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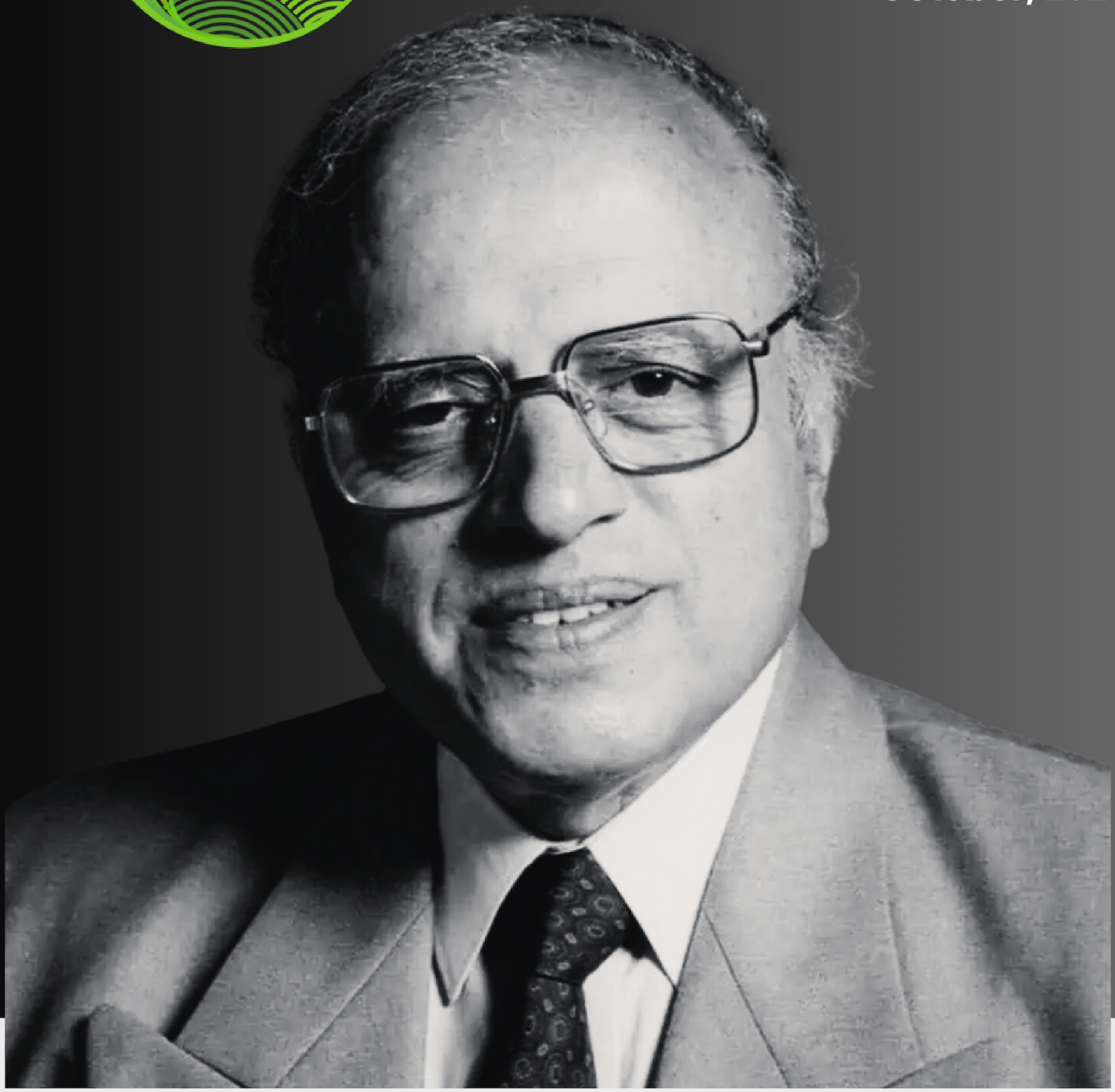

"If Agriculture fails, Everything else will fail"

- **M. S. Swaminathan**

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From the Editor-in-Chief's Desk

I am happy and proud to announce the release of the seventh issue of AgriTech Today Magazine. It gives me great pleasure to inform you that we have curated and finalized 51 articles for publication in this issue.

This issue is dedicated to Father of Indian Green Revolution M. S. Swaminathan. He was an agronomist, plant geneticist, administrator and humanitarian. He was the global leader of green revolution. On 28th September 2023, this Nobel soul left us to the eternal peace. The AgriTech Today Magazine pays tribute to the departed soul.

My sincerest hope is that this issue will provide readers with valuable insights into agricultural technologies and innovations. I extend my heartfelt gratitude to Meghashree D. R. IAS, for her invaluable time for the cover story and the dedicated editorial team and the talented authors for their invaluable contributions in bringing this issue to fruition.

Your efforts have played a pivotal role in making AgriTech Today Magazine a source of enlightenment and knowledge in the agricultural domain.

Editor-in-chief

TABLE OF CONTENTS

Remembering the Father of Indian Green Revolution – M.S. Swaminathan

Meghashree D. R., IAS
Inspector General – Registration and Director Schedule Tribes Development Department, Govt. of Kerala, Thiruvananthapuram

"If Agriculture Goes Wrong, Nothing Else Will Have a Chance to Go Right"

- M.S. Swaminathan

Cover Story

In 1943, when India's struggle for freedom was at its peak, many students from the University of Kerala were actively involved in the freedom struggle including young boy Monkombu Sambasivan Swaminathan. The same year three million Bengalis died due to the shortage of food. This tragedy greatly moved the young boy, and motivated him to utilize agricultural research to empower impoverished farmers and enhance their crop production. After graduating in zoology from Maharaja's College in Trivandrum, Kerala (Now University College, Thiruvananthapuram under the University of Kerala). His interest towards agriculture pulled him to study Bachelor of Science in Agricultural Sciences from University of Madras (now Tamil Nadu Agricultural University).

In the year 1947 he joined Indian Agricultural Research Institute (IARI) to pursue his Post Graduation in Genetics and Plant Breeding. He secured distinction in cytogenetics in 1949. His research focused on the genus Solanum, with specific attention to the potato. During his Post Graduation studies, he attempted Civil Services Examination and was chosen for the prestigious Indian Police Service (IPS), at the same time he got an opportunity as UNESCO fellow in the field of genetics. M.S. Swaminathan chose genetics.

During the Second World War, the demand for potatoes was very high. This caused deviations in age old crop rotation causing golden nematode infestations in certain areas even in reclaimed agricultural lands. This made him to work on adapting genes to provide resilience against such parasites as well as cold weather. In 1950, he moved to study at the

Plant Breeding Institute of the University of Cambridge School of Agriculture. He earned a Doctor of Philosophy degree in 1952 for his thesis "Species Differentiation, and the Nature of Polyploidy in certain species of the genus Solanum – section Tuberarium" During this time he met F. L. Brayne, Former Indian Civil Servant, who shared his extensive experience in rural India, agricultural practices, livelihood etc., which influenced young man M.S. Swaminathan. He remained resolute in his dedication to the noble mission of enhancing the quality of life for rural communities in India.

Continuing his research journey, during his initial years as a post-doctoral researcher at the University of Wisconsin, he specialized in plant

genetics and successfully created a frost-resistant strain of potatoes. However, M.S. Swaminathan declined a faculty position at the university and opted to return to his homeland India. After he returned, there were no jobs in his specialization and it was only three months later that he received an opportunity through a former professor to work temporarily as an assistant botanist at Central Rice Research Institute (CRRI), Cuttack. He was under an Indica-Japonica rice hybridisation program started by Krishna Swami Ramiah the founder director of CRRI, Cuttack who was a recipient of Padma Bhushan and Padma Vibushan for his contributions in the field of agriculture. Later, M.S. Swaminathan joined Indian Agricultural Research Institute (IARI), New Delhi as an Assistant Cytogenetist.

In 1960, India witnessed a major food crisis due to a large gap in production and consumption requirement, which was partially addressed by importing the grains. The entire world criticized India as a "Ship to Mouth" nation for existence – when food grains arrived in ships to feed the hungry population. M.S. Swaminathan collaborated with American agronomist Norman Borlaug, in India and toured together to understand the local agriculture issues. Dwarf wheat varieties with high yields from Mexico and Japan were hybridized. Initial trails in an experimental plot showed good results. The crop exhibited remarkable qualities, boasting high yields, superior quality and resistance to diseases. Nevertheless, Indian farmers were reluctant to embrace this new variety due to apprehensions stemming from its exceptionally high yields. In 1964, following repeated requests by M.S. Swaminathan, he was allocated demonstration plots to plant the new variety of plants. He succeeded in demonstrating 150 plots in one hectare of land. The results were promising and enhanced confidence of the farmers to take up the crop. Additional laboratory modifications were carried out to tailor the grain to Indian environmental conditions. Subsequently, these improved wheat varieties were cultivated and in 1968, the production yielded a remarkable 17 million tons, showing a significant increase of 5 million tonnes compared to the preceding harvest.

Just before receiving his Nobel Prize in 1970, Norman Borlaug wrote to M.S. Swaminathan "The Green Revolution has been a team effort and much of the credit for its spectacular development must go to the Indian officials, organizations, scientists, and farmers. However, to you, M.S. Swaminathan, a great deal of the credit must go for first recognizing the potential value of the Mexican dwarfs. Had this not occurred, it is quite possible that there would not have been a Green Revolution in Asia."

M.S. Swaminathan's idea was to increase production per unit of land and water and help small farmers increase their agriculture production. These scientific and Political breakthroughs led to the Green Revolution. With the vision to bridge the gap of scientific know-how to farmers do-how Krishi Darshan program was launched. With the help of radio and television, Krishi Darshan reached the nooks and corners of Indian villages. The combination of scientific research, local knowledge, enabling policies and the use of ICT resulted in further enhancement in the production of grains was recorded. For his remarkable contributions to agriculture, Swaminathan received numerous awards, including the prestigious first World Food Prize in 1987 and India's second-highest civilian honour, the Padma Vibushan, in 1989.

To address practical problems faced by rural populations in agriculture, food and nutrition with science and technology, M.S. Swaminathan Research Foundation was established in 1988 with proceeds from the First World Food Prize that he received in 1987.

