International Science Conference
on
"Organic Farming Research, Technologies and Extension"

379

31st October 2020

EXTENDED SUMMARY

Coordinated By

ICAR-Indian Institute of Farming Systems Research
Modipuram, Meerut – 250 110, (UP), India

International Science Conference
on
"Organic Farming Research, Technologies and Extension"

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Compiled By

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Schedule of Events
31st October, 2020

Technical Session -1 “Production research and technologies for crop and livestock under Organic Farming”			
Chair	Dr V. Praveen Rao, VC, PJTSAU, Hyderabad	Convenor (s)	Dr A.K. Prusty, Sr. Scientist, ICAR-IIFSR Dr Mahesh Chander, PS (ICAR-IVRI)
Co-Chair	Dr S. Bhaskar, ADG (AAFCC), ICAR, New Delhi	Rapporteurs	Dr P.C. Ghasal, Scientist Dr Amrit Lal Meena, Scientist

Time hrs IST	Speaker	Topic
10.30 - 11.00	Dr. Gerold Rahmann, Germany	Organic agriculture research: overview and ISOFAR
11.00 – 11.30	Dr. Mette Vaarst, Denmark	European potentials, challenges, and visions for future development of organic animal farming
11.30 – 12.00	Dr. Khalid Azim, Morocco	Improvement of tomato waste composting and compost quality by integration of sheep manure
12.00 – 12.20	Dr. N. Ravisankar, India	Organic farming: Indian perspective of production research and technologies
12.20 – 12.30	Chair and Co-Chair	Discussion and concluding remarks

Inaugural Session	
Welcome	Dr A.S. Panwar, Director, ICAR-IIFSR
Welcome & Brief Overview	Dr. A. K. Yadav, Advisor (MOVCD NER), GoI
Remarks	Dr. B. S. Negi, APEDA
Remark by Guest of Horner	Dr S. Bhaskar, ADG (AAFCC)
Remark by Chief Guest	Dr S.K. Chaudhari, DDG (NRM)
Vote of Thanks	Dr (Mrs) Poonam Kashyap, Sr. Scientist, ICAR-IIFSR

Technical Session -2 "Plant protection research and technologies for Organic Farming"			
Chair	Dr R. K. MIttal VC SVPUAT, Meerut	Convenor (s)	Dr Chandra Bhanu, Sr. Scientist, ICAR-IIFSR Dr Raghuveer Singh, Scientist, ICAR-IIFSR
Co-Chair	Dr A.K. Yadav, Advisor (MOVCD-NER), DAC&FW	Rapporteurs	Dr Amit Kumar, Scientist Dr Jairam Chaudhary, Scientist

Time hrs IST	Speaker	Topic
13.30 -14.00	Prof. Ulrich Schmutz UK	Phasing out contentious inputs from agriculture in Europe – and beyond? Examples from the 4-year research project Organic-PLUS
14.00-14.30	Dr M. Suganthy India	Science and technologies for non-chemical management of insect, disease and nematode
14.30 – 14.50	Dr Mukesh Sehgal India	Application of Integrated Pest Management practices under Organic farming
14.50 – 15.00	Chair and Co-Chair	Discussion and concluding remarks

Technical Session -3 "Success stories on implementation of organic farming technologies"			
Chair	Dr Anupam Mishra, VC CAU, Imphal	Convenor (s)	Dr Poonam Kashyap, Sr. Scientist, ICAR-IIFSR Dr M. Shamim, Scientist, ICAR-IIFSR
Co-Chair	Dr A.S. Panwar, Director ICAR-IIFSR	Rapporteurs	Dr Amit Kumar, Scientist Dr Jairam Chaudhary, Scientist

Time hrs IST	Speaker	Topic
15.15 -15.30 hrs	Dr R.K. Avasthe, Sikkim	Success story on Integrated Organic Farming System cluster in Sikkim
15.30-15.45 hrs	Dr Jayanta Layak, Meghalaya	Success story on Integrated Organic Farming System cluster in Meghalaya
15.45 – 16.00 hrs	Dr Mahesh Chander, ICAR-IVRI	Extension strategies for promotion of organic farming in India
16.00 – 16.15 hrs	Mr Anshuman Pattanayak, Odisha	Implementation of organic farming technologies in farmers field: Experience sharing by CFA on OF

16.15 -16.30 hrs	**Ms Priti Sanjay Sonkusare, Maharashtra**	**Success story on Entrepreneurship through organic farming: Experience sharing by CFA on OF**
16.30 -16.45 hrs	**Mr Motesh, Tamil Nadu**	**Implementation of organic farming technologies: Experience sharing by progressive farmer and CFA on OF**
16.45-16.55 hrs	**Chair and Co-Chair**	**Discussion and concluding remarks**
16.55 hrs	**Vote of Thanks**	

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Technical Session I

“Production research and technologies for crop and livestock under Organic Farming”

Organic agriculture research and the role of ISOFAR

Gerald Rahman

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Introduction

Organic farming is knowledge based innovative and sustainable farming of tomorrow. It is a global harmonized concept and approach in the context of the principles of "ecology", fairness", "health" and "care". The global organic production is done on 70 mio ha farmland by 3 mio farmers and has a global market of 100 billion USD (2019). Despite the success story of production and market share, that Organic Agriculture is not scaling up fast enough and has recently (2019) only 1.6 percent of the global farmland area. Big players in the Organic world are the EU and the US, who have 90% share of the market. Particularly, the EU has identified Organic Agriculture as an important farming approach for the future and claimed a share of 25% of Organic farmland till 2030 (recently 6%).

Nevertheless, Organic Agriculture has not only a scaling-up challenge, but also a need to develop the practice and the food chain, to become even more sustainable, efficient and affordable. Research is needed to reach the goals. The EU has established already good structures an competences in Organic Agriculture research, but in other parts of the world, needed research is lacking interest and resources. ISOFAR as a global network of Organic Agricultural scientists tries to overcome the isolation and structural problems with joint actions and concepts. To help each other. ISOFAR has no own money, but good influence in governmental research bodies and ministries to promote more and better Organic Agriculture research.

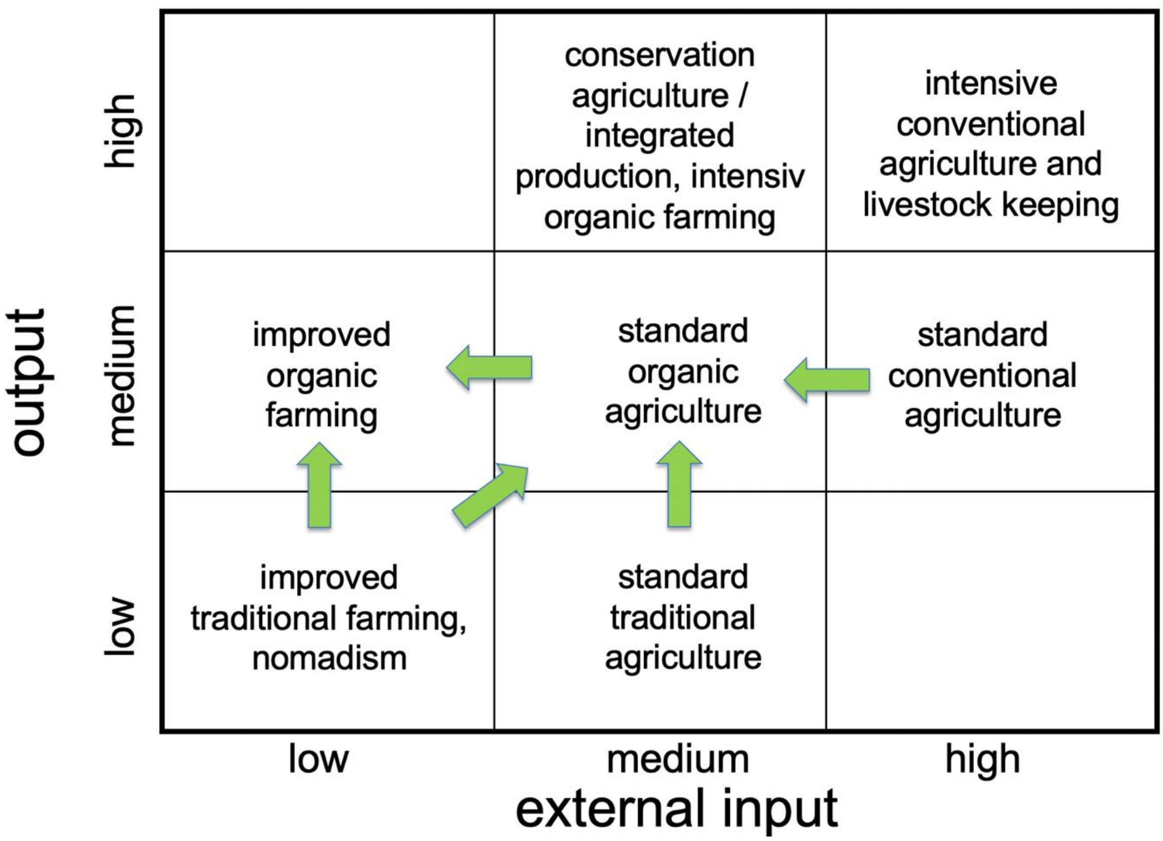
Organic Agriculture research – some key figures

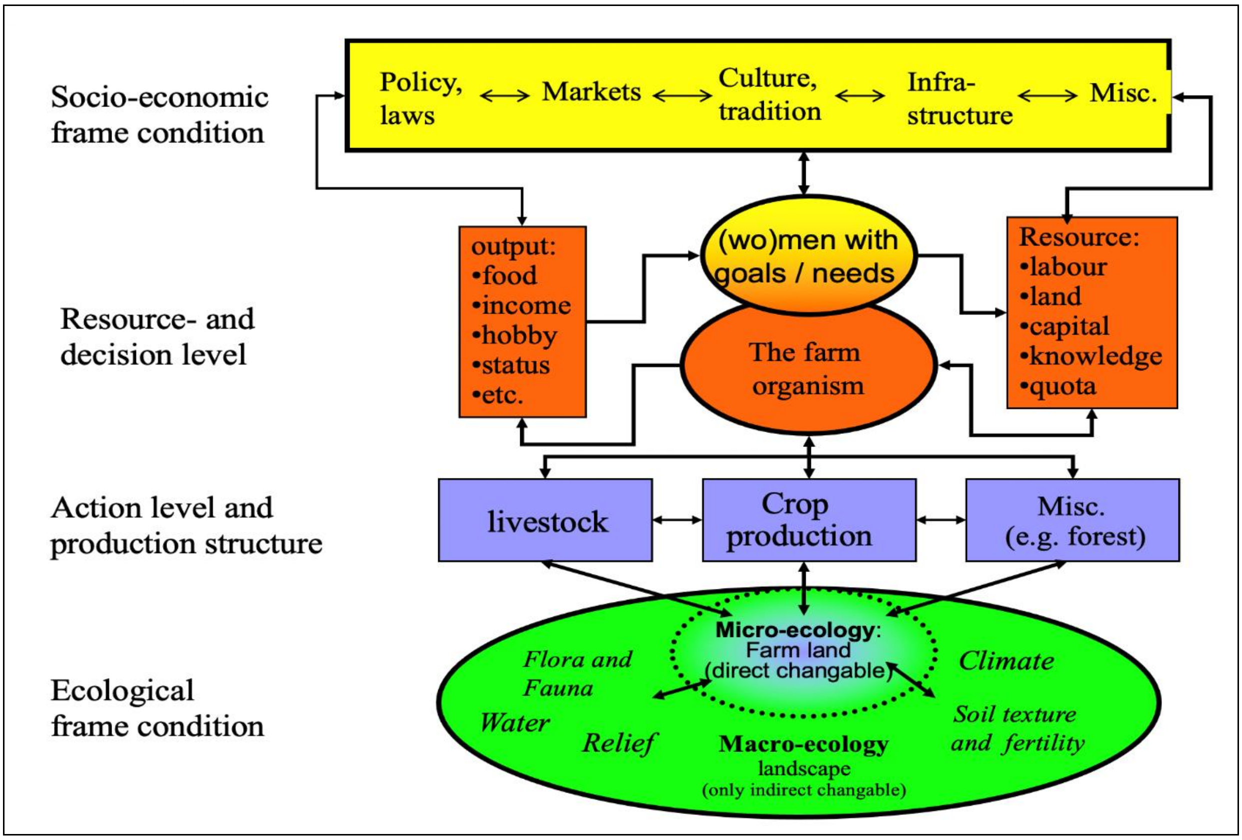
- Global: 3,000 scientists work (min. PhD) full time in public OA Research (0.5% of total public agricultural scientists and 0.2% of total agricultural researchers)
  - 2,000 Europe (inkl. 500 in Germany)
  - 500 Asia (mainly China, South Korea, India)
  - 400 Americas (North and South)
  - 50 Africa
  - 50 Oceania
- Global: Annually 250 mio Euro public research money for OA (50% of total research budgets) (0.1% of total agricultural research money) (without extension, dissemination and subsidies)
  - 80% Europe (40% Germany)
  - 10% Americas
  - 5% Asia
  - 3% Oceania
  - 2% Africa

The system approach is the main advantage of OA research, the main challenge to have higher production yields to produce enough healthy and affordable food for everyone, not only for the rich.

- OA yields and qualities are lower than non-OA:
  - OA goals and standards have restrictions to ensure ecological sustainability.
  - Markets are not as much developed as non-OA: losses and costs
- OA does re-invent research methodologies and concepts:
  - System research versus isolated disciplinary approaches
  - Working with practice and find solutions together

The development paths are in a system approach.



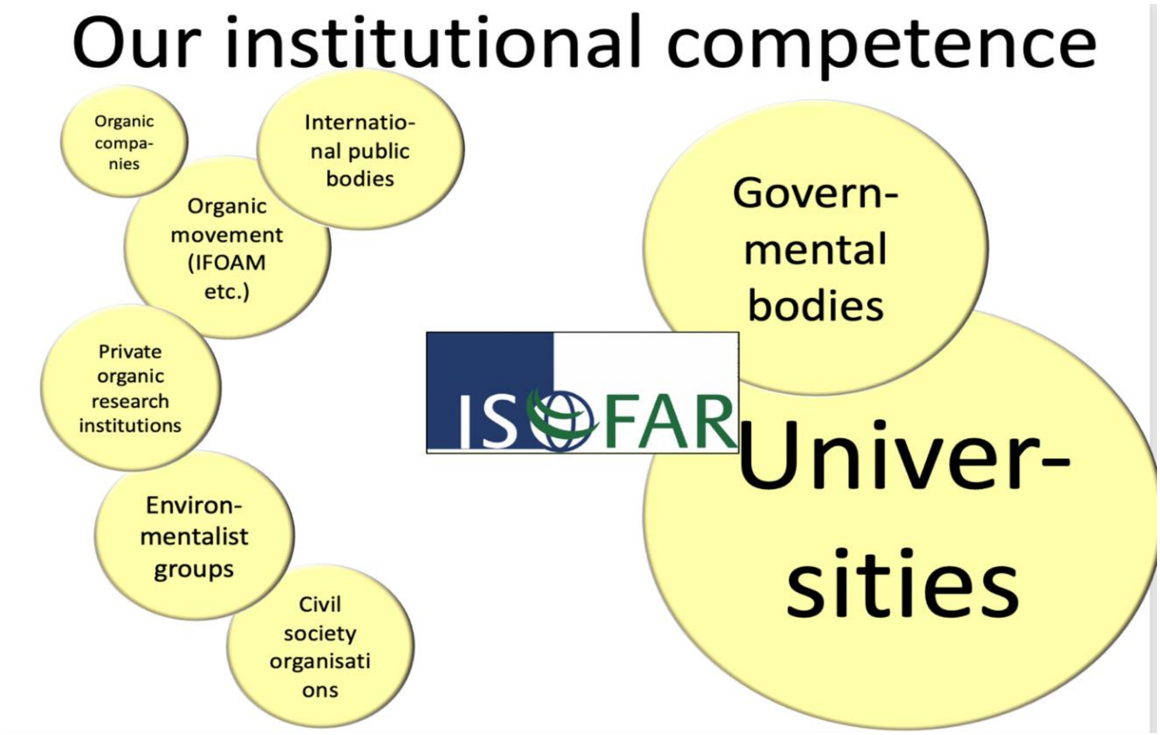


Organic Agriculture research can help to solve the future challenges. But it needs more resources to produce high relevant results. This is lacking in the most of the countries on the earth.

International Society of Organic Farming Research (ISOFAR)

ISOFAR is a nonpartisan, nonprofit organization founded by scientists in 2003. We facilitate global co-operation in research, education and knowledge exchange, and international collaboration with the goal of advancing research on organic systems. We support our members through a wide array of services, publications, and events.

