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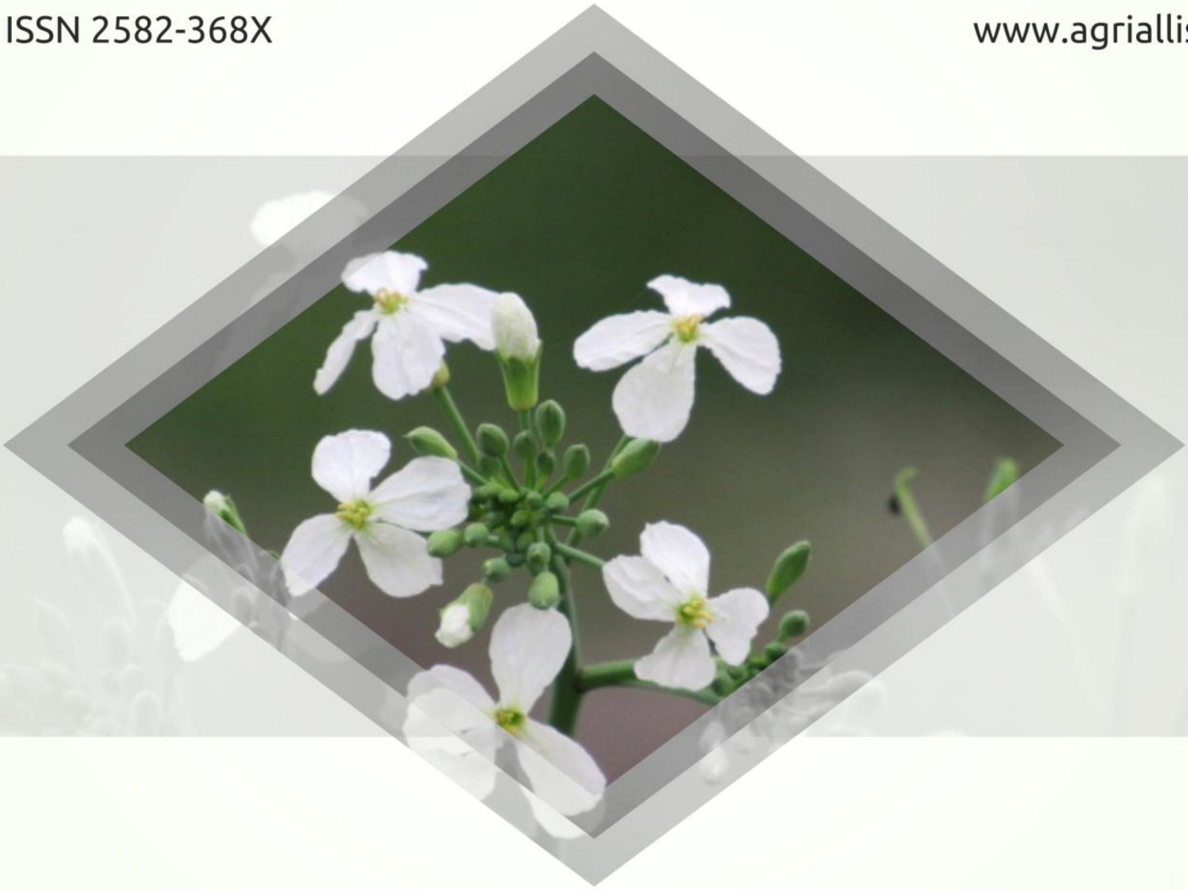

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Growing seed

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SMART BREEDING: FAST TRACKING PLANT BREEDING

Article Id: AL202061

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"Plant varieties identified by marker-assisted selection (MAS) are gaining prominence as a publicly acceptable alternative to transgenic crops, such as 'Golden' Rice." (PH 2008**).** Feeding the world within the carrying capacity of planet earth, improve food security, safety and quality, increase the production, reduce input at the same time, use biomass for biofuels and green chemistry while securing food production is the key challenge to the breeder. So, the need is accelerating the breeding cycle (crossing, evaluation and selection) of a crop. This goal can be achieved by SMART breeding, (**Selection with Markers and Advanced Reproductive Technology breeding**) *i.e.* marker-assisted selection, which is simpler than phenotypic screening, which can save time, resources and effort. MAS is a non-invasive biotechnology alternation to genetic engineering (Stevens, 2008).

How molecular markers server our purpose

Selection can be carried out at the seedling stage of the plant. Single plants can be selected. Shorten the breeding cycle. Selection of drought-tolerant plant without drought—no question of bio-safety and bioethics.

Molecular marker

Defined as DNA sequence with a known location on a chromosome. Qualities of a Suitable molecular marker are: Must be polymorphic, Co-dominant inheritance, Randomly and frequently distributed throughout the genome, Easy and cheap to detect, Easily reproducible. eg. RFLP, RAPD, AFLP, SSR and SNP (Xu et al., 2013).

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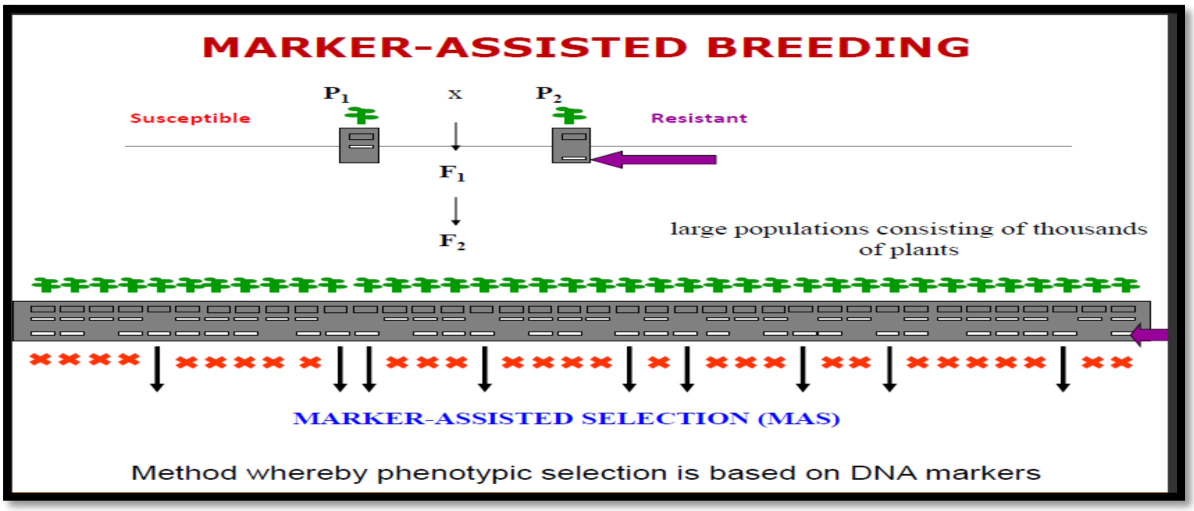
Marker assisted selection (MAS)

MAS also called marker-assisted breeding or marker aided selection (MAB) is the indirect selection for the desired plant phenotype based on the banding pattern of linked molecule (DNA) marker.



Applications of MAS in plant breeding

1. Marker assisted evaluation of breeding material
2. Marker-assisted backcrossing
3. Marker-assisted pyramiding
4. Early generation marker-assisted selection and
5. Combined marker-assisted selection

1. **Marker-assisted evaluation of breeding material:** Marker genotype data can be used to establish cultivar identity/assessment of 'purity, assessment of genetic diversity and parental selection, the study of heterosis and identification of genomic regions under selection

2. Marker-assisted backcrossing (MAB): A backcross program based on the marker is known as MAB. Advantages over conventional backcrossing: minimize linkage drag (Recombinant selection), effective selection of target loci (Forground selection) and accelerated recovery of the recurrent parent (Background selection) (Semagn et al., 2006).

3. Marker-assisted pyramiding: It is proposed by Nelson to develop crop varieties with durable resistance to disease by bringing multiple disease resistance oligogenes for specific races of a pathogen. Pyramiding is extremely difficult to achieve using conventional methods.

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4. Early generation marker-assisted selection: MAS conducted at F2 or F3 stage. Very useful in self-pollinated crops to fix alleles in their homozygous state as early as possible. It allows breeders to focus attention on a lesser number of high-priority lines in subsequent generations. Linkage between the marker and QTL is not very tight. The disadvantage is the cost of genotyping a larger number of plants.

5. Combined MAS approaches A combination of MAS with phenotypic selection/ screening also known as combined MAS**.** Advantages: to maximize genetic gain (when some QTLs have remained unidentified), especially when large population sizes are used and trait heritability is low, low level of recombination between marker and QTL, to reduce population sizes for traits where marker genotyping is cheaper or easier than phenotypic screening.

'Marker-directed' phenotyping also called **tandem selection**: use when markers are not 100% accurate or when phenotypic screening is more expensive compared to marker genotyping. It saves time and reduce costs and especially for quality traits

Reasons to explain the low impact of marker-assisted selection

Reliability and accuracy of QTL mapping Studies, insufficient linkage between the marker and gene/QTL, limited markers and limited polymorphism of markers in breeding material, 'Application gap' between research laboratories and plant breeding institutes, 'Knowledge gap' among molecular biologists, plant breeders and other disciplines, effects of genetic background, Quantitative trait loci × environment interaction and high cost of marker-assisted selection.

Conclusion

More than 25 years after the discovery of molecular markers, marker-assisted selection (MAS) has become a routine component of some breeding programmes. Recently, applications of MAS for forward breeding have been shown to increase Significantly the rate of genetic gain when compared with conventional breeding. The cost associated with MAS is still very high. The use of molecular marker in plant breeding programmes is expected to increase with time because of QTL mapping combined with breeding facilities, comparative mapping and high-resolution mapping and genomics.

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MICROPLASTICS: AN EMERGING CONTAMINANT WITH POTENTIAL THREAT TO AGRICULTURE

Article Id: AL202062

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Microplastics have recently drawn great attention on their environmental impacts due to their small particle size, ubiquity, bioavailability and negative effects on the ecosystem (Wright et al., 2013; Scheurer and Bigalke, 2018). Microplastics are generally defined as plastic particles <5 mm (Rilling et al. 2017). The term "microplastics" was coined by Thompson to describe the small plastic particles in the oceans in 2004. The majority of plastic include polyethylene, polypropylene, polystyrene, polyvinylchloride and polyethylene terephthalate (R.Geyer 2017).

Plastic products are widely used in everyday life, mostly due to the advantage of low cost, malleability and durability. In the past 50 years, the global production of plastic is about 9.1 billion tons, with an increasing annual rate of 8.7% (R. Geyer 2017). Because of enormous production and inefficiency management, the issue of plastic waste is no doubt a critical environment challenge. Although the recycling rate of plastic products is increasing, most of plastic are still released into the environment. For instance, an estimated value of 250 million tons plastics arrived in marine environments in 2015 (S.L. Wright 2017). The recalcitrant material is then slowly shredded into smaller particles once they enter into the environment. With the increasing exposure time, the degradation process will continue and produces even smaller particles. The thus formed microplastics have increased surface area. They can absorb various noxious substances, such as persistent organic pollutants and heavy metals, which make them more harmful in the long-term (Fendall and Sewell, 2009).