His contributions greatly helped us to achieve self-sustainability in food grains production. However, they were not free of controversies. M.S. Swaminathan was criticized for unsustainable agriculture practices in the garb of green revolution. In his later years M.S. Swaminathan spoke about evergreen revolution with sustainable and responsible agriculture practices. He said other varieties of wheat

and rice needs to be grown and preserved. He stressed on biodiversity conservation and preservation of nature in its original form. He presented five reports of the national commission for farmers and became a household name. His desire was to see farmers pulled out of acute distress and misery and continued to work for it.

When he departs us at the age of 98 years, He leaves behind a rich legacy of Indian agriculture science which may serve as a guiding light to steer the world towards a safer and hunger-free future for humanity.

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Role of Conservation Agriculture in Sustainable Agriculture and Its Impact on Soil Property

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Conservation Agriculture (CA) is a farming system that can prevent losses of arable land while regenerating degraded lands. It promotes maintenance of a permanent soil cover, minimum soil disturbance, and diversification of plant species. It enhances biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and to improved and sustained crop production. CA principles are universally applicable to all agricultural landscapes and land uses with locally adapted practices. Soil interventions such as mechanical soil disturbance are reduced to an absolute minimum or avoided, and external inputs such as agrochemicals and plant nutrients of mineral or organic origin are applied optimally and in ways and quantities that do not interfere with, or disrupt, the biological processes.

CA facilitates good agronomy, such as timely operations, and improves overall land husbandry for rainfed and irrigated production. Complemented by other known good practices, including the use of quality seeds, and integrated pest, nutrient, weed and water management, etc., CA is a base for sustainable agricultural production intensification. It opens increased options for integration of production sectors, such as crop-livestock integration and the integration of trees and pastures into agricultural landscapes.

Three principles of Conservation Agriculture

Minimum mechanical soil disturbance

Direct seeding involves growing crops without mechanical seedbed preparation and with minimal soil disturbance since the harvest of the previous crop. The term direct seeding is understood in CA systems as synonymous with no-till farming, zero tillage, no-tillage, direct drilling, etc. Planting refers to the precise placing of large seeds (maize and beans for example); whereas seeding usually refers to a continuous flow of seed as in the case of small cereals (wheat and barley for example). The equipment penetrates the soil cover, opens a seeding slot and places the seed into that slot. The size of the seed slot and the associated movement of soil are to be kept at the absolute minimum possible. Ideally the seed slot is completely covered by mulch again after seeding and no loose soil should be visible on the surface.

Permanent soil organic cover

Keeping the soil covered is a fundamental principle of CA. Crop residues are left on the soil surface, but cover crops may be needed if the gap is too long between harvesting one crop and establishing the next. Cover crops improve the stability of the CA system, not only on the improvement of soil properties but also for their capacity to promote an increased biodiversity in the agro-ecosystem. While commercial crops have a market value, cover crops are mainly grown for their effect on soil fertility or as livestock fodder. In regions where smaller amounts of biomass are produced, such as semi-arid regions or areas of eroded and degraded soils, cover crops are beneficial as they:

- Protect the soil during fallow periods.
- Mobilize and recycle nutrients.
- Improve the soil structure and break compacted layers and hard pans.
- Permit a rotation in a monoculture.
- Can be used to control weeds and pests.

Species diversification

The rotation of crops is not only necessary to offer a diverse "diet" to the soil microorganisms, but as they root at different soil depths, they are capable of exploring different soil layers for nutrients. Nutrients that have been leached to deeper layers and that are no longer available for the commercial crop, can be "recycled" by the crops in rotation. This way the rotation crops function as biological pumps. Furthermore, a diversity of crops in rotation leads to a diverse soil flora and fauna, as the roots excrete different organic substances that attract different types

of bacteria and fungi, which in turn, play an important role in the transformation of these substances into plant available nutrients.

Table 1: Comparison between conventional and traditional agriculture

Issues	Traditional Agriculture	Conservation agriculture
Practice	Disturbs the soil and leaves a bare surface	Minimum soil disturbance and Soil surface permanently covered
Erosion	Wind and water soil erosion maximum	Minimum
Soil physical health	Poor	Good
Compaction	Reduces compaction by tillage operation	Compaction can be a problem but\use of mulch and promotion of biological tillage helps to reduce this problem
Soil biological health	Poor due to Frequent disturbance	More diverse and healthy biological properties and populations
Water infiltration	Lowest after soil pores clogged	Best water infiltration
Soil organic matter	Oxidizes soil organic matter and causes its loss	Soil organic build up in the surface layers even better than traditional agriculture
Soil temperature	Surface soil temperature more variable	Moderated variable
Fuel use and cost	High	Low
Production costs	High	Low
Yield	Can be lower where planting delayed	Yields same as TA but can be highest if planting is done timelier

CA include practices or technologies such as

Direct sowing: Direct sowing consists of promoting the growth of a new crop without the preparation of mechanical seedbed and minimal soil disturbance since the harvest of the previous crop.

No-tillage: is the process where the crop seed will be sown through drillers without prior land preparation and disturbing the soil where previous crop stubbles are present.

Reduced tillage: It involves considerable soil disturbance, though to a much lesser extent than that associated with conventional tillage.

Surface incorporation of crop residues: Crop residues can improve soil structure, increase organic matter content in the soil, reduce evaporation, and help fix CO2 in the soil.

Types of conservation tillage

Ridge Tillage

Ridge tillage is a form of conservation tillage that uses specialized planters and cultivators to maintain permanent ridges on which row crops are grown.

Minimum tillage

Aims at reducing tillage operations to the minimum necessity for a reasonably good seed bed to establish adequate crop stand and favorable Soil conditions for growth and development of crops.

Zero/No tillage: As the name implies, do not use tillage for establishing a seedbed.

Impact of Conservation Agriculture Practices

Reduction in Cost of Production

This is a key factor contributing to rapid adoption of zero-till technology. Cost reduction is attributed to savings on account of diesel, labour and input costs, particularly herbicides.

Reduced Incidence of Weeds

By supressing weed germination through incorporation of residue.

Saving in Water and Nutrients

Experimental results and farmers experience indicate that considerable saving in water (up to 20% – 30%) and nutrients are achieved with zero-till planting and particularly in laser leveled and bed

planted crops. Higher soil water content under no-till than under conventional tillage indicated the reduced water evaporation during the preceding period.

Increased Yields and Productivity

CA enhance the yield level of crops due to associated effects like prevention of soil degradation, improved soil fertility, improved soil moisture regime (due to increased rain water infiltration, water holding capacity and reduced evaporation loss) and crop rotational benefits.

Environmental Benefits

Conservation agriculture involving zero-till and surface managed crop residue systems are an excellent opportunity to eliminate burning of crop residue which contribute to large amounts of greenhouse gases like CO2, CH4 and N2O. Burning of crop residues, also contribute to considerable loss of plant nutrients, which could be recycled when properly managed. Large scale burning of crop residues is also a serious health hazard.

Conclusion

All conservation tillage practices significantly improved soil physical properties mainly aggregate stability, bulk density, porosity, and maximum water holding capacity as compared to conventional tillage practices. No-tillage with BBF and FB with crop residues retained on the surface significantly increased nutrient status in the soil and higher productivity as compared to conventional tillage with no crop residues in soybean-wheat and maize-chickpea cropping systems.

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Anatomical and Histological Characteristics of Pituitary Gland in Domestic Animals

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Abstract

As it regulates important physical functions and general wellbeing, the hypophysis plays a major role in responding to the increased demand for different hormones. In the current review, we described the anatomical and the histological structures of the pituitary glands in different domestic animals. Unlike other glands, the pituitary gland has two main parts; the adenohypophysis (anterior lobe), which contains multiple populations of endocrine cells and is responsible for producing each of the pituitary trophic hormones. Another part of the pituitary gland is that the neurohypophysis (posterior lobe) secretes granules that contain certain neurohypophyseal hormones, like antidiuretic hormone and oxytocin, which are synthesized in the hypothalamus.

Keywords: domestic animals, effectiveness, hormones, hypophysis, structure.

Introduction

As a key component of regulating physical functions and general welfare, the hypophysis plays a significant role. Although the animal's body is complex and has many functions, it is significantly effective, and it is controlled by two main systems: the nervous system and the endocrine system. A nerve's chemical and electrical signals are carried at high speed by the nervous system, resulting in a high rate of organ activity. The endocrine system synthesizes and releases chemicals substances in the body of animals. This system has many functions and presents slowly but persists for a long time. During development, the pituitary gland has two lobes, the anterior lobe (adenohypophysis) and the posterior lobe (neurohypophysis . Adenohypophysis develops from the (Rathke's pouch) of oral ectoderm, whereas the neurohypophysis develops from neural ectoderm and diencephalons. The pituitary gland or hypophysis can be considered the master organ in domestic animals, which produced many hormones that directly activated other endocrine organs. The signals that send to different glands and organs in the body are regulated by the pituitary gland which maintained their function. The messengers are transmitted through many hormones secreted from this gland and passed the information from the hypophysis to distant cells, regulating their activity. As with other glands, their actions are similar, as are those of the adrenal cortex. Other body functions and regulations also might be influenced by the action of this gland.

Anatomical characteristics

Because it is an appendage of the brain, it has significance as a relay between nervosa and hormonal mechanisms that control certain functions in conjunction. Located at the ventral midline of the diencephalon, the hypophysis cerebri is suspended from the hypothalamus by a cylindrical stalk. It is an extension of the median eminence of the hypothalamus, referred to as the pars proximalic neurohypophysis. A gland's oval shape resembles a peanut (peanut-like), a disc in shape in rats, and it is bilaterally symmetrical from a sagittal plane in size and shape. The terminal of the hypophysis in Bactrian camels is a tiny protuberance that served as the neurohypophysis terminal. There are two endocrine glands in the brain, one of these is the Pituitary gland which is gray-red in color and positioned down dorsolaterally, and have an oval shape structure in donkeys. Anatomical structures of the gland are very affected by the seasons, age, and sex of the animals (Dent 1961). The pituitary gland in rats is unpaired. It is a disc in shape and positioned in the caudal part of the brain. It is surrounded by a very thin white capsule which is part of the dura mater called the (sella diaphragm) in rats. While in the dogs and small ruminants, the gland is rounded in shape, placed in the sella, next to the optic chiasm there is a small slip in the sphenoid bone that is positioned on the base of the brain

Histological characteristics

In the pituitary gland, there are two parts: the anterior pituitary, also known as the adenohypophysis, and the posterior pituitary, also known as the neurohypophysis. The adenohypophysis, is composed of three pars distalis, pars tuberalis and pars intermedia.