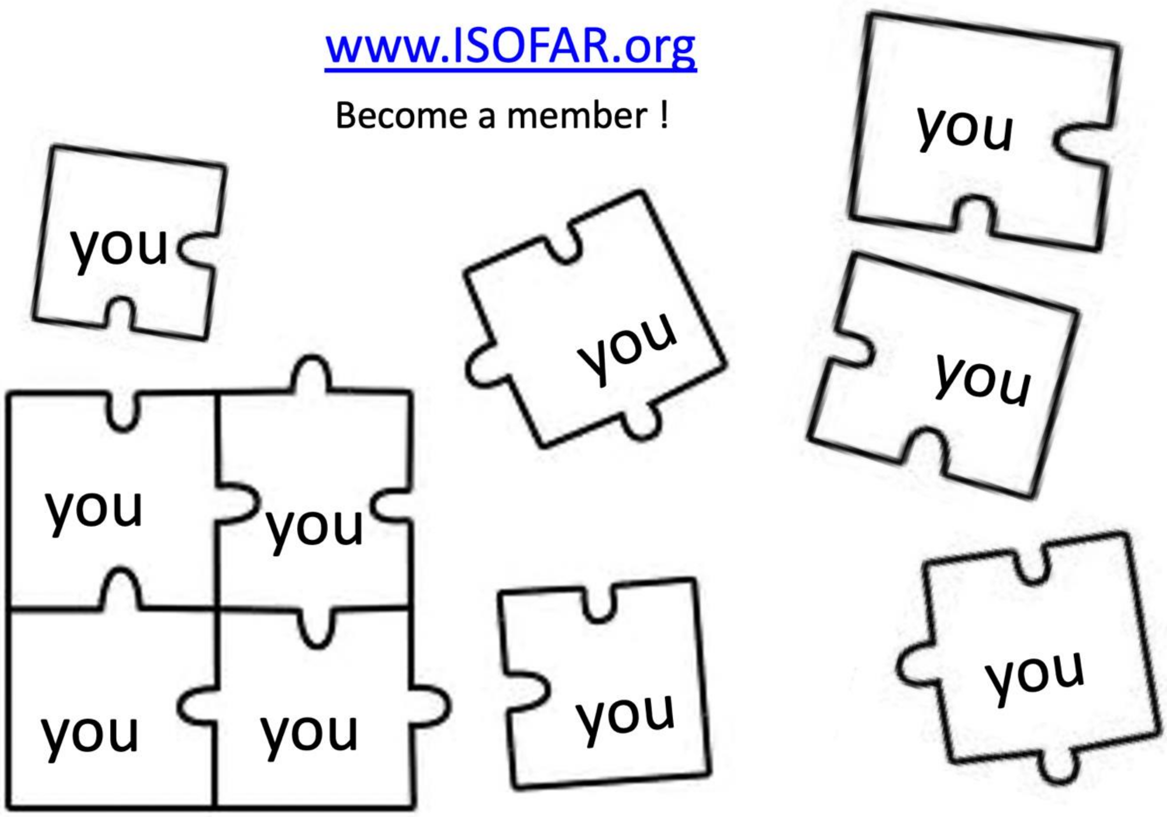
Our mission is to promote and to support research in all areas of organic agriculture, as it is defined by the global consensus of organic agriculture movements and documented in the IFOAM Basic Standards for Organic Production and Processing.



We organize conferences (including the scientific track at the Organic World Congress), are editors of scientific publication journals (Organic Agriculture, published by Springer) and inform members and friends about the OA research activities in the world.

Journal of Organic Agriculture

We invite all researchers, who are interested in Organic Agriculture research to become member.



European potentials, challenges, and visions for future development of organic animal farming

Mette Vaarst[1], Stephen Roderick[2], Guillaume Martin[3], Stefan Gunnarson[4], Anet Spengler Neff[5], Anna Bieber[6] and Anne Grete Kongsted[7],

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Introduction

There is a serious need for significant and fundamental changes to the way food is produced and consumed. Facing the current global environmental challenges, animal husbandry needs to find new balances for a positive and sustainable contribution.

Identification of strategies for the future development of European organic animal husbandry

In organic agriculture animals are considered as living sentient beings, and a key aim should be to enable, from the animal's perspective, a life that is worth living. The 'Treaty on the Functioning of the European Union' (TFEU) 2009 also introduced the recognition that animals are sentient beings (Article 13 of Title II). This implies that humans should provide the necessary conditions that allow farm animal's to meet their natural needs. However, achieving this aspiration has the potential of conflicting with what is considered the overarching goal: efficiently providing food for humans whilst trying to meet wider sustainability objectives, such as reducing greenhouse gas emissions and promoting biodiversity. Nevertheless, with reference to the organic principles, we are strongly guided towards finding solutions and synergies that have multiple aims. Values that are adaptable and relevant to different contexts and embrace diversity and resilience can guide developments towards husbandry practices that break the 'one-size-fits-all' conventional intensification of farming that places undue pressure on animals as well as humans.

Here a short outline of the six suggested strategies for future European organic animal farming, which were discussed in the IAHA conference, is presented. Each applies differently to each animal species but are highlighted because they support innovative ways of thinking about integrating animals into farms and landscapes, compared to the last half century's increasing specialisation and industrialisation.

1) Integrating diversified multi-species systems

Diversity at the farm level, in terms of breeding two or more animal species on the same farm, has the potential to improve three dimensions of sustainability: environmental soundness, economic viability for farmers and social acceptability by being respectful of animals. This is in focus in the project MixEnable, which show, for example, interesting aspects of how guardian animals co-grazing with vulnerable species can support a significant reduction of predation.

2) Pastoralism, agroforestry and sustainable foraging which can integrate pigs, pasture and trees

Natural, pasture-based and more extensive production systems are sometimes viewed and criticised as inefficient. More and more evidence and recognition points to these systems as representing a form of food production that is not dependent on excessive fossil fuel usage and offers a vast carbon storage capacity. Several perspectives on these issues are investigated for different animal species in the current CORE Organic projects, and the book 'Improving organic animal farming' (linked below) explores perspectives for different range and pastoral systems.

3) Finding new potentials for home grown protein feeds

The issue of home-grown protein feed crops is relevant for all animal species in organic production, and many organic farms rely on imported sources even though there are many good possibilities to grow protein feeds, even under Nordic conditions. We highlight the potential for improvements of organic animal farming with regard to, for example, balancing the protein and energy component of animals' diets to ensure the lowest possible emissions, supported by appropriate breeding and efficient grassland management.

4) Adopting resilience as a core of health principle and developing strategies to significantly lower or phase out the use of antibiotics

Resilience is a core concept in organic farming at all levels, including the farm, system, herd and individual level. The relative resilience of an individual or group of animals will influence the occurrence and impact of disease. While the EU organic regulations allow antibiotics to be used in animal production, their prophylactic use is banned and reducing dependence on therapeutic use is encouraged along with a strong emphasis on health and welfare promotion. The actual use of antibiotic drugs in European organic animal farming compared to conventional animal husbandry is not comprehensively documented, but various aspects of health-promoting and/or prudent medicine uses are emphasised in all CORE Organic projects.

5) Emphasising appropriate breeding and breeds, including multipurpose and local breeds

In Northern Europe, it is common practice to use the same high-yielding breeds in organic production as in conventional animal production. This can provide a key challenge given the priority placed on natural elements of life, including outdoor living, longevity, natural behaviour and species-specific feeding. Some of these challenges can be met through more appropriate breeding strategies, including broadening the breeding goals to fit organic objectives and the use of cross-breeding, as well as breed diversity and the use and conservation of endangered breeds.

6) Enabling enhanced mother-infant contact

Two CORE Organic Cofund projects research cow-calf contact systems, which represents a fundamental shift from a common understanding of dairy herds focused entirely on milk production for consumers. However, the issue is not restricted to milk production and the fundamental ethological and economic issues apply to other animal species, including small ruminants, pigs and poultry.

Future perspectives

Many of the key challenges of global agriculture are also organic farming aspirations. Placing emphasis on four broad strategic categories, diversity, integration, resilience and communication, could contribute significantly to solving the current problems in our food and farming systems. It is also necessary to have frank and open discussions about the circumstances under which we involve animals in farming in a way that allows us and them to make positive contributions to the health of the planet.

This author group emphasise dairy cows, pigs and chickens, because the CORE Organic research projects mainly focus on these species. Still, the same perspectives and opportunities could be equally applicable to other species, including, e.g. fish and honeybees. Although not necessarily unique to organic farming, diversity is emphasised as a key to future development. All of these perspectives can only be taken into account if they are supported by relevant policies and the wider society, undergoing fundamental changes in the way we demand, consume and waste food.

Do you want to know more?

The international meeting in IAHÀ (https://www.ifoam.bio/about-us/our-network/sector-platforms/ifoam-international-animal-husbandry-alliance) was held 21st-22nd September – here are the proceedings:

- Organic Animal Husbandry systems – challenges, performance and potentials- Proceedings of the IAHA Video-Conference on Organic Animal Husbandry - 21. and 22. September 2020 linked to the 20th Organic World Congress of IFOAM 2021 conference proceedings

The presentation is developed by coordinators and representatives from CORE Organic projects (CORE Organic Cofund project page); here are the links: GrazyDaiSy, Mix-Enable, FreeBirds, ProYoungStock, POWER, and OrganicDairyHealth. And here is the link to the book 'Improving organic animal farming' Improving organic animal farming book information

Improvement of tomato waste composting and compost quality by integration of sheep manure

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Each season, a huge amount of crop residues is regenerated by horticultural production. The main type of wastes are tomato stalks, leaves and axillary buds which are subsequently the result of crop operations like trimming and plants trellising and uprooting. The landfilling of corps residues is a serious problem that need to be solved. Therefore, the valorisation of these organic wastes by composting is a simple way for suitable management and the produced compost could be used as an organic amendment to satisfy the crop growth needs and agronomic soil requirements. The aim of the study is to investigate the impact of the mixing proportion of tomatoes residues and sheep manure using an experimental biocomposter of capacity 220 L with passive aeration system. Two different mixing ratios were set-up on volume basis: R1 (2/3 tomato plant residues ''TPR'' + 1/3 sheep manure "SM") and R2 (1/3 tomato plant residues ''TPR'' + 2/3 sheep manure "SM") and two controls CTRP (1/1 tomato plant residues ''TPR'') and CSM (1/1 sheep manure ''SM''). Parameters such as Temperature, pH, EC, Carbon-to-nitrogen ratio, mineral and organic nitrogen, potassium and phosphorous were monitored for a period of 60 days. According to the results, tomato wastes proportion is negatively correlated to the Germination Index (GI) of the final compost, the nitrogen and the organic matter loss. After 9 weeks of composting, GI was 87%, 91%, 92%, and 95% respectively for CTRP, R1, R2 and CSM. Tomato plant residues are not adequate for composting alone, and could limit the efficiency of the process.

Keywords: Composting optimization, Nitrogen dynamic, tomato plant waste, sheep manure, humification

Introduction

Tomato waste generated by greenhouse industry has become environmental problem that is facing Morocco country and could have a greater impact on the environment. In Souss Massa region, tomato corps production is one of the most important horticultural scope were tomato representing 96% of national production (APEFEL 2017). In 2011, more the 1.000.000 tons of organic waste are generated which 29% are tomato plant residue (leaves, axillary buds, and the entire end cycle plant) with important proportion of organic manner and macro-nutrient (0.7% N, 0.31% P_2O_5, 1.8% K_2O) (Azim *et al*, 2017). Therefore, Tomato wastes represent a valuable source of macro-nutrient that can be profitable. On global perspective, composting can put back this nutrient into the agricultural system as compost which can be considered as a valuable source of humic substances, nitrogen, phosphorous, essential trace elements to support plant growth and might be possible to decrease their dependence on chemical fertilizers and enhance the sustainability of the nutrients cycle. (Karak *et al.,* 2013). Composting efficiency of all crop residues depends mainly on their physicochemical characteristic and environmental conditions together. According to (Onwosi *et al.* 2017) Certain chemical characteristics of the tomato plant residues are not adequate for composting alone and could limit the efficiency of the process: high N concentration for the organic-C gives low C/N ratio which can result in nitrogen loss as NH_3 and even N_2O, excess of moisture content and low porosity, which together make aeration challenging. To overcome the challenges that these peculiarities impose mixing with other compost feedstock materials can be employed. In this scenario, (Gavilanes- Terán *et al.*, 2016) sawdust and laying hen manure were added to tomato waste in order to calibrate C/N which results in a ratio range of 29-30. The C/N ratio of compost feedstock is the leading parameter when setting up a new composting process. However, the C/N should not be used as absolute parameter as it is important to identify the nature of C in the composted materials. (Maheshwari *et al.,* 2014). A similar suggestion assuming a C/N effect has been done by (Kumar *et al.* 2010), they revealed that that C/N alone is not a limiting factor for composting efficiency and low C/N is possible and depend the moisture content. In this study, the objectives were to determine whether addition of sheep manure to the stage composting of tomato plant residues, to monitor the physico-chemical changes and offering an optimal ratio that allows adequate composting and compost quality.

Materials and methods

Feedstock preparation

Composting assay was performed and monitoring at the National Centre of Agronomical Researches Melk Zhar. Tomatoes plant residues (TPR) and Sheep Manure (SM) were used to formulate starting mixture, tomatoes waste was collected during greening maintenance of greenhouse industry consisted of fallen leaves and branch cuttings. Physicochemical properties of starting material are showed in Table 1. The two wastes were crushed to obtain uniform particle size and mixed with four proportions in order to calibrate nutriment balance in the bench-scale reactors.

Table 1. Physico-chemical characteristics of the starter material

	pH [a]	EC (mS/ cm)	TOC (mass%)	C/N (Ratio)	TN (mass%)	TP (mg/Kg)	TK (g/kg)	Ca (g/kg)	Mg (g/kg)	Fe (mg/kg)
TPR	8.33	5.37	27,1	9.9	2.73	0.135	0.075	0.747	0.386	92
SM	7.96	2.03	28.64	12.73	2.25	0.322	0.1	0.682	0.447	153

SM: Sheep Manure
TPR: Tomatoes plant residues [a] Percentages are based on air-dry weight. [b] Percentages are based on oven-dry weight.

Composting sampling and monitoring

Samples were collected as the composting mixtures every on day 0, 12, 14, 26, 38, 50, 62, On these days, three subsamples (200 g per subsample) was collected from the top, middle, and bottom of each reactor. The three subsamples were combined to form one composite sample

(600 g per simple). Each sample from each reactor was oven-dried at 65°C. When dry, the samples were crushed in a small grinder, passed through soil sieves (0.5mm), sealed in plastic containers, and stored at 4°C. Temperature was measured daily at the middle of each reactor using a self-made temperature sensor with a temperature dial and 1-meter-long rod. Ambient temperature was also recorded using the same temperature sensor.

Chemical properties

The pH, electrical conductivity (EC), organic matter (OM), total organic carbon (TOC), total Kjeldahl nitrogen (N-TKN), ammonium nitrogen (N-NH+4), total phosphorus ($P–P_{soluble}$), total potassium (TK), humic acid (HA) and micro-nutriment Ca, Mg, and Fe were determined for oven-dried samples.

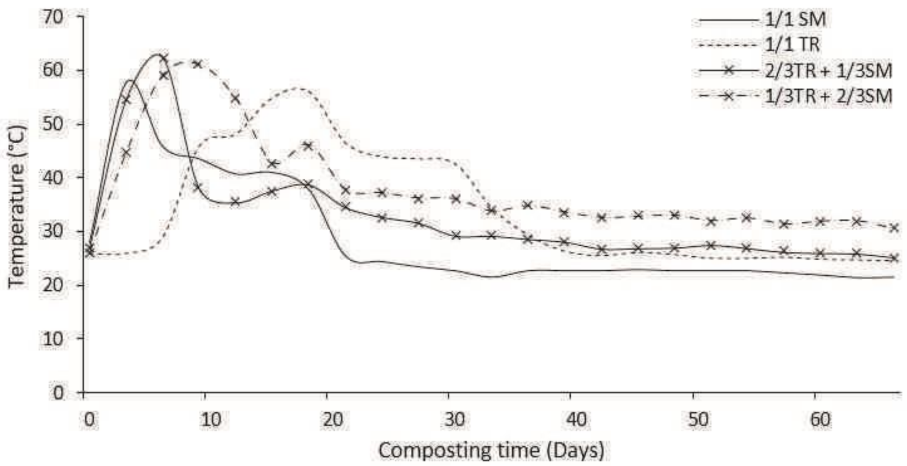
Seed germination test

The germination index (GI) was determined in accordance with (Gu *et al.*, 2011). 20 radish seeds and 5 mL compost extract were placed on sterilized petri dish with a filter paper. Deionized water was used as a control. The petri dishes were kept in the dark at 30 °C for 48 h. Germination rates and root length were measured. The calculation of GI was based on the following formula:

$$GI\ (\%) = \frac{\text{Seed Germination} \times \text{Length of Treatment "mm"}}{\text{Seed Germination} \times \text{Root Length of Control "mm"}} \times 100\%$$

Results and discussion

Temperature is a major parameter provides composting efficiency, a good thermophilic is important for effective inactivation of pathogens and splitting lignine and cellulose in compost (Soobhany *et al.*, 2017; Tuomela *et al.*, 2000).



After the addition of each mixture in the bioreactor, increasing in temperature was observed in all treatment, indicating a marked microbial activity. In composters containing the controls CTPR (Tomato plant residues) and CSM (Sheep manure), the thermophilic phase (up to 47°C) lasted 15 and 5 days respectively for CTPR and CSM. The maximum temperature inside of controls composters is 57°C for CSM and 55.7°C for CTRP, reached within 2 days and 4 days respectively. For composters contending the mixtures of tomato plant residues and sheep manure at different ratio R1 and R2, the thermophilic phase is lasted 12 and 5 days for R1 and R2 respectively. The maximum temperature inside composter was higher than all controls and was 62°C observed for R1 and 61 °C for R2, reached within 2 and 5 days respectively. The high temperature reached during composting process in all digesters ensured higher efficiency of hydrolysis rate and was sufficient for destruction of pathogens and weed seeds according to (Converti *et al.*, 1999; Remade Scotland, 2003; Ziemba *et al.*, 2010; Bayr *et al.*, 2012). All temperature variation versus time of composting is shown in Fig. 1.

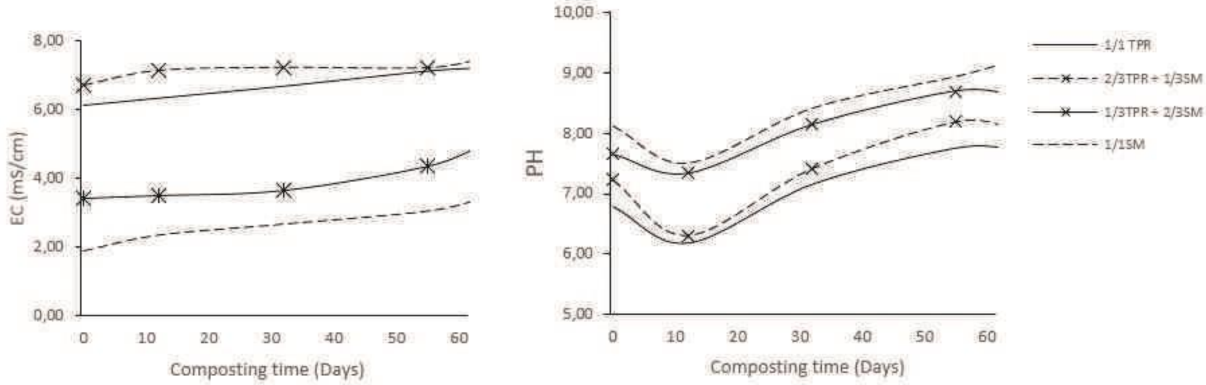


Figure 1. Change in pH and electrical conductivity (EC) during composting of pH variations

pH is one of selective factors for microbial population and influencing the microbial activities and community during composting process (Chan *et al.*, 2016). As shown in Fig. 2a and 2b, most of starting materials and mixture are a pH value ranging between 6, 75 to 8, 12, generally adequate for composting and couldn't limit the efficiency of the process. pH profile decreased during the first week and then was stable around 6.2 for CTRP, R1 and around 7.4 for R2 and CSM. This decreasing in pH values is likely due to the accumulation of organic acids and volatilization of ammonia as suggested by (Ref). As composting is progress, pH profile shows a little alkalization and then was stable in neutral value and R2 and higher than 8 for R1 and CSM. After 9 weeks of composting the final pH values were 7.76, 8, 01, 7, 61 and 8.95 respectively for treatment CTPR, R1, R2, and CSM. This increase in pH is one of indices of compost maturation according to Juarez *et al.* (2015). During this study, the proportion of TPR in the mixture show a direct influence on pH evolution. Since, in two first weeks, CTRP and R2 had slightly higher pH compared to R2 and CSM, the pH becomes more acid if the proportion of TPR in mixture is higher. By against, acidification is low in the control CSM and R1 which the proportion of sheep manure is higher than TPR. After 2 weeks of composting, the pH gradually decreased and stabilized in alkali values for the two composting mixtures and their controls.