Primary microplastics are produced on purpose and used in cosmetic products and various industries. Secondary microplastics are degradation products of larger plastic waste. Both primary and secondary MPs are ubiquitously present in the environment. A study has shown 80% of the plastics in marine wastes come from the land (Andrady, 2011). Exacerbated by the copious use of single-use plastics, plastic constitutes 10% of waste generated worldwide (Matthew et al., 2011). To further clarify the distribution and impacts of microplastics, many scientists began to focus on freshwater and terrestrial systems (Kooi et al., 2018; Rochman, 2018). There are many pieces of evidence identified that MPs are also arising as freshwater pollutants. Eerkes-Medrano et al. (2015) have reviewed that early studies on freshwater ecosystems showed that the presence and interactions of MPs are as profound as those surveyed in the ocean. In addition, a biological study (Silva-Cavalcanti et al., 2017) found that *Hoplosternum littorale*, a widespread fish living in freshwater usually, could intake large quantities of MPs. The high incidence of ingestion may be due to the unique feeding behaviour and heavy environmental pollution. Likewise, the agroecosystem is a primary entry point for microplastics in terrestrial systems (Nizzetto, 2016; Rillig et al., 2017). A recent study (de Souza Machado et al., 2018) has shown that there maybe 4 to 23 times more MPs on land than in the ocean and that arable soil alone may contain more microplastics than the oceans. Contamination from the wide application of plastics as so-called "white pollution" (He et al., 2013) is becoming more and more serious. Scheurer and Bigalke showed that 90% of floodplain soils contain microplastics (up to 55.5 mg kg_1) in Switzerland.

Sources of Microplastics

The fast-growing plastic packaging Wastes

It is clear that the serious contamination of microplastics in the soil cannot be separated from the countless use of disposable plastic products. With the emergence of plastic resin, plastics are becoming increasingly dominant in the consumer marketplace. The largest portion of the application in the market is packaging (Jambeck et al., 2015). As early as 1977, polyethylene was converted into single-use grocery bags (Williamson, 2003; Weinstein, 2009). Since then, the application of plastics in packaging has been growing rapidly and made significant contributions to the convenience of a human's daily life.

The contamination from the wide application of plastics as so-called "white pollution" (He et al., 2013) is becoming more and more serious. In 1984, plastic packaging accounted for 53% of all plastic waste and in 1986, with 5.2 billion kilograms plastics were used in the packaging industry (Selke, 1988). Recent data indicate that over 90 billion flimsy ploy bags end up as non-recyclable waste and garbage annually (Li and Richter, 2015).

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The durability, unsustainable use, and inappropriate waste management lead to massive accumulation of plastic debris in the environment. In addition, during the process of deterioration, the additives and toxic substances in the plastics are released. These materials are relatively resistant to environmental breakdown and can be easily accumulated in the soil and water. Geyer et al. (2017) predicted that about 630 million tons of plastic waste would be produced, and 120 million tons would be transferred to landfills or natural environments by 2050. Lebreton et al. (2017) estimated that over 300 million tons of microplastics had been accumulated on the earth.

The wide application of Plastic mulch

Polyethylene was employed as a plastic film in 1938, and then it was extensively applied as plastic mulch in agriculture. Its introduction revolutionized the commercial production of selected crops and brought huge economic benefit to mankind (William, 1993; Steinmetz et al., 2016). It has been reported that the residual Polyethylene film in cropland soil reached nearly 10% of the total area (Ramos et al., 2015). Plastic mulch has a profound effect on the soil. Since the coverage of the film isolates the exchange of external air and water, it could elevate soil temperature as well as soil moisture, and increase soil biological activity to some extent. Subsequently, it may increase carbon and nitrogen metabolism; deplete soil organic matter storage (Li et al., 2007; Zhang et al., 2015).

However, when plastic mulch is embedded in soil, it undergoes numerous processes, such as physical crushing, chemical ageing and biodegradation, and is converted into microplastics (Blasing and Amelung, 2018).

Land application of microplastics containing sewage sludge

Microplastics are directly transferred to soil by applying synthetic fiber containing sewage sludge or plastic sediment from personal care or household products to the land (Habib et al., 1998; Zubris and Richards, 2005; Horton et al., 2017).To learn more about the main sources of microplastics in sewage outlets (cleaning products, plastic debris, clothing), Browne et al. (2011) collected samples of wastewater and found that polyester (67%) and acrylic (17%) fibers were the major plastic components. Subsequently, compared with the original waste materials, it was found that the proportion was very similar to the composition of textiles (78% polyester, 5% acrylic), so a decision was reached that the microplastics from sewage discharge outlet mainly came from washing-clothes.

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Moreover, a piece of clothing from each wash by a domestic washing machine can produce N1900 fibers. MPs-containing wastewater is discharged into the sea without any restraint, and the unadvisable treatment of waste sludge further accelerates the distribution of MPs (Kerstin and Fredrik, 2014; Mintenig et al., 2017).

Microplastic pollution in soils

Although numerous studies reported the occurrence of microplastics in aquatic ecosystems, microplastics in terrestrial ecosystems have received relatively little attention. Once an entry in the soil, microplastics may persist, accumulate, and eventually reach high levels that can affect organisms and biodiversity. Additionally, microplastics can also act as a vector for the transfer of pollutants, either plastic additives or other toxicants absorbed from soil matrices, to soil biota and thus pose a hazard. For example, Zhang et al. found the high concentration level of organophosphorus esters and phthalic acid esters in microplastics collected from 28 coastal beach soils in north China. In fact, the terrestrial environments are the critical source of plastic rubbish in the water column. Soils were theoretically speculated to be the major storages for microplastics, which is a bigger store more than oceanic basins (L. Nizzetto 2016). Another study points out that the total value of microplastic contaminations on land might be 4-23-fold larger than that in the ocean (Horton A.A. 2017). Once microplastics accumulated in soils, the topsoil provides a degradative environment due to increased oxygen availability, and relatively high temperature (Y. Chae. 2018). Soil microbes and terrestrial organisms may accelerate the degradation of plastics into smaller

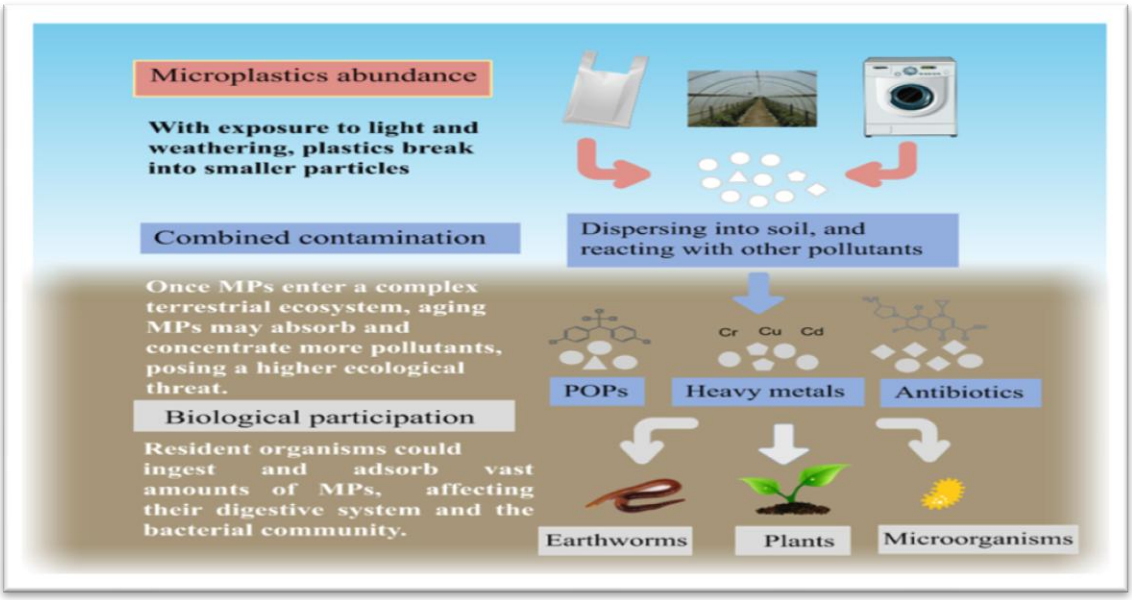

Fig: Microplastics as contaminants in the soil system (Source: J. Wang et al. 2019)

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particles. In addition, agricultural processes such as tillage and crop rotation may turn fragment plastic debris into microplastics. Microplastics in the topsoil might be incorporated into deeper soil by tillage, and even into the plough layer along large cracks.

Ecological risks of microplastics on soil organisms

Some review papers pointed out the potential effects of widespread microplastics and emphasized the adverse effects on biota. Soil organisms include various types such as fauna, nematodes, and collembolans.

- Gaylor et al. observed combined effects of biosolids or polyurethane foam microparticles and polybrominated diphenylether on earthworm *Eisenia foetida*
- They found that microplastics could exert toxicity to earthworms and has effect on mortality, growth and tunnel formation. In addition, earthworms can ingest microplastics, accumulate in the body and further transport to other organisms in the soil ecosystem.
- Recently, one study revealed that microplastics could be availably ingested by nematodes *Caenorhabditis elegans* (L. Lei 2018). The adverse effects of microplastics on nematodes include intestinal damages, oxidative damages.
- Some studies have shown the accumulation of microplastics in yeasts and filamentous fungi which indicates potential accumulation or magnification of microplastics along the soil food web.
- The impacts of microplastics in the aquatic plant have been reported. The plants cell wall is not available for entering of microplastics due to the high molecular weight and large size. So, smaller-sized micro- and/or nano-plastics may be taken up by plants.
- Lwanga et al. studied the transfer of microplastics in the terrestrial food chain.
- Microplastics have been detected in seafood, salt. Similarly, microplastics could be transported via the food chain in soil ecosystems, which may further threat human health to a certain extent.

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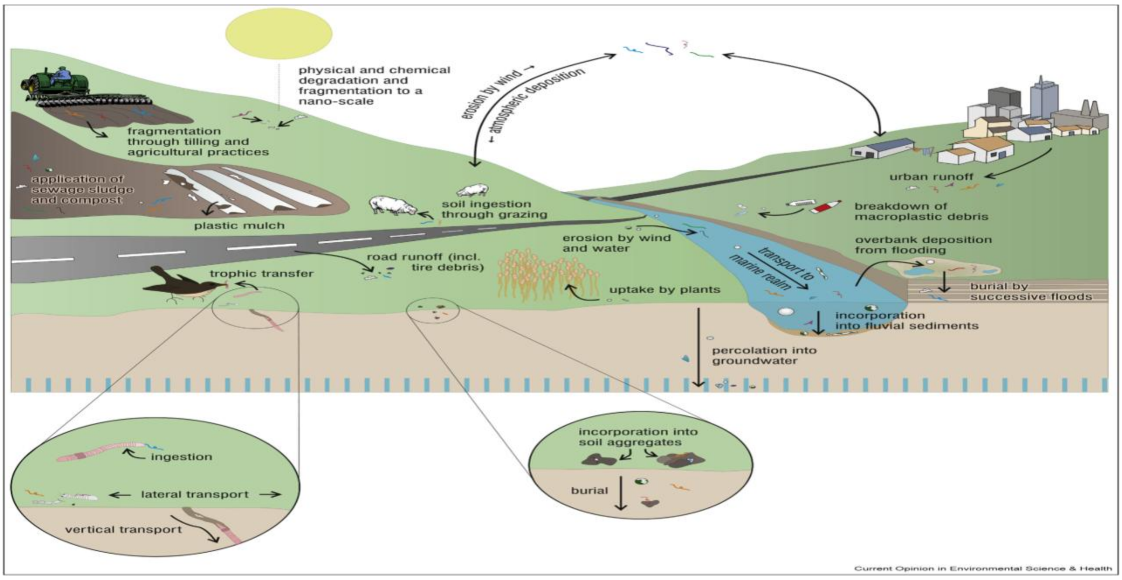

Fig: Fate of microplastics in soil

Possible Strategies to solve the problem of microplastics Pollution

- Removing plastic microbeads from personal care products. In 2015 the US government introduced the Microbead-Free Waters Act banning the sale of personal care products containing plastic microbeads, effective on 2017.
- Biodegradable or biocompatible plastics such as polylactatide, polyhydroxyalkanoates can replace traditional plastics for many applications.
- Improved solid waste infrastructure and management will decrease plastic debris entering rivers and the ocean and thereby decrease the rate of microplastics accumulation. Multiple uses of plastic products can also significantly reduce plastic wastes and decrease the formation of microplastics.
- Existing wastewater treatment facility should be upgraded to remove microplastics efficiently and to prevent microplastics from entering surface waters, such as rivers and the ocean.
- Development of clean-up and bioremediation technologies.
- Recycling of used plastics is an effective approach but recycling of used Styrofoam remains problematic, mainly due to costs. The use waste plastic as energy source and recovery of waste plastics as synthetic crude and valuable products will also reduce sources of microplastics.

