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Cover Article

NEMATODES AS BIOINDICATORS OF SOIL ECOSYSTEM HEALTH

By Phani et al.

Vol. 2, Issue 12

Raichur, Karnataka

Chief Editor
Dr. K. K. Shivakumar

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Article ID: 21/12/100424

PROSPECTS OF EDIBLE COATING IN FRUIT CROPS

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INTRODUCTION

Due to rapid deterioration during pre-and post-harvest conditions, postharvest loss of fresh produce is a serious problem. It adversely affects the quality of fruits. Chemical fungicides provide primary means for post-harvest decay control in the case of fruit crops. However, these chemicals have a harmful impact on human health and the environment and are high in costs, and leave residual effects**.** Over the years, many strategies have been developed to increase the storage life of fruits. One such approach is the use of low-cost, environmentally friendly coatings. Here we prefer alternatives to chemical fungicides for preserving the quality and prolonging the shelf life of fresh fruits, particularly in those areas where refrigeration facilities for storage of bulk material for a longer duration are unavailable. The edible coating is one-of-a-kind and maintains the freshness and extends the shelf life of fresh fruits. Because they are made of food-grade materials, therefore can be consumed both as part of a product and on their own without fear of contamination **(Tavassoli-Kafrani *et al*., 2016)**.

I) Types of edible coating:

COMPONENT-BASED			
Polysaccharide-based	**Protein-based**	**Lipid-based**	**Mixture with herbal extract**
i. Starch-based	i. Soy protein	i. Bee wax	i. Neem Oil & Extract
ii. Cellulose and its derivatives	ii. Casein	ii. Mineral oil	ii. Thyme oil & Extract
iii. Chitosan-based	iii. Whey Protein	iii. Vegetable oil	iii. Citrus essential oil
iv. Alginate based	iv. Zein protein	iv. Surfactants	iv. Cinnamon extract
v. Pectin based	v. Egg albumen	v. Acetylated monoglycerides	v. Oregano extract
vi. Gum based	vi. Collagen	vi. Carnauba wax	vi. Aloe vera
vii. Carrageenan		vii. Paraffin wax	

The edible coating covers the fruit's epicarp, seals the stomata and lenticels, thereby preventing moisture loss and gaseous exchange between the fruit and its external environment. This increases the shelf-life of the fruit by delaying ripening and physico-chemical changes, and preventing the development of physiological disorders. Proteins, polysaccharides, and lipids are used exclusively in the production of these films, which are generally 0.25 to 0.3 mm in thickness and are made up of food-grade components. Generally speaking, edible coatings can be divided into the following categories, which are discussed below:

1. POLYSACCHARIDE-BASED COATINGS

Several different polysaccharides have been evaluated or used as an edible coating. It includes starch and starch derivatives, cellulose derivatives (including alginates), carrageenan (including carrageenan glucosides), various plant and microbial gums, chitosan, and pectinates.

1.1 STARCH-BASED COATINGS

It is the most common polysaccharide and can be found in cereal grains such as wheat, maize, rice, and other grains like oats. Potatoes and other tubers, as well as legumes, are excellent sources of starch. They are colorless and have an oil-free appearance, and they can be used to extend the shelf life of fruits.

1.2 CELLULOSE AND ITS DERIVATIVES

Edible coatings consisting of cellulose and its derivatives, such as carboxymethyl cellulose, methylcellulose, and hydroxypropyl cellulose, have been employed in fruit crops to establish moisture, oxygen, and oil barriers, and these coatings have been shown to be effective **(Vargas *et al*., 2006)**. Using carboxymethyl cellulose (CMC) bilayer coatings on grapefruit, mandarins, and oranges post-harvest life was found to be improved. It also maintains the fruit quality by decreasing gas permeability, weight loss, and oxidation in the fruit **(Arnon *et al*., 2014)**.

1.3 CHITOSAN-BASED

It is a naturally occurring carbohydrate polymer that has been formed by the deacetylation of chitin (a major component of the shells of crustacea such as crab, shrimp, and crawfish). Its antimicrobial action against a wide spectrum of food-borne filamentous fungus, yeast, and bacteria has made it a possible food preservative to inhibit the growth of these pathogens **(Hafdani and Sadeghinia, 2011)**.

1.4 ALGINATE BASED

It is extracted from brown seaweed, which is a member of the phaeophyceae family. It is made up of alginate salts, which are derived from alginic acid. It is found in the form of a white, yellow, fibrous powder. This brown algae-derived sodium alginate is the most commonly encountered form of alginate in food preparation and cosmetics.

1.5 PECTIN BASED

Pectin is a polysaccharide of plant origin. It is beneficial for low-moisture fruits and vegetables, but it is not an effective moisture barrier in other situations. It is most typically found in the peel of citrus fruits and the pomace of apples.

1.6 GUM BASED

The majority of gums are polysaccharides, which means they are composed primarily of sugars. Gums are utilized in the manufacture of edible coatings for fruits and vegetables because of their ability to impart texture to the coating. Gums are easily dissolved in water. They can be classified into three categories a) exudate gums (e.g., Arabic gum), b) extractive gums (e.g., guar gum), and c) microbial fermentation gums (e.g., xanthan gum).

1.7 CARRAGEENAN

Carrageenan is a water-soluble polymer that contains a linear chain of partly sulphated galactans, which can create coatings or film materials when exposed to heat and light. It is isolated from the cell walls of several red seaweeds belonging to the family rhodophyceae.

2. PROTEIN-BASED EDIBLE COATING

Protein-based edible coatings are obtained from animals and plants source. Milk protein (casein), whey protein, zein (maize), gluten (wheat), soy protein, and other plant-based proteins are used as edible coating materials, whereas animal-based proteins include egg albumen, collagen, and other proteins.

3. LIPID-BASED EDIBLE COATING

Edible coatings based on lipids have been used for many years to keep fruits and vegetables fresher longer. These ingredients give meals a glossy appearance and have a high-water barrier capability. Carnauba wax, beeswax, paraffin wax, mineral or vegetable oil, and other lipid-based coating compounds are the most commonly used.

4. HERBAL EXTRACT

The use of herbal extracts in edible coatings for fresh produce is becoming more popular as they have a variety of health benefits. Neem, aloe vera, oregano, cinnamon, clove, mint, and peppermint are just a few examples of the herbs that are being employed. They prevent water loss, regulate the rate of respiration and the ripening process in fruits, inhibit microbial growth, and delay oxidative browning. Because of their non-toxic and environmentally friendly character, herbal edible coatings hold great promise as a food-coating alternative **(Raghav *et al*., 2016)**.

II) HOW TO APPLY

Application of edible coatings on fruits can be done in a variety of ways. Dipping, dripping, foaming, fluidized bed coating, panning, spraying, and electrostatic coating are some of the methods available. The dipping method is extensively used for applying edible coatings to fruits and vegetables. Fruits and vegetables are dipped in a coating solution for 5-30 seconds before being removed from the solution. The use of high-pressure spray applicators and air atomizing systems to coat whole fruits has been the most preferred approach for coating whole fruits in recent years.

CONCLUSION

To maintain the freshness of fruit for a longer duration, edible coatings have been used in the fruit industry from many years. It is a method that is both safe and environmentally friendly. But this technique has to be employed in all sectors of horticulture so that marginal farmers can also take advantage of it and could get better returns of their produce even after a long period of storage.

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Article ID: 21/12/100425

IMPORTANCE OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE

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INTRODUCTION

The importance of technology in improving productivity in agriculture is gaining importance. The easiness in handling and carrying out various functions in smart agriculture will help the farmers to increase productivity from the same piece of land. It has been stated that world population would increase by 2 billion approximately in near future *i.e* 2050 and the extra land which will be available for agriculture will only remain at 4% (United Nations FAO). In order to satisfy the need of these populations, smart agriculture has already penetrated in global agricultural system. By definition, Smart Agriculture is a revolution in the industry of agriculture which will help in modifying and reorienting agricultural systems to support the development effectively ensuring the food security in this changing climate. Application of Artificial Intelligence (AI) or Machine Intelligence in agriculture will make a drastic effect on farming sector (Khandelwal and Chavhan, 2019). Silently, AI is making an entry in Indian Agriculture and greatly influencing the society (Bhar *et al.* 2019). The use of Information and Communication Technology (ICT) in modern Smart Agriculture will be helpful in achieving pivotal role in developing different solutions for various problems faced in agricultural practices.

ARTIFICIAL INTELLIGENCE (AI):

AI is apart of computer science which focuses on the manufacturing of tangible and intangible systems resulting in intelligence and behavior to level of human beings thinking using only the logical reasoning. From the word artificial intelligence, artificial is correlating to non-biological and the intelligence is correlating to ability to accomplish a complex task. AI is the cognitive process one can associate with human thinking like speech recognition, natural language understanding and translation, knowledge management, image analysis, decision making, learning etc. which will make systems powerful and useful

THERE ARE THREE TYPES OF AI:

1. **ARTIFICIAL NARROW INTELLIGENCE (ANI)**
   ANI is all over the place, like Google maps, it's awesome at finding efficient routes to places while riding a car, or can be likened to a chess playing program.
2. **ARTIFICIAL GENERAL INTELLIGENCE (AGI)**
   AGI is like a computer that is as smart as a human in all aspects. So, anything we can do with our brain, it can do, including learning.
3. **ARTIFICIAL SUPER INTELLIGENCE (ASI)**
   AI is getting powerful day by day what with applications leading to machines and systems leading to more advanced AI *i.e.* ASI. ASI is when a computer or a system is better than a human being – wiser, more creative, more socially adept, and this ranges from being a little bit better to being smarter than the sum of all humanity combined

IMPORTANCE OF AI IN AGRICULTURE

Adaptation of AI in agriculture has been observed in various farming techniques. The cognitive computing concept is the reason which imitates human thought process in computer model (Dharmaraj and Vijayanand, 2018). This will help in developing turbulent technology in Smart agriculture where AI technology has been used and it will help in interpreting the data and reacting in different situations. Chatterbot can also be an important source of information which will help the farmers and act as conversational partner in farming.

SCENARIO IN INDIA

AI has started entering in Indian Agriculture. At present in India, 175 farmers of Andhra Pradesh have been rendered services by Microsoft Corporation for solutions in land preparation, sowing and nutrient management for plants. A round off of 30% increase has been observed in yield of plants compared to the harvest done before. AI can also be used in modelling the optimum sowing period in different seasons from daily rainfall data and moisture condition of soil. This will help in preparing a forecast chart for optimum time of sowing after carrying out statistical climate data and real time Moisture Adequacy Data (MAI).

AI IN SMART AGRICULTURE

AI have been proved to benefitting agriculture in various forms thus improving the productivity of plants (Khandelwal and Chavhan, 2019).

1. THE INTERNET OF THINGS (IOT) DRIVEN DEVELOPMENT

Many data are generated regarding soil condition, weather reports, rainfall data, susceptibility to pest attack in structure and non-structured format and it is a massive volume of data. IoT would relate this information with perception of sense and recognize solutions to give enhancement in crop productivity. Proximity and remote sensing are two primary technology which is used as a fusion in IoT.

2. IMAGE-BASED INSIGHT GENERATION

Capturing image can save time for visiting the field. So, imaging field with drones can assist in proper field analysis. It can help in monitoring the crop generally for any effect in time.

Imaging through drones can assist in rigorous field analysis, in monitoring crops and scanning of fields. Combining the efforts of computer-based technology, drone data and IoT will assure the rapid action taken by farmers.

3. Crop health monitoring

Nowadays, remote sensing with hyperspectral imaging helps in constructing crop metrics of large area of crop under cultivation. This will monitor the health of crops periodically using imaging and remote sensing without directly being in contact with the crop field. It will increase the efficiency of farmers in terms of both time and effort.

4. Disease detection

The ability of artificial intelligence in sensing analyzing the images of plants will help in detecting the background of the diseased or non-diseased part of the leaf. The infected part diagnosed through imaging can be sent to laboratory for further analysis.

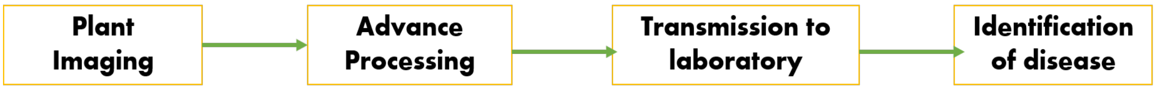

Fig.1: Steps of identifying disease using Artificial Intelligence

5. IDENTIFY THE READINESS OF THE CROP FOR HARVESTING

Images taken in white light and UV light can be used to see if the fruits are ripped or not. By knowing the different stages of ripened fruits, farmers can plan the harvesting and marketing of them.

6. FIELD MANAGEMENT

Inspecting the field through drones and copter systems will help in better employing the field with the images taken. A field map can be prepared and new areas can be identified where water deficiency or water logging is there. The deficiency and toxicity of nutrients may also be captured in image and this information can be used in proper field management. Therefore, the resource optimization is at maximum.

7. AUTOMATION TECHNIQUES IN IRRIGATION AND ENABLING FARMERS

Irrigation requires lots of investment both in terms of financial and labour. AI system can be digitized in such a way it can detect the soil and plants condition in terms of water deficiency by analyzing the historical weather pattern, therefore, with this information and technology irrigation can be automated which will increase the efficiency of cost of cultivation. In the world, around 70% is used up for irrigation but it is automated only when needed, it will conserve water also beneficiating farmers in managing water scarcity problem. Many of the parts in India, water scarcity is major problem, therefore resource optimization will be an important step in current scenario of Agriculture.

8. YIELD MANAGEMENT USING AI

Futuristics technologies like Artificial Intelligence (AI), satellite imaging, cloud machine learning etc. has enabled the smart agriculture with proper planning and management of the field, thus increasing the efficiency of farming. These technologies together build up better yield management practices thus befitting the farmers ensuring more profit.

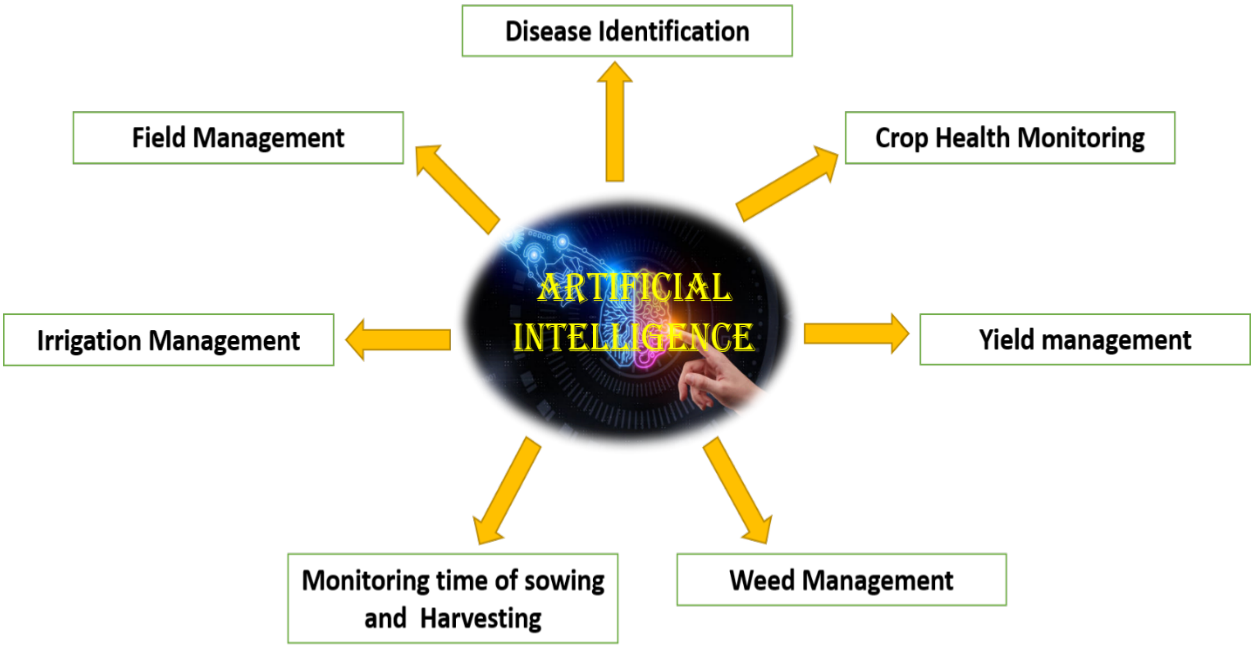

Fig. 2: Benefits of Artificial Intelligence (AI) in Agriculture

CHALLENGES IN AI ADOPTION IN AGRICULTURE

- AI systems require a lot of information/data to train machines so as to take precise forecasting or predictions.
- Collecting spatial data is easy while getting temporal data of the field is challenging.
- Collection of data of a specific crop can be obtained only when the crop is grown in the field. Acquiring information of different crops is time consuming and learning the process of AI machine model is also challenging.
- Another important challenge is that, the cost is expensive in opting AI for farming as compared to the readily available solutions in the market.
- The need of disseminating the information about AI and its adaption in farming is also a major challenge. It should become more viable so as to reach the farming community.