Electrical Conductivity

Electrical Conductivity is an important laboratory measurement since it reflects the total salt content coming from microbial mineralization of organic matter fractions present in the substrates of the composting (Jiang *et al.*, 2015; Shah *et al.*, 2015) and thus reflects quality of the compost as a soil amendment. The variations of electrical conductivities of the all treatments are shown in Fig. 2(2a and 2b). During the first week of monitoring, the EC of mixture R2 was constant and they show a gradual increase for R1 mixture and two controls CTRP and CSM. After that, all treatments continued with a slow increase in EC till the end of composting process. Awasthi *et al.* (2014) suggested that increases of EC could be caused to the "biotransformation of complex materials to simple compounds and mineral salts such as phosphates and ammonium ions. This hypothesis is clearly confirmed in Tab which during the composting process, concentration of NO_3^- -N increase in all treatments, especially after 2 weeks.

Conclusion

This study concluded that it's not desirable to compost tomato wastes alone. Thus, using sheep manure in the mixture has been found to constitute a suitable bulking agent for in-farm composting of tomato residues. Adding sheep manure to tomato plant residues improves composting process conditions and compost quality by decreasing the compost toxicity, improving the porosity, extending thermophile phase and enriching compost with beneficial elements P, K, N and Humic substances. It could be concluded that tomato producers in Souss Massa region, can finally valorize efficiently and convert tomato wastes into safe and valuable soil amendment through its composting with sheep manure.

Organic Farming: Indian perspective of production research and technologies

N. Ravisankar, Raghuveer Singh, M. Shamim, A.K. Prusty, A.S. Panwar and S. Bhaskar
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During pre-green revolution period (up to 1960s) the rate of national agricultural growth was not able to keep pace with population growth and 'ship to mouth' situation prevailed. This was the major factor for introduction and large-scale popularization of the high yielding varieties (HYVs) of crops, which were highly responsive to the chemical fertilizers and water use. As a result, the total food grain production increased phenomenally – from mere 50.83 million tonnes in 1950-51 to 283.37 million tonnes in 2018-19 – indicating 5.57 times increase. This increase can be primarily attributed to large-scale adoption of HYVs, combined with other green revolution technologies (GRTs) in cereal crops, expansion of gross irrigated area (22.56 million ha in 1950-51 to 94.46 million ha in 2014-15) and increase in fertilizer nutrient consumption (0.07 million tonnes in 1950-51 to 27.35 million tonnes in 2018-19). All of them put together have led to substantial increase in the productivity of crops, especially food grains (from 522 kg/ha in 1950-51 to 2233 kg/ha in 2017-18) culminating into the change the status of India from a food importer to net food exporter in many commodities. The total factor productivity growth score prepared by National Institute of Agricultural Economics and Policy Research, New Delhi has revealed that technology-driven growth has been highest in Punjab and lowest in Himachal Pradesh. It implies that some of the states like Himachal Pradesh, Uttarakhand, Madhya Pradesh, Rajasthan, Jharkhand and north-eastern region of India have not been influenced much by the modern inputs of agriculture like chemical fertilizers and pesticides. India's average fertilizer and pesticide consumption stands at 137.9 kg/ha and 0.60 kg a.i./ha, respectively during 2018-19. Moreover, despite all technological advancements, the nutrient use efficiency is on lower side. On the other hand, it has been proved scientifically and convincingly that integrated use of organic manures with chemical fertilizers improves the use efficiencies of the latter owing to concurrent improvement of soil physical, chemical and biological properties. The water holding capacity of the soil also gets improved on account of regular use of organic manures. It is estimated that various organic resources having the total nutrient potential of 32.41 million tonnes will be available for use in 2025. To feed the projected of population of 1.7 billion in 2050, 400 million tonnes of food need to be produced which is expected to require around 60 million tonnes of nutrients. Therefore, organic farming promotion in the entire country will not be a viable option considering the difficulty in handling the bulky organic manures and its low-level nutrient contents. Conservative estimates indicate, around 15 million tonnes of nutrients can be shared through organic manures and other sources. Hence, niche area and crop approach for promotion of organic farming is considered to be a viable and efficient option for promotion of certified organic farming while in other areas towards organic approach otherwise called as integrated crop management would better in achieving the targets of food production besides ensuring sustainability in agriculture.

Institutional development such as National Programme for Organic production (NPOP) launched during 2001, followed by setting up of National Centre of Organic Farming (NCOF) under Ministry of Agriculture and Farmers Welfare and initiation of research through All India Network Programme on Organic Farming (AI-NPOF) under ICAR-Indian Institute of Farming Systems Research by ICAR during 2004 laid the foundation for systematic development of technologies for organic farming in the country. Started with just 58,300 ha during 2003-04 (the year of launch of AI-NPOF by ICAR), the area under organic farming has grown almost 39-fold, reaching to 2.299 million ha by March 2020 (Fig 1) Share in area under organic farming by major States are given in Fig 2. (APEDA, 2020).

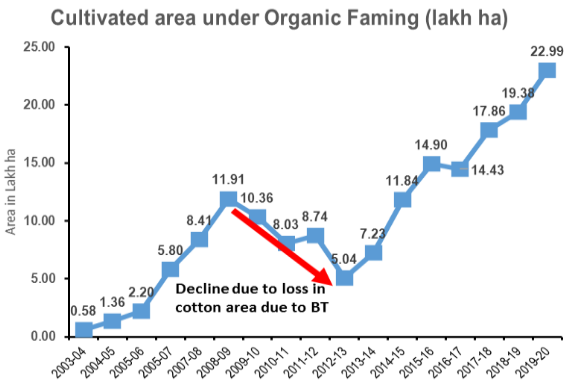

Fig.1. Growth of cultivated area under organic certification in India

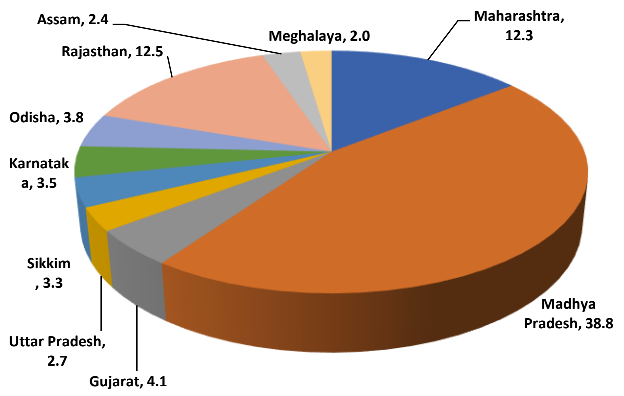

Fig.2. Share in organic farm area (%) by top 10 States to total area in country (2019-20)

India is now the ninth largest in terms of total arable land under organic farming and largest in terms of total number of organic producers in the world. Conducive policy, technological advancements, demonstrations, and farmer led innovations have contributed for phenomenal increase in area besides the market. India is producing wide range of crops under organic management with oilseeds, sugar crops, fiber crops, cereals and millets and pulses occupy the large chunk of the basket. India produces around 2.75 mt (2019-20) of certified organic products export volume and value of 6.389 lakh tonnes, Rs 4,686 crores (689 million USD) respectively. Therefore, launch of All India Network Programme on Organic Farming by ICAR helped significantly for promotion of organic farming practices in India. 'Towards organic' (integrated crop management) approach for input-intensive areas (food hubs) and 'certified organic' approach by integrating tradition, innovation and science in the de-facto organic areas (hill and rainfed/dryland regions) has been found to be better option for national food security, higher household income and climate resilience (Aulakh and Ravisankar, 2017) which will further enhance the safe food production and meet the social values.

Organic and towards organic agriculture

Scientific evidences in India clearly establish that conversion of high intensive agriculture areas to complete organic systems lead to reduction in crop yields considerably (up to 25-30%), especially during initial 3-4 years; before soil system regains and crop yields come to comparable level. In this scenario, if all the cultivated areas are brought into organic production systems, the national food production system may get jeopardized; hence a phased approach may be desirable. Integrated approach of crop management – including integrated nutrient management and inter/ mixed cropping – is also considered as **"towards organic"** approach; and at the same time has been found to increase the use efficiency of all costly inputs especially fertilizers and water, it would be appropriate to adopt it in the food bowl areas contributing major share to the food basket. This approach will also contribute to **'more crop per drop and less land, less resource/ time and more production'** strategies of the government. Considering this fact on one hand and looking into global scenario of organic agriculture, Government of India has set target to bring 4 % of Net cultivated area under organic farming by 2025.

Production issues, research, and technologies

Although several issues exist for organic growers, practically there are three major issues which constraints the productivity of crops under organic farming compared to conventional farming. These issues are

A. **Nutrient supply through organic sources:** Crop needs nitrogen, phosphorus, potassium and several other secondary and micronutrients for assimilation and better biomass output. These nutrients need to be supplied in a form which does not have synthetics and environmental degradation. Organic farming discussion starts with the question that how to meet the nutrient requirement of crops through organic manures and where it is available?
B. **Insect and disease management:** Another important issue which related to crop productivity and environment. Is it possible to manage the pests and diseases without using synthetics?
C. **Weed management:** It is the major issue for many of the organic growers as it has been observed that under organic management, weeds grow intensively if manures from outside the farm are used?

Research and technologies

Under All India Network Programme on Organic Farming, several options for nutrient, pest and weed management have been tested under multi-location trials which resulted in development of technologies for organic farming. Salient findings and technologies are listed below.

Supply of sufficient nutrient through organic sources

Enough scope for production of sufficient organic inputs exists in India. Among different sources, livestock accounts for major share (nearly 40 per cent). It is followed by crop residues (30 per cent) and other sources (15 %) which include the rural compost, vermi-compost and agricultural wastes. Concept of promoting organic farming in individual crops should be done away and it should be practiced in cropping/farming systems. The issue of sufficient nutrient supply under organic systems can be addressed reduce and rotational manuring in cropping systems, integrated organic farming systems and combination of sources.

Technologies generated for organic farming

Combination of organic nutrient sources: Combining more than one organic source for supplying nutrients to crops has been found to be very effective as meeting the nutrient requirement by single source is not possible. For example, rice-wheat system requires around 30 t FYM/year to meet its nutrient demand. This can be very easily managed by adopting strategies of cropping systems involving green manures, legumes and combined application of FYM + vermicompost and neem cake. This type of management also helps in reducing the insect/disease incidences as incorporation of neem cake in soil has been found to much effective. FYM (partially composed dung, urine, bedding and straw), edible and non-edible oil cakes, enriched composts and effective microorganisms are some of the combinations which can be used for meeting the nutrient demand of crops. Identified nutrient management packages for various cropping systems are given in Table 1.

Table 1. Identified combination of nutrients for different cropping systems

Location (State)	Cropping System (s)	Sources to meet nutrients
Coimbatore (Tamil Nadu)	Cotton-maize-green manure (GM) Chillies-sunflower-greenmanure	Farmyard Manure (FYM) + Non-Edible Oil Cakes (NEOC) + Panchagavya (PG)
Raipur (Chhatisgarh)	Rice-chickpea	Enriched compost (EC) + FYM + NEOC + Bio dynamic (BD)+PG
Dharwad (Karnataka)	Groundnut-sorghum Maize-chickpea	EC + VC + Green leaf manure (GLM) + biodynamic and PG spray
Ludhiana (Punjab)	Maize-wheat-summer greengram	FYM + PG + BD in maize, FYM +PG in wheat and FYM alone in moong
Bhopal (Madhya Pradesh)	Soybean-wheat Soybean-chickpea Soybean-maize	FYM+PG + BD
Pantnagar (Uttarakhand)	Basmati rice-wheat-greenmanure Basmati rice-chickpea Basmati rice-vegetable pea	FYM + VC + NC + EC + BD + PG
Ranchi (Jharkhand)	Rice-wheat-greenmanure	VC+ Karanj cake + BD+ PG

Reduced manuring: Application of 75 % nutrients only through combination of organics such as FYM, vermicompost, non-edible oil cakes and other locally available sources + 2 innovative inputs such as cow urine, panchagavvya, *PGPR* with complete organic management for 8 States and 11 cropping systems (Table 2).

Table 2. Identified cropping systems for reduced manuring under organic production system

State	Crop/cropping System
Chhattisgarh	Soybean-pea, soybean-chilli
Himachal Pradesh	Okra-pea-tomato (Summer)
Jharkhand	Rice (Basmati type)-wheat
Karnataka	Greengram-sorghum
Madhya Pradesh	Soybean-wheat, soybean-mustard, soybean-chickpea, soybean-linseed
Punjab	Green manure-basmati rice-chickpea
Uttar Pradesh	Green manure -basmati rice-mustard
Uttarakhand	Green manure -basmati rice-vegetable pea + coriander (4:2 rows)

Rotational manuring: Application 100 % nutrients through combination of organics such as FYM, vermicompost, Nonedible oil cakes with complete organic management for following states and cropping systems. Application of 100 % can be rotated intermittently over the years (Table 3).

Table 3. Identified cropping systems for rotational manuring

State	Crop/Cropping System
Jharkhand	Rice (Basmati type)-potato, Rice (Basmati type)-linseed
Kerala	Black pepper
Maharashtra	Rice-groundnut
Meghalaya	Rice in sunken beds and French bean and tomato in raised beds
Punjab	Green manure-basmati rice-wheat; soybean-wheat
Uttarakhand	Green manure-basmati rice-chickpea + coriander (4:2 rows) Green manure-basmati rice-potato

Towards organic approach (Integrated crop management): Towards organic approach with 75 % organic + 25 % inorganic package and 50 % organic + 50 % inorganic package for the 9 cropping systems and 5 States (Table 4).

Table 4. Identified cropping systems for towards organic approach (integrated crop management)

State	Crop/cropping System
Himachal Pradesh	Blackgram-cauliflower-summer squash; Cauliflower-frenchbean
Kerala	Turmeric
Maharashtra	Rice-mustard, Rice-dolichos bean
Meghalaya	Rice in sunken beds and Brocoli, potato & carrot in raised beds
Tamil Nadu	Green manure (GM)-beetroot-maize; GM-cotton-maize; GM-chilli-sunflower

Suitable varieties: Identified best suitable varieties for basmati rice, coarse rice, wheat, maize, chickpea, groundnut, mustard, soybean, tomato, cauliflower, pea, okra, frenchbean, turmeric, black pepper and cotton) for organic farming in 12 states. These varieties tend to result in higher yield under organic production system.

Resource conservation practices: Resource conservation practices under organic farming have been standardized for 4 cropping systems in Karnataka, 2 cropping systems in Meghalaya and 1 cropping system in Uttarakhand (Table 5).

Table 5. Identified resource conservation practices for different cropping systems

Cropping System	Land configuration
Karnataka	
Soybean-Wheat	BBF with crop residues
Groundnut + Cotton (2:1)	Conventional FB with crop residues
Greengram-Sorghum	Conventional FB without crop residues
Soybean + Pigeonpea (2:1)	BBF with crop residues
Meghalaya	
Carrot- Okra	Raised bed
Rice (Lampnah) -Pea	Sunken bed
Uttarakhand	
Direct seeded rice -chickpea–greengram in BBF	Direct seeded rice with chickpea on broad bed (105 cm x 45 cm)

Integrated Organic Farming Systems: One acre Integrated Organic Farming System (IOFS) models suitable for marginal farmers have been established in Gujarat, Kerala, Meghalaya, Rajasthan, Sikkim and Tamil Nadu (Table 6) which provides scope to generate more than 80 % of inputs required for organic farming with in the farm, thus reducing the cost of production.

Table 6. Components of Integrated Organic Farming Systems

State	IOFS model composition
Kerala	Spices based system [Turmeric, ginger, tapioca, vegetable cowpea and fodder grass) + livestock (2 cows)]
Meghalaya	Field & horticulture-based system [Cereals + pulses + vegetables +fruits + fodder) + Dairy (1 cow + 1 calf) + fishery + vermicompost]
Tamil Nadu	Field crop-based system (Green manure-cotton-sorghum; Okra + coriander-maize + cowpea (fodder), desmanthus, 1 milch cow, 1 heifer & 1bull calf + vermicompost + boundary plantations (*Gliricidia, coconut*)

Insect and disease management

In general, the incidence of pests and diseases are comparatively low under organic production system compared to inorganic systems due to several factors such as application of oil cakes having insecticidal properties, use of green leaf manures such as calotrophis and slightly higher content of phenols in plant parts under organic management. Further, organic management also increases the natural enemies in the farm. Natural enemies of crop pests and diseases such as Coccinellids, syrphids, spiders, Micromus, Chrysopa and campoletis were higher under organic management compared to integrated and inorganic management. Coccinellids, which naturally reduce the hoppers and leaf folders was found to be two to three times higher under organic management in cotton, groundnut, soybean, potato and maize crop fields. Similarly, spiders which also control the pests are found to be twice higher under organic management compared to inorganic management. The diversity of arthropod population in soil viz., Collembola, dipluran, pseudoscorpians, cryptostigmatids and other mites population was also found to be higher under organic management compared to integrated and chemical management.