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Steps taken by Government to reduce Plastic Pollution

- India's first Governmental Waste to Energy Plant developed in Bhubaneswar
- Development of Polycrack Technology – it is the world's very first patented heterogenous catalytic process which converts multiple feedstocks into liquid hydrocarbon fuels, gas, carbon as well as water. This technology is used to treat Municipal Solid wastes. All wastes are in general preferred as feedstocks for the unit. They are Plastics, Sludge, rubber tires etc.
- Waste in the poly crack plant is processed and converted into energy within 24 hrs.
- United Nations member states agreed to significantly reduce single-use plastics over the next decade (2030).It is the World's First global Commitment to curb Single –Use Plastics held in 2019.

Conclusion

- It is necessary to develop accurate, simple, efficient methods to assay microplastics in soils
- As Microplastics can be taken up by soil biota, it is important to investigate the potential toxicity of microplastics on soil organisms
- Little information about the source and fate of microplastics in terrestrial ecosystems
- The potential consequences for sustainability and food security have not been adequately analyzed
- Some soil enzymiological activity can develop with that some part of remediation can be done

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NANO-FERTILIZERS -SMART NUTRIENT DELIVERY SYSTEM TO INCREASE THE NUTRIENT EFFICIENCY

Article Id: AL202063

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The first Green Revolution during the 1970s targeted to the four basic elements of production system which are high yielding varieties of rice and wheat, extensive use of irrigation, fertilizers and agro-chemicals as a resulted in a tremendous increase in the agricultural production but present agriculture is generally chemical-intensive by using more doses of chemicals for insect, disease, weeds and nutrient management for getting maximization of production per unit area without concern of natural resources and ecosystems therefore resultant, adversely impact our soil health (Soil –physical, chemical, biological property) indirectly in our ecology. In the past 50 years, the fertilizer consumption exponentially increased from 0.5 (1960’s) to 24 million tonnes (2013). That is commensurate with a four-fold increase in food grain output (254 million tonnes)but also observed that yields of many crops have begun to stagnate due to imbalanced of fertilization and decline in organic matter content of soils. We are well vast about the optimal NPK fertilizer ratio of 4:2:1 is ideal for crop productivity while the current ratio is being maintained at 10: 2.7: 1 in India.So it is our crucial concern to reduce the huge amount of application of fertilizer whereas increase the higher yield with increasing the nutrient use efficiency, therefore, Nanotechnology is the novel approach for optimization of targeted yield with its higher nutrient use efficiency along with the concern of soil health.

Nano-fertilizers -Smart nutrient delivery system

Nano-fertilizers are also termed as “Smart Fertilizers”. Nano-fertilizers are synthesized or modified form of traditional fertilizers, bulk materials or extracted from different vegetative or reproductive parts of the plant with different chemical, physical, mechanical or biological methods along with the help of nanotechnology used to improve soil fertility, productivity and quality of agricultural produce (Tarafdar J. C, et al., 2012). A

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nanoparticle (nanopowder or nanocluster or nanocrystal) is a small particle with at least one dimension less than 100 nm where 1 Manometer = 10-9 m = 1 billionth of a meter. Nanosized particles can even pass through the cell wall in plants and animals having with this property Nanotechnologists are used this property to deliver at the cellular level that is more effective than the conventional method because of high surface energy and spatial confinement. Example like Rock phosphate if use as nano form it may increase the availability of phosphorus to the plant because of the direct application of rock phosphate, nanoparticles on the crop may prevent fixation in the soil. As a result, there is no silicic acid, iron and calcium for fixation of the phosphorus, increase phosphorus availability to the crop plants.

Classes of Nanofertilizers

Three classes of nano-fertilizers have been proposed

1. Nanoscale fertilizers (nanoparticles which contain nutrients),
2. Nanoscale additives (traditional fertilizers with nanoscale additives)
3. Nanoscale coating (traditional fertilizers coated or loaded with nanoscale).

Nonmaterial coatings (such as a nanomembrane) may slow the release of nutrients, or a porous nano fertilizer may include a network of channels that retain nutrient solubility. The use of nanotechnology for fertilizers is still in the budding stage but is already adopted for medical and engineering applications

Types of nanofertilizer designs

i. **Slow-release:** The nano-capsules release nutrients over a specific period of time (slow delivery of a substance in the body).

ii. **Quick-release:** The nanoparticle shells break upon contact with a surface (such as a shrinking leaf).

iii. **Specific release:** The shell breaks upon when it encounters a specific chemical or enzyme.

iv. **Moisture release:** The nanoparticle degrades and releases nutrients in the presence of water.

v. **Heat release:** The nanoparticle releases nutrients when the temperature reaches a set limit.

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vi. **pH release:** The nanoparticle releases nutrients only at specified acid or alkaline conditions.

vii. **Ultra-sound release:** The nanoparticle is ruptured by an external ultra-sound frequency.

viii. **Magnetic release:** A magnetic nanoparticle ruptures when exposed to a magnetic field.

Advantages of nanofertilizers over conventional fertilizers:

Nanofertilizers have a higher surface area, which makes them easier to for the absorption by crops and have better solubility and retention capacity in soil thus making more available for the crops uptake.

DESIRABLE PROPERTIES	EXAMPLES OF NANO-FERTILIZERS ENABLED TECHNOLOGIES
Controlled release formulation	So-called smart fertilizers might become a reality through a transformed formulation of conventional products using nanotechnology. The nanostructured formulation might permit fertilizer intelligently control the release sped of nutrients to match the uptake pattern of crop.
Solubility and dispersion for mineral micronutrients	Nanosized formulations of mineral micronutrients may improve the solubility and dispersion of insoluble nutrients in soil, reduce the absorption, fixation and increase the bio-availability to the crops.
Nurient uptake efficiency	Nanostructured formulations might increase fertilizer use efficiency and uptake ratio of the soil nutrients in crop production and save fertilizer resource.
Controlled release modes	Both release rate and release patterns of nutrients for water-soluble fertilizers might be precisely controlled through encapsulation in envelop forms of semi-permeable membranes coated by resin polymers, wax and sulphur.
Effective duration of nutrient release	Nanostructured formulation can extend increase the effective duration of nutrient supply of fertilizers into the soil.
The loss rate of fertilizer nutrients	Nanostructured formulations can reduce the loss rate of fertilizer nutrients into the soil by leaching or leaking.

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Conclusion

Application of nanotechnology in agriculture is still in its budding stage, but it has the potential to revolutionize agricultural systems particularly where the issues on fertilizer applications are concerned through reduce the cost of fertilizer for crop production and minimize the pollution hazard. It has the ability to more soluble or more reactive that can improve penetration through the cuticle and also performs to controlled release and targeted delivery. Meanwhile, there is awareness created on the risks of consuming and performing few operations rather than the benefits and effectiveness of the technology, and also the Governments across the world should form common and strict norms before commercialization and bulk use of these nanomaterials.

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APPLICATION OF REMOTE SENSING IN LAND USE AND LAND COVER MONITORING

Article Id: AL202064

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Remote sensing is the art and science of observing and obtaining information on an object using sensors without being in physical contact with the object (Satyawan *et al*., 2014). This technique is widely used to monitor natural resources like land, water, vegetation etc. in a very cost and time-effective manner. Satellite-based remote sensing can effectively be used for continuous monitoring land use types over a large area because satellite provides precise information with a wide field of view at a regular frequent interval (Panigrahy *et al*., 2005). Land use and land cover classification and land use mapping is the most popular utilization of high-resolution satellite imageries. Land use and land cover maps are used for resource planning and decision making purposes. Satellite sensors are to be equipped with appropriate spatial, temporal and spectral resolutions to delineate and monitor different environmental features like cropland, water bodies, natural vegetation, settlement areas etc. which exhibit significant ecological importance and to study the relationship among those ecological features (Radoux *et al*., 2016).

Satellite-based remote sensing has entered a new era with the launch of high-resolution optical satellites like Landsat-8 and sentinel-2. Landsat-8 is an American Earth observation satellite launched by NASA on 11-February, 2013 as Landsat Data Continuity Mission (LSDM). The two main sensors of Landsat-8 are Operational Land Imager (OLI) and Thermal Infrared Sensor (TRIS). OLI generates visible, near-infrared, short wave infrared, coastal and cirrus wave bands having 30 m spatial resolution and panchromatic bands having a spatial resolution of 15 m. TRIS produces two thermal bands with 100 m spatial resolution. Landsat-8 provides open-source data through USGS (United States Geological Survey) at an interval of 16 days. Landsat data is successfully used in agriculture, geology, vegetation monitoring, forestry, land use mapping, moisture estimation, hydrology, bathymetric and aerosol studies etc. (Ridwan *et al*., 2018). Sentinel-2, developed by European Space Agency

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(ESA) as a part of Copernicus programme, previously known as the Global Monitoring for Environment and Security, is a constellation of two satellites, Sentinel-2A (launched on June 23rd, 2015) with a revisiting interval of 10 days and Sentinel-2B (launched on March 7th, 2017) with a revisiting interval of 5 days (Main-Knorn *et al*., 2017). Sentinel-2 is a sun-synchronous satellite equipped with an optical imaging sensor MSI (Multi-Spectral Instrument) which measures reflectance in 13 spectral bands ranging from Visible and Near Infrared (VNIR) to the Short Wave Infra-Red (SWIR) spectral range. This mission offers an unprecedented combination of systematic global monitoring of coastal land areas from 56 ° to 84 ° latitude with 290km of swath coverage. The sensors measure reflectance at 10m resolution in visible and near-infrared wavebands which are mainly used for land classification. Six spectral bands (vegetation red-edge, narrow NIR and SWIR) at 20m resolution are useful for vegetation detecting. The rest three bands at 60m resolution help to study cloud cover, atmospheric aerosols and water vapour condition (Ramoelo *et al*., 2015). Purpose of the Sentinel-2 mission is to identify crop type and tree species and to monitor forests, land-use changes, coastal and inland waters, risk mapping in the context of disaster management and mapping of built-up areas as well as different biophysical factors such as fraction vegetation cover, leaf area index, leaf water and chlorophyll content etc. (Immitzer *et al*., 2016; Drusch *et al*.,2016).

Research conducted to monitor seasonal change in land use and land cover in Gosaba Island on Indian Sundarban:

Indian Sundarban is one of the most ecologically vulnerable regions in the world. Gosaba Island (Figure 1) is the last inhabited island of Indian Sundarban before the dense mangrove forest starts.The study area extends from 22°12’ N in the North to 22°6’ N in the South and from 88°46’ E in the West to 88°52’ E in the East. The entire island constitutes around 3500 ha of the geographical area including eight numbers of villages namely Uttardanga, Bagbagan, Rangabelia, Arampur, Gosaba, Pakhirala, Dulki and Sonagaon. The study area belongs to the coastal saline zone of West Bengal. The climate of the coastal belt is normally hot humid except for a short, mild winter in the months of December and January. This area receives rainfall mostly during June to September due to South West Monsoon. People mostly rely on agriculture to sustain their livelihood. Rice (*kharif*) based mono-cropping is the normal practice in this area as the post-monsoon period is encountered with moisture stress and soil salinity build-up. Proper land use and land cover monitoring of these areas can be helpful in successful planning and utilization of natural resource management which is essential for sustainable improvement of the livelihood of the inhabitants as well as for saving the natural biodiversity.