CONCLUSION

Artificial Intelligence improves the accuracy and efficiency of all the management practices accounted in Smart Agriculture. It has many befitting functions like crop monitoring, disease and pest detection, irrigation scheduling and automation etc. The present scenario of agriculture needs technology like AI, remote sensing, cloud machine learning etc. By overcoming the challenges, AI has great future in Agriculture. Overall, adoption of AI in Indian agriculture is an important step in improving the efficiency and productivity of crops in future.

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*Samiran Patra**
Dr. Uttam Roy

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A SUCCESS STORY ON VIETNAM KOI (*A. COBOJIUS*) CULTURE IN SEASONAL FISH POND IN MURSHIDABAD DISTRICT

Murshidabad Krishi Vigyan Kendra Digha-Milebasa, kalukhali, Bhagwangola-I Murshidabad-742135

Theme: Introduction of new breed
Name of Farmers: Mr. Subal Sur
Location of Field: Ayeshbagh, Roshanbag, Murshidabad
Contact No.: 08536045826
Implementing Centre: Krishi Vigyan Kendra, Murshidabad
Digha, Milebasa, Bhagwangola-I
Murshidabad-742135

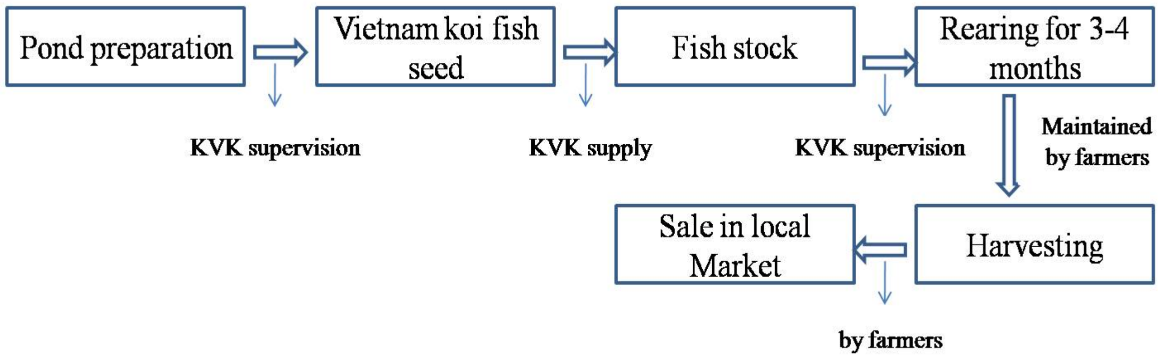
BACKGROUND:

Air-breathing fish culture is a age-old practices. But at present commercially culture this high value fishes in different area of West Bengal. Mr. Subal Sur is a rural youth of Ayeshbagh, district Murshidabad and he presently he culture this air-breathing fishes in his own pond. Before starting culture, he is not under this fisheries profession. He came in contact of Krishi Vigyan Kendra, Murshidabad in the year 2016-17. KVK, scientist Mr. S. Patra provides training and technical guidance to Mr. Subal Sur. Now he culture Vietnam koi, a new variety of exotic koi native to Vietnam in his 0.04 ha (7 katha) area.

KVK INTERVENTION:

KVK fishery expert provide training and technical support to Mr. Sur for culturing successfully. This is the short duration culture practices for 3-4 months only. This species have high vale and high growth rate and also FCR is 1.8. It is suitable for low water depth area and suitable for high seepage water area. Small area require for culturing this species. This species is also suitable for jute retting pond. So farmers can use as an alternative fish species like IMC.

PRODUCTION CYCLE



OUTCOME:

This is the short duration culture system maintained for 3-4 months by farmers and sale it @ 100-150 g average fish body weight in local market. They used 26% protein fish feed for the whole culture period.

FEED REQUIREMENT FOR 1000 NOS. OF VIETNAM KOI:

Feed	Quantity/day	Duration (Day)
Floating fish feed (26%)	600g	First 15 days
	800g	Next 15 days
	1000g	Next 15 days
	1200g	Next 15 days
	1400g	Next 15 days
	1800g	Next 15 days

PRODUCTION COST OF VIETNAM KOI CULTURE (5500 PCS. FRY):

Categories	**Rate (Rs.)**	**Amount (Rs.)**
Pond preparation		6000.0
Seed	2.0 / pc	11000.0
Feed	42/ kg	18849.0
Lime	6 /kg	720.0
Labour		1000.0
Medicine		500.0
Misc.		1500.0
	Total	39569.0

Total fish production (survival rate 80%) = 440kg
Gross income @ Rs. 250/ kg = (440x 250) = 110000.00
Net profit = (110000.0-39069.0) = 70431.0

IMPACT

Farmers can earn Rs. 23477.0 per month after 90 days of rearing of 5500 nos. of Vietnam koi in 0.04 ha (7 katha) pond area. Now more farmers are interested to follow Mr. Sur for culturing this species in this area

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NANOTECHNOLOGY IN PLANT DISEASE MANAGEMENT

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ABSTRACT

Nanotechnology is the one of the most fascinating and rapidly advancing sciences and possesses potential to revolutionize many areas of sciences, technology, medicine and agriculture .The application of nanotechnology in agriculture includes fertilizers to increase plant growth, yield and pesticides for pests and disease management. Their small size, large surface area, and high reactivity have enabled their use as bactericides/ fungicides and nano-fertilizers.Nano- Phytopathology can be applied as a tool to understand plant pathogen interactions, which will provide new methods for crop protection. Nanoparticles may act upon pathogens in a way similar to chemical pesticides or the nano-materials can be used as a carrier of active ingredients of pesticides, host defense inducing chemicals etc. to target pathogens. Also, Nanoparticles can be designed as biosensors for plant disease diagnostics and as delivery vehicles for genetic material, probes, and agrochemicals. As global demand for food production escalates against a changing climate, nanotechnology could sustainably mitigate many challenges in disease management by reducing chemical inputs and promoting rapid detection of pathogens. But before the commercial use of NP's in agriculture there are certain demerits, risk and apprehensions in the use of NP's which are required to be worked out on priority.

INTRODUCTION

Nanotechnology is the art of science of manipulating matter at the nanoscale According to British Standard Institution (2006), Nanotechnology is the design, characterization, production and application of structures, devices and systems by controlling shape and size at the nanoscale .The word 'nano' is used to indicate one billionth of a metre or 10-9. The word Nano is derived from Greek word "nanos" means Dwarf / small.The term nanotechnology (NT) was coined by Professor Norio Taniguchi of Tokyo Science University in 1974 to illustrate precision manufacturing of materials at the nanometre level. One nanometre (nm) is one millionth of a millimetre (mm). Nanomaterials also play an important role in promoting sustainable agriculture and provide better foods globally

(Grulre et al. 2012Nanotechnology can be used for combating the plant diseases either by controlled delivery of functional molecules or as diagnostic tool for disease detection.

In December of 1959, Richard Feyman (Father of nanotechnology) gave a talk called "**There's Plenty of Room at the Bottom"** at an annual meeting of the American Physical Society at Caltech. To put the nanoscale into context, a strand of DNA is 2.5 nm wide, a protein molecule is 5nm, a red blood cell 7000 nm and a human hair is 80,000 nm wide.

PROPERTIES OF NANOMATERIALS:

When a material is reduced to nano size, is acts differently and express some new properties completely lacking in macro scale form.

• Nanoparticles are usually small in size with the range of (1-100 nm)

• Nanoparticles have large surface to volume ratio, chemically alterable physical properties, and possess strong affinity to targets such as proteins

• Nanoparticles can melt at lower temperatures and are frequently more reactive than their larger bulked equivalents.

• They are more reactivethan their larger bulked particles

• As a result of nanoparticles' small size and large surface-area-to-volume ratio, they can be reactive and bind, absorb, and carry compounds such as small-molecule drugs, DNA, RNA, proteins, and probes with high efficiency.

TYPES OF NANOPARTICLES USED IN PLANT PATHOLOGY

At present, nanoparticles of metalloids, metallic oxides, nonmetals (single and composites), carbon nanomaterials (single- and multiwalled carbon nanotubes, graphene oxides, and fullerenes), and functionalized forms of dendrimers, liposomes, and quantum dots have begun to infiltrate plant pathology.

Type	Definition	Use in plant pathology
Metalloids, metallic oxides,non metals and their compositions	Engineered materials at nanoscale in cubes, spheres, bars and sheets	• Bactericides/ fungicides • Nanofertilizers • Delivery vehicle for antimicrobials and genetic material
Carbon nano materials	Allotropes of carbon designed at the nanoscale	Multiple uses
Single walled or multi-walled nanotubes	Graphene sheets rolled into single or multiple tubes	• Antimicrobial agent • Delivery vehicle for antimicrobials and genetic material
Fullerenes (buckyballs)	60 carbon atom in a specific soccer-ball arrangement	• Antimicrobial agents • Delivery vehicle for antimicrobials and genetic material
Quantum dots	Inorganic fluorescent , crystalline semiconductor nano particles used in biosensors	Diagnostics, research tool

Graphene oxide sheet (reduced or oxide forms)	Graphene oxide sheet	• Antimicrobial agents • Delivery vehicle for antimicrobials and genetic material
Liposomes	A lipid enclosing a water core	Delivery vehicle for antimicrobials and genetic material
Dendrimers	Nanomaterial with tree-like appendages that radiate from a central core	Delivery vehicle for genetic or antimicrobial products

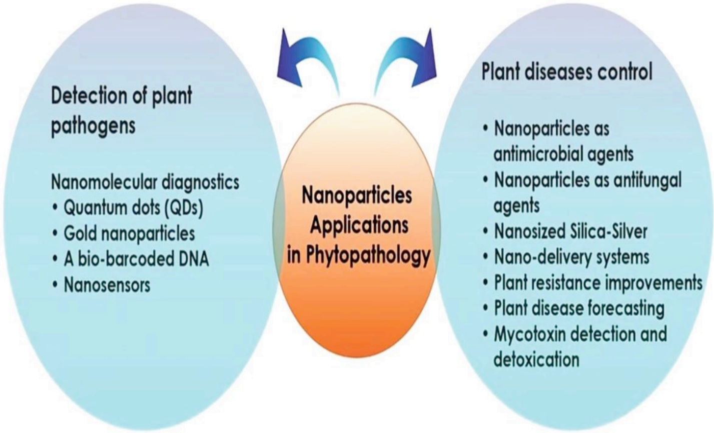
STEPS FOR PRODUCING NANOPARTICLES FROM MICROORGANISM AND PLANTS

Microorganisms are able to synthesize nanoparticles extracellularly or intracellularly. In extracellular synthesis, after culturing the microorganisms for 1–2 days in a rotating shaker under optimum conditions (including pH, temperature, medium components, etc.), the culture is centrifuged to remove the biomass. The obtained supernatant is used to synthesize nanoparticles by adding a filter –sterilized metal salt solution and is incubated again. NP can be monitored by observing a change in the color of the culture medium; for instance, for silver nanoparticles, the color changes to deep brown, whereas, for gold nanoparticles, it changes from ruby red to a deep purple color. After incubation, the reaction mixture can be centrifuged at different speeds to remove any medium components or large particles. Finally, the nanoparticles can be centrifuged at high speed or with a density gradient, washed thoroughly in water/solvent (ethanol/methanol) and collected in the form of a bottom pellet.

For the synthesis of nanoparticles by plant extracts, the plant parts (root, leaf, bark, etc.) are washed thoroughly with distilled water and then cut into small pieces and boiled to perform the extraction. Next, the extract can be purified by filtration and centrifugation. Different ratios of plant extract, metal salt solution, and water (depending on the plant species and parts) are used for nanoparticle synthesis. This reaction mixture is incubated further to reduce the metal salt and monitored for a change in color. After synthesis, the nanoparticles are collected by similar methodologies as in microorganism-mediated synthesis.

APPLICATION OF NANOTECHNOLOGY IN PLANT PATHOLOGY

Plant pathologists are working to find a solution for protecting food and agriculture products from bacteria, fungal and viral agents. A number of nanotechnologies can improve existing crop control protocols in short to medium term. Nanotechnology farm applications are also commanding attention. Nanomaterial are being developed that offer the opportunity to administer pesticides, herbicides and fertilizers more efficiently and safely by controlling precisely when and where they are released. Previous studies confirmed that metal NPs are effective against plant pathogens, insects and pests. For example, an eco-friendly fungicide is under development that uses nanomaterial to liberate its pathogen-killing properties only when it is inside the targeted pathogen



MAJOR NANOPARTICLES USED IN PLANT DISEASE MANAGEMENT

The potential applications of nanomaterials in crop protection, helps in the development of efficient and potential approaches for the management of plant pathogens. Various nanoparticles employed in plant disease management are

Biopolymer nanoparticles: Eg: Chitosan

Metallic nanoparticles : Silver, silica, copper, zinc

Nanocomposites : Chitosan silver NP's

Development of nanoformulation for field application of agrochemicals requires the use of readily biodegradable, nontoxic, environment friendly, safe and low-cost materials. So, use of biopolymers produced by natural sources with good physical and chemical properties is a fascinating approach to prevent the use of petrochemical and toxic chemical substances in production of nanomaterial.

SOME OF THE NANOPARTICLES SYNTHESIZED FROM BACTERIA, PLANTS AND PLANT EXTRACTS

Biological organism	**Nanoparticle**
BACTERIA	
Bacillus subtilis	Ag & Au
Pseudomonas aeruginosa	Au
E. coli	Cds (Cadmium sulphide)
PLANTS	
Azadiractaindica(leaves)	Ag , Au
Citrus medica(fruit)	Cu
Aloe vera	Au
Banana (peel)	Cds
Avena sativa	Au

CONCLUSION

Nanotechnology has rightfully begun to make serious inroads into plant disease management. Nano technology has potential prospects of use and application in the detection, diagnosis and management of plant diseases. Nanotechnology stands as a new weapon in our arsenal against these mounting challenges in disease management and plant health. This technology could reduce agrochemical inputs and increase yield and profits. Growers and scouts could perform diagnostics in situ once portable devices with biosensors are developed. Despite the tremendous scope of nanotechnology in PDM there are certain demerits, risk and apprehensions in the use of NP's in agriculture like phytotoxicty, enhanced transport, longer persistence and higher reactivity which are required to be worked out on priority.

