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Organic farming: A window yet to be well opened

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Organic farming system in India is not new and is being followed from ancient time. It is a method of farming system which primarily aims at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes and other biological materials along with beneficial microbes(biofertilizers) to release nutrients to crops for increased sustainable production in an eco friendly pollution free environment. According to FiBL Survey(2016), Oceania has the highest organic area i.e. 40%(17.3mha) followed by Europe(11.6mha), South America(6.8mha), Asia(3.6mha), North America(1.3mha), Africa(0.3mha). India's rank in terms of World's Organic Agricultural land was 15 in 2013. The total area under organic certification is 5.71 million hectare(2015-16). Of this, 26% accounts for cultivable area of 1.49 million hectare and the rest 74% (4.22 million hectare) includes forest and wild area for collection of minor forest produces. Sikkim has become India's fully organic state at first by implementing organic practices on around 75,000 hectares of agricultural land in the end of December,2016. Maharashtra, Rajasthan and Other states followed the suit after Sikkim in India's Organic Farming Mission. More and more cultivated areas are being dedicated for organic farming, with an aim to hit 10 lakh hectares by 2017-18 and to 20 lakh ha by 2020. India produced around 1.35 million MT (2015-16) of certified organic products which includes all varieties of food products namely sugarcane, oil seeds, cereals & millets, cotton, pulses, medicinal plants, tea, fruits, spices, dry fruits, vegetables, coffee etc. . The production is not limited to the edible sector but also produces organic cotton fiber, functional food products etc. Hike in population makes it compulsive not only to stabilize agricultural production, but to increase it further in sustainable manner. It can be truly achieved through organic farming .Moreover, having local market potential for organic products, India offers tremendous scope and global consumers are increasingly looking for organic food that is safe and qualitative one. It is assured with organic fertilizers as compost, manure, green manure, bone meal and emphasizes on techniques such as crop rotation and companion planting, biological pest control, mixed cropping and the fostering of insect predators. Although, low productivity, labour intensiveness, high skill requirement, inconvenient management, lack of awareness may obstruct the path towards adopting organic farming, but these dark sides can be lighted through showering innovative systems that protects and enhances the natural resource base, while increasing productivity by focusing on agro-ecology, agro-forestry, climate-smart agriculture and conservation of agriculture, which are based on indigenous and traditional knowledge. In view of these, the long-term objective of FAO, Organic Agriculture Programme, is to enhance food security, rural development, sustainable livelihoods and environmental integrity by building capacities of member-countries in organic production, processing, certification and marketing.

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Scope and importance of sustainable agriculture and organic farming in Odisha

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Agriculture is the most important source of income for Odisha. It employs 80 percent of the population. The average size of the farm holdings accounts to 0.8 ha and is the below the average size of the farm in other states. Evidently the agriculture plays a critical role in the economy of the state and livelihood of the majority of the population. Organic farming is the method of farming system which primarily aims at cultivating the land and raising crops in such a way as to keep the soil alive and in good health by use of organic wastes and other biological materials. Odisha has the maximum 26,300 ha of the total organically certified area out of 1,70,000 ha in the country.

As per the national statistics, consumption of chemical fertilizers and pesticides in Odisha is lower than the national average. The farmers in Odisha have traditionally been the custodian of rice genetic diversity. Traditional farming is still in practice in the inland districts. This has placed Odisha in an advantageous position to resort to organic farming, as the soil is less contaminated. A range of organic products like cotton, turmeric, pulses and scented rice are in high demand both in domestic and international markets. A recent study by ASSOCHAM suggests that Odisha has an export potential Rs.600 crore from organic farming produce in next five years. Organic farming also can create 80 lakhs additional jobs both in farm and non-farm sectors. Presently Government, NGOs and industries are promoting sustainable agriculture and organic farming in Odisha in various ways. 1) The project 'Sustainable farms, sustainable futures' operating in Kalahandi and Rayagada district of Odisha aims at increasing food security and reduced vulnerability of 4000 small and marginal farmers. 2) Odisha Livelihood Mission (Panchayatraj Department, Govt. of Odisha) has initiated a special programme 'Mahila Kishan Sashaktikaran Pariyojana (MKSP)' for livelihood enhancement and vulnerability reduction. 3) Per drop more crop- A study conducted by National Mission on Sustainable Agriculture on micro irrigation in 64 districts of 13 states including Odisha reveals that there is significant reduction in the use of water and fertilizers with concomitant increase in crop yield upto 45 percent in wheat, 20 percent in gram and 40 percent in soyabean. 4) OSSOPCA, Odisha is gearing up for a major drive to promote organic cotton. Organic cotton cultivation has been done successfully in Kalahandi, Balangir and Koraput district of the state. 5) Plantation programme (Organic) by ITDA- It is done in different districts of the state. The tribal farmers are given assistance since 2015 for growing mango, cashew, litchi etc organically. 6) Promotion of BGA production unit by Govt. of Odisha- It is done with assistance from Rashtriya Krishi Vikash Yojana (RKVY).

The organic farming will ensure responsibility, cost and decision sharing by the primary stake holders, i.e. organically growers at all levels. Instead of working with organic growers individually, conscious efforts will be made for promoting farmers group activities. All necessary supports like training, developing linkages with the market, skill improvements etc. should be developed.

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Role of organic farming in sustainable development

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Green revolution, although has multiplied our food productivity by excessive application of inorganic fertilizers, but at a huge cost in term of soil degradation, environmental pollution and human health reduction. Due to heavy use of chemical herbicides, pesticides and intensification of agricultural production during the past few decades has led to other harmful effects like nitrate in the ground water, eutrophication, changes in stratospheric etc. Agriculture sector is among the main contributors of global green house gases (GHG) emission. Organic farming seems to be more appropriate as it considers the important aspects like sustainable natural resources management and environment. Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. It favours the maximum use of organic materials like crop residues, FYM, compost, green manure, oil cakes, bio-fertilizers, vermicompost and adaptation of crop rotation practices. It avoids the use of synthetic fertiliser input and consequently lowers GHG emission in the form of nitrous oxide (N_2O). Organic farming also reduces the energy use for agricultural production and enhances carbon sequestration. It enriches organic matter in the soil that serves as food for soil biota. Organic farming is a practical proposition for sustainable agriculture if adequate attention is paid to this issue. There is urgent need to involve more and more scientists to identify the thrust areas of research for the development of eco-friendly production technology.

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A review on growing demand, benefits and future prospects of organic farming

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Agriculture in India is one of the most important sectors of economy. It provides livelihood to almost two thirds of the work force in the country and accounts for 18% of India's GDP. About 43% of India's geographical area is used for agricultural activity. Agriculture is the single largest employment provider and plays a vital role in the overall socio-economic development of India. A large number of production systems are in practice in different parts of the country. Large scale use of inputs both organic and inorganic has been a common sight in many of the farming is being forcefully projected as a method for sustaining the agricultural production in the country. Organic farming has given an alternate option to the agricultural system which has made a rapid change in farming techniques. It is a revolutionary step towards creating a healthy diet practice in the fast growing society. Organic farming is a combination of scientific knowledge of ecology along with modern technology with traditional farming practices. It can give rise to certain restaurants basing on a theme of therapeutic diets where the food will be prepared exclusively using organic fruits and vegetables. Organic farming aims at using natural fertilizers which are eco-friendly which do not pose any threat to human health. Use of organic fertilizers results in less use of synthetic fertilizers which are produced in industries which are a main source of air pollution. Organic farming is the form of agriculture that relies on crop rotation, green manure and compost. Increase in demand of processed foods containing chemical preservatives has been posing a serious threat to human race by affecting their health conditions. By adoption of organic farming techniques worldwide, this health hazard condition of human beings can be minimized to a greater extent. Organic farming has also proved to be beneficial for the farmers as well because the organic fertilizers are quite economical as compared to synthetic fertilizers and pesticides. Adoption of organic farming is gradually giving rise to a healthier lifestyle among people.

OFSA-2017/SS-05

Organic floriculture: An emerging trend

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Organic farming indicates a food production system where traditional wisdom and ancient knowledge of Indian farming such as crop rotations, mixed cropping, mixed farming, organic manuring, residue recycling, agro-forestry systems are amalgamated with modern practices of crop cultivation and livestock management to enhance profitability without dependence on off-farm resources. The potential organic sources of plant nutrients are green manure crops, crop residues, organic manures, FYM, night soil, sludges, oilcakes, blood meal, compost, phospho-compost, vermicompost, biogas slurry, agricultural wastes, press mud, biodynamic preparations, biofertilizers, etc. Flower growing, once used to be a gardener's activity has now transformed into a surprising business proportion. Globally, more than 140 countries are involved in cultivation of floriculture crops. But now a days, the extensive use of pesticides especially in greenhouse grown crops is threatening the health and safety of workers, besides disturbing environment and may also affect consumer health. In the book 'The game of the Rose', it was mentioned that floriculture consumes more pesticides than any other agricultural sector. Hence, there is a need for use of organics in floriculture. Organic floriculture, thus can be defined as growing of ornamental plants and gardening without the use of fertilizers, pesticides, herbicides, growth regulators and any other chemically treated products. In floriculture, organics are used as substrate media, as a component in plant production, in preparation of nursery for flower seeds, as a component for pot mixture for foliage plants, as important media for greenhouse crops to improve the soil physical properties, as a soil drench of bulb soaking or foliar spray, in propagation of ornamental crops, in the hardening of tissue cultured plants, and in plant protection. Organic floriculture has got a number of benefits such as the flowers grown organically meet stringent standards. It reduces the health risks as it prevents any more chemicals from getting into the air, earth, and water and also helps in building healthy soils. Organic floriculturists work in harmony with the nature, thereby, respecting the balance demanded by the ecosystem. Organically produced flowers and bouquets fetch 2-3 times more price, thereby increasing the profit of the grower.

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Sustainable agriculture practices through organic farming

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Intensive agriculture practices including high agricultural inputs such as chemical fertilizers and pesticides which are the major drivers of higher yield are unlikely to be sustainable for very long unless they are correctly judged in terms of both their quality and quantity. In the name of development, the indiscriminate use of environmental resources leads to deterioration of these resources. As a consequence, problems viz. acid rain, soil degradation, depletion of ozone layer, water pollution etc. are aggravating. A great challenge in the coming years is to provide safe and adequate food for the population not only for today but also for the future in the background of limited resources. Sustainable agriculture advocates the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of environment and conserving natural resources. Organic Farming seems to be

more appropriate as it considers the important aspects like sustainable natural resources and environment. The agricultural practices favour the maximum use of organic materials like crop residues, FYM, compost, green manure, oil cakes, bio-fertilizers, bio-gas slurry etc. to improve soil health through effective crop and soil management, on farm waste recycling, nonchemical weed management which facilitates promotion of soil fertility, conservation of biodiversity, production methods that are adapted to the locality and avoidance of chemical inputs thus leading to sustainable agricultural development.

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Biochar – A potential organic manure for climate smart agriculture

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Climate during crop season accounts for about 65 per cent variation in crop productivity. Climate change largely pertains to increase in atmospheric concentration of carbon dioxide (CO_2) leading to global warming. A resilient agricultural production system is the pre-requisite to sustain agricultural productivity in the event of extreme climatic variability. Need of the hour is, therefore, to synergize modern agricultural research with indigenous wisdom of the farmers to enhance the resilience of Indian agriculture to climate change. Present day atmospheric CO_2 concentration hovers around 397 ppm which is a significant increase over the pre-industrial level of 280 ppm. It is anticipated that the concentration of CO_2 will double by the end of this century. Consequence of increased green house gas (GHG) emissions is the entrapment of heat within the earth's atmosphere leading to an alarming rate of global warming. Methane (CH_4) emissions have increased by more than 150 per cent since 1750, with agriculture being the major source.

Biochar is a product of combustion using biomass or organic matter through a pyrolysis process without or with limited oxygen availability at relatively low temperature. It can be used for a range of applications: as an agent for soil improvement, improved resource use efficiency, remediation and/or protection against particular environmental pollution and as an avenue for greenhouse gas (GHG) mitigation. Advantage of biochar is that it is carbon negative. Essentially, application of biochar is a method of reducing atmospheric carbon dioxide by taking atmospheric carbon that is used to build plants and other organic materials and sequestering it in the ground. One of the most critical characteristics of biochar as a climate change mitigation technology is its long-term persistence in soil.

Biochar application improves soil physical properties by increasing bulk density and saturated hydraulic conductivity, including the total pore size and volume as well as water content. It has been shown that increase in macro-porosity and saturated hydraulic conductivity with biochar application increases oxygen diffusion rate (ODR) into the soil and reduces CH_4 emission by around 45 per cent and 55 per cent for an biochar application rate of 2 and 4 per cent, respectively, compared to the control. Enormous amount of organic residues burnt each year without any use can be effectively used to mitigate climate change. As Asia is the major rice growing continent, it is a larger source of CH4 emission. It appears that smart agriculture with cheap biochar application will reduce atmospheric CH_4 emission from lowland rice soils for sustained crop production.

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Organic plant nutrition and self-reliant farming system for small holder farm

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A Self-reliant farming system (SRFS) is envisaged as a system where the use of external sources for meeting the requirement of plant nutrients, water, animal feed and energy is minimized (Rautaray et al., 2016). For achieving the objective of sustainable agriculture, there is a need to develop SRFS which will conserve soil, water, and nutrients; and minimize the use of chemical fertilizers, fossil fuels, and synthetic pesticides. Farming has to rely on crop rotation, animal manures, legumes, green manures, farm generated composts, reduced tillage, mineral-bearing rocks, and biological pest control to meet plant nutrient requirement, maintain health, and manage pests. This system is important in the context of increased unavailability of land, water, nutrients and energy. Natural ecosystems are extremely resilient and use only renewable sources of input resulting in high productivity and environmental quality. In spite of numerous benefits from SRFS in terms of eco-services and sustainability, the difficulty may arise in adoption by big and medium farmers (4 to 10 ha size farm) as the system is labour intensive.

A self-reliant farming system with organic plant nutrition was developed in 1.5 ha area (representing a small holder farm) at ICAR-Indian Institute of Water Management, Deras, Bhubaneswar in the year 2015. Medium duration rice variety (Vijeta) was grown during Kharif season. Nutritional requirement of rice was met from sesbania green manuring (60 kg N ha^{-1}) and the remaining 20 kg N from 3 ton of vermicompost. After harvest of wet season rice, blackgram, cowpea, groundnut, maize, and cabbage were grown in sub-plots using vermicompost applied at 3175, 3968, 4127, 5460 and 9127 kg ha^{-1}, respectively.

The first year result showed that Grain and straw yields of rice under the organic nutrition (SRFS) were 3880 and 5520 kg/ha, respectively, which were 8 and 2 % lower compared to the conventional practice (inorganic nutrition). Total energy input and output under the organic nutrition were 6.2 GJ ha^{-1} 126 GJ ha^{-1}, respectively, whereas the values were 10.2 GJ $ha^{-1}$and 133 GJ ha^{-1} for the conventional practice of inorganic nutrition. However, energy efficiency in terms of energy output:input ratio (20.5) and the specific energy (0.63 for grain and 1.53 for biomass yield) was higher for the organic nutrition. The gross and net returns of rice were higher by 7 and 19 %, respectively under conventional practice as compared to organic nutrition. Results on performance of selected dry season crops revealed that there was decrease in equivalent yield of test crops under organic nutrition as compared to inorganic nutrition. Such yield decrease was highest for maize (25.2%) followed by cabbage (24.2%). Lowest equivalent yield decrease of 14.4% was noted in case of groundnut crop followed by black gram (18.1%) indicating suitability of these two crops for self-reliant farming system with organic mode of nutrition (using farm generated vermi-compost). Also, groundnut is an energy rich crop and haulm of groundnut and blackgram are protein rich fodder for livestock (integral part of self-reliant farming system). Net Return as well as net water productivity were highest for cabbage followed by cowpea. Among the crops grown for seed purpose, highest net return was noted for groundnut crop (Rs29228 under inorganic nutrition and Rs18032 under organic nutrition). Similar net return was noted for black gram crop. Net water productivity of groundnut and black gram were similar under organic nutrition. Net energy was highest for maize followed by groundnut. Considering the net energy, net water productivity, net return, rice equivalent yield and % yield decrease under organic nutrition together, ground is identified to be a suitable crop under self-reliant farming system.

It was feasible to develop a nutrient reliant farming system using in-situ bio-resources and farm wastes. Rice-Groundnut was identified as suitable cropping system under organic nutrition for the first year of conversion. Less yield and net returns under organic nutrition in the first year may be reduced over years due to possible accumulation of residual nutrients and increased soil water holding capacity.

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Effect of organic inputs in ginger cultivation in eastern ghat high land zone of Odisha

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Field experiments were carried out during *Kharif,* 2006 to 2011 in the Eastern Ghat High Land Zone at the research farm of High Altitude Research Station (Orissa University of Agriculture and Technology), Pottangi, Koraput, Odisha to find out the performance of organic ginger cultivation. The treatments consisted of T_1- Fully Organic inputs (Soil application of 1 t/ha neem cake, 5 t/ha FYM, 10 Kg *Azotobacter*/ha, 10 kg PSB /ha, 10kg *Trichoderma*/ha, 10kg Pseudomonas / ha in 3splits such as basal, 45DAS and 90DAS), rhizome treatment with *Trichoderma viridae* and *Pseudomonas fluorescence* before sowing,T_2 – Semi organic (62.5:50:50 kg NPK/ha + 0.5 t/ha neem cake + 2.5 t/ha FYM + 10 kg/ha Azotobacter + 10 kg/ha PSB with inorganic plant protection measures (Carbendazim @ 1g/lit. + Mancozeb @ 3g/lit. + Streptocycline @ 1g/lit.+ Trizophos @ 2 ml/lit. for seed treatment and spraying at 45 DAS and 90 DAS),T_3 – Recommended inorganic inputs (125:100:100 kg NPK/ha in 3 split doses like basal, 45 DAS and 90DAS)+ with inorganic plant protection measures (Carbendazim @ 1g/lit. + Mancozeb @ 3g/lit. + Streptocycline @ 1g/lit.+ Trizophos @ 2 ml/lit. for seed treatment and spraying at 45 DAS and 90 DAS and T_4- Control. Pooled data analysis revealed that there was significant difference among the four treatments for fresh rhizome yield of ginger. Application of semi inorganic inputs and following chemical plant protection measures produced the highest fresh rhizome yield (18.2t/ha) with yield advantages of 88.4% over control (9.7 t/ha) followed by T_3 (15.8 t/ha) and T_1 (14.3t/ha). Though the yield of organic management in ginger was lower than semi organic and inorganic management, however it had lower disease incidence (Rotting-11%, Wilting-9.25% and leaf spot-10.4%) and with increased quality parameters (Dry recovery-21.6%, essential oil-1.4%, oleoresin-8.9%) increased quality parameters (Dry recovery-21.6%, essential oil-1.4%, oleoresin-8.9%)

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Effect of organic inputs on growth and yield of cashew (*Anacardium occidentale* L.)

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The ongoing experiment on evaluation of organic inputs on growth and yield of cashew is being carried out at All India Co-ordinated Research Project on cashew, Orissa University of Agriculture and Technology, Bhubaneswar in a replicated field trial in Randomised Block Design. The treatment combinations were T_1-100% N as Farm Yard Manure

(FYM), T_2-100% N as FYM +Bio-fertilizer Consortium(BFC) 200g, T_3-50% N as FYM + BFC (200g), T_4-100% N Vermi compost + BFC (200g), T_5-Recycling of organic residue with the addition of 20% cow dung slurry (20% weight of organic residue as cow dung), T_6-*In situ* green manuring/green leaf manuring to meet 100% N, T_7-25% N as FYM + Recycling of organic residue + *In situ* green manuring/green leaf manuring +BFC(200g), T_8 -Recommended doses of fertilizer + 10kg FYM (Control).

The results of vegetative growth parameters indicated significant variations among the treatments. Among the different treatments of organic bases both T_2 and T_5 were found superior with respect to stem girth of 74.29 cm, while number of panicles m^{-2}(21.88) was the maximum in treatment T_2. Eventhough, the T_8 (control) i.e. application of recommended dose of fertilizer + 10kg FYM recorded significantly the maximum tree height (5.36), canopy diameter (8.72m), canopy surface area (57.11m^2) as well as ground coverage by canopy (114.41%) than the rest of the treatments under study, but on the other hand, this was found at par with T_7 and T_2 for most of the yield attributing parameters. Apple weight (61.5g), nut weight (8.3g), as well as mean annual nut yield (1288 kg ha^{-1}) were the maximum for treatment T_8(Control). The results on cumulative nut yield (kg $tree^{-1}$) ranged from 10.18 (T_6) to 21.87 (T_8) for the 7th harvest. The cumulative cost of cultivation over 7th harvest ranged from Rs 38,997.00(T_8) to Rs75,077.00 (T_4) while cumulative net returns varied from Rs30,570.85(T_4) to Rs 64,062.20(T_8). Similarly, the maximum benefit cost ratio of 2.64 was recorded in the treatment T_8 followed by 2.05 in T_7. On an average incidence of insect pest viz. foliage thrips, flowering thrips, shoot tip caterpillar and leaf minor was low in different organic sources as compared to T_8 i.e. inorganic fertilizer and FYM combination.

Thus application different organic combinations (T_1 to T_7) had contributed significantly to yield attributing parameters of cashew plants. Among the different organic treatments, 25% N as FYM + recycling of organic residue + *in situ* green manuring/green leaf manuring +Bio-Fertilizer Consortium(200g) was found to be the most superior and at par with the control i.e., application of recommended dose of fertilizer and FYM, the later being the most beneficial.

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Carrier based formulation and effect of plant growth promoting rhizobacterial isolates on growth & productivity of different crops

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Plant growth promoting rhizobacteria (PGPR) have gained worldwide importance and have been identified in influencing the growth and yield of different crops. On account of that, an attempt was made in the present investigation to study plant growth promoting activities of bacteria isolated from rhizospheric region of Oryza sativa (Rice) from Bakkhali, Sundarban, West Bengal, India. A total of 20 bacteria were isolated of which four isolates namely PGPR-BS-1, PGPR-BS-8, PGPR-BS-12 & PGPR-BS-18 showed phosphate solubilization and IAA production which were quantified. PGPR-BS-8 showed highest phosphate solubilization and IAA production**.** The potential bacterial isolates PGPR-BS-8 & PGPR-BS-12 showing PGPR activities were tried with three different crop plants such as Mung bean, Rice and Groundnut on germination paper and pot culture method. Of which PGPR-BS-8 showed increase in germination, root length, shoot length in germination paper and increased plant height & biomass. The physico-chemical properties of soil under cultivation of Mung Bean, Groundnut & Rice were changed significantly after treatment over that of control. There was significant increase in plant growth of Mung Bean, Groundnut & Rice with the inoculation of PGPR-BS-8. With charcoal based formulation of PGPR-BS-8 (Bacillus sp.), higher plant growth promoting activity was

reported as comparison with other carrier. It also showed antagonistic effect against different phytopathogens including Rhizoctonia solani (ITCC-186) and Fusarium oxysporum (ITCC-578). The isolate was subjected to molecular identification by 16S rRNA gene sequencing and was assigned with the accession no. KT253635 by NCBI, USA GenBank.

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Carbon sequestration: Enhancing productivity

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"Climate change and Global warming" has become a hot and globally discussed topic due to continuous rise in levels of greenhouse gases .The major sources are carbon and nitrogen based gases in the atmosphere. Among all, the continuous rise in CO_2 concentration in the atmosphere is attributed to human activities such as burning of fossil fuels, deforestation, leading to change in precipitation pattern and global temperature rise. The rise in temperature in 21st century is predicted to be around 1.4 and 5.8^{0}C by Intergovernmental Panel on Climate Change(IPCC), consequently causing damage to natural resources such as reduction in fertilizer efficiency, water holding capacity of soil, water pollution including both surface and ground water and the release of greenhouse gases in to the atmosphere both from the terrestrial and aquatic ecosystem.

The risk of carbon can be minimized to give a quality and sustainable environment when sequestered. This will also enhance soil productivity .The major reservoir of terrestrial carbon pool is soil. It can conserve up to 1550 pg in case of organic and 750-950 pg in case of inorganic component up to 1m depth. The global soil carbon pool is upto 2500 Gt. The total soil carbon pool is four times the biotic pool and three times of the atmospheric pool. The rate of SOC sequestration varies from 0.4 to 1.4 mg C per hectare per year depending on types of soil, cropping system, climate and site specific nutrient management. The mean residence time(MRT) and stability depend on strength of soil aggregates which can be enhanced by using organic amendments. Artificial consideration viz. use of peat bug, subsurface saline aquifier and other carbon sinks are also reported.

OFSA-2017/SH-07

Sustainability of Ginger (*Zingiber officinale* Rosc.) production as influenced by paper mill sludge, organic and inorganic nutrient management under EGHL zone of Odisha

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Ginger (*Zingiber officinale* Rosc.) is a leading high-value crop, extensively cultivated in the tribal dominated hilly areas of Odisha. The consumption pattern of ginger is increasing frequently due to its high curative and nutritional value. To meet the ginger requirement of the ever increasing population, it is essential to increase the average productivity from the restricted cultivable land. Higher productivity is only possible through quality planting material and balanced nutrient management.

Red soils predominate the districts like Koraput, Rayagada and Nawrangpur under EGHL zone of Odisha. These soils are moderately to strongly acidic with low to medium organic matter, deficient in macro and micronutrients and poor in water retention capacity which aggravate the biotic and abiotic stresses in the crop. Being, a commercially cultivated crop, ginger production is drastically affected in such type of soil. To develop the defence mechanism against the above-said situation, an experiment was conducted with seven treatments and replicated thrice at Regional Research and Technology Transfer Station (OUAT) during *Kharif*-2012-13 to assess the efficacy of paper mill sludge (PMS) with organic and inorganic fertilizers on ginger cv 'Suprava'.

Results from the above said experiment revealed that application of 100% recommended dose of fertilizer with paper mill sludge prove4d the best with the maximum values of vegetative growth parameters along with the optimum rhizome yield in ginger. In terms of vegetative growth, the treatment recorded the maximum plant height of 62.20 cm, the maximum no of tillers clump^{-1} of 13.27 and the maximum of 15.80 no of leaves tiller^{-1} with leaf length of 24.00 cm and leaf breadth of 3.50 cm, respectively. The same treatment recorded the maximum fresh rhizome yield of 20.157 t ha^{-1} .

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Effect of *Azotobacter vinelandii* strain SRIAz3 and N-source on growth and productivity of rice

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Rice (*Oryza sativa* L., Family *Poaceae*) is the most widely consumed staple cereal bgy a large part of the world's human population, especially in Asia. Rice production depends heavily on application of inorganic N fertilizers, as the majority of rice soils are N deficient. Imbalance in use of chemical fertilizers degrades soil environment, reduces fertilizer use efficiency of the crops, and inherently pollutes terrestrial ecologies by leaching and atmosphere through release of nitrogen oxides(mostly N_2O) from anaerobic or flooded rice. There are potent soil rhizospheric heterotrophic bacteria, which are beneficial in many different ways to the plant. One of the genus, *Azotobacter* represents the main group of heterotrophic free living bacteria principally inhabiting in neutral or alkaline soils, active particularly in the root region can be exploited for optimum crop productivity.

The present investigation was made to assess the efficiency as well as effect of bioinoculation of free living N_2 fixing bacterial strain (*Azotobacter vinelandii* strain SRIAz3) with N sources on rice growth and productivity as well as soil health. *A.vinelandii* strain SRIAz3 (gene bank accession number JQ796077) was isolated from SRI Field(Central Farm, OUAT, Bhubaneswar) with optimum nitrogenase activity [121.09 N_2-ase activity (nmole C_2H_4mg^{-1}bacteria^{-1}h^{-1})]. It is aerobic, free-living, motile, spherical gram negative (-ve) soil bacteria. Besides N_2 fixation, it produces plant growth hormones and vitamins viz; thiamine, riboflavin, IAA and GA.

A field study with rice(*Oryza sativa* L. cv. Pyari) was conducted in Agronomy Research Plot, OUAT, Bhubaneswar with eight(8) treatments and three(3)replications, mentioned as follows; T_1- Control, T_2- N_1 (50% N), T_3- N_2 (75% N), T_4- N_3 (100% N), T_5- *A. vinelandii* strain SRIAz3, T_6- *A. vinelandii* strain SRIAz3 + N_1, T_7- *A. vinelandii* strain SRIAz3 + N_2 and T_8- *A. vinelandii* strain SRIAz3 + N_3.

Results indicated that *Azotobacter* inoculated plots significantly influenced total heterotrophic batcteria, *Azotobacter* population, soil microbial biomass carbon, dehydrogenase, urease and phosphatase activity over uninoculated plots. Higher *Azotobacter* population resulted in increased soil enzymatic (dehydrogenase, urease and phosphatase) activities and microbial biomass carbon. Soil enzymatic activity has often been used as an index of microbial activity.Soil inoculated with *A. vinelandii* strain SRIAz3 and receiving 75% N recorded significantly higher available N and soil organic carbon while the effect of inoculation alone or in combination with N doses was inconspicuous on soil available P and K. *Azotobacter* inoculated plots yielded more but irrespective of bioinoculation, increasing N doses enhanced the grain yield. Bioinoculation with *A. vinelandii* strain SRIAz3 significantly influenced nutrient (N, P and K) uptake in grain and straw. To conclude, use of*Azotobacter vinelandii* strain SRIAz3 isolated from SRI Field (Central Farm, OUAT, Bhubaneswar) as biofertilizer significantly influenced soil microbial biomass and enzymatic activity, which consequently enhanced the rice yield and nutrient (N, P and K) uptake.

OFSA-2017/SH-09

Management of waterlogged soils for sustainable production

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Waterlogged soils are soils that are saturated with water for a sufficiently long time annually to give the soil the distinctive gley horizons resulting from oxidation-reduction processes. Due to submergence, the level of carbon dioxide and other toxic chemicals are increased in soil and affects plant growth by changing the physical, electro-chemical, chemical and biological properties of soils. Total area under water logging in India is 9.9 lakh ha, out of which odisha accounts for 2.42 lakh ha followed by West Bengal (2.40 lakh ha) and Bihar (1.9 lakh ha). Yaduvanshi *et al.* (2012) reported that wheat grain yield decreased significantly due to waterlogging. The yield of mustard, wheat, barley and berseem decreased with increase in days of water stagnation period (Gupta *et al.,* 2009). Waterlogging can be managed by levelling of land, drainage, controlled irrigation, reducing the seepage in the canals and irrigation channels, flood control measures, plantation of tree having high transpiration rate and selection of crops and their proper varieties. GRDC (2005) reported that the yield increased significantly in raised bed system due to improvement in soil structure as compared to flat bed. Wheat yield in the inter strip plantation of *Eucalyptus tereticornis* was 3.4 times more than the adjacent waterlogged areas without plantation (Ram *et al.,* 2010). Rice is the only major food crop that can be grown under various degree of submergence. Rice grown in waterlogged soils, escape from Fe toxicity by Fe precipitation caused by oxygen diffusion from roots due to extensive aerenchyma, whereas other crops fail to sustain (Yaduvanshi *et al.,* 2012). Omar *et al.* (2010) reported that urea incubated with zeolite and sago waste water decreased the ammonium loss by 40-60 % as compared to urea without additive in submergence. The ecological requirement of rice fields facilitate the inclusion of fish component which can generate additional net returns along with higher crop and water productivity. Datta *et al.,* (2009) reported that the grain yield was significantly increased in rice fish farming than sole rice system.

OFSA-2017/SH-10

Effect of integrated nutrient management practice on yield and yield attributes of brinjal

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A field study was conducted in Rabi season of year 2014-15 and 2015-16 at experimental plot of RRTTS, Dhenkanal to assess the effect of integrated nutrient management practice on yield and yield attributes of brinjal. The field was laid out in Randomized Block Design (RBD) with three replications and eight treatments. The treatments containing bio-fertilizers along with recommended dose of fertilizers (chemical) viz., T_1-Soil Test Based Fertilizer Application (STBFA) (N+P+K), T_2-STBFA (N+P-K), T_3-STBFA(N+K-P), T_4-STBFA (P+K-N), T_5-STBFA(2/3 N +P+K)+ *Azotobacter* @5 Kg ha^{-1}, T_6-STBFA(2/3 N + P+ K)+ *Azospirillum*@ 5 Kg ha^{-1}, T_7-(STBFA 2/3 N + P+ K +) *Azotobacter*@ 4Kg ha^{-1} + *Azospirillum*@ 4 Kg ha^{-1}, T_8-FYM @ 15 t ha^{-1}.The results revealed that application of 2/3rd of N + P + K*Azotobacter* @ 4 Kg ha^{-1}+ *Azospirillum*@ 4 Kg ha^{-1}(T_7) recorded the highest yield (36.1 t ha^{-1}) which is about 37% higher yield than FYM alone (T_8) followed by the treatment T_5 (34.4 t/ha)which is about 30.3% higher yield than T_8,whereas increase is lower (7.2%) in the treatment where only soil test based P and K (T_4) was applied. Treatment T_7also shows highest No of fruits /cluster (8.9), average fruit weight (gm) (44.8), No of clusters /plant (12.1), plant height (cm) (72.8) followed bySTBFA(2/3 N +P+K)+ *Azotobacter* @ 5 Kg ha^{-1} (T_5), T_6, T_1, T_2, T_3, T_4respectively and least effect found in T_8 where only 15 t ha^{-1} FYM was applied. This study demonstrated that integrated application of organic and inorganic nutrient results higher yield in comparison to sole application of organic and inorganic fertilizers.

OFSA-2017/SH-11

Effect of organic manure and chemical fertilizer on rice-wheat cropping system– A review

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The importance of organic manures and fertilizers in the maintenance and improvement of soil productivity particularly under intensive cultivation is well-known. Organic manures are the valuable byproducts of farming and allied industries derived from plant and animal resources. These organic manures being slow in release of nutrients, assume greater significance in a cropping sequence than individual crops and their usefulness needs to be investigated on long term basis. In this context, available literature in respect of nutrient content, effect of composting, effect of application of organic manure on soil properties, yield and quality of crops and residual effects are reviewed in this paper. The continuous depletion of nutrients due to intensive cropping system is posing a serious threat to sustainable agriculture. At the same time, the farmers can not afford to supply all the essential nutrients through chemical fertilizers. Organic sources of the nutrients although in small quantities, can solve the problem to some extent and help to conserve soil health. It is widely recognized that neither organic manures nor chemical fertilizers used separately can achieve the yield sustainability at a higher order under the modern intensive farming, in which the nutrient turnover in the soil-plant

system has been quite high. Integrated plant nutrient supply system involving conjunctive use of chemical fertilizers and organics assume great significance particularly in rice-wheat cropping system mainly due to two reasons. First, the system requires the application of higher amounts of nutrients than used at present and the present level of fertilizer availability and economic conditions of large number of Indian farmers do not allow this. Secondly, it leads to soil health deterioration because of high nutrient requirement. Several studies have also indicated that in intensive cropping systems, the sustainability could be achieved only through integration of inorganic and organic sources of nutrients.

OFSA-2017/SH-12

Effect of organic manure and chemical fertilizers on growth and yield of radish - coriander sequential cropping

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The advent of high yielding varieties / hybrids has no doubt meet the demand of increasing population but their continuous use has led to a depletion of soil fertility. Due to continuous exhaustion of plant nutrients from the soil, farming system has become unstable. Neither the chemical fertilizer nor organic manure alone can help to achieve sustainable crop production. Even with balanced use of only chemical fertilizer, high yield level could not be maintained over the years because of deterioration in soil physical and biological environments. In the present investigation an attempt has been made to study the effect of organic manures and chemical fertilisers on growth and yield of radish - coriander grown in sequence. The experiment was conducted in RBD with three replications during *rabi* season of 2016 under AICRP on Vegetable Crops at Horticultural Research Station, OUAT, Bhubaneswar. This experiment includes seven treatments viz. T1- Conventional practices (Recommended FYM + fertilizer + plant protection chemicals); T2- Vermicompost @ 12.5 t/ha (pp with organic methods); T3- FYM @ 20 t/ha (pp with organic methods); T4- Conventional practices (Recommended FYM + fertilizer + pp chemicals)+ IIHR microbial consortium @ 12.5 kg/ha; T5- Vermicompost @ 12.5 t/ha + IIHR microbial consortium @ 12.5 kg/ha (pp with organic methods); T6- FYM @ 20 t/ha + IIHR microbial consortium @ 12.5 kg/ha (pp with organic methods); T7- Safe production practices (Recommended FYM + fertilizer + pp with organic methods)+ IIHR microbial consortium @ 12.5 kg/ha. All the treatments were applied to grow radish (var.- Pusa Chetaki Selection). After harvesting of radish, coriander (var.- Mahak) was grown under residual soil fertility condition on the same plots.

There was significant difference among the treatments in respect of different characters in both radish and coriander. In case of radish root length was found to vary from 12.99 cm (T2) to 15.79 cm (T6) whereas shoot length varied from 16.20 (T5) cm to 28.23 cm (T1). Maximum root circumference was observed inT7 (10.23 cm) which was significantly higher than all other treatments. The highest number of leaves per plant was reported in T7 (10/plant). The highest root and shoot yield was produced by T7 (29.6 t/ha, 31.3 t/ha) and it was found to be at par with T4 (29.1 tq/ha, 31.0 t/ha). This result indicated that T7 and T4 have better effect on growth and yield as compared to T1 which is due to the positive effect of IIHR microbial consortium. In coriander the maximum plant height was recorded in T1 (17.1 cm) followed by T2 (16.7 cm) and the minimum being recorded in T5 (15.0 cm); T1 recorded the maximum branches/plant (6.8) and T3 had the lowest branches/plant (5.4); plant weight was found to vary from 2.79 g (T3) to 3.33 g (T7); final marketable yield was found to be the highest in T2 ((5.7 t/ha) and it was at par with T3 (5.4 t/ha), T6 (5.6 t/ha) and T5 (4.8 t/ha). From these experimental results it is revealed that organic manures alone could not replace the chemical fertilizers. It could complement chemical fertilisers to restore/ maintain soil fertility and productivity on sustainable basis.

OFSA-2017/SH-13

Effect of organic nutrient management on yield and quality of basmati rice

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A field experiment was conducted on effect of organic nutrient management on yield and quality of basmati rice during *kharif* 2011 at Central Research Station, Odisha University of Agriculture And Technology, Bhubaneswar in RBD with ten treatment combinations and three replications. The treatments consists of T_1- 100% N (75% FYM + 25% vermicompost), T_2-75% N (75% FYM + 25% vermicompost), T_3- 50% N (75% FYM + 25% vermicompost), T_4- T_2+ *Azospirillum*, T_5-T_2+ *Azospirillum* + PSM, T_6- T_2+ *Azospirillum* + PSM + EM spray, T_7- T_3+ *Azospirillum*, T_8- T_3+ *Azospirillum*+ PSM, T_9- T_3+ *Azospirillum*+ PSM + EM spray and T_{10}- control. The basmati rice variety "Geetanjali" was grown as the test crop. Among the treatments, T_6 recorded maximum grain yield of 3850 kg/ha which was at par with T_1(3753 kg/ha) and T_5(3742 kg/ha).The per cent grain yield reduction due to application of 75% and 50% N over 100% N were 5.3 and 10.7, respectively. Similarly, T_6 produced maximum straw yield (4876 kg/ha) which was significantly higher than any other treatments except T_4.The minimum straw yield of 3285 kg/ha was obtained with T_{10} (control).Treatments of T_7, T_5, T_1 recorded the maximum grain-straw ratio(0.83) which was at par with all other treatments except T_4.

With respect to quality parameters of grain, highest hulling per cent , milling per cent and head rice recovery was recorded with the treatment T_1 (74.3 %, 68.10%, and 57.6%, respectively) compared to other treatments. The increase in hulling per cent due to T_1, T_6, and T_5 were 4.5, 3.5 and 2.9 %, respectively over control. Similarly, the increase in milling % and head rice recovery due to T_1 over T_{10} were 4.6 % and 3.4 %, respectively. The crop with T_1 recorded the highest amylose content (23.57%) and protein content (7.56%) which were closely followed by T_5 and T_6. The lowest amylose content (22.76%) and protein content (5.56%) were observed in T_{10} (control).