The hypophysisis enclosed by a thinner coat of capsule with connective tissue, mainly collagen fibers and reticular fibers. In addition to the outer adenohypophysis, the inner neural part of the gland (neurohypophysis) exhibits numerous histolocytological features. The adenohypophysis and the neurohypophysis are connected together by thick layers of connective tissue. The adenohypophysis is divided into three zones, pars distalis, pars tuberalis, and pars intermediate. The parenchyma of the pars distalis components are organized as clusters or cords, which are covered by accurate connective tissue stroma that contained cells composed of large sinusoidal capillaries. The pars distalis is based solely on the staining properties of secretory granules within the cells. Secretory granules have an affinity for acidic and basic dyes, allowing histologiststo distinguish basophils, acidophilus, and chromophobes based on their staining reaction. Seven types of cells in pars distalis could be recognized by immunohistochemical techniques and electron micrographs (Ye et al 2018; Moriarty 1974). The pars tuberalis forms a sleeve around the stalk of infundibulum. Its thickness is 25-60 µm. It consists of highly vascularized cord, of epithelial cells. In humans, pars tuberalis is not known with certainty, the pars tuberalis encircled the infundibulum of the neurohypophysis. There are four cell types in buffaloes: 1- Light cells: Large pale polygonal cells, 2- Magenta- syncytial cells: The syncytium loaded with ovoid or irregularly triangular nuclei with dark chromatin, 3-Double squamous cells: This type of cells lied at the periphery of the pars tuberalis and encircled the pars nervosa, it consisted of two layers of small squamous cells with fine magenta secretion granules similar to that of the magenta-syncytial cells, 4-Water- clear cells: There are two types of cells, small and large, spherical. It is smaller than the light cells, found in a small number. It has a pale water- clear empty cytoplasm with dark spherical to ovoid nuclei.

Rats, pigs, and camels have well-developed pars intermedia (Malallahand Hussin 2010; Hewitt 1950). It lies close to the neurohypophysis and is separated from the pars distalis by a cleft. As a result of dense connective tissue intermingling with cells, the pars intermedia are poor. Many cells migrate from the pars intermedia into the pars nervosa. Two types of cells can be found in the pars intermedia; magenta cells have dark granules, while chromophobe cells are devoid of granules in their cytoplasm (Mahmood 2014). The pars nervosa, the infundibular stalk, and perhaps the median eminence are involved in neurohypophysis. The connective tissue, pituicytes, large numbers of nerve fibers without myelin, and capillaries are the main structures of this part.

Conclusions

In conclusion, the unique structure of the pituitary gland -which consists of two main parts; the adenohypophysis (anterior lobe) contains multiple populations of endocrine cells- is responsible for synthesizing and secreting each of the pituitary trophic hormones. The other part is the neurohypophysis (posterior lobe) is responsible for the secretion of granules that contain the neurohypophyseal hormones, i.e., antidiuretic hormone (ADH, vasopressin) and oxytocin, which are synthesized in the hypothalamus.

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Enhancing the Efficiency of Farm Labour

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There is great contribution of labourers in farming and its share in the total farm expenses is very significant. To make farming more profitable, there is a need to reduce the cost of cultivation. It has been observed that the labour engaged in agriculture is not utilized properly and there exists the scope for increasing its efficiency. In addition to family labour, farmers normally engage casual labour and permanent labour according to the quantum of work. A wise farmer gets more work from the labourers as compared to other farmers. The field surveys revealed that work being got done from labourers is not upto the full capacity of the labourers. Work being done on contract basis is not up to the mark in many cases. It has been observed that the farmers allocate the work of spray of pesticides/weedicides to the untrained workers who do not follow proper spray techniques.

Therefore, the pesticide/weedicide cannot be sprayed uniformly and some spaces/patches may be left without spray in the crop and the farmers do not get the desired results. Similarly, in the month of March, irrigation needs to be given to wheat when there is no heavy wind blowing and this condition can only be assessed by an experienced person. Mostly, the paddy transplanting work is being done by the migrant labour on contract basis. Migrant labour transplants 15 to 23 plants per square metre against the recommendation of 33 plants per square metre. Even the operations like marketing of produce are left to labourers who do not know marketing specifications/norms. Therefore, the farmer should supervise each farm operation to be done by the labour to avoid imperfections in the work and to get the desired results.

Reasons for not using the farm labour efficiently

- Allocation of work not in accordance with the capability of the labourers
- Lack of supervision of the allocated work
- No assessment of the allocated work
- Not keeping the agricultural machinery/implements in order
- Non arrangement of farm inputs prior to its use
- Non adoption of diversified farming and subsidiary occupations
- Lack of proper farm planning
- Less practice of farmers working with the labour

Tips for getting maximum work done from labour

- **Allocation of work in accordance with the capability of labour:** There is great need to allocate the work to labourers keeping in view their capability. Some of workers are specialized in performing a particular work or can be trained. So work needs to be allocated according to their interest and efficiency. Ability for proper maintenance of farm machinery needs to be kept in view while allocating the work related to the use of farm machinery and implements. A trained person can detect any defect in the farm machinery immediately and set it right at proper time. Proper handling of machinery enhances its life. Similarly, the work pertaining to spraying of plant protection chemicals needs to be allocated to skilled labourers only.
- **Supervision and assessment of allocated work:** To get more and proper work from the labour, supervision and assessment of allocated work is required. Some of the farmers having large farm size can not afford to work with labourers engaged but in this situation they should allocate the work to labourers and assess it in the evening whether the desired work has been done properly or not. Labourers performing well needs to be appreciated and less performer needs to be persuaded to work more efficiently.
- **Diversified farming and adoption of allied enterprises:** Paddy-wheat is the main crop rotation in the State which does not provide

enough opportunities to keep the labourers engaged round the year. There is need to diversify the farming and adoption of allied enterprises such as dairy farming, fishery, poultry, bee keeping, etc. Most of the allied enterprises can be run successfully with the existing family and permanently hired labour.

- **Proper planning**: Advance planning for proper utilization of the available resources is must for making farming economical. For proper planning in agriculture, the knowledge about optimum time of different farm operations, required inputs, need of farm machinery, etc. is most urgent. A farmer should think a day ahead about the work to be allocated to the labour during the morning of next day. In this way, there will be no wastage of time of the labourers.
- **Involvement of family labour to work with hired labour:** The tendency of family members working with the hired labour is declining day by day and this is not a healthy practice. If the family members work with hired labour, more work can be got done from the hired labour as this practice creates the sense of competition and the quality of work will also be better.
- **Keep the farm machinery in order:** Usually the farmers set right the machinery in the morning when the labour is about to start the work and resultantly labour time is wasted. Implements/machinery likely to be used next day needs to be checked a day earlier. Combines and threshers needs to get repaired before the commencement of season.
- **Adoption of proper crop rotation:** Crop rotation should be planned in such a way that the famer can get maximum work from the hired labour. If the available resources permit, prefer to take more than two crops in a year.
- **Kitchen gardening:** For domestic needs, there should be least dependence on the market for vegetables, fruits and pulses. These should be grown in kitchen garden. This practice would keep family labour busy. Proper use of labour would reduce cost of cultivation.

Therefore, it is advised that above points need to be kept in view for efficient management of farm labour.

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Crude Oil Pollution in Soil: Causes, Effects and Remediation

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Crude oil is a naturally occurring, unrefined petroleum product composed of hydrocarbon deposits in natural underground pools or reservoirs and remains liquid at atmospheric pressure and temperature. Although it is often called "black gold," crude oil has a wide-ranging viscosity and can vary in color to various shades of black and yellow depending on its hydrocarbon composition. Crude oil can be refined to produce usable products such as gasoline, diesel and various forms of petrochemicals.

Even though most crude oil is produced by a relatively small number of companies, and often located in remote locations far from the point of consumption, trading in crude oil on a global basis has always been robust. Nearly 80% of international crude oil is transported through waterways in large tankers and most of the rest by inland pipelines

Table 1: Composition of crude oil

Element	Weight (%)	Hydrocarbons	Weight (%)
Carbon	83-87	Paraffin	30
Hydrogen	10-14	Naphthene	49
Nitrogen	0.1-2	Aromatics	15
Oxygen	0.1-1.5	Asphaltic	6
Sulfur	0.5-6		
Metals	<0.1		

Crude oil is composed of volatile liquid hydrocarbons with varying molecular weight and structure. It contains more than 17,000 hydrocarbons and its classification are based on the most prevalent compound present in it. The three main hydrocarbons components present in crude oil are compiled in Table 2.

Transportation of crude oil

1) Pipeline transportation of crude oil

Crude oil pipelines are the most common, safest, and cheapest of all modes of crude oil and refined product transport. With a high upfront investment cost their long-term payoff comes from decades of use

Table 2: Three main hydrocarbons components present in crude oil.

Paraffins	Methane
	Ethane
	Octane
Naphthenes	Benzene
	Toluene
	Xylene
PAH	Naphthalene
	Anthracene
	Benzopyrene

2) Crude oil transportation through barges

Marine transport, largely via barge or tanker, is the second cheapest mode of oil shipment. This is especially true for companies that export crude oil internationally.

3) Transporting crude oil through rail

Not all oil wells are accessible via pipeline, making rail the most financially feasible option for accessing land-locked oil wells that later feed the refining landscape.

4) Crude oil transportation through truck

Over-the-road transportation is the most expensive and inefficient means of crude oil transportation. The amount of crude oil an average truck can transport is only between 200-250 barrels of oil per movement. This makes it an expensive and inefficient option. This method is typically utilized only when wellhead locations are not accessible by pipeline or rail networks, or for short distances during final-mile segments of the movement.