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PHYTIC ACID: A MAJOR ANTI-NUTRITIONAL FACTOR IN CEREALS AND GRAIN LEGUMES

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INTRODUCTION

Myo-inositol 1,2,3,4,5,6 hexa *kis* phosphate also known as phytic acid (PA), is a cyclic alcohol derived from glucose (Loewus and Murthy, 2000). Developing seeds of legumes like soybean tend to accumulate higher phosphorus, which is more than required to carry out the normal cellular activities. This phosphorus is stored in the form phytic acid which is deposited as salts in the vacuole and hence PA is the phosphorus store house in many cereals and pulses. Owing to the negative charge imparted by the phosphate residues, PA is a competent chelator of important micronutrients and forms stable salts on binding to divalent metal ions like Zn, Fe, Ca and Mg in the cytosol (Raboy, 2001). Due to its ability to form established complexes with proteins and metal ions, PA is a major antinutrient. PA, when consumed by humans and other non-ruminants through diet, strongly chelates the divalent metal ions and reduces their bioavailability. Moreover, lack of phytase in the alimentary canal of humans and non-ruminants, aggravates the unavailability of the essential micronutrients, ultimately resulting in nutritional deficiencies and impaired growth. Cereals, pulses, oilseeds and nuts which are indispensable components of human diet, are major sources of dietary phytic acid. They also contribute to around 60 per cent of the total calorie intake. Hidden hunger is a worldwide hitch where nearly 33 per cent of the global population is challenged with micronutrient deficiency with Fe and Zn being the most severe (WHO 2002). In developing nations, the average intake of PA is higher than the developed countries since vegetarian diet predominates in the developing countries (Kwun and Kwon, 2000; Amirabdollahian and Ash, 2010). Understanding the genetics and physiological foundations of PA biosynthesis, distribution of PA in different tissues, also ways to enhance the bioavailability of mineral by reducing the PA content is essential to develop a stable low PA mutant or transgenic lines.

PHYTIC ACID IN MAJOR LEGUMES AND CEREALS

The amount and allocation of PA in seeds differs from species to species. In cereals like rice and wheat PA accumulation is mostly restricted to bran layer, which can be removed during milling, whereas in maize, maximum amount of PA is found in the endosperm tissue and scutellum (O'Dell et al., 1972). However, in legumes like *Phaseolus* and soybean, 80 per cent of PA is reported to be found in the seed and a linear correlation is observed in the amount of PA as the seed progresses towards maturity (Fileppi et al., 2010; Pandey et al., 2016). Seed development in soybean is known to initiate at the R3 stage, when the plant has around 11-17 nodes (Ritchie et al., 1997) and rapid development of seeds takes place between R3 and R7, during which accumulation of Carbon, Nitrogen and storage proteins takes place (Bewley et al., 2009; Hills 2004). Nutrients uptake and accumulation of dry weight completes on reaching the R7 stage. As the embryo gets ready desiccation, the developmental processes come to a halt and seeds reach maturity on reaching the R8 stage (Bewley et al., 2009). A study conducted on pattern of PA accumulation in soybean cultivars during developmental stages showed a significant correlation of content of PA in genotypes harvested at R6, R7 and R8 (Mebrahtu et al., 1997) The PA present in the cotyledons is generally bound to protein bodies as protein/phytic acid conjugates, while 10-15 per cent of the PA is reported to be present in the globoid inclusion in the insoluble form (Prattley et al., 1982). The amount of PA was found to vary among the soybean genotypes from 1.0 per cent to 1.47 per cent on dry weight basis (Loals et al., 1976), while 2.2 per cent PA was observed in soybean (Harland and Prosky, 1979). A maximum of 10 per cent PA accumulation was found in soy concentrates (Lehrfeld, 1994). However, the PA content of Indian soybean genotypes varied from 2.8 - 4.6 per cent (Kumar et al., 2005). Apart from seeds, PA is also present in various soy products like soy isolates (1.27%), soy concentrate (1.38%) and soy flour (1.47%) (de Boland et al., 1975).

APPROACHES FOR REDUCING SEED PHYTIC ACID CONTENT- TRADITIONAL TO ADVANCED

The industrial and ecological issues caused due to PA have attracted significant interest for lowering the phytic acid levels in pulses and cereal crops. Several methods were developed in the past for enhancing the nutritional aspects of legumes and cereal crops and to alleviate the hitch of malnutrition prevalent in developing nations.

SOAKING AND MILLING

Milling is an acceptable method for lowering PA levels in cereals like rice, where phytic acid is accumulated in the bran layer. Traditionally, soaking was the commonly used strategy for lowering PA and enhancing bioavailability of minerals in beans and cereals (Perlas and Gibson, 2002). Soaking mimics the course of germination, during which the hydrolytic enzymes like phytase get activated, resulting in removal of major amount of PA. Soaking chickpea for a period of 2 to 12 hrs resulted in 47.4 to 55.71 per cent decrease in PA (Ertas and Turker, 2012). In a previous study conducted in our lab, soaking resulted in reduction of 10-13 per cent of PA in two popular soybean varieties (Kumari et al., 2015).

GERMINATION

40 per cent reduction in PA amount was observed in wheat at the time of of germination (Masud et al., 2007). Legumes and cereal grains during the course of germination show a striking increase in the phytase enzyme activity resulting in PA degradation. Malting for 72 hours was found to lower PA by 23.9 per cent in millets like sorghum and *Eleusine* (Makokha et al., 2002). However, no significant reduction in the PA content was observed in *Eleusine* during malting (Udeh et al., 2018). Pearl millet cultivars germinated for 96 hours resulted in extractability of Iron, Zinc and Calcium by 15–45, 12–25 and 2–16 per cent respectively (Badau et al., 2005). A strategy of germination following soaking for 72 hrs resulted in 46-65 per cent reduction in PA along with a simultaneous rise in the extractability of Fe, Zn and Ca by 25-36 per cent (Masud et al., 2007).

FORWARD AND REVERSE GENETICS

Approaches towards mitigating the nutritional and environmental issues as a result of PA can either include the forward or reverse genetics tools (Raboy 2009). Low phytic acid (*lpa*) mutants have been successfully generated by mutation breeding in *Zea mays* (Shi et al., 2003; Shukla et al., 2004), *Oryza sativa* (Liu et al., 2007), and *Arabidopsis thaliana* (Kim and Tai 2011). γ-irradiation has also been used to generate two *lpa* mutant lines in *Oryza sativa* (Liu et al., 2007), in which PA content was observed to be 34% and 64% less than the parents. In soybean, two *lpa* mutations were isolated and characterized- *Gm-lpa*-TW-1 and *Gm-lpa*-ZC-2 which of 66.6% and 46.3% respectively (Yuan et al., 2007). Additionally, two more soybean *lpa* mutants having mutation in *MIPS1* and CX1834 genes and a mutation in 2 multidrug resistant protein effected in 50 and 80 per cent decrease in seed PA content, respectively (Gillman et al., 2009; Maroof et al., 2009). In addition to mutation breeding, reverse genetics approach has been successfully employed for reducing the endogenous PA levels in several economically important crops. Reverse genetics tools like RNAi mediated silencing of gene has been used in a variety of crops plants, *viz. Oryza sativa* (Ali et al., 2013) and *Glycine max* (Nunes et al., 2006) targeted at lowering the intrinsic seed PA amount. Applying this technique, the rate limiting step, catalysed by *GmMIPS1,* which shifts the metabolic flux from glucose towards PA, was silenced in soybean that effected in drastic reduction of the PA content up to 94.5 per cent (Kumar et al., 2019). Likewise, the PA transporter *MRP4* candidate gene in *Zea mays* was as well silenced by by means of similar strategy to lower the PA amount (Shi et al., 2007). The RNAi construct targeting *TaIPK1* under constitutive promoter in wheat transgenic lines effected in 28-56 per cent reduction in PA amount with simultaneous enhancement in the bioavailability of (Iron and Zinc Aggarwal et al., 2018). New technologies in the area of genomics have emphasized the requiremenr for genome editing means like TALENs (transcription activator-like effector nucleases), CRISPR (clustered regularly interspaced short palindromic repeats) and ZFNs (zinc-finger nucleases). Attempts to lower the PA amount in maize by targeting *ZmIPK* via CRISPR and TALENs resulted in 13.1% and 9.1% targeting efficiency using CRISPR and TALLENs respectively (Liang et al., 2014).

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UNDERSTANDING FARMER PRODUCER ORGANISATIONS (FPOS) FOR THEIR IMPERATIVENESS TO THE SMALL HOLDER FARMERS

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BACKGROUND

Agriculture is more of a way of life than a profession for very large population of India. There was a time when farmers' cooperation was clearly present for completing the farming activities, because completing day-to-day agricultural operations was not possible individually. As time passed, the mode of farming changed a lot especially during the Green Revolution era (Manjunatha *et al.,* 2013) due to large scale mechanization especially in the north western India and cooperative culture among farming community got compromised (Bhattarai, 2018). Eventually the traditional subsistence based cropping systems were replaced by the market led cropping patterns and systems in this part of the country.

The new system of crops helped the country to become self-reliant and the income of farmers increased tremendously (Srivastava, 2008; Nene, 2012) in green revolution areas, yet, this income enhancement stagnated over the time (Manjunatha *et al.,* 2013). Over the time, enhancement in population resulted in fragmentation of holdings and marketed lots of agricultural products became uneconomical to market. According to the National Advisory Council of the Planning Commission (now NITI Aagog, Government of India) report (2012-13), 15 to 20 lakh small farmers are added every year in India (https:// niti.gov. in/ planningcommission.gov.in/docs/reports/genrep/annual_report12_13.pdf). Due to degradation of mutual cooperation, the cost of farming has been increasing on account of mechanization of un-economical land holdings, as a result the net income of the farmers is being compromised seriously.

THREE PRINCIPLES OF INCREASING FARMERS' INCOME

There are three principles to increase the net income of small farmers. 1) by increasing the crop yield of the farmer so that the marketable surplus of these farmers is increased. 2) by increasing the net returns received by the farmer through better realization of prices of farm output in the market. 3) by reducing the cost of cultivation (i.e., optimum use of various farm inputs) so as to enhance the net profit of the small holder farmers. By this we can conclude, the only farmer who can be successful today is the one who can get the higher yield, more efficient marketing of the farm produce, and reduction in the cost of production of farm products. However, it is worth mentioning that it is not easy for small/ marginal farmers to follow all these three principles, especially the higher realization of price in agricultural markets. Hence, the time demands that the structure of co-operation be revived, that is, professional thinking be adopted by forming small groups of farmers so that the cost of farming is reduced through economies of scales and marginal farmer prospers again by getting higher yields and better prices (Vinayak *et al.,* 2019; Singh *et al.,* 2021).

FARMER PRODUCER COMPANIES (FPCS)

A number of co-operative campaigns have been launched by the government agencies in India resulting, however, into mixed experiences. In the year 2002, as per the recommendations of Dr. Y. K. Alagh committee report, the government of India amended the Indian Companies Act (ICA), 1956. Section 9-A. was included in introduce the concept of Farmer Producers Company (FPC) under ICA. They are also called as the modern-day co-operatives as they retain the uniqueness of cooperatives with higher independence and facilities to transact as the private limited companies (Anonymous, 2013; Anonymous, 2015; Patil et al., 2019).

SCOPE OF FPCS VIS-À-VIS COOPERATIVES

It is worth mentioning that a farmer has to go through a lot of paperwork to form a Farmer Producer Company (FPC), but a FPC is more independent than any other legal entities for scalability and business operations. The intention of the FPC is multi-dimensional as compared to the sole purpose of cooperatives. The scope of work of a co-operative society is limited while the FPCs are able to do business activities around the globe. Like the authenticity of co-operatives, FPC does have the right of one member one vote and these companies are fully owned by the farmers/ members themselves.

AN FPO

An FPO is a group of primary producers working for the economic upliftment of their members. The term 'Primary producers' means anyone who is involved in the manufacturing, production and collection of any product/ commodity belonging to agriculture, horticulture, animal husbandry, fisheries, bee keeping, handicrafts, forests etc. (Anonymous, 2015). An FPO can provides quality seeds, fertilizers, pesticides, machinery, transportation, etc. to their members at fair prices. Similarly, in order to get higher value in the market, the facilities of mass storage of products, primary processing (cleaning, drying, grading of products, etc.), linkages with distant markets, overseas trade etc. are also provided to the members of the FPOs (Singh, 2012; Singh, 2020). However, various challenges faced by the FPOs and the needed strategies/ measures for ensuring their sustainability need to be taken care very seriously (Singh et al., 2021).

BOX 1: PRODUCER ORGANISATION PROMOTING INSTITUTES (POPI)/ CLUSTER BASED BUSINESS ORGANISATIONS (CBBO)

The Producer Organisation Promoting Institutes (POPIs) now known as Cluster Based Business Organisations (CBBOs) are responsible for the promotion and formation of FPOs in the country. A CBBO can be any Non-Governmental Organisation (NGO), bank branch, government agency, co-operative society, Krishi Vigyan Kendra, State Agricultural Universities and Trust or Federation etc. fulfilling the criteria determined by National Bank for Agriculture and Rural Development (NABARD) and National Cooperative Development Cooperation (NCDC). Primarily, these organizations must be a legal entity so that they can legally enter into agreements with other organisations to obtain financial and technical assistances (Anonymous, 2013; 2015; 2021).

Salient points about functioning of CBBOs

- CBBO have been formed at state level to form and promote FPOs.
- It is prerequisite for the CBBO to get registered under any Act of Government of India or State and should be at least 3 years old for being eligible to form an FPO.
- A CBBO will handhold an FPO for a maximum period of 5 years from the date of formation of the FPO, till it becomes self-reliant.
- It is mandatory for the CBBOs to have at least 3 professionals from the field of Agriculture, Marketing, Food processing, Social Mobilization, Information technology, Law and Accounts etc.

RESPONSIBILITIES OF CBBOS TOWARDS THE FPO

First of all, the CBBO has to identify a group of farmers (about 50 or more farmers). This step is followed by the assessment of potential of the group means analysing group's business activities for being and FPO and developing a suitable business plan for the FPO. The subsequent action of the CBBO is registration of the identified FPO. Depending upon the framework of the act in which the FPO is registered, it is known as a society/ a co-operative society/ Farmer Producer Company (FPC)/ Public Trust or Section-8 Company (Anonymous, 2015; Singh, 2020). The business needs of the FPO, organizational preferences and management capabilities of the legal entity need to be taken into consideration while selecting the legal entity at the time of registration.

After registration of the FPO, CBBO’s next task is to mobilize resources and set up a management structure for the FPO, viz., selection of crops, identification of marketing channels, determination of responsibilities of members and appointment of employees etc. Finally, the FPO starts its business activities through following their business plan. After this the assessment of work and audit is also carried out by the CBBO (Anonymous, 2013; 2015). Thus, from the commencement of the accounts of the FPO till it becomes self-reliant a CBBO cooperates or handholds the FPO up to for next five years till the FPO is able to professionally manage the activities of the organisation. It is worth mentioning here that these CBBOs are financially and technically assisted by the NABARD, Small Farmers’ Agri-business Consortium (SFAC), NCDC, Krishi Vigyan Kendras (KVKs), Corporate Social Responsibility (CSR) Institutions and many governmental and Non-Governmental Organisations (Anonymous, 2015; 2021).

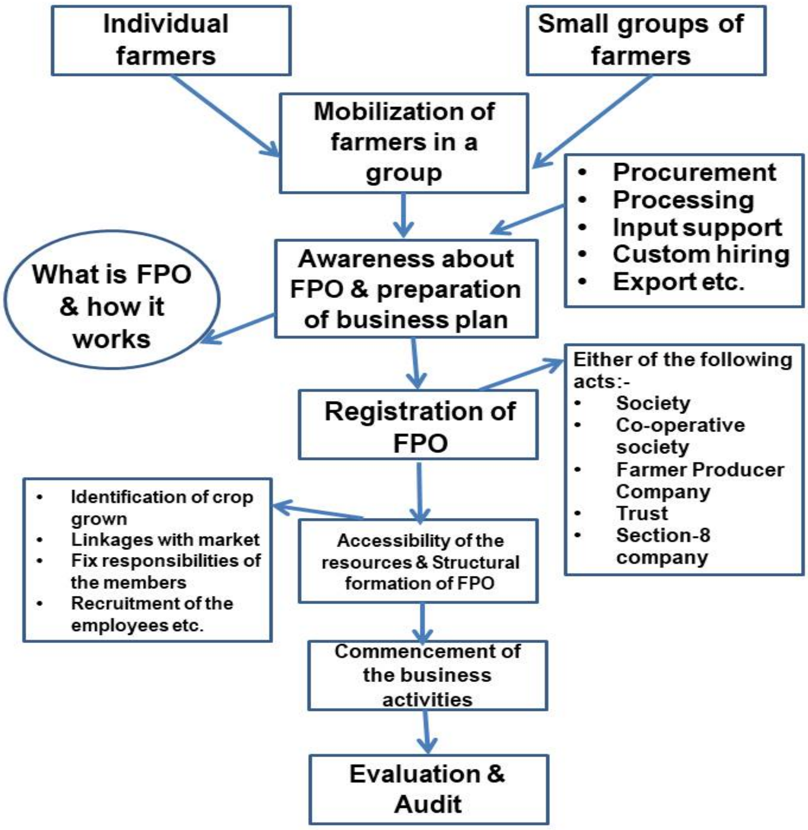

Fig. 1: Systematic flow chart of formation and functioning of an FPO

DIVIDEND DISTRIBUTION FRAMEWORK

The accrued profits by the FPOs are distributed among the members proportional to their shares holding however, distribution of dividends also depends on the legal entity under which the FPO operates or was registered. There is no limit to the distribution of profits of a FPC and the profit to be distributed depends on the scale of the business and the quantum of accrued profits.