OFSA-2017/SH-14

Effect of organic nutrient management practices on yield and economics of basmati rice

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A field experiment was conducted to study the "Effect of organic source of nutrients on productivity, profitability and quality of basmati rice" during Kharif 2012-13 to study the effect of organic source of nutrients on productivity, profitability and quality of basmati rice at Agronomy Research Farm, Central Research Station, Orissa University of Agriculture and Technology, Bhubaneswar. The soil was sandy loam and slightly acidic with pH 5.7, medium in organic carbon, low in available N, high in available P2O5 and medium in K2O content. The field experiment was laid out in a randomised block design with twelve treatments as T1 :100% N (75% FYM + 25% vermicompost), T2:75% N (75% FYM + 25% vermicompost), T3:50% N (75% FYM + 25% vermicompost), T4 :T2 + Azospirillum (10 kg/ha), T5 :T2 + Azospirillum + PSM (10 kg/ha), T6:T2 + Azospirillum + PSM + EM Spray (two times), T7: T2+ Azospirillum + PSM + EM Spray (two times) + Neem Cake (250kg/ha), T8 :T3 + Azospirillum, T9:T3 + Azospirillum + PSM, T10:T3 + Azospirillum + PSM + EM spray (two times),T11:T3 + Azospirillum + PSM + EM spray (two times) + Neem Cake (250 kg/ha), T12:Control. The Basmati rice variety utilized in the experiment was Geetanjali. Application of Azospirillum (10 kg/ha)+ PSM (10 kg/ha) + EM Spray (twice) + Neem Cake along with 75% N (75% FYM + 25% vermicompost) resulted in the highest grain yield (3570 kg/ha) and maximum net return (Rs.39,654/ha) closely followed by Azospirillum (10 kg/ha)+ PSM (10 kg/ha) + EM Spray (twice) with 75% N (75% FYM + 25% vermicompost). Twenty five per cent organic nitrogen source could be saved by addition of Azospirillum + PSM + EM spray or Azospirillum + PSM + EM spray + Neem cake without any yield reduction in basmati rice. Thus both soil fertility and grain quality could be increased by these treatments.

OFSA-2017/SH-15

Effects of fertilizer source on growth and cumulative yield of Amaranthus

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The efficacy of organic fertilizers can be enhanced when combined with inorganic fertilizers. An experiment was conducted in KVK, Jagatsinghpur with organic and inorganic fertilizer alone and in combination, to assess growth and yield of amaranthus (*Amaranthus caudatus* L) and determine the optimum ratio of combined sources. Ratios of 25:75; 50:50, and 75:25 of organic : inorganic fertilizers were compared to organic (5 Mt·ha^{-1}) and inorganic (400 kg·ha^{-1} 20N–10P–10K) fertilizers alone. Plant height, stem diameter, number of leaves/plant, leaf area, and fresh yield were measured. Inorganic fertilizer produced taller plants, plants with more leaves, thicker stems, and higher leaf areas. The 50:50 nutrient source produced plants with similar stem diameter and leaf area. Fresh yield was highest (246.8 q·ha^{-1}) at 4 weeks after planting. Combined sources had similar yields as inorganic or organic fertilizers. Amaranthus can be cultivated with organic sources to eliminate dependence on use of inorganic fertilizers.

OFSA-2017/SH-16

Enhancing soil health by carbon sequestration under organic farming

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Carbon sequestration is the provision of long-term storage of carbon in the terrestrial biosphere, underground, or in the ocean so that the buildup of carbon dioxide (the principal greenhouse gas) concentration in the atmosphere will reduce or slow down. It is also known as carbon capture and storage. It aims to prevent the release of large quantities of carbon dioxide into the atmosphere. It can be achieved through organic farming by increasing and maintaining soil organic matter, because in organic farming less external input viz; chemical fertilizers are added, rather more quantity of organic manures like farm yard manure, vermicompost, different cakes etc are added to soil. It has been seen that, the judicious application of bulky organic manures, balanced fertilization, reduced tillage and legumes help in restoring the organic carbon status of soil. Cultivation of fast growing trees with arable crops under agro-forestry systems such as agro-horticulture or agro-silviculture systems help in improving soil organic carbon content, which is the main purpose of discussion.

OFSA-2017/SH-17

Impact of sulphur on yield, quality, economics and nutrient uptake of garlic (*Allium sativum*.) in west central table line zone of Odisha

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A field experiment was conducted at All India Network Research Project on Onion and Garlic, college of horticulture, OUAT, Chiplima during rabi season in the year 2014-15 to harness the impact of Sulphur on yield, quality attribute viz. protein content, Total soluble solids (TSS), N, P, K and S content and storage quality as well as Benefit cost ratio of garlic in west central table line zone of Odisha. The experiment composed with 6 treatment combinations viz: T_1: without sulphur application (control), T_2: 15 kg Sulphur/ha, T_3: 30 kg S/ha, T_4: 45 kg S/ha, T_5: 60 kg S/ha, T_6: 75 kg S/ha with four replication in randomized block design. Increased quality attributes viz. TSS and protein content (30.03^0 Brix, 3.10 %) was obtained with optimum dose of sulphur application (T_6) followed by T_5 (29.78^0 Brix, 2.88 %). However, the treatment T_6 showed highest marketable yield (36.54 q/ha) and total bulb yield (41.75 q/ha) followed by marketable yield 22.25 q/ha and total bulb yield (32.56 q/ha) in T_5. Application of 75 kg sulphur /ha had maximum nutrient content and uptake of N, P, K, S by the crop followed by T_5. Again the same treatment had witnessed minimum storage loss in terms of Physiological loss in weight (PLW) (1.13 %), sprout loss (0.00 %) and rot loss (0.30 %) after 4 month of storage. Highest benefit cost ratio of 1 : 2.35 was observed with the application of sulphur @ 75 kg S/ha (T_6).

OFSA-2017/SH-18

Effect of organic nutrient management in *Kharif* rice

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Rice is the staple food for about 50 per cent of the world's population and in Asia 90 per cent of the world's rice is grown and consumed. To assure food security in the rice consuming countries of the world, rice production should be increased by 50 per cent in these countries by 2025. This additional rice will have to be produced on less land with less usage of water, labour and chemicals (Rath *et al.,* 2011). Conventional agriculture has resulted in declining factor productivity and hence, is no more sustainable. Furthermore, it has propped up many environmental problems including soil, air and water pollution and finally human health hazards (Singh *et al*., 2011). It is widely recognized that organic matter in soils plays an essential role in a range of soil physical, chemical and biological processes and that soil organic carbon (SOC) is one of the most important indicators of soil quality and health. Organic residues including green manure, farmyard manure (FYM) and vermicompost are traditionally applied to rice soils in order to maintain the SOM status including soil organic carbon storage and to increase the levels of plant nutrients and to improve the physical, chemical and biological soil properties that directly or indirectly affect soil fertility and productivity.

The experiment comprising of seven number of treatments viz., T_1- Dhanicha @ 25 kg seed/ha, T_2- Dhanicha + FYM @ 5t/ha (basal) , T_3- Dhanicha + Vermicompost 2t/ha (basal), T_4- T_1 + Vermicompost 2t/ha (split) , T_5- T_1 + FYM+ Vermicompost (split), T_6-T_1 + FYM+ Vermicompost (basal) and T_7-T_1 + FYM + Panchagavya in kharif season of 2015. Rice variety "Lalat" was grown as the test crop. Organic nutrient management expressed significant effect on all growth parameters of rice. Number of tiller per hill at 45 DAT were maximum (30.62) for treatment T_5 which was at par with those of T_3, T_4 and T_6. Number of effective tillers per hill also observed similar trend. Dry matter production per hill at maturity was significantly more for T_5 (73.11 g hill-1). Number of panicle m^{-2} was significantly maximum for T_5 (374.62) at harvest. Grain and straw yield were significantly higher for T_5 (5.39 and5.25 t ha^{-1}, respectively) which was at par with those of T_4, T_6 and T_7 for grain and straw yield.

OFSA-2017/SH-19

Industrial and agricultural applications of anaerobic digestion of biomass waste

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The global energy demand is increasing day by day. The current global energy supply is highly dependent on fossil sources (crude oil, lignite, hard coal, natural gas). But the source of fossil fuel is decreasing at a rapid rate and burning of fossil fuel also degrading the environment due to huge Green House Gas (GHS) emission. Hence, there is quick need for an alternate and a clean source of energy which can sustain the future development and also protect the environment. Biomass is a sustainable source of energy for producing steam, fuel and chemicals. Biomass can be digested anaerobically to produce biogas. Biogas is a clean, non-polluting and smoke free fuel. It can be used as an energy source for various applications namely, cooking, heating, space cooling/ refrigeration, electricity generation and gaseous fuel for vehicular application. The slurry from biogas plant can be used as manure to supplement different plant nutrients for organic farming.

OFSA-2017/SH-20

Physical and rheological properties of manure products-A review

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The concentration of animal production system has increased efficiency and improved overall economic return for animal producers. Land application at proper agronomic rates is the preferred use for manures. Fertility of the soil appears to be adversely affected due to the imbalanced use of nutrients viz., NP or N alone. Physical and rheological properties deemed to influence the performances of handling and land application equipment. After reviewing the paper, bulk density of all manure products i.e. dairy cattle, sheep, poultry, and pig manure (at different levels of total solids concentration (TS) ranging from 10% to 50% on a wet mass basis) was found to increase with TS and the values for poultry and pig manure were not significantly different at the tested TS levels. The average bulk density was 292 to 510 kg m^{-3} at different moisture content. The static friction coefficients of all manure types with the exception of pig manure on the different surface materials plywood, plastic, steel (bare and painted)] did not exhibit large differences and a single linear equation was suggested to predict the static friction coefficient as a function of TS. The angle of repose was 32, 37 and 42° at different moisture content of manure products. Animal manures were described as pseudoplastic fluids and the consistency coefficients were found to increase with TS for all manure types. The apparent viscosity of the tested manure products was well correlated to TS. The effect of temperature on the viscosity at different shear rates was

also reviewed. The manure has non-Newtonian flow properties, because the viscosity strongly depended on the applied shear rate. The manure behaves like real plastic materials. The power-law model of the shear stress and the rate of shear showed that the magnitude of the consistency coefficient decreased while increasing the temperature, with high values of the determination coefficient.

OFSA-2017/SH-21

Soil health management under organic farming system

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Organic farming is a method of crop and livestock production that involves much more than choosing not to use pesticides, fertilizers, antibiotics and growth hormones etc. Organic soil fertility management is guided by the philosophy of "feed the soil to feed the plant."This basic precept is implemented through a series of practices designed to increase soil organic matter content, biological activity and nutrient availability by adding organic materials such as cover crops, crop residues and composts to the cultivated soils over time. The ultimate goal is a healthy, fertile, biologically active soil with improved structure and enhanced nutrient availability. Demand for organic products, especially in developed countries, has been increasing. Globally, organic agriculture is practiced in 162 countries and 37 m ha of land are managed organically by 1.8 million farm households. Complex relationship exists between different components of the organic farm and the quality and quantity of the end products depend on the functioning of the whole system. As such it is very difficult to isolate soil fertility from production and environmental aspects of the system. Crop rotation is the central tool that integrates the maintenance and development of soil fertility with different aspects of crop and livestock production in organic system. Carefully planned diverse rotations help reduce the incidence of pest and disease and allow for cultural methods of weed control.

OFSA-2017/SH-22

Nutrient management for carbon sequestration and sustainable crop production under tropical rice- rice agro ecosystem

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Soil organic carbon is key attribute of soil fertility and productivity because of its influence on the physical, chemical and biological properties of soils. Irrespective of its potential benefits to productivity and profitability, organic carbon might be sequestered by vegetation and soils as a possible way of reducing the rate of CO_2 enrichment of atmosphere and moderate the global climate change. Net change in SOC depends not only on the current management practices but also on the management history of the soil. Long term experiments are the primary source of information to determine the effect of cropping systems and other management practices on C and N dynamics in soil . Labile organic carbon is sensitive to soil management practices and thus provides the better management of carbon dynamics in short-term to medium- term effect than total carbon alone. Thus, an attempt is made here to investigate into the carbon sequestration potential and dynamics of labile pools of SOC in relation to crop productivity. Soil sample of post-kharif 2014 were collected from long term fertilizer experiment started in the year 2005-06 in the central farm of OUAT under AICRP in an acidic sandy soil taking swarna (MTU-7029) as a test crop. The experiment was systematically initiated with quadruplicated 12 treatments in a Randomized Block Design. Out of 12 treatments, six treatments were selected for the present study i.e. no fertilization, 100% N, 100% NP, 100% NPK, 150% NPK and 100% NPK+FYM. A fallow treatment was also included to compare the impact of cultivation vis-a- vis no cultivation. The experimental results revealed that cultivation over the years caused a significant decrease in soil organic carbon content by 14% in unfertilized control as compared to uncultivated soil. The balanced fertilization with NPK, super optimal dose of NPK and integration of balanced fertilization with FYM increased the SOC content as well as SOC stocks over the initial year. The carbon sequestration potential (1.77 Mg ha^{-1}) was highest in 100%NPK +FYM treatment. The cumulative C mineralized in 36 days of incubation of surface soil ranged between 1.08 to 2.18 g kg^{-1}, being highest in the 100% NPK + FYM treatment. The biological pool such as MBC(C_{mic}) comprised of 3.4 % of the soil organic carbon content. The greater magnitude of C_{mic} and readily mineralisable C (RMC) was found in 100%NPK+ FYM. The greater accumulation of water extractable carbon, KMnO4-C was recorded in 100%NPK + FYM treatment. The content of SOC significantly correlated with sustainable yield index (SYI) which support better sustainable productivity. The highest Carbon management index (CMI) was computed in the integrated treatment of 100%NPK with FYM. CMI can be used as a more sensitive indicator of the rate of change of SOC in response to soil management changes. Results suggested that current fertilizer recommendation of 100% NPK+ FYM are adequate for maintaining SOC stock and this practice may help in maintaining the sustainability of rice-rice cropping system.

OFSA-2017/SH-23

Use of fly ash in sustainable agriculture

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Fine solid particles of ash fly ash, also known as flue-ash, is one of the residues generated by combustion process of fuel. Production of fly ash in India has been increased from 40 Mn T/yr (1994) to about 235 Mn T/yr (2013) and it is expected to be 325Mn T/yr (2016-17), 500 Mn T/yr (2021-22) and 1000 Mn T/yr (2031-32). As it is the problematic solid waste all over the world, this waste by-product material must be disposed of or recycled. Fly ash has great potentiality in agriculture due to its efficacy in modification of soil health and crop performance. Fly ash, being a good soil ameliorant and source of secondary plant nutrients as well as micronutrients can significantly improves the physico-chemical properties (like B.D., W.H.C., pH, CEC, free lime etc.).It improves soil buffering capacity, soil aeration, percolation and water retention in the treated zone .The high concentration of elements (K, Na, Zn, Ca, Mg and Fe) in fly-ash increases the yield of many agricultural crops. So fly ash is a resourceful material and can be effectively utilized as soil modifier in large quantity and micro fertilizer in converting wasteland (barren land, rocky nature, sandy and water logged soil, highly alkali and acidic soil etc.) into agriculturally productive land. Agricultural lime application contributes to global warming as Intergovernmental Panel on Climate Change (IPCC) assumes that all the carbon in agricultural lime is finally released as CO_2 to the atmosphere. It is expected that use of fly-ash instead of lime in agriculture can reduce net CO_2 emission and also reduce global warming.

OFSA-2017/SH-24

Soil management: its role, analysis and management of soil life and organic soil health relevance to crop nutrition and productivity

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Soil quality indicators are physical, chemical, and biological properties, processes, and characteristics that can be measured to monitor changes in the soil. Soil quality indicators are important to: focus conservation efforts on maintaining and improving the condition of the soil; evaluate soil management practices and techniques; relate soil quality to that of other resources; collect the necessary information to determine trends; determine trends in the health of the Nation's soils; guide land manager decisions. Objectives of this paper are to review current efforts to define soil quality, (2) to discuss factors and processes which influence soil quality, to identify, soil and crop management practices that affect processes influencing soil quality, and to demonstrate a method for evaluating soil quality. A common focus among all proposed soil quality definitions is that the soil must reflect its ability to "function" in numerous ways at the present time and in the future. Soil and crop management practices that add or maintain soil carbon appear to be among the most important for restoring, maintaining, or improving soil quality. The soil quality assessment method that has been developed does not provide a definitive answer with regard to the measurements or specific functions which should be included in a soil quality index, but it uses specific measurements that describe soil functions and it is dynamic. We concluded that Earthworm, nematode, or termite populations have been suggested for use in some parts of the country. Respiration rate can be used to detect microbial activity, specifically microbial decomposition of organic matter in the soil. Ergosterol, a fungal byproduct, has been used to measure the activity of organisms that play an important role in the formation and stability of soil aggregates. Measurement of decomposition rates of plant residue in bags or measurements of weed seed numbers, or pathogen populations can also serve as biological indicators of soil quality.

OFSA-2017/SH-25

Utilisation of biochar as a soil amendment and climate change mitigation:

A review

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Water and soil nutrients are most essential inputs in agriculture for better production. But climate change, has led to uncertainty in monsoon rainfall and also leading to occurrence of drought, which in turn is severely affecting crop productivity and livelihood security of farmers. Demand of water in other developing sectors is also increasing day by day, which leads to less availability of water for agriculture. Introduction of high yielding and hybrid seeds are also demanding more soil nutrients. Application of higher dose of chemical fertilizers is polluting both water and soil resources. Hence, improvement water and nutrient efficiencies are badly necessary for sustainable production and controlling environmental pollution. Agriculture contributes considerable amount of CO_2, N_2O and CH_4 emission into the atmosphere through different soil and crop management practices. On the other hand, soil is one of the major sinks of green house gases and it helps to sequester more carbon and cut the N_2O emission by adopting smart soil and crop management techniques. Biochar is one of the viable organic amendments to combat climate change and sustain the soil health with sustainable crop production. It is an anaerobic pyrolysis product derived from organic sources and store carbon on a long term basis in the terrestrial ecosystem and also capable of reducing greenhouse gases (GHG) emission to the atmosphere. Biochar application improve the soil health, soil water holding capacity, retain soil nutrients, increase the soil carbon, reduce the GHG emission and enhance the crop yield with less water and nutrient application, which ensure better production with higher water and nutrient use efficiencies .

OFSA-2017/SH-26

Effect of organic and inorganic sources of nutrients on grain yield of rice in north eastern coastal plain zone of Odisha

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Rice is the major crop grown in the North Eastern Coastal Plane Zone of Odisha and occupies around 85 to 90 per cent of the cultivable area during the Kharif season and therefore, rice productivity has a direct correlation with the food and livelihood security of the farmers of this zone. To maintain rice production, farmers apply higher doses of chemical fertilizers in general and nitrogenous fertilizer in particular and this trend of fertilizer application has been increasing over the years. The practice of indiscriminate use of chemical fertilizers coupled with decreased soil organic matter has emerged as a major factor responsible for soil health degradation; as a consequence, the stagnation in agricultural production is a major concern now-a-days. Restoration of organic matter is thus needed for maintaining soil health and nutrient management based on organic farming practices which has been proven as one of the best viable options. On this context, an experiment was conducted at Regional Research and Technology Transfer Station (OUAT), Ranital during Kharif'2011 and 2012 to study the effect of organic and inorganic sources of nutrient on seed quality and grain yield of rice. The experiment was laid out in Randomized Block Design with five treatments viz. T_1-100% inorganic (80-40-40 kg N-P_2O_5-K_2O /ha), T_2 - 50% organic+ 50% inorganic,T_3 - 25% organic+ 75% inorganic T_4 - 100% organic, T_5 - Control, replicated four times. The popular variety Ranidhan was selected. The organic sources of nutrients used were karanja oil cake, vermicompost and bone meal. Data collected on biometric observations (plant height, LAI, number of ear bearing tillers), yield attributes and yield. Maximum grain yield of rice (5.28 t ha $^{-1}$) was obtained due to combined application of nutrients for inorganic and organic sources at 1:1 ratio in comparison to all other treatments. The higher yield is due to highest number of EBT/m^2 (206), filled grains/panicle (125) and 1000 grain weight. While comparing with the best treatment, 100% organic sources of nutrient yielded at par while the duration of the crop was extended by five days and the grain quality was bold and shining. The return per rupee invested (1.82) was more with the inorganic sources of nutrient alone (T_1) due to cheaper cost of nutrients from inorganic sources closely followed by 50% organic+ 50% inorganic (1.79). Similarly 100 % organic showed lower return/rupee invested (1.62) due to higher cost of nutrient from organic sources. The harvest index was highest (0.516) in 100% organic crop followed by T_2 (0.504). So, the combined application of inorganic and organic manure in 1:1 ratio is a viable option to sustain rice productivity on long run than the complete inorganic one.

OFSA-2017/SH-27

Effect of siderophore producing *Rhizobacteria* on growth performance of vegetables

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Iron is one of the most essential microelements for all living cells but the availability of iron is limited due to very low solubility of the dominant ferric iron (Fe^{3+}) in soil. Some bacteria can produce low molecular weight iron chelating compound called siderophore. On account of that, an attempt was made in the present investigation to isolate potential siderophore producing bacteria from different places of Odisha and study their effect on different vegetables. A total of four siderophore producing bacteria were isolated from rhizospheric soil sample and amongst them BGBA-1 was found the most efficient siderophore (76.67% SU) producer. The potential isolates were further characterized for their different plant growth promoting activities like indole acetic acid production (IAA), ammonia production, phosphate solubilisation, N_2- fixation and HCN production. From biochemical and enzymatic characterization, it was found that these two bacteria belonged to the genus of Bacillus. The potential isolates were further tried with different vegetables to study the germination percentage, root length and shoot length by Roll towel method. A significant increase in various parameters of vegetables were observed which was also statistically significant.

OFSA-2017/SH-28

Plant growth promoting characteristics of sulphur oxidising bacteria isolated from long term pesticide treated paddy soil

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Sulphur is the key element for higher pulse production and plays an important role in the formation of proteins, vitamins and enzymes. Sulphur oxidisers are involved in oxidation of elemental sulphur to plant available sulphate. In search of efficient sulphur oxidising PGPR strains with multiple activities, soil sample was collected from the rhizospheric region of rice plants. Out of the total 46 sulphur oxidising bacterial isolates, 12 isolates showed efficiency maximum PGPR traits. Out of these, the best 06 were selected which showed positive PGPR traits. These 6 potential isolates were tested for effect on seed germination. Two of the isolates showed Indole acetic acid (IAA) production and were opted further for the quantification of IAA. The morpho-physiological characterization indicated that four isolates belongs to the genera Bacillus, one each belonging to Streptococcus and Micrococcus.

OFSA-2017/SH-29

Integrated nutrient management in scented rice and its residual effect on paira pea under rice- pea cropping system

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An experiment was conducted to study the effect of integrated nutrient management in scented rice and its residual effect on pea under rice-pea paira cropping system at RRTTS, Bhawanipatna during 2015-16 and 2016-17. Twelve treatments comprising T_1-FYM @10 t/ha + Vermicompost @ 2.5 t/ha+ Neem cake @ 2.5 q/ha + Azospirillum @ 5kg/ha + PSM @ 5kg/ha, T_2- STBFR (Soil test based Fert. Recommendation 75:30:20 kg N,P_2O5,K_2O/ha), T_3- STBFR + FYM @ 5 t/ha, T_4- STBFR + Azospirillum@ 5kg/ha + PSM @ 5kg/ha, T_5- STBFR + 5 Kg Zn/ha, T_6- STBFR + 20 kg S/ha, T_7- STBFR + 5 Kg Zn/ha + 20 kg S/ha,T_8- STBFR + FYM @ 5 t/ha + 5Kg Zn/ha + S@20 kg/ha, T_9- STBFR + FYM @5 t/ha + Azospirillum@ 5kg/ha + PSM @ 5kg/ha, T_{10}- STBFR + FYM @5 t/ha+ Azospirillum@ 5kg/ha + PSM @ 5kg/ha+ 5Kg Zn/ha + S @ 20 kg/ha, T_{11}- Farmers practice (only chemical fertiliser @ 40-20-20 kg NPK/ha), T_{12}- STBFR + Vermicompost @ 2.5 t/ha was tried in RBD with three replication. The soil of the experimental site was black cotton type having pH- 6.11 , O.C.- 0.72 %, E.C- 0.004 (dS/m), Available N -175.9 kg/ha (low), Available P-36.7 kg/ha (medium) and available K- 283.6 kg/ha (high). The test variety for rice was Geetanjali and Azad P-1for pea.

Application of STBFR (75:30:20 kg N,P_2O5,K_2O/ha) + FYM 5t + Azospirillum 5 kg + PSM 5 kg + Zn 5 kg + S 20 kg/ha to medium land aromatic rice (var. Geetanjali) gave higher rice grain yield (4965 kg/ha) and pea seed yield (1144 kg/ha) from aromatic rice-pairapea cropping system. However, application of STBFR + FYM 5t + Zn 5 kg + S 20 kg/ha producing grain yield (3944 kg/ha) and pea seed yield (1077 kg/ha) is another option. The yield advantage over farmer's practice (40:20:20 kg N, P_2O_5, K_2O/ha) and STBFR + FYM was 42% and 33 %, respectively, the net return (Rs. 52849/ha) is also higher for the same treatment.

OFSA-2017/SH-30

Panchagavya: An effective organic growth-promoter

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Panchagavya, an organic product has the potential to play the role of promoting growth and providing immunity in plant system. Panchagavya consists of nine products viz. cow dung, cow urine, milk, curd, jaggery, ghee, banana, tender coconut and water. Panchagavya contains macro and micronutrients necessary for the plant, many vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganism like yeast and Lactobacillus, Azotobacter, phosphor bacteria and Pseudomonas in abundant number. Lactobacillus produces various beneficial metabolites such as organic acids, hydrogen peroxide and antibiotics, which are effective against other pathogenic microorganisms besides its growth. It also contains some useful fungi and actinomycetes. As per the recommendation, 3 per cent solution was found to be most effective compared to the higher and lower concentrations investigated. It

acts as an organic growth promoters and immunity buster plant this also cures already infested plants and other living organisms. It increases the yield by 20 to 25 percent and quality of produce. It reduces the water requirement by 25 to 30 per cent thus sustain drought condition. Generally preparation cost is varies from 40 to 50 Rs. for preparing 1 liter of panchagavya. Market price is varied from 150 to 400 Rs. Per liter based on brand and quality. It is a cheap so affordable by small and marginal farmers. Panchagavya play important role in animal, human and environment health also. Panchagavya preserve the reproductive and regenerative capacity of the soil and produced nutritious food rich in vitality which has resistance to disease.

OFSA-2017/SH-31

Effect of integrated application of Ld Slag, vermi-compost and chemical fertilizers on productivity and quality of groundnut in acid soil of Bhubaneswar, Odisha

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A field study was carried out at the Central Horticultural Research Station, OUAT, Bhubaneswar, Odisha. The possibility of using low cost liming material like LD (Linz-Donawitz) slag to ameliorate acid soil and its impact on productivity of groundnut and its protein and oil content. Soil amelioration with LD slag @ 30 per cent lime requirement (LR) in conjunction with inorganics and vermicompost improved the growth, nutrient concentration and yield of the crop. The LD slag used in this study contained 32.5 per cent calcium carbonate which was applied at 30 per cent of LR along with organic and inorganic fertilizers in different treatments. The yield attributes viz plant height (37.98 cm) , stover yield (4.69 tonnes/ha), biological yield (8.2 tonnes/ha), number of pods per plant (22.33), pod yield (2.46 tonnes/ha), 1000-kernel weight (288.21 g), shelling percentage (77.36) and oil content (48.60%) were recorded highest in the treatment receiving LD slag, 100 per cent recommended dose as inorganic fertilizer and vermicompost. Highest crude protein content (26.19%) was also recorded in the above treatment. LD slag was found to be useful in enhancing biomass, protein content, yield and oil content of kernel. However no significant differences were observed when LD slag was applied without organic fertilizer.

OFSA-2017/SH-32

Response of biofertilizer application in Mustard

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Rapeseed and Mustard is a key edible oilseed crop contributing about one third of the oil produced in the country. Azotobacter, the nitrogen fixing bacteria can enhance plant growth by production of phytohormones, enzymes and mobilization of nutrients. Phosphate solubilising bacteria produces vitamins and growth substances like IAA and GA , solubilize unavailable soil P and increase the crop yield .Therefore the present study was under taken to explore the possibility of using bio-fertilizer in sustainable production of mustard. Field experiment was conducted during rabi season of 2010-11 at the central research station, Orissa University of Agriculture and Technology, Bhubaneswar. The

experiment was laid out in randomized block design comprised of eight treatments i.e. control (without N & P_2O_5), 50%(N+ P_2O_5) , 75%(N+ P_2O_5) , 100%(N+ P_2O_5), Azotobacter + PSB(AP), AP+50%(N+ P_2O_5) , AP+75%(N+ P_2O_5) , AP+100%(N+ P_2O_5) with three replications. Azotobacter and Phosphate Solubilising Bacteria (PSB) were applied by seed inoculation method @ 20g/kg of seed. The toria variety Parbati was sown with a spacing of 30X10 cm on 12 November in 2010. The recommended dose of fertilizer for toria is 50-25-25 kg N- P_2O_5 –K_2O/ha. Full P_2O_5 & K_2O and 50 % N were applied as basal and rest 50 % N at 3 weeks stage as per the treatment. Application of 100% (N+P_2O_5) along with seed inoculation of Azotobacter +PSB gave maximum seed and stover yield which was comparable with 100% (N+P_2O_5) applied as chemical fertilizer . Seed inoculation of Azotobacter +PSB along with 100% (N+P_2O_5) and 75% (N+P_2O_5) produced 9.3% & 3.2% higher seed yield respectively as compared to 100% (N+P_2O_5) applied as chemical fertilizer. Integrated use of chemical and biofertilizers resulted in better nutrient availability and their mobilization in the plant tissues which ultimately improved the growth and yield attributing characters and finally the seed yield. Even with no fertilizer use seed inoculation with bacterial culture produced 4.5% higher seed yield as compared to control.

So it can be concluded that under Odisha condition super imposition of biofertilizers along with recommended dose of of N-P_2O_5-K_2O can be a viable option for increasing productivity and profitability of toria in a sustainable manner.

OFSA-2017/SH-33

Importance of sustainable integrated farming systems under dryland conditions

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The drylands include hyper-arid, arid, semi-arid and dry sub-humid areas where rainfall is highly variable, droughts are common and water is the principal limiting factor for agriculture. Dryland soils are characterized by low levels of moisture, organic matter, and biological activity, often display poor fertility. When inappropriately utilized for agriculture, these soils are susceptible to rapid fertility loss, erosion, desertification, and salinization. In India these areas incidentally are highly populated which makes the people vulnerable to environmental stress and impacts livelihoods directly. Dryland constitutes nearly 62 per cent of the total cropped area out of the 142 mha in the country and contributing about 42 per cent of total food grains production. Therefore, dryland agriculture will continue to play an important role in the Indian economy. The traditional cropping leads to a high degree of uncertainty in yield, income and employment under dryland conditions. The integrated farming systems approach introduces a change in the farming techniques for maximum productivity in farming by optimal utilization of resources while ensuring sustainability. It views the whole farm as a system with the integration of crops, animals, soils, workers, other inputs and environmental influences wherein the farm family attempts to produce outputs within the limitations of its capability and resources and the socio-cultural setting. The present day trend towards sustainable agriculture encourages the utilization of residue and waste materials of crop and its allied activities for enrichment of soil nutrients, water retention to protect the environment over a long period. The different components of the farming system have complementarities with each other, where waste products of one component becoming source of food and energy for other components. Judicious mix of agricultural crops and other enterprises suited to the given agro-climatic condition and socio-economic status of the farmer would improve the prosperity in the dryland fanning. Adoption of sustainable integrated farming system will bring productivity enhancement, employment, income generation and nutritional security both for human and livestock in the dryland areas.

OFSA-2017/SH-34

Non chemical strategies for enhancing yield and quality of sugar beet (*Beta Vulgaris L.)*

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A field experiment entitled "Response of sugar beet (Beta vulgaris L.) varieties to land configuration under south Gujarat condition" was conducted at the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during rabi season of 2015-16. The investigation aimed at assessing the effects of land configuration and tropical sugar beet cultivars on crop growth parameters, yield and quality traits under south Gujarat condition. Nine treatment combinations comprising three land configuration and three varieties were tested in split plot design with four replications. Three different land configuration treatments viz. flat bed, ridge furrow and raised bed were randomly allocated to the main plots. The three cultivars viz. 'SV-887', 'SV-889' and 'SV-892' were allocated to the sub plots under each main plot through the process of randomization. The soil of the experimental plot was clayey in texture and slightly alkaline (pH 8.29) in reaction, low in available nitrogen (172 kg/ha), high in available phosphorus (49 kg/ha), fairly rich in available potassium (458 kg/ha) and moderately high in organic carbon (0.72%), which is very congenial for raising sugar beet crop.

Raised bed planting had favourable effect on growth and yield of sugar beet as compared to ridge furrow planting. Among the land configurations, raised bed and ridge furrow were equally effective but superior to flat bed with respect to plant growth in terms of plant height, number of leaves plant^{-1}. However, raised bed recorded conspicuously higher dry matter accumulation plant^{-1}, leaf area index, foliage biomass (fresh and dry), root biomass (fresh and dry) and total biomass (fresh and dry) per hectare and thus, turned out to be significantly superior to rest of the land configurations. Raised bed method registered increase in foliage, root and total biomass (fresh) to the tune of 40.3, 22.3 and 26.5 per cent respectively, over flat bed method. Similarly, varieties also showed discernible influence on growth characters and yield of sugar beet. Variety 'SV-887' remarkably improved plant height, number of leaves plant^{-1}, dry matter accumulation plant^{-1}, leaf area index, foliage biomass (fresh and dry), root biomass (fresh and dry) and total biomass (fresh and dry) per hectare over 'SV-892' and 'SV-889'. The magnitude of increase in foliage, root and total biomass (fresh) under 'SV-887' was to the tune of 27.5, 10.6 and 14.4 per cent, respectively, over 'SV-889'. Land configuration failed to influence both impurities and desirable attributes significantly. However, raised bed method recorded maximum values for TSS, Sucrose content and sugar recovery percentage. Quality characters namely, TSS content, sucrose content, α Amino N, Na, K content and sugar recovery percentage were influenced significantly due to different varieties. Variety 'SV-892' recorded significantly maximum TSS, sucrose percentage and sugar recovery percentage while from the impurity point of view 'SV-887' proved the worst with maximum value of α Amino N, Na and K content. There was a positive interaction between land configuration and varieties with regard to dry matter accumulation plant^{-1}, foliage biomass (fresh and dry), root biomass (fresh and dry) and total biomass (fresh and dry) per hectare. Planting on raised bed along with variety 'SV-887' turned out to be superior to rest of the treatment combinations.

OFSA-2017/SH-35

Biopolymer (polyhydroxyalkanoates) production by bacteria and its application in seed coating for sustainable agriculture

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In the current context of eco-pollution, academia and industry have given special attention for the development of biodegradable polymer. Polyhydroxyalkanoates (PHAs) are the fascinating group of most common biodegradable biopolymer produced by a wide array of bacteria. Though, it is used for various biomedical and to some extent in domestic applications but their use in agriculture is still limited. Seed quality is the basic input in agriculture that plays an important role in crop yield and productivity. As a matter of fact, seed coating by synthetic and biobased polymer is widely used for different purposes such as seed quality enhancement, delivery of biofertilizer, biopesticide, nutrients, hormones etc. The present study was undertaken to investigate seed coating by PHAs extracted from the bacteria, Bacillus sp. C1 (2013). Under optimized conditions the Bacillus sp. C1 (2013) produced 1.5 g/l of PHAs in the minimal salt medium using solid state fermentation process. Considering this fact, further research is highly indispensible for characterization of extracted biopolymer and its successful applications in seed coating for sustainable agriculture.

OFSA-2017/SH-36

Organic fertigation: Concept and challenges

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Humanity will be challened in feeding the increasing global population without any major improvement in food production through increased water and nutrient use efficiency in the coming decades. Although application of water and nutrients requires careful management, it offers significant potential for improving their use efficiency for sustainable crop production. To achieve these goals, fertigation is well suited since it can deliver appropriate amounts of nutrient and water when properly practised. Fertigation is the practice of conjunctive application of fertilizer and water to crops. Since small quantities of nutrients are applied each time the plants are irrigated, this method of fertilizer application is highly efficient. Increasing demand for organic production requires efficient use of different farm inputs especially water and nutrients. Despite of such increased demand for organic production, little research has been done in organic fertigation system. There are many organically approved liquid fertilizers and powdered fertilizers that are completely soluble that can be used for fertigation. Among the different fertigation methods, drip irrigation or micro irrigation system proves to be the ideal in delivering the water soluble nutrients in the crop root zone increasing its use efficiency. However, there are many hurdles to overcome, in making the organic fertigation a reality. Thus, the objective of the study focused on the potentiality and challenges of conjunctive application of soluble organic fertilizer and water for enhancing their use efficiencies for stabilizing the production of organic farms.

OFSA-2017/SH-37

Rock phosphate as a source of phosphorus for P nutrition of groundnut in alfisols

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Two sources of phosphorus namely Rock Phosphate (RP) wth 16, 17 and 1 percent P2O5, Ca and S respectively, Single Super phosphate (SSP) and their combinations were evaluated as to study their effect on (i) efficacy of P sources on productivity, oil content and uptake of P and S, (ii) Interrelationship among soil inorganic P fractions and forms of S on productivity and P and S uptake, on groundnut productivity, uptake of P and S by the crop, forms of P and S in soil (iii) sulphate sorption pattern in the field experiment designed in RBD with seven treatments--control,100% P (Rock Phosphate), 100% P (SSP), 75% P (RP) + 25% P (SSP), 50% P (RP) + 50% P (SSP), 25% P (RP) + 75% P (SSP), 100% P (SSP) + Lime @ 0.2 LR- in three replications to evaluate their efficiency in Groundnut crop and the sulphur sorption behavior in Alfisols -loamy acidic (pH-5.2) soil with available P (Bray's P) status 15.68 kg ha-1 and organic carbon 3.4 g kg-1, crop (cv, TAG-24, 120 days) had receiving 20-40-40 kg N-P2O5-K2O ha-1in 2014&2015 both Rabi and pre-Kharif seasons at OUAT Bhubaneswar. The effect of these were also studied on the sulphate sorption behaviour of post- harvest soils in the laboratory with 0, 25,50,75,100,125, 150 and 200 µg S g-1of soil. The data were fitted to linear, Langmuir and Freundlich models. The sorption, desorption and retention were also modelled.

OFSA-2017/SH-38

Effect of organic sources of nitrogen on the incidence of rice stem borer, Scirpophaga incertulas (Walk.)

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Judicious and integrated application of inorganic N2 fertilizer in relation to paddy growth stage can suppress the pest incidence without any conciliation of the yield generation. Field experiment was conducted at Regional Research and Technology Transfer Station, Bhawanipatna, Kalahandi, Odisha.during kharif 2013-14 and 2014-15 in randomized block design with three replications and eight treatment combinations viz T1: Recommended Dose of Fertilizer, (RDF 12:60:60 N2, P2O5, K2O) with 1/3rd N at transplanting (Tp)+ 1/3rd at tillering (T) + 1/3rd at PI (Panicle initiation) , T2: 5t FYM + 50% RDF with 1/3rd N at Tp+ 1/3rd N at T +1/3rd N at PI , T3: 5t FYM + 75% RDF with 1/3rd N at Tp + 1/3rd N at T + 1/3rd N at PI, T4: 5t FYM + RDF with1/3rd N at Tp + 1/3rd N at T +1/3rd N at PI, T5: 5t FYM + RDF with1/2 N at Tp+ 1/4th N at T +1/4th N at PI, T6: 5t FYM+ RDF with1/4th N at Tp + 1/2 N at T + 1/4th N at PI, T7: 10t FYM+50% RDF with1/3rd N at Tp + 1/3rd N at T + 1/3rd N at PI and T8: FYM 5 t ha-1 + vermicompost 2.5 kg ha-1 + Azosporilum 5 kg ha-1 + PSB 5kg ha-1.