Weed Management

Weeds are major problem under organic management and almost 43 % of organic growers expressed; low and no cost weed management techniques should be identified for successful practicing of organic farming. Slash weeding is to be done between the plants. Weeds under the base of the plants can be cleaned and put as mulch around the plant base. The weeded materials should be applied as mulch in the ground itself. Stale seed beds, hand and mechanical weeding are the other options available for managing weeds under organic management. Further, effective crop rotation, mixed and intercropping is also essential for reducing the weeds. Few identified weed management practices for various locations and cropping systems are given in Table 7.

Table 7. Identified weed management practices for different cropping systems

Location (State)	Cropping System	Recommended practice
Raipur (Chhatisgarh)	Rice-mustard	Conoweeder with square planting for rice Stale seed bed for mustard
Coimbatore (Tamil Nadu)	Rice-blackgram-greenmanure	2 hand weeding + spray of aqueous leaf extract at 3-4 leaf stage of weeds
Dharwad (Karnataka)	Groundnut	Spray of *cassia* and *Prosppis juliflora* as post emergent
Ludhiana (Punjab)	Basmati rice-wheat-greenmanure	High density planting + hand weeding at 25-30 DAT
Pantnagar (Uttarakhand)	Basmati rice-wheat-*greenmanure*	one hand weeding at 25-30 DAT during *kharif* and 2 hand weeding at 25-30 and 45-50 DAS during *rabi*
Umiam (Meghalaya)	Maize (green cob)-mustard	Mulching with fresh eupatorium/ambrosia @ 10 t/ha (after earthing up)

Crop productivity and economics under organic management

Analysis of yield recorded at various locations under organic management over inorganic indicated many crops responded positively to yield higher under organic systems. Sustainable yield index of basmati rice, rice, cotton, soybean, sunflower, groundnut, lentil, cabbage and french bean are higher under organic management compared to integrated and inorganic management systems. Long-term results of organic management clearly establish that the scientific Package of Practices (PoP's) for organic production of crops in cropping systems perspective should be adopted for keeping the crop productivity at comparable or higher level than chemical farming. Under ICAR-All India Network Programme on Organic Farming (AI-NPOF), location specific package of practices for organic production of crops in cropping systems (51 no's) suitable to 12 states have been developed which can be practiced for getting optimum productivity under organic management.

Carbon sequestration: Continuous practice of raising the crops organically has good potential to sequester the C (up to 63 % higher C stock in 10 years), higher soil organic carbon (22 % increase in 6 years), reduction in energy requirement (by about 10-15 %) and increase in water holding capacity (by 15-20 %), thereby promoting climate resilience farming.

It can be concluded that scientific organic farming packages with ecological perspective needs to be maintained for obtaining comparable or higher yield of crops and income with that of chemical farming. Accelerated adoption of **"towards organic"** (integrated crop management) approach in intensive agricultural areas (food hubs) and **"certified organic farming"** with combination of tradition, innovation and science in the de-facto organic areas (hills) and rainfed/ dryland regions can contribute towards safe food security and climate resilience, besides increased income of farm households. This approach will also positively contribute to the cause of human, livestock and eco-system health, the basic objective of organic agriculture.

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Technical Session II

“Plant protection research and technologies for Organic Farming”

Phasing out contentious inputs from agriculture in Europe – and beyond? Examples from the 4-year research project Organic-PLUS

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Across Europe, there has been an ongoing discussion regarding inputs into organic agriculture and horticulture. These discussions led to the European Horizon-2020 research programme to invest 8 million Euros into two 4-year projects: RELACS and Organic-PLUS. Both started in 2018 and are running till end of 2022. Here we discuss research approaches and results from Organic-PLUS. The focus is on research relevant to organic agriculture and horticulture. It is also relevant to non-organic agriculture. This includes alternatives to the use of copper and mineral oils used for plant protection, with a special focus on potatoes, perennial Mediterranean crops like olives and citrus and greenhouse crops like tomatoes and aubergines. Further research is on better organic fertilisers such as non-animal derived fertilisers, which are compatible with 'Vegan Organic Standards', but also other 'bio-economy fertilisers', which make use of existing resources, like fishpond sediments and marine-derived fertilisers. Alternatives to peat as a growing media, an area where peat replacement is most challenging i.e. in specialised nursery crops is also researched. In addition, the increasing use of plastic mulch materials and potential impact of plastic and alternative mulch materials on soil pollutants. The oral presentation invites discussion on further contentious inputs and possible phase-out scenarios and their impact on agriculture outside of Europe.

Background

In the European Union (EU), and within the IFOAM-EU group (International Federation of Organic Agricultural Movements) specifically, there has been an ongoing discussion regarding inputs into organic agriculture and horticulture. These discussions have been ongoing since the EU regulation for plant production and livestock production were introduced in 1991. This debate has also contributed to the decision by the European Horizon-2020 research programme to invest more than 8 million Euros into two 4-year projects, starting in 2018 (call SFS-08-2017: Organic inputs – contentious inputs in organic farming). In the recently adopted new organic regulation 'Regulation EU-2018/848', published 14.6.2018 in the Official Journal of the European Union, most contentious issues mentioned in the call SFS-08-2017 are still allowed, however more or less tightly restricted, and few phase-out scenarios are set (European Parliament Regulation EU-2018/848, 2018). This is true for copper, mineral oils, antibiotics, peat, and fertiliser derived from conventional inputs. One phase-out example is for conventional manure section 1.9.2. (c) is *"The fertility and biological activity of the soil shall be maintained and increased…by the application of livestock manure or organic matter, both preferably composted, from organic production"*. Reference to non-organic manure is still made for mushrooms where farmyard manure has to come *"either from organic production units or from in-conversion units in their second year of conversion; or… only when the product…is not available"*.

Overview of the research to phase out contentious inputs

'Organic-PLUS' means minimising, and eventually phasing out contentious inputs from certified organic agriculture. By doing so organic food systems can be more true to the IFOAM organic principle of 'ecology'. This principle is now shared by the EU Bio-economy agenda, focusing on renewable biological resources from land and sea. Furthermore, this research is also applicable to non-organic farming systems seeking to adopt more agroecological solutions. This combined focus on organic principles and Bio-economy may not only lead to more resilience and quality assurance within organic production, but also reduced environmental impact and fairer, more reliable rules and regulations that organic consumers (current and new) can trust to "buy-into" the growth of the sector.

Organic-PLUS has three large 'topical' work packages. WP PLANT researches alternatives to copper and mineral oils used for plant protection, working on potatoes, glasshouse crops and perennial Mediterranean crops. WP LIVESTOCK researches the use of natural plant sources of vitamins as alternatives to synthetic products and the remaining use of antibiotics in organic livestock systems. WP SOIL researches alternatives to the use of manure from non-organic farms and other animal-derived fertility inputs such as blood and bone meal (including legume-based fertilisers in horticultural production, marine derived fertilisers and pond sediments from organic aquaculture). Some of these fertilisers can be compatible to the recently developed urban and vegan organic standards (Schmutz et al. 2014, Schmutz and Foresi, 2017), e.g. the bio-cyclic-vegan standard was approved into the IFOAM family of standards in February 2018. Organic-PLUS also works on alternatives to peat in growing media (including materials from agroforestry) and alternatives to fossil fuel-derived plastic used as a weed supressing mulch (including degradable plastics and biocomposites).

Phasing out Copper and Mineral Oils

Many contentious inputs in organic (and conventional) plant production are directed towards plant health. Copper applications have been used primarily to control diseases caused by Oomycetes and other foliar, shoot and fruit diseases caused by fungi and bacteria. Despite its unfavourable eco-toxicological profile (Flemming and Trevors, 1989), a limited use of copper is tolerated in acknowledgment of its unique properties as a wide-spectrum fungicide and bactericide. Mineral oils are particularly effective against powdery mildews, and may enhance host plant resistance (Northover and Timmer, 2002). Many potential alternatives have been proposed e.g. resistant cultivars, biocontrol methods, system changes, but few have been extensively tested under real farming conditions und uptake of alternatives is slow. Organic-PLUS generates additional knowledge required for optimal use of alternatives, and answers many practical questions important for the uptake, such as duration of elicitation, timing, rates of application, effect of combinations of control measures. The work is with a range of important European crops, and with a focus on Mediterranean crops (annual i.e. aubergines and perennial i.e. citrus, olive), which have seen less investment into organic research than other parts of Europe.

First results are published in Katsoulas et. al. (2020). Results show that copper is widely used by Mediterranean organic growers in citrus, olive, tomato and potato production. Tomato producers apply high amounts of copper in winter crops in greenhouses. Mineral oils are applied to control scales, mites and whiteflies. Sulphur is also commonly used by organic vegetable growers, especially in greenhouses.

Phasing out conventional and animal derived fertilisers

For high value horticultural crops, other products derived from conventional agriculture (such as blood and bone meal) are commonly used, but this is particularly unacceptable to a growing number of vegan consumers. There are many potential alternatives, some well-established and others more novel, but there is a lack of information about how these should best be used in practice to match nutrient supply with crop demand (Benke et al., 2017). Organic-PLUS is investigating 'vegan organic fertilisers', which are compatible with vegan organic standards and the optimisation of the use of legume-based fertilisers in organic horticultural production is therefore important. However, there are other 'bio-economy fertilisers' like marine-derived fertilisers (e.g. organic seaweed or fish by-products) and pond sediments from organic aquaculture which are equally of interest to replace conventional manure and by-products from conventional agriculture like Vinasse from sugarbeet.

Phasing out peat as a growing media

Peat is still the most widely used substrate in plant nurseries in Europe (López-López et al., 2016). It is seen as a good substrate for plant growth, being cheap, compactable, low in nutrients but able to absorb and release them from added fertilisers, free from weed seeds and other hazards, and free from heavy metals and other potentially toxic elements. Organic-PLUS examines the use of novel materials (composted and extruded agroforestry products, cocoa shells and composted vine waste) as components of growing media. It focuses on nursery crops and specialist growing media where the peat component is considered most difficult to replace.

Phasing out plastic mulch as soil cover

Polyethylene plastic covers of films obtained from petroleum or synthetic polymers has been widely used in agriculture for a long time. However, there is growing concern about pollution from micro-plastics and phthalates included as plasticisers (Steinmetz et al. 2016). Biodegradable plastic is available, with less negative effects, but production costs are higher and need to be reduced (Touchaleume et al., 2016) to increase its uptake. Organic farming already utilises organic materials as mulch (e.g. chopped grass/clover) but the N efficiency can be rather low (Riley et al., 2003). Organic-PLUS tests the agronomic performance of different mulches under field conditions. The materials include novel degradable non-fossil fuel derived polymers After the use of the mulch materials (contentious and alternatives toxicological testing of soil is conducted. This is done to understand a potential build-up of organic pollutants as a result of the use of different mulch materials.

Conclusions

Phase-outs take time at least in the case of the peat phase-outs. Voluntary phase-out schemes are useful to raise awareness of the issue among the industry but they are used to delay and of only 'industry-lead' they lack the rigour and commitment legal frameworks provide (Schmutz et al., 2020). For example, a phase-out commitment in the next update of the EU organic regulation (European Parliament Regulation EU-2018/848, 2018), as described above for conventional manure would change the situation. In addition, simple but legally committing **EU-wide labelling rules** for all ingredients in growing media and compost, would make consumers more aware of the issues and give an informed choice. These product ingredient labelling has shown to be helpful to inform consumers about ingredients in food, but has excluded any contentious inputs going beyond the ones used in organic farming, e.g. the fact that if imported GM feed is used to produce conventional meat in Europe, it is not required to shown this as an input ingredient on food labels. These are important EU regulatory omissions where contentious inputs can be 'hidden from consumers. It is also important to consider the global implications of any changes to the EU organic standards. As Martin Häusling, the Member of the European Parliament (MEP) responsible for steering the plans through the EU parliament, points out for the revised EU organic regulation: *"the harmonisation of production standards for [non-EU] countries… will bring them into line with European standards. The new rules on imports are also positive for the consumer, as they will benefit from the harmonisation of high standards"* (European Parliament, 2018). The Organic-PLUS project has therefore an international advisory board and a global outlook – specially into India as the largest democracy and most populous country in the world. While first research results (Katsoulas et. al., 2020) identified some interventions already feasible (resistant cultivars, biocontrol methods, plant oils, DSS - decision support systems) copper, sulphur and mineral oils are still widely used; mineral oils to a lesser extent, as plant-based oils are mostly available. They are not used as mineral oils are this legally allowed, showing the effects of lack of regulation if alternatives are already available. Regarding the aim of **zero-copper** we conclude this is unlikely reached by simple substitution, it requires changed re-design cropping systems, even in organic.

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Science and Technologies for Non-chemical Management of Insects, Diseases and Nematodes

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Introduction

The manufacture of chemical pesticides in India has grown from 66.4 thousand metric tonnes during 1989-90 to 88.75 thousand metric tonnes during 1998 -99 and to 217.00 thousand metric tonnes during 2018-2019. The use of chemicals is also on the rise with many new molecules being imported. Excess and indiscriminate use of inorganic chemicals has disrupted the ecosystem and balance of nature. Chemical pesticides destroy natural enemies, bees and non-target organisms. Resurgence of target pests and out break of secondary pests are other side effects. Moreover, pesticide residues in food chain and environment have caused serious health problems. Decline in quality of produce due to pesticide contamination is also frequently reported. Hence, the organic farming, which prohibits the use of inorganic and synthetic chemicals in crop production, can be the best available solution for health problems and environmental degradation.

Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs such as the synthetically compounded fertilizers, pesticides, growth regulators and livestock feed additives and on management practices that restore, maintain and enhance ecological harmony. The principal guidelines for organic production are to use materials and practices that enhance the ecological balance of natural systems and that integrate the parts of the farming system into an ecological whole. The primary goal of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people.

Insects are highly mobile and well adapted to farm production systems and pest control tactics. In the organic farms, where the focus is on managing insects rather than eliminating them, success depends on learning the biological, ecological and behavioral information about the insects. Biological information means what the insect needs to survive can be used to determine if insect pests can be deprived of some vital resource. Ecological information is how the insect interacts with the environment and other species can be used to shape a pest resistant environment. Behavioral information is about both pest and beneficial insects and how the insect goes about collecting the necessities of life can be manipulated to protect the crops. According to the organic standard, insect pest problems may be managed through cultural, mechanical or physical methods; augmentation or introduction of parasites and predators of the pest species; development of habitat for natural enemies of pests and non-synthetic control such as traps, lures and repellents etc. When these practices are insufficient to prevent or control crop pests a biological, botanical or chemical materials are allowed for use in organic crop production to prevent, suppress or control insect pests.

Components of non-chemical pest management

The following components may be included in non chemical organic method of pest management

1. Ecology based pest management and Habitat diversification
2. Use of resistant varieties
3. Physical methods
4. Mechanical methods
5. Use of plant products/ botanicals/ organic manure preparations
6. Use of insect pheromones
7. Biological control of pests
8. Use of synthetic organics permissible for use in organic agriculture
9. Indigenous technical knowledge in organic farming

Ecology based pest management

Various eco-friendly tactics of pest management have to be integrated so as to avoid the use of chemical pesticides. The knowledge of interaction among plant, pest, natural enemies and environment is essential for effective pest management. When the balance of nature is disturbed by man made interventions, nature strikes back in the form of pest outbreaks. Some examples of pest outbreaks are as follows

a. Whiteflies in cotton
b. *Helicoverpa armigera* in cotton
c. Slug caterpillar in coconut
d. Eriophyid mite on coconut

Moreover, the pest status changes over years due to interaction of various biotic and abiotic factors. One has to thoroughly understand the reasons for outbreak of pests and their changing status and plan the management practices accordingly so as to prevent further outbreaks.

Habitat diversification

Habitat diversification makes the agricultural environment unfavourable for growth, multiplication and establishment of insect-pest populations. The following are some approaches by which the pest population can be brought down:

1. Intercropping system

Intercropping system has been found favourable in reducing the population and damage caused by many insect pests due to one or more of the following reasons.

- Pest outbreak less in mixed stands due to crop diversity than in sole stands

- Availability of alternate prey
- Decreased colonization and reproduction in pests
- Chemical repellency, masking, feeding inhibition by odours from non-host plants.
- Act as physical barrier to pest.

The following table gives a few examples of intercropping system where reduction in damage level was noticed

Table 1. Effect of intercropping system on pest levels

No.	Crop		Pest reduced	Reference
	Main crop	**Intercrop**		
1.	Sorghum	Red gram	Earhead bug	Raheja (1973)
2.	Sorghum	Cowpea	*Chilo partellus*	Balasubramainian (2000)
3.	Pigeon pea	Sorghum	*Empoasca kerri*	Sekhar *et al.* (1997)
4.	Green gram	Sorghum	*E. kerri*	Sekhar *et al.* (1997)
5.	Ground nut	Sorghum	*E. kerri*	Sekhar *et al.* (1997)
6.	Pigeon pea	Sorghum	*H. armigera*	Mohammed and Rao (1998)
7.	Chickpea	Wheat/ mustard/ Safflower	*H. armigera*	Das (1998)
8.	Sugarcane	Greengram / Blackgram	Early shoot borer	Rajendran *et al.* (1998)

Inter-planting maize in cotton fields increased the population of Araneae, Coccinellidae and Chrysopidae by 62.8-115.7% compared with control fields. Maize also acted as a trap crop for *H. armigera* reducing the second generation eggs and damage to cotton (Wu *et al.*, 1991). Intercropping pulses in cotton reduced the population of leafhopper on cotton (Rabindra, 1985) and Lablab bean in sorghum reduced the sorghum stem borer incidence. Hence it is highly important that appropriate intercropping systems have to be evolved where reduction in pest level occurs.

2. Trap cropping

Crops that are grown to attract insects or other organisms like nematodes to protect target (main) crops from pest attack. This is achieved by:

- Either preventing the pests from reaching the crop or
- Concentrating them in a certain part of the field where they can be economically destroyed

Table 2. List of successful examples of trap crop

No.	Main Crop	Trap crop	Pest
1.	Tobacco / cotton/ groundnut	Castor	*Spodoptera litura*
2.	Maize	Sorghum	Shoot fly, Stem borer
3.	Cotton	Onion / Garlic	*Thrips tabaci*

Growing of 2 rows of mustard as trap crop per 25 rows of cabbage is recommended for the management of diamond back moth. First mustard crop is sown 15 days prior to cabbage planting or 20 days old mustard seedlings are planted. Growing castor along the border of cotton field and in the irrigation channels act as indicator or trap crop for *Spodoptera litura*. Planting of 40 days old African tall marigold and 25 days old tomato seedlings (1:16 rows) simultaneously reduces *Helicoverpa* damage.