Sentinel-2 imageries acquired on 26-December, 2017 and 14-February, 2018 was downloaded from the data archive of ESA and supervised classification was employed using SAGA (6.4.0) software after atmospheric and radiometric correction of the imageries in QGIS (2.18.12) software. This period was chosen due to very little cloud cover so that there was more possibility to get good quality satellite imageries. Moreover, the ecological features of that region could be detected accurately due to less water logging during this dry period. The ground truth survey was done through transact walk across the island to identify different ecological features.

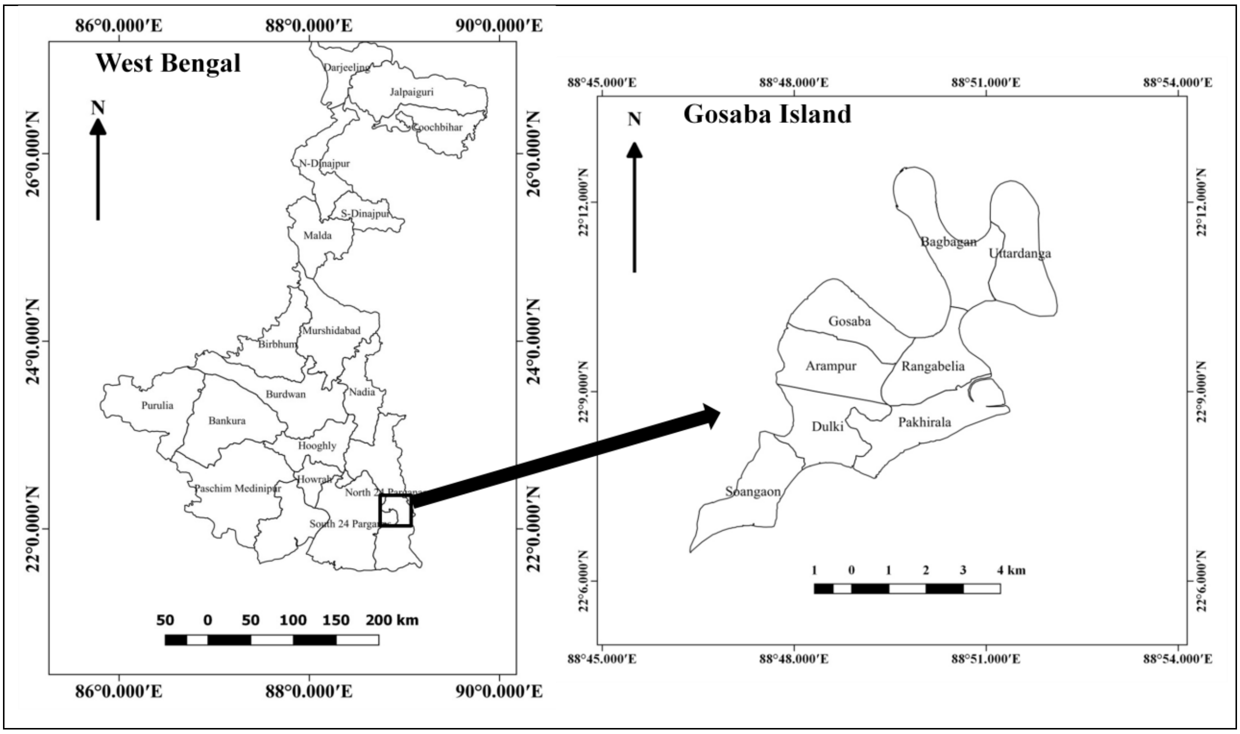

Fig 1: Study area

Major findings

The area under water bodies over the study period did not changes to a considerable extent. The area under the perennial trees (including settlements) was observed to be slightly higher in December which may be attributed to the regrowth from the paddy stubbles left over the field after harvesting of rice. During the month of December, residual moisture content in the field was much higher than during February, and this might lead to stubble regrowth in December. The cropped area was much higher in February. In December grass pea growth was not so prominent that it could be detected in a satellite image. On the other

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hand, in the month of February, a number of post-monsoon crops were at their peak growing stages which reflected in the increased cropped area during that time. Besides some class mixing was observed in between wet fallow land and initial grass pea growth in the December image. With the advancement of the post-monsoon period, moisture availability in the field decreased, which is represented by more dry fallow land and less wet fallow land in February and vice-versa in December. In the month of December, a considerable proportion of land was waterlogged or substantially wet, which became dry gradually with the progress of the dry period. In February, very less area was waterlogged, but in some portion of the island, the field was puddled for *boro* rice cultivation.

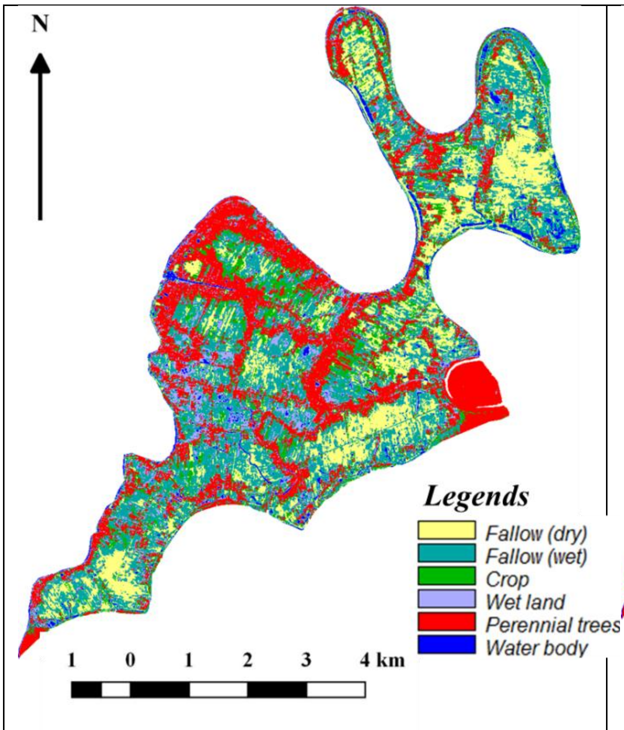

Figure 2a: Land use and land cover map of 26-December, 2017

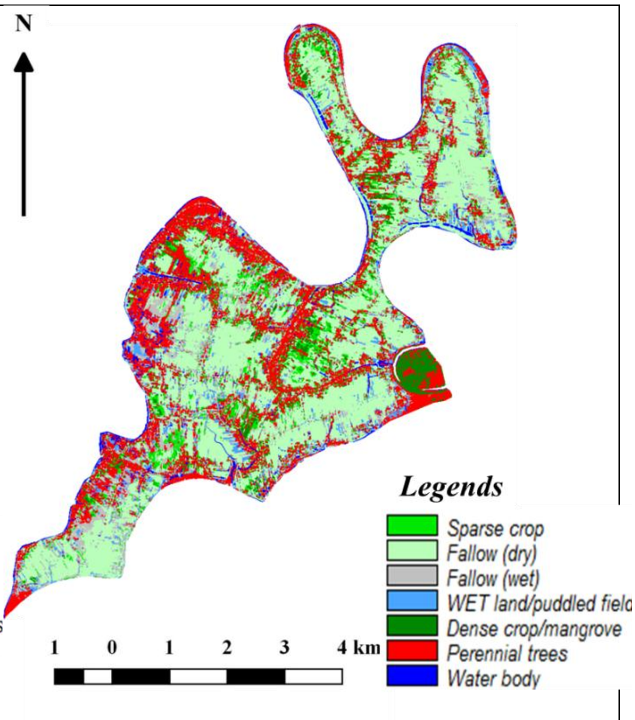

Figure 2b: Land use and land cover map of 14-February, 2018

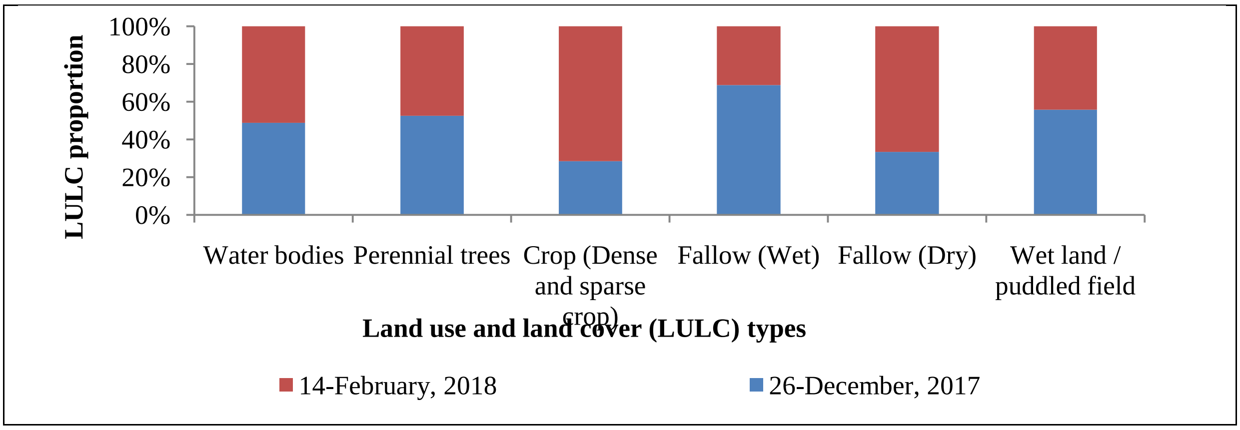

Fig 3: Changes under different land sue and land cover from 26-December, 2017 to 14-February, 2018

Conclusions

Satellite-based remote sensing has great potential to be effectively used in land use and land cover monitoring in any area. Sentinel-2 data with its fine spatial resolution and high temporal frequency can be applied successfully to assess the seasonal variability in land use pattern. Seasonal dynamics of fallow and cropland can be accurately determined by using sentinel-2 data. Cropping system analysis and cropping intensity mapping can also be done. There is a great future scope of Sentinel-2 data for use in crop monitoring, field moisture estimation and identification of the suitable areas for sustainable intensification.

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"OUR ACTIONS ARE OUR FUTURE" – A ZERO HUNGER WORLD BY 2030 IS POSSIBLE

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Conflict, immoderate weather phenomenon closely related to climate change and economic deceleration, as well as expeditiously escalating overweight and obesity levels, are overturning the advancement created in the fight against hunger and malnutrition. According to FAO, almost 821 million people in the world and one in nine people suffer from chronic hunger. In agreement with data received in 2016, nearly 11 per cent of the global populations are fighting with continual undernourishment. The dictatorial number of malnourished people is the greatest in Asia and the extensiveness of underfed persons is rapidly increasing in South Asia, from 9.4 per cent in the year 2015 to 11.5 per cent in 2016 (FAO, 2017) and United Nations confirmed that 3 out of 10 stunted children in the globe are observed in our country. The government has launched numerous techniques for the improvement of agricultural crop production and productivity and to guarantee that food can reach the poor section of our society through a well organized public distribution network. Nevertheless, the achieved production level is not sufficient to culminate the prevalence of severe malnutrition and to encourage dietary diversification. India, one of the largest food-producing nations, holds the rank of 103rd out of 119 countries while considering 2018 Global Hunger Index and suffers from a grievous level of hunger with a score of 31.1. Nelson Mandela once said, "It always seems impossible until it's done'. This foundation of belief resonates with the theme of World Food Day 2018 *i.e.* Zero Hunger World is possible by 2030. World Food Day is celebrated on 16 October every year to reconsider the position of food, and nutritional assurance which recommences the pledge to end hunger reminds the world that Zero Hunger is conceivable if we can move altogether and take account of experiences learnt and also displays a commitment to achieve the Sustainable Development Goals 2 – to acquire Zero Hunger status by the year 2030. It actually indicates working together to ensure everyone, everywhere, has access to the safe, healthy and

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nutritious food they require. Combating hunger is a universal agenda and obtaining zero hunger demands agrarian systems to become more efficacious, sustainable and endurable, climate-smart, nutrition-sensitive as well as need synchronization among malnutrition, dietary and production diversity. ‘Zero Hunger’ is one of 17 SDGs that make up the 2030 Mission for sustainable development that needs a very strong determination level and commitment from individual nations.