Mean analysis of two years data on stem borer incidence in different organic and inorganic treatment combination of N-fertilizer revealed a significant difference with dead heart and white ear head. The plot which received the organic source of nutrients (T8: FYM 5 t ha-1 + vermicompost 2.5 kg ha-1 + Azosporilum 5 kg ha-1 + PSB 5kg ha-1) recorded lowest incidence of stem borer(1.94% dead heart and 0.65% white ear head). The lowest per cent increase of dead heart (22.71%) and white ear head (21.69%) was recorded in T6 which received 5t FYM+ RDF with1/4th N at Tp + 1/2 N at T + 1/4th N at PI. The grain yield (75.4q/ha) was also significantly higher in T6 receiving combination of organic and inorganic treatment. The lowest grain yield (41.8q/ha) was recorded in plot receiving the organic source of nutrients (T8). Present study clearly indicates that the application of 5t FYM along with N-fertilizer at recommended dose of fertilizer (RDF) with ¼ at transplanting, ½ at tillering and 1/4 at panicle initiation stage (T6) is the best one with respect to low incidence of rice stem borer and higher grain yield.

OFSA-2017/SH-39

Effect of integrated nutrient management practice on yield and yield attributes of brinjal

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A field study was conducted in Rabi season of year 2014-15 and 2015-16 at experimental plot of RRTTS, Dhenkanal to assess the effect of integrated nutrient management practice on yield and yield attributes of brinjal. The field was laid out in Randomized Block Design (RBD) with three replications and eight treatments. The treatments containing bio-fertilizers along with recommended dose of fertilizers (chemical) viz., T1-Soil Test Based Fertilizer Application (STBFA) (N+P+K), T2-STBFA (N+P-K), T3-STBFA(N+K-P), T4-STBFA (P+K-N), T5-STBFA(2/3 N +P+K)+ Azotobacter @5 Kg ha-1, T6-STBFA(2/3 N + P+ K)+ Azospirillum@ 5 Kg ha-1, T7-(STBFA 2/3 N + P+ K +) Azotobacter@ 4Kg ha-1 + Azospirillum@ 4 Kg ha-1, T8-FYM @ 15 t ha-1.The results revealed that application of 2/3rd of N + P + KAzotobacter @ 4 Kg ha-1+ Azospirillum@ 4 Kg ha-1.(T7) recorded the highest yield (36.1 t ha-1) which is about 37% higher yield than FYM alone (T8) followed by the treatment T5 (34.4 t/ha)which is about 30.3% higher yield than T8,whereas increase is lower (7.2%) in the treatment where only soil test based P and K (T4) was applied. Treatment T7also shows highest No of fruits /cluster (8.9), average fruit weight (gm) (44.8), No of clusters /plant (12.1), plant height (cm) (72.8) followed bySTBFA(2/3 N +P+K)+ Azotobacter @ 5 Kg ha-1 (T5), T6, T1, T2, T3, T4respectively and least effect found in T8 where only 15 t ha-1 FYM was applied. This study demonstrated that integrated application of organic and inorganic nutrient results higher yield in comparison to sole application of organic and inorganic fertilizers.

OFSA-2017/PM-01

Integrated management of root-knot disease of okra through application of fungal bio-agents

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Root knot nematode, *Meloidogyne incognita,* is a major limiting factor for profitable vegetable cultivation in Odisha. Okra (*Abelmoschus esculentus* L. Moench), the important vegetable crop grown throughout Odisha is frequently affected by Root knot nematode with 20.1% yield loss. A field study was carried out to manage this nematode in a natural infested field soil (206 J_2 / 200 cc soil) in okra (cv. Utkal Gaurav) through integration of liquid formulation of biological control agents in experimental plots under AICRP on Nematodes, Bhubaneswar during Kharif, 2016. For this study, liquid formulated egg parasitic fungus *Purpureocillium lilacinum* and *Pochonia chlamydosporia*) were applied as seed treatment (5ml /kg seed) followed by soil application of @ 2.5 ton/ha pre incubated vermicompost (10 ml/ kg) in different combinations in a Randomized Block Design . All the treatment combinations reduced the incidence of root-knot disease of okra compared to the untreated control. Among the different treatments evaluated, seed treatment with *Purpureocillium lilacinum* @ 5 ml/kg followed by soil application of vermicompost @ 2.5 ton/ha enriched with *P. lilacinum* @ 10 ml/kg recorded the maximum increase in plant height (50.23%), fresh shoot weight (39.44%), fresh root weight (36.51%) and plant biomass (41.26%) of okra plant with decreased root knot nematode population in soil (52.98%) and root (60.24%) , root galls (73.64%) and egg masses per plant (74.39%) over untreated check with lowest root knot index(2.0). This management practice gave the highest fruit yield (7.19 t/ha) with ICBR of 2.75 followed by seed treatment with *Pochonia chlamydosporia* @5 ml/ kg + soil application of vermicompost @ 2.5 ton/ha enriched with *P. chlamydosporia* @ 10 ml/kg (7.10 t/ha).Therefore, it is suggested that integrated approach using bio-control agents with vermicompost to manage root-knot disease of okra under natural infestation is not only environmentally friendly but also more beneficial to growers.

OFSA-2017/PM-02

Bio-intensive management of fruit borer (H*elicoverpa armigera* hubner) in off-season tomato

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Tomato cultivation during off-season (*kharif*) is considered as highly remunerative due to higher consumers' demand and better market price. However, tomato fruit borer is the most destructive pest of tomato contributing around 24-65 % yield loss and in the worst years the fruit damage may go up to 88 %. It is a highly polyphagous pest infesting over 182 host plants and rapidly expanding the host range by attacking other vegetables like okra, chilli, cow pea, cabbage, pea and beans. The larvae bore into the fruits, consume the inner content and the damaged fruits ultimately rot due to the secondary infection by other micro-organisms rendering the fruit unfit for human consumption. Farmers mostly apply chemical insecticides to reduce the pest infestation and indiscriminate application of insecticides has many adverse effects on human health and crop environment. This pest is quickly developing resistance against many insecticides and hence, sole reliance on chemical pesticides cannot result in its satisfactory control. This has necessitated the development of effective bio-intensive IPM strategy to reduce the damage of this pest without any adverse effect on the eco-system.

Experiments were conducted at Kuspada village of Keonjhar district during kharif 2009 and 2010 to evaluate the efficacy of three bio-intensive IPM modules against the existing farmers' practice. Tomato hybrid "Chiranjibii" was transplanted in the experimental plots with all the standard agronomic package of practices and intercultural operations. The parasitoid *Trichogramma chilonis* was released in the BIPM treatments based on the pheromone trap catch and spraying of biopesticides was given on initiation of pest damage. Periodic observation on the larval population/ plant was recorded at weekly interval and the average population was calculated from cumulative counts of the entire crop growth stages. The module wise observation on fruit damage was recorded at each picking and the cumulative value was worked out. The module wise marketable fruit yield was calculated by cumulating the weight of each harvest of healthy fruits.

The results indicated that the larval population and fruit infestation was substantially reduced in all the BIPM plots compared to the farmers' practice of frequent application of insecticides. However, the maximum suppression in larval population and fruit damage (3.6 larvae/ 10 plants and 6.24 and 8.45 % fruit damage on number and weight basis, respectively) was recorded in the module comprising of Intercrop with cabbage + Release of *Trichogramma chilonis* + Alternate Spraying of 5 % NSKE and HaNPV + Installation of pheromone trap for monitoring + Fixing of bird perches. Similarly, the highest marketable fruit yield (254.8 q/ ha) was obtained in this module, while, the lowest fruit yield (212.4 q/ ha) was observed in the farmers' practice. The incidence of other pests like whiteflies and aphids were minimized to great extent in the IPM plots may be due to the presence of higher natural enemies like spiders and lady bird beetles and lack of resurgence effect of insecticide application. Hence, it can be concluded that a compatible integration of suitable intercrops, biopesticdes or botanicals, bioagents and pheromone traps can minimize the incidence of tomato fruit borer, maximize the marketable fruit yield and conserve the natural enemy population.

OFSA-2017/PM-03

Sustainable yield maximization through integrated management options in medium duration pigeonpea

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Medium duration pigeonpea genotypes with 160-180 days duration are popular among Odisha farmers due to their high yield potentiality. The national productivity (approx. 800kg/ha) lag far behind to its potential yield of 1500-3000kg/ha. Being a long duration crop and grown in marginal upland it needs better nutrient management .Slow growth habit of pigeonpea at initial stages along with wide row spacing, encourages rapid growth of weeds and leads to severe crop weed competition which finally reduces the crop yield. Pod borer complex is a major problem responsible for huge yield reduction in pigeonpea. Individual technologies for nutrient, weed and pest management in Pigeonpea are recommended. However, the interactions of these technologies and cumulative effect to be studied for sustainable yield maximization in pigeonpea.

A field experiment was conducted under AICRP on Pigeonpea over two consecutive years (kharif 2014-15 and 2015-16) at the Centre for Pulses Research, OUAT, Berhampur, Odisha, which comes under East coast plains & hills agro-climatic zone of India and East & South Eastern Coastal Plain zone of Odisha with the objectives to study the interactions of integrated management options for yield maximization in medium duration pigeonpea in Odisha. The trial was laid

out in Randomized Block Design with three replications and 8 treatments viz. T1: INM (FYM @ 5t/ha +STBF ie. NPKSZn) ; T2:IWM (pendimethaline (30% EC) 0.75kg/ha on 3 DAS + imazethapyr (10% SL) @ 100g ai/ha on 10-15 DAE of weeds + 1 HW on 50 DAS/ 1 inter cultivation on 50 DAS);T3: IPM (Indoxacarb 15.8% EC at the time of flowering @ 375ml/ha + imidachlopride @ 125ml/ha at 15 days after 1st spray) ; T4: INM+IWM; T5: INM+IPM ; T6: IWM+IPM ; T7: INM+IWM+IPM ; T8: Control (Farmer's practice). . Variety TTB-7 was sown in rainfed condition during Kharif. The soil was sandy loam with pH 6.1, low Organic Carbon (0.42 %) , medium available Phosphorus (21.8kg/ha) and medium available potassium (181.7kg/ha), EC – 0.007 dS/m (Normal), Avl. S(kg/ha): 3.4(L) and Zn (mg/kg):0.36(L). Observations on weed, pest, growth, yield attributes and yield were recorded. Economics of the treatments were also calculated.

The growth, yield attributes and yield of Pigeonpea were significantly affected by integrated management options. The pooled result revealed that the maximum plant height(179.5cm), number of primary fruiting branches/plant(9.23), number of pods/plant(151.7), number of seeds/pod(3.80) and ultimately the highest Grain yield (1674.5kg/ha) recorded with the T7 (INM+IWM+IPM) which was 79.5% higher than that of control(933kg/ha). This treatment also registered highest net return (49,341/-). However, maximum B:C ratio (3.15) was obtained with T5 (INM+IPM).Prioritizing management options, IPM proved to be the first priority followed by INM and IWM in respect to grain yield & economics. However, Combined adoption of all management practices ie. INM, IWM and IPM together sustainably maximize the grain yield of medium duration pigeonpea.

OFSA-2017/PM-04

Field screening of mungbean germplasms against yellow mosaic disease (YMD) under natural field condition

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Pulses are an important component of dietary habit of Indian people ranging from class to mass. Recently the lack of sufficient pulses in country has created havoc. So there is an urgent need to have an accelerated production of pulses so that in addition to making the country self sufficient in pulses it can also meet the demands of increasing population. Mungbean is the most important pulse crops and being Shorter life span makes them more popular among the growers of India particularly of northern and eastern India and Odisha being the part of eastern India can play a significant role in it. Moreover, mungbean can be grown in all seasons such as kharif, rabi, rice fallow and summer. However, Yellow Mosaic Disease (YMD) is the major impediment causing up to 85% of yield losses in Mungbean and in some cases the yield penalty may go up to 100% (Maiti et al. 2011; Karthikeyan et al., 2014). Several disease management strategies have been developed for YMD but no complete and durable resistance has been observed. Breeding for disease resistance has been a key strategy to incorporate resistance in commercially excellent varieties. For conducting a breeding programme donor parents are required which can be met by screening the genotypes either in controlled condition by artificial inoculation or in field at natural disease pressure condition. Present investigation was undertaken to identify resistant sources against mungbean yellow mosaic virus under natural field conditions. All entries were sown in the experimental field of CPR, Berhampur following infector row technique wherein two rows of each entry was followed by one row of a susceptible check (LGG 460). Each entry and the susceptible check were sown in a row length of 4m with a spacing of 30cm× 10 cm in the summer season of the year 2016-17. Symptomatic observations were taken as per 1 to 9 scale recommended by AICRP on MULLaRP. Out of forty six mungbean germplasms screened, fourteen entries were found to be highly resistant, fourteen entries were resistant and six entries were found to be moderately resistant to Yellow Mosaic Disease(YMD). Hence these germplasms showing resistance to YMD may either be used as donor parent in breeding programme for the development of resistant varieties or may be released for general cultivation.

OFSA-2017/PM-05

Development of IPM module for management of whitefly (*Bemisia tabaci)* on mungbean

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Mungbean is an important pulse crop used by people since ages in India. The crop being short duration in nature, blends well in the rice fallow cropping system in Odisha. The production of the crop is badly affected by the incidence of MYMV disease. The whitefly *(Bemisia tabaci)* has proven to be the potential vector of MYMV virus apart from causing damage being a sucking pest. Constant evolution of new biotypes of whitefly has proved to be an important factor for breakdown of resistance to MYMV in resistant varieties. Therefore an experiment was planned and conducted for development of an IPM module for management of whitefly in un-replicated design during kharif 2016 at experimental plots of CPR, Berhampur. The variety OUM 11-5 was sown over an area of 500 m^2 in two plots (Module 1: IPM practice and Module 2: Farmers pactice). The IPM module was set with the following components: 1) Seed treatment with Imidacloprid 600 FS @ 5ml/kg. 2) Tall growing millet crop @ 2 thick rows around the field as barrier crop. 3) Monitoring with yellow sticky trap @ 50 per ha. 4) NSKE 5 % spray on appearance of whitefly on sticky trap. 5) Spraying of Diafenthiuron 50 WP @ 312.5 g a.i. per ha. (Need based rotation was done with Acetamiprid 20 SP@ 30 g a.i./ha). The IPM module was then compared with farmers practice module where seeds were simply broadcasted without (seed treatment, barrier crop and yellow sticky trap and insecticide spray). The population of whitefly was recorded from one trifoliate leaf after 30 days after sowing. The infestation of aphids, defoliators and pod borers were also recoded and finally the yield was also computed and compared in both the modules.

The percent leaf damage by defoliators was 2.6 % in Module 1 compared to 6.8 % in Module 2. The no. of whitefly/ trifoliate leaf recorded 1 DBS was found to be 3.1 and 3.6 in Module 1 and Module 2 respectively. The no. of whitefly/ trifoliate leaf recorded 3 DAS in Module 1 was 1.6 compared to 6.5 in Module 2. The no. of whitefly/trifoliate leaf recorded 7 DAS in Module 1 was 0.7 compared to 11.6 in Module 2. The no. of aphids/trifoliate leaf recorded 3 DAS was found to be 2.2 in Module 1 compared to 13.2 in Module 2. The percent pod damage recorded during harvest was found to be 4.3 % in Module-1 compared to 10.9 % in Module-2. The yield of mungbean was found to be 7.5 q/ha in Module-1 compared to 3.2 q/ha in Module-2. An additional yield obtained from two thick rows of finger millet used as barrier crop was found to be 10.0 kg. Therefore, basing on the observations it can be clearly concluded that, The IPM module is a better module over the farmer's practice module and can be successfully used in management of whitefly in mungbean.

OFSA-2017/PM-06

Efficacy of insecticides for management of Bihar hairy caterpillar (*Spilosoma obliqua*) in black gram [*Vigna mungo* (L.) Hepper] crop

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Black gram [*Vigna mungo* (L.) Hepper] is the fourth important short duration pulse crop grown in India. The black gram (NDU-1) crop was grown in plots having size 8x6 m with a spacing of 30×10cm at the Students' Instructional Farm, Narendra Dev University of Agriculture & Technology, Faizabad, Uttar Pradesh. The crop was grown during the *Kharif*, 2015 following the recommended agronomic practices in a Randomized Block Design (RBD) with three replications. The crop was sown on 23th July 2015 and harvested on 4th November 2015. Seven species of insect pests belonging to four orders and six families were recorded at different growth stages of the crop. Bihar hairy caterpillar (*Spilosoma obliqua*) was found to be the major pest of highest population density 1.60-12.60. Insecticides judiciously applied in the experiment were Indoxacarb 14.5 EC@ 75g a.i/ha, Imidacloprid17.8 SL@ 30g a.i./ha., Thiamethoxam 25 WG@ 40g a.i./ha, Lambda-cyahlothrin5EC@ 40gm a.i/ha, Triazophos40EC@ 250gm a.i./ha and Azadirachtin 1500ppm @ 3ml/L. Total three observations were recorded 3rd, 7th and 14th days after spray. The most effective insecticide was Triazophos40EC@ 250gm a.i./ha. The percentage reductions in population after final spray were followed by: Triazophos (95.00), Indoxacarb (90.00), Lambda-cyahlothrin (82.00), Imidacloprid (80.00), Thiamethoxam (78.60%) and Azadirachtin (60.60%). Highest cost:benefit ratio 1:23 was observed in Triazophos40EC@ 250gm a.i./ha. Different cultural practices with judicious application of insecticides were better for management of hairy caterpillar. The seed yield of unprotected crop was 6.43 q/ha, whereas the protected crop gave a seed yield of 12.50 q/ha.

OFSA-2017/PM-07

Management of M*eloidogyne incognita* (root-knot nematode) with *Crotalaria juncea* (sunnhemp) in brinjal

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Root knot nematode (RKN) is an important pathogen of vegetable crops causing heavy economic losses. Due to limited availability of good nematicides in market and their hazardous effects, there is shift in focus on management with alternative controls. Addition of organic cover crops, green manure, amendments not only increases the nutrient content of soil but also play role in change of micro flora and micro fauna community structure in the soil. Certain amendments also play role in disease suppression of some important soil borne pathogens. Therefore, the present studies were conducted to study "Management of *Meloidogyne incognita* with *Crotaiaria juncea* in Brinjal". Sunnhemp (*Crotalaria juncea* L.) is a fast-growing legume that is used as a cover crop in many tropical and subtropical areas. In addition to its antagonistic nature to nematodes when incorporated into the soil, sunnhemp adds organic manure thus increasing its twofold utility in sustaining productions in organic systems. Screening of twenty five accessions of *Crotalaria* procured from Central Research Institute for Jute and Allied Fibres (CRIJAF), Barrackpore along with

two recommended cultivars of PAU revealed that all *Crotalaria* accessions were resistant to root knot nematode. The present study showed that incorporation of sunnhemp at the age of fifty and seventy days was found to decrease nematode population effectively and increased the growth parameters. Incorporation of sunnhemp at the age of twenty five, ninety and one hundred twenty days was less effective. Variety PAU-1691 was more effective as green manure than variety NS-1. Soil health was improved with incorporation of sunnhemp and there was increase in available N, P, K and micro nutrients Cu, Mn, Zn, Fe along with soil organic carbon (SOC) and (Microbial carbon) MBC in soil. Root knot nematode population decreased with increase in nitrogen upto ninety days. Increase in soil organic carbon (SOC) and (Microbial carbon) MBC decreased root galling index (RGI) in brinjal. Application of sunnhemp as green manure was found to be comparatively more effective than its use as amendment in reducing *M. incognita* infestation. Both organic and inorganic amendments decreased nematode population significantly in soil and increased growth parameters of succeeding crop brinjal. However, reduction in nematode population was higher in soil amended with organic manures as compared to inorganic manure.

OFSA-2017/PM-08

Bio-management of nematodes - A step towards sustainable agriculture

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Cowpea is an important vegetable crop grown throughout the state round the year. It is a rich source of protein used both as green vegetable as well as dal. Being a leguminous crop, it also adds nitrogen to the soil. However, its production and productivity are affected by so many biotic and abiotic factors including phyto-nematodes. Root-knot nematode, *Meloidogyne incognita* is an important limiting factor of cowpea cultivation with reported yield loss to the tune of 69%. The management modules developed for this nematode so far are mostly consist of the hazardous chemical pesticides . Therefore, an attempt was made under the aegis of AICRP on Nematodes to find out suitable non-chemical management module by use of bio-agents and organic amendments. A field trial was conducted during kharif ,2016 in the OUAT campus, Bhubaneswar with seven treatments including some fungal and bacterial bio-agents and Neem cake in three replications under RBD. Application of the fungal bio-agents, *Purpureocillium lilacinum* @ 20 g/ m^2 + Neem cake @100g/m^2 along with FYM prior to sowing of seeds performed better in reducing final nematode population in soil (121.67) and root of cowpea (34.33) followed by the application of *P. lilacinum* @ 20 g/ m^2 alone. However, significantly highest pod yield (5.11 t/ha) was recorded from *P. lilacinum* @ 20 g/ m^2 + Neem cake @100g/m^2 followed by application of bacterial bio-agent *Pseudomanas fluorescens* @ 20 g/ m^2 + Neem cake @100 g/m^2 and Neem cake @ 100 g/ m^2 alone which are at par. Therefore, it was concluded that the application of harmful agro chemicals can be avoided for management of phyto-nematodes by suitable exploitation of available oilcakes as well as bio-agents in a sustainable manner with natural harmony.

OFSA-2017/PM-09

Antagonistic potential of *Biocontrol agents* against *Macrophomina phaseolina* causing root rot disease in black gram

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Macrophomina phaseolina (TASSI) GOID is a destructive fungus in Black gram crop causing root rot and wilt disease. Being a soil borne as well as seed borne pathogen, it affects all the parts of plant at any stage of crop. Chemicals are less effective, expensive as well as not environment friendly. In search of best alternative for chemicals to manage stem and root rot disease in the field condition the application of biocontrol agents either by seed treatment or soil application or both were very effective. Different bio control agents were isolated from soil as well as collected from different places. Five different *bio control agents* were collected and grown in respective specific medium. In dual culture technique, Bacillus sp. gave highest inhibition (92.0%) followed by the *Trichoderma harzianum (86.00%), and Trichoderma viride (75.0%)* and no inhibition was observed by *Aspergillus niger* and *Saccharomyces cerevisiae* (yeast) after 5 days of inoculation, The microsclerotia of the test pathogen under microscopic observation was totally arrested by this bio control agents. The *Trichoderma sp*. collected from native soil of black gram root zone from Bhawanipatna and Nuapada found significantly reducing the growth of *M.phaseolina in vitro condition.*

OFSA-2017/PM-10

Eco-friendly management of pink stem borer (*Sesamia inferens* walker) in finger millet

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The pink stem borer (*Sesamia inferens*) was a major pest of finger millet in Odisha causing considerable damage in finger millet during summer season. It is polyphagous in nature and cause damage by boring into the stem resulting “dead heart” at vegetative stage and “white ear head” at reproductive stage of the crop. Field experiments were conducted in randomized block design to study the effect of different eco-friendly management tactics against pink stem borer on finger millet variety “Bhairabi” during summer 2016 and 2017. Eco-friendly management tactics *viz.*, T_1-Release of *Trichogramma chelonis* as biocontrol agent at 50000 per hectare at 7 days interval(3 times released starting from 30 days after sowing (DAS)), T_2-Foliar spray of neem pesticide 0.03%(300ppm) @ 5ml./L of water, T_3-Foliar spray of *Bt* (*Bacillus thuringiensis*) @ 2g/L of water , T_4-Foliar spray of NSKE 5% at 15 DAS, 25 DAS(T_5) and 35 DAS(T_6) were evaluated and compared with an untreated check for their efficacy against the stem borer. At 45 DAS the total number of tillers and infested tillers(DH) were counted in each treatment plots and the percent incidence of DH was calculated. Similarly, at 70 DAS , the total number of ear heads and White ear heads(WEH) were counted and from which % WEH was calculated. From two years of experiment *i.e*. summer 2016 and 2017, amongst the management statergies, foliar spray of NSKE 5 % at 35 DAS was found most promising with lowest record of dead heart(DH) (13.79 %)at 45 DAS and 9.20% white ear head(WEH) at 70 DAS which was closely followed by foliar spray of *Bt* (*Bacillus thuringiensis*) @ 2g/L of water at 30 DAS with a record of (15.68 %) dead heart (DH) and 10.59 % WEH as against (22.50 %) dead heart (DH) and 17.84 % WEH in untreated check . From the point of field efficacy, Overall performance showed the superiority of NSKE 5 % at 35 DAS and *Bt* (*Bacillus thuringiensis*) @ 2g/L of water at 30 DAS against the pink stem borer which can well be recommended for integration into the IPM in finger millet.

OFSA-2017/PM-11

Bio-intensive pest management (BIPM) in Cucurbits

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India is the second most populous country in the world. Food production process in India during the green revolution period has been based on the use of more chemical fertilizers and pesticides. Biointensive IPM incorporates ecological and economic factors into horticultural system design and decision making, and addresses public concerns about environmental quality and food safety. The most recent bio-intensive integrated approaches for pest management utilizes components such as cultural methods *viz.,* crop rotation, summer ploughing, fallowing, intercropping, pruning, mulching, spacing, planting date, trap cropping, etc and use of resistant cultivars; bio-agents *viz.,* predators, parasitoids and bio-control agents, mycorrhizal fungi, botanicals including bio-fumigation, oil cakes, FYM, crop residues, green manuring and other organic amendments, physical methods *viz.,* hot water treatment of planting material, soil solarization and bio-rational chemicals like pheromones. Cucurbits are an important group of vegetable crops. Many insect pests infest the cucurbit crops and affect the appearance of the marketable yield. These pests include red pumpkin beetle, fruity fly, leaf miner and white fly. Unlike other crops cultural control is proved to be equally effective as other control options and very economical, and requires very low inputs. Installation of yellow sticky traps smeared with castor oil as adhesive works effectively against whitefly covering the fruits with paper protects against fruit fly. Hand collection and destruction of pumpkin beetle and grubs from plant and stirring the soil imparts mortality of pupal stages of *D. cucurbitae*. Fruit fly infected fruits should be collected and destroyed. Ploughing the infested field after the crop is harvested can help in killing the pupae. Apply the bait spray containing 20 ml Malathion 50 EC + 10 g protein hydrolysate + 500 g of molasses/jaggery in 20 litres of water per acre. Use 10 banana pulp traps/acre against fruit flymix 20 gm banana pulp, 3 drops of palm oil and 10 granules of carbofuran and keep in plastic container. Parasitoids like *Hemiptarsenus varicornis* Hymenoptera (Eulophidae) an endo larval parasiotid of leafminer is found to be very effective against this pest. Predators like *Chrysoperla carnea* 2 grubs plant-1, *Opius compensatus, O. incisus, Spaladia philippinensis* are effective against fruitfly. Conserve predators such as Pennsylvania leather wing beetle (*Chauliognathus pensylvanicus*); larvae of which feed on pumpkin beetle larva. Microbial treatments like *B. bassiana* 2 x106 cfu/ g proved to be effective against pumkin beetle. Studies indicated that neem seed kernel extract at 5 per cent concentration found promising in control of leaf miner and recorded highest yield of bittergourd. Karanj *P. pinnata* oil (29.68%) was found next in the order of efficacy. Fruit fly (*D.cucurbitae*) tolerant/less susceptible varieties available are MM22-2, Lakhazda, Khara, IHR 40 and 47 for muskmelon; HISSAR II and Ghote in Bitter gourd. Fruit fly resistant varieties are ,Arka Suryamukhi in Pumpkin, Pusa Sharbati, Punjab Hybrid, Punjab Sunheri and Durgapura Selection in Muskmelon and Arka Tinda in Round melon. Red pumpkin beetle resistant/tolerant varieties, like Punjab Hybrid in Musk melon, Pusa Chikini in Spong gourd and Pusa Nasdar in Ridge gourd. This concept of bio-intensive pest maangement proposes effective balance of pests and beneficial organisms in an ecological context.

OFSA-2017/PM-12

Effect of different oil cakes against root knot nematode infecting tomato

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Nematodes are commonly known as roundworms and found in diverse environments. They can be beneficial and harmful. Plant pathogenic nematodes colonize various plant tissues and cause severe disease symptoms. The annual yield loss in the world's major crops due to the plant parasitic nematodes is about 12.3%. Root-knot nematodes (*Meloidogyne incognita*) are among the most economically important genera of plant parasitic nematodes on horticultural and field crops. Among various vegetables, Tomato is considered as an important supplement for our daily life. Many pathogenic microorganisms including nematodes cause various diseases in tomato hampering its adequate productivity. More specifically, it is assumed that for root knot nematodes, tomato behaves as the most favourable host. Root knot nematode causes an annual loss of approximately 27.24% in tomato in India. To manage nematodes diseases farmers often use chemicals like Cartap hydrochloride or Carbofuran to check the growth of nematodes population. Since most of these chemicals have serious adverse effects on environment and living organisms, the paper suggests certain biological management practices and eco-friendly approaches which could be a better option for the farmers. In present investigation experiments were conducted to evaluate the effectiveness of different oilcakes against root knot nematodes infecting tomato in pot cultures. Pot culture experiment was conducted in the net house of the Department of Nematology, College of Agriculture, OUAT, Bhubaneswar. The experiment comprised of six treatments in order of T1 = Neem cake @ 100g/m² , T2 = Mahua cake @ 100g/m², T3 = Groundnut cake @ 100g/m², T4 = Mustard cake @ 100g/m², T5 = Carbofuran standard check @ 0.3g a.i./m², T6 = Untreated check. Each treatment was replicated thrice following complete randomised design. The tomato plantlets variety Pusa ruby was transplanted to the pots. At one week after transplanting, nematodes were inoculated into the pots. Observations were taken at 45 days of inoculation which indicated that all treatments increased the plant growth parameters and reduced root knot nematode population over check. The result revealed that the pot treated with neem cake showed improved plant growth rate and reduction in nematode infection as compared with other treated plants. However the present investigation needs testing of treatments in micro plots / field condition for more concrete results.

OFSA-2017/PM-13

Effects of nematode infection on total sugar and starch contents as influenced by root-knot nematode, *Meloidogyne incognita* in susceptible and resistant bitter gourd cultivars

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A pot culture experiment was conducted in the department of Nematology under green house conditionto study the mechanism of resistance & post infectionalalterration of biochemical parameters relating to pathogenesis due to root knot nematode, *Meloidogyne incognita* taking three moderately resistant varieties like Sundargarh hybrid, Amatallabeejgharkarala long green, Ankur hybrid and three highly susceptible varieties like Nakhara local, Indojapane hybrid, Rajsunakhala local of bittergourd. The results revealed that there was variation in the Total sugar contents of different varieties as -6.33, -7.02, -27.49, -19.685, +4.407 &+20.92 percentage &starch content as-26.76, -49.32, -44.74, -18.99 -60.66 & +9.73 percentage over healthy plants in the varieties above mentioned in order. It can be concluded the root knot nematodes bring about great physiological changes in the infected plants which seem to employ physiological & biochemical strategies either to avoided or to tolerate the adverse effect of nematode infection. In general plants infected by root knot nematode show anincrease trend in Total sugar & Starch of infected resistant plants in comparison to infected susceptible plants.

OFSA-2017/PM-14

Feasibility of integration of soil solarization and organic amendments under temperate climate

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Sustainable agriculture necessarily includes the farming practices/techniques without any deleterious effect on ecology and environment. Soil solarization is such a sustainable non-chemical approach that utilizes the solar radiation for soil disinfestation by trapping the solar heat with the help of transparent polyethylene sheet by covering the moist soil, to combat soilborne plant pests including fungi, bacteria, nematodes, and insect and mite pests along with weed seed. To explore the feasibility of soil solarization in temperate regions, the study was conducted during winter months in foothills of South Shivalik Ranges of the Himalayas, to assess the efficacy of soil solarization at low temperatures during winter and its integration with organic amendments on soil temperature and growth response in tomato and brinjal plants grown in such soils. The results indicated that the maximum soil temperature in non amended solarized soil increased to the range of 29°C to 39°C as compared to 24°C to 31°C in non solarized soils. Integration of soil amendment of chicken manure, spent compost and Farm Yard Manure (FYM) with solarization further increased the maximum soil temperatures to the range of 30°C to 44.5°C.

The maximum soil temperature was recorded in soil amended with FYM (44.5 °C) followed by chicken manure (43°C) and spent compost (41.5°C) showing an additional increase in soil temperature ranging from 12 % to 58% over non amended soil. The per cent increase in soil temperature over non amended control during first two weeks was about 25 per cent which and further increased to 32% in 3rd week, 58 per cent in 4th week and about 50 per cent in the 5th week. Integration of organic amendments wit soil solarization significantly improved the root length (23.4 to 39.4% increase over control) and fresh root weight (12.7 to 158 % increase over control) in tomato. In case of brinjal, significant increase in root length, shoot length and fresh and dry weight of root and shoot was observed up on integration of soil solarization and soil organic amendment.The study revealed that soil solarization as a hydrothermal soil disinfestation technique usually promoted to be practiced during summer season, can be useful in temperate climates too through integration of organic amendments and confirmed the efficacy of the technique for increased plant growth response under temperate climatic conditions

OFSA-2017/PM-15

Habitat manipulation in organic ecosystem for insect pest management

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In organic farming pest control heavily relied on biological control avoiding use of synthetic pesticides. Habitat manipulation (ecological engineering) strategy favour the effectiveness of biological agents (predators and parasitoids). It involves altering the cropping system to conserve, augment or enhance the effectiveness of a natural enemy. Habitat manipulation aims to improve the living conditions for natural enemies within the agro ecosystem, by introducing resources needed for fulfilment of their vital requirements. Growing plants providing food in the form of nectar and pollen, additional non-pest prey, provision of structural diversity (for shelter) and breeding and overwintering sites are key factors. Habitat manipulation aims to counter the negative effects caused by agriculture by increasing plant diversity in the agro ecosystem.

Provision of shelter habitat in field influence the abundance, diversity and distribution patterns of natural enemies. It provide protection from anthropologically operations and disturbances (ploughing and harvesting). They are most important in providing overwintering sites for survival in off seasons. They can also offer suitable sites for breeding. Examples of shelter habitats outside the field can be hedgerows, ditches and field margins. During off and on-season, nectar can be an effective food for some stages (adults). Both floral nectar and extra floral nectar can be used effectively. Nectar is energy-rich and is used by natural enemy insects from different orders such as Diptera, Coleoptera and Hymenoptera. It consists of different sugar compounds (mainly sucrose, fructose and glucose) and smaller amounts of other compounds such as amino acids, lipids, alcohols and alkaloids. The composition of nectar differs between plants and various growing conditions. Most natural enemies can feed on more than one type of prey, i.e. they are polyphagous. During periods when the preferred prey is absent, or only found in low numbers, natural enemies can shift to other prey of a suitable size, so called alternative prey. Similarly, parasitoids that can parasitise and develop on more than one specific host species may benefit from having access to alternative hosts. Alternative prey/host can thus be crucial for the survival and reproduction of natural enemies. Pollen is a source of proteins and amino acids for many natural enemies. Pollen consists primarily of nitrogenous compounds, mainly proteins, and other less common compounds such as lipids and sterols. The importance of pollen as a food for syrphid flies and lacewings has been well studied. Before proper planning in a habitat manipulation there is a need to study various tri-trophic interactions existing in the ecosystem. Field execution of habitat manipulation concept involves multi-departmental cooperation and research orientation. Finally the most important thing may be reducing the gap between the farmer and the research findings.

OFSA-2017/PM-16

Integrated management of root-knot disease of okra through application of fungal bio-agents

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Root knot nematode, *Meloidogyne incognita,* is a major limiting factor for profitable vegetable cultivation in Odisha. Okra (*Abelmoschus esculentus* L. Moench), the important vegetable crop grown throughout Odisha is frequently affected by Root knot nematode with 20.1% yield loss. A field study was carried out to manage this nematode in a natural infested field soil (206 J_2 / 200 cc soil) in okra (cv. Utkal Gaurav) through integration of liquid formulation of biological control agents in experimental plots under AICRP on Nematodes, Bhubaneswar during Kharif, 2016. For this study, liquid formulated egg parasitic fungus *Purpureocillium lilacinum* and *Pochonia chlamydosporia*) were applied as seed treatment (5ml /kg seed) followed by soil application of @ 2.5 ton/ha pre incubated vermicompost (10 ml/ kg) in different combinations in a Randomized Block Design . All the treatment combinations reduced the incidence of root-knot disease of okra compared to the untreated control. Among the different treatments evaluated, seed treatment with *Purpureocillium lilacinum* @ 5 ml/kg followed by soil application of vermicompost @ 2.5 ton/ha enriched with *P. lilacinum* @ 10 ml/kg recorded the maximum increase in plant height (50.23%), fresh shoot weight (39.44%), fresh root weight (36.51%) and plant biomass (41.26%) of okra plant with decreased root knot nematode population in soil (52.98%) and root (60.24%) , root galls (73.64%) and egg masses per plant (74.39%) over untreated check with lowest root knot index(2.0). This management practice gave the highest fruit yield (7.19 t/ha) with ICBR of 2.75 followed by seed treatment with *Pochonia chlamydosporia* @5 ml/ kg + soil application of vermicompost @ 2.5 ton/ha enriched with *P. chlamydosporia* @ 10 ml/kg (7.10 t/ha).Therefore, it is suggested that integrated approach using bio-control agents with vermicompost to manage root-knot disease of okra under natural infestation is not only environmentally friendly but also more beneficial to growers.

OFSA-2017/PM-17

Integrated pest management of pasture crops in organic farming

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Organic farming is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activities. It is based on minimal use of off-farm inputs and management practices that restore, maintain and enhance ecological harmony. Crop diversity is a distinctive feature of organic farming which supports a wider range of beneficial insects, helps environments thrive and protect species from getting extinct. In this process pasture crops play an important role in crop diversification as well as boost up the organic farms attempt to provide animals with natural living conditions and feed. The benefit of pasture crops to humans, however, is not limited only to livestock production. They also contribute to food crop production and many other aspects of human life like soil conservation, landscape and wildlife conservation, protection of the environment from pollution, potential

conversion of biomass to energy. The insect pests like Alfalfa weevil, Potato leafhopper, True Armyworm, Fall Armyworm, Cutworms, Green June beetle, Meadow spittlebug, Clover root curculio, Greasy Cutworm, Spotted alfalfa aphid, Grasshoppers and crickets are the major pests of some pasture crops i.e. Alfalfa, White clover, Guinea grass, Perennial Rye grass, Bent grasses, Stylo, Kentucky bluegrass. For controlling these pest population i.e. below EIL (Economic Injury Level), Integrated Pest management (IPM) approach is the best option for maintaining environment sustainable. For this various control measures like Host resistance, Biological control, cultural control, mechanical control, sanitation, bio fumigation, botanicals, use of pheromone traps are done. Row covers can be adopted to protect crops during pest migration periods.

OFSA-2017/PM-18

Nematode management in sustainable and subsistence agriculture

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Most of the world's agricultural land still cultivated along traditional lines and there is now greater recognition by the international scientific community. Although subsistence is an important aspect of farming for small holder farmers in developing countries, very few pure subsistence holding remain in most cases supplementary cash cropping is practiced. Sustainable system can apply to agriculture in both developed and developing countries.Small scale and subsistence farmers using traditional methods manage to avoid the build up of damaging nematode population densities, and the occurrence of a serious nematode problem is often one of the first indications that a farming system has become unsustainable. Indigenous nematodes may remain benign in traditional cropping systems and may only achieve pest status through the introduction of modern intensive cultivation practices, as has occurred with *Meloidogyne acronea* on cotton in southern Africa. Many practices used in traditional agriculture help in managing nematodes and other pests, either in total or in modified form. Nematicides are occasionally used by subsistence farmers, but normally their use is not recommended nor is it appropriate in these farming systems as they have negative impact on environment.

The management of nematodes and some other pests can be achieved in sustainable and subsistence agricultural systems by the integration of different farming practices. Those are preventing the introduction and spread of nematodes by the use of nematode free planting material; using direct, nonchemical, cultural, and physical control methods, particularly crop rotations and soil cultivation, fallows, flooding, burning stubbles, planting antagonistic or trap crop, grafting;encouraging naturally occurring biological control agents by an understanding of cultivation methods and appropriate use of soil amendments; maintaining or enhancing the biodiversity inherent in traditional farming systems that use multiple cropping and multiple cultivars to increase the available resistance or tolerance to nematodes.

So, the integration of these practices will have the most beneficial effect whichis being developed to manage nematodes that incorporate or consider many of the alternative small-scale farmer practice. As information is improved and nematodes and other organisms become recognized as pests by these farming communities, new methods are introduced or develop to cope with the new circumstances and maintain or increase productivity.Our aim should be to assist in this development by recognizing the valuable means of nematode management that can be retain and improved as change occurs.