BUSINESS THEMES/ ACTIVITIES FOR FPOS

FPOs can carry out their business activities at any particular point or different points under the value chain of the agricultural commodities. Right from production of agricultural commodities to the ultimate customers, the agro-commodities pass through several continuous processes such as procurement, aggregation, primary/ secondary processing, packaging, storage and transportation etc. and for all this the producers require various inputs (e.g., seeds, fertilizers, pesticides etc.), infrastructure, cool chains and logistics etc. (Patil *et al.,* 2019; Singh *et al.,* 2021). Thus, FPO can start their services at any one or more stages listed below:

1. To procure good quality agricultural inputs at remunerative prices for providing them to their members.

2. Benefitting the members by collecting credible and crucial market information and providing it timely to the members of the FPO.
3. To acquire and provide advanced technical know-how on farming techniques to their members.
4. Providing financial support to their members through loans/ advances for purchase of agricultural inputs.
5. Facilitating collective storage and selling of agricultural goods for exercising better bargaining power and higher net income for all the members.
6. Undertaking collective basic processing (cleaning, drying, grading, etc.) of agro-products for enhancing pricing power and better profitability.
7. Establishing identity of quality of products produced by the members by brand building and positioning for attaining pricing power.
8. Undertaking electronic/ distant trade of agro-commodities through commodity exchanges and electronic national agriculture markets etc.
9. Facilitating and managing exports marketing of agro-commodities produced by the members of the concerned FPOs.

BOX 2: AN EXAMPLE OF DIFFERENT BUSINESS ACTIVITIES THAT CAN BE UNDERTAKEN BY AN FPO

Agri-commodities or products go through a series of stages while travelling from a producer to the end consumer and at different stages its form changes and value is added (i.e., the price goes up with every change in the form of the agri-products). Let us take an example of wheat. The production of wheat needs; fertile land, quality/ healthy seeds, irrigation water, machines for performing various cultural operations along with various agro-chemicals for ensuring good health of the crop. After harvesting the wheat grains pass from through various stages and destinations e.g., stores/ siloes and processing plants for converting the grains into wheat flour which is further packaged and provided to the final consumer through retailers. A large distribution network of market middlemen is associated in the process of marketing of raw and processed wheat.

An FPO can adopt any one or more of these steps/ stages explained in the preceding paragraph as the business activities. The FPO can either provide quality inputs (seeds, fertilizers and pesticides etc.) to its members at a fair price by bulk purchasing the inputs directly from the manufacturers and help to reduce the cost of production of their members. In addition, the FPO can also get dealership of any company by getting certificate for sale of seeds, fertilizers and pesticides etc. Similarly, the FPO can also provide machinery to its members at low cost (Anonymous, 2015; Singh, 2020) and/ or provide processing services/ facilities to the members.

Further, in marketing, FPOs can procure the crops of their members by obtaining the license of the commission agent and distribute a portion of commission received to the members in the form of dividend.

BOX 3: AN EXAMPLE OF INNOVATIVE 'FATEHGARH SAHIB VEGETABLE PRODUCER COMPANY', PUNJAB

Fatehgarh Sahib Vegetable Producer Company is an FPO with its unique and innovative business model. The FPO has been running for about five years in Fatehgarh Sahib district of Punjab (registered in 2014 at Khamano tehsil of the district). The FPO has become a certified commission agent in the Bassi Pathana APMC of the district. They acquired a shop in the market in 2015. The FPO has been distributing about 40% of the commission earned in the process of purchase and sale of food-grains in the market. In some of the years the FPO purchased produce of their members at a price higher than the minimum support price or the general procurement price.

ਕਿਸਾਨ ਕੰਪਨੀ ਵਲੋਂ ਸੰਘੋਲ ਮੰਡੀ 'ਚ 20 ਰੁਪਏ ਵੱਧ ਮੁੱਲ 'ਤੇ ਝੋਨੇ ਦੀ ਖ਼ਰੀਦ ਸ਼ੁਰੂ

ਸੰਘੋਲ, 17 ਅਕਤੂਬਰ (ਗੁਰਨਾਮ ਸਿੰਘ ਚੀਨਾ) - ਫ਼ਤਹਿਗੜ੍ਹ ਸਾਹਿਬ ਵੈਜੀਟੇਬਲ ਪ੍ਰੋਡਿਊਸਰ ਕੰਪਨੀ ਲਿਮਟਿਡ ਨੇ ਆਪਣੀ ਆੜ੍ਹਤ ਅਨਾਜ ਮੰਡੀ ਸੰਘੋਲ 'ਚ ਪਿਛਲੇ ਸਾਲਾਂ ਦੀ ਤਰ੍ਹਾਂ ਝੋਨੇ ਦੀ ਖ਼ਰੀਦ ਦਿਲਬਾਗ ਸਿੰਘ ਨਿਰੀਖਕ ਪੰਜਾਬ ਵੇਅਰ ਹਾਊਸ ਦੀ ਰਹਿਨੁਮਾਈ 'ਚ ਕਿਸਾਨ ਲਾਭ ਸਿੰਘ ਪਿੰਡ ਕਲੌਂਦੀ ਵਲੋਂ ਲਿਆਂਦੀ ਫ਼ਸਲ ਦੀ ਬੋਲੀ ਕਰਕੇ ਖ਼ਰੀਦ ਸ਼ੁਰੂ ਕੀਤੀ। ਕੰਪਨੀ ਨੇ ਆਪਣੇ ਕਮਿਸ਼ਨ 'ਚੋਂ ਪਹਿਲਾ ਦੀ ਤਰ੍ਹਾਂ ਕਿਸਾਨਾਂ ਨੂੰ 20 ਰੁਪਏ ਵੱਧ ਦੇ ਕੇ ਖ਼ਰੀਦ ਸ਼ੁਰੂ ਕੀਤੀ। ਕੰਪਨੀ ਦੇ ਮੁੱਖ ਪ੍ਰਬੰਧਕ ਕੇਹਰ ਸਿੰਘ ਕੰਗ ਨੇ ਸੰਘੋਲ, ਖਮਾਣੋਂ, ਮਾਜਰੀ ਦੇ ਨਾਲ ਲਗਦੇ ਕਿਸਾਨਾਂ ਨੂੰ ਅਪੀਲ ਕੀਤੀ ਹੈ ਕਿ ਉਹ ਸਰਕਾਰ ਦੀਆਂ ਹਦਾਇਤਾਂ ਅਨੁਸਾਰ ਕੰਪਨੀ ਦੀ ਆੜ੍ਹਤ 'ਚ ਵੇਚ ਕੇ ਫ਼ਾਇਦਾ ਉਠਾਉਣ। ਕੰਪਨੀ ਨੂੰ ਸਹਿਯੋਗ ਦੇ ਕੇ ਕਿਸਾਨੀ ਨਾਲ ਸਬੰਧਿਤ ਸਮੱਸਿਆਵਾਂ ਦਾ ਹੱਲ ਸੰਜੀਵਾਲਤਾ ਦੇ ਲਿਹਾਜ਼ ਨਾਲ ਕਰਨ। ਕਿਸਾਨ ਕੰਪਨੀ ਕਿਸਾਨਾਂ ਨੂੰ ਖਾਦ ਤੇ ਦਵਾਈਆਂ ਆਦਿ ਸਸਤੇ ਰੇਟ ਤੇ ਦਵਾ ਕੇ ਕਿਸਾਨਾਂ ਦੀ ਆਮਦਨੀ ਵਧਾਉਣ ਦੇ ਯਤਨ ਕਰ ਰਹੀ ਹੈ। ਮੌਕੇ ਤੇ ਕਿਸਾਨ ਆਗੂ ਕਿਰਪਾਲ ਸਿੰਘ ਬਦੇਸ਼ਾ, ਨਛੱਤਰ ਸਿੰਘ ਸਿੱਧੂਪੁਰ, ਨਿਰਮਲ ਸਿੰਘ ਧਿਆਨੂੰ ਮਾਜਰਾ, ਹਰਸ਼ਰਨਦੀਪ ਸਿੰਘ ਰਾਣਵਾਂ, ਭਗਵੰਤ ਸਿੰਘ ਢੋਲੇਵਾਲ ਤੋਂ ਇਲਾਵਾ ਕਿਸਾਨ ਅਤੇ ਮਜ਼ਦੂਰ ਹਾਜ਼ਰ ਸਨ।

ਅਨਾਜ ਮੰਡੀ ਸੰਘੋਲ ਵਿਖੇ ਕਿਸਾਨ ਕੰਪਨੀ ਦੇ ਅਧਿਕਾਰੀ ਝੋਨੇ ਦੀ ਖ਼ਰੀਦ ਸ਼ੁਰੂ ਕਰਨ ਦੌਰਾਨ। ਤਸਵੀਰ: ਚੀਨਾ ਖੰਟ

GOVERNMENT SUPPORT TO FPOS

So far, there are more than 5,000 registered FPOs in the country. About 10 lakh farmers have been mobilized in these FPOs. In the Central Sector Scheme (CSS) viz., "Formation and Promotion of Farmer Producer Organizations (FPOs)" a target of establishment of 10,000 FPOs in the country by 2023-24 has been set. A grant of more than Rs 6,000 crore has been allocated for this purpose. NABARD, SFAC and NCDC are the implementing agencies for this scheme. CBBOs have been set up at various levels to form and promote these FPOs. A CBBO has professional experience in mobilization of the farmers under FPOs for providing hand holding support to the newly formed FPOs. CBBOs are financially supported by the NABARD, NCDC, SFAC and CSR departments while they are technically supported by the KVKs, State Agricultural Universities, National Institute of Agricultural Extension and Management (MANAGE), State Agriculture Extension Management and Training Institutes (SAMETIs) etc. The various financial aids are acquired by the CBBO for undertaking different purposes (Anonymous, 2015; Anonymous, 2021; Table 1).

TABLE 1: PURPOSES OF FUNDING CBBOS AND FPOS

Support to CBBO	Support to FPOs
• Identification and mobilization of the farmer. • Training and exposure visits of the identified farmers. • Capacity building of CEOs and Directors of the FPOs. • Salary of professionals and other staff. • Travel cost for the travels of CBBO staff. • Others (Auditing, survey, campaign etc.).	• Documentation and registration of FPO. • Salary of CEO for first 5 years of the FPO • Office rent of the FPO for first 5 years • One time expenditure for office furniture and stationery etc. of the FPO • Expenses of postage and electricity etc. • Revolving Fund Assistance for processing, storage etc. by NABARD • 100% tax holiday till 2022 • Matching Equity Grant of 15 lakh from SFAC • Credit Guarantee Scheme by SFAC up to 100 crores • 80% subsidy on residue management machinery • Subsidy by the department of MSME to establish cold chain and processing plants. Etc.

CHALLENGES TO THE FPOS

Lack of awareness among the farmers about the potential benefits of co-operation and non-availability of the competent promoting agencies to mobilize the farmers under FPOs is one of the key challenges. Moreover, lack of technical know-how of the scheme and complex registration process further pose a variety of challenges in the implementation of the scheme. However, following points are some of the important challenges that CBBOs and FPOs may faces at the ground level (Singh, 2020; Verma *et al.,* 2020): -

- To mobilize farmers in a group for making the group a vibrant and functional unit.
- Raising needed funds to start a business at a scale that provides meaningful livelihood for all the members.
- Creating an effective business plan is another challenge that needs a lot of expertise.
- Maintaining business relationships with funding agencies in order to obtain sustainable financial support.
- Technical information about legal rules is not known to the members of the FPOs.
- Reliability of CBBO/ POPI on proper use of received grants as there have been incidences of misallocations of funds.
- Lack of transparency in functioning between CBBO/ POPI and FPOs
- Lack of professional thinking among the members of the FPOs as they lack business skills and competencies.
- Lack of mutual support or team work due to fast degrading cooperation culture among the members of the FPOs.

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FERTIGATION- ADVANTAGES AND CHEMICAL FERTILIZERS SUITABLE FOR FERTIGATION

Krishi Vigyan Kendra, Kalikiri

WHAT IS FERTIGATION

Supply of irrigation water and required nutrients to plants simultaneously through micro irrigation method is known as fertigation.

WHY FERTIGATION IS IMPORTANT

In Agriculture to improve production and productivity of crops, not only the yields should be improved but also cultivation cost should be reduced. For this improving water and nutrient use efficiency of crops is the best option.

Area under fertigation: In Israel, 75% and 81% of irrigated land is under micro irrigation and fertigation, respectively. However, in India only 0.3% of irrigated area is under micro irrigation and very less area is under fertigation.

ADVANTAGES OF FERTIGATION

- Improves nutrient use efficiency as nutrient requirement of crops, crop growth stage and climatic conditions are taken into consideration.
- Nutrients will be available to crops in required amount and at required time
- No wastage of nutrients as nutrients are supplied directly to the roots
- Through fertigation, nutrient loss through leaching, voltalization or converting to unavailable form can be avoided.
- 15-40 % of fertilizers and 10-15% of labour usage can be reduced
- Compared to traditional methods like broadcasting and band placement fertilizer use efficiency is more in fertigation
- In slopy lands and problematic soils, fertigation is the suitable method.
- 30-40 % of crop yields can be improved
- Quality of produce can be improved

CHEMICAL FERTILIZERS SUITABLE FOR FERTIGATION:

NITROGEN FERTILIZERS (N-P-K):

- Urea (46-0-0)
- Ammonium nitrate (34-0-0)
- Ammonium sulphate (26-0-0)

- Calcium nitrate (16-0-0)
- Urea Ammonium nitrate (32-0-0)
- Potassium nitrate (13-0-46)
- Magnesium nitrate (11-0-0)
- Mono Ammonium phosphate (12-61-0)

PHOSPHORUS FERTILIZERS (N-P-K):

- Urea phosphate (17-44-0)
- Mono Ammonium phosphate (12-61-0)
- Mono Potassium phosphate (0-52-34)
- Phosphoric acid (0-52-0)
- NPK (19-19-19/20-20-20)

POTASH FERTILIZERS (N-P-K):

- Potassium chloride (0-0-60)- only white coloured
- Potassium nitrate (13-0-46)
- Potassium sulphate (0-0-50) – fertigation grade
- Potassium thio sulphate (0-0-25)- liquid
- Mono potassium sulphate (0-52-34)

Fertilizers should be completely soluble in water. Otherwise, drip pipes will be clogged. For fertigation powder or liquid form of fertilizers can be used. For higher yields and superior quality chloride free fertilizers should be used.