Sustainable development goals (SDGs)

- ✓ SGDs or Global Goals are a universal call to take action to combat poverty, safeguard our planet and make sure that all people can enjoy peace and prosperity, which came into existence in January of the year 2016 and will proceed to conduct UNDP policy and funding until the end of 2030.
- ✓ Aspire to culminate all forms of hunger and malnutrition by 2030, ensuring all the people, specifically children and the more vulnerable sections have proper access to sufficient and nutritious food all year round.
- ✓ Promote sustainable agricultural practices, improve the livelihoods and capacities of small scale farmers, and allow equal access to land, technology and markets.
- ✓ Require international cooperation to ensure investment in infrastructure and technology to improve agricultural production and productivity.

Path to zero hunger by 2030

1. **Demand for food will grow**
    - Increase investment in agriculture
    - Build market infrastructure and improve public goods to raise productivity and rural incomes.
2. **About 800 million people go hungry today**
    - Promote nutrition policies, including dietary education, and shift to consumption and production approaches that promote biodiversity and long-term health benefits.
    - Establish social protection systems to improve food access, such as school food and cash transfers. Without nourishment, humans cannot learn or lead healthy and productive lives.
3. **Increasing competition for natural resources**

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- Sustainably manage forests, oceans, water, land and soil and promote an ecosystem approach to extract greater agricultural yield with fewer inputs.

4. **A large share of food produced is lost or wasted**
   - Make food systems more efficient, inclusive and resilient and limit extreme food price volatility
5. **4 in 5 poor people live in rural areas**
   - Develop pro-poor growth strategies in rural areas, focusing on small-scale farmers and the people left furthest behind.
6. **Gender equality is a precondition for prosperity**
   - Ensure rural women have equal access to resources, income opportunities, and education.
7. **Youth numbers are rising fast**
   - Diversify rural employment into non-agricultural activities targeting youth to slow their exodus to cities.
8. **Inequalities are increasing both within and between countries**
   - Address the root causes of inequality. Give poor people access to health, education, land, finance and new technology.
9. **Outbreaks of transboundary pests and diseases are growing alarmingly**
   - Establish best practices in preventing diseases and anti-microbial resistance that threaten plant and animal production, public health and trade.
10. **Increasing greenhouse gas emissions are exacerbating climate change**
    - Transform agriculture so that it contributes to fossil fuel reduction.
11. **Climate change is jeopardizing crop and livestock production and fish stocks**
    - Adopt holistic approaches, such as agro-ecology, agroforestry, climate-smart and conservation agriculture
12. **Conflicts and crisis are becoming increasingly protracted**
    - Build the resilience of rural communities to withstand shocks, crisis and disasters. Tackle distress migration.
13. **Globalization is increasing demand for information, technology and participation**
    - Build institutions and mechanisms that provide international norms, standards and data, and promote cooperation among countries and partners.

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Zero Hunger challenge

The Zero Hunger vision is comprised of five elements which can end hunger, eliminate all forms of malnutrition and build inclusive and sustainable food systems if taken together. These five elements are:

1. All food systems are sustainable: from production to consumption
2. An end to rural poverty: double small-scale producer incomes & productivity
3. Adapt all food systems to eliminate loss or waste of food
4. Access to adequate food and healthy diets, for all people, all year round
5. An end to malnutrition in all its forms

How India can overcome the zero hunger challenge

1. Design and development of efficient integrated systems of food production, processing, preservation and distribution
2. Adequate warehousing facilities, cold storages, resilient transportation infrastructure and improved marketing channels
3. Developing and upgrading rural infrastructure
4. Impart training to farmers about post-harvest practices
5. Integrating small scale enterprises into value chains
6. Organizing smallholder farmers into farmer producer organizations
7. Customized financial services and investment in agricultural research
8. Setting up genetic gardens for bio-fortified plant crops

Solutions for world hunger

1. Food donations

One of the easiest means of combating world hunger and malnutrition is to commence more food collection drives which can bring the entire world to a position of self-sustainability, and it is not something that can happen overnight.

2. Urban farming

Almost one-quarter of malnourished people dwell in an urban environmental condition; therefore, a big initiative for urban farming has been taken up that gives empowerment to the families to gain control over their own food source. Rooftop/indoor farming in the middle of

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cities can solve the hunger problem, and vertical farming can feed about 10 billion people and make agriculture independent of weather and the need for land.

3. Sustainable farming

Sustainable agriculture integrates three main goals like environmental soundness, economic profitability and social and economic equity which is based on the principle that farmers must meet the requirement of the present generation without compromising the ability of future generations to meet their demands.

4. Government intervention

Encouragement should be given to foreign nations to be more focused on government intervention programs that contribute food to mothers and children in poor areas to fight global hunger.

5. Birth control education

Higher birth rates impose a major threat while trying to solve the hunger problem as many people are not well educated on reproduction or do not have enough access to contraceptives.

6. Access to credit

In the last few years, a large section of people in poor countries has gained access to credit by many organizations. Most of these credit loans are repaid, and they have created many industries, like farms, that can generate a sustainable provision for people and also develop an economically viable nation.

7. Access to education

A better education system is the best weapon against poverty and hunger, and it can provide better opportunities and more access to income and food. Additionally, some countries have food-for-education programs where students are given free food for coming to school.

Conclusion and way forward

Agriculture is a huge business which can create opportunities for the younger generation to take up agriculture as their profession in order to protect long-term food and nutritional security and technologies like mobile phones and many others can be used for knowledge dissemination to rural farmers on the food production cycle and market linkages. There is a huge need to formulate policies for supporting better agricultural investments; on the other hand agricultural subsidies and incentives must be provided as well as the production and consumption of climate-resilient native nutritional crops should be encouraged. To achieve

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the mission entitled ‘Zero hunger’, we must adopt a more sustainable lifestyle, work with others, share our knowledge and be willing to change the world – for the betterment. It is at the heart of FAO’s mandate to ensure that people have access to sufficient high-quality food to lead active and healthy lives. FAO collects, analyses and disseminates data that aids development and works with countries both to devise and implement policies that take into account the multifaceted elements of Zero Hunger.

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CROP BASED INTEGRATED FARMING SYSTEMS FOR SUSTAINABLE PRODUCTION, NUTRITIONAL SECURITY AND ENVIRONMENTAL SAFEGUARD

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In India, different types of farming systems co-exist depending upon available resources, agriculture practices, and location-specific needs of humans to meet the requirements of food, fuel and fiber. Integrated Farming System (IFS) is a complex, interrelated matrix of soil, plants, animals, implements, power, labour, capital and other inputs controlled in part by farming families and influence to a varying degree by political, economic, institutional and rest factors that operate at farm level. The farm holding size in India has been declining over the years, and about 86% (126million) out of 146 million operational holdings are marginal and small. Presently, India comprises of 18% human and 15% livestock population of the world which is maintained on 2.3% land and 4.2% water, 1% forest land and 0.5% pasture and grazing land resources of the globe. Thus, these exist tremendous pressure on available resources to meet domestic needs. The burgeoning population and rising income levels have, however, consistently increased the demand for basic food items and value-added food products also. This increased demand for food from the limited resources available in India can possibly be met by integrating farming systems which offers a whole farm policy and whole systems approach to farm management. The income of average farmers from cropping alone is hardly sufficient to sustain his family. An integrated farming system approach is not only a reliable way of obtaining fairly high productivity with substantial fertilizer economy but also a concept of ecological soundness, leading to sustainable agriculture (Swaminathan, 1987). Different farming systems have been developed and being practised by the farmers indigenously without any rationale for utilizing the residues derives from crops/animals and other associated enterprises at the farm. Dairy animals are an integral part of the prevailing farming system across the country. With rising population, declining land-man ratio and increasing mechanization in farm operations, agriculture alone are not able to provide adequate income and employment to households in India. Integration of farm enterprises provides better livelihood in terms of increased food production, higher net income, improved productivity and reduced income imbalance between the agricultural labourer and urban factory worker. Increase in non- farm employment has also become essential for improving income and living standard of the rural population (Chadha, 1993; and Kumar *et al*., 2003). The farming system is the integration of farm enterprises to which a farm family allocates its resources in order to efficient utilizes the existing enterprises for enhancing the productivity and profitability of the farm. The farming system, as a holistic approach broadly addresses itself to different components of the farm enterprises and inters-relationship among themselves and the farm environment. Despite different researchers in India and elsewhere generally, restrict themselves to the crop sub-system while referring the farming system without farming adequate attention to the other farm enterprises and socioeconomic conditions in which the farmer operate.

The main objective of opting different kinds of farming was to reduce dependency on external sources. However, following industrialization, farming became commodity-based depending upon agro-climatic conditions of the area and proximity to industries like sugar factory, soya processing plant, rice mill, oil mill, ginning mill, dal mill etc., similarly poultry farming, dairy farming, piggery, beekeeping, fish cultivation, vegetable farming, fruit-farming, floriculture, mushroom farming gained popularity in the peri-urban areas also to exploit the market of the produce available in the city (Meena *et al.*2018). However, with the pace of time, the sustainability of single commodity based farming became questionable because of fluctuating market trends and dependency on external inputs. The ‘green revolution’ further intensified the crop-based farming system with indiscriminate use of fertilizers leading to a situation of fatigued land and reduced crop production. In IFS, farmer seeds to provide efficient and profitable production which is economically viable and delivers safe, wholesome and quality food through the efficient management of livestock, fish, forage, fresh produce and arable crops, while conserving and enhancing the environment at the same time. Thus, the integrated farming system is adoption and integration of wide rages of a resource-saving package of practices, which ensures an acceptable level of profits/income, make the whole system economically sustainable, ecologically renewable, socially acceptable, minimizes the negative impacts of intensive farming and preserve as well as improve the environment (Gill *et al*. .2009).

Farming systems: definition and importance

Farming system though is not a new concept and is defined by different persons in their own way. However, most practicable and meaningful definitions are documented hereunder:

The farming system is a resource management strategy to achieve economic and sustained production to meet diverse requirements of farm households while preserving resource base and maintaining a high-level environmental quality (Lal and Miller, 1990).

"Farming system" is a complex inter-related matrix of soil, plants, animals, implements, power, labour, capital and other inputs controlled in parts by farming families and influenced in varying degrees by political, economic, institutional and social forces that operate at many levels (Mahapatra, 1992).

The main purpose of the integrated farming system is to bring self- sufficiency in farmer's requirement of food and cash; increased income and employment opportunity; recycling of farm wastes and byproducts and increasing resource use efficiency through efficient management of resources (Mahapatra and Bahera, 2004). The land-based enterprises such as dairy, poultry; mushroom, biogas etc. were included to complete the cropping program in order to fetch higher income and employment, thus leading to higher social and economic upliftment. The philosophy of such an integrated farming system revolved around better utilization of time, money, resources and family labourers. The farm family gets scope for gainful employment round the year, thereby ensuring good income and a higher standard of living. The income analysis of such studies revealed that from a small farm piece of 1.0 ha area, the net return of Rs. 3,04,465/ha could be realized from an investment of Rs.1,02,350 generating 356 man-days of employment with a resource use efficiency of Rs. 2.97 per rupee invested.

Principles of Integrated Systems

Principles behind the Integrated Farming System approach as described by several workers as summarized below:

1. The integrated farming system is a farmer-centric bottom-up approach wherein all research and developmental activities of the farm revolved around the farmer-the real

beneficiary and are planned and executed accordingly: keeping in view his/her farm resources, economic status and family's annual household food and fodder demand.