OFSA-2017/PM-19

Polyculture: a tool for pest management in organic agriculture

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Organic agriculture is a holistic production management system which promotes and enhances agroecosystem health, biodiversity, biological cycles and soil biological activities. Insect pests pose a major challenge in organic crop production systems since genetically modified crops and synthetic pesticides are not permitted for use in organic production systems. Therefore, it has been realized to formulate ecofriendly strategies for the integrated management of insect pests in organic agriculture. Crop diversification can help to realize the potential of resource-limited natural enemies by satisfying their requirements for food and shelter. Polyculture is an agricultural practice in which multiple plants are grown in the same space and imitates the diversity of natural ecosystems, which has a significant impact on the insect populations. The population density of arthropod herbivores in polyculture was found to be lower than in monoculture. Growing plants of different species in close physical proximity may suppress insect pests problems by releasing different plant volatiles into the surroundings as compared to growing host plants in concentrated manners allowing easy and rapid colonization of insect pests. The growing different distantly related plant species can visually or chemically interfere with specialist herbivores, making the habitat less favourable. Intercropping is one of the important forms of polyculture which is based on the principle of reducing insect pests by increasing the diversity of an ecosystem. The presence of multiple crops in a same agro-ecosystem provides a habitat for a variety of insects and therefore increases the local biodiversity, especially the beneficial insects, such as parasitic wasps, leading to reduction of outbreaks of crop pests. Colorado potato beetles were reported to attract to volatiles emitting from potato, but are repelled or not attracted by mixtures of potato and tomato. Growing trap crops in organic farming can reduce pest pressure on the main crop by being more attractive to insect pests than main crops. In recent years, efforts in trap cropping has been increased considerably and become a vital component in IPM Package. Inherent characteristics of a trap crop may include not only differential attractiveness for feeding but also other attributes that enable the trap crops to serve as a sink for insects. Raising tomato with marigold in 3:1 combination gave maximum reduction in fruit damage caused by *Helicoverpa armigera* in tomato. Different species of plants may vary in their ability in serving as a trap crop. However, the effectiveness of trap cropping depends on the proper timing of planting, adequate spacing and size of the trap crop. In order to achieve successful pest management in organic agriculture, the development of ecologically sound, appropriate insect pests management systems for each crop is necessary and ITKs should be taken into consideration in integrated pest management system.

OFSA-2017/PM-20

Use of botanicals in control of plant parasitic nematode

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Plant-parasitic nematodes are worst enemies of mankind, causing great damage to all agricultural and horticultural crops. They infect all plant parts and cause damage directly or indirectly. The estimated annual yield loss by nematodes in major crops of the world is 12.3%. There are two broad categories of nematode management practices i.e. Chemical

and Nonchemical. The chemicals usually used were fumigant and non-fumigant nematicides. These are not only expensive but also have negative impact to the environment. The demerits of hazardous chemicals have created interest in searching alternate methods for nematode management i.e. botanical insecticides; It possess a spectrum of properties including insecticidal activity, repellence to pests, insect growth regulation, toxicity to nematodes and other pests of agricultural importance and also possess antifungal, antiviral, and antibacterial properties against pathogens. Generally, botanicals degrade more rapidly than most conventional (synthetic) pesticides, and so are considered relatively environmentally benign and less likely to kill beneficial insects, mites and nematodes than pesticides with longer residual activity. Many compounds with nematicidal activity have been found in plants including alkaloids, diterpenes, glucosinolates, isothiocyanates. Botanicals can be used in four different ways to reduce nematode infestation i.e. by using the parts of botanicals directly i.e. extraction of parts of botanicals, compounds of botanicals possessing nematicidal activities, plants as oilseed cakes, mature crop residues and organic amendments. So, they can be applied as different ways like application of fresh leaves of Azadirachta indica, Sesbania aculeate and water hyacinth or water hyacinth compost @ 60 kg N/ha found useful for managing the population of Hirschmanniella oryzae and increasing grain yield of rice. Seed soaking with aqueous extracts of neem and karanj seed kernel at 20% proved to be most effective among various plant products tested in improving plant growth of cowpea and minimizing infection of R. reniformis. Egg masses or larvae of Meloidogyne incognita were exposed to varying concentrations of neem leaf (fresh and dry), Borrelia sp., groundnut leaf and garlic bulb. Neem leaf and garlic bulb extracts inhibited hatching of egg masses and were lethal to larva. Botanicals bring sustainability to agriculture as it involves integration of biological, cultural and natural inputs for the management of nematodes. For the conservation of biodiversity aiming to maximize food production and minimizing health hazards, botanicals may stand as the most promising source of bio-active products of plant origin.

OFSA-2017/PM-21

Use of traps for pest management in organic farming

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Organic farming is gaining popularity worldwide among the farmers, entrepreneurs, policy makers and scientists as it minimizes dependence on chemical inputs, thus safeguarding quality of natural resources and environment. In organic farming, insect pest pose a major challenge since genetically modified crops and synthetic pesticides are not permitted for use in organic production systems. The underlying principle of integrated pest management (IPM) in organic system of cultivation involves application of ecologically sound practices. Major emphasis is given on use of multiple and various tactics incorporated into the cropping system design to prevent the damage caused by the insect pests. The key strategies of IPM of organic farming are selection of resistance/tolerance varieties, planting trap crops, following crop rotation, conservation of biological agents and soil quality management. The use of different traps is one of the preventive control measure taken in pest management in organic farming.Uses of sticky traps, physical barriers and pheromone lures to suppress insect pests have more relevance in organic farming with a view to monitor their population and management as well. When paired with traps, pheromone and scent lures utilize both chemical and visual attractants. Yellow sticky traps can be used as an efficient tool to monitor the population of leaf miners, aphids, thrips and whiteflies as these insect pests are attracted to the yellow colour. This control method when used at proper time, can suppress specific insect pests. Yellow sticky traps have been used as a practical control measures for *Liriomyza* flies as well as for whiteflies in vinyl houses producing vegetables. Physical traps or barriers can also be used to manage snails to determine if they continue to spread. Exploration of pheromone trap is another important approach to monitor and manage key destructive insect pest species which are really difficult to manage in organic system of cultivation. Mass

trapping of males of squash vine borer by using pheromone deprived the females from successful mating and oviposition. In India, pheromone traps have already been successfully used against pests like rice stem borer and brinjal fruit and shoot borer.

The farmers should be more educated about traps and their effective use in pest control. Placement of traps is essential so that insects are likely to come into contact with them. Hence the use of traps should be popularised as it not only economises the cropping but also helps maintain the purity of ecosystem to be maintained**.**

OFSA-2017/PM-22

Role of silicon in reducing insect attack and pest incidence on plants

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Crop residues especially of silicon accumulating plants can be used as silicon resource. Silicon is absorbed by the plant roots through a passive process regulated by transpiration stream, which occurs via the xylem along with water or by an active process through transporters located in the plasma membrane of root cells. The absorbed silicon accumulates in the old tissues of the plants mainly in the walls of epidermal cells as polymerized monosilicic acid which strengthens cell wall and increases the structural rigidity of tissues .The application of silicon as pest management resource can save the cost of expensive fungicides, insecticides and other fertilizers as reported in rice as it eliminates the need of fungicides or pesticides .Silicon is potent enough to act as a biological inducer of plant defense responses other than being a mechanical barrier. It has been observed that sucking pests and leaf eating caterpillars have a low preference for the silicified tissues than low silica containing succulent parts. Silicon decreases the food intake, growth longevity, fecundity and population growth of xylem feeding white backed plant hopper *Sogatella frucifera*. Soluble silicon reduces reproduction capacity of phloem feeding aphids *Myzus persicae* in potato, wheat and white fly in cucumber plants. The hardness of cane of sugarcane plants is due to a higher silica content which reduces the shoot borer attack. The inert dust containing silicon are safe and adversely affect on stored pests by their dehydration and desiccation, it impaires the digestive tract of the pests, blocks spiracles and tracheae, absorbs lipids from cuticle by damaging the wax layer and reduces the weight of the insects. Increasing evidence shows that silicon treatment increases transcript levels of defense-related genes, there by enhancing the activities of plant defensive enzymes leading to increased accumulation of defensive compounds, such as phenolics, phytoalexins, and momilactones.Increased abrasiveness of leaves due to silicon deposition reduces food quality for herbivores and may cause wear of herbivore mouthparts, which further reduces feeding efficiency and growth rates.

OFSA-2017/PM-23

Seasonal incidence of whitefly, *Bemisia tabaci* (gennadius) on field pea

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Field pea is one of the most popular food crop as it is very nutritious and its cultivation is also easy. Field pea usually grows in the cold areas unlike the other major pulses. The whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) is one of the limiting factor among the other limiting factors to the higher yield of field pea. It causes direct damage by feeding the phloem sap, and producing copious amount of honeydew. Besides this direct damage, it also inflicts an indirect damage by transmitting large number of viral diseases (Al-Deghairi, 2009). Taking the field pea genotype DF-1, a field pea experiment was conducted at the Centre of Excellence for Research on Pulses, S.D.A.U, Sardarkrushinagar, Gujarat which was kept insecticide free. The observation of pests, number of whitefly (adult and pupa) were counted separately from three leaves one each from top, middle and bottom region per plant (from five randomly tagging plants from each net plot) at weekly interval. Whitefly (*B. tabaci*) population on field pea commenced 2 WAS (Week after Sowing) *i.e.* second week of December (0.90 whitefly/3 compound leaves). The pest population increased gradually and reached to the first peak level 10.36 whitefly per three compound leaves during the first week of February *i.e.* 11 WAS. Subsequently, its population decreased gradually and reached to a minimum level of 0.80 whitefly per three compound leaves during 16 WAS *i.e*., second week of March.

OFSA-2017/PM-24

Evaluation of bio-agents for management of rhizome rot of ginger

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A field experiment was conducted at RRTTS, G.Udayagiri , Kandhamal, Odisha to find out an effective control measure against rhizome rot disease of ginger(*Zingiber officinale* Rose).Kandhamal district of Odisha is famous for organic turmeric and ginger .Experiment consisted of seven treatments of bioagents like *Trichoderma viride, Trichoderma harzianum*, and *Pseudomonas fluorescens* were tested. Bioagents were used as rhizome treatments and soil drenching in ginger crop. All the treatments were significantly decreased the incidence and severity of the disease .the most effective treatment was rhizome treatment for 30minutes with *Trichoderma harzianum* @ 5gm/litre followed by soil drenching at the appearance of the disease. Rhizome treatment with *Trichoderma viride* @5gm/litre and soil drenching at the appearance of the disease and rhizome treatment with *Pseudomonas fluorescens* @10gm/lt and soil drenching at the appearance of the disease were also found effective to manage the disease and increase in yield.

OFSA-2017/PM-25

Effectiveness of different organic products and reduced levels of fertilizers on the incidence of Epilachna beetle and sucking insect pests of brinjal

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The field experiment was conducted at the Central Research Station, OUAT, Bhubaneswar (Odisha) during 2012-13 to reveal the impact of indigenous products and bio-nutrients along with reduced levels of fertilizers on the incidence of insect pests of brinjal cv. Blue star. The jassid population was unaffected with nutrient levels tested, while application of 50% recommended dose of fertilizers (125:100:80 kg/ha of N, P and K) (RDF) with Bio-NPK like azospirillum , phosphate solublising microbes, potash mobilizing bacteria showed significantly high population of whiteflies (3.65/3 leaves) as against 3.05/3 leaves in plot receiving RDF. The leaf damage by epilachna beetle, fruit damage (both on number and weight basis) and marketable fruit yield were however, found unaffected by the nutrient sources tested. The benefit cost ratio was appreciable when the crop was raised with 50%RDF + Bio-NPK and protected with carbosulfan 25EC(3.44:1) and spinosad 45SC (2.20:1)

OFSA-2017/PM-26

Biofumigation: An eco-friendly management for soil borne diseases

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Fumigants like Methyl bromide, Carbon disulphide have been in use for agricultural and horticultural crops at a large scale for many years with the aim of reducing soil borne pathogens like *Rhizoctonia, Fusarium, Phytophthora* etc. But the restrictions on the use of synthetic soil fumigants generated interest in alternative method like Biofumigation**.**The term 'biofumigation' was originally coined by J.A. Kirkegaard to describe the process of growing, macerating / incorporating certain *Brassica* or related species into the soil, leading to the release of isothiocyanate compounds (ITCs) through the hydrolysis of glucosinolate (GSL) compounds contained in the plant tissues . This can result in a suppressive effect on a range of soil borne pests and diseases. Plants belonging to Brassicaceae (Cabbage, Mustard, Radish etc.) are mainly used for biofumigation, but plants in Moringaceae and Salvadoraceae families also have biofumigant properties.Biofumigation can be done either by incorporation of live brassica plants at flowering stage or brassica meal as cake or powder.Biofumigationis very pathogen specific and is one of its major limitations.*Gaumannomyes* is most sensitive while *Pythium* is least sensitive and *Rhizoctonia* and *Fusarium* are found to be intermediate in sensitivity. In addition it does not provide a long term control option.Thus to ensure sustainable agriculture production, it has to be integrated with other disease management practices such as biocontrol agents, organic amendments together with reduced fungicide applications.This is a promising research area in future prospects.

OFSA-2017/PM-27

Studies on effectiveness of aqueous seed extracts of some plants against *Pectobacterium carotovorum Pv. carotovorum* causing soft rot disease of potato

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In our state planting of potato starts from 2nd week of November and it may extended last week of December depending upon the land availability as potato is usually grown after paddy. Harvesting starts from 1st week of February and extends to end of March depending upon the planting time. The potato crop is affected by number of diseases from the time of emergence till harvest . Among these diseases rotting of potato tubers by Pectobacterium carotovorum occurs before and after emergence at harvest also in transit and storage. In present studies in vitro testing ofantibacterial property of aquous seed extracts of some selected crops against P. carotovorum pv. carotovorum was tested in Dept. of Plant Pathology,Orissa University of Agriculture and Technlogy,Bhubaneswar in the year 2010. As use of organic products gaining popularity day by day.These are produced by following organic method of cultivating crops and storing of plant products.The seeds used for the studies were ,i.eTerminalia chhebula (Chebulic myrobalan), T belerica(Beleric myrobalan) , Emblica officinalis (Indian goose berry),lAmomum subulatum (Greater cardamom) Raowlfia serpentine(snake root),banasorishan, Coleome viscose(wild mustard), Coriandrum sativum(Coriander) (Cuminum cyminium (Cumin), Aazadiracta indica (neem),Cassia tora (Senna tora),Nigella sativa (Black cumin), Foeniculum vulgare (Fennel), Piper nigrum (black pepper), (Amomum aromaticum (Aromatic cardamom), Syzygium caryophyllus (Cloves), Cassia fistula(Indian laburnum).Fifty grams of seed samples of each crop were soaked in 50 ml. of distilled water overnight and grinded with the help ofpistil and mortar.The paste was and the filterate was collected in sterile culture tube. The filerate was centrifused at 1500 rpm for 15 minutes. The supernatant was drawn out syringe aby filter sterilized by passing through membrane filter. Finally the extract was transferred into 2ml viales and stored in deepfreeze(-20^{0}C) for use. The inhibition zone technique was followed to test the effectiveness of aqueous seed extracts against P.carotovorum. In control sterile water was used. The experimental results revealed all the aqueous seed extract exhibited zone of inhibition ranged from 6.68 to13.53mm Maximum zone of inhibition was observed in R serpentine (13.53 mm) followed by A.subulatum(11.33mm). Minimum zone of inhibition was in E.officinalis(6.68mm).

OFSA-2017/PM-28

Use of ladybird beetle (Coleoptera: Coccinellidae) and pheromone technology in organic farming for sustainable agricultural practices

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Coccinellids are best known as predators of aphids and scale insects. The majority of coccinellid species are generally considered useful insects. Among them thelady beetles can play an important role in managing insect pests in agricultural as well as ornamental crops. This makes them particularly valuable as agents in biological control programmes of sustainable agricultural practices.Phermones are organic compounds that transmit chemical messages. They are used

by insects for intra- and interspecies communication. These pheromones are a diverse category in terms of their chemical structure.The study of phero-chemicals among the Indian ladybirds through head-space solid phase micro-extraction(HS-SPME) coupled with GC-MS technique is employed for detection and quantification of volatile profile of the ladybird-phermones from Indian ladybirds namely: Coccinellaseptempunctata(L.),Coccinellatransversalis(Fabr.), Menochilussexmaculatus(Fabr.), Propyleadissecta(Mulsant), andAnegleiscardoni(Weise)for the first time. Designing a novel and low-cost indigenous technique for detection and estimation of volatile phermones of ladybird beetles through divinylbenzene/carboxen/polydimethylsiloxane (DVB/CAR/PDMS) fibers is a unique innovation in the field of biological pest management. The interesting part of this technique is that, without sacrificing or without providing undue stress to these insects the semiochemicals can be detected naturally. The major compounds reported inC. septempunctata, C. transversalisandA. cardoniwere methyl-branched saturated hydrocarbons, whereas in M. sexmaculatusandP. dissectathey are unsaturated hydrocarbons. This variation in pheromones might have a role in behavioral or ecological aspects of the studied ladybirds. The different hydrocarbon profiles may further be helpful in the sustainable agriculture practices where, organic agriculture in terms of biological control of pests and insects can be carried out. Use of this ladybird-phermone technology in controlling the insect-pest instead of the pesticides and insecticides will promote the organic farming in a sustainable agricultural practices.

OFSA-2017/PM-29

Management of post harvest disease of banana by bio-agents & botanicals

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India ranks first in banana production, contributing about 23% in world pool of banana production. In resent years, considering the adverse impact of indiscriminate use of chemicals, new trend for organic production of banana is increasing in the country. This refers to organically grown crops which are not exposed to any chemicals right from source of planting material to the final post harvest handling and processing. Among the several diseases associated with banana crops, Anthracnose disease is a major post harvest disease of Banana in which up to 29.2% loss was recorded. To manage this disease through Bio agents and botanicals an experiment was carried out under AICRP on fruits, Bhubaneswar during 2015-16. For this study five treatments were taken in a five replicated trial in CRD in which sample size of five hands as replication with ten fruits per replication were adopted.Treatments like dipping of Banana fruits in Botanicals like Solanum torvum extract (50%), Trichoderma viride solution @ 20g/ litre of water , Pseudomonas Virideflava solution 20 g/litre of water , Yeast suspension @ 10^7 cfu/ml and tap water washing as control were taken. All the treatments reduced the anthracnose disease of Banana and enhanced the post harvest life of Banana. Among different treatments evaluated plant extract dipping of the banana fruits in Solanum torvum extract 50% was highly effective in reducing the Anthracnose disease (PDI 1.19%) (19.0 days) shelf life. Among bio agents, dipping the banana fruits in Trichoderma viride solution @ 20 g/litre of water was effective in reducing the anthracnose disease (PDI 1.50%) (shelf life 15.33) followed by dipping the banana fruits in Pseudomonas virideflava solution @ 20 g/litre of water (PDI 1.52%) (shelf life 14.33 days). Dipping the Banana fruits in Yeast suspension at 10^7 cfu/ml had the good effect on the post harvest life of Banana (PDI 2.5% and shelf life 12 days). All the treatments reduced the post harvest disease of Banana and enhanced the shelf life compared to the untreated control. It is suggested that using Botanicals Solanum tarvum leaf extract (50%) is not only environmental friendly but also more beneficial to the growers in enhancing the shelf life to as long as 19 days.

OFSA-2017/PM-30

Silicon in Agriculture

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Silicon (Si) is a noble element. It is known to be second in abundance to oxygen in the earth crust and accounts for 50 - 70% of the soil mass. It deposits in the soil as two main forms of silicates and alumino-silicates. Silicon has been shown to enhance growth and yield, promote upright stature, prevent lodging, promote favorable exposure of leaves to light, and provide resistance to bacterial and fungal diseases. It is therefore essential that future research endeavors should take advantage towards defining and understanding on how Si can best be integrated into sustainable management practices. In spite of the many scientific reports, the properties, spectrum of efficacy and mode of action of Si remain speculative. The distribution of silicon in plants, transport in plants with regard to abiotic and biotic stresses and possible mechanism against oxidation of cell membranes and regulation of osmolytes within cells, leading to the protection of various plant structures and functions, is very crucial to comprehend. Silicon effect is even more marked in terms of post-harvest internal quality parameters, such as nutritional content, chemical residues (where crops are treated with fungicides and pesticides) and characteristics that positively influence the resistance of produce to transport, handling, storage and its behavior in food transformation and processing. They also exhibit soil-conditioning properties by enhancing the water-holding capacity, without any augment in heavy metal contamination. The demand for increased productivity of rice requires integrated sustainable agricultural practices in combination with silicon fertilization, which has evident to promote plant growth. The exploitation of silicon in agriculture thus has the potential to become a fundamental tool in support of sustainable agriculture, biological/organic production and in safeguarding the environment conditions.

OFSA-2017/PM-31

Bio-efficacy of mineral oil against yellow mite (Polyphagotarsonemus Latus Banks) in jute

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Jute is an important commercial bast fibre grown in different states of India viz.West Bengal, Bihar, Odisha, Assam and other North Eastern states. Pest is one of the important obstacles in jute cultivation. Different pests like Semilooper, Anomis sabulifera, Guen, Stem weevil, Apion corchori, Marshall and yellow mite, Polyphagotarsonemus latus Banks are very important. But, among the important insect pest, only mite infestation at 35DAS to young unfolded leaves is very important (Gotyal, etal.).Looking at the importance and infestation of mite an experiment was conducted at Jute Research Station,Kendrapara.An experiment was conducted taking seven treatments and three replication adopting RBD.The details of treatment are, T1-Mineral oil 3 ml/litre @35 and 50 DAS,T2- Mineral oil 6 ml/litre @35 and 50 DAS,T3- Mineral oil 9 ml/litre @35 and 50 DAS,T4-Neem oil 3 ml/litre @35 and 50 DAS,T5- Mineral oil 3 ml/litre + Neem oil 3 ml/litre @35 and 50 DAS,T6-Insectcidal soap solution @ 3 ml/litre @ 35 and 50 DAS.T7- control (No spray).The observation on mite population was taken on number of mites/sq2 in second unfolded leaves at 35 DAS(before spraying).Then succeeding no. of mite population was also counted at 4 and 7DAT. Similarly, second observation was taken at 50 DAS (Pre count), then succeeding observations were taken at 4 and 7 DAT after spraying.Besisides

the mite population, plant height and fibre yield data were taken simultaneously. During first spraying T3 gives highest result in reducing the mite population to 4.8 mite/cm2 over all other treatments as well as from control(19.7 mite/cm2) at 3DAT and at 7 DAT the same trend was reflected to reduced the mite population to 1.9 mite/cm2 in T3 which is statistically significant over all other treatments and also control(21.9 mite/cm2).During second spraying all the treatments are significantly different over control reducing mite population from T7(14.3 mite/cm2) to minimum mite population in T3(3.6 mite/cm2) at 3 DAT as well as same trend was reflected in reducing mite population in T3(1.3 mite/cm2) over control (11.4 mite/cm2) at 7 DAT.From this trial, T3 (Mineral oil 9 ml/Litre @35 and 50 DAS) gives highest result (25.53q/ha) with plant height 342 cm and basal diameter 2.1 cm.

OFSA-2017/PM-32

Population of Sogatella furcifera (Horvath) in rice as influenced by organic source of silicon

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Diatomaceous Earth (DAE), an organic source of silicon, was field evaluated for its efficacy against rice white backed plant hopper, Sogatella furcifera as a sole product and in combination with insecticides having different mode of action. Experiments were carried out in the central research farm of Orissa University of Agriculture and Technology, Bhubaneswar during Kharif 2016. DAE was applied as basal at the rate of 300 kg/ha during last puddling and insecticides were sprayed twice at 30 and 70 days after transplanting. Basal application of DAE through field broadcast exhibited promising result and effectively arrested the hopper population built up with a record of 2.57 to 15.13/hill at different stages of crop growth as against 22.47 to 111.0/hill in control, revealing the importance of exogenous application of silicon in rice. Amongst the test insecticides, dinotefuran belonging to neonicotinoid group, alone and in combination with buprofezin gave better control of plant hoppers with a record of 4.08 to 7.92 hoppers/hill as against a maximum of 31.12/hill in plots receiving acephate and 45.97 hoppers /hill in untreated check. Buprofezin as such, being a chitin inhibitor, showed delayed action and found moderately effective against S.furcifera resulting in a population of 15.80/hill but remained distinctly inferior to that of dinotefuran or dinotefuran+buprofezin. On the other hand, DAE along with insecticides hardly showed any perceptible improvement over insecticides alone except in plots receiving acephate but were found compatible with each other. The interaction effect of DAE with acephate can simply be attributed to the resistance inducing ability of silicon rather than their additive effects. Thus, the treatment combination was helpful in arresting the hopper population built up (9.68/hill) resulting in 78.9% decrease in population over control as against 32.2% decrease by acephate alone. From yield point of view plots receiving both dinotefuran and combination product dinotefuran+buprofezin along with DAE resulted in highest grain yield of 42.0 - 45.0 q/ha compared to 30.53q/ha in untreated check. The overall performance of DAE as basal application in the experiment revealed the absolute necessity of using this organic source of silicon in rice particularly in hopper endemic areas, which can suitably be integrated in to the sustainable pest management system, especially in areas of organic farming.

OFSA-2017/CD-01

Integrated rice based crop- livestock –agro-forestry system: An eco-efficient and climate resilient agricultural practice for small and marginal farmers

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Eco-efficient agriculture are concerned with the development of land management system with integration of crop-livestock-agro-forestry system with recycling and judicious farm resources with lesser dependence of non-renewable resource which can be achieved through either by altering the management of individual crop and livestock enterprises or by altering the land-use system. The rationalization of farm resource with energy-efficient agriculture along with the provision of environmental protection is paramount essentials for sustainability in agricultural production. We have developed crop- livestock- agro-forestry based integrated farming system (IFS) model having an holistic approaches of farm managements with the objective of soil health management, water harvesting and conservation, judicious use farm resources with nutrient recycling along with increasing agricultural productivity with provision of sustainability, enhancement of farm income, employment generation, nutritional and environmental security to the farm families. The system having agro-ecological features of biodiversity and dependence on local resources and crop varieties, etc. have been proved to be enhancing sustainability and resiliency in climate changing scenario. The climate change adoption strategies includes the re-shaping of their farm land to make the land cultivable and to accommodate multiple subsystem (pond - rice field - vegetable garden, livestock- duckery, poultry, goatry, horticulture and agro forestry), helping farmers for diversifying the source of income and employment. The presence of duck in the system, feeds on dead leaves, weeds and pests in the field, and during process of continuous moving and foraging action causing stir up the water, soil and continuously fertilize the fields with droppings. This helps in releasing nutrients from the soil as well addition organic manure, which stimulates rice plant growth and yield. Presence of ducks helps in controlling the weeds and insect's pest population in the rice fields subsequently reduced the requirements of herbicides and pesticides, resulting avoidance GHG emission. The integration of crop-livestock-agro-forestry system enhances the farm and water productivity as well as diversifies and enhancing the farm income with provision of biological control of weeds, pests and organic fertilizer. The system having potential for climate change resiliency and mitigation strategies and thus enabling the farmer's participation of climate risks managements for building climate resilient organic production systems for national food security.

OFSA-2017/CD-02

Scope of use of industrial wastewater in agriculture for sustainable development

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Water and nutrients are the key inputs for crop production. Current population of our country is about 1.27 billion and the World Bank estimates that it will reach around 1.6 billion by the year 2050. Though there has been a quantum jump in food grains production, from mere 72.35 to 264.77 million tonnes during the fifty years of green revolution but there is a need for increased production to meet the ever growing demand. At the same time, there has been a mounting pressure on both land and water.India accounts for only 4% of world's renewable water resources, but the country has to support about 18% of the world's human population.Therefore, the country has twin challenges- meeting the demand for food and facing water scarcity.

Today much effort is being made to make use of wastewater for irrigation and it is looked upon as a valuable resource. Wastewater use in agriculture has certain benefits, providing water and nutrients for the cultivation of crops, ensuring food supply to cities and reducing the pressure on available fresh water resources. A study was taken in Angul, Odisha to find out seasonal variation in wastewater quality. Six different locations within the Central Pollution Control Board identified periphery was taken at different locations viz Kulad, Kulad culvert, Gotamara, Bonda culvert, Nuahatta and Digi.It was observed that wastewater quality containing ammoniacal N, nitrate N, phosphate and available potassium of 11.2 ppm, 22.4ppm, 2.85 ppm and 3.73 ppm respectively, was found quite suitable for irrigation during *rabi* season. At the same time most of the tested heavy metals Fe^{2+},Cr^{6+},Mn^{2+},Ni^{2+} were found within the permissible limit.The study revealed that wastewater can be used safely for peri-industrial agriculture and can enhance farmers' income even when freshwater is scarce.

OFSA-2017/CD-03

Crop residue management and conservation agronomy for sustainable crop production

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Sustainability of soils depends upon its physical, chemical and biological health, intensity of crop production practices, input use pattern and withdrawal from the system through crop production outputs. Soil and water are important natural resources for crop production systems. An attempt has been made for a brief synthesis on the soil and water management strategies and technologies, based on the field experimental studies conducted in different soils and climatic conditions in India. Crop residue management and conservation tillage for soybean-wheat cropping system was successful. In a long-term experiment on vertisols, it was found that crop yield in soybean-wheat cropping system in no tillage (i.e., with crop residues retained on the surface and direct drilling of seeds without any preparatory tillage) was similar to conventional tillage, mould board ploughing and reduced tillage systems. No tillage was adequate to support the crop in terms of crop yields with concomitant saving of energy and improvement in soil health. Soil crack dimensions (length, width, depth & volume) reduced in conservation tillage systems. Rice residue management options like incorporation in the plough layer and residue retention on the soil surface hold promise. Optimum puddling is essential in vertisols; effects of varying intensity of puddling to clayey soil were explained by changes in soil aggregate stability, bulk density, penetration resistance, soil cracking pattern upon drying, water movement through seepage and percolation, and intensity of weed growth during cropping. Soil-water-nutrient management using *Gliricidia* leaves and/ or farmyard manure (FYM) and crop diversification on broad-bed and furrow (BBF) land configuration in a landscape micro-watershed in vertisols led to sustainability of soils. Integrated nutrient management (INM) is found effective. Maintenance of soil organic carbon (SOC) in soils is very essential. The agricultural production systems leading to loss of SOC might be contributing to release of CO_2 into the atmosphere. An analysis for cropping systems like rice-fallow, rice-groundnut, rice-potato, rice-rice, mango and guava orchard showed that SOC stock was the highest within 0-15 cm soil and gradually decreased with increase in depth in each land use systems. Conservation agriculture is spreading to several states; no-tillage/ minimum tillage or the conservation tillage is being promoted by central and State Govt for adoption by the farmers with use of zero-till seed drill, and avoiding burning of crop residues.

OFSA-2017/CD-04

Integrated farming system: Paved the way to enhance the income of farm families

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In recent years, land based livelihoods of small and marginal farmers are increasingly becoming unsustainable, since their land has not been able to support the family's food requirements and fodder for their cattle. it is imperative to develop strategies and agricultural technologies that enable adequate employment and income generation, especially for small and marginal farmers . The integrated farming systems therefore, assumes greater importance for the sound management of farm resources to enhance the farm productivity, reduce the environmental degradation, and improve quality of life for resource poor farmers and to maintain sustainability. Hence the study was conducted using participatory research methods with the objectives to assess the resources, priorities, opportunities and constraints for promoting IFS models and ascertaining the linkages/ interrelationships among the selected farming system levels for enhancement food security and livelihood. Research was conducted in the farmer's field of Mahanga block of Cuttack district, which is situated in the east and south east coastal plain agro climatic zone of Odisha. PRA was conducted in eight villages for identification of problems and to assess the resources, priorities and opportunity for promoting IFS. Socio-economic data from 320 households (40 households from each village) were collected for encouraging IFS. As per their resource availability and willingness of the respondent ten households were identified for developing IFS. Components in Farming System Developed IFS Models Crop + Hort. + Fishery + Duckery (4 nos.),Crop + Hort. + Dairy + Honeybee (2 nos.), Crop+ Hort. + Poultry + Mushroom (4 nos.) The crop activity in the IFS consists of field crop (60%), vegetable crop (10%) and fodder crop (15%) suited to irrigated upland condition. The cropping system for field crop is paddy + pulse (green & black gram) (0.60 acres) in vegetable crop, cucumber, beans, pumpkin, cauliflower, chilli, tomato, brinjal, lady finger, leafy vegetable (0.10 acre) and fodder crop Napier hybrid. Out of these three IFS models, the second one, which consists of Crop + Hort. + Dairy + Honeybee is resulted to be the best practise. The interventions during last three years (2014-2017) by ICAR-CIWA have transformed their socio-economic status. Based on the farmer participatory research which revealed that after investing Rs 38,800/- the farmer got Rs 79,300/-. The bio-compost served as organic manure for sustaining the productivity of the crops. It is concluded that a model of 1.5 acre (0.9 acre- cropping system, 0.45 acre- horticulture, 0.07 acre- honeybee, 0.06 acre- milch cow, 0.02 acre- bio compost) for a five member family is better than the mono-culture system in its contribution to productivity, profitability, economics and sustainability for small and marginal farmers.

OFSA-2017/CD-05

Reversing climate change by organic farming

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Organic agriculture offers a unique combination of environmentally-sound practices with low external inputs while contributing to food availability. Recent studies have highlighted the substantial contribution of organic agriculture to climate change mitigation and adaptation. The potential of organic agriculture to mitigate climate change is mostly

claimed on the basis of assumptions concerning the soil carbon sequestration potential of organic management. Terrestrial carbon sequestration is proposed by scientists as an effective mitigation option because it combines mitigation with positive effects on environmental conservation and soil fertility. Regenerative organic agriculture uses conservation tillage, cover crops, residue mulching, composting and crop rotation and can "easily" keep annual emissions within the desirable range of 41 to 47 GtCO2e by 2020, according to the report.

The most common agricultural practices today are doing the opposite of sequestering emissions: GHG emissions from the agriculture sector accounted for 9 percent of total GHG emissions, according to Environmental Protection Agency (EPA) estimates. The practices used in regenerative organic agriculture not only pose the best chance for sequestering vast amounts of carbon, but they are also good for the soil. They "minimize biota disturbance and erosion losses while incorporating carbon rich amendments and retaining the biomass of roots and shoots," All of those things contribute to carbon sequestration.

Switching to conservation tillage would improve soil structure plus reduce carbon emissions while contributing to increases in soil organic carbon. No-till farming systems are also a part of regenerative organic agriculture as they have the best chance of reversing the "trend of soil organic carbon losses in agriculture" when used with cover-cropping and enhanced crop rotations. No-till organic farming has been shown to increase soil organic. Conventional farming already uses cover crops. Cover crops are very good for the soil as they discourage wind and water erosion. They also increase soil carbon and reduce nitrogen leaching. The other benefits of cover cropping, including reduced weed pressure, decreased water runoff, improved soil structure and water infiltration and reduced evaporation.

However, it should be remembered that in terms of climate change mitigation, there are many other ways in which organic farming can contribute. For instance, lower rates of fossil energy use have been identified on organic farms, compared to conventional. Organic systems can also reduce N_2O emissions, through avoidance of mineral fertiliser manufacture. There is also great potential for organic farming to contribute to coping with climate change effects in the near future, through higher diversity, robust varieties and better soil quality. Quantification of such benefits will take time and considerable investment in research; however it is already clear that organic farming will have a significant role to play in creating lower greenhouse gas agriculture.

OFSA-2017/CD-06

Agroforestry: A tool for organic farming to scale up Sustainable and climate smart agriculture

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Agriculture faces the unprecedented task of feeding a world population of 9 billion people by 2050 while simultaneously avoiding harmful environmental and social effects. One effort to meet this challenge has been organic farming, with outcomes that are generally positive. However, a number of challenges remain. Organic farming offers an alternative that can eliminate many of the environmental problems of conventional agriculture in the industrialized world. Instead of using petroleum-derived chemicals to fertilize and protect crops, farmers manage their fields so as to take advantage of naturally-produced composts and mulches that recycle nutrients, and control pests and weeds. Organic yields lag behind those in conventional agriculture, and greenhouse gas emissions and nutrient leaching remain somewhat problematic. We examine current organic and conventional agriculture systems and suggest that agroforestry,

which is a modern and scientific farming practice. Agroforestry being a sustainable land use system imbided the all the agricultural practices of organic farming from *in situ* grennmanuring (Improved fallows), fertilization and nutrient management, plant protection etc. promotes the organic culture. Agroforestry has the potential to alter the microclimate under the tree canopy. It plays a major role in enhancement of overall farm productivity, soil fertility through addition of litter and organic matter, climate change mitigation through carbon sequestration, phytoremediation, watershed protection and biodiversity conservation. Through agroforestry in organic farming there will be enhancement in agro produce diversification as well as increase in agro diversity leading to ecological balance. The systematic approach in inclusive progressive organic farming with agroforestry component is essential for development of sustainable agriculture. The agroforestry practices like silvipasture, alley cropping, protein banks, energy plantations, biofuel plantations etc are one way or other way supporting the agro ecosystem and alternative source of food, fuel, fodder etc. Under the agroforestry system multipurpose and N2 -fixing trees are played a valuable and significant role for upliftment of productivity and combating the soil health problem. Generally, farmers are used N2 -fixing trees like some leguminosae family comprises Acacia spp., Dalbergia sissoo etc. on their farmland for enhancement productivity with better soil health and generating incomes through employment. By implementing systems that mimic nature's functions, agroforestry has the potential to remain productive while supporting a range of ecosystem services. We are moving in phase of integrated approach for natural resource management linked with productivity and sustainability to achive the goal of climate smart agriculture. Hence Agroforestry is highly adaptable and applicable among a wide range of physical and social conditions as it enhances stability and productivity of agro-ecosystems and alleviate environmental stresses.

OFSA-2017/CD-07

Water productivity enhancement through runoff harvesting, its recycling and land modification practices

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Providing lifesaving irrigation to kharif rice against climate induced dry spell and converting mono cropping to double cropping are the two most challenging task farmers are facing today. Enhancing farm income and its regular supply to small and marginal farmers along with fulfillment of their nutritional needs stand on the way of large scale labour migration. Considering the above facts, this experiment was undertaken in the research farm of ICAR-IIWM, Bhubaneswar to develop the model in 0.97 ha land. Out of the total 9700 m^2, one water harvesting structure was constructed in 1200 $m^2$and some portion of excavated soil was used for pond dyke and left over soil was used for construction of paraboloid heap at a distance of 7 m with 1 m height and 2 m diameter having gradual slope all around the heap. During kharif, Lalat variety of paddy was transplanted in the inter row space of heap following recommended package of practices. On the side slope of the heap cowpea was grown for supplying vegetable, fodder, erosion control and nitrogen fixation. On the pond dyke, papaya variety Red Lady was planted at distance of 2m. In the harvested water 1200 fish fingerlings of Indian Major Carps were released and recommended feeding schedule was followed. In rabi, harvested water was used for growing mustard, cabbage, broccoli, black gram and green gram following their recommended package of practices in the inter row spaces of the heaps. In kharif, total of 4842 m^3 of excess runoff was harvested in water harvesting structure and utilized for various crops. Water productivity in terms of monetary return per m^3 water used for rice, rice + papaya, rice + papaya + fish and rice + papaya + fish+ green gram + black gram+ mustard+ broccoli +cabbage were calculated to be Rs 5.96 /m^3, Rs 9.45 /m^3, Rs 16.0 /m^3 and Rs 19.33 /m^3, respectively. With application of this technology, net income from the entire system is increased to Rs 180000, which is 4.5 times higher than the exiting rice- black gram pairacropping(Rs 40000.00).