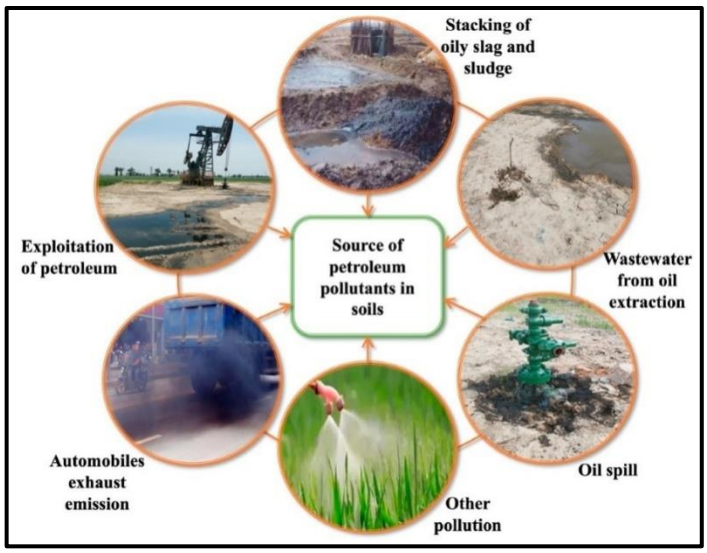

Fig. 1 Sources of petroleum pollutants in soil

Environmental behavior of oil pollutants in soil

- Soil is an important part of human environment. It is a multi-medium complex system composed of solid-liquid-gas-biology.
- The environmental behaviors of oil in soil mainly include:
  - ✓ **Migration,**
  - ✓ **Adsorption**
  - ✓ **Degradation**
- The environmental behavior of petroleum in the soil and its harmfulpollutants will infiltrate into the soil and remain in the soil. Because there are a large numberof organic and inorganic colloids, soil plants, animals and microorganisms in the soil.
- The pollutants entering the soil are continuously adsorbed, decomposed, migrated and transformed through the physical, chemical and biological processes of the soil. Generally, the migration ability of oil in the soil is very weak, and it is mostly absorbed and concentrated in the surface soil.
- The oil on the soil surface can be self-purified by volatilization. When the pollution intensity is high and the content of small molecules of hydrocarbons is high, they can migrate into the groundwater aquifer.

Remediation of oil polluted soils

Chemical methods

- ✓ Chemical oxidation is an efficient method to remove dangerous wastes from the soil at the oil spilled sites. The efficiency of this method strongly depends on the soil matrix.
- ✓ Fenton's reagent, a mixture of Hydrogen peroxide and Ferric ion, is used for chemical oxidation. Hydrogen peroxide is a strong oxidizing agent that generates hydroxyl ions during Fenton's reaction while ferric ion acts as catalyst. Hydroxyl ions are very powerful and effective agents that destroy the contaminants present in the soil.
- ✓ Removal of oil from sand at lower pH by using Fenton's reagent is much efficient than at natural pH or peat. Another efficient oxidant that is used for the removal of crude oil from soil is ozone.

Physical methods

- ✓ Excavation of crude oil contaminated soil is the quickest and safe way but not a sophisticated and cheap method. The contaminated soil is removed and transported to appropriate landfill for the disposal.
- ✓ The samples are collected from bottom and sidewalls of the excavated area to check if the site is clean or not. Another physical method is the washing of contaminated soil. Washing with organic solvents such as ethanol- water mixture and ethyl acetate-acetone-water mixture exhibited significant removal of hydrocarbons from the contaminated soil.
- ✓ Soil washing does not only treat the oil contaminated soil but also remove the heavy metals from the soil. The efficiency of washing can be enhanced by the addition of surfactants.

Thermal methods

- ✓ In Thermal stripping/low temperature thermal desorption/soil roasting contaminated soil is heated to very low temperature (200- 1000 °F) to increase the vaporization and separation of low boiling point contaminants from the soil.
- ✓ By this process organic contaminants can be completely or partially decomposed depending upon the thermal stripping

temperature and organic compounds present in the soil.

- ✓ This method can remove approximately 90% of the contaminants but it is very costly and not eco-friendly. Another way to remove crude oil from the soil is incineration.

Biological methods

- ✓ Bioremediation is a traditional method that involves the use of living organisms (bacteria, fungi and plants) to degrade harmful substances present in the environment.

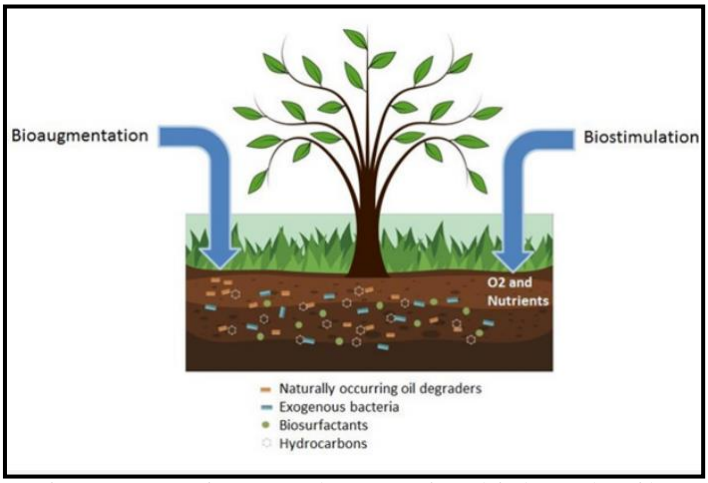

Fig. 2 Strategies to enhance microbial crude oil degradation in soil.

- ✓ Bioremediation of crude oil from the soil is very efficient, cheap and environmentally friendly solution. The effectiveness of this method is depended on hydrocarbon concentration, soil characteristics and composition of pollutants.

Microbial remediation of contaminated soil is affected by many factors such as water amount, temperature and pH of soil, concentration of oxygen, soil quality and amount of nutrients. Change in any of these factors can decrease the population of microbes and in turn decreases the bioremediation. Microbial activity can be accelerated by using bioaugmentation and biostimulation strategies.

In bioaugmentation exogenous oil degrading bacteria are supplemented to enhance soil microbiota while in biostimulation addition of nutrients, aeration and optimization of physical conditions like pH and temperature is performed. Research has shown that bioaugmentation and biostimulation when used together effectively remediate crude oil hydrocarbons polluted soil. It has been observed that the number of exogenous bacteria decreases after sometimes because of nutrient unavailability or other abiotic factors (pH, temperature or oxygen).

Therefore, bio stimulation incorporation with bioaugmentation provided effective results in the degradation of crude oil pollutants. Different types of surfactants produced by many microorganisms are called biosurfactants. These biosurfactants enhance the bioavailability of hydrocarbons to the microbes and in turn increases its degradation. Use of biosurfactants producing microbes is a good bioremediation choice as this process is cheap, nontoxic with efficient degradation rate.

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Promoting Child Safety at Home

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When you become a parent, your child's safety takes topmost priority and can often leave you overwhelmed, because, it's your job to protect your child. Your adult-friendly home has many potential hazards for a child. But you can keep your child safe by finding out what the dangers are, and then preventing or removing them. But even when you think you've detached all the home safety hazards, the reality is that children can still have tumbles and falls. That's why observation is one of the keys to child safety at home. And along with supervision and a safe environment, you can also improve home safety by teaching your child about what's safe and what's not. There are many steps you can take to defend your child against accidental injury and harmful situations. We rounded up our top baby safety guidelines that'll help you protect and care for your little one.

Tips for child/ Baby safety in the home

- For bath safety, always supervise and give your full attention to babies and children under five years in the bath. Never leave your baby unattended in the bathtub or bath ring. It only takes a few seconds for a baby to drown.
- Prevent scalds in the bathroom. Reduce the temperature of the hot tap water at the basin. Always test bath water temperature before bathing children – the safest bath temperature is 37-38°C.
- Store small appliances, such as hair dryers and radios, away from the water and bathing areas. Keep these appliances unplugged and out of reach when not in use.
- Do not use a baby support or bath seat to prop the baby up in the bath.
- Never leave an older child to supervise a younger child in the bath.
- Empty the bath immediately after use. And use non-slip mats in your baby's bath area.
- Keep soft toys and soft bedding, including blankets, pillows and bumpers pads, out of the baby's sleep area.
- Avoid feeding your baby raw pieces of carrot and raw apple. Shred, grate or steam hard fruit and vegetables to reduce the risk of choking. Peanuts are not suitable for children under the age of five. Teach children to sit quietly while they are eating, and enjoy an unhurried meal.
- To prevent burns, keep your child away from fire and hot surfaces. Keep a close eye on your child whenever they're near things that can burn- especially around stoves, microwaves, heaters, ovens, and other appliances.
- Keep hot food and drinks away from and out of reach of children.
- Avoid holding your child if you're having hot food and drinks.
- Establish the area in front of the stove as off-limits while you are cooking.
- To prevent burns, do not microwave your baby's bottle. Make sure you test the temperature on your hand or wrist before feeding it to your baby.
- Never prop up your baby's bottle and leave your baby unattended; your baby could choke. Do not put your baby to bed with a bottle.
- Store medicines, chemicals and cleaning products out of reach and in lockable cupboards. Never store toxic substances in bottles or jars that could be mistaken for food products Never "double dip" with baby food. Throw away any unused food after a feeding.
- Never share spoons. If you want to show your baby how to eat, use a separate dish and spoon for yourself.
- Never store opened baby food for more than three days.
- Never feed your baby expired formula.
- Don't use formula from a dented container.