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COMPARISION OF PERFORMANCE OF DRIP IRRIGATION WITH PLASTIC MULCH AT DIFFERENT LEVELS OF DEFICIT IRRIGATION WITH REGARD TO GROWTH AND SEED YIELD OF FLEMINGIA SEMIALATA

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ABSTRACT

A study was conducted to assess the effect of drip irrigation and plastic mulch on growth of Flemingia semialata .Two types of plastic mulch(green and silver/black) were tested at three levels of irrigation(75%,50% and 25%) by drip irrigation. The drip irrigation in conjunction with plastic mulch help reduce loss of water and controls weeds, pests and diseases. Also the plastic mulches directly affect the microclimate around the plant by modifying the radiation budget of the surface decreasing the soil water loss resulting in more uniform soil moisture. Green plastic mulch transmits only warming wavelengths of the sun resulting in warmer soil than black plastic mulch causing faster development of plants.The daily water requirement of Flemingia semialata was estimated by the equation ETcrop= ETox crop factor. ETcrop is crop water requirement mm/day. ETo (reference evapotranspiration,mm/day) was calculated by FAO calculator which uses temperature and humidity data. Highest seed yield (9gm./plant) was recorded with drip irrigation and green plastic mulch at 50% irrigation level. It was also observed that drip irrigation with green plastic mulch performed best in terms of seed yield at all levels(25%,50%,75%) of irrigation as compared to other treatments of drip irrigation alone and drip irrigation with silver/black plastic mulch and control plot.Minimum weed weight(5gm/plot) at the end of the season was recorded with drip irrigation and silver/black plastic mulch at 75% irrigation level.It was also observed that minimum weed weight/plot recorded with drip irrigation and silver/black plastic mulch at all levels (25%,50%,75%) of irrigation as compared to other treatments of drip irrigation alone and drip irrigation with green plastic mulch and control plot.

Providing irrigation water to the plants during water stress is essential to obtain higher crop yield. Water is a scarce natural resource. Hence, it should be used judiciously. Drip irrigation utilizes water judiciously for irrigation as it supplies water drop by drop directly or below the root zone of plants as per the water requirement of plants eliminating evaporation and deep percolation losses thus enhancing its water use efficiency as compared to other methods of irrigation.The beneficial aspects of drip irrigation includes higher water use efficiency, less weed growth, no soil erosion, no leaching of fertilizer in to the ground, less evaporation losses of water, improved seed germination, early maturity of crops, maximum crop yield, improved product quality, less labour requirement etc. Use of drip irrigation in conjunction with plastic mulch increases soil temperature, reduces the loss of soil moisture and checks the weeds, pests and diseases and further improves its water use efficiency and adds/increases its other advantages. Crop yield and water use efficiency can be considerably increased by deficit (HalilKirnak*et al.,* 2006, Ian Mc Cann*et al.,*2007, Spehia*et al.,*2007, Basal *et al.,*2009, Singh *et al.,*2009,Ramalan*et al.,* 2010, Biswas *et al.,*2015) drip irrigation alone, and in conjunction with plastic mulch.

MATERIAL AND METHOD

A drip irrigation system was installed at the experimental field of research farm of ICAR-Indian Institute of Natural Resins and Gums, Ranchi. One line of drip lateral was provided to each row of the *Flemingia semialata* plantation. Every plant was provided with one dripper. The varying discharge drippers were used in the said drip irrigation system to facilitate the application of different levels(75%, 50% and 25%) of irrigation. The drippers were calibrated for applying desired quantity of water to each plant in stipulated time. Furrows were excavated on both sides along the length of nine furrow irrigated plots. The experiment was laid out in randomized block design (RBD) with thirteen treatments replicated thrice making total number of plots to 39.The treatments are as follows:

T1, 75% irrigation requirement met through drip irrigation. T2, 75% irrigation requirement met through drip irrigation and silver/black plastic mulch. T3, 75% irrigation requirement met through drip irrigation and green plastic mulch. T4, 50% irrigation requirement met through drip irrigation. T5, 50 % irrigation requirement met through drip irrigation and silver/black plastic mulch. T6, 50% irrigation requirement met through drip irrigation and green plastic mulch. T7, 25% irrigation requirement met through drip irrigation. T8, 25% irrigation requirement met through drip irrigation and silver/black plastic mulch. T9, 25% irrigation requirement met through drip irrigation and green plastic mulch. T10, 50% irrigation requirement met through furrow irrigation. T11, 50% irrigation requirement met through furrow irrigation and silver/black plastic mulch. T12, 50% irrigation requirement met through furrow irrigation and green plastic mulch. Tc, Control (without irrigation and without mulch)

For plastic mulch treatment two types of plastic mulch silver/black and green were spread over plots as per treatments. The holes were punched in the plastic where *Flemingia semialata* plants were grown. The plastic mulch was anchored in the soil on all sides of plot up to a depth of 6 inches. The drip laterals and drippers were placed under plastic mulch before it was laid. The irrigation was provided to plants with drip irrigation on every alternate day and with furrow irrigation on every fifth day.

RESULTS AND DISCUSSION

It was observed that drip irrigation with plastic mulch is yielding best results in terms of growth of shoot height (19.75 cm) at 75% level of irrigation as compared to other treatments of drip irrigation and plastic mulch and control. It was also observed that drip irrigation with silver/black plastic mulch at 25% level of irrigation is performing best in terms of shoot girth (1.84mm), leaf area (88.21sqcm) and number of flower(63.75) as compared other treatments of drip irrigation and plastic mulch including control . Increase in shoot number(3.75) is maximum with drip irrigation and silver/black plastic mulch at 75% level of irrigation as compared to other treatments of drip irrigation and plastic mulch including control. Highest seed yield (9gm./plant) was recorded with drip irrigation and green plastic mulch at 50% irrigation level. It was also observed that drip irrigation with green plastic mulch performed best in terms of seed yield at all levels(25%,50%,75%) of irrigation as compared to other treatments of drip irrigation alone and drip irrigation with silver/black plastic mulch and control plot. Minimum weed weight(5gm/plot) at the end of the season was recorded with drip irrigation and silver/black plastic mulch at 75% irrigation level. It was also observed that minimum weed weight/plot recorded with drip irrigation and silver/black plastic mulch at all levels (25%,50%,75%) of irrigation as compared to other treatments of drip irrigation alone and drip irrigation with green plastic mulch and control plot.

Table: Effect of different treatments on growth parameters and seed yield of *Flemingia semialata*

Treatments	**Growth inshoot height (cm)**	**Growth inshoot girth (mm)**	**Increase inshoot number**	**Leaf area (cm^2)**	**Flower number**	**Pod number**	Seed Yield, gm/plant
T1	12.67	1.69	2.75	75.24	41.83	37.61	5.83
T2	19.75	1.17	3.75	67.61	50.66	42.13	6.91
T3	19.75	1.16	2.67	80.31	57.83	41.44	7.5
T4	13.58	1.42	1.75	73.30	58.16	45.83	7
T5	9.41	1.42	1.92	76.26	49.25	36.19	5.58
T6	9.67	0.92	1.25	79.01	53.75	36.97	9
T7	18.41	1.09	3.17	67.77	57.25	41.99	6.08
T8	15.75	1.84	1.84	88.21	63.75	44.32	5.08
T9	15.50	1.00	2.17	83.18	57.25	41.16	6.5
T10	18.45	2.89	1.83	69.32	34.08	36.83	4.65
T11	22.42	0.66	2.25	80.84	64.25	45.38	7.83
T12	14.05	1.08	3.00	76.5	59.58	43.74	6.75
Tc	18.17	1.33	1.59	85.52	55.83	46.24	5.16

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NEMATODES AS BIOINDICATOR OF SOIL ECOSYSTEM HEALTH

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ABSTRACT

Nematodes constitute the numerically most abundant group of Metazoans, and participate in the two most vital soil ecological processes – nutrient cycling and decomposition. The soil inhabiting free-living and plant-parasitic nematodes may serve as potential bioindicators of soil ecosystem health. The variability, ubiquitous habitat, abundance, morphology and diversity in community structure components make the nematodes amenable for analyzing the ecosystem stability and disturbance. Despite being potential bioindicators, the qualitative correlation (as deduced hitherto) patterns between nematological and environmental data hinder broader use of these organisms under variable ecological conditions.

INTRODUCTION

Soil inhabiting flora (all plant life) and fauna (all animal life) are abundantly linked to several vital ecosystem processes like food web structuring, nutrient cycling, soil structure maintenance, biological pest control, etc. Soil health predominantly depends on the functioning and integrity of these assemblages, along with the physical properties of the associated habitat. The services provided by these biotic communities in soil ecosystems enable them to serve as bioindicators of any ecological disturbance. Thus an indicator fauna/flora must represent the structure and function of ongoing ecological processes and respond to the change(s) that arose due to any land-management practice. Additionally, it should be sufficiently taxonomically studied, easy to monitor, applicable to all geographical and vegetation regimes, and responsive to laboratory procedures and experiments. Nematofauna is considered to be the most numerous metazoans present on the earth. They are found in all types of terrestrial, marine, and freshwater environments either in free-living (live independently) or parasitic forms (live in or on another organism and draw nutrients). Sometimes the nematodes are found under extreme environmental conditions; for example *Auanema* sp. in hyperalkaline arsenic-rich water body, *Panagrolaimus davidi* in the Antarctic environment, *Halicephalobus mephisto* at soil depth of 3.6 Km etc. The vast majority of nematode species known are free-living that feed on the bacteria (bacterivore), fungi (fungivore), algae (algivore), and a variety of foods (omnivore) or predate on others (predator). These organisms represent almost every trophic group (Figure 1), play important roles in ecosystem processes, and respond rapidly to environmental changes. Application of general community and nematode-specific ecological indices, which have enabled us to consider these organisms as bioindicators of ecosystem disturbances induced by various components such as salts, heavy metals, pharmaceuticals, toxicants, and agricultural practices.

HOW DO NEMATODES CONTRIBUTE TO SOIL HEALTH

The nematodes play vital roles in essential soil processes; they contribute direct and indirect ways to the various biological activities as follows:

(1) The bacterivorous and fungivorous nematodes directly feed upon the soil microbes and release large amount of ammonium, as the bacteria and fungi contain much more nitrogen (N) than the nematodes require. Thus the nematodes contribute to nitrogen mineralization process, releasing N in plant-available form.

(2) Predatory nematodes feed on other groups of nematodes and contribute to nitrogen mineralization process, thus they pass nitrogenous resources from bottom to top trophic levels.

(3) At low densities, bacterial and fungal feeding nematodes stimulate microbial growth in soil. The increased level of microbes results in increased decomposition and immobilization of nutrients.

(4) Nematodes help in distributing the bacterial and fungal population in soil; they carry live and/or dormant microbes on their body surfaces or in the digestive systems.

(5) Nematodes also share a fraction of total biomass and respiration in the soil for being large in number and close association with microbes. Being aerobic in nature they emit carbon dioxide in soil, which may contribute to soil carbon storage and also helps the bacteria and fungi in decomposition process.

WHY ARE NEMATODES GOOD BIOLOGICAL INDICATORS

Since bacteria and fungi are the dominant microbial decomposers it is often considered that they provide the best information about soil biological processes. However, nematodes being an abundant soil fauna possess some advantages over the microbes as a better bioindicator. The reasons are:

(1) Nematodes are ubiquitous and present in all types of ecosystems in large numbers; and certain species are frequently the last animals to die in a polluted or disturbed ecosystem for their ability to withstand desiccation and revive with moisture.

(2) The body size and relative abundance of nematodes typically make sampling and extraction easier and less costly.

(3) Nematodes show great variability across ecosystems in terms of their forms, habits, regulatory biology underlying their habits etc.

(4) Nematodes have relatively longer generation time than the metabolically active microbes which makes them more stable at least for period of time.

(5) Nematodes are one or two steps higher in the food chain, hence serve as integrators of physical, chemical and biological properties related to their food sources.

(6) Nematodes are considered to be the most useful group for community analysis as compared to other micro-, meso- and macro-fauna (e.g. collembolans, mites, tardigrades), as morphological structures are closely linked with their feeding habits. They can be readily extracted from soil and others substrates, and easily identified based on feeding structures in their mouth cavities under a compound microscope.

WHAT INFORMATION CAN BE GAINED FROM NEMATODE COMMUNITY ANALYSIS

Once identified, the nematodes can be grouped either as bacterial feeders, fungal feeders, omnivores, predators or plant parasites according to their feeding habits. Extracting the soil nematodes, enumeration of their number and abundance, and then dividing them into feeding groups provides a good opportunity of obtaining a picture of what is happening within the soil food web. For example

(1) A high ratio of bacterial- to fungal-feeding nematodes in soil indicates nutrient cycling is occurring rapidly through bacterial decomposition, which may be an indicative of high nitrogenous inputs or recent tillage.

(2) A predominance of fungal-feeding nematodes in soil indicates that the food web is dominated by fungi, and thereby a relatively slow rate of biological nutrient cycling can be expected.

(3) Low population levels of omnivorous and predatory nematodes indicate that the soil biology may be affected by pollutants or excessive fertilizer inputs or agronomic practices like tillage. Whereas, a high population density of such nematodes indicates that the soil is biologically complex and stable capable of suppressing parasitic nematodes and other soil borne pathogens.

HOW NEMATODES CAN BE USED AS BIOINDICATORS

Nematodes can be associated with the ecological conditions of soil, and thereby being associated with the sustainability condition of agricultural production. Studies of their diversity can be applied with the purpose of using them as bioindicators of environmental changes and productive impacts. For example

(1) Several free-living bacterivorous nematodes are sensitive to heavy metal (e.g. lead, arsenic, cadmium etc.) toxicity in soil, where high proportions of heavy metal contaminations affect nematode molting, body size and life span. *Panagrellus redivivus* has been used as a biomonitor for toxicity effects in water, where high level of toxin concentrations disrupts molting and body size of the nematode species.

(2) Nematodes and copepods are abundantly present in aquatic ecosystems, and nematode: copepod ratio has been used to monitor aquatic ecosystem conditions. Generally, the nematodes are less sensitive to environmental stress or pollution than the copepods. Hence, a high ratio indicates pollution, like oil spills, sewage and organic enrichment in water.

(3) Populations of microbes (e.g. bacteria, fungi) increase with increase in organic matter content in soil. Hence, nematodes that feed on bacteria (e.g. Rhabditids, Panagrolaimids) and fungi (e.g. Aphelenchids) are directly responsive to changes of their food. Relative

biomass and community analyses of such bacterivorous and fungivorous nematodes may provide good opportunity to monitor organic enrichment in soil.

(4) Generally, the free-living microbivorous nematodes having high fecundity, short generation times are considered to be colonizers. These nematodes appear early in succession and show large population fluctuations. Besides, the plant-parasitic nematodes are considered to be persisters having opposite characters as above. The colonizer:persister ratio (C:P ratio) is used to interpret the stability of a soil environment and long-term changes in soil ecological conditions. Smaller C:P ratio reflects tolerance and higher ratio reflects sensitiveness.

(5) The nematode C:P ratio is ranked on scale 1-5. The CP-1 nematodes are pure colonizers (also called enrichment opportunists), and are most responsive to organic enrichment in soil. The CP-2 nematodes (e.g. Aphelenchids, small Dorylaimids) colonize afterwards with enrichment of high C/N ratio organic matter. Thus, nematode community successively alters with change in C/N ratio in soil. The correlation of C/N ratio in soil with community structures of the colonizing nematodes can well reflect the soil health with respect to its organic matter content.

(6) Simple indices, like abundance, proportions and diversity index of nematodes by trophic group reflect the soil ecological conditions. Greater diversity reflects higher number of fungivorous, omnivorous and predatory nematodes than the bacterivorous and plant-parasitic species.

(7) Nematode maturity indices are used to measure the ecological succession status of a soil community. Succession can be interrupted different agricultural practices, viz., tillage, cultivation and applications of fertilizer and pesticides. Hence, smaller index values are indicative of a more disturbed ecosystem and larger values may indicate a less disturbed environment.

(8) Nematodes generally undergo resistant life stages on occurrence of stressful environment. Hence, number and community structure differences of the nematodes with no resistant life stages (e.g. several Dorylaimids) may be used as an indicator for environmental stress.

(9) Certain nematode species (e.g. *Rhabditis teres*, *Caenorhabditis elegans*) undergo recognizable encysted or dauer stage when food availability is less, and emerge from resting stage when food supply is adequate in soil. These nematodes feed on bacteria, and development of bacterial population in soil is directly proportional to organic matter content. Thus, the prevalence and proportion of active and resting stages of such nematodes can be used as an indicator for soil organic matter enrichment.