OFSA-2017/CD-08

Technology adoption in organic aquaculture

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Utilization of organic waste as organic manure or aquaculture practices become more eco-friendly and profitable. Vermicompost prepared from different substrates like neem leaves, mangrove leaves and vegetable wastes and cow dung have been tested and the one prepared out of neem leaves is more effective in increasing primary productivity of water. Biofloc based system act as additional food source for shrimp and an avenue for nitrogen removal in the system. Recent advances in super-intensive, limited-discharge, biofloc systems for the culture of Litopenaeus vannamei, suggest that these systems can be profitable in farming. These systems offer improved biosecurity with reduced risk of crop losses to viral disease outbreaks. Furthermore, operating these systems with no water exchange minimizes the negative effluent impact on receiving waters. Implementing biofloc technology to culture shrimp in ponds and reticulating systems could offer several advantages, including improvement of water quality and animal nutrition. There are two primary biofloc technology systems that can be considered for shrimp culture. The first are in-situ biofloc systems, where biofloc form in the culture pond/tank along with the shrimp. The second are ex-situ biofloc systems, in which effluent waters are diverted into a suspended-growth biological reactor where biofloc are generated and subsequently can be used as an ingredient in shrimp feed. In-situ systems are currently in use, and ex-situ systems are in the developmental stage. Each option (in-situ versus ex-situ) has unique benefits and limitations. Biofloc are a consortium of microorganisms, micro/macro invertebrates, filamentous organisms, exocellular polymers, and uneaten feed. Biofloc nutritional composition varies greatly depending on many variables, including sunlight, temperature, salinity, nutrient loading, carbon supplementation, residence times, oxygen levels, etc. Other technologies i.e. Forage based aquaculture practices. Integrated multi-trophic aquaculture (IMTA) is an ecosystems approach in mariculture that has been proven to solve pollution problems associated with fish culture mainly in temperate waters. IMTA system uses species those are not only commercially viable, but are also environmentally sustainable, based on the concept that the wastes consisting of uneaten feed, feces and metabolic excretion of one species are a useful input for growth of another species, working in a natural self-cleansing mechanism. Other technologies i.e. forage based aquaculture and bio pond technology have been discussed in the paper.

OFSA-2017/CD-09

Agroforestry options for environmental stability- A review

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Agroforestry system is a land management practice to cultivate woody perennial and agricultural crops on the same piece of land in temporal and spatial arrangement with sustainable production of crops. Agroforestry system can be better climate smart option because of the secondary environmental benefits such as food security, nutritional security and secured land tenure, increasing farm income restoring and maintaining above ground biodiversity, watershed hydrology and soil conservation. The increased pressure on the world natural resources which arises from population growth as well

as economic pressure has resulted in unsustainable use of natural resources and environmental instability. The unstable nature of the world climate, attributed to human activities, depletion of forest cover due to increased hunger for forest and non-forest products has caused a lot of environmental problems such as, land erosion, flooding, frequent and severe storm, depletion of soil fertility, natural disaster as well as seasonal changes of world climate. These negative effect on the world ecosystem required a crucial attention.Agroforestry is a means of halting the vicious circle of deforestation, soil erosion and other environmental problems facing by the people. It serves the diverse needs of individual farmers in harnessing the natural resources around them, as this cannot be reconciled by the traditional cropping system. It involves the combination of trees and crops that increase the medicinal, environmental, and economic value of land with the much-needed profit and food security. Hence Agroforestry systems such as live fence, home garden, shelterbelt, alley farming, taungya system, improved fallow and agrosilvopastoral are highly recommended as solution to environmental problems.

OFSA-2017/CD-10

Impact of farm mechanization on rice economy of Bargarh district

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The study was conducted to study the impact of farm mechanization on rice economy of Bargarh district of Odisha. Personal interview method was used to collect primary data using structured questionnaire from 120 sample farmers. Farm budgeting and Garrett ranking techniques were used to analyze the collected data. In case of manual cultivation of rice in the study area, a total of 35.65 man days of man labour, 22.84 days of woman labour and 2.96 pair days of bullock labour and 3.57 hours of machine labour were utilized. the need of human labour is more in traditional farming the semi-mechanical farming. The average yield per acre of manual and semi-mechanical cultivation is 23.50 quintals and 24.75 quintals respectively. The net returns per acre for rice cultivation for traditional rice growers and adopters of mechanical harvesting was found to be Rs. 13190.45 and Rs. 17613.91 leading to returns to cost ratios of 1.70 and 2.07 respectively. Semi-mechanical cultivation of rice was found to be economical over manual cultivation of rice. The major constraints faced by the owners of machines in semi- mechanical cultivation of Rice were coverage of long distances in different states/districts, high cost of machines, non-availability of financial support and fluctuations in area under the crop. For easy availability of machines during requirement and uniform rates, the cooperative model of custom hiring of agricultural machinery (developed by the Punjab government) should be introduced in rice growing regions of Odisha.

OFSA-2017/CD-11

Climate change and climate smart agriculture

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Climate change has been affecting human activities for centuries. As agriculture is completely dependent on weather conditions, any change in weather patterns would directly impact it. Affect can be positive or negative depending upon the crop properties. To reduce the negative impact, it is necessary to alter agricultural practices and adopt such techniques that would mitigate the impact of climate change. Climate Smart Agriculture (CSA) has gained a lot of popularity in past two decades because of its integrated approach of soil, water, land, forest and energy management based on three pillars of productivity, adoption and mitigation. It addresses many problems like food insecurity, food wastage, malnutrition, misdistribution and poverty. By adopting, transforming and reorienting agricultural activities the impact of climate change can easily be mitigated and thereby saving farmers from the risk of crop failure and losing livelihood income. The objective of the paper is to understand climate change and its effect on agriculture. In order to feed the rising population and meet the already unmet demand of many undernourished people there is a pressure on agricultural productivity and climate change impacts are adding further pressure. Thereby the objective is also to understand the importance of CSA practices and activities in today's agriculture sector along with its approaches that enable increase productivity, reduce greenhouse gas emissions, adopting climate change and promoting environment sustainability. Through the paper, it can be concluded that various problems of climate change in agriculture sector is best resolved by understanding and adopting Climate Smart Agriculture approaches and interventions.

OFSA-2017/CD-12

Combating the problems of minor millets grown under organic farming

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Minor millets comprise a group of cereal species that are genetically diverse and adapted to a range of marginal growing conditions where major cereals are relatively unsuccessful. In India finger millet and other minor millets account 1.13 and 0.58 million hectares with an annual production of 1.98 and 0.38 million tonnes having a productivity of 1661 and 654 kg ha^{-1} respectively (AICSMIP, Annual report, 2015-16). Millets are low input requiring, high carbon sequestering climate resilient miracle grain crop due to their higher nutritional value. The neglect in several arenas has resulted in a steady decline in the cultivation of minor millets in India over the past few decades, but they are recently re-emerging as vital dietary food crops owing to increased public awareness about its nutritional value. Organic farming, as a simple principle of utilizing on-farm resources, devoid of agricultural chemicals is gaining importance all over the world because it offers viable option to the ill effects of modern agriculture and mitigation scope against climate change. India ranks 33rd in terms of total land under organic cultivation and 88th in agricultural land under organic crops to total farming area. The present agricultural research is focusing towards evolving ecologically sound, sustainable and socio-economically viable technologies, through exploitation of organic farming approaches. Mal *et al.*, (2010) reported that intercropping of finger millet, little millet or foxtail millet with pigeon pea in 4:2 row ratio recorded higher net returns and benefit: cost ratio than farmers' practice of 5:1 row ratio at Dharwad, Karnataka. Shivakumar *et al.* (2011) stated that application of neem cake @ 2.5 t ha^{-1} + FYM @ 12 t ha^{-1} produced significantly taller plants, more number of tillers $plant^{-1}$ and higher grain yield in finger millet than with FYM @ 12 t ha^{-1} + 100 per cent RDF through inorganic fertilizers. Ahiwale *et al*. (2013) reported that application of FYM @ 15 t ha^{-1} and seed treatment with biofertilizers (*Azospirillium* + Phosphorous Solublising Bacteria each @ 25 g kg^{-1} seeds) and transplanting method of plant establishment resulted in comparable grain and straw yields with 100 per cent recommended dose of nutrients (80-40-100 kg N, P_2O_5 and K_2O ha^{-1}) through fertilizers and *awatani* method of sowing respectively in finger millet during *kharif* at Dapoli, Maharashtra. Among the organic sources of nutrients, soil application of jeevamruta and seed treatment with biofertilizers (*Aspergillus awamoori and Azospirillium brasilancae)* resulted in comparable grain yield with application of FYM @ 9.2 t ha^{-1} in finger millet (Nigade *et al*., 2014). Millet based organic farming systems may ensure the nutritional food and farming security in India at the present juncture of climate change. Hence, it is necessary to develop strategies for addressing the various hurdles in the transition from conventional to organic farming of minor millets.

OFSA-2017/CD-13

Assessment of hydraulic performance of drip emitters for adoption in hilly terrain of north eastern region of India

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The north eastern region of India is a unique region rich in natural resources viz., land and water. The region receives an average annual rainfall ranging from 2000-4000 mm that is distinctly higher than most of the regions in the country. The available water resources were never harnessed to its full potential as the productivity could meet local demand. But with the growth of population, the need for growing more crops has arisen. As such the need of irrigation in the region is being increasingly felt. The region often suffers from a water-scarce situation particularly during the non-rainy season. The steep terrain conditions do not support conventional irrigation systems and therefore micro-irrigation system needs to be promoted. In micro-irrigation systems, maintaining uniformity of application is necessary to achieve a satisfactory crop yield. Maintaining the system hydraulics is a challenge due to the terrain conditions and equipment available. A study was conducted to observe various uniformity parameters of selected emitters at five different operating pressures, viz. 0.5, 0.75, 1.0, 1.25 and 1.5 kg cm^{-2}. In the study it was observed that the discharge variation of the selected emitters was between 8.7 and 37.82%. The uniformity coefficient varied from 87.3% to 99.5%, where the distribution uniformity and statistical uniformity varied from 81.1 to 99.1% and 83.4–99.1% respectively. The emitter flow variation ranged from 0.03 to 0.49 in the range of 0.5 to 1.5 kg cm^{-2}. The emitter exponent indicated that the values ranged from 0.20 to 0.55. All these values were far from the manufacturer's value. From the study we can interpret that the emitting system needs to be tested before adoption in the field to ensure uniformity of water application.

OFSA-2017/CD-14

Direct Seeded Rice: An approach towards sustainability

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Most of the rice farmers raise their crop by transplanting of seedling under puddle condition. However puddling is labour intensive and requires huge amount of water. Raising seedlings puddling of field, followed by transplanting involve high labour cost and fossil fuels. Transplanting after puddling is associated with various constraints like late planting due to non availability of water and labour at peak time which causes low plant population and ultimately reduction in yield at the same time field preparation by puddling results in alteration of soil physical succeeding crops. The area under transplanted rice decreasing due to scarcity of water and labour. So there is need to search for alternate crop establishment methods to increase the productivity or rice. Direct seeding in row are alternative to transplanting, due to less labour requirement, low water intensive and shorter the duration of crop by 10 days and these methods provide comparable grain yield as that of transplanted rice. The system eliminates preparation of nursery, puddling of main field for transplanting and impounding of water throughout the rice growth period, thereby increases the production and returns. An alternate method of crop establishment in rice is need of the day. Direct seeding in lines have several

advantages. It saves labour and involves less drudgery, facilitates early sowing, reduces water requirement, enhances tolerance to water deficit, advances crop maturity by 7-10 days, reduces cost of cultivation, gives higher yield and more profit, improves soil physical conditions for succeeding crops, reduces methane emission and reduces yield risk and uncertainty. Several workers have confirmed the advantages of direct seeded rice. Due to aerated environment for a month in semi dry rice cultivation, the fields provide congenial environment for weed seed germination and establishment. A weed free period for the first 30-45 days after sowing is required to avoid any loss in yield because the dry weight of weeds increases greatly from 30 DAS in direct seeded rice. Thus effective weed control often requires a combination of cultural mechanical and chemical control such as an integrated weed management approach to delay herbicide resistance and reduce the herbicide load in the agro-ecosystem.

OFSA-2017/CD-15

Effects of elevated CO_2 and temperature on yield and fruit quality of strawberry (*Fragaria ananassa* Duch.) cv. Chandler

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Theresearch was conducted to check whether elevated CO_2 could alleviate the negative effect of high temperature on fruit yield of strawberry (*Fragaria* × *ananassa* Duch. cv.Chandler) at different levels of nitrogen and also tested the combined effects of CO_2, temperature and nitrogen on fruit quality of plants cultivated in controlled growth chambers. Results show that elevated CO_2 and high temperature caused a further 30% decrease in fruit yield The fewer inflorescences and smaller umbel size during flower induction caused the reduction of fruit yield at elevated CO_2 and high temperature. Interestingly, nitrogen application has no beneficial effect on fruit yield, and this may be because of decreased sucrose export to the shoot apical meristem at floral transition. Moreover, elevated CO_2 increased the levels of dry matter-content, fructose, glucose, total sugar and sweetness index per dry matter, but decreased fruit nitrogen content, total antioxidant capacity and all antioxidant compounds per dry matter in strawberry fruit. The reduction of fruit nitrogen content and antioxidant activity was mainly caused by the dilution effect of accumulated non-structural carbohydrates sourced from the increased net photosynthetic rate at elevated CO_2. Thus, the quality of strawberry fruit would increase because of the increased sweetness and the similar amount of fruit nitrogen content, antioxidant activity per fresh matter at elevated CO_2. Overall, we found that elevated CO_2 improved the production of strawberry (including yield and quality) at low temperature, but decreased it at high temperature. The dramatic fluctuation in strawberry yield between low and high temperature at elevated CO_2 implies that more attention should be paid to the process of flower induction under climate change, especially in fruits that require winter chilling for reproductive growth.

OFSA-2017/CD-16

Climate smart agriculture for sustainable rice production

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"Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meet their daily diet needs and food preferences for an active and healthy life."Change is nature's law, it is inevitable and it causes loss to agriculture. Agriculture is prone to the climate change which directly and indirectly affecting the farming practices and crop yields as well as GDP of the country. Farmers face many problems due to climate change. To mitigate the condition we should go toward to climate smart agriculture.Climate smart agriculture defines an integrated approach to developing technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. According to FAO 2013 it is included under adaptation and mitigation. Agriculture contributes 28% GHG (INCCA 2013).Tillage contributes CO_2 through the rapid organic matter decomposition due to exposure of larger surface area to increased oxygen supply. Nearly 400 Kg CO2 is generated assuming an annual use of 150 liters diesel in the conventional Rice-Wheat system).There are 3 ways like reducingemission, enhancing removal and avoiding emission to mitigate the climate change. There are 4 measure practices are seen for climate smart rice production i.e.Water smart, Carbonsmart, Yieldsmart, Communication smart. Aerobic rice cultivation is the best practice to mitigate this situation. RDF with 100% N with neem coated urea is also the best practice for nutrient management .They also reported that aerobic rice production has also the lowest methane production. Drip irrigation also be adopted for climate smart agriculture practice. It is also reported that 150-100-40-40 N-P-K givesmore yield 6.32 t/ha.SRI method is also known as climate smart rice production system. It is also reported that Rice-potato-green gram is the best practice anduse of improved seeds along with zero tillage can be a better option for increase rice production.

OFSA-2017/CD-17

Climate smart horticulture: Tansitioning dreams into reality

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The days are gone when the ultimate objective is to only feed the ever-increasing mammoth size population of the globe. In the recent era, the desired transition is happening *i.e.*, from the food security to the nutritional security. On the other hand, we have to keep a bird eye view towards the security of the environment and ecology in order to sustain the overall development. Understanding both the challenges of climate change as well as the nutritional security, climate smart horticulture has got an immense role to play at this crucial moment as it addresses the both the problems together, rather than in isolation. It is also the only sector that offers the triple win of increased productivity, reduced emissions, and enhanced resilience to climate change.The overall efficiency, resilience, adaptive capacity, and mitigation potential of the production system can be enhanced through improving its various components such as soil and nutrient management, water harvesting, pest and disease control, resilient ecosystem, genetic resources and harvesting, processing and supply chain managements. An integrated approach is also neededin order to achieve the multiple objectives of climate smart horticulture namely adaptation and mitigation goal along with improvement in horticultural crop productivity, economic development, and livelihood through converting waste to wealth.

OFSA-2017/CD-18

Comparative performance evaluation of different weeders for wetland rice

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Using of efficient and inexpensive method for weed control has an important role in increasing efficiency and reducing costs of production. The three weeders namely Ambika paddy weeder, Cono weeder and Power operated rotary weeder were operated in the line sown rice crop to uproot the weeds. Performance of these weeders is compared with the hand weeding. Minimum population of weeds was recorded under Cono weeder and maximum population of weeds was recorded under Power operated rotary weeder. Weed dry matter production was found significantly maximum (15.42 g/m^2) in Power operated rotary weeder has to be performed at 20 DAS and minimum weed dry matter (11.02 g/m^2) was production by Hand weeding. The weeding efficiency of Hand weeding, Power operated rotary weeder, Ambika paddy weeder, Cono weeder were observed to be 95.28 per cent, 91 per cent, 78 per cent and 70 per cent respectively. Highest plant damage (90.98 per cent) was observed in Hand weeding and lowest (70.22 per cent) was got in Ambika paddy weeder. Field capacity (0.19 ha/h) under Power operated rotary weeder, Ambika paddy weeder (0.0589 ha/h) and Cono weeder (0.013 ha/h), Hand weeding (0.0026 ha/h). Field efficiency of different weeding methods was recorded that the highest field efficiency 69.45 per cent was observed under Ambika paddy weeder followed by 68.42 per cent and 61 per cent in Cono weeder and Power operated rotary weeder respectively. Performance index of Power operated rotary weeder, Ambika paddy weeder, Cono weeder and Hand weeding was found (0.10), (0.045), (0.031) and (0.026) respectively. Energy consumed was followed by 1521.80 MJ/ha, 927.16 MJ/ha, 270.40 MJ/ha and 302.11 MJ/ha in Power operated rotary weeder, Hand weeding, Ambika paddy weeder and Cono weeder respectively. The minimum cost of operation was observed under Power operated rotary weeder (808.42 Rs/ha) followed by Ambika paddy weeder (1050 Rs/ha) and Cono weeder (1160 Rs/ha) respectively. The highest cost of operation was observed with Hand weeding (4250 Rs/ha).

OFSA-2017/CD-19

Précised crop production and yield enhancement by nutriseed pack technique

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Normally fertilizers are broadcasted in crop fields and straight fertilizers are mostly used as the source of nutrients. Under surface application the fertilizer use efficiency is low. In this situation Nutriseed pack technique helps in improving the fertilizer use efficiency and yield. Each Nutriseed pack contains seed at top, enriched manure in the middle and encapsulated fertilizer at the bottom. By placing a Nutriseed pack vertically or horizontally in soil each plant can be established. Nutriseed pack gives support for each plant in the root zone in terms of optimum nutrient supply, biological activity, release of pesticide etc. and consequently enables fullest utilization of nutrients by plants. There is no

wastage of fertilizer nutrients with Nutriseed packs. Nowadays labors scarcity in villages prevails particularly at start of crop season. This delays timely sowing of seeds, fertilizer application, and etc. Incrop production, fertilizers are costly input. Improper, delayed and broadcast applications of fertilizers are major reasons for the reduction in yield of crops. If deep placement can be advocated by Nutriseed pack technique for saving fertilizers and labors, then it can be welcomed by farmers for adoption. This technique was tested in research trials and demonstration plots in crops like maize, rice, cotton, carnation and marigold and found to record more yield and profit over the conventional broadcast method of fertilizer application. Hybrid maize recorded grain yield of 6779.25 kg/ha on an average in four different locations under Nutriseed pack over 5345.25 kg/ha yield under farmers practice showing 27% increase in yield. Similarly, Bt. Cotton recorded 21% increase in yield under Nutriseed pack over farmers practice. Rice recorded 18% yield increase over farmers practice. Marigold recorded a remarkable increase of 50% yield under Nutriseed pack over farmers practice. Carnation recorded 37% increase is yield under Nutriseed pack over farmers practice.

OFSA-2017/CD-20

Effect of different plant spacing on the growth and yield of okra *(Abelmoschus esculentus L. (Moench)*

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A field experiment was conducted during *kharif* season of 2014 at College of Agricultural Engineering and Post Harvest Technology (Central Agricultural University), Marchak, Gangtok, East Sikkim mainly to study the effect of different plant spacing on the growth and yield of okra. Four treatments T_1(60cm. X 30cm.),T_2(65cm. X 35cm),T_3(75cm. X 40cm),T_4(70cm. X 45cm) were taken which was replicated three times. The height of the plant, number of pods, length of pods and fresh weight of pods/fruits of okra was shown on increasing trend with the advancement of crop age and was found maximum at full maturity of crop (105 DAS). The maximum plant height was recorded under T_3 (75cm x 40cm) treatment whereas the maximum number of pods, length of pods and fresh weight of pods/fruits was observed under T_1(60cm x 30cm) treatment. Yield of okra was maximum under T_1(60cm x 30cm) treatment followed by T_2(65cm x 35cm), T_3 (75cm x 40cm) and T_4(70cm x 45cm) treatments respectively. The lowest growth parameters and yield was recorded under T_3 treatment where the plant spacing of 75cm x 40cm along with organic manure (FYM) was applied.

OFSA-2017/CD-21

Effect of dyke height on the performance of medium land paddy in the north central plateau zone of Odisha

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Increased hydrological uncertainty and spatio-temporal variation in occurrence and distribution of rainfall has been widening the gap of supply-demand status of agricultural water. Rapid industrialization and urbanization has also been leading to reduction in the share of agricultural water day by day. Rice, the major staple food grain in the eastern region of India, is the highest consumer of agricultural water. Almost 30% of the India's rice growing areas are rainfed, which are prone to vagaries of rainfall. The north central plateau zone (NCPZ) of Odisha covering the districts of Keonjhar and Mayurbhanj is one of them. The climatological analysis of the region shows decreased trend in annual rainfall and increased trend in air temperature. Hence, it is highly essential to harvest the available rain water and use it effectively in agriculture. The farmers of the NCPZ are mostly tribal and small to marginal. Looking into their financial condition, it may not be advisable to go for expensive water harvesting measures but in-situ water harvesting can be possible in dyked paddy fields with comparatively lower investment. Realizing the present agricultural practices of the region, a field experiment was conducted during kharif 2016 in the research block of the Regional Research & Technology Transfer Station (RRTTS), Orissa University of Agriculture & Technology (OUAT), Keonjhar. One of the plots in the farm was divided into four sub-plots. Uniform dyke height of 35 cm was maintained around each sub-plot with additional provision of weirs of heights 15, 20, 25 and 35 cm, respectively. Paddy var. Lalat was transplanted on 10th August 2016 and harvested on 12th November 2016. Standard cultural practices including recommended dose of fertilizers and inputs was followed. It was observed that 20 cm and above weir height plots were capable of handling the entire quantity of rainfall occurred during the experiment period, whereas spillage of around 2 cm was observed from the 15 cm weir height plot for one rainfall event only. The 15 cm weir height plot resulted in minimum grain yield of 39.5 Q/ha, whereas maximum grain yield of 50.8 Q/ha was observed in the 20 cm weir height plot, which was found to be decreased with increase in weir height. Hence, looking into the prevailing climatic condition, in-situ water harvesting potential and stability of dyke, 20 cm dyke height can be practiced around the paddy fields of NCPZ for effectively utilizing the rain water and enhancing the grain yield.

OFSA-2017/CD-22

Genetic variability and heritability studies with respect to seed yield and its component traits in *Vigna mungo* l.

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In crop improvement and varietal development programme, diversity is the prerequisite to obtain the desirable recombinants in segregating generations. The current study was intended with an objective to check accessions for genetic variability, heritability and genetic advance in black gram. The experiment was conducted at EB-2 section of the Dept. of Plant Breeding and Genetics, OUAT during *rabi* 2015-2016. The experimental material consisted of 50 black gram

genotypes which were tested in randomized block design (RBD) with two replications. Twelve yield attributing characters were observed namely: days to 50% flowering, days to maturity, plant height, number of branches/plant, number of clusters/plant, numbers of pods/plant, pod length, pod girth, number of seeds/pod, number of seeds/plant, hundred Seed weight and seed yield/plant. Highly significant differences ($p < 0.05$) were taken in all characters which illustrated significant variation. The magnitudes of heritability in broad sense were found to be low for number of seeds/pod, pod girth and pod length; moderate for days to maturity, days to 50% flowering and number of branches for plant; high for number of clusters/plant, hundred seed weight, plant height, number of pods/plant, number of seeds/plant and seed yield/plant. The high heritability in conjunction with high genetic advance was noted in number of seeds/plant and seed yield/plant, which gave the evidence that these traits were under the control of additive gene action which will be more useful in predicting the gain under selection than heritability alone.

OFSA-2017/CD-23

Impact of climate change on agriculture and its mitigation through adaptations of different agronomic practices

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Climate change may refer to a change in average weather conditions, or in the time variation of weather around long-term average condition. Climate changes primarily due to some biotic and abiotic process. Human activities primarily responsible for on going climate change. The Intergovernmental Panel on Climate Change (IPCC) has projected that the global mean surface temperature will rise by 2.0-5^{0}C in the next century due to increase in carbon dioxide concentration in the atmosphere. Climate variability affect agricultural crop in various way like uncertainty in onset of monsoon, high temperature, incident of disease and pest. Climate change has a significant impact on agriculture. In general, the faster is the climate change the greater will be the risk of damage. Agronomic studies suggested that extreme warming could cause reduction of yield. So there is a great problem to supply of food to the world population. The effect of climate changes on crops due to rise of temperature leading to more transpiration losses, accelerates the maturity of the crops, changes the pest dynamics new weed flora, soil degradation. There are some agronomic measures like resources conservation technology (RCTs), micro irrigation techniques, wind break and also moderate the stress due to biotic and abiotic factor to mitigate the deleterious effect of climate change.

OFSA-2017/CD-24

Impact of climate change on Indian agriculture

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Climate change is likely to directly impact food production across the globe. This paper estimates the economic impact of climate change on Indian agriculture. The largest known economic impact of climate change is upon agriculture because of the size and sensitivity of the sector.The climatic change could affect agriculture in several ways such as quantity and quality of crops in terms of productivity, growth rates, photosynthesis and transpiration rates, moisture

availability etc.The consequences of agriculture's contribution to climate change, and of climate change's negative impact on agriculture, are severe which is projected to have a great impact on food production and may threaten the food security and livelihoods and hence, require special agricultural measures to combat with. The present paper focused on the current scenario of agriculture in India andthe various implications of climate change on food security and livelihoods.

OFSA-2017/CD-25

Impact of climate variability on agriculture production and gross domestic product in India

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Climate change is any significant long-term change in the expected patterns of average weather of region (or the whole Earth) over a significant period of time. India's agriculture is more dependent on monsoon from the ancient periods. Any change in monsoon trend drastically affects agriculture. Data were collected from various secondary sources and were subject to appropriate analytical tools to derive meaningful relationship between changing climate and agriculture production as well as GDP. The percentage of normal rainfall in India is showing the much variation in the last two decades the highest percentage of rainfall was received in 2013-14 (106%) in India and the lowest rainfall was received in 2009-10. Since from the 1990-91 to 2013-14 the percentage of rainfall is varying from around 77 per cent to 106 per cent, However, the annual growth rate of the percentage of rainfall is decreasing from CAGR of -0.29 per cent which is showing the negative growth rate. The Indian total food grain production was showing very slow growth rate i.e, with an annual growth rate 1.66 per cent but this growth is not helpful to fulfill the present growing population food demand we have to increase our food grain production but there is so many threats are on the way to fulfill the food demand. The production of pulses and oilseeds in India is increasing with annual growth rate of 1.26 per cent and 2.10 per cent which is less than the global average. The service sector (8.10%) and industrial sector (6.2 %) show consistency growth in the contribution of total GDP of India but in case of agriculture GDP it is around 3.3 per cent growth to the total GDP growth (5.7%) of India. Agriculture sector is the most sensitive sector to the climate changes because the climate of a region/country determines the nature and characteristics of vegetation and crops. Increase in the mean seasonal temperature can reduce the duration of many crops and hence reduce final yield.

OFSA-2017/CD-26

Intervention of precision farming in cashew

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Advancing knowledge in tree architecture, growth physiology, possibility of using promising cultivars, water management etc. has enabled farmers to adopt closer planting and maintaining reachable canopy by tailoring soil and crop management applications to fit in varying conditions in the field. This system is popularly known as Precision farming . It enables profitable cropping, high, regular yields and improved farm management practices, leading to

higher productivity. Precision farming is a modern method of cultivation involving planting of trees densely, allowing small or dwarf trees with modified canopy for better light interception and distribution and ease of mechanized field operations. Control of pests and diseases, weeds and pruning of tree canopy can be carried out by machine, Irrigation and Fertigation are automatically controlled. This system produces precocious cropping, high and regular yields of good quality fruits and low labour requirement to meet ever rising production costs. Cashew (*Anacardium occidentale* L.), a member of *Anacardiaceae* family is cultivated in tropical regions on either side of the equator for its delightful nutritious kernel and apple. Precision farming has been negotiated in cultivation practices and the best soils for cashew are deep and well-drained sandy loams without a hard pan. The technique of softwood grafting has found thoroughly standardize for commercial multipication of cashew in a short time. Mulching the cashew tree basins helps to conserve the soil moisture and to prevent soil erosion. With organic matter, it inhibits weed growth and reduces surface evaporation during summer and also regulates the soil temperature. High density planting in cashew accommodates maximum possible number of the plants per unit area without impairing soil fertility. The use of fertigation is gaining popularity because of it's efficiencies in nutrient management, time and labour and have control over crop performance. Adopting this type of technology allows growers to evolve their standard practices and benefit from the improved crop outcomes.

OFSA-2017/CD-27

Optimal size of the unlined on-farm pond for partial crop diversification in rainfed uplands of eastern India

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Rice (*Oryza sativa L.*) dominated rainfed uplands of eastern India are mono-cropped with low productivity. Major problems experienced in the terrain are due to erratic monsoon, lack of reliable water sources, quick depletion residual soil moisture and faulty cropping pattern etc. In fact, unlined on-farm pond (OFP) technology is a proven technology for mitigating droughts as far as rice is concerned. Previous studies reveal that the unlined OFP technology fails to ensure supplemental irrigation (SI) for the second crop in uplands. In order to overcome the shortcomings in the technology, the location of the OFP has been changed and a new concept of partial crop diversification (PCD) has been introduced in the present study with an objective to strengthen the technology through provision of SI for the second crop. Maize (*Zea mays L.*) and rice crops at upper and lower compartments of the field, respectively, were tried at various ratios of rice substitution such as 70:30, 60:40, 50:50, 40:60, and 30:70 during monsoon season. Rainfall excess from both the compartments was harvested in an unlined OFP located in between the compartments and used for SI to the crops. In winter, black gram (*Vigna mungo L.*) and mustard (*Brassica campestris*) were taken in the upper and lower compartments, respectively, based on availability of water in the OFP. Water balance models were used to simulate the soil moisture in crop root-zone as well as the volume of water stored in the OFP on daily basis. It was found that the unlined OFP irrespective of its size was incapable to provide SI to the second crop. Under such circumstances, the optimal size of the OFP for average land holdings (1200 m^2) in rainfed uplands with 60:40 rice substitution ratio was found to be 6% of the crop field.

OFSA-2017/CD-28

Organic aquaculture: A way forward for its sustainability

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Organic fish farming is a method of aquaculture, where the methods and materials used have very low impacts on the environment, thus promoting environmentally, socially and economically sound production. It is sustainable based on long term ecologically and environmentally sound practices (Diwan and Ayyappan, 2004). Its principles are based on protecting the environment, minimising soil and water degradation, decreasing pollution and optimising biological diversity and productivity. Generally, the object of organic fish farming is to optimise the health and productivity of the independent communities of water, soil, plant and animal life. Management practices for sustainable organic aquaculture are carefully selected with the intent of restoring and then maintaining ecological harmony on the farm and the environment. For this, steps should be taken to encourage and enhance the biological cycles with respect to nutrient management and to retain the integrity of organic products from farmer to consumer and conversion requirements for moving conventional aquaculture systems to organic systems. Thus looking at the growing consumers demands of organic aquaculture products, the present paper deals with the concept of organic aquaculture and its sustainability with regards to standards to be followed, nutrient contents of organic feeds and fertilisers to be used, criteria for certified organic aquaculture, farmed organic fishery products, sustainable management plan and market perspectives of organic farm fresh products.

OFSA-2017/CD-29

Organic vegetable cultivation inside a naturally ventilated greenhouse

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A greenhouse is a framed or inflated structure covered with transparent materials like glass, polyethylene and poly carbonate and is large enough to grow crops under partial or fully controlled environmental conditions to get optimum growth and productivity. It consists mainly of two parts, frame and covering material. The covering material works as barrier to air flow and traps energy within the greenhouse which heats both the plants and the ground inside it. This warms the air near the ground which increases the temperature inside the greenhouse. The greenhouse can be used for growing high value vegetables, flowers, nursery, ornamental and medicinal plants. Organic cultivation of vegetable crops inside a greenhouse focus on management of practices that promote and enhance ecological harmony. Organic cultivation avoids the use of chemical fertilizers, pesticides and growth regulators. The main aim of organic agriculture is to ensure sustained productivity, environmental protection and making available food and food products raised without chemicals of any kind. Greenhouse cultivation is practised now-a-days due to its many fold advantages. The returns are good as greenhouse enables us to grow crops throughout the year irrespective of seasons. Also the quality of produce is better than the open field condition. The yield under greenhouse cultivation can be achieved to the levels of 4 to 8 times as compared to open field condition. Various research trials conducted at agro-research centres in northern India indicates that tomato (November planting), capsicum (Mid-September planting) and cucumber (Mid-October

planting) under poly house produced 1550 kg, 1500 kg and 1100 kg per 100 m^2 area. The duration of these vegetative crops were 4 to 10 months and more than 90% of total yield were obtained during off-season, which fetches higher market price.

The integral components of organic farming inside a greenhouse consist of selection of healthy seedlings, green manuring, crop rotation, use of bio-fertiliser, mulching, drip irrigation, ,use of bio-pesticides and residue management. Most important aspects are use of bio-fertiliser, like azotobacter, blue green algae, rhizobium, and phosphate solubility bacterium azospillum. Integrated nutrient management is possible in organic cultivation like green manuring, residue incorporation and application of organic manure. Well decomposed FYM is thoroughly mixed with trichoderma, azotobacter and phosphate solubilising bacteria (PSB), moistened with sprinkling water and covered with plastic sheet is kept for 15 to 20 days. The enriched FYM can be used in the field. The soil health in terms of organic carbon, bulk density, water holding capacity and microbial biomass carbon is very much improved. Few important vegetables that can be grown under a poly house in organic way are onion, cabbage, capsicum, tomato, cucumber, french bean, brinjal and spinach etc. Greenhouse vegetable cultivation is a 24 hour commitment. The crop production inside the greenhouse is affected by micro-climate, fertilisers, quality of seed, seed treatment, pest control, field preparation and irrigation. The organic farming can be adopted in case of tissue-cultured plants. If the vegetables are grown organically inside a green house, the demand will be more, as it is safe and nutritious. Generally, the cost of organic vegetables will fetch more prices in the market. The development of organic market and effective supply chain will come up. As a result, there is a wide spread organic movement and large demands for organic vegetables.

This paper describes about various methods of cultivation of vegetables in an organic manner inside a greenhouse in a tropical climate.

OFSA-2017/CD-30

Productivity and economics of maize + vegetable intercropping system under organic management in north eastern ghat zone of Odisha

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Kandhamal district of Odisha has 80% of arable land as rainfed upland. The length of growing season in rainfed uplands is 128 days. Rice is the staple food of the region and is grown in all types of land as a preferential choice of farmers, which is subjected to erratic rainfall in three out of five years. Maize is a crop of alternative choice during kharif season and, of late, gaining momentum in the rainfed uplands. However, for spatial and temporal intensification of cropping, maize + vegetable intercropping is tested. Traditionally, farmers adopt inorganic management practice of crop production but, gradually soil fertility, productivity and economic returns go on a diminishing trajectory. Ill effects of inorganic farming on crop ecology can be suitably substituted by organic management practices. To augment the long term ecological sustainability and crop economics, the present investigation was carried out to examine the effect of different organic management practices on maize + vegetable intercropping system for sustainable higher productivity. The experiment was conducted in the experimental farm of the All India Coordinated Research Project for Dryland Agriculture, Phulbani, Odisha during kharif season of 2015-16 and 2016-17. The experiment was conducted on different maize + vegetable intercropping system such as maize + runner bean, maize + cowpea, maize + bitter gourd and sole maize under different organic management practices such as (i) Farm Yard Manure (FYM) @10 t ha^{-1} (ii) FYM 10 t ha^{-1} + Vermicompost@2 t ha^{-1} as basal (iii) FYM@10 t ha^{-1} + Vermicompost (VC) @2 t ha^{-1} as basal + Pot manure (Spray 4 times at 15 days interval from sowing). The experimental design was FRBD with 3 replications. The crop experiment was conducted in 36 experimental plots of 7m × 5m size. The soil at the experimental site was sandy loam, slightly acidic (pH 6.2), medium EC (0.141dS m^{-1}) and having low organic carbon (3.4 g/kg soil). Available N, P_2O_5 and K_2O of the experimental plot were 186.8, 29.5 and 178.4 kg/ha respectively. Improved varieties of crops such as Maize (Hybrid P-3501), Cowpea (HYV Var. Gomti), Runner bean (HYV K-1) and Bitter gourd (Hybrid Bipasha-2) have been taken for the experiment.

The two years result revealed that intercropping of maize + vegetable results in higher maize equivalent yield (MEY) and net income as compared to sole maize. Intercropping of maize + cowpea results in higher MEY (5700 kg ha^{-1}) followed by maize + bitter gourd (5070 kg ha^{-1}) and maize + runner bean (5000 kg ha^{-1}) intercropping system. Application of FYM @10 t ha^{-1} + Vermicompost@2 t ha^{-1} as basal + pot manure recorded higher MEY and economic profit in all the maize + vegetable intercropping system.

OFSA-2017/CD-31

Screening of short stature lines for higher yield in niger [*Guizotia abyssinica* (L. f.) Cass.] under EGHL Zone condition

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Niger is a minor oilseed crop and used generally by tribal farmers for oil and cooking purposes. EGHL zone of Odisha covered a lot of population of tribal farmers being depend on this crop for cultivation. Niger generally grows in hilly areas during the Kharif season. In hilly areas during the cyclonic period high rainfall occurs with the more wind velocity which cause the severe logging problem in this crop. Sometimes due to logging problem the plants totally fall down and yield reduced up to 40%.

Keeping in view to this problem an investigation was carried out in Kharif-2015 to screen the short stature lines of Niger for higher yield under All India Coordinated Research Project on Niger at Regional Research & Technology Transfer Station, Semiliguda. Thirty genotypes having short stature characteristic were selected and evaluated with three replication in open pollinated condition. All the important observations like seed yield, no. of branches per plant, test weight , 50% flowering, no of capitulla per plant, no. of seeds per capitulla , Plant height, days to maturity were taken during the cropping season to estimate the yield.

Out of thirty genotypes, SL-33 recorded highest seed yield (716.7 kg/ha) with low plant height followed by N-244 (683.3 kh/ha), SP-23 (655.6 kg/ha) and others. Many genotypes were identified with short stature nature were categorised into different groups on the basis of different important characters like high no. of branches per plant, more no of capitulla per plant ,early maturity, seed weight, short height, more no of seeds per capitulla. During this study many short stature genotype were identified like Kunduli local, SP-79, IGP-76, IGPN-0-16, N-244, N-35 and many more others which can be used in further selection programme. Short stature plants are logging tolerant and ultimately reduce the yield losses in Niger.

OFSA-2017/CD-32

Sowing window for Niger (*Guizotia abyssinica* L.f. Cass.) varieties in the context of climate change under eastern ghat high land zone of Odisha

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Niger (*Guizotia abyssinica* L.f. Cass.) is an edible oilseed crop known for its adaptability to rainfed conditions on poor soils such as marginal and sub-marginal lands in tribal areas, hill tops and slopes. It is grown in India in an area about 3.0 lakh ha with a production of 0.99 lakh tonnes and a productivity of 329 kg/ha (2012-13). In the state of Odisha, it is mostly grown in the districts of Koraput, Kandhmal, Rayagada, Kalahandi, Mayurbhanj, Sundargarh, Keonjhar, etc. covering an area of 0.65 lakh ha with a production of 0.23 lakh tonnes and productivity of 359 kg/ha (2013-14).