- Use clean bottles and nipples.
- Prepare formula in smaller quantities on an as-needed basis.
- Make sure all drawers have stops so that your baby can't pull the drawer out on top of themselves.
- Anchor down unsteady pieces of furniture, such as bookcases.
- Move furniture with sharp corners away from areas where children run around, like hallways and near doorways. If you can't move the furniture, pad its corners with foam or corner protectors.
- To keep your child safe around glass, install safety glass in windows and doors or apply shatter-resistant film to windows and doors of older homes. Use window guards to prevent your child from tumbling out a window.
- Place furniture away from high windows so children won't climb onto windowsills. Screens aren't strong enough to keep children from falling through windows.
- When you change your baby, make sure you put them down in a safe place, for example, on a change table with raised edges to prevent the baby rolling off. Remember to keep one hand on the baby at all times. Never leave your baby alone on the change table.
- Keep children away from exercise equipment and rooms with heavy duty appliances such as treadmills.
- Use door barriers across kitchen and bathroom doors.
- When your child starts crawling, install safety guards across entries to stairs and balconies. And you still need to supervise your child on stairs and balconies.
- Get a licensed electrician to install safety switches, which cut power off quickly to avoid electrocution.
- Get a licensed electrician to do any repairs.
- Replace electrical appliances and cords if they're worn.
- Use power point covers.
- Unplug and electric tools away whenever you are not using them.
- Leave a hall light on at night, or use sensor lights to make it easier for older children to get to the toilet without tripping.
- Supervise young children whenever they are near the other baby.
- To prevent choking, choose age-appropriate toys with no parts of the toy smaller than a 'D' size battery. Check toys regularly for any small loose parts. Small parts can be a hazard and can choke a child less than three years of age.
- Make sure your child is out of the way when you're using any household tool.
- To keep your child safe from suffocation and strangulation tie knots in plastic bags, and keep them away from children.
- It's a very good idea to do some first aid and CPR training. Keep first aid kits in your home.
- Keep the toilet lid down to prevent drowning and to keep the lid from slamming on your baby's head or hands. Consider installing toilet lid locks.
- If you use an infant carrier, always place it on the floor, never on a counter or table top. Make sure the baby is always strapped in.
- Never leave your baby alone on a bed, couch, changing table, or infant seat from which they can fall or roll off. Even if looking away for a second, an accident can happen.
- Keep sharp objects (knives, scissors, tools, razors) and other hazardous items (coins, glass objects, beads, pins, medications) in a secure place out of your baby's reach.
- NEVER shake a baby or throw your baby in the air. This can cause brain damage or blindness.
- If your home uses gas heat, install a carbon monoxide detector.
- Do not smoke and do not allow smoking around your baby. Even smoking "outside" is harmful for the baby because clothing, hair and skin still carry smoke particles.

- Install a working smoke alarm on every level of your home. Change the batteries of your smoke detectors every 6 months.
- Be cautious with balloons to prevent choking.
- Never put your child in a walker. They send thousands of kids to the emergency room every year, mainly by causing falls down stairs.
- NEVER put strings or cords around your baby's neck. Be cautious of strings or buttons on clothing; make sure they are not in danger of choking your baby.
- Cover areas under and around backyard play sets with shock-absorbing material, such as sand, rubber, or mulch, 9-12 inches deep.
- During hot summer days, check the temperature of slides and swings. They can become hot enough to cause burns to the skin.
- Always supervise children on playground equipment. Watch for hazards like stair rungs where they can get stuck, missing guardrails, protruding bolts, or dangling ropes or cords.
- Keep kids away from driveways and streets.
- Don't put bug spray on younger babies. Keep them inside when bugs are biting at dawn and dusk. Cover their skin with long sleeves and pants, and cover strollers with mesh netting.
- Keep animals away from the baby.
- Keep pet's food and water bowls in an area your baby can't reach. Same with the litter box.
- Supervise your child's interactions with your pets and teach them to be gentle. Hitting or tail-pulling can lead to bites and scratches.
- Don't let your animals lick your baby's face or skin, especially if they have a cut or scrape.
- Wash your child's hands after they play with the dog or cat.
- Keep the pet toys out of your baby's mouth.
- Most doctors say pets shouldn't sleep in your child's bed.
- Don't put babies to sleep with soft toys, crib bumpers or blankets.
- Babies should sleep in a safety approved crib or bassinet, not in bed with their parents or caregivers.
- Sleep in the same room with your baby until they are at least 6 months old.
- Pacifiers at naptime and bedtime can reduce the risk of sudden infant death syndrome (SIDS).
- All infants should be put down for sleep on their backs to reduce the risk for sudden infant death syndrome, also called SIDS.
- Crib slats should be 2 3/8 inches apart or less so the baby's head can't get trapped.
- Keep your baby's room at a moderate temperature and dress them in a way that they can't overheat. This also reduces the risk of SIDS.
- Avoid devices marketed to reduce the risk of SIDS, such as sleep positioners.
- Keep your baby's head uncovered while they sleep.
- Don't nurse in a chair or on a couch if you feel you might fall asleep.
- Try to have skin-to-skin contact with your baby.
- Breastfeeding your baby provides important immune factors, such as antibodies, to help protect babies from SIDS. Breastfed babies are also more easily aroused from sleep at two to three months of age, which is the peak age of SIDS occurrence.
- Nursing your baby and making sure that your baby gets all of the recommended vaccines can help protect against SIDS.
- Gather a list of emergency numbers and keep them by the phone. These numbers should include: your child's paediatrician, your family doctor, the police department, ambulance, the fire department, poisons information centre etc. Always consult your healthcare professional if you have concerns about your baby.

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Role of Legumes in Improving Soil Fertility

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Legumes are a group of plants in the family of Fabaceae or Leguminosae. This family is also known as the pea or bean family. Pulses are the dried mature seeds that are grown to maturity and then harvested when they are dry. Common pulses are lentils, chickpeas, red kidney beans and dried peas. These mature seeds are high in protein and easy to store over winter for use in stews, soups and savoury puddings. However, the variety of pulses that we commonly find in shops has diminished over time. There are many forgotten British pulses, which are colourful (red, blue and black), tasty and very nutritious. Red Fox Carlin Peas and Black Badger Carlin Peas, for example, are a much-loved traditional food in the North of England and make a great alternative to chickpeas. Some important food crops are legumes – soya beans, broad beans, green peas, kidney beans, lentils, lima beans, butter beans, chickpeas, peanuts, cowpeas, black-eyed peas and pigeon peas.

Most legume plants can associate with friendly soil bacteria to produce their own nitrogen fertilisers. They allow the bacteria to enter their roots and form roundish structures called nodules to house these bacteria. These nodules then function like tiny factories that can fix nitrogen from the air and provide nitrogen fertilisers for the plant. The seeds of legumes are richer in protein than other staple crops like rice, maize, potatoes, cassava and wheat thanks to their nitrogen-fixing ability. This increased nitrogen gives legumes their high protein content, since nitrogen provides the building blocks for protein. In addition to legume crops, there are many other plants that are legumes. They include gorse, sweet peas, clovers, vetch and trees like acacias, mimosa and tamarind.

Biological nitrogen fixation in legumes

Nitrogen is a critical limiting element for plant growth and production. It is a major component of chlorophyll, the most important pigment needed for photosynthesis, as well as amino acids, the key building blocks of proteins. Even though it is one of the most abundant elements (predominately in the form of nitrogen gas (N_2) in the Earth's atmosphere), plants can only utilize reduced forms of this element. Plants acquire these forms of "combined" nitrogen by: 1) the addition of ammonia and/or nitrate fertilizer (from the Haber-Bosch process) or manure to soil, 2) the release of these compounds during organic matter decomposition, 3) the conversion of atmospheric nitrogen into the compounds by natural processes, such as lightning, and 4) biological nitrogen fixation.

Biological nitrogen fixation (BNF), known as a microbiological process, is used by legumes that transform atmospheric N into a plant in its usable form, which can be this alternative. Mineral N shortage is a recurring character of arid and semi-arid soils. Consequently, it is understood that BNF is a sustainable and environmentally friendly substitution to chemical fertilizers. There exists convincing proof that some non-leguminous crops, in some cases, may benefit from association with diazotrophs. Considerably, a natural association between plants mainly gains the potential benefit from N fixation and bacteria, which is seldom manageable as, part of agricultural practices.

Inclusion of legumes in cropping system:

Sequential cropping

Crop rotation is considered to be incomplete if legumes are not included in a cropping system. The amount of nitrogen addition to soil through legume inclusion depends on the legume crop taken for the system (Squire et al., 2019). Crop rotation through suitable legume inclusion not only improves biomass production but also enhance soil carbon and nitrogen status (Lal 2010). This increased C and N status in soil not only makes soil microbes active and supply N in the current season but also benefits the succeeding crops.

Intercropping

Intercropping is the cultivation of two or more than two crops on the same land as they coexist for some period of their life cycle which is practiced to achieve some ecological goals, i.e., reducing risks of

farmers from complete crop failure against climate abnormalities, increasing resource use efficiency, increasing diversity of the farm promoting species interaction and cybernetics. Generally, the main crop or base crop of intercropping should be the dominant crop of the locality and the second or component crop is grown for additional output using the left-out resources.

Crop rotation

Crop rotation is also an intensive strategy with recurrent succession of crops to enhance the output of the system in terms of crop productivity through inclusion of suitable crops. Inclusion of legume in the system is mostly encouraged knowing their multifaceted advantages, i.e., BNF, nutrient recycling, increase soil carbon and nitrogen stock, etc. Leguminous crops produce higher biomass and improve Complimentary Contributor Copy Role of Legumes in Cropping Systems for Soil Ecosystem Improvement 7 soil organic carbon, that further increase the soil microbial population and maintain soil health. The inclusion of legumes in cropping system produces more biomass using limited resource base, improves soil carbon and nitrogen stock and can be adopted suitably in any cropping system as they can complete their life cycle even in a very short time period and can be used in sustainable land development programmes.

Cover crop and bio-mulch

Legumes are close growing crops and hence serves as cover crop. Also, the dense foliage of most legumes reduces the erosive action of rainfall to a large extent. Legumes release many root exudates such as organic acids to the soil which acts as a binding agent and reduces soil erodibility by improving aggregate stability. Legumes can also be grown in alternate strips along with some erosion susceptible crops to keep the soil loss below acceptable threshold. Legume residues are comparatively more succulent and hence easy to manage. This can be a prospect that should be taken into consideration while planning a conservation agriculture based cropping system. Maintaining mulch on the soil surface is beneficial in reduction of erosion, enhancement of soil organic matter, addition of nutrient to soil, improvement in soil microbial status and maintenance of proper soil temperature.

In response to global scale mechanization, increase in oil price and soil erosion, to maintain the soil health, several conservation practices being followed globally and legumes are included in rotation and as cover cropping. The residues of legumes can improve soil physical, chemical and biological health and quality on their incorporation and increase both nutrient and water holding and supplying ability of the soil. It has also been reported that, taking crops having different rooting depths and requiring minimal soil disturbance, i.e., legumes optimize micro and macro- pores in soil that increases infiltration of water to deeper root zone depth. Legume crops along with biological nitrogen fixation can add high quality soil organic matter because of their extensive root system and low C:N ratio, helping the growth of soil micro-flora and nutrient cycling.