2. Social and political environment plays a key role in the selection of the system of farming in respective areas/zones and are considered during the process of planning.
3. IFS is a multi-enterprises and multidisciplinary holistic approach combining all related field of agriculture and subject specialization for maximum synergetic impact and outcome with less input energy.
4. Knowledge of farmers resources, a system of farming and constraints analysis are the pre-requisites for successful planning of any IFS activities.
5. All the farm resources are allocated, keeping in view the households needs, market availability and demand of different commodities.
6. Diversification of existing cropping and farming systems through complementary combination of proven cost effective technologies and less resource requiring farm enterprises.
7. The integration is made in such a way that the product of one component should be the input for other enterprises with a high degree of complementary effects on each other.
8. All farm wastes and crop residues etc. are properly collected, composted and or recycled in-situ and nothing goes waste promotion to vertical farming with multiple uses of resources.
9. Adoption of resource conservation technologies for maximizing resource use efficiency.
10. More emphasis is given to lowering a chemical load and thus promoting organic farming with the ultimate goal of environmental protection.
11. Being more diversified in nature, the approach is more employment generative, particularly for rural unemployed youths.
12. More emphasis is given for on-farm processing and adding product value before use at farm and marketing of surplus produces (if any).

Farming Systems Scenario of Small Farm Holders in India

The marginal and small categories of farmers, in general, are literally illiterate, financially handicapped (more than 30% are below poverty line), small and scattered land holding not suited for high-tech agricultural machinery, work in resource-poor and risk-prone

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diverse conditions. Further, these farmers most after are laggards and practice whatever their neighbours do and because of wide spread poverty among these categories of farmers, they cannot take much risk to adopt new innovations in the field of agriculture and hence could not achieve advantages of several commodity based revolution took place (Mahapatra and Bapat,1992). Even after six decades of independence and eleven five year plans completed, the economic conditions of small farm holders is still bad to worst. It is because the efforts made so far were in favour of resource rich and large holding farmers and not planned according to real conditions of these categories of farmers representing 4/5th of the total farm holding of the country. A detailed analysis for these categories of farmers is given in the Table1 below;

Table1: SWOT analysis of small farm holders.

Strengths	Weaknesses	Opportunities	Threats
The only strength of these category of the farmers is sufficient available man power	1. Small & fragmented land holdings 2. Wide spread poverty 3. Lack of resources 4. Illiteracy 5. Laggardness	1. Loans on low interests 2. Subsidies on implements, milch animals and new enterprises like fish production, horticulture and a number of small scale industries. 3. Free trainings for agriculture related enterprises. 4. Research oriented technologies to increase the productivity and profitability of existing On-Farm farming systems.	1. Any type of technological and methodological failures can affect the economic condition of the family. 2. Small farmers' works in risk prone diverse conditions. 3. Environmental factors such as climate and weather adversities are beyond the control of small economically handicapped farmers 4. High risk to introduce any new technology.

Existing and Integrated Farming Systems

The benefits of advancement in agriculture are harnessed mainly by small group of large and medium category of the farmers who are resource endowed. At present about 86% farmers are marginal and small in India. Small-land holdings are not well suited to mechanize farming coupled with poor economic condition and lack of resources is responsible for slow growth rate in agricultural sector. Pigeonpea, urd bean and moong bean are the second choice of the farmers after sugarcane-ratoon-wheat cropping system in western plain zone of Uttar pradesh. However, the legume crops like cowpea and *dhaincha* arebeing used asgreen fodder and green manuring crops. The predominant existing farming systems are in India: crop alone, crop dairy, crop dairy+ horticulture, crop plantation+ dairy horticulture etc.

There is urgent need to optimize the limited available resources with farmers and cut down the cost of production through integration of different enterprises at one place to use them as byproducts and supplementary for getting higher benefits. Thus, we can save inputs purchased from the market by 70-80% and rest 20-30 % will be required. The farming system research is considered to be a powerful tool for natural and human resource management in developing countries like India. This is a multidisciplinary whole–farm approach addressing the constraints of small and marginal farmers. The main aims of increase income and employmentfrom small holdings by integration of various farm enterprises and recycled of crop residues and byproducts within the farm system. The small and fragmented land holdings are forbidden in the way of mechanization and hence the whole crop operations are carried out by the farm family resulted in meagre farm production which is consumed by the farm family itself. The interaction of biophysical, technological, institutional and socioeconomic conditions are leading to temporal and spatial variability among the farming systems which are not only help in enhancing productivity and profitability but also contribute in creation of available balanced diet. Under the existing agrarian structure, most of the rural farm families are of small and marginal in nature they are living below the poverty line with the continued threats to their livelihood security characterized by low in food security and income, unemployment, health problems, education etc. Due to this reason, these categories of farmers are poorly adopted to the changed farming scenario especially in rainfed areas (Lal and Miller, 1990). Further, this section of farming community is very much susceptible to the natural vagaries (drought & flood) and resulting in large scale migration to urban areas for seeking livelihood opportunities. Keeping in view of these problems, the innovation on IFS developed by ICAR-IIFSR, Modipuram, Meerut, Uttar Pradesh, India. To ensures the consolidation of the natural resource base at farm level and offers better opportunities for adoption of improved technology/ies with the target of enhancement of overall production and productivity of the farm. To provides an opportunity to arrive at appropriate combination of the enterprise through interlinking of different farm enterprises for the effective use of natural resources available at farm level and for recycling of nutrients on the farm. And this technique ensures in the creation of better awareness on the adoption of technology/ies which can lead to sustainable production process with on-farm employment creation to support livelihood of the rural farm families. Based on need, choice and resources

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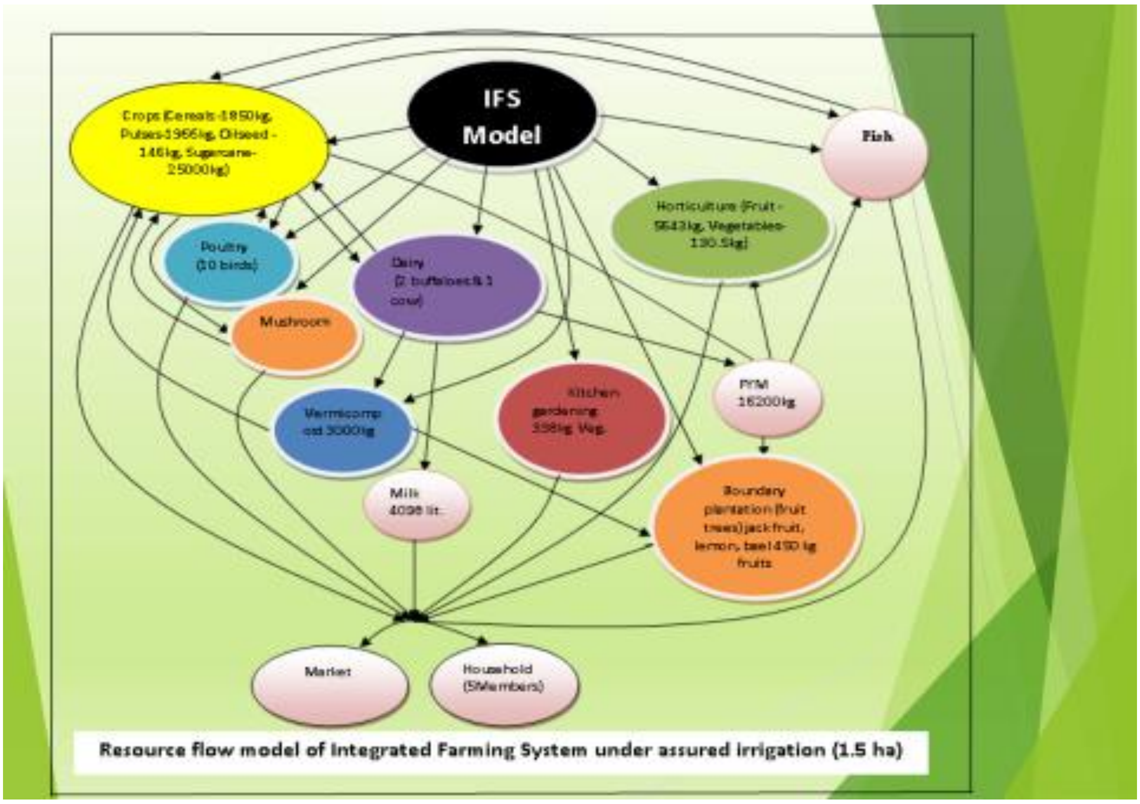
available on the farm, different allied activities such as horticulture, dairy and vermi compost should be included in the production system with an aim of generating income and employment for the farm family through economically friendly model to get regular income, employment and livelihood security. The crop and animal residues can be recycled for vermicomposting for applying in the field crops. The productivity enhancement after intervention and stability in crop productivity was noticed as indicated by higher sustainable yield index in crops adopted in all farms. The change in productivity is variable and in constraint farming situations the interventions have greater impact and brought greater increase in yield (38 to 80 %) and stability in yield was noticed. This shows the impact of whole farm demonstration of IFS is significant because of improvement in natural resource base of the farmer and risk reduction. The new vegetable crops and varieties are to be introduced in the farms, one of the important interventions which enhanced the income of farm families, increased the cropping intensity, boost employment and increase nutritional security for the farm families and surrounding rural households. Gill (et al. 2009) also reported that, horticultural and vegetable crops can provide 2-3 times more energy production than cereal crops on the same piece of land and will ensure the nutritional security on their inclusion in the existing farming system. The emphasis was given for the incremental changes with seasonal crops and with the other activities, with the introduction of new technologies, forced the farmers to re-organize substantial portions of their activities. Economic analysis was done by recording and the cost and income involved in crop production activities and for other farm enterprises. The monitory values used for comparing the alternatives that includes only those outputs sold for cash are those inputs purchased with cash.

The important components of IFS model are includes vegetables crops like cabbage, cauliflower, okra, french bean, tuber crops, floriculture, medicinal, aromatic and forest plants (used for timber /fuel/ fodder), grasses and fodder crops and hence alternatives suitable farming systems for different farming situation in the India are: Crop alone, Crop+ dairy, Crops+ dairy + horticulture, Crops+ plantation+ dairy and Crop + horticulture.



Resource flow model of Integrated Farming System under assured irrigation (1.5 ha)

The soil, water, climate, marketing, labour, transport and local demands are the main criteria to select the farming systems. For example in western plain zone of Uttar Pradesh irrigation facilities are ample, hence farmers has preferred to grow sugarcane as a remunerative crop thereafter rice, wheat and maize are the another important crops. Apart from this, pulses like pigeonpea, urd bean and moong are grown by the farmers. While, the legume crops like cowpea and dhaincha are taken for green manuring, fruit crops *viz.* mango, guava, jackfruit, jamun and oilseeds such as mustard, toria, vegetables crops like potato, cabbage, cauliflower, okra, potato, French bean, tubers (sweet potato) , floriculture, medicinal, aromatic and forest plants (used for timber, /fuel/ fodder), grasses and fodder crops. Thus, all available natural resources indicate that number of potential, profitable and feasible farming system enterprises and their alternatives are available in the region. The various potential, profitable and sustainable of farming systems. The integration of location specific suitable and socio-economically acceptable farming system enterprises can help to achieve sufficient food and nutritional security, farm resource recycling to enhance the farm income and employment opportunities in general and improve livelihood in different states of India as given in Table2.

