Development explores the applications of microbes for the improvement of environmental quality and agricultural productivity through inoculants and enzymes. These are useful for the conservation and restoration of degraded natural and agricultural ecosystems, crop yield extension, soil health improvement, and other aspects of agriculture and the environment. It discusses the effective use of microbial technology, wastewater treatment, and recycling of agricultural and industrial wastes. It provides detailed accounts of recent trends in microbial application in plant growth promotion, soil fertility, microbial biomass and diversity, and environmental sustainability through bioremediation, biodegradation, and biosorption processes.

It will be an invaluable addition to the bookshelves of researchers and graduate students in agriculture and environmental engineering, soil science; microbiology, sustainable agriculture, and ecosystems.

Entrepreneurship to promote organic farming

Victor I and Suresh Kanna K

Farmers dependant on rainfall are always vulnerable. But turning crisis into an opportunity requires determination and support from many. Sebastian is one such example who transformed into a role model, supporting farmers transition to organic farming methods.

Sebastian explains the process of making organic manure to the visitors

It is a well-known fact that the use of organic or biological inputs has assumed importance in the promotion of organic agriculture. In conventional agriculture where the application of chemical inputs is widely known for its direct action to feed and protect the crop, on the contrary, in organic agriculture, inputs are being used to feed the soil and to create an environment to keep the pests below the economical threshold limit (ETL). In this effort, there are two crucial issues for farmers who are in the mindset of transitioning to organic. One is the availability of organic inputs and the other one is the quality of the product.

In recent years, few innovative entrepreneurial farmers have made attempts to adopt appropriate production methodologies to produce quality bio-products and have made them available to other farmers at reasonable prices. They took advantage of the growing awareness of organic agriculture among farmers. Various types of organic and biological inputs are being launched and sold to farmers. Sebastian is one such farmer entrepreneur who has been successfully producing organic inputs, serving as a role model to others in the region.

Sebastian is a small farmer from Mugavanur Village in Vaiyampatti block of Trichy district, Tamil Nadu. He owns four and a half acres of agricultural land in which two and half acres are under rainfed condition. He irrigates 2 acres from well and borewell sources. With cyclic years of drought for more than a decade, cultivation of crops has always been a challenge for him. Hence, he limited the cultivation of high-water intensive crops like paddy and has moved to cultivation of creepers like ridge gourd, snake gourd, bottle gourd. In the shade of these creepers, he cultivates tomato, innovatively. This has been recognized as one of the effective grassroots level innovations and included in the Clima-adapt program of Norway and TNAU in the year 2012.

The journey of organic agriculture

The place he lives and farms is very close to Vanagam, an organization founded by late Shri. Nammalvar, a renowned organic agriculture proponent in Tamil Nadu. During 2013, he attended a 5-day course on ecological agriculture conducted on Vanagam's ecological farm at Surumaanpatti village. This was a turning point for him to shift his approach towards farming.

Sebastian also participated in a training on integrated pest management organized by AHIMSA, a local NGO. It is one of the pioneering organizations which took up IPM approaches in the late 1990s in Tamil Nadu with the technical guidance of AME (Agriculture Man Ecology) and continues to work for the promotion of ecological agriculture in Vaiyamppatti block. Later, he became an active member of *Uzhavar Mandram* facilitated by NABARD and AHIMSA. With the exposure he got from VANAGAM and AHIMSA, Sebastian was motivated and strengthened by his conviction towards organic agriculture. He started to adopt organic agriculture approaches in his own farm and within a year he completely adopted organic methods in his entire farm area of four and a half acres.

Crisis to creativity

To challenge his conviction, nature started to play its role in the form of consecutive years of drought and dry spells which shattered his dream of continuing as an organic farmer. Cultivation on the rainfed land could not be taken up owing to consecutive years of low rainfall in the region. The open well as well as the borewell dried up making it impossible to grow anything on irrigated lands. To save his vegetables, Sebastian was forced to fetch water in pots and irrigate his creepers.