Improvement of soil physical properties

Physical properties of soil, i.e., structure, texture, density, stability, porosity, etc. are fairly constant towards crop husbandry practices, but are important criteria associated with aeration, erosion, runoff, infiltration rate, nutrient and moisture holding capacity of soil. Therefore, proper soil physical condition is essential for optimum tillage, root growth, ground water recharge, prolonged soil moisture availability and deprived soil physical condition may lead to difficulty in farm activities. Soil texture is the relative proportion of soil separates, i.e., sand, silt and clays and fairly resistance to change and remain stable for long time, while soil structure can be manipulated using cultural activities i.e., tillage, residue retention, minimum tillage, etc. Bulk density and soil porosity affects root growth significantly and crop management practices, i.e., tillage, residue incorporation, etc. affects these edaphic factors. Soil porosity as influenced by soil texture and structure broadly categorized into micro and macro pores, depending on pore size diameter, which directly influences on the soil moisture holding capacity and availability to crop plant. Inclusion of legumes in soil acts as soil conditioner and improves soil physical properties significantly.

Improvement of soil chemical properties

Soil chemical properties i.e., pH, CEC, SOC, base saturation, buffering capacity and nutrient concentration has direct relationship with the nutrient dynamics and availability in soil to support higher crop yields. Legume crop has the properties to release organic root exudates and their incorporation in soil has significant influence on soil chemical properties through addition of organic matter and BNF, sustaining the soil fertility and optimizing the system productivity. Legume has well known beneficial effect on available nutrients, soil pH and soil organic carbon stock. Further, legumes included in the cropping system changes the soil pH by releasing organic acids which may enhance soil phosphorous availability and growth and activity of soil microbes which significantly influence the diseases and nutrient dynamics. Legume soil inclusion not only adds N to soil but also augments huge quantity of essential nutrients, organic matter and sequester atmospheric carbon dioxide. The legume biomass can either be incorporated in-situ or transferred from another field and incorporated i.e., ex-situ. The quantity of available nutrient depends on the nutrient content, decomposition rate, soil type, climate, plant density, crop management, etc.

Improvement of soil biological properties

Soil biological properties are most sensitive towards soil management and can be considered as an early indicator of change in soil quality on different management practices. Nitrogen is the limiting macro-nutrient in most of the agricultural soil and the requirement of nitrogen in plant is also higher than other mineral nutrients. Rhizobia in association with legume synthesize nitrogenase enzyme which help in atmospheric nitrogen fixation. Nitrogen fixed in biological nitrogen fixation assimilates as protein and glycoproteins in plant biomass. Phosphorous is one of the essential mineral elements for plant growth, but its availability in soil is limited by soil reaction and complexation with Fe, Al, Ca and Mg. Legume inclusion in cropping system help in releasing soil fixed phosphorous by releasing several acids in the form of root exudates and enhancing phosphatase enzyme activity. Hydrogen gas is released as biproduct during biological nitrogen fixation which encourage microbial activity, microbial carbon and microbial nitrogen in root zone.

Conclusion

Legume being a short duration crop, is grown world-wide in resource limited conditions. Inclusion of legume in cropping systems has several advantages such as food as well as nutritional security, ecological soundness and creation of an efficient agroecosystem, reduction of soil erosion, enhancement of water and nutrient use efficiency, sustained soil function, biological nitrogen fixation and improvement of soil health, increase in soil organic carbon and nitrogen stock, soil carbon sequestration, and thus, increase in agricultural productivity. In this chapter, an attempt has been made to collect different research outcome and summarize them in such a way to present the importance of legumes and their inclusion in cropping systems to facilitate qualitative improvement of soil and agroecosystem, and their subsequent benefit on the sustainability of the agricultural system.

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Various Uses of Castor (*Ricinus communis* L.)

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Castor plant (*Ricinus communis*) is from the family Euphorbiaceae and grows wild in varied climatic conditions. The plant produces castor seeds that contain up to 50 % castor oil by weight. The oil produced from this crop is considered to be of importance to the global specialty chemical industry because it is the only commercial source of a hydroxylate fatty acid. The oil can easily be extracted from castor seeds and find its use in a multitude of sectors such as medicine, chemicals industry and in other technologies The demand for castor oil and its products in the world market has been on the steady increase partly due to their renewable nature, non-competition with food, biodegradability, low costs, and eco-friendliness. It is now estimated that the oil has over 700 industrial uses and the uses keeps on increasing.

In 2020-21, World major producing countries are India (16.47 lakh tonnes), Mozambique (0.72 lakh tonnes), Brazil (0.35 lakh tonnes), China (0.21 lakh tonnes), Thailand (0.12 lakh tonnes) and Myanmar (0.12 lakh tonnes). Area under castor reported during 2023-24 was 9.00 lakh ha (22.24 lakh acres) as against 7.94 lakh ha (19.62 lakh acres) during the same period in 2022-23. Among states, Gujarat is leading with 6.70 lakh ha (16.55 lakh acres) under castor followed by Rajasthan 1.84 lakh ha (4.55 lakh acres), Andhra Pradesh 0.34 lakh ha (0.85 lakh acres), Odisha 0.04 lakh ha (0.10 lakh acres) and Karnataka 0.02 lakh ha (0.05 lakh acres). According to Government 3 rd advance estimates, all India castor production in 2022-23 is at 18.70 lakh tonnes.

The increased interest of substitution of conventional fuel by bio fuels, volatile crude oil prices, higher demand from Europe, China and the US, and growth of key enduse industries including cosmetics and lubricants are expected to drive the global castor oil and derivatives market. On the other hand, threat from other vegetable oils in terms of price and application, and high dependency on seasonality may hinder the market growth. Some major companies operating in the castor oil and derivatives global market are: Thai Castor Oil Industries Co. geographical location and the method of extraction. Like other vegetable oils, castor oil exists as a mixture of saturated and unsaturated fatty acids attached to a glycerol. In the mixture of castor oils fatty acids, ricinoleic acid accounts for about 90 % of the mixture with other components in small proportions of not more than 5 %. Castor oil is extracted colourless to very pale-yellow viscous liquid with a distinct taste, mild odour and it boils at 586 K. The hydroxyl group in ricinoleic acid account for the unique properties of castor oil. For instance, the oil has relatively high viscosity and specific gravity; it is soluble in alcohols in any proportion and has limited solubility in aliphatic petroleum solvents. In addition, the polar hydroxyl group in castor oil makes it compatible with plasticizers of a wide variety of natural and synthetic resins, waxes, polymers and elastomers.

India has a history of using different plants in its indigenous systems of medicine (Ayurveda, Unani and Siddha) that dates back to 5000 years. Ayurveda records over 8000 herbal remedies. About 6000 plants were used in traditional, folk and herbal medicines in India. Different parts of the plant or oil from castor can be used as a base material in most of the medicinal treatments. Modern research backs up some of its traditional uses, including laxative effects, anti-inflammatory properties, and the ability to help induce labor.

While studies continue to investigate other potential health benefits, castor oil is considered safe if used as directed, and can be found in a range of skin and hair care products sold today. Castor oil is a common ingredient in many beauty products. It's rich in essential fatty acids that moisturize the skin, and research continues to study how their properties may be effective in treating common skin conditions.

Nutrition Information

A one-tablespoon serving of castor oil contains:

- Calories: 120
- Protein: 0 grams
- Fat: 14 grams
- Carbohydrates: 0 grams
- Fiber: 0 grams
- Sugar: 0 grams

Laxative Properties

One of castor oil's most traditional uses is to stimulate digestion, relieving temporary constipation. Modern research has found that this effect is due to the oil's high levels of ricinoleic acid, an omega-9 fatty acid that acts as a natural laxative.

Anti-Inflammatory Effects

Studies show that castor oil's ricinoleic acid reduces swelling and pain caused by inflammation. Research suggests that, when applied to the skin, castor oil may reduce arthritis symptoms more effectively than prescription topical treatments. More studies are needed to confirm this effect in humans.

May Heal Wounds

Castor oil's fatty acids are natural humectants, substances used to moisturize the skin by preventing water loss. This effect can promote good skin health, relieve dryness, and soothe skin inflammation.

It may also have the potential to accelerate wound healing. Castor oil is a triglyceride that has antibacterial and antimicrobial properties. Research shows that, when applied to the skin, it may prevent infection, reduce inflammation, improve localized blood flow, and shed damaged skin cells — all of which help skin's healing process.

Treats Some Skin Conditions

Castor oil can benefit overall skin health, but may treat specific skin conditions as well. Though there's a lack of clinical research, its combination of antibacterial, anti-inflammatory, and moisturizing effects is thought to help treat some causes of acne. One study showed that castor oil also fights fungal infections, which may help relieve hard-to-treat fungal acne. Other studies have found castor oil helpful in the treatment of melasma, dandruff, and ringworm.

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Nutrient Management in Calcareous Soils

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In dry regions, presence of $CaCO_3$ is very common. Formation of $CaCO_3$ in soils is an important pedogenic process in many arid and semi-arid parts of the world including the Indian sub-continent (Pal *et al.* 2000). It has been observed that when the zone $CaCO_3$ accumulation coincides with depth of root concentration, it could be an important factor in terms of plant nutrition. Many soils of India formed in arid and semi-arid parts are typically calcareous either throughout the profile or within the rooting depth. However, there are many calcareous soils in climates other than arid and semi-arid. Therefore, it is very necessary to identify factors and processes that are related to the genesis of $CaCO_3$ in soils for precise taxonomic grouping.

Calcareous soils

The calcareous class is listed in the family group of soil classification (Soil Survey Staff, 1999). The control section for the calcareous class could be either of these,

(i) soils with a root-limiting layer that is 25 cm or less below the mineral soil surface meaning a 25 cm thick layer directly above the root-limiting layer

(ii) soils with a root-limiting layer that is 26 cm to 30 cm below the mineral soil surface meaning the layer between a depth of 25 cm below the mineral soil surface and the root limiting layer

(iii) all other listed soils meaning between a depth of 25 and 50 cm below the mineral soil surface.

The Soil Taxonomy (Soil Survey Staff, 1999) again keyed out calcareous soils as those which effervesce (in cold dilute HCI) in the fine-earth fraction in all parts of the control section. It, therefore, appears that the calcareous soils may have $CaCO_3$ content varying from a small amount in some part of the profile to an appreciable amount occurring throughout the profile).