Growing trap crops like marigold which attract pests like American bollworm to lay eggs, barrier crops like maize/sorghum to prevent migration of sucking pests like aphids and guard crops like castor which attracts *Spodoptera litura* in cotton fields was reported by Murthy and Venkateshwarulu (1998).

3. Proper nutrient management

Plant growth is dependent on the nutritional status of the soil which in turn has indirect effect on pests. High levels of N fertilizer always favour insects and makes plants more susceptible to insect infestation (Rathore and Lal, 1994). On the other hand lower potassium supply favours the development of insects, while optimum and high K has depressant effects (Dale, 1988). The following table (Table 3) shows the role of nutrient management on pest levels:

Table 3. Effects of host plant nutrition on insect-pests attack

S. No.	Host plant	Insect	Response	Reference
1.	Rice	Thrips, GLH, Whorl maggot, Leaf folder	High K application reduced pest incidence	Subramanian and Balasubramanian (1976)
		Leaf folder, gall midge, BPH, Yellow stem borer, WBPH Bacterial leaf blight, sheath blight, blast	High N levels increased pest population and damage	Upadhyay *et al.*(1981) Narayanan *et al.* (1973) Saroja and Raju (1981)
2.	Wheat	Cutworm *(Mythimna separate*, rusts	High N increased incidence	Deol *et al*. 1987
3.	Sorghum	Shootfly	High P reduced incidence	Bangar, 1985
4.	Cotton	Pink boll worm, leafhopper	High N increased incidence	Simwat *et al*. 1987, Purohit and Deshpande, 1992

5.	Chickpea	*Helicoverpa armigera*	N increased infestation, while, P and K reduced	Yadav, 1987

4. Planting dates and crop duration

Planting dates should be so adjusted that the susceptible stage of crop synchronizes with the most inactive period or lowest pest population. The plantings should be also based on information on pest monitoring, as the data varies with location. Crop maturity also plays an important role in pest avoidance. The following table (table 4) shows the importance of planting dates on pest population and damage

Table 4. Role of planting dates on pest population and damage

No.	Host plant	Insect	Response	Reference
1.	Rice	Leaf folder	Early planted rice (up to 3rd week of June) suppressed population	Dhaliwal *et al*. (1988)
2.		BPH	Planting during end of July in Kharif and early in Rabi escapes attack in Andhra Pradesh	Krishnaiah *et al.* (1986)
3.		Gall midge	Lowest incidence if planted in August or October	Uthamasamy and Karuppuchamy (1986)
4.	Sorghum	Shoot fly	Advancing sowing date (September to October) decreased incidence	Kotikal and Panchbavi (1991)
5.	Cotton	Leafhopper	Higher incidence in late sown crop	Dhawan *et al*. (1990)
6.	Chickpea	Pod borer	For every 10 days delay in sowing 4.02% increase in pod damage	Devendra Prasad *et al*. (1989)
7.	Tomato	Whitefly	Incidence is less if planted within July to November	Saikia abd Muniappa (1989)
8.	Chillies	Thrips	Late planted crop severely affected by thrips and leaf curl virus	Bagle (1992)

5. Planting density

Interplant spacing, canopy structure, etc., affect insect behaviour in searching food, shelter and oviposition site and also the plant to plant spread of many crop diseases. It also affects natural enemy population. The effect of plant density on pest population is shown in Table 5.

Table 5. Effect of plant density on pest population

S. No.	Crop	Spacing/ density	Insect	Response	Reference
1.	Rice	Dense planting	Leaf folder, BPH	High incidence	Kushwaha and Sharma (1981); Kalode and Krishnaiah (1991)
2.	Chickpea	Dense plant population	*H. armigera*	High incidence	Yadav (1987)
		Less plant population	*Aphis craccivora*	High incidence	Lal *et al.* (1989)
3.	Sugarcane	Dense seed rate	Top shoot borer	Low incidence	Singla and Duhra, 1990
			Early shoot borer	High incidence	

6. Destruction of alternate/alternative host plants

Many insects use a wide range of plants especially weeds as alternate hosts for off season carry-over of population. Matteson *et al.* (1984) reported that weeds around the crop can alter the proportion of harmful and beneficial insects that are present and increase or decrease crop damage.

Table 6. Important alternate hosts of insect-pests in crops

S. No.	Crop	Pest	Alternate host to be removed	Reference
1.	Groundnut	Thrips	*Achyranthes aspera*	Mohan Daniel *et al.* (1984)
2.	Rice	Gallmidge	Wild rice (*O.nivara*)	Kalode and Krishnaiah (1991)
		GLH	*Leersia hexandra*	
			Echinochloa colona	
			E.crusgalli	
			Cynodan dactylon	
		WBPH	*Chloris barbata*	
3.	Sorghum	Earhead midge	Grassy weeds	Prem Kishore (1987)

Destruction of off types and volunteer plants, thinning and topping, pruning and defoliation and summer ploughing are other cultural methods which can reduce pest load in crop field.

7. Water management

Availability of water in requisite amount at the appropriate time is crucial for proper growth of crop. Hence, water affects the associated insects by many ways such as nutritional quality and quantity, partitioning of nutrients between vegetative growth and reproduction etc. The following table shows the effect of irrigation on pest population /damage.

Table 7. Effect of irrigation on pest population / damage

No.		Crop	Insect	Response	Reference
1.		Rice	Mealy bug	Continuous stagnation of 5 cm water reduced incidence	Gopalan *et al.* (1987)
2.		Rice	Caseworm, BPH and Bacterial leaf blight	Draining of water to field capacity reduces incidence	Thomas (1986)
3.		Fruit tree nursery	Termite	Copious irrigation reduces incidence	Butani (1987)
4.		Groundnut	Aphids	Copious irrigation increased incidence	Rao *et al*. (1991)

8. Crop rotation

Crop rotation is the back bone of nutrient and pest management in organic farming. It is practice of growing a series of dissimilar or different types of crop on a piece of land in a definite time schedule. To keep the soil healthy and to allow the natural microbial systems working, crop rotation is must. Generally 3-4 years of crop rotation is followed. All high nutrient demanding crops should precede and follow low nutrient requiring crops like legume dominated crop combinations. Rotation of a host crop with non-host crops helps in controlling soil borne diseases and pest. Legumes should be used frequently in rotation with cereal and vegetable crops. Green manure crops should also find place in planning rotations to maintain soil fertility and productivity. Breaking the life cycle and population build-up of pests, pathogens and weeds in agro-ecosystems, crop rotation is one of the main strategies. During adoption of crop rotation, care should be taken to include non-host crops of a particular pest or pathogen, to manage that particular pest. The important benefits of crop rotations are:

a. It exploits the differential in nutrient requirement of different crops categories and thus improves the soil fertility
b. It improves soil structure through different types of root systems, and
c. It helps in breaking the life cycle and population build-up of pests, pathogens and weeds in agro-ecosystems

Sustainable systems of agricultural production are seen in areas where proper mixtures of crops and varieties are adopted in a given agro-ecosystem. Monocultures and overlapping crop seasons are more prone to severe outbreak of pests and diseases. For example growing rice after groundnut in garden land in puddled condition eliminates white grub.

9. Use of organic manure

Application of press mud in groundnut @ 12.5 t/ha had a better influence on leaf miner with a lower leaflet damage at 38.84 per cent and 2.48 larval numbers per plant during summer 1991. It was 34.93 per cent and 2.72 numbers during kharif, 1991 (Sathiyanandam and Janarthanan, 1995). Rajasekar *et al.* **(**1995) reported that farm yard manure, *Azospirillum* and Phosphobacteria has no significant influence on the control of leaf hopper and fruit borer in bhendi. The incidence of paddy plant and leafhopper was low in *Azospirillum* combined with farmyard manure (Athisamy and Venugopal 1995). Application of organic manure lowered the rice gall midge incidence (5.28%) (Mohankumar *et al.*, 1995).

Use of resistant varieties

Host plant resistance forms an important component of non-chemical method of pest management. Several resistant varieties of crops have been evolved against major pests, through intensive breeding programmes. Development of varieties with multiple resistances to several pests / diseases is essential.

Physical methods

The following are some examples of the use of physical methods of insect control

- Use of activated clay at one per cent or vegetable oil at one per cent has been found to effectively control damage by *Callosobruchus chinensis* in stored pulses.
- Solar heat treatment of sorghum seeds for 60 seconds using solar drier kills rice weevil and red flour beetle without affecting germination of seeds.
- Biogas fumigation for 5 days period caused mortality of eggs, grubs, adults of pulse beetle *C. chinensis* (Mohan *et al.*, 1987; 1989)
- Drying seeds (below 10% moisture level) prevents insect development.
- Hot water treatment of rice seeds at 52 to 54 °C for 15 minutes will kill white tip nematode infesting rice.
- Cold storage of fruits and vegetables to kill fruit flies (1-2° C for 12-20 days)

Mechanical methods

1. Mechanical destruction

- Hand picking of caterpillars
- Hooking of rhinoceros beetle adult with iron hook
- Sieving and winnowing for stored product insect control
- Shaking plants to dislodge caseworm in rice and to dislodge June beetles from neem trees

2. Mechanical exclusion

- Wrapping of fruits against pomegranate fruit borer
- Banding with grease against mango mealy bug
- Trenching against larvae of red hairy caterpillar

- Tin barrier around coconut tree trunk to prevent rat damage
- Rat proof structure in storage go downs

3. Appliances based on mechanical control method

- Light trap
- Yellow sticky traps for attracting aphids and jassids
- Bait trap - fish meal trap for sorghum shoot fly
- Methyl eugenol trap for fruit flies
- Probe trap for stored product insects
- Pheromone trap for various adult insects
- TNAU automatic insect removal bin for stored product insects

Use of botanicals in pest management

Grainge and Ahmed (1988) listed about 2400 plant species with pesticidal properties (insecticide, acaricide, nematicide, fungicide etc. which are distributed in 189 plant families). Neem oil 3% and neem seed kernel extract (NSKE) 5% with liquid soap 0.05% was proven to be effective against major pests of rice, sucking pests of cotton and vegetable. Neem cake applied at 250 kg/ha at last ploughing before sowing has been found effective against cotton stem weevil, soil insects, soil pathogens and nematodes of many crops.

Neem seeds contain more than 100 compounds among which azadirachtin has been found to be biologically most active. The biological effects of neem products are insect growth regulation, feeding deterrent and oviposition deterrent effect.

Commercial Neem formulations are available in market which contain varying levels of azadirachtin (from 0.03% to a maximum of 5%). In India, more than 50 firms are manufacturing neem formulations which are available in different brand names. A few examples are given below:

Table 8. Various neem products available in market for insect-pest management

No.	Brand name	Azadirachtin content
1.	Nimbicidine	0.03%
2.	Neem guard	0.03%
3.	Bioneem	0.03%
4.	Jaineem	0.03%
5.	Neem gold	0.15%
6.	Fortune-aza	0.15%
7.	Econeem	0.3%
8.	Achook	0.5%
9.	Neem azal TS	1.0%
10.	Neem azal F	5.0%

In addition to neem which belongs to Meliaceae, plants belonging to Annonaceae, Asteraceae, Fabaceae, Labiatae, Rutaceae and many other families have been found to possess insecticidal activity. Research in this field will provide valuable information that will help in managing insect pests with plant products.

Preparation 5 leaf herbal leaf extract

Collect the leaves of *Azadirachta indica*, *Adathoda vasica*, *Vitex negundo*, *Ailanthus excelsa* and *Jatropha curcas* each weighing 1 kg. Cut the leaves into small pieces, grind with cow urine at 1 litre per kg of fresh leaves and allowed for fermentation for 15 days with frequent stirring. Filter the contents and apply as foliar spray @ 10 per cent for the management of insect pests in organic farming. The herbal plants for preparation of five leaf herbal extract can be selected based on the properties *viz.*, availability in the local areas, pesticidal nature of the herbal plants and extraction properties. The studies conducted at Tamil Nadu Agricultural University revealed that application of 10 per cent 5 leaf herbal extract as foliar spray effectively managed the sucking pests like whiteflies, aphids, thrips and red spider mites in cotton and bhendi.

Preparation of 3G extract

3 G extract consists of 1 kg of ginger, *Zingiber officinale* fresh rhizomes, 1 kg of garlic, *Allium sativum* bulbs and 1 kg of green chillies, *Capsicum annum*. Grind ginger, garlic and green chillies separately with cow urine @ 1 litre/kg, mix together, keep it for fermentation up to 15 days with regular stirring twice a day. Filter the contents and apply as foliar spray @ 10 per cent for the management of sucking pests and leaf feeding insects. Studies conducted at Tamil Nadu Agricultural University revealed that application of 5 per cent 3 G extract as foliar spray effectively manage the sucking pests like white files, aphids, thrips and red spider mites in cotton and bhendi.

Herbal insect protectant (Agniasthra)

This is also popular among the organic farmers of Tamil Nadu. It consists of cow urine (20 litres), neem leaves (5 kg), green chillies (2 kg), garlic (1 kg) and tobacco leaves (1 kg). All the 5 ingredients will be mixed in a mud pot and boiled. The extract will be kept as such as for 48 hours. To the filtrate, 100 litres of water and 3 litres of cow urine will be added. This is sufficient for spraying an area of one acre to repel all types of insect pests.

Pheromones in Pest Management

Pheromones are chemical substances released by insects which attract other individuals of the same species. Sex pheromones have been used in pest management in the following ways

a. Monitoring
b. Mating disruption
c. Mass trapping

These methods can be successfully included in organic method of pest management. Sex pheromones of the following insects are commercially available in market.

Table 9. Example of insect-pest managed by using sex pheromones

No.	Common Name	Scientific name
1.	American bollworm	*Helicoverpa armigera*
2.	Pink bollworm	*Pectinophora gossypiella*
3.	Spotted bollworm	*Earias vitella*
4.	Spiny bollworm	*Earias insulana*
5.	Tobacco cutworm	*Spodoptera litura*
6.	Early shoot borer of sugarcane	*Chilo infuscatellus*
7.	Yellow stem borer of rice	*Scirpophaga incertulas*
8.	Diamond back moth	*Plutella xylostella*
9.	Mango fruit fly	*Bactrocera dorsalis*
10.	Melon fruit fly	*Bactrocera cucurbitae*

Aggregation pheromones of red palm weevil and Rhinoceros beetle of coconut are also available in market. Different types of pheromone traps such as sleeve type trap, delta and sticky traps are also manufactured and sold by different firms. In addition to the above many new pheromones of field and storage pests are being manufactured by commercial firms and will be available to farmers soon.

Biological control as component of organic farming

Management of pests and disease causing agents utilizing, parasitoids, predators and microbial agents like viruses, bacteria and fungi is termed as biological control. It is an important component of IPM.

The three important approaches in biological control are

a. **Importation**: Importation is also called classical method of biological control where bio-control agents are imported to control pests of exotic origin.
b. **Conservation**: This is a method of manipulating the environment to protect the bio-control agents
c. **Augmentation**: Augmentation aims at mass production of natural enemies / microbial agents and field release. Genetic improvement of bio-control agents to have superior traits also comes under this category.

ICAR and State Agricultural Universities play an important role in identifying potential bio-control agents. The commercial bio-control laboratories mass produce the agents and distribute among the farmers. There are at least 20 bio-pesticides production laboratories in Tamil Nadu managed by co-operative and private sectors. The following are the bio-control agents mass produced in Tamil Nadu.

Table 10.. Bio-control agents commercially produced in Tamil Nadu

No.	Biocontrol agents	Pests managed
	I. Parasitoids	
	Egg parasitoids	
1.	*Trichogramma* spp.	Borers, bollworms
2	*Telenomus remus*	*Spodoptera litura*
	Egg larval parasitoid	
3	*Chelonus blackburni*	Cotton bollworms
	Larval parasitoids	
4.	*Bracon brevicornis*	Coconut black headed caterpillar
5.	*Goniozus nephantidis*	Coconut black headed caterpillar
6.	*Elamus nephantidis*	Coconut black headed caterpillar
7.	*Bracon kirkpatrici*	Cotton bollworms
8.	*B.hebetor*	Cotton bollworms
	Pupal parasitoids	
9	*Brachymeria* spp.	Coconut black headed caterpillar
10	*Tetrastychus Israeli*	Coconut black headed caterpillar
11.	*Trichospilus pupivora*	Coconut black headed caterpillar
	II. Predators	
12.	*Chrysoperla carnea* (Green lacewing)	Soft bodied homopteran insects
13.	*Cryptolaemus montrouzieri* (Australian lady bird beetle)	Mealy bugs
	III Insect Pathogens	
14.	NPV of *Helicoverpa armigera* (Virus)-HaNPV	*H. armigera*
15.	NPV of *S.litura* (Virus)- SlNPV	*S.litura*
16.	*Bacillus thuringiensis* (Bacteria)	Lepidopteran insects
17.	*Beauveria bassiana* (Fungus)	Many insect pests
	IV. Fungal Antagonists	
18.	*Trichoderma viride*	Root rot and wilt causing fungi (*Rhizoctonia solani*, *Macrophomina phaseolina*, *Fusarium* sp.) in pulses, cotton, oilseeds, vegetables
19.	*Trichoderma harzianum*	
20.	*Pseudomonas fluorescence*	Root rot causing fungi in various crops
	V. Weed killers	
21.	*Neochetina bruchi* and *Neochetina eichhornae* (beetles)	Water hyacinth (Aquatic weed)
22.	*Zygogramma bicolorata* (beetle)	Parthenium weed

Even though many commercial bio-control laboratories are involved in production of these agents, they are hardly sufficient to cover less than one percent of the total cultivated area. Hence, there is a vast scope for improvement.