IS THERE ANY DISADVANTAGE OF USING NEMATODES AS BIOINDICATORS

Although there are several advantages of using nematodes as bioindicators for soil health, there still lie some difficulties for which their application has been hindered. The reasons may be enumerated as

(1) Species assignment and morphological studies of nematodes present in the different environments needs expert taxonomists.

(2) The differences in numerical species proportions (over- or under representation) may arise due to faulty observations that may mislead the results and interpretation.

(3) Adequate knowledge on nematode habitat, behaviour and trophic level is necessary involving trained biologists and taxonomists.

(4) The indices like abundance, diversity, species richness, maturity index often show a qualitative correlation with environmental disturbances; and no definite quantitative correlation has been achieved so far that may ease up the use of nematodes as bioindicators.

CONCLUSION

In conclusion, the nematodes are ecologically sensible to be used as bioindicators of soil health. They represent a prominent position in the soil food web structures and participate in the like nitrogen cycling, decomposition, microbial distribution, plant growth etc. Although having great potential to be used as bioindicators, nematode's use is largely hindered due to the type of assessment and interpretation of correlation data while inferring the conclusion. Hence, extensive research should be prioritized in their life history, taxonomy and calibration of nematode indices to ecosystem to use these organisms in practical sense.

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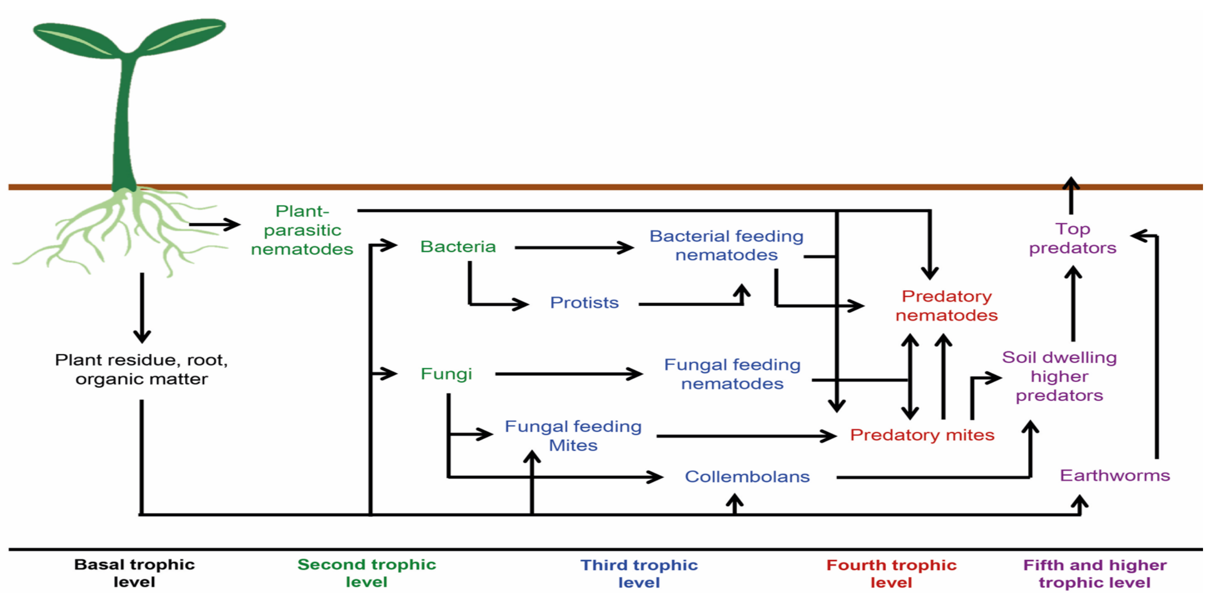

FAIGURE 1: A schematic representation of complex trophic web in soil

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BIOCHAR

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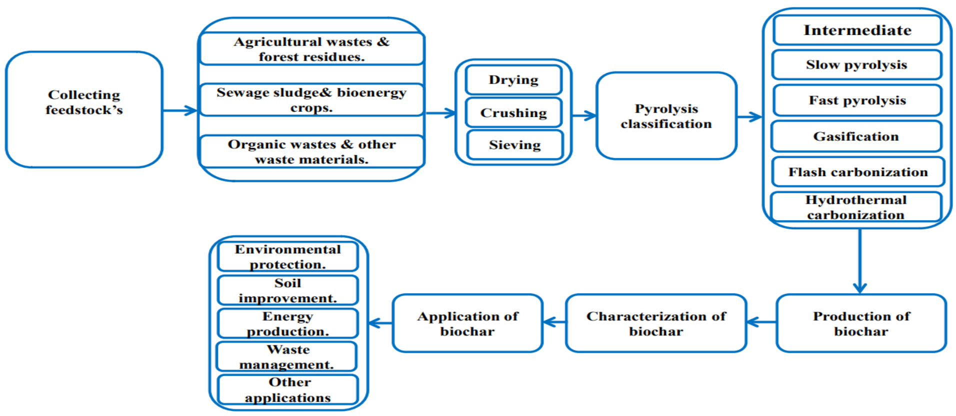
INTRODUCTION

Biochar is a type of black carbon, product of carbonaceous material (Lehmann, 2007a; Novak *et al*., 2009), has been combusted under low or no oxygen conditions through the process of pyrolysis (Atkinson *et al*., 2010; Karhu *et al*., 2011). The native Amazonians used to burn trees and plants for many reasons. Wastes were baked beneath a layer of soil. This process, known as pyrolysis, produced a charcoal soil amendment rich in carbon. The result was "terra preta", literally "black earth" in Portuguese. This is a highly fertile dark-coloured soil that has supported the agricultural needs of the Amazonians for centuries.

PRODUCTION OF BIOCHAR



FEEDSTOCK PRODU CTS UNDER DIFFERENT KINDS OF PYROLYSIS METHODS

Pyrolysis methods	The main reaction conditions	The liquid products (TAR)	Gas products (CH_4, CO, H_2)	Firm product (biochar)
Slow method	Not rising temperature (400°C - 660°C), not rising heating rate (0.1 - 1°C/S), Gas or vapor residence time(5 - 30 min)	30% and 70% Wood vinegar	35%	35%
Medium speed pyrolysis	Not rising temperature(400°C - 550°C), Modest heating rate (10 - 200°C/S), Gas or vapor residence time(10 - 20 S)	50% and 50% Wood vinegar	25%	25%
Fast pyrolysis	Middle temperature (about 500°C), Fast heating rate (1000°C/S) Vapor residence time (<2 S)	75% and 25% Wood vinegar	13%	12%
Flash pyrolysis	High temperature (>800°C), Fast heating rate 1000°C/S, gas vapor residence time (<1S)	5% and 55% Wood vinegar	About 80%	About 10%

POWER OF BIOCHAR

Biochar may increase soil pH, nutrient retention, cation exchange capacity (CEC), crop biomass, and many other variables important to soil quality and agriculture (Schnell *et al*., 2012; Xu *et al*., 2012) in addition to increased soil C sequestration (Lehmann, 2007b, Deem and Crow, 2017). Biochar is currently promoted as a way to initiate a "doubly green revolution" (Barrow, 2012) by potentially addressing soil organic matter GHG emissions and food insecurity concurrently (Jones *et al*., 2012; Deem and Crow, 2017). Agriculture has to address three intertwined challenges: food safety through increased income and productivity, adaption to climate change and climate change mitigation. If properly made and used, biochar can relieve climate change and other environmental effects (Shareef and Zhao, 2017): Rise soil fertility & agricultural yields, Sequester carbon, Enhance soil structure, water penetration & aeration, Decrease use of pesticides and synthetic fertilizers, Reduce methane emission from soil and nitrous oxide, Decrease farm chemicals leaching into watersheds and nitrate, Create or produce renewable fuels from feedstock's, Change green & brown residues into valuable resources, Decrease dependence on imported oil, Support local, distributed energy production and distribution, Increase energy security and community food, Construct local jobs and economic cycles.

AGRICULTURAL INFLUENCES OF BIOCHAR

Crop	Experimental Type	Soil	Region	Biochar	Application Rate	Effect
Cherry, tomato	Pot	Chromosol	Australasia	Wastewater sludge pyrolysed at 550˚C	10 ton/ha	64%
Wheat, Soybean, Radish		Ferrosol & Calcerosol	Australasia	Pyrolysed paper grindery waste	10 ton/ha	Up to 225% rise in biomass production (soybean only: negative responses for wheat and soybean).
Rice (*Oryza sativa* L., cv Wuyunjing 7)	Field		China		10 & 40 ton/ha	Increase in rice yield of up to 14% in highest application rate and in the absence of applied N.
Maize	Pot	Ultisol	China	Rice straw, pyrolysed at 250˚C - 400˚C for 2 - 8 Hours.	1% ± NPK	Increased maize yield of 146% in the presence of NPK and 64% in its absence.
Maize	Pot	Top soil & subsoil	South America	sugarcane, bagasse	50 g kg/soil +/−bio digest waste(100kgN /ha)	Biochar improved green biomass growing of maize in top soil non-attendance and attendance of waste. Biochar increased green biomass in presence of effluent in subsoil.
Maize	Field	Degraded Amazonian	South America			Biochar doubled maize yield.
Radish	Pot	Alfisol	Australasia	Poultry litter, pyrolysed at 450˚C and 550˚C	0 - 50 ton/ha +/− 100 kg N/ha	(+42%) at 10 ton/ha without N (+96%) at 50 ton/ha without N with N, lower temp material more effective.
Radish (*Raphanus sativus*)	Pot	Alfisol	Australasia	Green waste, pyrolysis	10 - 100 ton/ha	At highest rates with nitrogen (100 kg·ha^{-1}) application, +280% yield, compared to +95% in absence of biochar.

Source: Shareef and Zhao, 2017

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PROSPECTS OF EDIBLE COATING IN FRUIT CROPS

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Introduction

Due to rapid deterioration during pre-and post-harvest conditions, postharvest loss of fresh produce is a serious problem. It adversely affects the quality of fruits. Chemical fungicides provide primary means for post-harvest decay control in the case of fruit crops. However, these chemicals have a harmful impact on human health and the environment and are high in costs, and leave residual effects**.** Over the years, many strategies have been developed to increase the storage life of fruits. One such approach is the use of low-cost, environmentally friendly coatings. Here we prefer alternatives to chemical fungicides for preserving the quality and prolonging the shelf life of fresh fruits, particularly in those areas where refrigeration facilities for storage of bulk material for a longer duration are unavailable. The edible coating is one-of-a-kind and maintains the freshness and extends the shelf life of fresh fruits. Because they are made of food-grade materials, therefore can be consumed both as part of a product and on their own without fear of contamination **(Tavassoli-Kafrani *et al.*, 2016)**.

I) Types of edible coating:

Component-based			
Polysaccharide-based	**Protein-based**	**Lipid-based**	**Mixture with herbal extract**
viii. Starch-based	vii. Soy protein	viii. Bee wax	vii. Neem Oil & Extract
ix. Cellulose and its derivatives	viii. Casein	ix. Mineral oil	viii. Thyme oil & Extract
x. Chitosan-based	ix. Whey Protein	x. Vegetable oil	ix. Citrus essential oil
xi. Alginate based	x. Zein protein	xi. Surfactants	x. Cinnamon extract
xii. Pectin based	xi. Egg albumen	xii. Acetylated monoglycerides	xi. Oregano extract
xiii. Gum based	xii. Collagen	xiii. Carnauba wax	xii. Aloe vera
xiv. Carrageenan		xiv. Paraffin wax	

The edible coating covers the fruit's epicarp, seals the stomata and lenticels, thereby preventing moisture loss and gaseous exchange between the fruit and its external environment. This increases the shelf-life of the fruit by delaying ripening and physico-chemical changes, and preventing the development of physiological disorders. Proteins, polysaccharides, and lipids are used exclusively in the production of these films, which are generally 0.25 to 0.3 mm in thickness and are made up of food-grade components. Generally speaking, edible coatings can be divided into the following categories, which are discussed below:

1. POLYSACCHARIDE-BASED COATINGS

Several different polysaccharides have been evaluated or used as an edible coating. It includes starch and starch derivatives, cellulose derivatives (including alginates), carrageenan (including carrageenan glucosides), various plant and microbial gums, chitosan, and pectinates.

1.1 STARCH-BASED COATINGS

It is the most common polysaccharide and can be found in cereal grains such as wheat, maize, rice, and other grains like oats. Potatoes and other tubers, as well as legumes, are excellent sources of starch. They are colorless and have an oil-free appearance, and they can be used to extend the shelf life of fruits.

1.2 CELLULOSE AND ITS DERIVATIVES

Edible coatings consisting of cellulose and its derivatives, such as carboxymethyl cellulose, methylcellulose, and hydroxypropyl cellulose, have been employed in fruit crops to establish moisture, oxygen, and oil barriers, and these coatings have been shown to be effective **(Vargas *et al*., 2006)**. Using carboxymethyl cellulose (CMC) bilayer coatings on grapefruit, mandarins, and oranges post-harvest life was found to be improved. It also maintains the fruit quality by decreasing gas permeability, weight loss, and oxidation in the fruit **(Arnon *et al*., 2014)**.

1.3 CHITOSAN-BASED

It is a naturally occurring carbohydrate polymer that has been formed by the deacetylation of chitin (a major component of the shells of crustacea such as crab, shrimp, and crawfish). Its antimicrobial action against a wide spectrum of food-borne filamentous fungus, yeast, and bacteria has made it a possible food preservative to inhibit the growth of these pathogens **(Hafdani and Sadeghinia, 2011)**.

1.4 ALGINATE BASED

It is extracted from brown seaweed, which is a member of the phaeophyceae family. It is made up of alginate salts, which are derived from alginic acid. It is found in the form of a white, yellow, fibrous powder. This brown algae-derived sodium alginate is the most commonly encountered form of alginate in food preparation and cosmetics.

1.5 PECTIN BASED

Pectin is a polysaccharide of plant origin. It is beneficial for low-moisture fruits and vegetables, but it is not an effective moisture barrier in other situations. It is most typically found in the peel of citrus fruits and the pomace of apples.

1.6 GUM BASED

The majority of gums are polysaccharides, which means they are composed primarily of sugars. Gums are utilized in the manufacture of edible coatings for fruits and vegetables because of their ability to impart texture to the coating. Gums are easily dissolved in water. They can be classified into three categories a) exudate gums (e.g., Arabic gum), b) extractive gums (e.g., guar gum), and c) microbial fermentation gums (e.g., xanthan gum).

1.7 CARRAGEENAN

Carrageenan is a water-soluble polymer that contains a linear chain of partly sulphated galactans, which can create coatings or film materials when exposed to heat and light. It is isolated from the cell walls of several red seaweeds belonging to the family rhodophyceae.

2. PROTEIN-BASED EDIBLE COATING

Protein-based edible coatings are obtained from animals and plants source. Milk protein (casein), whey protein, zein (maize), gluten (wheat), soy protein, and other plant-based proteins are used as edible coating materials, whereas animal-based proteins include egg albumen, collagen, and other proteins.

3. LIPID-BASED EDIBLE COATING

Edible coatings based on lipids have been used for many years to keep fruits and vegetables fresher longer. These ingredients give meals a glossy appearance and have a high-water barrier capability. Carnauba wax, beeswax, paraffin wax, mineral or vegetable oil, and other lipid-based coating compounds are the most commonly used.

4. HERBAL EXTRACT

The use of herbal extracts in edible coatings for fresh produce is becoming more popular as they have a variety of health benefits. Neem, aloe vera, oregano, cinnamon, clove, mint, and peppermint are just a few examples of the herbs that are being employed. They prevent water loss, regulate the rate of respiration and the ripening process in fruits, inhibit microbial growth, and delay oxidative browning. Because of their non-toxic and environmentally friendly character, herbal edible coatings hold great promise as a food-coating alternative **(Raghav *et al.*, 2016)**.