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Table 2: Prevailing system and integrated farming systems in different states of India

State	Prevailing systems	Integrated Farming Systems
Tamil Nadu	Rice-Rice-Black gram	Rice-Rice-Cotton+Maize Rice-Rice-Cotton+Maize+Poultry/Fish
	Rice-Rice	Rice-Rice-Azolla/Calotropis+Fish
	Rice-Rice-Rice-Fallow-Pulses	Rice-Rice-Rice-Fallow-Cotton+Maize+Duch cum Fish
	Cropping alone	Cropping+Fish-Poultry Cropping+Fish-Pigeon Cropping+Fish-Goat
	Rice	Rice+Fish Rice+Azolla+Fish
Goa	Cashew	Coconut+Forage+Dairy Rice-Brinjal (0.5 ha)+ Rice-Cowpea (0.5 ha)+ Mushroom + poultry
Madhya pradesh	Arable Farming	Mixed Farming + 2 Cow Dairy (2cows) +15 Goats+ 10 Poultry+10 Duch+Fish
Maharashtra	Cotton(K)+Groundnut(S)	Black Gram (K)-Onion (R)- Maize+Cowpea Crop+Dairy+Sericulture Crop+Dairy
Punjab	Crops (Rice-Wheat)	Crops (Rice-Wheat)+Dairy Fish+Piggery
Uttar pradesh	Crop (Sugarcane-Wheat) Crops alone (Diversified)	Crops(Sugarcane+Wheat)+Dairy Crop+Dairy Crop+Dairy+Horticultrue Crop+Dairy+Apiary Crop+Dairy+Vermicomposting

Major Focus in Farming System Research

In the past few decades farming system research (FSR) has emerged as a popular and major theme in international agricultural research (Sands, 1986). Yet despite the widespread use of the term FSR, substantial ambiguity persists about its meaning and the types of research concepts, objectives, approaches, activities and methods to which it should be applied. FSR integrates the following key activities and concepts into a coherent research process designed to overcome the perceived weaknesses in mainstream agricultural research.

It is problem solving: FSR is an operational research which first identifies technical, biological and socioeconomic constraints to improve production in farming systems. It then endeavours to develop solutions which are appropriate for the management conditions of that system (Biggs, 1995).

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FSR is farmer-oriented: FSR views small farmers as clients for research and technology development (Jayanthi et al.2007).Therefore, its fundamental objectives are to generate technologies relevant to their goals, needs and priorities. Several mechanisms are employed to attain these objectives: (i) farmers are integrated into research process, the existing farming system is studied before proposing technological solutions and (iii) technologies are adapted to local circumstances and needs of a specified group of farmers (Rhoads and Booth, 1982; Chambers and Ghildyal, 1985).

FSR is system oriented: FSR views the farm in a holistic manner and focuses on interactions between components. In practice the whole farming system serves as the frame-work for analysis, but specific components, sub-systems or interventions.

FSR is interdisciplinary: FSR, by nature, cuts across conventional, commodity and disciplinary boundaries. Biological and social scientists must collaborate in order to understand the conditions under which small farmers operated, to diagnose constraints and to develop appropriate and improved technologies (Rhoades and Booths, 1982; Mahapatra and Behera, 2004).

FSR complements mainstream commodity and disciplinary agricultural research: it does not replace it: FSR draws on the "body of knowledge" of technologies and management strategies, generated by discipline and commodity research and adapts them to the specific environment and socioeconomic circumstances of a target group of relatively homogeneous farmers (Sands, 1986).

On-farm research is central to FSR approach: On-farm research provides the context for collaborations between farmers and researchers (Chambers and Ghildyal, 1985). Researchers get a deeper understanding of the farming system and the decision making context of the farm family. It revolves round the basic principle that successful agricultural research and development efforts should start and end with the farmers (Rhoades and Booth, 1982). Farmers' participation is ensured at different stages of technology generation and transfer processes such as system description, problem diagnosis, design and implementation of on-farm trials, and providing feedback through monitoring and evaluation.

Technological Interventions for Integrated Farming Systems

There is urgent need to generate low cost holistic farm technologies involving agricultural diversification focusing enterprises like crop (crop diversification with drought resistance crops/varieties and remunerative crops), dairy, goatory, apiary, agroforestry and

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agro-processing etc. diren by market demand and opportunities (Lightfoot *et al.* 1993; Prein 2002).

Many researchers advocated farming system analysis and multidisciplinary research for the development of small farms (Devendra, 2002; Prein, 2002). Hence, development of suitable IFS models for the small farmer in different agro-ecological regions of the state is of major importance. The basic aim of an IFS is to derive a set of resource development and utilization practices, which lead to substantial and sustained increase in agricultural production. Farming system studies involving a number of enterprises and taking the physical, socioeconomic and bio-physical environments into consideration are very complicated, expensive and time-consuming (Mahapatra and Behera, 2004). There exists a chain of interactions among the components within the farming systems and it becomes difficult to deal with such inter-linking complex systems (Behera and Mahapatra, 1999; Shekinah *et al.*, 2005). This problem can be overcome by construction and application of suitable whole farm models.

Conclusion

In brief, the system agriculture is based on the idea of enhancing peoples' capacity to mange change by developing their ability to learn, how to learn, to improve problem situation and to communicate effectively. It draws on the concept of experiential learning and on systems thinking and practice as well as scientific method and encourages intuitive, creative activity, as well as logical, systematic thinking. It envisages agriculture as complex interaction between natural and social phenomena. In India, the increasing population demands coupled with decreasing resources base and declining productivity warrants an immediate attention of researchers to attend to these problems and there is urgent need to reorient agriculture research programmes from individualistic enterprise approach to holistic (System oriented) approach in agricultural system. The concept of integrated system research takes various enterprises and resources inputs at the farm into consideration for planning production of crops, selecting cropping systems and combining various enterprises to develop integrated farming systems having sustainable agriculture production.

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MOLYBDENUM: ESSENTIAL ELEMENT FOR PLANTS AND ANIMALS

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The Word micronutrient represent some essential nutrients that are required in very small amount, micronutrient molybdenum is one among eight micronutrient for growth of plant and microorganism which is needed by plants in a small amount ranged from 12 to 32 g ha-1 for physiological function. In-plant tissues generally it ranges between 0.3-1.5ppm. Molybdenum is present in numerous enzymes. One of these important enzymes is nitrogenase, which fixes nitrogen of the atmosphere and transformed into compounds that allow bacteria, plants, to synthesize and utilize proteins. Molybdenum predominantly found to be an integral part of an organic pterin complex which is known as molybdenum cofactor (Moco). This Moco binds with molybdenum-requiring enzymes (molybdoenzymes) found in most biological systems, including plants, animals and microorganism.

Molybdenum Status among Indian Soils

Among Indian soils total Mo content ranged between 0.4 and 14.5 mg kg^{-1} soil. In Indian soils available Mo contents extracted with ammonium oxalate (pH 3.3), ranged between 0.07 and 2.67 mg kg^{-1}. The availability of Mo in soils depends upon the nature of the parent material and environmental conditions. Deficiency of Mo is not very common in Indian soils. It has been reported that soil of Andhra Pradesh is about 49%, Gujarat 10%, Haryana 28%, Madhya Pradesh 18% are deficient in Mo. On an average 11% of Indian soils are deficient in available Mo. Deficiency of Mo is widely reported in red and lateritic alfisols of the north and north-eastern Himalayan regions, the Konkan and Malabar regions and acidic and leached areas of humid zones. Its deficiency is rarely reported in calcareous alkaline soils of arid and semi-arid regions as these soils have high available Mo contents. Continuous submergence, use of organic manure, high soil pH and use of P and S fertilizers

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increased the availability of Mo. As the soil solution becomes more alkaline MoO^{-}_{4} availability increases. Every unit increase above pH 3, MoO^{-}_{4} solubility increases 100-fold primarily through decreased adsorption of metal oxides.

Functions of Molybdenum in Plants, Animals and Human

Molybdenum is involved in several enzyme systems including nitrate reductase, xanthine oxidase, sulfite oxidase etc. As a cofactor for these enzymes, it performs the following functions:

1. Molybdenum plays an important role in N metabolism. It catalyzes the fixation of dinitrogen gas to ammonia by rhizobia in legumes which can be utilized by the host plant.
2. Xanthine oxidase breaks down nucleotides particularly adenine into uric acid which act as an antioxidant. Mo aids in catalyzing the oxidation or metabolism of sulfur-containing amino acids, purines, pyrimidines, and aldehydes.
3. Sulfite oxidase is a Mo-containing hemoprotein and mediates the electron transfer between sulfite and sulfate. This reaction allows our body to metabolize methionine and cysteine (the sulfur-containing amino acids). When these amino acids are not metabolized sulfite will build-up, this can be toxic for the body. Sulfite oxidase turns the sulfite into sulfate, which can be safely removed from the body. Aldehyde oxidase helps in breaking several different types of toxin, including several drugs.
4. The human body contains about 0.07 mg of molybdenum per kilogram of body weight, with higher concentrations in the liver and kidney.
5. Molybdenum present within human tooth enamel prevents its decay.
6. Molybdenum helps in energy production by breaking down some of the amino acids, cell protection, by activating antioxidants, waste removal and by metabolizing toxins that can be excreted in the urine.

Deficiency Symptoms of Molybdenum

1. Mo deficiency in forages grasses (Maize, Sorghum, Pearl millet and Oat etc.) resulted in the golden yellow coloration of older leaves along the apex and the apical leaf margins. Plants had short internodes and reduced foliage.

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2. In lambs molybdenum deficiency observed as renal lithiasis which is known as "Xanthine disease".
3. In adult goats, and kids, Mo deficiency decrease feed consumption and cause a reduction in live-weight gains. Reproductive effects of deficiency include decreased pregnancy rates and higher mortality in offspring.
4. On chicken farms, birds displayed a number of symptoms characterized by the loss of feathers, disorders in the ossification of long bones, and changes in joint cartilage, leading to complete immobility.
5. 'Acquired molybdenum deficiency syndrome' in humans characterized by high blood methionine, low blood uric acid, and low urinary uric acid and sulfate concentrations. The patient suffered mental disturbances that progressed to a coma. People severely deficient in molybdenum have poorly functioning sulfite oxidase and are prone to toxic reactions to sulfites in foods.

Factors Affecting Availability of Molybdenum to Plants

1. ***Soil pH***: Soil pH is one of the most important factors affecting the availability of Mo to plants. The MoO_4^{2-} concentration increases 100-fold for each unit increase in pH. With increasing pH, the amount of soluble MoO_4^{2-} in equilibrium with soil Mo which is much greater than $HMoO_4^-$ and H_2MoO_4. Like PO_4^{2-} and SO_4^{2-}, the MoO_4^{2-} anion is strongly adsorbed by Fe and Al oxides at low pH. As a result, Mo deficiency is normally a problem on acid soils.
2. ***Soil texture***: In sandy and low organic matter soil, MoO_4^{2-}retention is low leads to increase in the probability of Mo deficiency; especially with high Mo requiring crops i.e. crucifers and legumes.
3. ***Organic matter***: The amount of ammonium-oxalate-extractable Mo is correlated significantly with organic matter content. Mo complexed with the organic matter may be unavailable to plants in the short term, but it will be released later for plant use through the mineralization process.
4. ***Drainage***: Soil wetness seems to be one of the main factors affecting the availability of Mo. Wet soils tend to have high organic matter content and large amounts of Mo that may be readily available. Poorly drained soils accumulate so much MoO_4^{2-}that the plants grown on them are toxic to animals.

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5. ***Nutrient interactions***: Uptake of Mo by plants is usually enhanced by soluble P through the formation of a complex phosphomolybdate anion, which is absorbed more readily by the plants and decreased by available S primarily during the absorption process with an antagonistic mechanism involved during translocation from roots to leaves. Copper-molybdenum antagonism is well known, and toxicity arising from excess Mo in herbage is effectively prevented by applying Cu to the soil. Soils high in Fe_2O_3 are frequently deficient in Mo.