Distribution and extent of calcareous soil

In India, calcareous soils are distributed in the states of Rajasthan, Gujarat, Punjab, Haryana, Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh and parts of Madhya Pradesh and Bihar and some union territories (Fig. 1). Patches of these soils have also been reported in the state of Jammu and Kashmir, in the Nowgaon district of Assam and the Jampui hills of Tripura. Calcareous soils are developed on organogenic calcium carbonate ($CaCO_3$) in the Lakshadweep islands. The estimated area of calcareous soils is 228.8 m ha and covers 69.4% of the total geographical area (TGA) of the country and spreads over 38 out of 60 AESRs (Pal et al. 2000).

Calcareous soils are soils in which a high amount of free calcium carbonate dominates the problems related to agricultural land use. They are characterized by the presence of $CaCO_3$ in the parent material and by a calcic horizon, a layer of secondary accumulation of carbonates of Ca and/ or Mg in excess of 15% $CaCO_3$ equivalent and at least 5% more carbonate than an underlying layer". In the world Reference Base (WRB) soil classification system calcareous soils may mainly occur in the Reference soil group of calcisols. Calcareous soil is classified into four groups as per the ratings given by National Bureau of Soil Survey and Land Use Planning (NBSS LUP).

Class	Free $CaCO_3$ (%)
Non calcareous	Nil
Slight	< 5
Moderate	5-15
Strong	>15

Characteristics of calcareous soils

- Usually have alkaline soil reaction (PH >7.0) and High buffering capacity.
- Soils are dominated by carbonates of calcium and magnesium mainly soil contain $CaCO_3$ in free form CaCO3 may occur indifferent forms (powder/nodules) with reduced availability of N, P, K, S, Fe, Zn, and B.
- Iron deficiency due to high $CaCO_3$ leads to chlorosis also called lime induced iron chlorosis and reduced rate of seed germination.
- Decreased water holding capacity (WHC) due to alteration in soil structure, formation of hard pan.
- Flocculation due to enough Ca and Mg present in calcareous soil increases aggregate stability and when a large percentage (>30%) of $CaCO_3$ is present in the clay fraction, the soils WHC can be reduced.
- Surface crusting and sub-surface hard pan formed restrict aeration, infiltration and affects rate of seedling emergence and establishment.
- Activity of rhizosphere micro-organisms is reduced under less moisture conditions.

Formation of calcareous soils

In situ by weathering of parent rock materials

There is formation of calcium carbonate due to weathering of rocks. The low rainfall in arid and semi-arid regions is not sufficient to leach out the soluble products of weathering to ground water. In dry weather, the salt moves up with the water by capillary movement to the surface where they are deposited.

Development of calcareous soil by secondary origin

These are developed in low lying areas generally drainage is impeded in these low-lying areas. During the rainy season, soluble calcium bicarbonate of nearby areas accumulates in the low-lying areas. During dry season, calcium bicarbonate converted into calcium carbonate and deposited on the soil surface by capillary movement.

Main production constraints of calcareous soils

- Calcareous soils develop in regions of low rainfall and must be irrigated to be productive. Therefore, one of the main production constraints is the availability of water for irrigation.
- Crusting of the surface may affect not only infiltration and soil aeration but also the emergence of seedlings. Cemented conditions of the subsoil layers may hamper root development and water movement characteristics
- Calcareous soils tend to be low in organic matter and available nitrogen.
- The high pH level results in unavailability of phosphate and sometimes reduced micronutrient availability, e.g., Zinc and Iron (Lime induced Chlorosis)
- There may be also problems of potassium and magnesium nutrition as a result of the nutritional imbalance between these elements and calcium.

Nutrient management in calcareous soils

Nitrogen

1) Decreased availability of plant nutrients due to alkaline nature.

2) Most of plant nutrients are available when soil pH ranges between 6.5 to 7.5, under high pH of soil the availability of N to plant decreases due to reduced rate of nitrification and loss of N through volatilization process.

$$(NH_4)_2SO_4 + CaCO_3 \longrightarrow 2NH_3 + H_2O + CO_2 + CaSO_4$$

3) When ammonical fertilizers are used in calcareous soil, nitrogen is lost in the form of NH_3 as ammonical compounds turn into ammonia after reacting with $CaCO_3$ in soil

4) Hence, use of ammonium sulphate, ammonium phosphate should be avoided in calcareous soil. Instead of these ammonium nitrate and ammonium chloride is ideal.

Phosphorous

- At pH 6 to 7.5 phosphorus is usually available due to higher pH, availability of P is reduced in calcareous soil and P often turns into tri-calcium phosphate, magnesium phosphates which are less soluble in water.

- As these insoluble compounds are formed after addition of P fertilizers in calcareous soil, its availability is decreased this is called as P fixation.
- These insoluble compounds are formed and retained within soil. As soil pH increases, rate of formation of these insoluble compounds increases and availability of P decreases.
- Hence, to increase its availability P fertilizers should be added with organic matter and use of PSB is also helpful to increase solubility of P in soil. Easily soluble sources like SSP, DAP should be used.
- Band placement of P fertilizers near to roots and in granular form helps in increasing availability of P. Time of application of fertilizer is very important regarding plant growth. Plant must get right time for development of roots
- Addition of SSP along with FYM/compost to crops helps in increasing P availability and development of roots.

Potassium

- Calcareous soil contains enough amount of potassium but due to higher concentration of calcium, potassium uptake is affected.
- Hence, deficiency of potassium is observed in plants.
- Potassium should be added in quantity more than its recommended dose under high calcium content in soil.

Micronutrients

- The deficiencies of micronutrients are mostly saviour problems of calcareous soil. Calcium carbonates can easily fix all the nutrients and render them unavailable
- Thus, application of micronutrients along with organic manure is helpful in increasing their availability on the basis of soil test value would be helpful in increasing the yield. The deficiencies of micronutrients are normally corrected through soil or foliar application.

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Adoption of Technologies for Profitable Mithun Husbandry in Northeastern Hills region of India

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Mithun, often called the 'Cattle of the Mountains,' is a unique and valuable bovine species found in the Northeastern Hills region (NEHR) of India-Arunachal Pradesh, Nagaland, Manipur, and Mizoram. It has also been found in China, Myanmar, Bhutan, and Bangladesh. Mithun thrives in these hilly states, challenging terrain and harsh weather conditions at moderate altitudes along the Himalayan slopes. It can thrive in a free-range system within dense forest areas. In addition, Mithun displays remarkable disease resistance compared to cattle, and has distinct feeding habits.

Mithun is the pride of the NEHR of India. This animal holds the distinction of being the state animal in Arunachal Pradesh and Nagaland while also serving as the official state emblem of Nagaland. Traditionally, tribal farmers in the NEHR have reared Mithun in free-range conditions within dense forests at altitudes ranging from 1000 to 3000 meters above sea level.

Mithun holds great significance in the lives of tribal communities in the NEHR, serving as a valued, versatile animal deeply entwined with their socio-economic, religious, and cultural traditions. It is also used for fieldwork in some parts of Arunachal Pradesh. Ownership of the Mithun herd is considered a sign of prosperity and the highest social status in society, particularly in the states of Nagaland and Arunachal Pradesh. Mithun is also used as a form of 'currency' in trade, for valuable exchanges, penalties, marriage gifts, and more in Nagaland. This animal is primarily raised for meat, with additional uses for milk and hides. They are frequently sacrificed for meat during significant social ceremonies and festivals.

Recently, Mithun has been included in the Domestic Animal Diversity Information System (DAD-IS) database. Mithun meat, known as 'Weeshi' holds immense potential for creating value-added meat products due to its exceptional tenderness and quality. Notably, the Food Safety and Standards Authority of India (FSSAI) officially recognized Mithun as a food animal. This move not only broadens culinary choices for meat enthusiasts across India but also serves as a catalyst for socio-economic development in the regions where Mithun is raised.

Mithun produces 1–1.5 kg of milk per day with high-fat content (8–13%), solid-not-fat (18–24%), and protein (5–7%), making it ideal for value-added milk products. The ICAR-National Research Centre on Mithun in Nagaland has successfully standardized products such as meat nuggets, meat powder, meat patties, meat blocks, paneers, sweet products, ghee, cream, cheese barfi, rasgulla, curd, and lassi using Mithun milk (Mondal et al., 2014). Additionally, Mithun hide yields high-quality leather, superior to

cattle, and can be processed into various goods such as bags and shoes (Das et al., 2011).

Semi-Intensive System

In the hilly regions of the NEHR, tribal farmers traditionally reared Mithun under free-grazing conditions within dense forest areas. This traditional approach involves minimal inputs with no additional feed supplementation or housing. Farmers occasionally visit the forest to provide salt to their Mithun. Some farmers have constructed temporary shelters with locally available materials in specific locations for shelter and salt feeding. They train their Mithun to return to these areas daily with a small amount of salt, enabling regular monitoring.

However, several challenges have emerged, including a decline in forest areas due to urbanization, deforestation caused by shifting cultivation (Jhum), village boundary conflicts, difficulties in fencing hilly jungles, hunting by poachers, and predation of Mithun (especially newborn calves) by wild animals. Additionally, the absence of an organized Mithun meat market has contributed to a decline in Mithun husbandry among tribal farmers in the NEHR.

To address these issues, there is a need to promote and practice scientific Mithun husbandry, particularly through semi-intensive methods instead of the traditional free-range approach. The feasibility of semi-intensive Mithun husbandry has been successfully demonstrated by the ICAR-National Research Centre on Mithun, Nagaland, over the past two and a half decades at their institute, Mithun Farm. This shift towards a more structured approach holds promise for revitalizing Mithun husbandry in the region.

In the semi-intensive system of Mithun rearing, farmers constructed shelters using locally available materials, requiring minimal capital investment. These shelters provide a secure place for animals to rest at night after grazing in the forest during the day, offering comfort, protection from harsh weather, and safety from predatory animals. This scientific approach to Mithun husbandry using a semi-intensive method offers the following advantages.

1. Allow supervision of individual animal care and management.

2. Additional feeding and ad libitum watering of the animals.

3. Proper healthcare, including vaccination and quarantine, to prevent the spread of diseases.

4. Detection of estrus and breeding of either natural service or artificial insemination (AI) with superior germ plasma.

Feeding Managements

In the traditional method of Mithun rearing under free-range conditions, these animals rely solely on foraging in the jungle for nutrition, consuming tree fodders, shrubs, herbs, and natural vegetation without any additional feed or mineral supplementation. However, this approach has certain limitations. During the rainy season, mineral leaching is common in hilly forest areas, leading to deficiencies in essential minerals within forage. In addition, the availability of nutrients in jungle fodder decreases in terms of both quality and quantity during the lean winter season. This can result in suboptimal growth rates and productivity in Mithun over a short period.