The field experiment was conducted under All India Coordinated Research Project on Niger at Regional Research and Technology Transfer Station (OUAT), Semiliguda (Koraput) during *kharif* -2016 to study the effect of different dates of sowing on the varieties of Niger in the context of climate change under Eastern Ghat High Land zone of Odisha. There were twelve treatments comprising of six dates of sowing viz. 15th July, 30th July, 14th August, 29th August, 13th September and 28th September in the main plots and two varieties viz. Deomali & Utkal Niger-150 in the sub plots with three replications evaluated in split plot design. The crop was sown with a spacing of 30cm x 10cm & seed rate of 10 kg/ha. The recommended dose of fertilizer (40:40:20 NPK kg/ha) was applied to the crop with full dose of P, K & ½ N as basal and rest ½ N after three weeks of sowing. The results revealed that the 2nd date of sowing on 30th July recorded highest seed yield of 716 kg/ha which is at par with 15th July and 14th August sowing with seed yield of 671.2 kg/ha and 673.6 kg/ha respectively. The 30th July sowing recorded highest net monetary return of Rs.11689.00 per ha and B:C ratio of 1.7. The effect of the two varieties of Niger viz. Deomali & Utkal Niger-150 were found non significant.

OFSA-2017/CD-33

An insight to organic aquaculture

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Organic aquaculture is an offshoot o organic agriculture where holistic production management system is followed to promote and enhance ecosystem health including biodiversity and biological cycles. It is based on specific and precise standards of production aiming at achieving optimum production which is socially acceptable, economically feasible and ecologically sustainable. Basically, the organic farm management relies on natural or traditional production methods. Intensive monitoring, integration of natural plant community in the arm management, use of poly culture, use of indigenous species, practice of natural breeding methods without hormones and antibiotics, no use of GMO in production chain, stocking at appropriate density in accordance to carrying capacity of the system and site specific behavior of animals, preference for natural medicines to treat diseases are considered to be important principles of organic aquaculture. While selecting site for aquaculture, it is necessary to ensure the protection of terrestrial ecosystem of the surrounding. Extreme conditions like high saline and acid soil is avoided. Use of ground water for culture purpose is also

avoided. Herbivores fishes are preferred over carnivore and exotic ones. Selective stocking of wild seeds is prohibited. Plant derivatives are permitted for eliminating unwanted fishes in pond where synthetic herbicides and pesticides are prohibited. Fertilization with locally produced manures, farm made feeds prepared out of organic ingredients should be used instead of commercially available feed to avoid entry of antibiotics, pesticides, heavy metals, antioxidants, preservatives, growth hormones. However, minerals, trace elements, vitamins are used.

OFSA-2017/CD-34

Application of DSSAT crop model to simulate the effect of organics and inorganic fertilizer on growth and yield of maize in Odisha

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DSSAT crop model was tested during the rainy season of 2016 to study the effect of organics and inorganic fertilizer on growth & yield of maize by comparison of simulated and observed variables. The genetic coefficients of Dekalb 485 are used in the crop model. The observed variables collected from the experimental data were used for comparison. Results shown that among the various combination of organics and inorganic fertilizer, the treatment with the combination of 75% RDFN + 25% N through FYM gave higher yield as compared to the only application of sole application of inorganic fertilizer. The model was tested for accuracy in determination of other crop parameters in which the simulated variables are quite similar with the observed variables. The DSSAT crop model predicted the grain yield of 6493 kg/ha in the treatment combination of 75% RDFN + 25% N through FYM which is found to be 9 % higher as against grain yield of 5978 kg/ha in the treatment where sole application of inorganic fertilizer was administered. The same result was validated in the experiment conducted in the field during 2016. So it is concluded that the application of combined organics and inorganic fertilizer with suitable ratio can give sustainable production in maize with eco-friendly approach in long run. Thus, the use of DSSAT simulation of the effects of organic and inorganic fertilizer on growth and yield of maize was successful and helps in decision-making to choose specific treatment combination of organic and inorganic fertilizer application in farming.

OFSA-2017/CD-35

Performance evaluation and efficiency estimation of solar operated knapsack sprayer

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An experiment was conducted in December 2016 to evaluate the performance and efficiency of the Solar operated Knapsack sprayer fabricated by the authors. The performance of the sprayer was evaluated based the power developed by the solar panel and the power required to deliver the spray liquid with an aim of to assess the capacity of the sprayer from the stand point of energy use. The efficiency of the solar panel was estimated by measuring the photovoltaic efficiency of the solar panel which is based on the intensity of the incident solar radiation and the area of the solar

panel. The pump efficiency was estimated based on the performance of the sprayer and finally the system efficiency was estimated using the solar panel efficiency and the pump efficiency. Results revealed that the power developed by the solar panel was 12.6W and the power required to deliver the liquid was 4.07W. The photovoltaic efficiency was found to be 21.69% excluding various losses. The pump efficiency was 32.33% and the overall system efficiency was estimated to be 7.01%.

OFSA-2017/CD-36

Studies on effect of different organic supplements on mushroom productivity

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Oyster mushroom is an edible mushroom of the tropics and sub-tropics. In India, Odisha is the leading state in terms of oyster mushroom production. Mild winter coupled with humid coastal agro-ecological situation with abundance of manpower and agricultural waste has

made it most suitable for cultivation of oyster mushroom. It was estimated that the total mushroom production of the state comprising of oyster and paddy straw was 12,010.80 tonnes in the year 2012-13 out of which the contribution of oyster mushroom was 4003.60 tonnes accounting for 33.33 per cent of total production. Keeping this in view an attempt was made to evaluate the efficacy of six organic supplements such as wheat bran, rice bran, boiled wheat, maize power, mustard cake and poultry manure as additives over the control (without any additive) in yield improvement of five *Pleurotus* species such as *Pleurotus eous, Pleurotus florida,Pleurotus sajor-caju, Pleurotus citrinopileatus and Pleurotus ostreatus*. The treatments were replicated six times. Appropriate light, temperature, humidity and substrate moisture were maintained in the cropping room.

Observations on time taken for spawn run, days taken for pin head formation, time taken for 1st flush, 2nd flush and 3rd flush, fruiting body number and mushroom yield (Biological efficiency) were recorded. Analysis of data showed significant difference among the substrates in respect of their influence on time taken for third flush to come. The total crop

cycle was found earliest (48.83-53.33 d) on banana leaf substrate in all the oyster species. The crop cycle ranged from 48.83-60.33 days among the five oyster species evaluated on seven diverse substrates. However, the crop cycle of the five oyster species varied within 52.29-57.61 days on paddy straw substrate. Wide variation was observed among the substrates and oyster species in terms of number of fruit bodies emerged. Substrates like coconut coir, paddy husk, paddy straw and pulse stick were found superior for *P. eous* in bearing 161.66, 148.83, 129.33 and 127.00 number of fruits respectively. However, for *P. sajor-caju* (CTMRT strain), pulse stick, paddy straw, banana leaf, coconut coir, saw dust and paddy husk were encouraging having given 290.16, 249.16, 237.33, 219.83, 207.83 and 206.33 number of fruits respectively. The fruit body number varied from 65.83-290.16 in the investigation.

Significant variation was observed among the substrates in respect of average weight of sporophores of five number of oyster species. The average weight of fruit bodies, however, ranged from 4.04-11.07 g in the investigation. The maximum average weight of sporophores was recorded at 11.07 g in *P. eous* on saw dust, 6.08 g in *P. sajor-caju* (CTMRT strain) on paddy straw, 7.44 g in *P.florida* on pulse stick, 6.86 g in *P. citrinopileatus* on paddy straw and 7.35 g in *P.ostreatus* on paddy straw substrate. It appeared that the overall average weight of sporophores was low in the investigation. However, the performance of paddy straw was found better in comparison to other substrates. Signifi-

cant variation was observed among the treatments in respect of yield realization and the biological efficiency obtained therefrom. The significantly highest yields of *P. eous* (782.50 g). *P.sajor-caju* (CTMRT

Strain) (858.33 g), *P. florida* (880.50 g), *P.citrinopileatus* (775.00 g) and *P.ostreatus* (601.66 g) were obtained on pulse stick, paddy straw and paddy husk substrates respectively. Jute stick, as a substrate, was proved to be a poor yielder in all the species evaluated. The biological efficiency of species ranged from 36.92-88.05 on different substrates. In general, the bioconversion of organic waste was found low in the investigation. Bio efficiency of paddy straw was recorded within 59.85 *(P. ostreatus*) to 85.83 (*P. sajor-caju*) .

OFSA-2017/CD-37

Alternate areas /protected cultivation method of hybrid seed production

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Vegetable seed cultivation is an awesome business in India, but under open field conditions by following traditional cultivation practices it is difficult to manage various abiotic and biotic stresses. Can we provide protection to the crops against climatic fluctuations and various other related stresses. The basic benefit is its extra protective shelter restricting or minimizing the exposure of the crops to various adverse factors, which are high in open conditions. The application of chemicals for controlling biotic stresses is low under protected structures which gives a high quality safe vegetables for human consumption. Under the new era of FDI (Foreign Direct Investment) in retail, these kinds of models posses high potential for enhancing the income of farmers opting for quality and offseason vegetable cultivation through protected cultivation. Protected cultivation technology requires careful planning, attention and details about timing of production and moreover, harvest time to coincide with high market prices, choice of varieties adopted to the off season environments, and able to produce economical yields of high quality produce (Singh et a., 2012).

Seed yield of such crops can be 3-4 times more compared to their open field cultivation along with high quality of seed. Insect proof net houses are the most suitable and low cost protected structures suitable for quality hybrid seed production of OP varieties of large number of vegetables viz., tomato, sweet pepper, chilli, okra, brinjal and several cucurbitaceous vegetables. The major objectives of seed production under insect proof net houses are to grow virus free seed crops, to protect the seed crops against other major insects/pest. Not only this, insect proof net house also provides protection to the seed crops against mild frost conditions. Massive work on quality seed production of vegetables is being carried out at the Centre for Protected Cultivation Technology, IARI, New Delhi and excellent results in hybrid seed production of brinjal, pumpkin, bitter gourd, cucumber and summer squash has been recorded as compared to open field seed production of these crops (Balraj Singh,2011).

In vegetable production hybrid seeds, transgenic, stress resistant varieties, micro propagated transplants, synthetic seeds are likely to replace conventional varieties. Protected environments will be helpful in production of hybrid seeds of cucumber and summer squash by using gynoecious lines. Gibberellic acid is used to maintain gynoecious lines followed by selfing. The desired pollen can be used for production of hybrid seed of cucumber. Similarly in summer squash use of Ethephon in inducing female flower at every node would help in the hybrid seed production by using desired pollen parent (Devi and Thakur, 2013). Photo–thermo-sensitive genetic male sterile (PTGMS) rice is a new hybrid rice technology that uses prolonged light length and high temperatures to induce sterility. To overcome this, we grew PTGMS under greenhouse conditions where day light length was prolonged to 14 hrs using solar illumination and day and night temperatures were maintained above 36Cº and 24ºC respectively. Sterility of PTGMS was determined by

the level of abortive pollen and seed set rates. Hybrid seeds were produced by crossing three PTGMS lines (V1PGM, V2TGM and V3PGM) as female lines with Basmati 370 and Basmati 217 varieties as pollen donors. Under long and normal day lengths and high temperatures, pollen sterility ranged from 99-100% but no seeds were set in PGMS lines. However, TGMS recorded 3% and 2% seed set under similar conditions. Under natural conditions both PGMS and TGMS reverted to fertility. We elucidate that greenhouse conditions could be used as initiation breeding conditions for the F1 hybrids followed by adaptability evaluation later in natural conditions (Kanya et al.,2013).

In future, if the outer environmental condition degrades with severe high or low temperature, then Green house can be used for growing plant successfully by regulating the inside temperature favorable for plant growth.

OFSA-2017/CD-38

Management of mid season drought in Black gram(Vigna mungo L. Hepper)

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Black gram (Vigna mungo L. Hepper) the major winter pulse crop of Odissa is grown extensively in rice fallow situation. The monsoon rain ceases by october and the black gram grows rain fed suffering moisture stress at critical stages. Drought is a major constraint in realizing the crop productivity. Pre flowering and pod initiation stage are two critical stages of black gram for moisture stress. Hence an experiment involving foliar sprays of potassium chloride was tested to manage moisture stress.

The field experiment was conducted at Pulse Research Center, Orissa University of Agriculture and Technology, Berhampur (19 18' north latitude, 84 54' east longitude and 34m above MSL.) in the east and south eastern coastal plain zone of Odisha, during Rabi 2005. The soil of the experimental site was loamy sand class aeric haplustalfs, order alfisols with pH 5.5, low in boron (0.304 ppm) and exchangeable calcium 1.5 c.mol (p^+) kg^{-1} . Lime requirement (LR) of soil was 2.6 t/ha. The experiment was laid out in randomized block design with three replications involving ten treatment Viz. $\mathbf{T}_1$ Absolute control (No spray); $\mathbf{T}_2$ Water spray; $\mathbf{T}_3$ 2% KCl spray; T_4 6% Kaolin water spray; T_5 Soil mulch (hoeing); $\mathbf{T}_{6:}$ Removal and incorporation of alternate rows at moisture stress; $\mathbf{T}_7$ 2%KCl+1ppm boron spray: $\mathbf{T}_8$ 2% Urea spray; $T_{9;}$ 1%KNO3 Spray and T_{10} Triacontanal spray @ 1ppm.The foliar spraying were given at pre flowering and at pod initiation stage .Black gram Variety "OBG-17" was sown at 30 cm x10 cm spacing. The crop was applied with 20-17-20 kg NPK in form of Diammonium Phosphate (18%N,46%P_2O_5),Urea and Muriate of potash as basal . Pre germination irrigation was given.The crop received38.1,10.2,7.4,29.2mm rainfall on 27 january,29january,12 march and13 march,2005 respectively. All the agronomic and plant protection practices were followed as per the treatments during crop growth.Initiation of flower hud, and initiation of first flower were not affected due to different treatments. The crop could complete growth, attended physiological maturity at 67 days with the treatment of foliar spray of 2%KCI+lppm boron, where as the crop matured earlier in 60 days under moisture stress treatment and produced 365 kg/ha . Foliar spraying of 2%KCI+lppm boron produced tallest plant of 29.1cm, LAI (0.46) and maximum seed yield of 530 kg/ha which 45% higher over no spray and was at par with 2% urea spray with seed yield of 510 kg/ ha and 2%KCI spray (505kg/ha) and was signi ficantly different from othertreatments .This may be due to beneficial effect of potassium regulating transpiration through stomata, control under moisture stress condition and boron responsile for transport of photosynthates from source to sink.

It may be concluded that foliar sprayings of 0.2%KCl+lppm boron can manage mid season drought in black gram.

OFSA-2017/CD-39

Computational analysis of the molecular architecture and cis-elements of Heat-shock-protein Hsp70 encoding gene in different ecotypes of rice (Oryza sativa)

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Climate change is predicted to aggravate the occurrence of abiotic stresses which in turn affect the yield and quality traits in different crop plants including rice which is one of the principal staple food crop in the world. In this context, there is a need to design sustainable innovative strategies to ensure food and nutritional security for burgeoning billions from shrinking resources in a warmer world under the climate change regimen. This can be accomplished by elucidation of mechanisms of plant response to abiotic stresses and their role in stress tolerance to design interventions such as climate resilient varieties in crop plants especially in rice. Heat-shock proteins (Hsps) play a fundamental role in all living organisms. Hsps are not only expressed during high temperature stresses but also during other abiotic stresses such as water stress, salinity and osmotic, cold and oxidative stress, whose role in plants are least explored. Hsp70 is one of the major plant Hsps having a molecular weight of 70KDa help in maintaining the cellular homeostasis by maintaining the functional conformation of proteins and preventing protein aggregation in different cellular compartments. Role of Hsp70 in rice is not fully understood due to lack of suitable 3-dimensional structure. Here, we have computationally modelled the 3D structure of candidate Hsp70 protein of indica ecotype (CAA47948.2) and japonica ecotype (AAX95352.1) of Oryza sativa using their amino acid sequence informations as targets using Heat shock 70 kDa protein (3a8y.1.A.pdb) and heat shock 70kDa protein 2 (4fsv.pdb) of Homo sapiens as templates, respectively with the help of Swiss-Modeller. Built models were subjected to the evaluation of global and local quality, stereochemical quality, 3D-geometry and Ramachandran plot assessment using GQME, QMEAN, VERIFY3D and RAMPAGE softwares, respectively. High degree of reliability scores for predicted models were obtained. The determined 3D-scaffold information of Hsp70 would be useful in gaining momentum in to its role in plants in abiotic stress response processes through site-directed mutagenesis and protein-protein interaction based functional genomics studies. Similarly, analysis of cis-elements present within the 500bp upstream region from the start codon ATG of genes encoding for Hsp70 of both indica and japonica ecotypes with PlantCARE tools revealed the presence of canonical transcriptional motifs, phytohormonal-responsive elements for ABA, Salycylic acid, Gibberillin and MeJA, stress response elements for anerobic induction & drought induction and elements for light response, meistem-specific activity and endosperm specific activity and cell cycle regulation. All these informations suggest that different phyto-hormonal clues, stress and developmental stimulus modulates the transcription of Hsp70 gene. Therefore, both cis-element and molecular architecture information of Hsp70 would help in designing site-directed based mutagenesis studies to gain fundamental understanding of its role in abiotic stress response in rice both at transcriptional and translational level, which can help in designing climate-resilient rice varieties.

OFSA-2017/CD-40

Biological efficiency of Indian oyster mushroom (Pleurotus pulmonarius) as influenced by different lingo-cellulosic substrates

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Among the edible mushrooms, oyster mushroom is one of the most popular edible species that belongs to family *Pleurotaceae*. They are well known for their ability to degrade lingo-cellulosic materials, abundantly available in the form of different agro-wastes. Pleurotus pulmonarius, commonly known as Indian oyster mushroom, prefers warmer weather for its fructification resembles white colored shell. A trial was conducted in the Mushroom Research Centre, Orissa University of Agriculture and Technology, Bhubaneswar, India to evaluate its biological efficiency (BE) on different agro-wastes. Ten different locally available agro-wastes viz. banana leaf, coconut coir, maize stalk and leaf, mustard stalk, paddy husk, green gram stick, saw dust and paddy straw were evaluated for their comparative yield potential. The well dried substrates were soaked for six hours, steam pasteurized for one hour and allowed to retain 65 per cent moisture. Oyster mushroom cultivation was done in poly bags @ 1.5 kg dry substrate/bag. Each treatment was replicated thrice with six bags in each. Proper temperature and humidity were maintained throughout the cropping period. It was observed that paddy straw sustained significantly highest mushroom yield (1530 g, 102 % BE) followed by green gram stick (1300g, 86.6 % BE). Groundnut haulms, mustard stalks and maize leaf supported satisfactory harvest (78.8- 84.4 % BE). Banana leaf, maize stalk, sawdust and coconut coir were found to be comparatively poor substrates (60-70 % BE). Faster spawn run (14.6 d) was observed in paddy straw closely followed by green gram stick (15 d). The time taken for pinhead emergence was earlier (18.6 d) in paddy husk followed by paddy straw and green gram stick (19.3 d). There was not much difference between paddy husk (22 d) and paddy straw (22.3 d) in the time taken for primordia initiation. It was thus inferred from the investigation that paddy straw was the most suitable substrate for cultivation of P. pulmonarius in terms of higher yield potential, faster spawn run in the substrates and crop duration.

OFSA-2017/CD-41

Farmers-scientists' perception on climate change

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A study was conducted on the perception f scientists of Central Rice Research Institute(now National Rice Research Institute, Cuttack) regarding climate change. The specific objectives of the study are to select one appropriate group having adequate understanding on climate change and analyze their profile and to identify the major areas of impact of climate change and extent of severity amongst Environment, Agriculture and allied, Coastal zone, Forest and wildlife and Hydrology and water resources. Again twelve important action programme were decided and selected by the group as most important after careful statistical analysis from thirty-five variables. Frequency, percentage, method of paired comparison and factor analysis were used for analysis. It was found that due to climate chan**ge.** Another specific objective of the study was a comparative analysis of perception regarding seasonal variations between the situation of 20 years back and present situation using frequency and percentage method.It was found that

due to climate change the environment will be most severely damaged followed by Agriculture and allied and others. Application of e-Extension, promotion of bio-fertilizers, resource monitoring, awareness, pollution control etc gained foremost importance followed by others as important action programme here. The environment will be most severely damaged followed by Agriculture and allied and others. Application of e-Extension, promotion of bio-fertilizers, resource monitoring, awareness, pollution control etc gained foremost importance followed by others as important action programme here. A study was also conducted on the farmers of Eradanga, Chhapada and Vidyadharpur villages of Raghunathpur block of Jagatsinghpur district of coastal Odisha to assess the experienced farmers. Farmers who had more than twentyfive years of farming experience were deliberately selected and interviewed. Farmers ' perception relating to monsoon, off-season rainfall, winter rain, duration of winter, duration of summer, occurrence of tornadoes etc were taken into consideration. And farmers perceived that there is a significant change of timing and days and months relating to above parameters.

OFSA-2017/CD-42

Management of water scarcity for future irrigation purpose

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It is surprisingly difficult to determine whether water is truly scarce in the physical sense at a global scale or whether it is available but should be used better. Supplies of good quality irrigation water are expected to decrease in the future because the development of new water supplies will not keep pace with the increasing water needs of industries and municipalities. Thus, irrigated agriculture faces the challenge of using less water, in many cases of poorer quality, to provide food and fiber for an expanding population. Due to water scarcity the future water needs can be met by using available water supplies more efficiently, but in many cases it will prove necessary to make increased use of irrigation drainage waters and wastewaters after treatment. Aside from increased levels of salinity (total salt content) and sodicity (sodium content) of these waters will be higher than that of the original source water because of the direct addition of salts to the water and the evapoconcentration that occurs as water is used. The use of these waters may requires modifications of existing irrigation and agronomic strategies in most cases, there will be some situations that will require major changes in the crops grown, the method of water application, and the use of soil amendments. Use of poor quality waters requires three changes from standard irrigation practices: (1) improvements in water management, and in some cases, the adoption of advanced irrigation technology; (2) selection of appropriately salt-tolerant crops; and (3) maintenance of soil-physical properties to assure soil tilth and adequate soil permeability to meet crop water and leaching requirements (LR).

OFSA-2017/CD-43

Understanding the freshwater consumption trend from department to field: water foot print assessment (WFA) in Department of Life Sciences of Presidency University

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Water consumption and pollution can be associated with specific activities of daily life. Freshwater is increasingly becoming a scarce global resource, as it is finite. Water footprint (WF) is an indicator of freshwater use that looks not only at direct water use of a consumer or producer but also at the indirect water use. WF is regarded as a comprehensive indicator of freshwater resources appropriation, instead of a traditional and restricted measure of water withdrawal. WF of a product is the volume of freshwater used to produce the product, measured over the full supply chain. We have used Extended Water Footprint Calculation Method. We have studied water resource consumption pattern for students, scholars & faculties in Department of Life Sciences of Presidency University, Kolkata. The average water footprint is 1209 m^3/year, which is much more than the country average. Then we have performed Principal component analysis (PCA) to get more insight into the relationship between freshwater consumption patterns in daily life and agricultural water. This indicates the consumed resources that are more water-intensive which are to be used to a minimum necessity level or should be replaced by some other water non-intensive resources for the common goods to contribute positively to reduce over-exploitation of agricultural water and decreasing groundwater levels in West Bengal.

OFSA-2017/CD-44

Organic farming research in small millets - A comparative study

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Small millets are a group of six crops namely finger millet, little millet, kodo millet, foxtail millet, baryard millet and proso millet representing the area coverage in that order. Small millets have a unique place in Indian agriculture even though they contribute only 2.5 percent to the annual cereal grain production. The importance is because of the position they occupy in the ecological niche, where no other food crop is economical. Small millets are primarily grown under rainfed dry land and poor fertility conditions by resource poor farmers. Though under dry land conditions, millets grow better in the absence of chemical fertilizers. Most millet farmers grow them using farmyard manure under purely ecofriendly conditions. Due to ignorance of the need for better management of these lands and no investment on development, their productive capacity has declined over years.

With the aim to increases the productivity and to find out the response of chemical fertilizers, organics and integration of both, a field experiment on little millet was conducted under All India Coordinated Research Project on Small Millets at Centre for Pulses Research, Berhampur during Kharif 2016-17. The little millet variety SABARA was taken in three non replicated plots of size 10m x 10m each with the spacing of 30 cm between rows and 7.5 cm within rows for three treatments viz. T1- Only organics (FYM 5 t/ha + Vermi Compost 1 t/ha + Neem cake 500 kg /ha), T2- Only Inorganics (Recommended dose i.e, 40:20:20 kg NPK/ha only) and T3- INM (FYM + RDF). The yield attributing

characters like plant height, no. of tillers and panicle T3- INM length were taken from 10 random plants of five spots from each plot. The total grain yield and straw yield of each plot was taken for comparison.

Results indicated that Treatment-3, INM (FYM + RDF) i.e., a combination of organics and inorganics recorded highest plant height(122.4 cm), no. of tillers/plant(2.6) and panicle length(29.0 cm) as compared to other two treatments. Treatment-3 also recorded highest grain yield (979.0 kg/ha) and straw yield (3450.0 kg/ha), net income (Rs 5580.00) and B:C ratio(1:39) compared to that of only organics and only inorganics. The above characters as well as grain and straw yield were lowest in case of trial with only organics. It was thus concluded that higher yield in little millet was obtained when organic manure and fertilizers used in integrated manner, rather than either recommended dose of chemical fertilizer or only organic manures applied individually.

OFSA-2017/CD-45

Prospects and future of moringa as a super food in sustainable development

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Food security is an ever burning issue globally. The availability of foods, its nutrients and convenience of use is always a challenge. Moringa oleiferais the superfood providing tree, provide many super foods in form of leaf,fruit and seeds. Moringa shows great promise as a tool to help overcome some of the most severe problems in the developing world - malnutrition, deforestation, impure water and poverty. It is an outstanding source of nutritional components such as Vitamin A, Vitamin C, Beta carotene, Potassium, Iron and Protein.Producing moringa in a organic and organized way will ensure better price for the produce. Producing hygienic and quality products and exporting the products by following ethical business approach will increase the share of the country in the world market.The value addition and conversion of seeds, flowers and leaves of Moringa as drumstick powder, Moringa bio oil, Moringa leaf powder, Moringa tea, Moringa soup powder and Moringa capsule provides super foods with best nutrition that nature can offer. Apart from this the seed powder is a water purifier and leaf juice is a fertilizer. This reveals that though Moringa has the potential of being a nutritional security provider and the high value energy crop, it is least utilized in most of the growing areas. However, feasible approaches are thus critical in addressing the key issues of Moringa utilization at production level, during crop management, postharvest utilization as food and feed, nutritional and health value addition, and trade and commercialization as super food, bio oil & water purifier.Thus, Moringa emerging as a future crop of the nature will be a novel resource to growers and entrepreneurs to eradicate malnutrition and synthesizing bio-energy.

OFSA-2017/CD-46

Impact of farm mechanization on rice economy of Bargarh district

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The study was conducted to study the impact of farm mechanization on rice economy of Bargarh district of Odisha. Personal interview method was used to collect primary data using structured questionnaire from 120 sample farmers. Farm budgeting and Garrett ranking techniques were used to analyze the collected data. In case of manual cultivation of rice in the study area, a total of 35.65 man days of man labour, 22.84 days of woman labour and 2.96 pair days of bullock labour and 3.57 hours of machine labour were utilized. the need of human labour is more in traditional farming the semi-mechanical farming. The average yield per acre of manual and semi-mechanical cultivation is 23.50 quintals and 24.75 quintals respectively. The net returns per acre for rice cultivation for traditional rice growers and adopters of mechanical harvesting was found to be Rs. 13190.45 and Rs. 17613.91 leading to returns to cost ratios of 1.70 and 2.07 respectively. Semi-mechanical cultivation of rice was found to be economical over manual cultivation of rice. The major constraints faced by the owners of machines in semi- mechanical cultivation of Rice were coverage of long distances in different states/districts, high cost of machines, non-availability of financial support and fluctuations in area under the crop. For easy availability of machines during requirement and uniform rates, the cooperative model of custom hiring of agricultural machinery (developed by the Punjab government) should be introduced in rice growing regions of Odisha.

OFSA-2017/CD-47

Performance and combustion characteristics of CI engine using Polanga biodiesel blends

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In the present world it is essential to find an alternate fuel source due to the increased industrialization and depletion in natural resources. The method of obtaining biodiesel from various sources and blending them with diesel is adopted in many economically developed and developing countries around the world. This paper investigates the utilization of Polanga biodiesel blends with diesel in CI engine. The performance and combustion characteristics of B10, B20 and B30 blend of Polanga biodiesel blends have been studied. Polanga Biodiesel is a renewable source of energy that can help for reducing green gas emission and minimize the "carbon footprint" of agriculture. It is found out that the blends of Polanga biodiesel with diesel could substitute in the place of pure diesel and be used as an alternate source of fuel in the near future, thus saving the natural resources for the future generation. Performance parameters like brake power, fuel consumption, brake specific fuel consumption are evaluated. It is concluded that with the increase in load the brake power increases for same blend percentage and decreases with increase in blend percent. But the fuel consumption increases with both increase in load and blend percentage. The brake specific fuel consumption increases with increase in blend percentage but decreases with increase in load. This gives satisfactory result in engine performance.

OFSA-2017/CD-48

Effective management of irrigation water in canal command areas

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Rapid change in global climate has increased the level of hydrological uncertainty resulting in high spatio-temporal variation in precipitation, which in turn is widening the gap of supply-demand status of agricultural water. Increased industrialization and urbanization has also been leading to reduction in the share of agricultural water day by day. Hence, sound management of agricultural water has been a challenge to the water resources planners and managers for sustainable livelihood security. Looking into the above facts, a study was undertaken in the Panam multi-purpose major irrigation project in Gujarat, India to analyse the spatio-temporal variability in local weather condition and the supply-demand status of agricultural water. Monthly and seasonal volumetric irrigation requirement was estimated by using standard methodology. Daily water deliveries of the Panam main canal during the crop period from 2009-10 to 2012-13 was collected from potential sources and analysed for yearly supply and demand. The soil infiltration capacity, water front advance and recession under furrow irrigation were studied to analyse the efficiency in water distribution. Empirical infiltration equations were developed from the field data and advance and recession functions were formulated as empirical power equations. Three different experiments were conducted at different time intervals. The supply-demand ratio of the selected command area was found to be less than one almost every year except few monsoon months, when the rainfall was comparatively higher. Depth of infiltration was found to increase rapidly for a period up to about 15 minutes from the start of irrigation and then slowed down, which indicates that surge irrigation may perform better in the study region. Almost all the experiments showed reasonably good uniformity in water application over the furrow run resulting in nearly parallel advance and recession curves. Hence, furrow irrigation can be advantageous for better management of irrigation water, which requires the adoption of alternate cropping pattern having less water requiring and row-crops like pulses, oilseeds, vegetables etc. Global warming being a major worldwide concern, paddy area should be restricted to minimum requirement, just sufficient to fulfill the regional food demand.

OFSA-2017/CD-49

A new sesame variety suitable for organic cultivation

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Sesame is known as queen of oilseeds due to its high nutritive and medicinal value. It is cultivated mostly by small and marginal farmers in Odisha state in an area of about 212 thousand ha with a productivity of about 403 kg/ha. The productivity in Odisha is low due to various biotic stresses that affect the crop. To control the disease and pest attack various plant protection chemicals are applied by the farmers due to which the export quality of the seed and oil is reduced.

Growing of sesame varieties having resistance to the biotic stress factors will reduce the application of chemicals and thus maintain the seed quality. A new sesame variety OSC-79, developed by recombination breeding is found suitable for varied agro-ecosystems coupled with resistance to biotic stresses. The cream colored variety has recorded an average yield of 560 kg/ha in the coastal ecosystem. It is found resistant to alternaria leaf spot disease with an average disease incidence recorded upto 1.8, moderately resistant to phytopthora blight (2.1), macrophomina stem rot (10.4), powdery mildew (2.8) and CLS (2.2). It is also found resistant to a major insect pest i.e leaf roller and capsule borer attack at 30 & 50 days after sowing with leaf damage recorded upto 10.1% and 10.8% respectively while moderately resistant at 70 DAS (8.3% capsule damage). Thus this new sesame variety can be grown with reduced application of plant protection chemicals by the farmers of Odisha and nearby states.

OFSA-2017/CD-50

Role of tribal women in conservation of organic agriculture in Nayagarh

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Organic agriculture is aimed at producing food with minimal harm to ecosystems, animals or humans. Women in tribal pockets play a crucial role in the production of organic food. In their farming they produce organic manure, use bio-inputs,conserve seeds organically, maintain biodiversity, produce traditional crops and live stocks which provide healthy and safe foodsIn this context, the present study was carried out purposively by taking 105 households to assess the role of tribal women in conservation of organic agriculture and ecosystems of Kiapala and Kusapala villages under Ranpur block of Nayagarh district of Odisha during the year 2013-14. The villages were surrounded by forest areas that extended food, fuel, building materials as well as livelihood support to the poor households throughout the year even if extremely drought situation. The study revealed that out of 105 households, 81.9 per cent women involved in field operations during rice cultivation. It was observed that application of organic admixture in stored grains by them was maximum (96.2%) followed by collection and preparation of organic manure (92.4%), production of organic fruits and vegetables in the nutritional garden (87.6 %) and application of FYM in the rice field (64.8%). About 45.7 per cent tribal women prepared organic pesticides collecting certain leaves,roots and fruits from nearby forest to protect their rice crops from harmful insects and pests. It was concluded that the tribal women not only produced organic food for maintaining healthy life but also conserved the agro-ecosystem for a sustainable community.

OFSA-2017/CD-51

Performance evaluation of bullock drawn drum seeder as resource conservation technology in wet-land paddy cultivation with conservation agriculture perspectives.

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A field experiment was conducted during *Kharif* season, 2016 in Central Farm, OUAT for performance evaluation of Bullock drawn pre-germinated paddy seeder, developed through AICRP on Utilization of Animal Energy, OUAT, Bhubaneswar as Resource Conservation Technology in Wet-land paddy cultivation with Conservation Agriculture perspectives. In the above mentioned field experiment the resource conservation technologies were manual drawn drum seeder and bullock drawn drum seeder operated under un-puddled field condition. These two methods were compared with other existing methods of paddy establishment such as line transplanting using rope and guide and manual random transplanting along with manual drawn drum seeder and bullock drawn drum seeder operated under puddled field condition.

The results revealed that Highest cost of operation among the treatments was recorded as Rs11456/- per ha for manual line transplanting using rope and guide while it was lowest as Rs 941/- per ha in case of manual drum seeder under un-puddled condition which is due to the fact that the highest and lowest labour requirement of 54.78 man days/ha and 4.95 man days/ha were observed in line transplanting using rope and guide method and manual drum seeder under unpuddled condition respectively. The cost of operation in case of bullock drawn drum seeder was Rs 1275/- per ha and Rs 1235/- per ha under puddled and unpuddled conditions respectively. Considering the other plant growth parameters such as No of panicles/sq m, No of grains/ panicle and 1000 grain weight, the performance of the bullock drawn drum seeder under puddled condition was found to be superior to other treatments under the experiment. The highest No of panicles/sq m, No of grains/ panicle and 1000 grain weight in case of the said treatment were 340, 118 and 24.1 g respectively. Highest and lowest grain yield of 51.8 q/ha and 42.7 q/ha were recorded in case of bullock drawn drum seeder under puddled condition and manual drum seeder under un-puddled condition respectively. The grain yield in case of manual drum seeder under puddled condition and manual line transplanting using rope and guide were at par. Similarly the straw yield was found to be highest as 67.3q/ha in case of bullock drawn drum seeder under puddled condition which was at par with manual drum seeder under puddled condition and manual mechanical transplanter. The highest and lowest B:C ratio of 2.26 and 1.55 were found out in case of bullock drawn drum seeder under puddled condition and manual random transplanting respectively. Considering the performance indicators, plant growth parameters and yield parameters, the performance of the bullock drawn drum seeder was found superior to other method of paddy establishment under the study. Though the yield components in the bullock drawn drum seeder and manual drum seeder operated under un-puddled condition as resource conservation technologies were less as compared to the same methods under puddled condition, there was less labour requirement and soil properties indicated better stability with respect to bulk density and Penetrometer resistance.

OFSA-2017/CD-52

Nutrient utilization of ensilaged maize fodder in working bullocks and its effect on draughtability

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There is a shortage of approximately 62% of green fodders through out the year in our country. In Odisha, the present short fall is 48.4 %. Bullocks are the main source of farm power for small and marginal farmers in interior Odisha. Green fodder is only provided to them to some extent in rainy and autumn season only. Maize silage has 25-30% higher nutritive value compared to maize grain & maize straw (Cooper and Austin, 2000). In general, silage is more palatable and easily digestible. The green maize fodder was collected at pre flowering stage and dried under shade for 2 days to reduce the moisture content to 60-70% level. Then the fodder was chaffed to 2-3 cm size by a chaff cutter and then added with lactobacillus inoculants at the rate of one *sporolac* sachet per 5 q fodder and was filled compactly in two silo tanks, each of 5 quintal capacity made of four concrete well rings (Dia-3.5 ft) laid with polythene sheets, packed air tightly, covered and left for one month for ripening to silage.

The proximate analysis of the maize silage was found to contain Crude Protein- 2.08%, Crude Fibre- 37.38%, Nitrogen Free Extract- 50.6% and Ether Extract-1.36%. The maize silage was supplemented to the bullocks as 25% replacement

with paddy straw initially and was increased to 50% level gradually for 3 months in addition to 2 kg concentrate mixture per day. The draughtability test of the bullocks was conducted by ploughing for 3 days with a work rest cycle of 1h work + 10 min rest + 1h work + 10 min rest + 1h work in normal feeding practices and maize silage feeding.

The average daily DCP, TDN and ME intake under maize silage supplemented feeding was 0.308 kg, 3.62 kg and 12.79 Mcal, respectively. The maize silage supplemented feeding practice (Conc. mixture- 2.25 kg + paddy straw-2.2 kg + maize silage-2.2 kg) was found better in nourishing the medium sized bullocks during working season.

OFSA-2017/CD-53

Development of a turmeric polisher operated by bullock power in rotary mode

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Improved quality of turmeric has its own appeal and smell to attract customers and hence turmeric polishing is becoming one of the important aspects of post harvest operation for turmeric. Polished turmeric has its advantage in local market but also has high demand in foreign countries. It is also used to make turmeric powder which has larger customer base and used in day to day life. Going beyond the traditional method of polishing like, hand polishing which requires intensive labour, machine polishing is rapidly accepted in commercial world. In this research study, a turmeric polisher with carborundum powder as the polishing element is used and the developed polisher is compared with wire mesh polisher. Bullock power with rotary transmission unit was used to provide the necessary power source to run the machine. The polisher was tested for 35, 30, 25, 20, 15 kg feed rates and weight loss was measured at 10, 15, 20, 25, 30, 40 minutes time intervals. In wire mesh type turmeric polisher, the mean output was found to be 50 kg/h with a feed rate of 25 kg taking 30 minutes as batch time which gives an optimal polishing efficiency of 6.17% and energy consumption of 1.54kWh/day. For carborundum type turmeric polisher, the mean output is found to be 75 kg/h with a feed rate of 25 kg considering 20 minutes as optimal batch time which gives a polishing efficiency of 6.43% and energy consumption of 1.62 kWh/day. On economical point of view, though the cost of operation of both wire mesh and carborundum polisher is almost equal, carborundum type turmeric polisher is preferred for its better performance.

OFSA-2017/CD-54

Application of particle film technology in potato at coastal Odisha.

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Particle film technology is a potential approach in both organic and integrated pest management (IPM) of horticultural crops. It is a combined synthesis of knowledge on mineral technology, pest behaviour and light physics as they apply to both pest control and plant physiology. Particle film technology constitutes Kaolin-based sprays that deposit a "particle film" having numerous beneficial effects on plants, in insect pest control and form a highly reflective white film

over plant surfaces that enhance plant photosynthesis and reduce heat stress in plants by reflecting the infra-red light spectrum (en.wikipedia.org). Kaolin is a white non-porous, non swelling, low abrasive, fine grained, plate-shaped alumino-silicate mineral that easily disperses in water and is chemically inert over a wide range of pH (Glenn and Puterka, 2005). A natural mineral, Kaolin clay create a barrier film by covering the leaves and fruit with a white powdery film, which adheres and irritates insects result in insect pest reduction. It does not hamper honeybee activity or other beneficial insects (www.gardeningknowhow.com). It affects by interfering with feeding behavior and egg-laying, increasing mortality and concealing the crop (nwdistrict.ifas.ufl.edu).