II) HOW TO APPLY

Application of edible coatings on fruits can be done in a variety of ways. Dipping, dripping, foaming, fluidized bed coating, panning, spraying, and electrostatic coating are some of the methods available. The dipping method is extensively used for applying edible coatings to fruits and vegetables. Fruits and vegetables are dipped in a coating solution for 5-30 seconds before being removed from the solution. The use of high-pressure spray applicators and air atomizing systems to coat whole fruits has been the most preferred approach for coating whole fruits in recent years.

CONCLUSION

To maintain the freshness of fruit for a longer duration, edible coatings have been used in the fruit industry from many years. It is a method that is both safe and environmentally friendly. But this technique has to be employed in all sectors of horticulture so that marginal farmers can also take advantage of it and could get better returns of their produce even after a long period of storage.

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CHANGES IN MIGRANT LABOUR POLICY OF INDIA AND NEED OF A SUSTAINABLE RURAL FRAMEWORK: LESSONS FROM THE COVID-19 MIGRANT EXODUS

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ABSTRACT

With India having a population of 45 million migrant workers, the nationwide sudden lockdown of March 2020 in response to the rising cases of Covid-19, triggered the "Great Indian Exodus" of migrants workers from cities to their native villages after losing their urban livelihoods overnight. Such a phenomenon of reverse migration in Indian villages was an unprecedented one. The existing migrant labour policies of India being ambiguous, proved inadequate in containing the migrant crisis. A National Migrant Policy 2021 has been drafted recently in response to the distress. The authors are apprehensive of the adequacy of the draft in absorbing the socio-economic repercussions of Covid-19 single handedly. Hence along with immediate implementation of the drafted policy, the authors propose formulation of a sustainable policy of developing Pandemic Tolerant Model Villages as a back-up strategy in handling reverse migration effects. Such villages would be characterized by existence of sustainable livelihood opportunities and resilient nature.

INTRODUCTION

It has been a year since the global pandemic of Covid-19 has struck humanity and brought upon mankind an untold and unforeseen misery. India faced the worst second wave just few months back with over one hundred thousand corona cases and over 2500 deaths each day (as in first week of June, 2021) (Government of India, 2021). While the Indian healthcare system is grappled for oxygen to save thousands of patients, the state governments and local administration brought upon stricter restrictions of lockdown to prevent the severe spread of the disease. Last year in March 2020 a nationwide lockdown was imposed restricting the movement of 1.3 billion population. What followed thereafter was a horror story of the Indian history's largest internal exodus, since partition (1947), of millions of migrant workers from cities to villages back home after losing their urban livelihood sources overnight. This can be called as reverse migration because generally people migrate from villages to cities in search of livelihood opportunities. The migrant workers were forced to walk their way back home due to unavailability of transportation and in that spree, thousands lost their lives due to illness, thirst, starvation, weariness and even accidents. The migrant workers again returned back to cities for the sake of livelihood later in 2020 when the lockdown was lifted. In 2021 just as the second wave set foot in India, the migrant labourers started fleeing from the cities again back to their villages. The state wise lockdown by local administrations generated fear amongst the migrants and again a second exodus was in the making, this time not on foot but in proper transportation. The following article discusses the modified labour policies of India made over the years, which being ambiguous, proved inadequate in containing the migrant crisis and the recent policy which has been drafted in response to the distress. The authors are apprehensive of the adequacy of the draft National Migrant Policy 2021 in absorbing the socio-economic repercussions of Covid-19 single handedly. Hence the article proposes the formulation and implementation of a self-sustainable rural framework in addition to the policy changes, for the various social, economic and humanitarian ramifications of the pandemic centralized around the urban-rural imbalance created though the migrant exodus in India.

STATUS OF MIGRATION IN INDIA

In India the human census is conducted once in a decade. According to Census of India, when a person is enumerated in census at a different place than his/her place of birth, he/she is considered a migrant (Office of the Registrar General and Census Commissioner, India, 2021a). Migration may be internal (within country) or international (across countries) borders. Internal migration is of two types: intra-state and inter-state. As of 2011 Census, India had 456 million migrants (38% of the population). 396 million people had migrated internally that is within the country of which 54 million had migrated from one state to another (Office of the Registrar General and Census Commissioner, India, 2021b).

MIGRANT WORKERS: THE INVISIBLE CITIZENS OF INDIA

The reasons for migration are varied. As of 2011, majority (70%) of intra-state migration was due to reasons of marriage and family with variation between male and female migrants. While 83% of females moved for marriage and family, the corresponding figure for males was 39%. Overall, 8% of people moved within a state for work (21% of male migrants and 2% of female migrants) (Iyer, 2020) as evident from Fig.1.

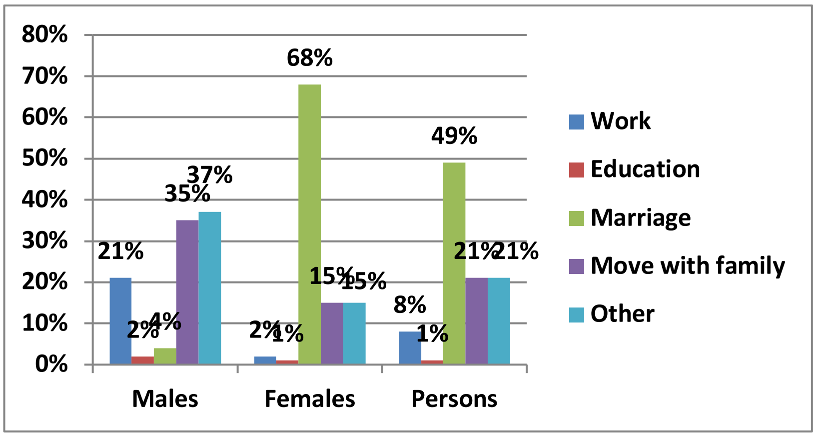

FIG. 1: Reasons for Intra-state Migration

Amongst migrants, migrant workers need to be looked upon in a different angle because these are the ones who migrate either intra or inter-state in search of livelihood opportunities. Migrant workers face key challenges including: i) lack of social security and health benefits and poor implementation of minimum safety standards law, ii) lack of portability of state-provided benefits especially food provided through the public distribution system (PDS) and iii) lack of access to affordable housing and basic amenities in urban areas (Ministry of Housing and Urban Poverty Alleviation, 2017). Movement for work was higher among inter-state migrants- 50% of male and 5% of female inter-state migrants, as shown in Fig.2. As per the Census 2011, there were 45 million migrant workers in India.

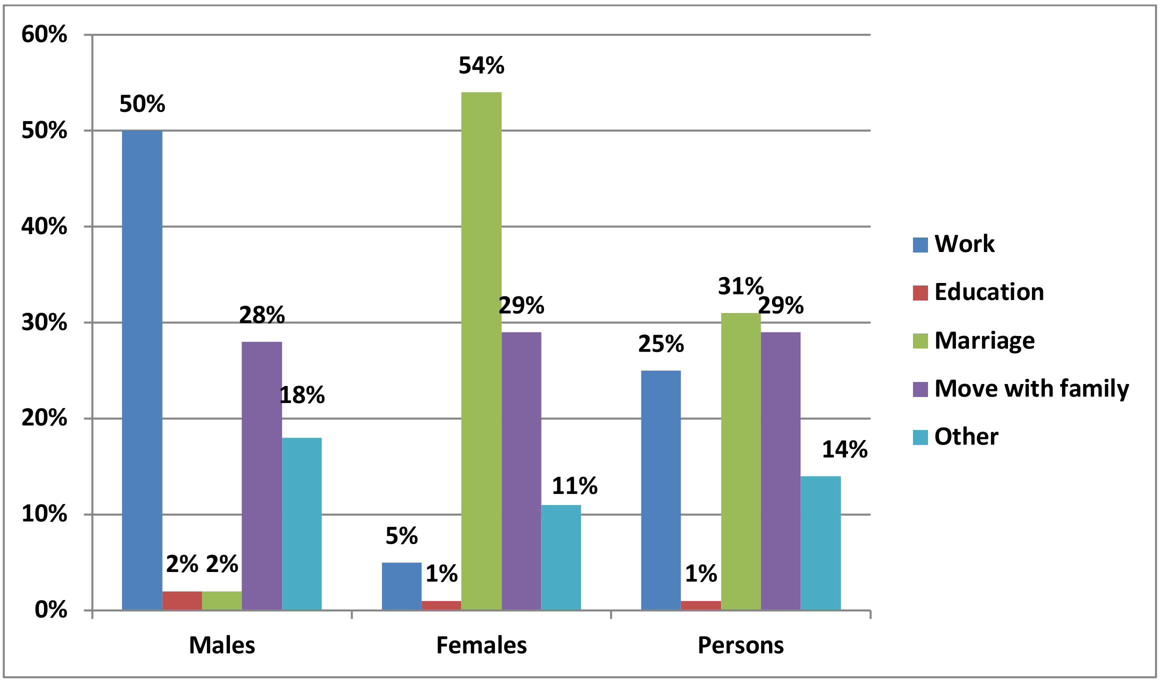

FIG. 2: Reasons for inter-state migration

However, according to the Working Group Report on Migration, 2017, the Census underestimates the migrant worker population, like, not reporting the women who after marriage, start working in migrated states. According to the Economic Survey, 2016-17, Census data also underestimates temporary migrant labour movement (Iyer, 2020). Due to their frequent movement from one place to another in search of livelihood, an accurate database of migrant worker does not exist in India. These people form a group of invisible, untraceable population of India. And this lack of traceability opened to the world, a can of worms exposing the weak migrant labour policies of India when the Covid-19 hit India and triggered unpredictable socio-economic repercussions.

SOCIO-ECONOMIC REPERCUSSIONS OF COVID-19
THE GREAT INDIAN EXODUS AND GOVERNMENT POLICY

During the nationwide complete lockdown in 2020, activities not contributing to the production and supply of essential goods and service sere completely or partially suspended. Passenger trains and flights were halted. The lockdown had severely impacted migrants, several of whom lost their jobs due to shutting of industries and were stranded outside their native places wanting to get back (Iyer, 2020).

SOCIAL REPERCUSSION:

Distressed migrant workers, stranded without jobs, savings, shelter, food, transport or any organized support system, began long treks back home with their families and sparse belongings. The homeward exodus of around 11.4 million migrant workers resulted in at least 971 non-COVID deaths, including 96 workers who died on trains (Paliath, 2021).Migrants died due to reasons ranging from starvation, suicides, exhaustion, road and rail accidents, police brutality, and denial of timely medical care (Kumar and Choudhury, 2021; Dandekar and Ghai, 2020; Singh et al., 2020; Kuttappan, 2021) As per an estimate putting together the numbers of short-term seasonal/circular and long-term occupationally vulnerable workers gives us about 128 million workers whose livelihoods may have been adversely impacted with the onset of COVID19 (Vasudevan et al., 2020).

ECONOMIC REPERCUSSION

The pandemic had caused an economic contraction and the number of poor Indians (with incomes of $2 or less a day) rose by 75 million. In April 2020 alone, 122 million Indians lost their jobs, a 30% fall in employment over the previous year (Paliath, 2021). Estimates suggest that up to 80 % workers from the informal sector lost their jobs as the lockdown progressed. India's GDP growth reduced by 23.9 percent in the first quarter of FY 2020-21 (Gokhroo, 2021) It has been reported that 38.6 % migrants found no work after returning home, and that household incomes dropped by 85 % in the immediate aftermath of the lockdown (Deka, 2021).

GOVERNMENT POLICY IN RESPONSE TO THE MIGRANT DISTRESS

Government of India announced some measures to immediately mitigate the trauma of the poorer strata of the population and to put the economy of the country back on track. A relief package of Rs 1.71 lakh crores was announced under the *Pradhan Mantri Garib Kalyan Yojana* to alleviate the financial loss faced by migrant workers, farmers, urban and rural poor, so that up to 800 million people can be covered. Besides, many states had announced steps to provide free or highly subsidized food rations to people. Considerable enhancement to funding for the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) was envisaged (Ramamurthy and Srivastava, 2020). MGNREGA had emerged as a safety net in most rural areas of the country. As of April 1, 111.7 million people had availed it in 2020-21, up from 78.8 million in 2019-20. Yet, an ILO study last year revealed that while 95 per cent of India's internal migrants lost their jobs during the lockdown, only 7 per cent benefitted from MGNREGA (Deka, 2021).Under the second tranche of the *Aatma Nirbhar Bharat Abhiyaan*, free food grains were announced to be provided to 80 million migrant workers who do not have a ration card for two months. The Finance Minister also announced that One Nation One Ration card will be implemented by March 2021, to provide portable benefits under the PDS. This will allow access to ration from any Fair Price Shop in India. Some state governments announced one-time cash transfers and maintenance allowance for returning migrant workers (Iyer, 2020).

However there are no Government reports released till now on the extent of implementation of all above mentioned efforts and the actual amount of beneficiaries of them.

WHAT WENT AMISS? THE HISTORY OF MIGRANT LABOUR POLICIES OF INDIA

The tumultuous distress of migrant workers returning home to their villages, sent the Indian think tank in a spree to unearth the migrant labour policy of India, only to find that no such exclusive and comprehensive policy exists in India. The historical timeline of migrant labour policies in Fig 3 will make it clear how this untraced population contributing significantly to the GDP went unnoticed and remained uncovered by any specific labour policy.