Molybdenum Deficiency Can be Corrected as Follows

1. ***Seed treatment***: Seed treatment is a process where the seeds are soaked in the molybdenum solution, which is an effective approach to prevent Mo deficiency. However, the Mo concentration and content of the seed affect the response. The solution of molybdenum salts is applied on seeds at a rate equal to 50 to 100 g Mo ha^{-1}. When the seed contains Mo in the range 0.5 to 0.7 mg Mo kg^{-1} there will be no response for seed treatment.
2. ***Soil application***: Soil application is an approach where Mo is applied to the soil in the form of fertilizer. The application rate can vary from 100 to 500 grams per hectare depending upon the Mo availability in the soil.
3. ***Foliar spray***: Since plants require such low levels of molybdenum and molybdenum is highly phloem-mobile, a suitable and effective procedure is a foliar application with concentration of 0.1% to 0.5% to correct molybdenum deficiency.
4. ***By liming***: Liming help in reclamation of acidic soil through rising pH of the soil thereby increasing the availability of molybdenum.

Molybdenum Toxicity and Interrelationships between Molybdenum-Copper-Sulphur in Animals;

In forage, Mo concentrations vary and depend on the moisture content, the pH of the soil and concentration in soil. Alkaline environments greatly increase the bioavailability of Mo to plants and thus increase Mo toxicity in grazing animals. Molybdenum is not toxic itself, but when combines with sulfur (S) forms thiomolybdate, which can cause physiological copper (Cu) deficiency in ruminants. There is a risk of secondary Cu deficiency or molybdenosis if the Cu: Mo ratio is less than two. This disorder is referred to as “molybdenosis” or “teart” or “peat scours.” occasionally results in death. Severe

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molybdenosis in cattle occurs under natural grazing conditions in many countries. An amount of 20-100 ppm Mo in the herbage on a dry matter basis was related to scouring of cattle and sheep. All cattle are susceptible to molybdenosis, milking cows and young stock suffering the most, with sheep next in susceptibility, whereas horses and pigs are the most tolerant farm livestock. Common symptoms include faded hair coats and profuse diarrhoea with foul-smelling faeces.

Method of Treating Molybdenum Poisoning

If molybdenum poisoning is present, then increasing the intake of copper can prevent molybdenum from binding to the intestine and thus prevent its toxicity in the body. However, copper is a poison so when we are going to feed copper to animals, we have to calculate how much copper has to feed. Too much copper will cause copper poisoning. If the risk of toxicity of Mo does not reduce, the elimination of molybdenum in milk may cause toxicity in nursing calves. Dietary supplementation with copper sulfate will reduce the bioavailability of molybdenum in the gastrointestinal tract, ultimately reducing absorption and increasing excretion. On feeds containing molybdenum more than 5 mg per kg supplementation with 1% copper sulfate in salt will control the development of the syndrome.

Conclusion

Molybdenum is a micronutrient required in minimal amounts by plants. It is mainly absorbed by plants as MoO_4^{2-}. Molybdenum is present in dozens of enzymes. One of these important enzymes is the nitrogenase enzyme, which allows bacteria and plants to synthesize and use proteins by using nitrogen in the atmosphere. Legume forage plant suffers essentially from a shortage of protein due to the failure of the of NO_3^-reduction under Mo deficiency. The human body has about 0.07 mg of molybdenum per kilogram of body weight help in energy production, breaking down certain amino acids, cell protection by activating antioxidants and helps in the removal of waste by metabolizing toxins that can be excreted in the urine. Under molybdenum deficiency, all these metabolic functions will be hindered, so it is very necessary to supply molybdenum externally under deficiency conditions. At the same time, it is also necessary to take care of molybdenum toxicity, as it can cause copper deficiency leads to "molybdenosis "Or" diarrhea "or" peat scores ". All cattle are susceptible to molybdenosis with milking cows and young animals suffer the most, the next sheep in the susceptible while horses and pigs are the most tolerant agricultural livestock. Feed containing molybdenum more than 5 mg per kg, supplemented with 1% copper sulfate in salt, will control the development of the syndrome. Therefore; molybdenum is highly essential for plants, animals and humans, it should be recommended carefully.

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POST EFFECT OF PANDEMIC COVID-19 (NOVEL CORONA VIRUS DISEASE) IN INDIA: AN AGRICULTURAL PERSPECTIVE

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Impact of novel coronavirus (COVID-19) on human health and the economy, globally has been substantial and is likely to intensify. The current ongoing health crisis in the world has affected all the way of life. According to WHO (World Health Organisation) report, COVID- 19 is a new disease, distinct from other diseases caused by coronaviruses, such as Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome(MERS). The outbreak of the virus spreads rapidly through the exponential rate. International Monetary Fund (IMF) managing director Kristalina Georgieva started on 23 March, the outlook for global growth will decrease sharply "negative" in 2020. India had declared a nationwide lockdown for three weeks till mid-April in the initial phase. To combat this imminent spread of COVID-19, the nationwide lockdown has been subsequently extended up to third-May. During these situations, Indian agriculture is facing multifarious challenges. The government has more than sufficient food reserve, Food Corporation of India (FCI) is ensuring uninterrupted supply of rice and wheat throughout the country during the lockdown period.Under National Food Security Act (NFSA), FCI is prepared for meeting not onlyfood requirement at 5 kg/month per beneficiary but also ready to meet any additional demand and supply of 5 kg per person for the upcoming 3 months to serve 81.35 crore population under Pradhan Mantri Garib Kalyan Anna Yojana.

Through this article, we have tried to summarise the ongoing situation from the agricultural perspective through several governmental websites, scientific reports and news. The farming sector is facing several challenges, starting from rabi crops harvesting to the marketing of vegetables, the price crashed of several perishable commodities, from the

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unavailability of labour to farm equipment etc. As the effect of the virus disseminates all around the world, the scope of agricultural export is also negligible. To tackle this situation, the government has taken several mitigation strategies starting from income support scheme Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) to increase the wage rate under the National Rural Employment Guarantee Scheme (MGNREGS) for the agriculture sector. Beside these strategies, the farm sector in India is facing several challenges. Keeping in mind the lockdown, we have tried to find and assembled the major problems faced by the farming sector in India.

Challenges Faced by the Farm Sector

On this pandemic, nationwide lockdown creates multifarious challenges in front of the farming sectors. We have assessed and able to find out the major factors and the consequences of this pandemic on agriculture.

Prices of Perishable Commodities Drop By 20 Per Cent

In West Bengal, most of the farmers are marginal and small farmers; they are in a distress sale. Due to lockdown, they are forcibly selling their farm produce at lower market price and facing economic challenges. As bulk demand from hotels and restaurants has nosedived and there is uncertainty over exports, the prices of agricultural commodities such as perishable vegetables, grapes and sugar have fallen 15-20 per cent. Farmgate price for export of grapes fallen from Rs. 100 per kg to Rs. 70-75 per kg (All India Grape Exporters' Association).

Labour Shortage Hits Harvest of Rabi Crops

Due to this lockdown reverse migration of labour took place. The nationwide lockdown has triggered the labour shortage. Harvesting of rabi crops, especially wheat, will face a severe labour scarcity phenomenon. The major source of labour in wheat-growing states of Haryana, Punjab and Uttar Pradesh is from eastern India. Most of the labour has returned to their home after lockdown before 24 March due to fear from COVID-19 and has to face wage disruptions. Lasalgaon is one of the biggest onion markets in Maharashtra. Marketing practices like loading, unloading grading of onions are mostly operating through the migrant workers. Lockdown results in the shortage of migrant labours, which creates challenging situations in front of the farmers and traders.

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Demand for Dairy Products Drops Sharply

Hotels, cafes, restaurants are the bulk consumers of dairy products. Due to lockdown, these are shuttered down, and also there is a ban on inter-state trade. Therefore, demand, as well as sales of dairy products, drastically reduced. Amul, the largest player of the dairy industry, has witnessed 25 per cent dip in sales, while the second-largest milk co-operative, the Karnataka Milk Federation (KMF) faced 30 per cent fall in sales. There is a demand for dairy products in metros and other regions, but manufacturers are not able to transport due to restrictions.

Lockdown Results In Wilting of Flower Trade in the Country

Flowers like jasmine, marigold, rose, lily possesses high demand during this time. But as there is no wedding and also ban on prayers in temples, flower demand has drastically reduced in this lockdown. Farmers are simply destroying the flower, which brings negative impact in the flower industry. In this peak season of harvesting of marigold in Jammu & Kashmir farmers are simply throwing the flowers in canals instead of selling it into Jammu markets.

Lockdown Disrupts Supply Chain

The main aim of nationwide lockdown in India is to stop the spread of coronavirus, which is preventing the movement of perishables to reach from production to consumption sites. This results in pushing up the prices, and farmers are forced to feed their produce to the animals. Many wholesale markets are empty of produce. Unavailability of drivers and transport facilitates the blockage in the supply chain. Millions of urban and rural poor are especially affected after the breakdown of the supply chain in India. $APMC_s$(Agricultural Produce Market Committees) are the bulk suppliers of fruits, vegetables, flowers and grains in each district. To prevent the overcrowding and facilitate the implementation of lockdown, most of the $APMC_s$ are closed.

Lockdown Hits Poultry Farmers Hard

Lockdown hits the poultry industry tremendously. First, the spread of rumours about linking chicken consumption with coronavirus pandemic in social media. After those misconceptions allayed due to awareness campaign and circular from the Department of Animal Husbandry & Dairying, the poultry farmers are facing the lockdown situation.

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Therefore, the poultry industry has faced a double whammy problem. The result of this rumour and lockdown is decreasing in chicken demand and eggs by 30-40 per cent.

Agricultural Equipment Market in Slow Lane

The primary aim of this lockdown is to stop the spread of the coronavirus. But lockdown has a negative effect on the demand for agricultural equipment and tractors. Labour scarcity has prompted the mechanisation activity. In India, around 95 per cent tractors are purchased on credit basis. Though agricultural machinery and spare parts are exempted from the effect of lockdown, tractor selling remains locked out.

Government Initiatives to Mitigate the Pandemic Situation

Immediately after the nationwide lockdown, Indian Finance Minister has announced Rs 1.7 lakh crore as a relief package for the vulnerable sections including farmers of the society. Apart from direct cash transfers for the next three months, 800 million population will get free cooking gas and cereals. Through PM-KISAN scheme Rs. 2000 will be transferred to each beneficiary accounts as income support scheme. Pradhan Mantri Garib Kalyan Yojana has been announced as a welfare scheme for the vulnerable population of the nation.

For ensuring that the farmers do not suffer from any adverse fall out during lockdown, Department of Agriculture Cooperation and Farmers Welfare is taking all possible measures to accelerate the harvesting of rabi crop and also sowing of the summer crop. The video conference was conducted with all states and insurance companies to review the payment of claims, understanding the status of Crop Cutting Experiments (CCEs), implementation of smart sampling technique and crop loss survey. For facilitating farm insurance, the letter has already issued to all the states to issue passes to a representative of respective insurance companies for co-witnessing CCEs. Necessary coordination established with cultivators, aggregators, mandi associations, wholesalers for smoothening the transport and to sort out all challenges. In the lockdown period, Kisan Call Centres (KCCs)are being operated at all 21 locations. All the KCC (454) seats are continuously operated on a daily basis from 6 AM to 10 PM.

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Conclusion

The lockdown is driving some long-awaited positive changes in agriculture. Lockdown brings direct contact between farmers and big buyers in metro cities and forcing a change in cropping practices that will help rejuvenate the soil and conserve water. Direct selling has been strengthening due to uncertainty in mandis. Farmers are able to bring their produce in different cities by the help of central and state interference, which drastically reduce the middlemen and their profit share in the entire supply chain. Lastly, the impact of COVID-19 would have a long term effect, which can be known after precise assessments. For a better healthy environment, in this pandemic situation, policymakers have the opportunity to repurpose the existing agricultural policies.

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