The experiment was conducted at AICRP on Potato, OUAT, Bhubaneswar during *Rabi*, 2015-16 in potato variety Kufri Ashoka. The treatments comprises of untreated control(T_1), Imidacloprid 17.8 SL @0.03%(T_2), Kaolin @1.25%(T_3), Kaolin @2.5%(T_4) and Kaolin @3.75%(T_5) applied in mulching(M_1) and no-mulching(M_0) plots designed in two factor RBD with 4 replications. Black color plastic mulching was used to cover the soil after potato plants emerged. Foliar spray of Kaolin and Imidacloprid was done at 30 and 45 DAP. Observations on population of sucking insect pests and foliage feeders were taken at weekly interval after each spray. At harvest potato tuber yield was recorded.

The results indicated that the insect pest damage was significantly decreased in Kaolin treatment plots. Kaolin @2.5%(T_4) and Kaolin @3.75%(T_5) performed statistically at par in decreasing both the sucking and foliage feeder insects. The number of white flies/three leaves/plant was found to be minimum in M_0T_5 (8.58) which is at par with M_0T_4 (9.6) as compared to 22.18 in untreated control. The hoppers/three leaves/plant was recorded minimum in the treatment M_1T_5 (7.67), at par with M_1T_4 (7.71) as 15.79 in untreated control. The foliage feeders like *Spodoptera litura* and *Helicoverpa armigera* were found to be very less or nil in Kaolin sprayed plants in T_4 and T_5. The tuber yield was highest in M_0T_4 (183.3q/ha) followed by M_1T_4 (174.4 q/ha). David *et al* (2000) had given similar opinion that Kaolin was highly effective in preventing citrus thrips. He also said that Kaolin did not interfere with photosynthesis or stomatal conductance and may possess yield enhancement qualities. The yield in non mulching treatment plots was found to be significantly better than the black plastic mulching.

OFSA-2017/CD-55

Conservation agriculture improves maize based system productivity and profitability under rainfed uplands of India

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Traditional agriculture in rainfed uplands of India has been experiencing low agricultural productivity as the lands suffer from poor soil fertility, susceptibility to water erosion and other external pressures of development and climate change. A shift toward more sustainable cropping systems such as conservation agriculture (CA) may help in maintaining soil quality as well as improving crop production and farmer's net economic benefit. This research assessed the effects over 3 years (2011– 2014) of reduced tillage, intercropping, and cover cropping practices customized for maize-based production systems in upland areas of Odisha, India. The study focused on crop yield, system productivity and profitability through maize equivalent yield and economics of production. Results showed that maize grain yield did not differ significantly over time or among conservation agriculture production system (CAPS) treatments, while cowpea yield was considered as an additional yield in intercropping systems. Mustard and horsegram grown in plots after maize cowpea intercropping recorded higher grain yields of 25 and 37%, respectively, as compared to those without intercropping. Overall, the full CAPS implementation, *i.e.,* minimum tillage, maize–cowpea intercropping and mustard residue retention had significantly higher system productivity and net benefits than traditional farmer practices, *i.e.,* conventional tillage, sole maize cropping, and no mustard residue retention.

OFSA-2017/CD-56

Mitigating climate change with varietal substitution of paddy in Kendrapara district of coastal Odisha

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Kendrapara district of Odisha comes under East and South Eastern coastal plain zone. The district is one of the natural calamity prone area particularly during the months of August to October. Flash flood or submergence is a common phenomenon of low land areas of this region. Flash flood is associated with monsoon rains that seriously affects crop establishment which results in yield losses to varying levels, especially when submergence occurs during early vegetative stage and prolongs for more than a week. In such unpredictable, adverse situation, the growing of submergence tolerant varieties is the objective for getting higher yield. International Rice Research Institute (IRRI) and its collaborators have developed a submergence-tolerant rice variety - Swarna-Sub1, which can survive up to 14 days under full submergence. It is developed by introgressing a single quantitative trait locus (QTL) that causes submergence tolerance in Swarna, a popular rice variety in eastern India. To assess the performance of the variety, front line demonstrations with Swarna- sub-1 were conducted in farmers fields during *kharif*, 2011 and 2012 at Krushnadaspur village of Pattamundai block, during 2013 in Kanpura village of Kendrapara block and during 2016 in Kasotibali village of Marshaghai Block of district Kendrapara. The soils were loamy to clayey loam in texture with medium available Nitrogen (345.8 Kg/ha), medium in available phosphorus (14.5-35.4 Kg/ha) and high exchangeable potassium (378.8-476.0 kg/ha). The soil was neutral to acidic in nature having pH of 6.2. Seedlings were raised in the months of July with 40kg/ha of seed rate , crop was transplanted with 21-23 days old seedlings at 20 cm x 15 cm spacing ,fertilised with N-P_2O_5-K_2O @ 80-40-40 Kg/ha with prophylactic plant protection measures. In all the years the average grain yield of Swarna sub-1 was 42.7- 49.5 quintals per hectare within a period of 143 to 146 days duration having average cost benefit ratio of 1.95, which was higher than Swarna. This strategy of varietal substitution benefitted the farmers under changing climate situation.

OFSA-2017/CD-57

Effect of organic mulches on runner production of strawberry (Fragaria x ananassa Duch.) cv. Chandler

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The runner production of strawberry cv. Chandler was evaluated under various organic mulches viz., dry grass, saw dust, sugarcane trash and paddy, while plants without mulch served as control in the year 2016 at Fruit Research Station, Department of Fruit Science and Horticulture technology, College of Agriculture, OUAT, Bhubaneswar, Odisha. The mulches of about 6 cm thickness were applied around plant basin one week after transplanting. Results revealed that all the organic mulches significantly increased runner production of strawberry. Maximum number of runner per plant, runner platelets per runner and runner plantlets per plant was recorded with paddy straw followed sugarcane trash. The per cent increase in number of runner plantlets over control with paddy straw, sugarcane trash, saw dust and dry grass mulch was 33.33 percent, 27.78 percent, 18.00 percent and 14.00 per cent, respectively. Organic mulches also increased the length of the runner stolon, number of leaves and leaf area of runner plantlets. Organic mulches under study resulted in better growth of strawberry vegetative growth in terms of increased runner production and better growth of runner plantlets. Maximum growth was observed with paddy straw followed by sugarcane trash, saw dust and dry grass as compared to control. The enhanced growth of runner of strawberry might be attributed to optimum soil moisture, spare weed population and availability of nutrients which might have formed increased number of runners and their better growth.

OFSA-2017/CD-58

Influence of thermal stress on milk constituent traits of Murrah buffaloes under subtropical climatic conditions

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Increased pressure for more milk production and rise in environmental temperature due to global warming has increased the thermal load on dairy animals. Buffaloes due to their dark skin, sparse hair coat, and scanty sweat glands are very prone to thermal stress. Among the several ways of estimating thermal load on animals, Temperature Humidity Index (THI) that combines dry bulb and wet bulb temperature along with relative humidity to measure the heat load serves as one of the efficient way. The present study was conducted to identify the effect of THI on milk composition traits (monthly test day fat% and SNF%) of Murrah buffaloes. Data on 734 Murrah buffaloes (March 1994 to December 2013) were collected from ICAR-National Dairy Research Institute, Karnal and climatic parameters (dry bulb temperature (T_{db}), Wet bulb temperature (T_{wb}) and relative humidity (RH)) were collected from Central Soil Salinity Research Institute, Karnal. The overall least-squares means for monthly test day fat% ranged from 7.58 ± 0.04 in TD2 to 8.02 ± 0.04 in TD 9. The overall least-squares means for monthly test day SNF% of Murrah buffaloes ranged from 9.61 ± 0.01 in TD5 and TD 6 to 9.65 ± 0.01 in TD 8. The analysis of variance revealed that monthly test day fat% was not significantly affected by non genetic factors like parity, year of calving significantly influenced ($P<0.01$) the trait while age group at first calving influenced the trait only at TD 6 ($P<0.05$). Similarly, significant effect ($P<0.01$) of parity at TD 5 and year of calving in all test days was observed for monthly test day SNF % while age group at first calving had no significant effect on the trait. Effect of test day was significant ($P<0.01$) on fat% and non-significant for SNF%. The data were adjusted for the significant effect of the non-genetic factors. The effect of THI on the adjusted milk constituent traits was analysed using Least Squares Analysis and was found significant for monthly test day fat% ($P<0.05$) and monthly test day SNF% ($P<0.01$). It was concluded that thermal stress measured in terms of THI influenced milk constituent traits significantly. Hence, care should be taken for prior heat amelioration programmes during thermal stress periods. Furthermore, THI may be included in selection and breeding programmes for improved selection efficiency in the farms.

OFSA-2017/CD-59

Response of potato variety to different dates of sowing

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A field experiment was carried out during rabi season of 2015-16 in Regional Research and Technology Transfer Station(OUAT),Keonjhar, Odisha to identify the suitable variety and date of planting of potato for North Central Plateau Zone of Odisha. The climate of the zone is hot and sub-humid with mean maximum summer temperature of 37.30°C and mean minimum winter temperature of 11.78 °C. The mean annual rainfall is 1487.7 mm of which about 86.8% is received during Monsoon season (June to September) and about 7.3% and 5.9% is received during Rabi (October to January) and summer (February to May) respectively. The soil of this area was loamy sand in texture and slightly acidic in nature having pH 6.3. The trial was laid out in Factorial RBD with three replications. There were four varieties of potato (K.Jyoti, K.Surya, K.Ashoka, K. Pukhraj) and three date of sowings (15 November, 25 November and 5 December). The seed tubers were obtained from AICRP on Potato(OUAT),Bhubaneswar. The tubers were treated with Dithane M-45@ 0.3% before planting. The treated seed tubers with 2-3 eyes were planted in furrows with a spacing of 50 cm x 20 cm. A fertilizer dose of N: P_2O_5 : K_2O @ 60:60:60 kg NPK + 10 t FYM/ ha was applied as basal and N: P_2O_5 : K_2O @ 60:0:60 kg NPK/ha was applied as top dressing 30 days after sowing. Hoeing, earthing up and other intercultural operations were done at periodic intervals.The result of the experiment revealed that plant height was maximum in K. Phukraj(36.4cm) which was at par with other varieties tested. Number of branches per plant was found to be highest in K. Ashoka (6.1) which was significantly higher than other treatments. K. Pukhraj recorded highest yield of 28.37 t/ha closely followed by K. (25.97t/ha).The first date of sowing (15 November) resulted inmaximum yield(26.25t/ha).

OFSA-2017/ CD-60

Economic impact and usability analysis of medium range weather forecast for Keonjhar district of Odisha

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The medium range weather forecast issued from National Centre for Medium Range Weather Forecast (NCMRWF) on various weather parameters and impact of agro advisories issued based on this medium range weather forecast for for Keonjhar district of North Central Plateaue Zone of Odisha state during the period from 2006-07 to 2015-16 are discussed in this paper. The usability of different forecasted weather elements was more than 65 per cent in most of the years except for wind direction which was less than 40 per cent in most of the years. Further, the survey data revealed that the forecast and related advisories issued for day to day farm activities were found to be excellent in 31.2 cases and satisfactory in 34.7 cases. The economic impact studies indicated that there was considerable benefit to farmers who adopted the advisories made from Gramin Krishi Mausam Sewa (GKMS) Unit, Keonjhar. The per cent gain in income from different crops by the AAS farmers was to the tune of 4.8 to 11.6 per cent over non AAS farmers

OFSA-2017/ CD-61

Effect of organic nutrient management in *Kharif* rice

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Rice is the staple food for about 50 per cent of the world's population and in Asia 90 per cent of the world's rice is grown and consumed.To assure food security in the rice consuming countries of the world, rice production should be increased by 50 per cent in these countries by 2025. This additional rice will have to be produced on less land with less usage of water, labour and chemicals (Rath *et al.,* 2011). Conventional agriculture has resulted in declining factor productivity and hence, is no more sustainable. Furthermore, it has propped up many environmental problems including soil, air and water pollution and finally human health hazards (Singh *et al*., 2011). It is widely recognized that organic matter in soils plays an essential role in a range of soil physical, chemical and biological processes and that soil organic carbon (SOC) is one of the most important indicators of soil quality and health. Organic residues including green manure, farmyard manure (FYM) and vermicompost are traditionally applied to rice soils in order to maintain the SOM status including soil organic carbon storage and to increase the levels of plant nutrients and to improve the physical, chemical and biological soil properties that directly or indirectly affect soil fertility and productivity.

The experiment comprising of seven number of treatments viz., T_1- Dhanicha @ 25 kg seed/ha, T_2- Dhanicha + FYM @ 5t/ha (basal) , T_3- Dhanicha + Vermicompost 2t/ha (basal), T_4- T_1 + Vermicompost 2t/ha (split) , T_5- T_1 + FYM+ Vermicompost (split), T_6-T_1 + FYM+ Vermicompost (basal) and T_7-T_1 + FYM + Panchagavya in kharif season of 2015. Rice variety "Lalat" was grown as the test crop. Organic nutrient management expressed significant effect on all growth parameters of rice. Number of tiller per hill at 45 DAT were maximum (30.62) for treatment T_5 which was at par with those of T_3, T_4 and T_6. Number of effective tillers per hill also observed similar trend. Dry matter production per hill at maturity was significantly more for T_5 (73.11 g hill-1). Number of panicle m^{-2} was significantly maximum for T_5 (374.62) at harvest. Grain and straw yield were significantly higher for T_5 (5.39 and5.25 t ha^{-1}, respectively) which was at par with those of T_4, T_6 and T_7 for grain and straw yield.

OFSA-2017/ CD-62

Performance of Strawberry Grown Under Rooftop at Bhubaneswar

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5 is Ex-Prof. & Head, Dept. of Horticulture, CA, OUAT, Bhubaneswar

Strawberry (*Fragaria vesca)* is an important fruit crop of India and its commercial production is possible in temperate and sub-tropical areas of the country. Irrigation is a vital input and for that knowledge of crop water requirement is required. The experiment was carried out for growing strawberry under the roof top of College of Agricultural Technology and Engineering, Bhubaneswar during the period 2015-16 taking different MAD (manageable allowable depletion) levels like 10 (T_1), 20 (T_2), 30 (T_3) and 40 (T_4) per cent and one control for irrigation to crops for studying its performance under deficit irrigation. The roof top of the college building is at a height of 11.3 m from ground surface. The strawberry plants were grown in pots following the standard package of practices. The crop evapotranspiration,

crop coefficient, yield and yield attributes were observed during the experimentation. The highest evapotranspiration of 1.19, 2.13, 2.70 and 2.23 mm/day was observed in T1 for initial stage, development stage, mid-season stage and late-season stage of strawberry compared to other conditions. Similarly the crop coefficient for strawberry was respectively determined to be 0.23, 0.35, 0.43 and 0.37. In treatment T1 (irrigation at 10% MAD level) showed the highest plant heights of 4.8 cm, 11.5 cm and 12 cm at 30, 60 and 75 DAP, which is significantly better from other treatments. Highest number of branches of 12, 15 and 18 after 30 DAP, 60 DAP and 75 DAP respectively were found in T1 i.e. at 10% MAD level followed by T2, T3, control and T4. The no. of fruits harvested were found to be highest of 10 under the treatment T1 followed by 9 in T2, 3 in T3 respectively. Similarly after 75 days no. of fruits were found to be highest of 16 under the treatment T1 followed by 13 in T2, 5 in T3, 3 in T4, and 2 in control respectively.

OFSA-2017/ CD-63

Front line demonstration of flood and submergence tolerance paddy variety Swarna sub -1 to mitigate climate change

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The Kendrapara district of odisha comes under East and south eastern coastal plain zone. This district is one of the natural calamities prone area particularly during the months of August to october. Flash flood or submergence is a common phenomenon of low land areas of this region.Flash flood is associated with monsoon rains that seriously affects crop establishment which results in yield losses to varying levels. It brings a complex abiotic stress in flood-prone ecosystem, because it substantially reduces crop stand, especially if it occurs during early vegetative stage and prolongs for more than a week. In such unpredictable, adverse situation, the growing of submergence tolerant varieties is the objective of producing higher yield. A few submergence–tolerant rice varieties have been developed by incorporating SUB 1 gene into mega rice varieties of South Asia. The International Rice Research Institute (IRRI) and its collaborators have developed a submergence-tolerant rice variety known as Swarna-Sub1 .The rice variety has been released in India for the commercial cultivation. Swarna-Sub1 survives full submergence for up to 14 days because it was developed by introgressing a single quantitative trait locus (QTL) that causes submergence tolerance in Swarna, a popular rice variety in eastern India. Under normal conditions, Swarna-Sub1 is considered to show no significant differences in agronomic performance, grain yield, or grain quality compared with Swarna.

Front line demonstrations were conducted in farmers fields using Swarna- sub-1 during kharif, 2011 and 2012 at Krushnadaspur village of Pattamundai, during 2013 in Kanpura village of Kendrapara and in the year 2016 in Kasotibali village of Marshaghai Block of Kendrapara. The demonstrations were made by raising seedlings in the months of july with the use of seed rate of 40kg/ha, transplanting of 21-23 days old aged seedlings with 20 cm x 15 cm spacing ,application of fertiliser doses of N-P_2O_5-K_2O @ 80-40-40 Kg/ha and taking prophylactic plant protection measures. The soils were loamy to clayey loam in texture with medium available Nitrogen (345.8 Kg/ha), medium in available phosphorus (14.5-35.4 Kg/ha.) and high exchangeable potassium (378.8-476.0 Kg./ha.) The soil was neutral to acidic in nature having pH of 6.2. Results of the demonstration revealed that plant survival, yield attributes and grain yield of test variety Swarna Sub -1 is better than variety swarna.In all the years the average grain yield of Swarna sub-1 was 42.7- 49.5 quintals per hectare within a period of 143 to 146 days duration having average cost benefit ratio of 1.95. This strategy of varietal substitution benefitted the farmers under changing climate situation

OFSA-2017/SEN -01

Agricultural commodity trading in India: trends and composition

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In the post-liberalization period, largely on the advice of a study by the World Bank and the United Nations Conference on Trade and Development (UNCTAD), and the recommendations of Kabra Committee Report, the Indian government lifted the ban on commodity futures trading in 2003. Since then agricultural commodity trade has registered an impressive growth over the years. The total size of commodity futures market was Rs.170468 billion outstanding in the financial year 2012-13 but it has drastically decreased to Rs. 101447 billion in 2013-14. The monthly turnover in Indian commodity exchanges is next only to the US and China. Over the years, the composition of trading has dramatically changed in the Indian futures markets.The total value of agricultural trading has shown considerable variation during 2009-10 to 2013-14. In 2009-10, the total value was Rs. 1217949 crores which rose significantly to 2196149 crores in 2011-12. However, it has declined to Rs. 1602401 crores in 2013-14. The percentage share of agricultural commodity trade in total commodity trade was 15 per cent in 2009-10 which declined to 12.11 per cent in 2011-12. In the year 2013-14, the percentage share increased to 15.79 per cent.

OFSA-2017/ SEN -02

Farmers' perception on ICT tools used in organic farming in Kandhamal district of Odisha

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The study investigated farmers' perception on ICT (Information and Communication Technology) in organic farming in Kandhamal district of Odisha, with the specific objectives of assessing the demographic characteristics of farmers, identifying the major crops grown by the farmers, assessing farmers' sources of information on organic farming, examining farmers' knowledge of organic farming, as well as farmers' perception on organic farming and ICT tools used in organic farming. A simple random sampling technique was used to select 70 farmers in the study area. The data collected were analyzed using suitable analytical tools like frequency counts, percentages, Chi-square and Garette ranking. Results obtained show that farmers in the study area are mostly illiterate with a mean age of 51.5 years married, having lack of any modern technology and also lack of awareness regarding recent governmental schemes on organic farming like Paramparagat Krishi Vikash Yojana. Organic turmeric is the main crop being grown by the tribal farmers, other crops like vegetable, mustard, paddy, maize, oilseed etc., are also grown. The sources of information on organic farming are very less which needs to be upgraded. Their most preferred sources of information is KASAM (Kandhamal Apex Spice Association for Marketing). Farmers in the study area have a favourable perception towards organic farming but lack of information regarding ICT in organic farming. Results further reveal that significant relationships exist between sources of information on organic farming and farmers' perception of organic farming. These imply that those who have more access to information on organic farming tend to have a favourable perception towards organic farming than those who have less access to information on it. Policy recommendations emanating from the study include active involvement of

youths in organic crop production, improvement of information sources on organic farming, and enlightenments on various organic methods of weed, pest and disease control, nutrient management through the regular sources of information on organic farming. Farmers should be motivated through credit facilities and access to ICT tools on organic farming in order to ensure sustainable production of food, since the farmers have a favourable perception towards organic farming.

OFSA-2017/ SEN -03

How to communicate green marketing through social media by applying golden circle theory

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Green Marketing have become very popular terminology in these day. Most of the companies are focussing on green marketing by selling natural product and trying to make more positive brand value. As consumer are becoming health consciousness and people like to buy environmental friendly product, companies also believe both in achieving environmental objectives as well as profit related objectives. It helps in maintaining the competitive edge in the market.

Green marketing also helps in reducing cost by reducing harmful waste and ensure long term growth with profitability. Government is also framing rules and regulations to reduce the harmful product which effect the society, like by banning plastic bags. With so many benefits of green marketing still consumers are confused to adopt the green product or are refusing to pay premium for green product. This is due to poor communication about green marketing.

Most of the consumer do not have knowledge that what is green product. For this companies need to be more transparent about their product details and produce fact and figures. But the question is how? And which medium has maximum reachability? Answer is Social Media.

By using Social media platform company can reached to maximum customer and tell about their products and product related information. This can be done more effectively by using Simon Sinek Golden Circle theory. Every company is saying that they are making green product that is "What" they are doing. But not emphasis on "Why" they are making? Until and unless people should know why they must buy, they are not ready to paypremium for green product. This paper outlines the how green company can use social media to communicate about green product by applying Simon Sinek Golden Circle rule.

OFSA-2017/ SEN -04

Gender gap analysis in cultivation of fruit crops

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Farm women constitute an important component of human resource in agriculture. However, their participation in different activities like crop production, animal husbandry, horticulture etc. varies as per the locality and agro-climatic conditions .Complex household responsibilities and other off farm livelihood options are the strong determinants affecting their quality participation in agriculture and allied sectors. Women play a significant role in fruit cultivation,

however their roles are hardly visualized, which creates perceptible gender gap. Therefore, role of women in fruit cultivation was explored in predominantly fruit growing areas of Kuchinda block of Sambalpur district of Odisha, covering 138 women in the year 2016 by using a semi-structured interview schedule. Results of the study revealed that farm women had low participation in land preparation and layout of orchard. Their participation was nominal in use of spraying machineries and other power operated farm implements. They had full participation in post planting care, mulching and harvesting, while participation was moderate in planting of saplings, application of organic manures, water management and weed management. The extent of intercropping of vegetables and other short duration crops was low. Farm women had nominal to low knowledge regarding improved technologies of fruit crops. They had moderate participation in sorting & grading of fruits, low participation in value addition, preservation and processing of fruits and nominal participation in marketing of processed products. The overall access to all kinds of resources such as credit, agricultural inputs, training and capacity building were low. The decision making ability of farm women in crops selection and in situation of surplus yield of harvested product was moderate. Considering the crop-wise over all participation of farm women in various activities of fruit cultivation, it can be concluded that the farm women had full participation in cultivation of banana, moderate participation in mango and papaya. The participation was low in fruit crops like litchi, guava, lemon and nominal in case of minor fruits like sapota, custard apple and jackfruit. The emerging issues like migration of male members from rural areas and situation of distraction of rural youth in agriculture, warrants the need for analysing women's role and their participation in growing fruit crops. As fruit crops are highly remunerative and lucrative, gender gaps analysis in this sector, will play a significant role in development of Agro based or Horticulture based small and medium enterprises through gender mainstreaming.

OFSA-2017/ SEN-05

Agricultural credit in India: Trends and composition

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Credit is an important mediating input for agriculture to improve productivity. Access to institutional credit enables the farmer to enhance productivity by investing in machinery and purchase of variable inputs like fertilizers, quality seeds, and manure and providing funds till the farmer receives payment from sale of produce, which is at times delayed and staggered. Input use by farmers is sensitive to credit flows to the agriculture sector.Despite the impressive gains made by the rural credit delivery system in terms of resource mobilisation, geographical coverage and functional reach, the financial health of the rural credit institutions has deteriorated raising questions about their sustainability. Nearly three quarters of the farmer households still do not have access to the formal credit system. This leaves them vulnerable to the informal money lenders. There was a visible fall in the rate of growth of agricultural credit in the early 1990s and it remained modest in the rest of the decade too. Accelerating growth could only be seen from around 2002-03. Indirect credit has risen even more impressively, due mainly to more and more categories being brought within the ambit of agricultural credit.

OFSA-2017/ SEN -06

Reducing gender gap in access to agri-production resources to promote organic farming

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Agriculture remains as prime source of women's livelihood and women remain as backbone of agricultural workforce. In spite of women making up the prime workforce in agricultural production and processing in India, they lag well behind men in ownership of assets, access to production resources and decision making. By improving farm women's access to agri-production resources, their potential could be unlocked, thereby enhancing their efficiency and productivity. Another side, organic farming is the most dynamic and rapidly growing sector in India. Women in organic farming often have a more diversified roles to play in the household as well as on farm which increases their self-esteem and decision making power. It offers economic opportunities to women which are more affordable and accessible to them. It supports women's health through prohibition of synthetic chemicals. It encourages biodiversity and traditional knowledge as women are often custodians of local seeds and traditional knowledge. Farm women's capacity to adopt improved farm technologies mostly depends on their access to and control over agri-production resources. Hence, there is a need for timely and adequate access to agri-production resources and services if organic agricultural production is to be increased. But, underlying socio-cultural norms and gender stereotypes mediate access to and control over agri-production resources. Women's low participation in decision making is a typical aspect of gender inequality in organic agriculture. Hence, women's participation in farm decision making should be encouraged. Agricultural extension systems need to facilitate both men and women to become an active change agent for dissolving rigid gender stereotypes and transforming gender relations in organic agriculture. Therefore, it is worthwhile to capture, integrate and scale out best bet practices to build gender transformative agricultural extension system in India which will be able to provide timely, affordable and quality access to agri-production resources and tailored advisory services to men and women farmers in order to fetch gender equality in organic agricultural implementation and production.

OFSA-2017/ SEN-07

Agro-industries for development

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Developing competitive agro-industries is crucial for generating employment and income opportunities. It also contributes to enhancing the quality of, and the demand for, farm products. Agro-industries have the potential to provide employment for the rural population not only in farming, but also in off-farm activities such as handling, packaging, processing, transporting and marketing of food and agricultural products. There are clear indications that agro- industries are having a significant global impact on economic development and poverty reduction, in both urban and rural communities. However, the full potential of agro-industries as an engine for economic development has not yet been realized in many developing countries. To address these issues, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Industrial Development Organization (UNIDO) and the International Fund for Agricultural Development (IFAD) organized the first Global Agro-Industries Forum (GAIF) in New Delhi, India, from

8 to11 April 2008. The Forum developed a shared vision on the factors critical to the future development of agro-industries, the key factors affecting their competitiveness, and potential priority action areas. The objectives of the Forum were threefold: to learn lessons from previous efforts and successes to develop competitive agro-industries in the developing world; to ensure stronger collaboration and joint activities among multi-lateral organizations working on agro-industrialization; and to clarify the distinctive roles of the public sector, multi-lateral organizations and the private sector in agro-industrial development. A related objective was to engage international organizations and financial institutions into launching initiatives at national and regional levels to foster agro-industrial development Especially in Africa.

FAO, UNIDO and IFAD are committed partners for the development of a shared vision to maximize the impact of the agro-industrial sector on the livelihoods of those in the developing world. Our agencies are working together to assist their Member States in creating enabling environments for the development of agribusiness, agro-industries and agro-based value chains. We are doing this through the formulation and implementation of strategies for improving policies, regulatory frameworks, institutions and services. We are also promoting the incorporation of agro-industrial development strategies into country level programme frameworks and strategic action plans to assist the poor and small farmers.

OFSA-2017/ SEN -08

Intervention of organic manures and bio-fertilizers for eco-restoration of iron mine spoil

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Open cast mining generates enormous quantity of mine spoil as a result of the removal of top soil. The mine spoil loses its nutritional status over the years by leaching thereby rendering the spoil inhabitable for microbial colonization and vegetation. Conventionally iron mine spoil has low pH, organic carbon and N, P, K .The spoil dumps cover very large area in and around the mining sites. Reclamation of mine spoil requires nutrient enrichment which could be achieved through suitable intervention of organic manures and bio-fertilizers. The reason for mine spoil amendment is to provide a better environment for roots and plant growth with an objective for re-vegetation of the spoil dumps. Addition of organic matter improves soil structure and water holding capacity, availability of nutrients and creates a better environment for soil biota. Pilot experiments on various combinations of organic manures and bio-fertilizers on sterile iron mine spoil have shown encouraging results. Farm yard manure ,poultry manure ,vermimanure and bio-fertilizer in various combinations increased soil nutrient level along with microbial colonization .Intervention of organic matter too positively influenced growth of native plant species .Experiments are also in progress to evaluate vermi-technology as a supplementary option to facilitate quality enhancement of iron mine spoil.

OFSA-2017/ SEN -09

Farmers-scientists' perception on climate change

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A study was conducted on the perception of scientists of Central Rice Research Institute(now National Rice Research Institute, Cuttack) regarding climate change. The specific objectives of the study are to select one appropriate group having adequate understanding on climate change and analyze their profile and to identify the major areas of impact of climate change and extent of severity amongst Environment, Agriculture and allied, Coastal zone, Forest and wildlife and Hydrology and water resources. Again twelve important action programme were decided and selected by the group as most important after careful statistical analysis from thirty-five variables. Frequency, percentage, method of paired comparison and factor analysis were used for analysis. It was found that due to climate change. Another specific objective of the study was a comparative analysis of perception regarding seasonal variations between the situation of 20 years back and present situation using frequency and percentage method.It was found that due to climate change the environment will be most severely damaged followed by Agriculture and allied and others. Application of e-Extension, promotion of bio-fertilizers, resource monitoring, awareness, pollution control etc gained foremost importance followed by others as important action programme here. The environment will be most severely damaged followed by Agriculture and allied and others. Application of e-Extension, promotion of bio-fertilizers, resource monitoring, awareness, pollution control etc gained foremost importance followed by others as important action programme here. A study was also conducted on the farmers of Eradanga, Chhapada and Vidyadharpur villages of Raghunathpur block of Jagatsinghpur district of coastal Odisha to assess the experienced farmers. Farmers who had more than twentyfive years of farming experience were deliberately selected and interviewed. Farmers ' perception relating to monsoon, off-season rainfall, winter rain, duration of winter, duration of summer, occurrence of tornadoes etc were taken into consideration. And farmers perceived that there is a significant change of timing and days and months relating to above parameters.

OFSA-2017/ SEN-10

Gender mainstreaming through organic agriculture

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The African proverb 'Without women we all go hungry' rightly point outs the importance of women in agriculture. Women provide much labour to agriculture-allied production activities in addition to the stipulated house hold activities. Women are central to the house hold economy as they manage wide varieties of home based agri-business and income generating activities. Women play crucial role in agriculture production, processing and storage as well as marketing and value addition. As like Women have specialized skill and specific knowledge in organic farming and thus play a more diversified role in organic farming. Organic agriculture is a production system that sustains of soil health, ecosystems and people. Ecological processes, biodiversity and cycles adapted to local conditions are more relied rather than the use of inputs with adverse effects. Organic farming assures gender equality in terms of offering gainful employment, increasing their income generating potential, offering health benefits, encouraging control and access over preservation of biodiversity and indigenous knowledge base, equitable work standards with equal wages for both men women and the like. Unlike conventional agriculture creating the problem of gender bias as because it puts obstacles for women in owning farms due to high investments for machinery and external inputs like seeds (hybrid/Genetically modified), chemical fertilizers and pesticides, and synthetic growth hormones. Environmental degradation and displacement disproportionately affects women and children. Though women contribute almost towards half of the world's agricultural production, hardly 2% of women in developing countries and about 20% in developed countries own land. Their role in agricultural and rural development perspectives is usually overlooked. In this context organic farming can be a better alternative in increasing gender equality. This calls for more action in enhancing its role. Mainstreaming gender in rural development and agricultural programs in particular and supporting organic agriculture as a means to improve gender equity through research, capacity building and financial opportunities need to be the Governments' support. Women's participation should be encouraged in formulation of these policies and programs and so also in agricultural and rural development organizations. FAO, UNEP, UNCTAD and IFAD, should give priority to finance programs that aims at offering opportunities in organic agriculture, and thereby increasing women's access to land, credit, training and extension services. Researchers should study organic agriculture and gender equality in order to enhance its positive effect and disseminate applicable findings. Organic Family Farming should be encouraged to promote gender equality by providing healthy working environments, fair labour practices, and equal opportunities. Formal gender equality, as expressed in fair trade norms needs to be respected. Consumers should also support organic agriculture in order to ensure that their food is grown in a socially and environmentally responsible manner.

OFSA-2017/ SEN -11

A study on green marketing: With special reference to organic product in Dehradun

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Green marketing is a phenomenon which is vital in modern marketing. Today the world requires new decisions and innovations which lead to green marketing environment and also to create a new market condition for the potential buyers. The objective of the study is to create awareness about green product or organic product as it's important to the society. A well-structured methodology has been adopted to collect primary and secondary data for the research. Suitable statistical tools have followed for analysis and as output of the study reveals that there is an increasing trend in customer's awareness and in turn the green product market have gained momentum. It also highlighted about the impact of non-organic product on society and suggestions were given based on the study. This study also creates an opportunity for future research program in the same field.

OFSA-2017/ SEN -12

Identifying histological and enzymatic biomarkers in earthworms to evaluate toxicity due to pesticides and chemical fertilizers in agricultural soil

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To achieve high agricultural productivity in India, the use of chemical fertilizers and pesticides have increased consistently since the first green revolution. Although conventional agricultural practices have helped achieve food security, it has proved detrimental to sustain soil quality due to contamination problems. Uninterrupted use of agrochemicals has adversely impacted many useful soil biota including the earthworms which are considered as vital component for maintaining soil health. Earthworms facilitate aerobic decomposition of organic matter and mineralization in soil and play key role in maintaining the nutrient pool. Earthworms are extremely sensitive groups of soil fauna and invariably indicate ecosystem disturbances. Therefore, these animals have been used worldwide as bioindicators of soil contamination due to xenobiotics. Research in India is in progress to evaluate the native earthworms as sensitive indicators for diagnosis soil toxicity arising out of over application of chemical fertilizers , pesticides and herbicides in agricultural fields. Important histological and histo-enzymatic biomarkers have been identified which could indicate soil toxicity. It has been observed that considerable alteration in circular and longitudinal muscle fibres occur when earthworms such as *Drawida willsi* and *Lampito mauritii* are exposed to sub lethal concentrations of organophosphorous pesticides and herbicides. It has been further observed that stress indicating histoenzymes such as lactate dehydrogenase, acetyl cholinesterase and catalase show significant variation in their activities in response to different concentrations of agrochemicals. Besides these enzymes, protein and lipid peroxidation in the earthworm tissue too could be useful markers indicating toxicity in soil.

OFSA-2017/ SEN-13

New verticals for promotion of organic farming as livelihood

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Shri Aurobindo said – "One ought to be able to see how beautiful outward nature can be and usually in, although it is itself apparently "inconscient" . Why should the growth of consciousness is inward Nature be attended by so much ugliness and evil spoiling the beauty of outward creation."

Many techniques like composting methods, bio-dynamic farming, uses of green manures/bio-fertilizers, mulching, use of indigenous varieties, water management, mixed farming, composite farming, biological control of diseases and

pests, plantation of neem on large scales, mulching etc. are followed in organic farming. Whether these techniques leads to livelihood while practicing the same by the target groups. This paper is packed with meaning, principle and ideology of organic farming, identification and revival of organic farming activities, developing replicable models, linking technological inputs to flagship programmes of Govt. of India i.e., Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGA), National Rural Livelihood Mission (NRLM), Swachh Bharat Abhiyan (SBA), Unnat Krishi Yojana and Skill Development through self help groups (SHGs) as well as youth skill development training programme. This will enhance the promotion of Organic Farming based livelihood activities.

OFSA-2017/ SEN-14

Price discovery and volatility of spot and futures market in agricultural commodities in India

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India is an agriculture-dominated economy. Farmers face not only the production risk but price risk as well. Commodity derivatives, especially futures play a crucial role in fixing a price, especially in agriculture providing a hedge against adverse price movements. The present study is an examination into the price discovery and volatility of spot and futures markets in agricultural commodities in India. The study uses the data of daily spot and futures prices of a sample consisting of ten agricultural commodities traded on Multi Commodity Exchange of India, (MCX) i.e. Guar Seed, Kapas, Potato Agra, Soy Bean, Chana, Wheat, Cardamom, Mentha Oil, Cotton, Crude Palm Oil for a period of 2006 to 2016. The results of cointegration test explain the long run equilibrium relationship for all the commodities validating that in general there is a price discovery process in the spot and futures commodity markets. Vector Error Correction Method (VECM) results show that spot market leads the futures market in price discovery mechanism in case of 7 commodities i.e. Cardamom, Chana, Crude Palm Oil, Guarseed, Mentha Oil, Soyabean and Wheat. In case of other 3 agricultural commodities i.e. Cotton, Kapas and Potato, futures market leads in price discovery process. The findings indicate that in case of agricultural commodities in India, spot market is more efficient than the futures market in price discovery. The results of Granger causality test show bi-directional Granger lead relationships between spot and futures in all agricultural commodities. The bivariate EGARCH results show that the market-specific volatility spillover coefficients are significant in case of 7 commodities i.e. Chana, Cotton, Guarseed, Kapas, Potato, Soybean and Wheat. In case of other 3 commodities, the existence of volatility spillover from future to spot market and from spot to future is not significant. The findings indicate that Indian futures market for agricultural commodities are not yet matured as useful mechanisms of price discovery and risk management.

OFSA-2017/ SEN -15

Rural empowered agro-based women cooperatives–An analysis & implementation of ICT behavioral model

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Women empowerment in general and rural unorganized women particular is a big issue in this global arena though they constitute a vulnerable segment of 40% more of the total population, are associated with rural economy of the country. Today, Rural and unorganized economy has the demand for agricultural value chain for local & external markets, can be taken as a powerful tool for Rural economic growth & can fight against the challenge of food security on economic backward states , where 70% more people based upon their livelihood upon agriculture and living below the poverty line. This issue may be solved with the establishment and development of ICT based women cooperatives for proper processing, marketing & distribution, which is now empowered by the legislation & development of self -help cooperative act, 2001, whereas these women members of the cooperatives have to do the work in processing ,marketing , distribution in general and the vegetable distribution channel in particular by availing ICT based proposed model of distribution for the smooth ,economic, effective distribution channel of the vegetables to enhance the economic growth of the women members of the cooperatives with the social benefits. Here the authors have developed a proposed ICT based behavioral economic model for proper and effective distribution channel through the help of LPP technique by taking production, supply and market segmentation into consideration.

OFSA-2017/ SEN -16

Sustainability and perception about organic farming

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In this era of exponentially increasing population, it is very essential to find a way to sustainable farming to meet the food needs without damaging the environment and the ecosystem. The difficulty with "sustainable agriculture" is that there is much disagreement as to what it entails and how to approach it. Scientists claim that it is more beneficial for the environment, as well as the humans and animals that inhabit it. However, some research has shown that organic food production can be more resource intensive and have a larger effect on the environment than conventional methods. Organic farming, as a systematic approach for sustained biological diversity and climate change adaptation through production management, minimizing energy randomization of non-renewable resources; and carbon sequestration is a viable alternative. Organic food production was associated with a production process that was small scale, environmentally friendly, and socially conscious; but, modern organic food production has been industrialized and now involves many of the same processes as the conventional food production system. The sustainability of organic farming depends on factors other than specific processes defined by organic legislation, including regional climate, pre-cultivation soil conditions, distribution techniques, access to fresh water, topography, and other site specific alternative farming practices used in a given organic system i.e. zero tillage, crop diversification, closed nutrient cycling, local sourcing.