Insecticidal oils

Oil kills insects and mites by smothering eggs, larval stage and adults. Insecticidal oils can control wide range of soft-bodied insects such as aphids, mites, thrips and whiteflies. These oils may be used for pesticidal purpose only when other non-chemical practices documented under organic system are insufficient to prevent or control insect pests. Oils derived from vegetable and fish sources are widely used in organic crop production as new refining methods have made it possible to make oils less phytotoxic to plants. Plant oils are derived from seeds, whereas fish oils are byproducts of fish processing industry. Essential plant oils including mixture of clove and rosemary are generally derived from stem and leaves rather than seeds. Plant and fish-derived oils are becoming more available than in the past, and they show promise for mite management also.

Organic insecticides

Historically, conventional insecticides are not approved for use in certified organic system. However, some companies manufacture and sell agricultural chemicals having active ingredients derived from natural sources. An example is the insecticide spinosad. Spinosad is a fermentation product of the soil-dwelling actinomycetes, *Saccharopolyspora spinosa*. There are commercially available formulations of spinosad which are allowed for pest management under organic systems. These formulations of spinosad will provide excellent control of many lepidopteran caterpillars, but they are less efficacious on piercing and sucking insects such as stink bugs and plant bugs. Formulations of spinosad are labeled for a wide array of crops such as potato, brinjal, tomato, cucurbits, cole crops, groundnut and rice.

Indigenous Technical Knowledge in organic farming

The knowledge of traditional agriculture with millions of farmers should be utilized and modern technology in agriculture should be blended with traditional wisdom. The following are certain practices of farmers which they have been following time immemorial

- Diluted cow dung slurry sprinkled to hasten paddy germination.
- Coconut fronds cut into small bits erected as perches in field to attract nocturnal birds which preys upon rats.
- Chilli mash and garlic juice sprayed to control rice earhead bug.
- Application of common salt at 1 - 1.5 kg/ palm of coconut gives insect resistance and prevents button shedding.
- Use of scarecrows to ward off bird pests in day time, which also serve as perches to nocturnal predatory birds.
- Use of Kavankal where stones are released from slings to scare birds

- Ploughing of field during Agninakshatra (April-May) when temperature is around 40 - 45 °C brings about killing of soil insects, pathogens, nematodes and pupae of lepidopteran pests.
- Treating stored pulses with red earth to prevent insect damage.
- Use of Tanjore bow trap, a common traditional gadget to kill rats in rice fields of Cauvery delta.
- 'Vrikshayurveda", a science of plant health, similar to 'Ayurveda" which is science of human life deals with maintenance of plant health and provides literature on control measures for control of pests and diseases.

There are many more such practices based on traditional wisdom of farmers in different regions of the country and state. The scientific bases behind such practices if established based on research, would help in including them in management measures.

Conclusion

Organic farmer's primary strategy in controlling pests and diseases is prevention. They build soil organic matter through the use of cover crops, compost and biologically based soil amendments. This produces healthy plants which are better able to resist diseases and insect feeding. Organic farmers also rely on a diverse population of soil organisms, insects, birds and other organisms to keep pest problems in check. When pest population gets out of balance, growers will implement a variety of strategies such as use of insect predators, mating disruption, traps and barriers. As a last resort, botanical or other non-toxic pesticides may be applied under restricted conditions.

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Application of Integrated Pest Management in Organic Farming

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Agriculture is the main cornerstone of the Indian economy. The government policies and technological innovations by the National Agriculture Research System (NARS) during the last 50 years have transformed Indian agriculture and achieved phenomenal success in increasing food and fibre production. India has attained a rare distinction of ushering in the rainbow (Green, White, Golden, Brown, and Blue) revolution by achieving outstanding productivity gains in food grain, oilseeds, pulses, and horticulture, milk, meat, poultry and fisheries sectors. While the progress made has been awesome and there is a significant change for the good, a lot more needs to be done doggedly to meet the food and fibre 'needs' and 'wants' of the growing human population. It is rather ironic and unacceptable that malnutrition is still widespread in some parts of the country. Continually decreasing land availability for food production, natural resources degradation, increasing risk of biological invasions, climate change and new global trade regulations are only some of the factors that are exacerbating the challenges to achieving food security for all.

All Kind of Pests destroy food, fibre, oilseed and horticultural crops, pre-and post-harvest and cause massive economic losses (Rs 1.1 to 1.5 trillion; US$ 17-39 billion) every year; the quantity of food lost is sufficient to meet the food requirement of millions of hungry people in the country. It is estimated that pest-induced food losses, if prevented would enable India to meet its food production targets for 2030 at the present levels of crop productivity. The main motto of crop protection research in India emphasises that not losing what is grown and produced is as important (if not more) as growing more food. Institutions engaged in crop protection research have made significant contributions to 'not losing food' to pests. Their conscientious efforts are targeted to ensure that pest control is achieved without adversely impacting the environment.

Integrated Pest Management (IPM) is a Pest Management system that, in the context of associated environment and population dynamics of pest species utilizes all suitable techniques and methods in as compatible a manner as possible and maintains pest populations at the level those causing economic injury or IPM and use of biotic agents in order to minimize the indiscriminate and injudicious use of chemical pesticides will be cardinal principle covering plant protection. The main aim of IPM is to manage the pest populations below the economic injury level (EIL). In IPM, a number of economic viable pest management strategies can be achieved by combining these. This can be a common-sense approach to pest management. IPM is an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides.

Whereas, organic farming systems main depends upon ecologically engineered practices like Cultural and biological pest management strategies which exclude the excessive or no use of chemical pesticides in raising the crops, in this we need to avoid genetically modified crop production. The main components and the various natural process of an ecosystem like nutrient cycling, soil micro-organism activities, species occurrence, and distribution which are extensively applied directly or indirectly for good agricultural practices. In this, we need to remain careful for using Good Agricultural Practices (GAP) which also include proper crop rotation, date of planting, habitat management, date of harvesting, proper monitoring and resource mobilization which enhances the population of the beneficial organisms.

In the present-day, organic agriculture is considered to be a holistic production approach which is socially, economically viable and environmentally safe and sustain the soil, plant, and human health. However, due to very strict regulations of organic farming limits options to those who desire to manage the pest population in comparison to those are doing traditional or IPM farming. The Organic farmers were advised to reduce key pest populations by doing minimum agro-ecosystem manipulation, which make the crop healthier, advantageous to natural enemies and detrimental to the pests. Few promising active plant protection substances are available which help in natural multiplication of natural enemies or added Biological control agents and side by side also reduces the pest population below EIL.

Pest Management presents a big challenge in organic farming, as many key pests are mobile and well adapted to local environment. Moreover, IPM application in organic farming focuses in reducing pest population below EIL, rather than eliminating them and to achieve success, we need to have the following information:

Pest Biological Information: What resources needed by the pest to survive, reproduce or adapt on the farm.

Ecological information: Abiotic and biotic factors pest need to survive or how the pest interacts with the available environment and natural enemies to shape a pest-environment.

Behavioural Information of both Pest and Natural enemies: How the pest goes about the necessities of life can be changed to protect targeted crops.

By collecting such information in advance, helps us to design a successful IPM in organic farming too, because an IPM experts incorporate many different strategies to reduce the pest population. It was found that none of the single method, employed alone to achieve the desired IPM or which will be chronic to key pests. Almost all the IPM modules are farmers participatory, hence in IPM we need to identify the organic farmers and certified organic farmers can widely use a number of IPM practices, which are easily available, economical, farmer-friendly and environmentally safe, few of them are explained as hereunder:

Seed Treatment with biological substances is one of the most common approaches that have been recommended and adopted by many organic farmers as pre-sowing treatment or vegetatively propagated material to reduce soil-borne pests, the promising biopesticides or biocontrol agents must have multiple effects which economically manages diseases organisms, insect-pests, etc. i.e they must be bactericides, fungicides, and insecticides. An IPM strategy should identify key pests, determine the various economical pest management options, and integrate them together. To use seed treatments effectively, it is important to understand the purposes of seed treatment, alternatives or supplements to seed treatments, and the various advantages and disadvantages of seed treatments. Natural enemy cum beneficial fauna population such as Coccinellids, spiders, and Chrysoperla, pollinators, and honey bees remain unharmed due to seed treatment.

Mating disruption is one of the well-known non-insecticidal methods. It targets the reproductive stage/adult and thus not allowing the development of damaging life stage. It is highly selective, non-toxic, and species-specific, as primary target species respond to the pheromone and other non-targeted useful natural enemies are not affected by its presence, they thrive inside or outside the field. This also reduces human labour and limited impact on other pre-harvest IPM strategies. Moreover, the use of pheromone against key pests neither results in an outbreak of secondary pests nor have pest resurgence.

Good Agricultural practices like crop rotation, nutrient management, field sanitation measures to reduce/remove disease vectors, weeds, and habitat management and moreover, to enhance the crop health, natural enemies and reduce pest populations.

Organic farming standard protocol, pest problems can be managed through a number of cultural, mechanical, or physical methods; augmentation or introduction of predators or parasites of the pest; habitat management for natural enemies of key pests; and non-synthetic management strategies, such as lures, traps, and repellents. When these practices are insufficient to prevent or manage the key pests, biological, botanical, or chemical material or substance included on the National list of non-synthetic and synthetic substances allowed for use in organic crop production may be applied to prevent, suppress, or reduce pests. However, the conditions for using the material must be documented in the organic system plan.

Integrated Pest Management is highly dynamic and location-specific. Hence, it is always recommended that IPM expert/organic farmer should develop or modify their own strategies based on their enriching experiences, resource availability, time and forecasting of climate change. All these pest management strategies used in combination comprise the IPM.

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Technical Session III

"Success stories on implementation of organic farming technologies"

Success Story on Integrated Organic Farming System in Sikkim

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A serious concern has been raised over the issue of environmental degradation due to increased use of inorganic inputs in agriculture and there is an urgent need for ecological sustainability. Consequently, attempts have been made worldwide to promote sustainable farming systems. Agriculture has also been affected by climate change and the consequences of changing climatic conditions are affecting the system productivity. Therefore, there is a necessity for innovative farming solutions to improve soil health conditions so that food production resilience may be ensured. One such option for sustainability in agriculture is integrated farming systems. Sikkim was declared as fully organic farming state in 2016 and implementing integrated farming systems under the organic management has resulted in higher return for the farmers.

Demonstration of IOFS in Sikkim

The majority of activities were initiated at the villages adopted by the Institute in East Sikkim district and the same were gradually replicated in the other three districts of Sikkim. Interventions were made in 34 villages covering about 115 households. Individual farmers with aptitude for adopting innovative technologies to enhance farm income through integrated organic farming system (IOFS) approach were brought under the project activities. The farmers/entrepreneurs interested to begin a medium to large-scale cash crop and poultry farming were facilitated by linking them with funding agencies, research institutions and marketing agencies. The details of villages and the interventions made are enlisted in Table 1.

Table 1. Details of IOFS models

Name of the district	Name of the villages (Total no.)	Model component	No. of units	Area (ha)
East Sikkim **Altitude range: 900 to 1300 m amsl**	Rumtek, Sajong, Timpyem, Rey, Thanka-Martam, Thanka-Lingtam, Yangtham-Martam, Loosing, Nandok, Pacheykhani, Damlakha, Ralap, Amba, Pakyong *etc*. (15 villages)	Agriculture + horticulture + dairy + fishery/poultry/pig + vermicomposting +large cardamom based agro-forestry model	47	27.6
West Sikkim **Altitude range: 900 to 2700 m amsl**	Hee-Martam, Lingchom, Tikjek, Khecheopalri, Darap, Soreng *etc*. (05 villages)	Agriculture + horticulture + dairy + fishery/poultry/pig + vermicomposting +large cardamom based agro-forestry model	14	9.5

North Sikkim **Altitude range: 900 to 4300 m amsl**	Lingdong, Lingdem, Tingbong, Hee-Gyathang, Upper Gyathang, Gor-Shyagong, Lachen and Naga, Thangu (09 villages)	Agriculture + horticulture + poultry/pig + vermicomposting +large cardamom based agro-forestry model	42	24.6
South Sikkim **Altitude range: 900 to 1800 m amsl**	Sadam, Sripatam, Yangyang, Sadam, Namthang, Rabitar, Pabong, Salghari, Bakhim, Namphok, Upper Jaubari (12 villages)	Agriculture + horticulture + poultry/pig + vermicompost	12	7.5
Total	**41**	**-**	**115**	**69.2**

Why Integrated organic farming system (IOFS)?

In order to overcome the problems of irregular economic return from agriculture, a holistic, resource based, client-oriented and interactive approach *i.e.*, integrated organic farming system (IOFS) model was designed and developed at Institute level and in farmers' fields in participatory mode for marginal and small farmers having land holding of ≤ 1.2 acre (Table 2). The performance of each model consisting of agri, horti, livestock (dairy/poultry) and fisheries components was also evaluated at Research Farm and replicated at farmers' field. Maize-Black gram/rajmash-buckwheat/pea-based cropping system along with fruits (Sikkim mandarin, guava *etc*.), vegetables (year-round seasonal vegetables under low cost poly tunnel and rain shelters), livestock (dairy/poultry/pig), and vermicompost were integrated in ≤ 1.2 acre land which increased the cropping intensity up to 300% with 481% - 518% higher net return and employment for 270 to 295 days as compared to only 60±10 man-days in maize/rice-based mono-cropping system (Table 2).

Table 2. Economics of IOFS model developed by ICAR-NOFRI

#	Model component	Model area (ha)	Cost of production (Rs.)	Gross return (Rs.)	Net return (Rs.)	B:C ratio	Total system employment (days)
1	Agriculture + horticulture + dairy + fishery + poultry + vermicomposting	0.60	114625	244550	129925	2.13	295
2	Agriculture + horticulture + dairy + vermicomposting	0.60	116695	238685	121990	2.05	270
3	Agriculture + horticulture + dairy + pig + vermicomposting	0.60	119600	248560	128960	2.08	285

Socio-economic profile after adoption of IOFS

1. Employment generation

People living below the poverty line were mostly dependent on agriculture and livestock component for their livelihood and had minimum scope of employment for 3 to 4 months during the cropping season. However, the introduction of second crop after maize, rice, integrated organic farming system, year-round vegetable production, kiwifruit production, semi-intensive poultry farming and pig farming created year-round employment avenues for farm women and rural unemployed youth.

An integrated organic farming system with agri + horti + dairy + fishery + vermicompost components generated employment for 270 to 295 days as compared to only 60±10 man-days in maize/rice-based monocropping system. The Vanaraja poultry having the capacity of 50 to 100 nos. of birds generated employment for farm women/youth round the year and generated income of at least of Rs. 2500 to 3000/-per month. Similarly, pig farming with 2 sows has the potential to generate employment for a person for about 100-140 days with monthly income > Rs. 2,000/- per month. Enhancing the number of sows from 2 to 10 with proper training in animal health care and vaccination may have tremendous opportunity to earn at least of Rs. 25,000 to Rs. 30,000/- per month. Overall, innovative scientific interventions significantly increased the financial status of tribal farmers over their existing farming conditions.

2. Improvement in purchasing power

After fulfilling the nutritional requirement at household level, IOFS model provides an additional amount of Rs. 70,000 ±10,000 per annum to the farmers. Hence, IOFS supported the poor farmers to spend more towards the purchase of essential commodities for household. The poor farmers who otherwise were not able to send the kids to school became capable to spend some money for education of their children and also could take better care of their health. Additionally, from the IOFS model, many landless tribal farmers obtained new means to sustain their livelihood by initiating small poultry units of 50 to 100 nos. of Vanaraja backyard poultry birds. After training at ICAR Research Complex, Sikkim Centre improved variety of poultry was reared to earn Rs. 2000 to 5000/- per month. Organic Kiwifruit cultivation also provided new avenues of income generation at high altitude areas to the farmers with land unsuitable for the cultivation of annual crops. Many self-help groups, NGOs in Sikkim have adopted IOFS for livelihood improvement at different villages and obtained tremendous success. The Govt. of Sikkim is also now promoting the IOFS models among the farming community of Sikkim. The performance of IOFS run by few successful beneficiaries is presented below (Table 3).

Table 3. Impact of IOFS in increasing purchasing power

Sl No.	Name and address of the beneficiaries	IOFS module	Performance/economic implication	Social implication
1.	Mrs. Pemkit Lepcha, Timpyem East Sikim	Agriculture + horticulture + dairy + poultry + pig + vermicompost	Net income Rs. 1.094 lakhs per year.	Managing family with her additional earning. **She received Mahindra Krishi Samridhi Award under Youth Category in 2017**
2.	Shri Nim Tshering Lepcha, Nandok, East Sikkim	Agriculture + horticulture +cattle + fishery /poultry + pig + vermicompost + large cardamom	Net income Rs. 3.25 lakhs per year.	Managing family with his additional earning and constructed pucca house, and is planning to develop agro-tourism
3.	Mrs. Doma Bhutia, Thanka-Lingtam	Agriculture + horticulture +dairy + poultry + pig + vermicompost	Net income Rs. 1.12 lakhs per year.	Managing family with her earnings

Conclusion

The identification of suitable technologies for enhancing the productivity of all possible components of Integrated Organic Farming System, and conduct of such demonstrations have the potential to bring economic improvement and empowerment of farmers under organic conditions. The adopted villages are now developed as Integrated Organic Farming System models for the farming community of East Sikkim district as well as entire Sikkim.

Integrated organic farming system (IOFS) is the best option for enhancing sustainability, consumer safety, market profitability and livelihood security. The research and extension in the IOFS area is necessary which majorly emphasise on the local needs and conditions. Dissemination and adoption of the IOFS practices among the existing farmers is very essential to know the importance of judicious implementation of organic farming which enhances the adaptability of the crops under changing climatic scenario. This will lead to economic improvement and empowerment of farmers under organic conditions.