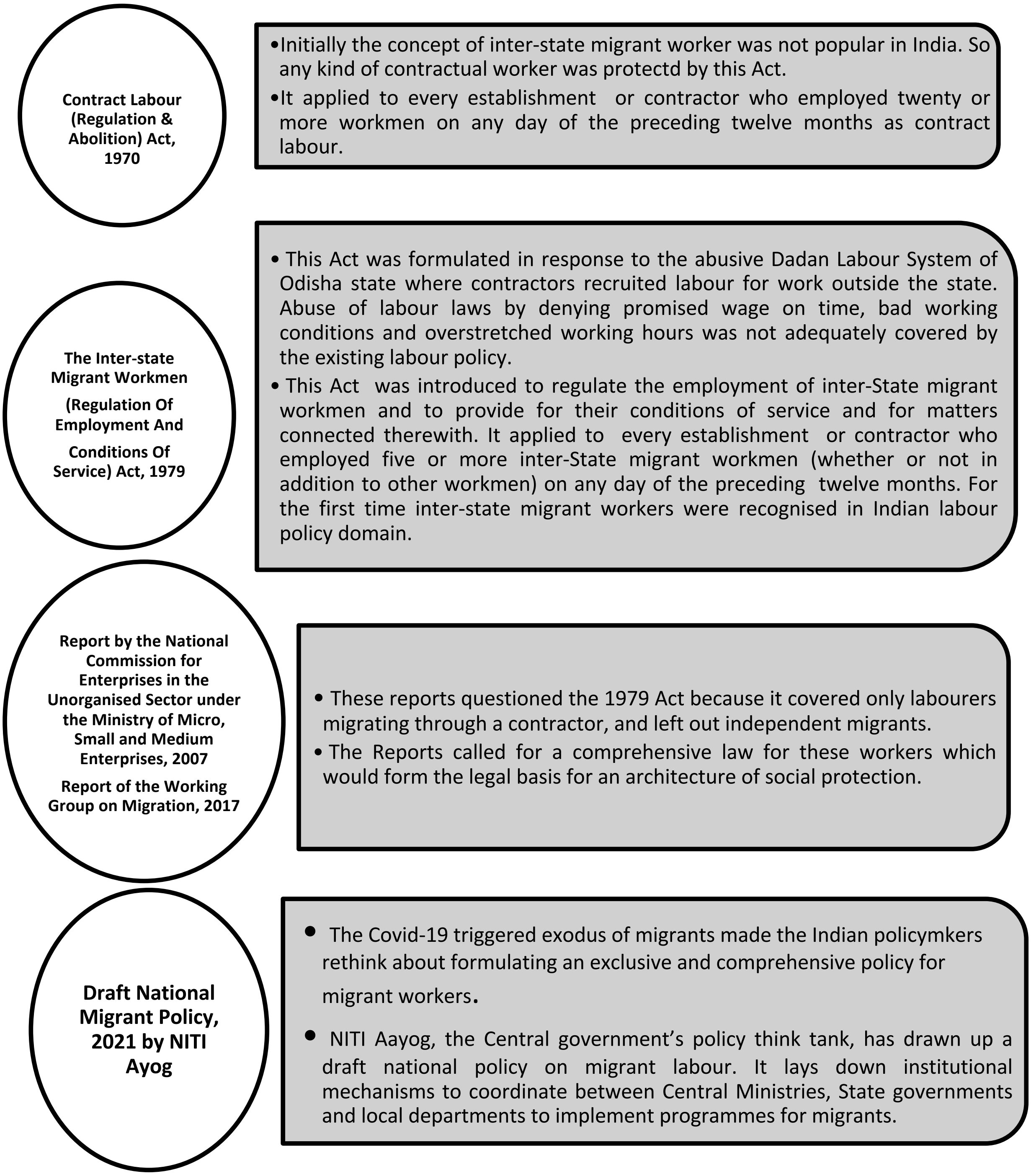

FIG.3: Historical Timeline of Migrant Labour Policies in India

With regard to the labour policies of India, migrant workers have been governed by various labour laws with no focus on migration status as pointed out by Rajan and Bhagat (2021) in their policy paper. Starting from the Contract Labour (Regulation and Abolition) Act, 1970 to the National Migrant Policy which is still in draft stage, migrants are yet to receive their quota of social security. Due to the inadequacy of the 1970 Act in protecting the inter-state migrant workers of Odisha state under the abusive Dadan Labour System (Fig.3), The Inter-state Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979 was brought into force. This was the first time inter-state migrant workers were mentioned in labour policies of India. But this Act had its own flaws because it was designed to protect labourers from exploitation by contractors by safeguarding their right to non-discriminatory wages, travel and displacement allowances, suitable working conditions; thus covering only labourers brought by a contractor and not independent migrants. The flaws were questioned by the 2007 and 2017 Migration Reports (Fig. 3). As reported by Katakam (2021), the only sector that had a social safety net for migrant labour was construction due to The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996. Migrant workers have also been covered to some extent under the Unorganised Workers Social Security Act, 2008. In 2020, different labour laws were amalgamated into four labour codes but with little concern for migrant workers, as reported by Rajan and Bhagat (2021). As already discussed that due to non-traceability, non-registration, lack of a database and also because many work establishments remain excluded till date in labour policies of India, the benefits of such policies do not reach most migrant workers.

The exodus of around 10 million migrant workers, painful loss of thousands of innocent lives sent shock waves across the country and moved the Central Government's think tank NITI Ayog to finally draft a National Migrant Policy in January 2021 along with a working subgroup of officials and members of civil society (Katakam, 2021).

DRAFT NATIONAL MIGRANT POLICY, 2021

The draft national migrant labour policy, opted a rights-based framework. The draft essentially describes two approaches to policy design: focus on cash transfers, special quotas and reservation; enhancement of the agency and capability of the community to remove aspects that come in the way of an individual's own natural ability to thrive (Mehrotra, 2021).

INSTITUTIONAL FRAMEWORK PROPOSED IN THE DRAFT

I) CENTRAL DATABASE

- Creation of a central database to help employers "fill the gap between demand and supply" and ensure "maximum benefit of social welfare schemes".
- Ministries and the Census office to be consistent with the definitions of migrants and subpopulations, capture seasonal and circular migrants, and incorporate migrant-specific variables in existing surveys.

ii) MIGRATION RESOURCE CENTRES

- The Ministries of Panchayati Raj, Rural Development and Housing and Urban Affairs to use Tribal Affairs migration data to help create migration resource centres in high migration zones.

- The Ministry of Skill Development and Entrepreneurship to focus on skill-building at these centres.

III) EDUCATION

- The Ministry of Education should take measures under the Right to Education Act 2009 to mainstream migrant children's education, to map migrant children, and to provide local-language teachers in migrant destinations.

iv) SHELTER AND ACCOMMODATION

- The Ministry of Housing and Urban Affairs to address issues of night shelters, short-stay homes and seasonal accommodation for migrants in cities.

v) GRIEVANCE HANDLING CELLS

- The National Legal Services authority (NALSA) and Ministry of Labour to set up grievance handling cells and fast track legal responses for trafficking, minimum wage violations and workplace abuses and accidents for migrant workers (Mehrotra, 2021).

THE RURAL SCENARIO AFTER THE EXODUS: IS THE DRAFT ADEQUATE TO PROTECT THE MIGRANTS?

Though migrant workers managed to reach their homes in villages after their exodus from cities amidst much plight, but tragedies were awaiting them back home also.

i) PRESSURE ON QUARANTINE CENTRES

Village quarantine centres overcrowded with returnee migrants, as in Bihar, posed a challenge to local authorities in maintaining safety protocols (Singh, 2020). While in villages of Kalahandi, Odisha, there was no facility of quarantine centre at all (Ghosh, 2020a).

ii) LIVELIHOOD CRISIS

With no source of income, no share of family inheritance, the delicate consumption and livelihood balance of villages got disturbed by the return of the migrants (Narayanan, 2020). As a result, after the lockdown was lifted, the migrants were forced to return to the cities from villages due to lack of jobs (Ghosh, 2020b).

iii) CULTURAL DISTRESS

The rural cultural fabric was also disturbed due to the incoming of urban migrants. Their way of living and language and behavior brought cultural rifts with locals (Narayanan, 2020).

iv) RETURNING TO THE ENVIRONMENT PRESSURES THEY LEFT BEHIND

The migrants returned back to the environmental stresses, such as sea-level rise and erosion which had forced them to migrate, thus making the option of farming as source of livelihood back home, impossible (Ghosh, 2020a).

v) NUTRITIONAL IMPLICATIONS

Wage loss, food insecurity gave rise to malnutrition cases especially in children. Though some relief packages were announced, still the implementation of such plans remained a question (Ghosh, 2020a).

Looking at the social exclusion and economic insecurity back home, it is now a question to social science researchers as to whether the Migrant Labour Policy will be adequate enough to protect the migrants in such lockdown and reverse migration scenarios. To some extent, the draft if brought into full action might tone down the impact of lockdown on economic well being of workers in urban areas but, the authors feel, that there is a sheer need of a complimentary policy at village level also to support the migrants who out of fear might return home during lockdowns. The absence of a backup policy at rural level can leave the migrants again to their fate, helpless as before. And with the second exodus already happening, there is an urgent need for developing a sustainable rural framework along with bringing the draft to action.

SUSTAINABLE MODEL VILLAGES

There is a need to develop Model villages with strong rural societies which are self-sufficient, sustainable by nature and progressive enough to not only prevent rural-to-urban migration itself, by providing remunerative livelihood opportunities to its rustic population but also resilient enough to absorb the shocks of reverse migration during any natural or man-made calamity. It is now high time to transform rural India into sustainable micro units or else the pandemonium which the pandemic had wrecked upon the migrant workers, is bound to happen again in near future.

COMPONENTS OF A PANDEMIC TOLERANT MODEL VILLAGE

As it has been already pointed out that reverse migration caused a shortage of livelihood opportunities in village, hence a pandemic tolerant Model Village should ideally have enough sustainable livelihood opportunities along with monitoring of health and nutrition of relocated migrants and also provision of adaptation to rural environment without putting much pressure on rural resources. Hence the components can be:

I) VILLAGE QUARANTINE CENTRE WITH MONITORING FACILITIES FOR INCOMING MIGRANTS:

A FULLY equipped Village Quarantine Centre should be established in an isolated spot away from the village with 1 or 2 attendants to count and register the migrants soon after they return from cities and keep them 14 days quarantined in the centre. A kitchen space can be made in the centre where meals for isolated migrants can be cooked. The staff of quarantine centre should be paid. This can generate some employment. The already designated doctors and nurses of nearest Primary Health Centre can make regular visits to monitor the health condition of the migrants.

II) INFRASTRUCTURE NEEDED TO GENERATE SUSTAINABLE LIVELIHOOD OPTIONS

AN IDEAL PANDEMIC tolerant model village is meant to have enough sustainable resources that migrants can very well be absorbed into the economic mainstream of the village without posing any threat to livelihoods of already existing local residents of the village. The migrants will have many options to choose from. Those migrant families who already have agricultural land in the village can start farming of seasonal crops. Those families who do not have land of their own can start some small business or seek employment. The national rural employment guarantee scheme of MGNREGA can come to the rescue. The following infrastructure in villages can bring sustainability in rural society.

a) FARM INPUT BANK (FIB)

An all-purpose farm input sale centre from where migrant families can either purchase all kinds of farm inputs like seeds, saplings, fertilizers, plant protection chemicals etc with cash or on credit if they do not have thecapacity to pay at that time. After a good harvest, the money can be repaid back with the sale proceeds.

b) CUSTOM HIRING CENTRE (CHC)

Farm machineries can be hired from this centre by those willing to till heir land. Migrant families will not have to venture out of the village in search of machines or even invest their money. A minimal rent or lease can be made between the centre and the migrant farmer.

c) FARM REPAIR CENTRE (FRC)

In lockdown, numerous farmers faced this constraint. Damaged farm tools could not be repaired as shops and mechanics were not available. A repair centre in village hence is essential.

d) LIVESTOCK BANK (LB)

With the help of Livestock Development Officer of the concerned block and nearest Krishi Vigyan Kendra, poultry chicks, ducklings, bees, ornamental birds, goat kids can be handed over to migrant families. They can rear them and sell the animal produce or the animals/birds after maturity.

e) SKILL DEVELOPMENT CENTRE (SDC)

The Central Government's National Skill Development Mission is already conducting skill trainings on various mechanical, agricultural subjects. A skill development centre in the village can hire skilled trainers and impart training to those migrants who wish to set up their own business.

f) AGRI-BUSINESS INCUBATION CENTRE (ABIC)

Agripreneurship is a viable and lucrative livelihood option. Skills on pickle making, jam making etc and how to set up an entrepreneurship of it can be learnt by migrant workers from this centre. Initial hand-holding support andfunds can be provided to the trainees to set up their business. Start-Up and Stand-Up India Missions of Central Government can support these trainees in their agri-business.

g) VILLAGE COTTAGE INDUSTRIES

Cottage industries related to food processing, handicrafts or textiles can be of great help during these tough times. Migrant families can seek employment here.

h) VILLAGE COMMUNITY RESOURCES

The village can maintain certain natural resources at community level by deploying minimal number of local residents as attendants and distributing the produce amongst villagers at normal times. The responsibility of managing these resources, distribution of produce or profit from sale can be given to migrant families who can benefit from this in terms of salary as attendants and also acquire nutritional benefit from the produce of these resources. Community resources can be Gaushalas, Nutrigardens, Medicinal gardens, Community ponds, Community pastures etc.

iii) COVID Special Community Health Centre

Taking lessons from the disastrous second wave of the pandemic in our country, presence of minimally facilitated Covid Care Centre at grassroot level is highly essential. Gram Panchayats can purchase medical kits and oxygen concentrators and keep them as handy in a fully bedded Covid Special Community Health Centre for emergency purpose.

iv) SMALL CULTURAL MEET-UPS

As already pointed out that incoming migrants from cities faced difficulty in mingling with rural culture and local residents, open air small meet-ups between local and migrant families can be arranged for cultural exchange and better understanding of each other. Such meet-ups should be conducted with strict adherence to Covid-19 protocols.

Fig. 4 illustrates how various components can be leveraged to provide not only sustainable livelihood to migrant families but also health and nutritional security after the reverse migration.

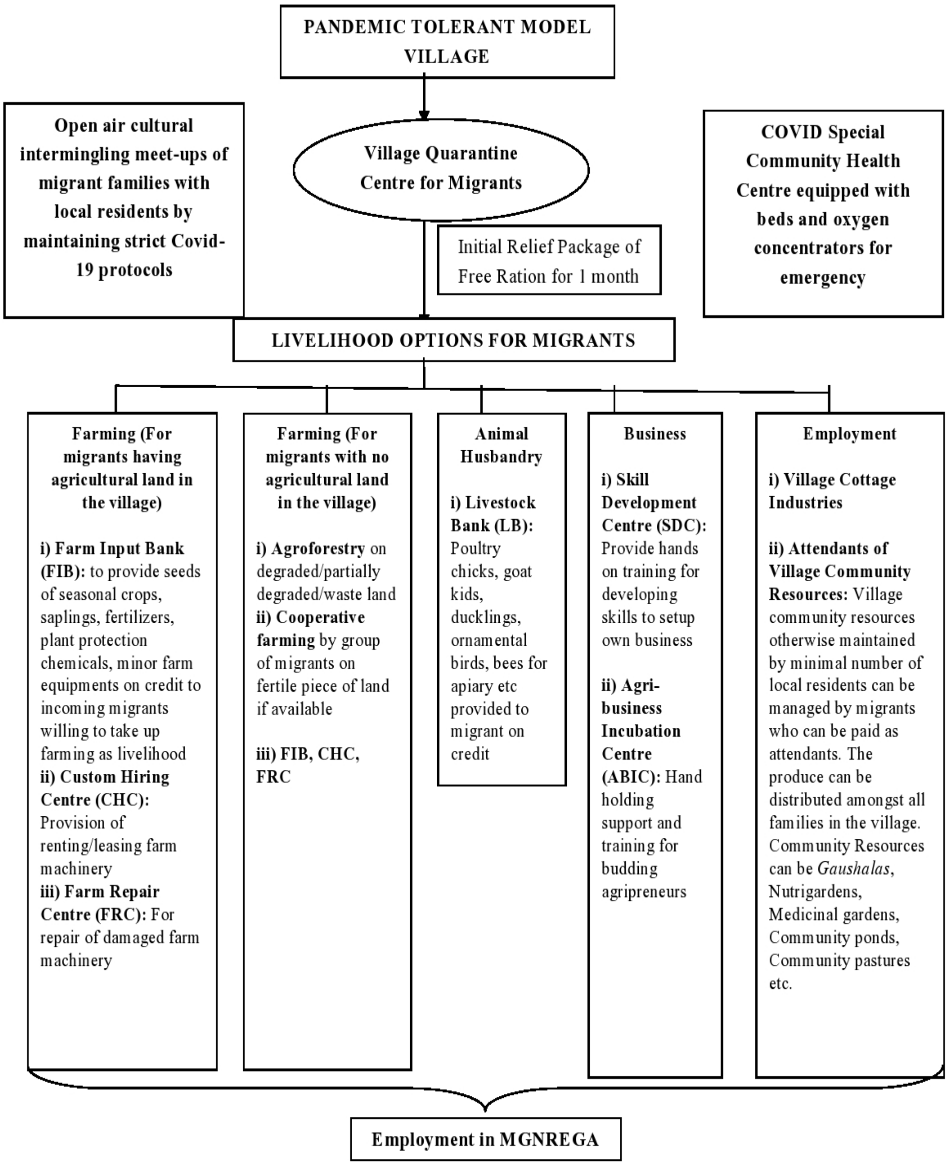

FIG.4: Pandemic Tolerant Model Village

CONCLUSION

As India fights this disastrous bout of Covid-19, it is high time to learn lessons from the past and present situation and prepare for future. Local administration can be given powers and funds for setting up self-sufficient micro units like such pandemic tolerant Model Villages so that bigger crisis can be averted at local level itself with not much interference of higher authorities. Also there is a need to bring certain policy changes like expanding social security programmes - *Pradhan Mantri Gareeb Kalyan Ann Yojana* and MGNREGA, universalizing PDS and introducing urban employment guarantee programme for those workers who wish to stay in cities during lockdown. Meanwhile, identification, tracking, providing social security to migrant worker's families, protection at destination states, seasonal hostels, women's access to safe and decent work should also be priority of Government. **Civil society and philanthropists need to join in such efforts along with the Government.** Though the pandemic has affected the country and the world as a whole, but still sustainable solutions can keep us prepared for any future disaster.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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