OFSA-2017/ SEN -17

Kolkata: A city heading towards environmental distress

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The rapid expansion of urban areas due to rise in population and economic growth is increasing additional demand on natural resources thereby causing land-use changes (both vertically and horizontally) especially in megacities. As a result of which our natural resources are under extreme pressure due to the burgeoning human population and rapid urbanization across the world. Many studies show that increase in the ecological footprint from the changing consumption behaviour, continues to negatively impact on the environment. This is an emerging challenge and a harsh reality. Like many other cities in India the growth of urbanization in Kolkata is occurring at a very faster rate. However, as conurbations and megacities grow, they spawn a disproportionately large footprint in the form of ravaged nature in and around these expanding cities. Therefore, understanding the impact of urbanization on biodiversity becomes imperative not only from the point of view of conservation, but also for planning sustainable cities. Through this present paper an attempts has been made to understand the impact of urbanization on biodiversity of Kolkata, ecologically which is an important landmark on the earth surface.

OFSA-2017/ SEN-18

Green marketing &and its impact on environmental safety

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Green marketing is a phenomenon which has developed particular important in the modern market. This concept has enabled for the re-marketing and packaging of existingproducts which already adhere to such guidelines. Additionally, the development of green marketing has openedthe door of opportunity for companies to co-brand theirproducts into separate line, lauding the green-friendliness of some while ignoring that of others. Green marketing is a phenomenon which has developed particular important in the modern market and has emerged as an important concept in India as in other parts of the developing and developed world, and is seen as an important strategy of facilitating sustainable development. In this research paper, main emphasis has been made of concept, need and importance of green marketing. As a result, this paper can be used by researchers who need to find out the impact of green marketing on environmental safety. With the outcome of this paper, the marketing will become safer and the consumers will have a safe and environment friendly access to the products. The result of this research paper will help in minimizing the wastages and making environment neat, clean and safe.

OFSA-2017/ SEN -19

Microalgae consortium: A potential option in removal of chromium from soil for environmental and agricultural sustainability

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Microalgae can be a suitable option for removing heavy metals from polluted areas like mining area, dumping sites, nearby cultivated lands. Chromium is the seventh most abundant metal in earth crust and a major contaminant. In Odisha, the peripheral regions including cultivable lands of Sukinda mining area in Jajpur district are badly affected with high concentration of chromium. Chromium at high concentration inhibit seed germination, seedling growth, nutrients uptake, lessens the antioxidant, disturbs water balance, degrades the pigments, induces chlorosis, necrosis and ultimately reduces the productivity. Chemical methods used for Cr removal are quite costly for which emphasis is being given for biological methods of soil Cr bioremediation. The microalgae are a better option for the removal and detoxification of Cr rich soil. More preferentially the nitrogen fixing Cyanobacteria and the dead remains of the algae can also be used as bio-fertiliser to enhance the productivity. In view of that a consortium of indigenous algae including cyanobacteria like Nostoc, Phormidium and green algae like Chlorella, Coccomyxa are used for Cr removal from the soil of cultivated lands around Sukinda mining area. Nostoc sp. and Phormidium sp. have greater application in absorption of Cr (VI). Similarly the green algae Chlorella and Coccomyxa sp. can be used for the reduction of Cr (VI) to Cr (III) making the soil less toxic. The removal/ degradation of Cr from soil by the micro-algal consortium can enable plants to grow properly being free from chromium stress. The fixation of atmospheric nitrogen by cyanobacteria can be a source of bio-fertiliser for sustainable improvement of the soil health and enhancement of crop yield.

OFSA-2017/CQ-01

Positioning of organic production in local agribusiness: A view from the industry and the resources and capacities

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The objective of completing this study is to analyze, from the perspective of critical thinking, those consequences and social costs that has left the agroindustry on a large scale production system in the same way how is that organic production can be alternative process against agroindustry, encompassing development background and have had the latter in recent years and the strong trend that has been going to this type of product. There will also be an analysis of how organizations of local cooperatives producing organic decrease transaction costs, and an analysis of the organic

production and commercialization in the theory of the industry, likewise it shows that in the case of market places that are local internationalization is not looking, but if a global strategy taking advantage applies paradigm shifts that occur worldwide.

OFSA-2017/CQ-02

Mexican SMEs in organic sector in the Asia pacific market: internationalization strategies

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The aim of this work is to propose the internationalization strategies that will have the greatest impact on Mexican SMEs in the organic food industry that want to reach the Asia Pacific market. The study method is based on theoretical review of the internationalization theories: neoclassical and modern, tripod strategy that analyzes the vision based on industry, resources and institutions, as well as the types of foreign participation the companies can have. The results of the analysis shows that the tripod of the strategy, can be the best way for Mexican SMEs in the organic market,to start analyzing the entry to foreign markets, and do it the best way possible.

OFSA-2017/CQ-03

Commodity trading, market levelling to sustainability: Relative study of agriculture and energy derivatives markets in India

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Sustainable development has now become the basic requirement of the time. Every nation is thriving to achieve Sustainable Development Goals (SDGs) on priority basis. As per SDGs set by United Nations 2030 agenda SDG2 and SDG7 clearly targets to achieve food security and energy efficiency respectively. Commodity market has crucial implications and affects agricultural productivity, food security and the socio-economic development of the country. The derivative market platform can stimulate a two-way process where the market creates demand and vice versa in a global context. In this context, the paper attempts to evaluate the price discovery in these two commodity derivates markets. In the study seven actively traded commodities have been covered including five agricultural commodities and two energy commodities in India over a period of 2006 to 2016. Volatility spill over in the concerned markets are also checked through EGARCH model to check the level of risk-transfer. The findings of cointegration tests confirmed a long-run equilibrium relationship between spot and futures prices for all sample commodities. The results also reveal that future market leads the spot market in price discovery mechanism. Granger causality results also confirm that price

information flows both ways. Although, the volatility spill-overs from spot to the futures market are dominant. Overall, the price discovery results are heartening given the emerging character of Indian commodity market. However, the results for volatility spill-over are weak in some cases, signifying that the efficient risk transfer system is yet to progress for most of the sample commodities.

OFSA-2017/CQ-03

Quality of organic and conventional tomatoes during storage

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Consumers generally believe that organically grown tomatoes taste better and have higher nutritional value than their conventionally grown counterparts. The study was conducted at KVK, Jagatsinghpur to compare quality properties of tomato cultivars grown using organic and conventional production systems during storage at 13°C for 35 days. Results indicated that fruits grown using organic production system retained their firmness better during storage than their conventionally grown counterparts. However, conventionally grown fruit showed significantly higher red coloration. Other quality parameters examined in the study for organically produced fruit were either lower or similar to those in conventionally grown fruit. Microbial fertilization and plant activator significantly increased total soluble and reducing sugar contents. Thus, no definite conclusion can be reached with respect to the superior quality of organically grown fruit compared to their conventionally grown counterparts. The influence of growing system appears to be cultivar and growth condition dependent.

OFSA-2017/CQ-04

Studies on the proteolytic bacterial growth and moisture pick up in black gram warrian packaged in different packaging materials

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Warrian prepared with black gram flour were packaged in paper, LDPE (low density polyethylene), tin containers, glass jar,Al (aluminum) laminates, and PET (polyethylene terephthlate) jars. The initial moisture content at the time of packaging was 10.2 and the permissible moisture uptake limit during storage was 3%. No signs of microbial growth were observed at these parameters. After 30 days of storage, the moisture pick up in unit package of paper and control samples exceeded the permissible limit of 3% with the development of mustyodor and microbial growth. Moisture pick up >2.0% was observed in warrian packaged in LDPE, Tin container >1% in 90 days and in glass jars 0.21 to 0.29% between 120 to 210 days of storage under similar conditions.The moisture pick up rate in aluminium laminates and PET jars was low throughout the period of storage.In comparison of moisture pick up of different materials, paper had the maximum moisture pick up followed by LDPE, tin container, glass jar, tightly screwed PET Jarsand aluminium laminates. In all the packaging materials employed,a rise in moisture pick up was observed after 180 days of storage. The moisture pick up was observed maximum in paper (19.2%) and minimum in aluminium laminates (0.088%) after 210 days of storage period. The proteolytic countscorresponded with the moisture pick up rates for storage of warrian up to 180days. After about 180 days of storage in all packaging materials the moisture pick up as well as proteolytic count declined.

OFSA-2017/CQ-05

Yield and quality of tomato grown with organic and synthetic fertilizers

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Compost is a source of plant nutrition that can be an alternative to, or used in conjunction with, synthetic fertilizers. Field trials were conducted at KVK, jagatsinghpur to evaluate the effect of fertilizer types on yield and quality of tomato *(Lycopersicon esculentum*Mill.). Compost(cow dung and poultry manure) was applied at 5 Mt·ha^{-1} and combined with 0, 30 and 60 kg·ha^{-1} of N from urea, and compared with application of an N:P:K (19:19:19) synthetic fertilizer providing 30 and 60kgha^{-1} of N. Microbial populations were determined in the soil at the rhizoplane (root surface), rhizosphere (soil surrounding the root surface), and bulk soil (soil away from the root zone. Application of CBF alone increased fruit yield by 145% over controls and was significantly better than other treatments. Application of combinations of Compost +urea to tomato affected growth and quality of fruit. Titratable acidity in tomato grown with Compost alone slightly decreased in relation to tomato fertilized with 30 kg·ha^{-1} of the NPK fertilizer and vitamin C increased by 13%, while the Ca content was 44% greater than controls. Microbial populations found at the rhizosphere, rhizoplane, and bulk soil due to application of Compost, Compost +urea (30 or 60 kg·ha^{-1}), and Compost +urea increased two to fivefold relative to treatment with 60 kg·ha^{-1} of synthetic NPK fertilizer. Organic fertilizer can be combined with synthetic fertilizer at rates below those recommended for sustainable production of tomato. However, other levels of urea need to be tested to determine whether addition of lower amounts of urea will consistently support yields.

OFSA-2017/CQ-06

Alternate areas /protected cultivation method of hybrid seed production

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Vegetable seed cultivation is an awesome business in India, but under open field conditions by following traditional cultivation practices it is difficult to manage various abiotic and biotic stresses. Can we provide protection to the crops against climatic fluctuations and various other related stresses. The basic benefit is its extra protective shelter restricting or minimizing the exposure of the crops to various adverse factors, which are high in open conditions. The application of chemicals for controlling biotic stresses is low under protected structures which gives a high quality safe vegetables for human consumption. Under the new era of FDI (Foreign Direct Investment) in retail, these kinds of models posses high potential for enhancing the income of farmers opting for quality and offseason vegetable cultivation through protected cultivation. Protected cultivation technology requires careful planning, attention and details about timing of production and moreover, harvest time to coincide with high market prices, choice of varieties adopted to the off season environments, and able to produce economical yields of high quality produce (Singh *et a.,* 2012).

Seed yield of such crops can be 3-4 times more compared to their open field cultivation along with high quality of seed. Insect proof net houses are the most suitable and low cost protected structures suitable for quality hybrid seed

production of OP varieties of large number of vegetables viz., tomato, sweet pepper, chilli, okra, brinjal and several cucurbitaceous vegetables. The major objectives of seed production under insect proof net houses are to grow virus free seed crops, to protect the seed crops against other major insects/pest. Not only this, insect proof net house also provides protection to the seed crops against mild frost conditions. Massive work on quality seed production of vegetables is being carried out at the Centre for Protected Cultivation Technology, IARI, New Delhi and excellent results in hybrid seed production of brinjal, pumpkin, bitter gourd, cucumber and summer squash has been recorded as compared to open field seed production of these crops (Balraj Singh,2011).

In vegetable production hybrid seeds, transgenic, stress resistant varieties, micro propagated transplants, synthetic seeds are likely to replace conventional varieties. Protected environments will be helpful in production of hybrid seeds of cucumber and summer squash by using gynoecious lines. Gibberellic acid is used to maintain gynoecious lines followed by selfing. The desired pollen can be used for production of hybrid seed of cucumber. Similarly in summer squash use of Ethephon in inducing female flower at every node would help in the hybrid seed production by using desired pollen parent (Devi and Thakur, 2013). Photo–thermo-sensitive genetic male sterile (PTGMS) rice is a new hybrid rice technology that uses prolonged light length and high temperatures to induce sterility. To overcome this, we grew PTGMS under greenhouse conditions where day light length was prolonged to 14 hrs using solar illumination and day and night temperatures were maintained above 36Cº and 24ºC respectively. Sterility of PTGMS was determined by the level of abortive pollen and seed set rates. Hybrid seeds were produced by crossing three PTGMS lines (V1PGM, V2TGM and V3PGM) as female lines with Basmati 370 and Basmati 217 varieties as pollen donors. Under long and normal day lengths and high temperatures, pollen sterility ranged from 99-100% but no seeds were set in PGMS lines. However, TGMS recorded 3% and 2% seed set under similar conditions. Under natural conditions both PGMS and TGMS reverted to fertility. We elucidate that greenhouse conditions could be used as initiation breeding conditions for the F1 hybrids followed by adaptability evaluation later in natural conditions (Kanya *et al.*,2013).

In future, if the outer environmental condition degrades with severe high or low temperature, then Green house can be used for growing plant successfully by regulating the inside temperature favorable for plant growth.

OFSA-2017/CQ-07

A study on green marketing: with special reference to organic product in Dehradun

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Green marketing is a phenomenon which is vital in modern marketing. Today the world requires new decisions and innovations which lead to green marketing environment and also to create a new market condition for the potential buyers. The objective of the study is to create awareness about green product or organic product as it's important to the society. A well-structured methodology has been adopted to collect primary and secondary data for the research. Suitable statistical tools have followed for analysis and as output of the study reveals that there is an increasing trend in customer's awareness and in turn the green product market have gained momentum. It also highlighted about the impact of non-organic product on society and suggestions were given based on the study. This study also creates an opportunity for future research program in the same field.

OFSA-2017/CQ-05

Smart energy for smart food processing

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The energy acquired from any natural source with near-zero after-effect during its utilization, is termed as *smart energy*. This comprises of the energies that are exploitable in the form of heat or electricity from a renewable energy source. This approach further focuses on increasing the energy efficiency of the processes by reducing energy wastages and environment harms with proper techniques. The transform of agricultural sector into energy efficient and zero-carbon technologies promotes the potential of smart concept in the food sector as well. Preparing and processing food using renewable energy sources are not new; however, as the idea of 'green technologies' started trending, small-scale and household devices run by renewable energy have been developed by various manufacturers. Commercial scale smart energy systems specific to processing operations and food is presently in emerging stage. Nevertheless, with its potential in the efficient post-harvest treatment of food, this simple and safe energy concept is gaining considerable attention among manufacturers and industrialists. Some of the important processing and preserving operations where the choice of smart energy is recognized for a safe and quality food are drying, milling of food grains, pressing of oilseeds and by-products of milling activity, refrigeration, etc. Important benefits of implementing smart energy in the food sector involve clean and sustainable energy source for food processing operations, environment friendly energy system, which is easy to install, reduced carbon footprint of products (such as agricultural wastes), free energy after installation with no labour and/or fuel and suitability for on-farm energy for on-farm applications. The main drawbacks associated with smart energy in the food sector involve high initial costs, requirements of regular equipment maintenances, considerable release of combustion gases (in biomass energy system), requirement of additional energy storage devices, etc..

OFSA-2017/CQ-06

Effects of elevated CO_2 and temperature on yield and fruit quality of Strawberry (*Fragaria* × *ananassa* Duch.) cv. Chandler

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Theresearch was conducted to check whether elevated CO_2 could alleviate the negative effect of high temperature on fruit yield of strawberry (*Fragaria* × *ananassa* Duch. cv.Chandler) at different levels of nitrogen and also tested the combined effects of CO_2, temperature and nitrogen on fruit quality of plants cultivated in controlled growth chambers. Results show that elevated CO_2 and high temperature caused a further 30% decrease in fruit yield The fewer inflorescences and smaller umbel size during flower induction caused the reduction of fruit yield at elevated CO_2 and high temperature. Interestingly, nitrogen application has no beneficial effect on fruit yield, and this may be because of decreased sucrose export to the shoot apical meristem at floral transition. Moreover, elevated CO_2 increased the levels of dry matter-content, fructose, glucose, total sugar and sweetness index per dry matter, but decreased fruit nitrogen content, total antioxidant capacity and all antioxidant compounds per dry matter in strawberry fruit. The reduction of

fruit nitrogen content and antioxidant activity was mainly caused by the dilution effect of accumulated non-structural carbohydrates sourced from the increased net photosynthetic rate at elevated CO_2. Thus, the quality of strawberry fruit would increase because of the increased sweetness and the similar amount of fruit nitrogen content, antioxidant activity per fresh matter at elevated CO_2. Overall, we found that elevated CO_2 improved the production of strawberry (including yield and quality) at low temperature, but decreased it at high temperature. The dramatic fluctuation in strawberry yield between low and high temperature at elevated CO_2 implies that more attention should be paid to the process of flower induction under climate change, especially in fruits that require winter chilling for reproductive growth.

OFSA-2017/CQ-07

Identification of rice varieties on the basis of seed characteristics through various chemical tests

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An investigation was undertaken for identification of rice varieties on the basis of seed characteristics through various chemical tests.Seed samples of eleven rice cultivars (Subhadra, Sankar, Parijat, Suphala, Rudra, Kalinga-III, Khandagiri, Lalat, Bhuban, Sidhanta, Manaswini), which are under cultivation in the state of Odisha, were collected from Central Farm, Orissa University of Agriculture and Technology, Bhubaneswar and subjected to the following chemical tests *viz.* Phenol test, Modified phenol test ($FeSO_4$ and $CuSO_4$), NaOH test and KOH test.One control was also taken in case of NaOH test and KOH test. Based on phenol colour reaction, Sidhanta, Lalat, Subhadra showed dark brown colour, whereas Parijat, Sankar, Khandagiri, Kalinga-III showed light brown colour and rest four varieties exhibited no colour change. The modified phenol test using $FeSO_4$ and $CuSO_4$ solution helped in further sub-division of standard phenol group. In case of $FeSO_4$ test Parijat, Sankar, Rudra, Sidhanta, Bhuban showed dark brown colour and Kalinga-III, Khandagiri, Manaswini, Lalat, Subhadra, Suphala showed light brown colour. In case of $CuSO_4$ test, all the eleven varieties showed light brown colour. In case of NaOH test among eleven varieties Subhadra, Rudra, Khandagiri, Lalat, Sidhanta showed deep wine colour whereas the other six varieties of rice showed wine colour. In case of KOH test except two varieties, Suphala and Khandagiri, other eight varieties showed deep wine colour.Control had no colour reaction in both NaOH and KOH test.

OFSA-2017/CQ-08

Prospects of value addition of mushroom for food and nutritional security

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India has moved closer towards the achievement of food security with its diverse agricultural crops grown today. The accessibility of food along with the issues of quality, health aspects and environmental sustainability are the certain factors of major concern in their utilization. However, the struggle to achieve the nutritional security is still critical, and has to be met with the fit crops. Mushroom is one such horticultural food crop that possesses these inherent properties as well as certain additional benefits like less space factor for its production. Mushroom cultivation offers an

added advantage to recycle agro-waste as carbon pool into good quality protein, much of which otherwise is wasted in the field. Present world production mushroom is around 3.5 million tones as per the recent scenario (FAO, 2015). The functional food properties and higher protein content of mushroom outnumbers many other common food commodities like pulses, which the interests of common people are lacking due to the increasing price rate. However, the utilization of mushroom is limited mainly because of the lack of feasible technologies with the growers to lengthen its use due to the factors like weight loss, veil opening, browning, liquefaction and microbial spoilage. This problem can be addressed through proper initiatives by converting them into more valuable products which may benefit the farmers as well as entrepreneurs at the same time. Also, it is evident that the products based on mushroom provide an enriched taste and flavor with its higher protein and fiber content and low fat. These products thus enhance the nutritional value in the market while boosting up the mushroom cultivation globally. Considering these prospects several studies have been conducted to exploit the value addition of mushroom by developing products such as pasta, biscuit, bread, ready-to-eat snack, pickle, soup powder, ketch-up, candy, papad and noodle. These products offer a better nutritional and food security which can fight protein malnutrition in the cereal dependent developing country like India.

OFSA-2017/CQ-09

Price discovery and volatility of spot and future market in agricultural commodities in India

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India is an agriculture-dominated economy. Farmers face not only the production risk but price risk as well. Commodity derivatives, especially futures play a crucial role in fixing a price, especially in agriculture providing a hedge against adverse price movements. The present study is an examination into the price discovery and volatility of spot and futures markets in agricultural commodities in India. The study uses the data of daily spot and futures prices of a sample consisting of ten agricultural commodities traded on Multi Commodity Exchange of India, (MCX) i.e. Guar Seed, Kapas, Potato Agra, Soy Bean, Chana, Wheat, Cardamom, Mentha Oil, Cotton, Crude Palm Oil for a period of 2006 to 2016. The results of cointegration test explain the long run equilibrium relationship for all the commodities validating that in general there is a price discovery process in the spot and futures commodity markets. Vector Error Correction Method (VECM) results show that spot market leads the futures market in price discovery mechanism in case of 7 commodities i.e. Cardamom, Chana, Crude Palm Oil, Guarseed, Mentha Oil, Soyabean and Wheat. In case of other 3 agricultural commodities i.e. Cotton, Kapas and Potato, futures market leads in price discovery process. The findings indicate that in case of agricultural commodities in India, spot market is more efficient than the futures market in price discovery. The results of Granger causality test show bi-directional Granger lead relationships between spot and futures in all agricultural commodities. The bivariate EGARCH results show that the market-specific volatility spillover coefficients are significant in case of 7 commodities i.e. Chana, Cotton, Guarseed, Kapas, Potato, Soybean and Wheat. In case of other 3 commodities, the existence of volatility spillover from future to spot market and from spot to future is not significant. The findings indicate that Indian futures market for agricultural commodities are not yet matured as useful mechanisms of price discovery and risk management.

OFSA-2017/CQ-10

Sustainable food processing through mycelium technology: A review

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The prospects of sustainability have increased over time in every veteran fields of the human occupation, and have vivifiedthe food sector as well. Green approaches that reduce the carbon foot-print in the environment, and causes zero ecological harms are gaining increased acceptances. Mycelium technology is one such novel that is known to offer several advantages in the context of sustainable food processing. It detains the problems created due to the wastes generated duringfood production, usually comprising of the food residues such as fruit and vegetable peels or grain chaffs,and that in packaging, mainly plastics. These are, however, very critical as majority of them are non-recyclable, contaminate the nature and thereby ease infectious diseases like hepatitis. Also, non-biodegradable food packages such as Styrofoam commonly used for the storage and supply of certain foods like instant noodles possess toxicity, further thrusting healthrisks. Thistechnology involves natural growing and branching of fungal rootina substrate of food wastewhichfinally results in a foam commercially known as 'mycofoams', and thus holds the potential to utilise the food waste and to cast the foam as package. The use of such biodegradable packagesin material logistics and acoustic purposes has been familiar, and its introduction in food packaging and transit has also begun by certain developers recently. Mycelium technology can be commercialised for food packaging for itsfeasibility in adoption, ease of manufacturing and the naturalist way of waste management, and can be a long-term tackle if all the food waste variants and fungiare focused.

OFSA-2017/CQ-11

Post harvest prospects and potential of watermelon seeds

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The watermelon (*Citrullus lanatus)* fruit grown in tropical and subtropical climate contain many seeds have high potential for value addition as these are rich in nutritional and medicinal values. India grows about 25 varieties and produces approximately 375,000 MT of fruits annually. Watermelon constitutes three main components as flesh (68%), seed (2%) and rind (30%). The seeds contain protein (28.33%), fat (47.37%), carbohydrate (15.31%), fiber (8.2%), ash (6.2%) and other minerals. It is a good source of vitamin-B, Magnesium and amino acids. The seeds of watermelons are known to have economic benefits especially in countries where cultivation is on the increase. The seed powder has excellent functional properties like oil and water absorption capacities, foaming capacity and emulsion stability. Traditionally, the seeds are roasted and are used to prepare snacks, milled into flour and used for sauces. Oil from the seeds are used in cooking and incorporated into the production of cosmetics. The cake with high protein is used as feed and fertilizer, which could otherwise be used for food preparation after removal of anti-nutrients and can contribute to reduce malnutrition. Further, the seeds can also be added in desserts and savory dishes. In spite of these

potential applications, the watermelon seeds are often discarded while the fruit is eaten. The fruit is seasonal and a huge amount of seeds get wasted every year due to lack of knowhow on process technology and has not yet received much attention. Manual method of removal of cotyledon from the seed is tedious and time consuming. Therefore, it is necessary to develop a device for shelling of watermelon seeds and to develop process technology for preparation of value added products which will encourage adequate consumption and effective utilization of the seeds.

OFSA-2017/CQ-12

Post-harvest Prospects of Star Gooseberry Fruits

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Star gooseberry (Phyllanthus acidus), a close relative of amla (Phyllanthus emblica) belonging to family Grossulariaceae(Gooseberry family) is one of the earliest known tribal fruit being grown abundantly in India. Though the fruits and plant parts are traditionally used for various diseases, the fruit is the most usable part of the plant. Due to lack of technical knowledge most of these fruits are not effectively utilised. The star gooseberry fruits are rich in ascorbic acid, niacin, riboflavin, carotene, calcium, phosphorous and iron. The fruits have antibacterial and antioxidant activity, rich flavonoids and phenolic compounds. The fruits are seasonal and perishable in nature due to high moisture content for which lots of fruits are getting wasted every year. Therefore, there is a necessity to develop a process technology to preserve the nutritional and medicinal values of the star gooseberry fruits in form of value added products for effective utilization throughout the year. With substantial promotions and research evidence, this underutilized fruit could play an important role as one of the alternative food sources to the world and in improving human health. A major part of the fruit is getting wasted at the production points due to non-availability of sufficient storage, transportation and processing facilities. In view of the above problems, development of a simple and inexpensive process of fruit preservation is desirable. Canning of the fruits in syrup is an attractive option. The feasibility of using modified atmosphere packaging to extend the shelf-life of whole fruit for export purposes may be investigated. Dehydration to various forms is an essential method of preserving the fruits with minimum spoilage. Among different drying and dehydration method, osmo-dehydration has gained attention recently due to its potential application in food processing industries. With the correct choice of process variables, water removal and impregnation, it is possible to maintain quality characteristics in star fruit products. The study recommends for preparation and commercialization of star gooseberry fruit products which not only provides health benefits to consumers but also holds immense potential to add to rural economy through profitable entrepreneurship.

OFSA-2017/CQ-13

Effect of botanicals on post harvest physiology of guava (*Psidium guajava*)

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The use of various chemicals and waxing material during the preharvest and postharvest stages is becoming popular among growers in recent years to enhance the shelf life of fruits. However, the use of these substances have their own limitations, as some of them are believed to be ecologically unsafe and economically unviable, besides leaving their residue on the fruit surface, which may have adverse effect on human health. The main objective of this work was to assess the effectiveness of plant extracts on physical properties of fruits and reducing the occurrence of spoilage. Fruits of guava were dipped for 10 minutes in aqueous extracts (15% and 30%) of neem and marigold, surface dried, and packaged in newspaper and gunny bags for storage at room temperature. Analysis of fruits was done at harvest and then on 2nd, 4th, 6th, 8th day after treatments. On 6th day the highest spoilage per cent and decrease in physical parameters was recorded in control. As the storage period advanced, there was further increase in spoilage per cent and on 8th day it was lowest in treatment with neem (30%) and wrapping newspaper. In this treatment, color and flavor of fruit were acceptable up to 8th day whereas in control acceptability lasted up to 4th day of storage. The statistical results of the study indicated that coating of leaf extracts and storage period significantly ($P \leq 0.05$) affected all traits.

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Agricultural marketing and futures markets: A review in the Indian context

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Agricultural producers all the time have to face many challenges and risks such as price, crop, weather variations and many other natural disasters. These challenges and risks could affect their expected income and have negative impact on their standard of living, ability to raise capital, availability of credit and repayment of debts. The uncertainty of market prices leaves a farmer open to the risk of receiving a price lower than the expected price for his yield. The scenario of fragmented landholdings have robbed the agricultural operations of economic viability in the case of small farmers. Whereas the big farmers are affected equally badly when prices are not attractive or crash at the marketplace. The signals emitted by the commodity markets may help the farmers or growers or producers to minimize the price risk and avoid lack of supply. These signals also help farmers in fine tuning marketing strategy after the harvest. Empowered with the price information, the farmer is able to avoid excess sale immediately after the harvest and is also able to bargain for better prices from the mandi. the consumers of the output at the same time can minimize the price risk with the help of suitable responsive actions to the signals emitted by the commodity markets, This paper has carried out a review of this mechanism in the Indian context focusing on how agri-commodities markets play a positive role both for the producers and the consumers.

OFSA-2017/SED-01

Potential of Organic Farming growers of Ganjam and Nayagarh districts of Odisha

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Organic farming as a sustainable agriculture system has attracted increasing attention over the last few years because it provides solution to agricultural sector. Organic farming replacing conventional one has the potential to provide benefits in terms of environmental protection, conservation of non-renewable resources and improved food quality. Odisha has lot of potential to produce all varieties of organic products due to its diverse agro-climatic regions. This holds promise for the organic producers to tap the market which is growing steadily in the domestic market. There is great opportunity on the part of the organic producers to link their product to export market with around 52787 ha land under organic certification. No proper information exists on costs and returns of organic farming inspite of giving attention. Organic farming is a way to escape from the vicious cycle of debt for farmers including small & marginal category. Organic farming is a food system that raises income and increases food and food safety. Organic farming is one to preserve environment, means of food production with fair return as well as free from chemical residues. Several studies reported that if all outputs and inputs are taken into account, organic farming rely on internal inputs has higher productivity in compared to the external input of chemical base. Keeping these potentials in mind , farmers in various districts of Odisha have started practicing organic farming but at the same time they are facing several constraints. So the efforts from various players like policy makers, researchers, extension workers, farmer representatives, input suppliers, marketing personnel and consumers are needed to promote organic farming in a big way to tackle the present agrarian crises.

OFSA-2017/SED-02

Potential of organic Spices with medicinal significance in the eastern ghat regions of Odisha

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Eastern Ghats are a discontinuous range of mountain set along Eastern coast. Starting at West Bengal, Eastern Ghats pass through Orissa, Andhra Pradesh and Tamil Nadu. The highest mountain peak in Odisha is Deomali (1672 m), situated in the Koraput district of southern Odisha. Geologically it is a part of the Indian Peninsula which was a part of the ancient land mass of Gondwanaland. The major rivers of Odisha with their tributaries have cut deep and narrow valleys through the Eastern Ghats (FSI, 1984 & CGWB 2013). The vegetation ranges from moist deciduous type in the north to dry deciduous type in the south. These forests are composed of tropical, subtropical and temperate and evergreen types occuring at high elevations. 200 flowering plants reported from Eastern Ghats of India, about 528 species under 271 genera and 80 families are trees which are distributed in different parts of Odisha, Andhra Pradesh, Tamil Nadu and Karnataka. Total 454 species under 243 genera and 78 families are endemic to Eastern Ghats.

Turmeric (Curcuma longa), Ginger (Zingiber officinale Rosc.) and Black Pepper (Piper nigrum L.)are three spices

predominantly grown in this area which is by default organic as very little to no chemical fertilizers is used by growers. The efficacy of medicines and drug delivery are reported to be more efficient in organically grown produce (Das et.al., 2017 & Seufert and Ramankutty, 2017, Jouzi et al., 2017 & Heimler et al., 2017). Turmeric has antioxidant, anti-inflammatory, antiviral and antifungal actions. Curcumin is main active constituent. It eases conditions such as bursitis, arthritis and back pain (Mishra & Palanivelu, 2008 & Maizura *et al*., 2011, Jiang et al., 2005). It is used for cancer prevention, liver protection and premature aging. Ginger is used as a stimulant and carminative, used frequently for dyspepsia and colic. Ginger promotes the release of bile from the gall bladder. The gingerols increase the motility of the gastrointestinal tract and have analgesic, sedative and antibacterial properties (O'Hara et al, 1998). Ginger is used for treating nausea caused by seasickness, morning sickness and chemotherapy (Ernst and Phittler, 2000). Black Pepper (king of spices) has many medicinal properties for gastrointestinal disorders including, constipation, and diarrhea. It also has antioxidant effects, anti-inflammatory, anti-arthritic, anti-hypertensive, analgesic effect (Sherawat *et al.,* 2017 , Yogesh 2017, Mehmood *et al*, 2010 & Gorgani et al., 2017).

OFSA-2017/SED-03

Entrepreneurial behaviour and knowledge level of veterinary students of Odisha towards organic livestock farming

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Entrepreneur is one who always searches for change, responds to it, and exploits it as an opportunity. The Global Entrepreneurship Monitor (GEM) Report 2014 reveals that In India, adults are generally positive about entrepreneurship and around 66% think that entrepreneurs receive a high level of status and respect. A nation's ability to generate a steady stream of business opportunities is possible when its people take to entrepreneurial activities. In recent days, there has been an increased entrepreneurial effort in the field of Organic Farming. In the last two to three decades, the organic livestock farming is increasing at rapid pace worldwide due to demand of organic milk, meat and eggs products. This is happening due to increased health concern of the people over quality of milk, meat and egg products produced under intensive system of production which uses various pesticides, insecticide, chemicals, drugs and hormone residues. Organic livestock farming is also becoming popular in India due to its advantages of traditional production system which heavily rely on organic inputs and increasing awareness level of the people about quality food. In order to understand the entrepreneurial behavior and knowledge level of Veterinary student of Odisha towards organic livestock farming, the study was carried out with 40 post graduate and 40 undergraduate (final year) students in the year 2014-15. The study revealed that the majority (58.75%) of the students are from urban background and 80 % of their father's education is above college level. 35 % of the students' family income is within Rs.2,00,000 - Rs.8,00,000. It was found that the main aim of the students joining in the course is service (61.25%) and only 32.5% of the respondents assist their family members in livestock activities and most of them provide assistance in health care management. The respondents have ranked commercial poultry farming as preference number one for entrepreneurial choice. Besides, it was found that majority of the students have good knowledge about the breeding, feeding, health care management of animals under organic livestock farming, however, they have a very poor knowledge about the certification process of organic products.

OFSA-2017/SED-04

Integrated Supply chain in Indian organic farming chain integration

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Demand for organic food is growing at a much faster rate than ever before, but not without numerous operational challenges. Farmers, retailers and food processor manufacturers are thus looking to streamline their supply chains while addressing ever-expanding market requirements. In the last few years there has been an emergence of more coordinated supply chains for fruits and vegetables in India catering to the export market and to the high end domestic market. On the domestic front this trend has primarily been led by the growth of large hypermarkets, supermarkets and other organized retailers in metropolitan centers. Key organic food supply chain challenges include: Food origin and mileage: In the past decade, the country of origin of the food and food mileage are becoming increasingly important & to achieve this, their first step should be to improve collaboration with local farmers and involve them in the planning of their value chain delivery networks. The planning itself must begin with the redesign of their transport networks, from farms to consumers, since food miles is a primary factor in the determination of the freshness of food, carbon emissions and the cost of delivery. The world's largest democracy (India) is well on its way to becoming the world most powerful economy. Concepts such as just-in- time, virtual inventory, supplier rationalization, and reductions in the number of distribution facilities have reduced total Supply Chain costs, but the result has been increased risk. There is good reason to believe that organic agriculture may lower certain health risks like: Organic standards focus primarily on environmental issues. Although they cannot eliminate environmental impacts, they seek to minimize the likelihood of water pollution, to build soil quality and to enhance biodiversity. Organic food usually costs more than conventional food. While the price of organic food is a deterrent to many consumers, for most farmers the high prices of organic commodities are very attractive.Many consumers and farmers think that organic agriculture does a better job of supporting small and family farms. The combinations of this decision define the differential and competitive advantage on the Supply Chains.

OFSA-2017/SED-05

Stevia rebaudiana – the future of medicinal agro-market in Odisha

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Stevia is likely to become a major source of high potency sweetener for the growing natural food market in the future. *Stevia rebaudiana* (Bert.) Bertoni as a natural sweetener with zero calories has recently found widespread use in the food and pharmaceutical industries. Although Stevia can be helpful to anyone, but more useful to diabetics, those interested in decreasing caloric intake, and children. Shade dried leaves of Stevia are 10 to 15 times sweeter than sucrose. Glycemic index of sweetening compounds of this plant is zero with no caloric value [Puri et al., 2011]. Stevia is a semi-humid subtropical plant that can be grown easily in the kitchen garden. The soil should be in the pH range of 6.5- 7.5; well-drained red soil and sandy loam soil. Saline soils should be avoided to cultivate this plant. It has been successfully cultivated in many Indian states like Rajasthan, Maharashtra, Punjab, Kerala and Orissa [Goyal

et al., 2010]. One Hectare of *Stevia rebaudiana* cultivation would be sweetener equivalent to 36 Hectares of Sugar Cane. Stevia is a semi-humid, subtropical plant and can grow in the temperature ranges between 04 - 48 ^{0}C. An annual average temperature of 31^{0}C with a rainfall of 140 cm per year has been found optimum for its good growth [Samsudin and Aziz, 2013]. Varieties like MDS-13 and MDS-14 are best for Indian climate and soil. Stevia plants can be propagated from cuttings or seeds or by tissue culture. As the seed germination is very poor and seedlings are very slow to establish, it is generally propagated clonally through cuttings. The stevia plant appears to have low nutrient requirements. Stevia plants respond well to fertilizers with lower nitrogen content than the fertilizer's phosphoric acid or potash content. Most organic fertilizers would work well, since they release nitrogen slowly. The commonly used organic manures are farmyard manure, compost, sheep manure, poultry manure, fish meal, bone meal, green manures and green leaf manures.

Stevia is relatively new to Indian market. Hence there is plenty of confusion with regard to marketing of this unique product. There are some farmers insist on buy back arrangement. There are reputed businesses companies offer buy back @ of 90-100 Rs per kilo. We feel that this price is on lower side, on an average the farmer should get a price of Rupees 125 to break even in first year.

OFSA-2017/SED-06

Organic farming: a new platform for sustainable entrepreneurship

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In India, the agriculture sector is the major employer and feeds around 50 percent of the total workforce. It provides basic standards of living to maximum population in our country. But it has its own set of problems like Lack of mechanization, decreasing productivity, lower quality, environmental threat and an increase in poverty and suicide among farmers. As the price for inputs rose, inorganic fertilizers became more expensive. Soil productivity decreased due to intensive tilling for higher yields. Groundwater declined as more and deeper wells were drilled and water salinization has become blights with the excess and irrational irrigation. So it becomes essential to analyze the problems and to evaluate the possible solutions to them. This paper tries to appraise organic farming as an option to deal with these problems that the agricultural sector faces and to point out the new and innovative business opportunities that it brings for entrepreneurs and farmers in the most sustainable way.

OFSA-2017/SH-40

Effect of integrated nutrient management on yield and fruit quality of Noni (*Morinda citrifolia*L.) grown as a mixed crop in coconut garden.

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Noni (Morindacitrifolia L.) is an important medicinal plant but less exploited as fruit crop, belongs to family Rubiaceae. Fruits are yellow, long and soft when ripe and considered as a brain stimulant. An experiment was carried out at All India Coordinated Research Project on Palms, OUAT, Bhubaneswar during 2013-2014 to study the effect of integrated nutrient management on growth, yield and fruit quality of Noni (Morinda citrifolia L.) grown as a mixed crop in coconut garden. The experiment was conducted on a ten years old Noni plantation with 7 treatments replicated thrice in a RBD. The treatments were T1: control, T2: 100 %RDF, T3: 75%RDF + 25% organic, T4: 50% RDF+ 50% organic, T5:25% RDF + 75%organic, T6:RDF through organics (FYM+ in situ green manuring+ biofertilizer), T7: RDF from organics (FYM+ in situgreen mauring + Vermicompost).Observations were recorded on plant biometrical parameters, yield and yield attributing characters, fruit quality and uptake of nutrients by noni crop. The results revealed that 50% inorganic nitrogen integrated with 50% nitrogen through FYM(T4)resulted highest fruit weight (34.24g),fruit length (6.4 cm), fresh fruit yield (12.34 kg/plant) as well as fruit yield per unit area (87.59 q/ha), higher TSS (10.7 0 B) and least acidity (0.32 %). From the experiment it could be concluded that integrated nutrient management practices were more effective in bringing out improvement in fruit quality, number of fruits per plant and hence yield.

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