Success Story on Integrated Organic Farming System (IOFS) Cluster in Meghalaya

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Introduction

Organic farming that relies mostly on animal manures, organic wastes, crop rotations, legumes and biological pest control method is practiced majority area of North East India especially the hill region (Das et al., 2017). In North-eastern region of the country, the application of chemical fertilizer and pesticide is very low and most of them are used in valley ecosystem but upland ecosystem is free from use of chemicals (Layek et al., 2017). The farmers have retained their traditional practices and have shown an inclination towards organic farming that is being harnessed for development of the region with ecological benefits (Das et al., 2019). The major challenge in 'organic agriculture' is the non-availability of huge quantity of organic inputs for satisfying the farm demand. Use of animal excreta based manure alone is not sufficient for meeting the nutrient needs of the crops. It is therefore, necessary to utilize all the resources available on- and off the farm effectively. Thus, focus should be on integrated organic farming system (IOFS) by integrating complementary and supplementary enterprises such as crop, fruits and vegetables, livestock, poultry, fish, multipurpose tree species, mushroom, etc. along with adequate nutrient recycling strategies (Das et al., 2019). For disseminating IOFS technology, a model village concept under Network Project on Organic Farming-Tribal Sub Plan (NPOF-TSP) was conducted in the village of Mynsain in Ri-Bhoi district of Meghalaya with financial assistance from ICAR-Indian Institute of Farming Systems Research, Modipuram. Realizing the potential, several farmers in village started practicing organic farming in IOFS mode for enhancing productivity, income and employment while minimizing dependence on external resources. It increased the crop productivity and diversify their homestead farming to growing remunerable crops and rearing cattle, pigs, poultry, etc.

IOFS models demonstrated at village levels in cluster approach

For disseminating organic production technology developed in the ICAR Research Complex for NEH Region, Umiam, in 2013, a model village concept under Network Project on Organic Farming-Tribal Sub Plan (NPOF-TSP) was conducted in the village of Mynsain in Ri-Bhoi district of Meghalaya with financial assistance from ICAR-Indian Institute of Farming

Fig. 1. Different components of IOFS model in adopted organic villages of Meghalaya

Systems Research, Modipuram. Under the program, seeds of improved varieties of crops and vegetables, planting materials, lime, rock phosphate, neem cake and other organic inputs were provided to the adopted farmers. Effective soil fertility management through application of well decomposed organic manures like farm yard manure, green leaf manure, composts, etc., were promoted. For pest and disease management, use of neem oil, trichoderma, derisom and indigenous technical knowledge were emphasized. Small scale mechanization, implements and tools were provided to the village and trainings in various aspects of organic farming along with conservation of natural resources and residue recycling were given to the farmers. Several farmers in village started practicing organic farming in IOFS mode. They integrated crops (rice, maize), vegetables (tomato, French bean, potato, lettuce, and carrot), livestock (dairy/ piggery), water harvesting (jalkund) etc. Water from micro water harvesting structure like Jalkund used for live saving irrigation in winter months. It increasedthe crop productivity and diversify their homestead farming to growing remunerable crops and rearing cattle, pigs, poultry, etc.

Flow chart/ steps of technology

Identification of suitable land for developing IOFS near the household

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Creation of rain water harvesting structure jalkund/farm ponds

↓

Etablishment of animal rearing unit dairy/piggery/poultry)

↓

Construction of compost pit /vermicomposting unit for efficient recycling of animal excreta and other farm biomass like kitchen waste, weeds etc.

↓

Development of kitchen garden and cultivation of year round vegetables having high market demand (okra, brinjal, tomato, chilli, cabbage, cauliflower, broccoli, lettuce, leafy mustard, carrot, coriander, spinach etc.)

↓

Cultivation of cash crops like ginger or turmeric for income generation

↓

Cultivation of Maize followed by French bean

↓

Fruit crops like pineapple, Assam lemon, papaya, banana, guava etc, at corners of the field

↓

Construction of bamboo machan over jalkund and cultivation of pumpkin, bottle gourd

↓

Promotion of fodder or other multipurpose trees

↓

Marketing of produce

Impact: The yield of crops and vegetables like maize, French bean, ginger, tomato, carrot and chilly enhanced by about 20-30, 40-45, 33-40, 45-50, 37-50 and 27-30%, respectively over their initial production under traditional practices (local variety, low input and resource recycling). The income from livestock component ranged from 41 to 49% and that for fishery ranged from 3.5 to 9.5%. Farmers are efficiently recycled the biomass and produce quality vermicompost in the range of 0.4 to 1.25 tonnes per annum. Two individual farmers, Mr. Jrill Makroh and Mrs. Skola Kurbah obtained net returns of Rs. 46,695 and Rs. 31,100 from their respective 0.27 and 0.21 ha IOFS models which is equivalent to Rs. 1,73,702/ha/year and Rs. 1,48,946/ha/year, respectively. The net return obtained from the IOFS models were significantly higher as compared to the farmers' practice of maize-fallow or cultivation of maize (rainy season) followed by vegetables in about 30% of the areas (winter season). The IOFS models established in these two farmers field could meet 76 - 95.1% of N, 68.6 - 82.0% of P_2O_5 and 85.5 -96.0 % of total K_2O requirement of the systems Almost 70% of the seed requirement was also met from the farmers own saved seed. It is expected that, with the certification of organic products, the income as well as livelihood of the farmers will be further improved over the years. Thus promotion of IOFS models in cluster approach can enhance the system productivity and income of farmers substantially while reduces the dependence on external farm inputs.

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Extension strategies for promotion of organic farming in India

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What

Extension services are crucial for promoting innovations, new methods, improved technologies, new systems of production including good agricultural practices, for improving profitability and sustainability of farming. The Green Revolution (GR) technologies were successfully disseminated by extension services using a variety of extension methods, media, extension programmes & extension interventions leading to higher farm productivity since 1960s. The GR technologies, viz. chemical fertilizers, pesticides, weedicides as also the drugs, synthetic feeds and antibiotics have significantly contributed to improving crop and livestock productivity world-over. But, these agrochemicals are now increasingly held responsible for many health hazards & chronic diseases too. With growing literacy, education, awareness coupled with rising incomes, consumers are becoming more quality conscious. Moreover, the food scares like food borne diseases are alerting people of harmful consequences of consuming food laced with chemicals and harmful residues of pesticides and antibiotics. The negative consequences of these agrochemicals are not restricted to only physical health but also these are blamed for growing psychological/ mental problems in society. Many chronic diseases which are on the rise are being attributed partly to these agrochemicals, making the sustainability of chemical based farming and intensive livestock production questionable. The original GR, thus, now faces an environmental crisis, which even the pro- GR scientists agree. As an alternative, therefore, organic agriculture is rapidly gaining ground world-over including in India.

Organic agriculture has potential to make agriculture sustainable, protect environment and prevent or reduce the adverse impact of climate change. Organic agriculture including organic livestock and poultry production as an emerging system of food production is expanding rapidly around the world. Over 2.8 Million producers grow organic foods in 69.8 Million ha land across 186 countries with $97 billion global market for organic products. Over 103 countries now have an organic legislation. In terms of number of producers, India continues to be number one in the world with nearly one million organic producers. As on 31st March 2020, total area under organic certification process (registered under National Programme for Organic Production) was 3.67 million Hectare (2019-20). India produced around 2.75 million MT (2019-20) of certified organic products which includes all varieties of food products. The total volume of export during 2019-20 was 6.389 lakh MT**.** The organic food export realization was around INR 4,686 crore (689 million USD). Organic products are exported to USA, European Union, Canada, Switzerland, Australia, Japan, Israel, UAE, New Zealand, Vietnam etc. The production is not limited to the edible sector but India also produces organic cotton fiber, functional food products etc. (APEDA, 2020). The available information on area under organic production and export indicate good prospects of organic agriculture in the country. It is important, therefore, that the stakeholders in India are acquainted with the concept, standards, practices, requirements and guidelines of organic farming to improve their understanding of this emerging system of food production. This is also important; since some still believe Organic agriculture is unscientific, being looked at with doubts, utopian, fad, devoid of logic, rationale an impractical idea. The Extension & Advisory Services (EAS) can develop right understanding about organic agriculture among the producers and consumers. We need science based approach to further develop OA by generating organic technologies through research. We need to demonstrate, OA is sustainable to wider community across the world. We can do it by doing more research, developing relevant technologies and effectively transferring the technologies to the interested farmers, processors and other stakeholders in the organic value chain.

So What

Besides rising domestic demand for organic products, significant export potential developing countries like India have, it is important that attention is paid to further developing organic agriculture in these countries. In doing so, extension systems have to play crucial role the way it was done for promoting GR technologies (Chander, 1996). This paper lists out the priorities for extension services, towards creating mass awareness, improving knowledge base of farmers including skilling them on organic production, processing and marketing across organic value chains. Organic agriculture is knowledge intensive system of farm production. Many confuse it with traditional agriculture being practiced since centuries, which it is not. It is altogether a new system of production, which have certain elements drawn from traditional practices as also from more advanced new systems. Organic products are grown under a system of agriculture without the use of chemical fertilizers and pesticides with an environmentally and socially responsible approach based on principles of organic agriculture & guided by a set of organic standards. There are opportunities as well as challenges in organic farming which need to be addressed. The organic agriculture development opportunities in developing countries can be enhanced further, if we could integrate this with indigenous knowledge of farmers under local conditions and strengthening institutional support.

Now What

Extension efforts directed to organic agriculture are weak as most of the formal institutions are promoting technologies fit for chemical dependent conventional agriculture.The formal educational programmes on organic agriculture are not yet commonly available except a few diploma courses. The existing extension systems and personnel are not trained or oriented to organic agriculture production systems, so they lack capacities in this area, often making it difficult for them to guide farmers on organic production practices. So, the EAS first need to enhance their own capacities on organic agriculture. Farmers often approach extension service providers to know about- conversion requirements from conventional to organic systems, alternative soil fertility measures to replace chemical fertilizers, non chemical plant protectants, agronomic practices, certification requirements & procedures etc. Information is frequently sought on certification process, farm record keeping, standards and requirements, traceability, information on marketing of organic produce etc. Any good extension agent is expected to meet these information needs of farmers and other actors in organic value chains. Currently, the certification agencies, organic traders/exporters are providing the information on limited basis to their clients. The farmers in general are mostly deprived of the required information and also there is possibility of incorrect information being passed on to them. The following extension strategies may help promote and develop organic farming:

1. Capacity building of extension services providers on organic production viz. principles, methods, standards, practices, certification procedures, marketing etc.
2. Capacity building of farmers and processors on organic farming methods.
3. Developing package of practices for organic production & processing of crops, livestock, poultry and fisheries.
4. Setting up organic demonstration units, documenting successes stories of organic farmers for sharing through different extension media including social media platforms.
5. Creating mass awareness on benefits of consuming organic products to boost organic production and markets.
6. Solving problems of organic farmers & sharing organic best management practices by organizing farmer field schools.
7. Sharing the practical information, do's & don't's including results of organic research projects being undertaken by various ICAR institutes, SAUs in easy to understand extension methods, media & literature viz. leaflets, folders, manuals, bulletins, newspapers, magazines, Farm Radio programmes, TV talks, videos, youtube uploads, personal contacts by extension agents, farmers' visit including Organizing tours of farmers to sites of organic farms/research centres.
8. The well established certified organic farmers may be used as lead farmers to inspire and motivate other interested farmers (Farmer to farmer extension).
9. Successful organic farmers may be awarded and their stories shared via various platforms including social media channels.
10. Producer- consumer alliance for organic products including cluster farming & buyback arrangements may be facilitated. The Extension and Advisory services (EAS) can promote Farmer Producer Organizations (FPOs) to broker better deal for farmers by encouraging organic production and consumption.

The State Departments of Agriculture (DoA) including line departments like Horticulture, Animal Husbandry, SAUs/SVUs, Central Agricultural Universities, Directorate of Extension (Govt. of India), MANAGE and Extension Education Institutes need to engage on capacity building of extension functionaries on organic agriculture. These trained extension functionaries then can cater to the extension needs of farmers and processors wishing to enter into organic farming. The budgetary allocations for organic farming promotion including capacity building initiatives and extension infrastructure development would go a long way in enhancing organic production, trade and exports.

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Implementation of Organic farming Technology in Farmers Field – Experience Sharing

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In the post COVID scenario importance of organic agriculture has got ample scope to alleviate rural poverty in a significant manner with potential opportunity to boost global food security and improving the nutritional security in a strategic intervention. To obtain comparable or higher yield of crop / farm income in hilly as well as rain-fed agro-eco situation, a scientific organic farming package of practices with ecological prospective, are to be adopted by the stakeholder. This needs a systematic approach for transfer of latest technology both developed in the research institute as well as proven traditional practices available across the country.

MANAGE Hyderabad has initiated the Certificated Farm Advisory programme under Massive Open Online Courses(MOOCs)with the help of ICAR research Institutes in the country to promote the professional excellence of the extension professionals trainee. After successful completion of the modules, the trainee can be able to support/solve the future advisory task on organic farming efficiently and effectively in various fields. A three month basic on-line course programme was made followed by Module II course programme of Organic Farming at ICAR-IIFSR, Modipuram, Meerut, the CFA Module-III field level practical oriented activities for hands on experience is pursued to acquire holistic understanding of the various practical aspects of organic farming and its obligatory processes of certification. The objective of the joint initiative is to improve the efficiency of selected extension personnel so that they could able to facilitate intended farmers for adoption of certified organic farming protocol with combination of tradition, innovation and science in the de-facto organic areas (hills and rain fed/dry land region) which can contribute towards safe food security and climate resilience with increased household farm income.

The 15 days rigorous training with the active participation of eminent scientists and resource persons in the IIFSR, Meerut was sufficient enough to boost our knowledge and skills in the field of Nutrient management, Bio based IPM and weed management in organic way as well as the principles and procedure of organic certification. The entire focus during the on campus and off campus training programme was to inculcate the various methods to improve the physical, chemical and biological property of the soil so that in due course of intervention the soil can able to build up to a desired fertility level and could provide a sustainable yield.

After the systematic training the real work stated in the field some of the high lights that has been performed in addition to the routine government duty are as follows:

- **Creation of Awareness PGS India in the Potential Areas For Developing Interest To Adopt Organic Farming.**

Sl. No.	Name of the Training Programme	No. of Person trained	Thematic issues discussed
1	PGS awareness campaign for organic farming	14	Formation of local group, role of organic farming in present day Agriculture.
2	Awareness campaign for school children & Organic farming ToT for farmers in Maa Mati campus of I Concept Initiative	52	Awareness on organic farming, practices, preparation of organic manure,
3	Producer consumers SHG and scientist interaction for safe food campaign, Bhubaneswar	50	Organic farming for safe food production. PGS guideline.
4	PGS awareness training to senior management	18	PGS operational manual and LG operational manual so that the members can able to know the PGS process

- **Providing hand-holding trainings to intended groups for liquid organic manure and botanical pesticide preparation.**

Systematic effort were made to provide hands on training on liquid organic manure like Jeebamrita, Ghana Jeebamrita, Beeja mrita, Panchagabya, Pancha Parni, Use bio fertiliser , application of Trichoderma and pseudomonas, preparation of Bramhastra, Neemastra, Agneyastra and other low cost ITK for organic farming.

The detailed training program are given in the table below

Sl. No.	Name of the Training Programme	No. of Person trained	Thematic issues discussed
1	Interaction with Coffee growers on application of liquid organic manure and waste decomposer	3	Preparation liquid organic manure and waste decomposer
2	Training on and preparation of liquid organic manure and LG formation at Kothabada,Dandamukundpur	20	Preparation liquid organic manure and Bio-pesticide.
3	Interaction with millets growers regarding application of liquid organic manures , Sorada Ganjam,	37	Preparation of liquid organic manure, Bio-pesticide and application of Bio-fertilizer.

- **Preparation of waste decomposer and use of the stock solution in their crop field.**

Waste decomposers developed by NCOF are available at RCOF office but very few farmers are accustomed with the application of waste decomposers. Keeping in view the economic and easy method of preparation and application in the field, number of hand holding training are organised to make the farmers well acquainted with the preparation application and multiplication method.

Sl. No.	Name of the Training Programme	No. of Person trained	Thematic issues discussed
1	Waste Decomposer and its application in vegetable cultivation and lemongrass cultivation, Morada, Mayurbhanj	08	Preparation of Waste Decomposer and its application in vegetable cultivation and lemongrass cultivation.
2	Visit to QPM nursery and demonstration of Waste decomposer , Pitapali Jatni Block	06	Preparation of Waste Decomposer and its application in QPM nursery.
3	Waste Decomposer demonstration and training on IMO, GUdayagiri, Kandhamal Dist,with the help of SNEH NGO	42	Preparation of Waste Decomposer and its application in vegetable and field crops.
4	Awareness campaign for use of Waste decomposer and trichoderma in maize cultivation Village Chacha ,Block Jharigaon, Nabarangpur	57	Preparation of Waste Decomposer and its application in vegetable, maize and field crops.

Hand holding training for Vermicomposting and Mass Multiplication of *Trichoderma viridi*.

Sl. No.	Name of the Training Programme	No. of Person trained	Thematic issues discussed
1	Mass multiplication of Tricoderma viridi under MSME Skill Development programe of GoI	18	Mass multiplication of Tricoderma viridi.
2	Mass multiplication of Tricoderma viridi under MSME Skill Development programe of GoI	12	Mass multiplication of Tricoderma viridi.

3	Skill development training for mass multiplication of trichoderma, Tomando, Bhubaneswar	17	Mass multiplication of Tricoderma viridi.
4	Training on Windrows method of Vermicomposting at Maa Mati campus Kothabada ,Pipili and Gosalas	18	Utilisation of aquatic weeds for vermicompost preparation in windrows method

The agro ecology situation and the mind-set of most of the stake holders provide wide scope of organic farming. Though successes are found in certain patches but for better sustainability the following constrains may be addressed for better efficacy in implementation of organic farming.

Some of the indicative constraints came across are:

- Inadequate knowledge and skill of farmers on critical organic practices and certification process/ methods
- Poor book keeping at field level
- Lack of coordination among farmers, Facilitating agency and government field functionary
- Inadequate hands on training for skill development of organic farmers
- Poor market linkage for organic products
- Availability of quality off farm organic inputs
- Low rate of continuance of organic practices
- Low visibility of buffer zone
- Lack of laboratory facility to ascertain the quality of the input and estimation of MRL at easy reach of farmer
- Inadequate postharvest management of organic produce
- Lack of vibrant RC to foster LGs in the state
- Lack of trained manpower at various level of implementation
- Lack of ownership

Future strategy to boost the organic farming

- Coordination between line department, KVK,SAU, ICAR institutes, RC, NGO and RCOF for integrating the stakeholders
- Integrating MGNREGS/Farm Pond/ for creation of buffer zone / developing IFS model to boost organic culture
- Involving CFAs in the strategic planning and evaluation process for effective monitoring
- Creation of online organic marketing platform for attracting national and international player and generate demand for area specific production and marketing tie up
- Establishment of accredited labs both at SAU and private basis for analysis of plant residues and evaluation of quality parameters of organic inputs

Success story on entrepreneurship through organic farming

Priti Sanjay Sonkusare, CFA on OF

Myself Priti Sanjay Sonkusare (M.Sc. agricultural economics) from Om Bio-Fertilizers. I am partner at Om- Bio-Fertilizers working in this field from last 6 years. Om Bio-Fertilizers was established in 2016 at tal- Armori , DIST. Gadchiroli , State - Maharashtra. With an aim to promote organic agriculture and provide employment in the forest dwelling, tribal dominating, LWE affected Gadchiroli district. With this incentive we started working in the field of Bio-Fertilizers and today we are a team of 10 employees and connected with 1200 farmers over 12 blocks in our district.