At this point of time, he had an opportunity to participate in two-day trainings organized by Tamil Nadu Agriculture University at Anna Horticulture Farm, Kudumiyanmalai in Pudukkottai District. The training was focused on how farmers can generate alternative income through bio input production and marketing. The inputs and ideas from the training have him confidence to venture into production of bio-inpupts. He perceived it as a solution to his farming crisis. Thus, he shifted his focus and energies from crop cultivation to bio-input production and marketing.

"Though, I have enough land to practice organic agriculture, I could only cultivate crops in 50% of my land due to the limited availability of water. At the same time few farmers interested in organic agriculture, expressed their inability to produce their own bio inputs. Hence, I decided to take up production of bio-inputs, which not only became a source of income to me, but has helped me to support farmers interested in moving towards organic. This makes me happy and satisfied", says Sebastian.

All the family members of Mr. Sebastian are involved in production of bio inputs

Production of bio inputs and income

Currently, he is involved in preparation of bio inputs like Dasagavya, Panchagavya, Fish Amino Acid, Vermi Compost, Herbal Pest Repellent Mixture based on the raw materials available in his farm. Cattle and crop residues serve as raw materials with limited inputs being sourced from outside. He owns 2 desi cows (a native breed called Manapaarai cows) and 1 jersey cow. He uses the cow urine and cow dung from desi cows only for bio input preparation.

Seeing his entrepreneurial skills, the department of agriculture supported him to construct vermi-compost pits with a capacity of 2 tonnes. Similarly, AHIMSA, the local NGO supported him by providing parallels to produce Dasagavya, Panchagavya, Fish Amino Acid and Herbal pest repellent mixtures along with sprayers for application.

His entire family, consisting of wife and two children, is involved in this initiative. He has trained his children in a way to identify herbs and its uses and involve them in collection of herbs and raw materials required, preparation of bio inputs, regular monitoring, maintenance and also marketing.

After fulfilling his farming needs, presently Sebastian annually markets 100 litres of Dasagavya, 100 litres of Panchagavya, 20 litres of Fish Amino Acid, 100 litres of herbal pest repellent mixture and 2000 kgs of vermicompost. His income from selling the bio-inputs is around Rs.60000 annually. Around 60-70 farmers are in his buyer list with 20 of them being frequent buyers.

Almost, 90% of the bio inputs are sold at his farm gate itself. For the remaining too, he sells through his phone contacts. Of late it is being shared on the social media , which has increased the demand for his bio-inputs. He also offers advice to farmers interested in preparation and application of bio inputs.

The mini lab

In the year 2018-19, the Department of Agriculture organized a state level training for strengthening farmers collective initiatives and enhancing their entrepreneurial skills. Sebastian, as a member of FPO, along with 70 farmers participated in the training. After the training, Sebastian expressed interest in the production of

> Farmers who produce bio-inputs require buy back support initially, to overcome marketing challenges.

Sebastian being felicitated as best farmer entreprenuer by Trichy District Collector

Metarhizium anisoppliae, a fungal entomopathogen which acts as a bio control agent for soil inhabiting insects and related root rotting problems. He approached the Department of Agriculture and expressed his interest in setting up a mini lab and producing Matarhizium.

As a follow up, the officials from the Department of Agriculture made a field visit to his place and interacted with their group members and finalized the plan for setting up a mini lab. A total support of Rs. 70,200/- was provided to purchase materials to establish the lab - tables, pressure cooker, UV lights, buckets and containers. Sebastian produces around 50 kgs of Metarhizium, annually and earns around Rs. 9,000.

However, there are challenges of marketing. The Department of Agriculture directly sells Metarhizium to farmers, with an attractive packing and a brand name. The department itself becomes a competitor for farmers like Sebastian, whose product is neither packed well nor branded. Buy back support initially is what Sebastian looks for to overcome this marketing challenge.

Conclusion

By going organic, Sebastian and other farmers are happy to see their soil health being improved. Application of bio-inputs has resulted in regeneration of life beneath the soil, healthy plants, less pest incidence and improved access to safe and tasty food for the family.

Experiences of Sebastian has been covered in the local newspapers and in All India Radio, Tiruchirappalli in *Velaan Arangam*, a special prime time slot for agriculture. Sebastian has emerged as a role model for entrepreneurship in the region.

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