Our company manufacturing and marketing Bio-Fertilizers under the brand name "MANIK" .

Bio-Fertilizers named:-	Organic input
1.Manik rhizobium	1. Manik Stimulant
2.Manik azatobactor	2. Manik Star
3. Manik azospirillum	3. Manik guard
4. Manik acetobactor	4. Manik clear+
5.Manik PSB	5. Manik boost flower
6.Manik KMB	6. Manik magic G.
7.Manik ZSB	7. Manik Neem
8.VAM	
9.NPK consortia	

Impact of our products on crop

1) Reduce the cost of fertilizers upto 50 % especially regarding urea.

2) Provide protection against drought soil born diseases and pests.

3) Crop yield increase by 20- 30 % in 3 years.

4)The key benefits of Bio-Fertilizers is their ability to aid soil, unlike traditional bulk fertilizers.

It takes two years of time to see the results of biofertilizers on the field. In India, majority of farmers are small and marginal farmers and the reduced production and subsequent fluctuations for this two year time are not bearable to these farmers. Thus we produce and provide selected organic inputs so that there is no change in the production of farmers in this time period. With the use of this combination of biofertilizers and organic inputs we have achieved:

1. Good texture, structure and quality for the soil

2. Improved crop health and nutrition

3. And increase crop yield.

In 2018, I completed the CFA- organic farming course at IIFSR, Meerut. Then I trained organic farmers from 31 clusters under the scheme of PKVY organic farming. I trained farmers to create *vermicompost*, *jeevamrut*, *beejamvrut*, *dashaparni ark* etc at their own fields, which I myself learned during my training program at IIFSR, Meerut. This helped the farmers to reduce their cost of production.

For effective use of biofertilizers we need :-

1. Maintained quality

2. Strong supply chain

3. Government support for biofertilizer promotion

Gadchiroli is predominantly a major Rice growing region. Rice is the major staple food in the world and it needs less fertilizers as compared to other crops. The biggest obstacle to produce organic rice is the flowing water from field to field and the same price of organic rice as compared to the chemical one. So if we wish to produce organic rice then cluster farming is the only way to proceed. And FPO formation can be an effective medium. Thus, last year I established "Sasyaved Farmer producer company" so that farmers can collectively produce organic rice and practice organic farming with ease throughout the region.

Implementation of organic farming technologies in Nilgiris – An Initiative

Motesh Mohan, CFA on OF

The Honorable Minister for Municipal Administration, during his visit to Nilgiris in September 2018 announced that, Nilgiris will be converted into a fully Organic District in a phased manner. Keeping this motto in mind, strenuous efforts have been taken towards Organic Nilgiris by the District Administration in coordination with various Government Departments. As a first step, a Core Committee was formed headed by the District Collector with all Government Departments and Farmer Associations as its members to discuss and decide upon Organic Conversion strategies. Every month, the Organic Committee meeting is conducted under the Chairmanship of the District Collector and the future prospects are discussed with all Stakeholders. As an important initiative, the Department of Horticulture has taken a team of 50 farmers to Sikkim, which is a fully Organic State in the Country, to practically have a glimpse of the Organic Farming activities carried out there.

On return from Sikkim, an Organic Farmers Association namely **The Nilgiris Organic Horticulture Farmers Association** was formed, registered and the farmers have been enrolled in the same. The association members started following organic farming techniques and are continuously motivating other farmers to follow the same. As a first initiative in the State, rally on Organic Farming was also organized to create an awareness among farmers and about 5000 farmers participated in the rally. It was one of the biggest rally in the history of Nilgiris. To provide an insight about Organic Farming Practices, Kisan Mela on Organic Farming was conducted in which about 500 farmers actively participated. Further, to motivate the farmers to adopt Organic Farming, various Seminars, Trainings and Exhibitions are being conducted regularly by the Department of Horticulture. To provide complete knowledge to the farmers about Organic Cultivation of hilly vegetables, the Organic Cultivation – Package of practices was received from Tamil Nadu Agricultural University specifically for hilly vegetables and the same was distributed to farmers by the District Collector.

In order to stop the usage of toxic chemicals in farming, which would deteriote soil fertility and also cause health hazards to people, a team of scientists from TNAU visited Nilgiris, collected and analyzed samples of soil, water and produces from various parts of the District for chemical residues. Based on their results, action is being taken by the District administration to ban toxic chemicals so as to protect our soil and convert it into organic.

Apart from these initiatives, various schemes have been implemented by the Department of Horticulture towards Organic Conversion:

- Under PKVY scheme, the farmers of two villages namely Kaggula and Yedakkad have been trained for the past two years for Organic cultivation of tea and are certified as Organic producers under Participatory Guarantee System.
- Under Special Area Development Programme, farmers of 4 villages have been educated to go in for Organic Farming and bio inputs have been distributed to them at subsidized cost.
- During the year 2019-20, under Mission for Development of Horticulture, subsidy for setting up of 50 vermicompost units have been given to farmers as an Organic Farming initiative. This

will aid farmers to produce manure I their own farm and thereby considerably reduce the amount spent on chemical fertilizers.

- Apart from this, for the first time in the history of Nilgiris, the Department of Horticulture has taken action to enroll 48 Farmer Producer Groups comprising of 4800 farmers formed under Collective Farming Scheme for Organic Farming Certification with the Tamil Nadu Organic Certification Department. The inspection of fields is under progress for issuing of Organic SCOPE Certificate to the farmers.
- Under RAD Integrated Farming System, during 2019-20, a subsidy of Rs.60 lakhs has been extended to 100 farmers of Kotagiri and Ooty block for purchase of livestock, bee hives and setting up of vermicompost units to take up horticulture based organic farming.
- Also, in order to maintain regular supply of bio inputs to the farmers, production of bio control agent like *Trichoderma viridi*, vermicompost and bio inputs such as panchagavya and dasagavya is being taken up in the State Horticulture Farms of Horticulture Departmet.
- The State Horticulture Farm, Nanjanad is being converted into a moder Organic Farm and Organic farming activities is being taken up to exhibit the benefits to farmers.

As various efforts are being taken for Organic conversion of vegetable area, now our next focus is towards organic conversion of tea farms and action has been initiated for the same.

The combined efforts of District Administration and various Government Departments and cooperation from the farming community, will not only help us to achieve our moto of Organic Nilgiris, but it will also aid farmers to get better price in the market, improve their livelihood and create a safe and healthy environment for the future generation.

Biodata of Speakers

Dr. Gerold Rahmann is a German agricultural economists. He studied agricultural economy at the University of Göttingen, Germany. From 1990 to 1993 he was scientist in the interdisciplinary project "Animal Husbandry in the Sahel - Recent situation and development. In 1993, he made his PhD in socioeconomics at the same university in the Institute of Rural Development and then moved to a post-doc position to the University of Kassel, the faculty of Organic Agricultural Research, and focused his work in the "Biotope management with Livestock in Europe. In 2000, Rahmann became founding director of the Federal Institute of Organic Farming at the German Federal Agricultural Research Centre (FAL). Rahmann was voluntarily active in national and international organizations, mainly in the area of organic farming. During 2014-2017 he was president of the International Society of Organic Farming Research (ISOFAR) and World Board of the International Federation of Organic Agricultural Movements (IFOAM). Since 2014, Rahmann is editor-in-chief of the scientific Journal of Organic Agriculture. He is associated editor of the scientific Journal of Applied Agriculture and Forestry Research.
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Dr Mette Vaarst is a Senior Researcher in the Department of Animal Science at Aarhus University, and in the International Centre for Research in Organic Food Systems (ICROFS), Denmark. She has published widely on organic animal farming and coordinated a number of major European research projects in this area. Her research interests include action research and qualitative research focusing on advisory service, daily care taking and management routines, as well as farmers and farm related actors' choices, farmers' perceptions of animal welfare, role in the farming community, herd management, development, legislation and relations between different aspects of animal husbandry and organic farming.
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Dr. Khalid Azim is a horticulture engineer with a Master's degree in Mediterranean Organic Agriculture from the CIHEAM-Bari Italy (2003-2005). Since 2007, Khalid is in a permanent position as a researcher in "Organic Horticulture and Composting optimization" at the National Institute of Agronomic Research (INRA). Recently, he has defended his PhD thesis on "Composting optimization of organic wastes and evaluation of the compost quality and its fertilizing value" in July 2019. Khalid is mostly oriented toward research and capacity building actions. Proud to be close to farmer needs in much Research to Action projects, he has discovered the rude task of a farmer in an arid region in Morocco, and totally committed to develop organic principles, in order to bring it out from niche to a mainstream as outlined by Organic 3.0. khalid is the National Scientific Coordinator of Organic Agriculture Research Program at INRA-Morocco and coordinated two research project and published 10 publications, one book chapter, 25 oral communications and 24 posters. He is a member of the National Board of FIMABIO, World Board member of ISOFAR and Associate Editor of its journal "Organic Agriculture" Springer, Germany.

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Dr N. Ravisankar, Principal Scientist (Agronomy) is working at ICAR-Indian Institute of Farming Systems Research, Modipuram from 2011. Having 20 years of research experience in the coastal and other regions, presently involved in coordination of integrated farming systems and organic farming activities at National level as Programme Facilitator (Coordination Unit) and looking after the national level research work of All India Network Programme on Organic Farming as National Principal Investigator. He has published 89 research papers in National Academy of Agricultural Sciences (NAAS) rated journals. Based on the farmer participatory research, 81 geo-referenced farming systems success stories have been documented by involving 23 State Agricultural Universities. As a National Principal Investigator of Network Project on Organic Farming (NPOF), detailed package of practices for organic production of crops in cropping systems perspective have been prepared for 79 cropping systems suitable to 14 states of India and published as "Organic Farming: Crop Production Guide".

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Prof. Ulrich Schmutz is an agricultural and horticultural economist, specialising in organic horticulture, agroecology and ecological economics. He has 30 years experience in academic research, policy and working within practical farms and food businesses of any size and complexity. In his academic work he specialised in ecological and rural economics, taking a broader view of this social science. His research interests are in organic horticulture, agroecology, urban agroecology, and social and environmental issues of food governance. Ulrich has long expertise in modelling farm, environmental and ecological economics and analysing large data sets efficiently. Ulrich has worked as Professor for Organic Agriculture at the Free University of Bozen/Bolzano, Italy, lecturing in the School of Economics and Management. Previous academic research and teaching was in tropical and subtropical horticulture at Humboldt University Berlin, Germany with projects in Israel and the Philippines. Other professional work is a management consultant, organic farm inspector and as a farm business consultant during the transition in East Germany and Eastern Europe.

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Dr. M. Suganthy, an Entomologist with specialization in Integrated Pest Management, is presently working as Associate Professor (Entomology) in the Department of Sustainable Organic Agriculture, TNAU, Coimbatore, Tamil Nadu. She has handled courses for both under-graduate, post-graduate and doctoral students for the past 14 years and guided 6 post-graduate students. Dr. M. Suganthy has undergone four international and twelve national training programmes such as advanced training cum workshop under US - INDIA AKI on “SPS Risk Analysis”, USDA - FAS - Professional Scientific Exchange under Norman E. Borlaug International Scientific Exchange Program and International Training Programme on Plant Bio-security at various universities of United States. She has been awarded with twenty five awards and to cite a few are “Norman E. Borlaug Fellowship” by United States Department of Agriculture, USA, “Tamil Nadu Young Scientist Award” by Government of Tamil Nadu and “Best Women Scientist Award” by Tamil Nadu Agricultural University, Coimbatore.

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Dr Mukesh Sehgal, Principal Scientist (Nematology) at ICAR-National Research Centre for Integrated Pest Management has done his PhD in Nematology. He has developed and validated Integrated Pest Management Technology (IPM Tool Box) for chickpea, pigeon pea, bell pepper, hot pepper, irrigated cotton and basmati rice. He has also developed used friendly software for nematode management information system for maize, chickpea and rice**.** He has been bestowed with many awards and accolades including Fellow of Nematogy Society of India, Fellow of plant protection science, P. Maheshwari Memorial award to name a few. He has 61 research papers, 10 books, 22 bulletins and 16 technologies to his credit.

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Dr. R.K. Avasthe, Joint Director, ICAR- National Organic Farming Research Institute (NOFRI), Tadong, Sikkim is PhD in Soil Science. His research area of interests includes Soil fertility and chemistry, integrated nutrient management, organic nutrient management, system of rice intensification, integrated farming systems, large cardamom agroforestry systems, conservation of agro and biological diversity. He is involved in working towards sustainability of organic farming in organic state Sikkim and spearheading campaign towards organic production technology of Sikkim mandarin and kiwifruit, organic vegetable production techniques under low cost plastic tunnels and rain shelters, organic farming production standards, organic agronomic practices of major field crops, role of agro-forestry systems in organic farming, organic pest and disease management in major crops of Sikkim, nursery raising techniques in organic crop production, backyard poultry and goat production and their role in organic farming, Dairy cattle management techniques and their role in organic farming and Organic pig production techniques.

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Dr. Jayanta Layek is a Scientist (Agronomy) in the Division of Crop Production, ICAR Research Complex for NEH Region, Umiam, Meghalaya, India. He has completed his MSc (with gold medal) and Ph.D. (with Inspire fellowship, DST, Govt. of India) from IARI, New Delhi. He has done his one year Post-Doctoral Associateship under world food prize laureate Dr. Rattan Lal at Carbon Management and Sequestration Center's (C-MASC), Ohio State University, USA. Dr. Jayanta Layek had done his research service for conceptualizing and developing environmentally and socioeconomically viable technologies for conservation of natural resources, enhancing productivity and profitability of organic farming in an integrated and sustainable approach for the fragile ecosystem of the North Eastern Hill Region (NEHR) of India. The most significant among them were development of organic package of practices for 33 crops and integrated organic farming system (IOFS) models for valley and terraced land, development of technologies for conservation agriculture in rice and maize based cropping systems, carbon sequestration through bio-char application and jhum improvement.
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Dr Mahesh Chander, Head, Division of Extension Education at ICAR-Indian Veterinary Research Institute has done a certificate course and a Master class on Organic Leadership from IFOAM Academy, Germany. He has been member of IFOAM International Standards Committee for three terms. He has widely published and presented papers on organic farming in national and international conferences including writing books and manuals on organic agriculture. Out of the 42 Masters and Doctoral students guided by him, 3 students completed theses on organic livestock farming topics. He has been a Board Member of ISOFAR since 2014. He received Bharat Ratna Dr C Subramaniam Award for Outstanding Teachers-2010 from ICAR and ISEE Young Scientist award from Indian Society of Extension Education in 2005. He has also been organizing Committee member of the IFOAM Pre-conference on Organic Animal Husbandry organized during 19th Organic World Congress. He has been serving several Government of India bodies concerned with organic agriculture. Also, he has been Associate Editor of Springer journal “Organic Agriculture”, a publication of ISOFAR.
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Sri Ansuman Patttnayak is working in the Agriculture and Farmers Empowerment department of Govt of Odisha and has worked more than 34 years. Apart from agriculture technology dissemination and implementation of various schematic activity under directorate of agriculture he has also worked in water resources department in the field of water management, Operation and Management of Water User's Association, development of Tank Improvement Management Plan. Sri Pattnayak has worked in Odisha Millets Mission for promotion of ragi in 14 tribal district of Odisha and significantly contributed for expansion/ revival of millet in the selected district, formation of FPO/FPC, seed bank, Participatory varietal selection of prominent land races value addition of millets, development of recipes with the support of IIMR Hyderabad and CFTRI Mysore. As a certified Farm Adviser of MANAGE Hyderabad, after getting training at IIFSR on "Organic Farming" he has created awareness programme for potential farmers/ NGOs to adopt Organic Farming, mobilised 07 local groups for PGS certification, provided hand holding training for 585 farmers on preparation of liquid organic manure and botanical pesticides wind rows method of vermicomposting , preparation and use of waste decomposer and trained around 65 students on preparation of Vermi Compost and Mass multiplication of Trichoderma.

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Mrs. Priti Bhele Sonkusare is an agricultural economist and a housewife with a vision of being an agripreneur. After marriage she shifted to Gadchiroli,a naxalhit and a major paddy growing area and refused to sit idle at home and decided to do something of my own earnings. She has established "OM BIOFERTILIZER" (31/3/2016) a biofertilizer company, by a combination of own investment and credit support from her family. With a view to create local employment for youth and women and to stop migration of youth from Gadchiroli to other cities in search of job. She has started her own production unit by providing employment to 10 young science graduates. In the beginning, her company manufactured Azotobacter,PSB, Rhizobium, Azospirillum, ZMB, KMB etc. which need no introduction. Now production is carried out at under the supervision of a young and energetic team of science graduate. She has been recognised as "**Certified Farm Advisor** (Organic Farming)" by undergoing training at ICAR-Indian Institute of Farming Systems Research,(IIFSR) Modipuram, Meerut, Uttar Pradesh in collaboration with National Institute of Agricultural Extension Management(MANAGE), Rajendranagar, Hydrabad, Telangana.

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Motesh M. is a Bachelor in Farm Technology from Tamil Nadu Agricultural University (TNAU) and progressive farmer as well as agri entrepreneur from Kotagiri, The Nilgiris, Tamil Nadu. He is undergoing Certified farm advisor training on Organic farming from ICAR-Indian Institute of Farming Systems Research, Modipuram in collaboration with MANAGE, Hyderabad with practical working experience in organic farming and integrated farming system. He is advisor to The Department of Horticulture and Plantation crops, TamilNadu in converting The Nilgiris to organic farming district and training of farmers in organic farming practices.

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