Under these circumstances, and to ensure maximum growth and productivity, a scientific feeding management approach is essential, which can be achieved through a semi-intensive method. In this system, Mithun's nutrient and mineral requirements are met by providing concentrate and mineral mixtures in the shelter during the late evening or early morning, when the animals are tied. In addition, ample drinking water is available to the animals. During the rainy season, when abundant jungle fodders are available, mineral mixtures and salt are the main additional supplements required. However, in the winter or lean season, it is advisable to offer additional concentrate feed (with 15% protein and 70% total digestible nutrients) fortified with a salt and mineral mixture (1 to 2 kg per animal daily for up to 2 years, and 2 to 4 kg per animal daily for those above 2 years) to maintain optimal performance (Das et al., 2011). This approach ensures that Mithun farmers achieve the best possible results in terms of growth and productivity.

Breeding Management

Mithun, similar to cattle, is a polyestrous animal capable of breeding year-round, with winter and spring being favorable seasons. Female Mithun calves reach puberty at 27–36 months of age (Mondal et al., 2014). Adult female Mithun exhibit repeated estrus cycles at intervals of 19 to 24 days, unless they are pregnant (Mondal et al., 2014). The gestation period, service period, and calving interval for Mithun typically range from 270 to 290, 50 to 100, and 350 to 400 days, respectively (Mondal et al., 2014).

In a free-range system, one superior and tested bull is typically introduced into a herd of 10 breedable females while simultaneously removing unwanted bulls. To prevent inbreeding depression, it is advisable to replace breeding bulls approximately once every five years. Detecting cows in heat can be challenging because of their silent estrus behavior when relying on visual observations alone.

Semi-intensive farming allows for the improved breeding of estrus cows using superior bull germplasm through methods such as artificial insemination (AI) or natural services, similar to cattle. It also facilitates the effective use of estrus synchronization along with fixed-timed AI and embryo transfer technology (ETT) to enhance Mithun production.

In the semi-intensive method, the identification of estrus females is more manageable. This can be achieved using a vasectomized bull and breeding with superior bulls, either through natural service or artificial insemination (AI). Therefore, the reproductive efficiency of Mithun farming can be improved. The characteristic signs of estrus include the following.

- Soft and slightly swollen vulva with mucus membrane congestion.
- Clear and transparent mucus discharges into the vagina and sometimes hangs from the vulva.
- Tail-raising, frequent urination, and loss of appetite.
- Loose diarrhoea-like feces during estrus
- Showing interest in bulls.

Among all the behavioral signs of estrus, mounting the Mithun bull over the estrous cow was the best indicator of estrus.

Conclusion

Mithun husbandry has long been a vital part of the local livestock production system in the hilly regions of northeastern India. However, the traditional method of free-range rearing is now facing a critical challenge as dense forest land continues to shrink. In light of evolving socioeconomic dynamics, the infusion of technology into Mithun husbandry serves not only the growing demand for meat protein but also presents an opportunity to generate additional income for the tribal communities that rear Mithun for their livelihoods. Therefore, it is imperative to prioritize and actively promote the dissemination of awareness and technology transfer in these regions. By embracing scientific farming practices in the northeastern hilly states of India, where Mithun rearing has a deep-rooted tradition, we can ensure the sustainability and prosperity of this invaluable practice, while meeting the evolving needs of the times.

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Vertical Farming- Future of Agriculture

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In the present time, with increasing populations and decreasing available arable land, making availability of food to each and all is the need of hour which ultimately demands the search for groundbreaking and sustainable methods and approaches of agriculture. For this in recent years, one such key solution gaining attraction of governments, policymakers, businesses and the people is vertical farming. The vertical farming is the agricultural practice that utilizes the available vertical space to cultivate crops in stacked layers, providing an efficient, effective and controlled environment for growth of plants. With its latent potential to revolutionize and transform conventional and ongoing traditional farming practices, vertical farming provides a promising and capable solution to address the challenges of food security, environmental sustainability, and urbanization. By considering all these points, this article will delve and explore the concept of vertical farming, its benefits, and its potential to shape the future of farming.

Benefits of Vertical Farming

Efficient use of space

Vertical farming's key benefit is its capacity and ability to maximize the utilization of the limited space. This approach of farming allows crops to be produced in high-density urban settings on stacking layers, where land is scarce and frequently prohibitively expensive. Vertical farms also contribute to huge savings in land resources by utilizing vacant buildings, warehouses, or skyscrapers. Furthermore, the vertical farm's well-organized, structured and compact design ensures that the entire area is utilized efficiently and effectively, resulting in enhanced crop and plant productivity per square meter of land.

Year-round crop production

By using vertical farming, year-round crop production of crops is possible by creating an optimized, controlled and balanced environment within greenhouses or indoor facilities, irrespective of weather variations or seasonal constraints. This will ultimately help in reducing the reliance on conventional weather-dependent farming, leads to mitigation of the risk of crop failures due to adverse weather events. Moreover, the controlled environment also allows for the cultivation of a wider range of crops, including those that are not typically suited to the local climate.

Water conservation

Vertical farming employs advanced irrigation techniques that significantly reduce water consumption, unlike traditional and conventional farming methods. Closed-loop systems used in vertical farming, captures and recycle water, minimizing waste and ultimately ensuring efficient use of water. The implementation of hydroponics or aeroponics methods in vertical farms in which plants are grown in water-based nutrient solutions instead of soil and these methods use up to 90% less water than conventional methods and still producing high yields and giving high profit. Reduction in water level and water scarcity becoming an increasing concern worldwide, which demands the water conservation due to which this water-saving potential of vertical farming is a significant advantage for coming future.

Reduced use of pesticides

Vertical farms are designed in such a way so that these can operate in a controlled, sterile and germ-free environment, thereby dropping the requirement for pesticides and herbicides. The hygienic environment in vertical farming results in absence of pests and diseases associated with traditional farming techniques and enables crops to thrive and flourish without the use of harmful chemicals. As a result, vertical farming offers a highly sustainable alternative against chemicals that ultimately minimizes environmental pollution and potential health risks associated with pesticide residues left in plants and crops. It not only improves the quality and safety of the produce, but it also promotes healthier ecosystems

by preserving beneficial insects and natural biodiversity.

Lower environmental impact

Vertical farming will help in reducing the carbon footprint attributed to traditional farming methods due to use of high doses of plant protection chemicals. Vertical farming also eliminates the need for long-distance transportation by locating these farms near to markets, which reduces greenhouse gas emissions due to long distance travel of vehicles. Moreover, the controlled environment and efficient use of resources in vertical farms can also minimize the energy consumption. The integration of vertical farming further with renewable energy sources such as solar or wind power will also help in enhancing the sustainability in vertical farms. Overall, vertical farming signifies a more environment friendly method in agriculture, by aligning with the goals of global sustainability. The alternative of vertical farming approach to traditional farming will be great hope for upcoming future.

Implications for Food Security

Vertical farming has the potential to play a significant and crucial role in fighting global challenges of the food security. According to estimates of Union Nation, the world's population will reach 9.7 billion by 2050, which will demand a 70% increase in production of food to feed each and every person adequately and also nutritious balanced food for proper growth and development. Vertical farming has ability to cultivate crops within urban areas and it can enable local production and ultimately help in reducing the reliance on long-distance transportation and importation of food. This localization of food production will ultimately enhance food security by reducing the susceptibility to supply chain disruptions, extreme weather conditions and events, or trade conflicts. Furthermore, vertical farming can provide fresh, nutritious food that is readily accessible to urban population and this comes as major contributing factor to improved dietary diversity and sound health outcomes.

Vertical Farming as a Solution to Urbanization

People from villages are moving to cities for employment and this creates problem of urbanization by demanding growth of cities. Urbanization is a global trend that poses challenges to traditional farming methods. The rapid growth of cities and shrinking of rural areas reduce available land for farming, pushing agricultural practices away from cities and vertical farming offers a viable solution to this problem with integration of agriculture into land of urban like roofs of houses. By utilizing the available vertical space in urban areas, vertical farming will reduce the distance between production and consumption, reduces transportation costs and carbon emissions. Additionally, vertical farms can create more job opportunities and also enhance food self-sufficiency and self-reliance, promote local economic growth and development. Vertical farming has great potential to transform urban areas into self-sustaining, food-producing belts and can mitigate the negative impacts of urbanization on traditional agriculture, local people and food systems.

Conclusion

Vertical farming epitomizes a promising and capable solution to the challenges of modern agriculture and problems of food security and urbanization. The innovative design, capability of optimize resource use efficiency and having potential for year-round production of crops make it a powerful and influential tool to address the challenge of food security, environmental sustainability, and the consequences of increasing urbanization. But with exception of all these benefits, vertical farming also has to face barriers such as high initial costs, technological limitations, lack of awareness and for the successful adoption of vertical farming, these must be overcome. As research and technology continue to advance and improve, vertical farming has the potential to reshape the future of farming, contributing factor to a more sustainable, economical and resilient food system.

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Bio-Methane: Fuel of Future

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Growing demand of energy and the exhausting of fossil fuel, the research and development of renewable energy has attracted more attention. Energy is an essential prerequisite for accelerated economic development and improved quality of life for citizens of any country. Due to rapid industrialization and urbanization in last few decades, there is a huge pressure on depletable crude oil, coal and other fossil fuels. This resulted into need for finding alternative sources of energy. Now-a-day, CNG (Compressed Natural Gas) vehicles are increasing day by day and government also focusing on it. Conventional CNG is also a limited source like fossil fuel so there is a need of an hour to switch on renewable fuel. Bio-CNG is emerging as promising fuel for future and it can be obtained from biomass. Biogas is one of the most important renewable sources of energy which may cope up to cater for the need of heating and power. Biogas is generated by the biological degradation of organic compound, has been considered as a valuable energy carrier, and it is now playing a key role in emerging market of renewable energy.

What is Biogas?

Biogas is a promising renewable fuel and produced by anaerobic digestion of biomass such as cattle dung, vegetable waste, municipal solid waste, poultry droppings, industrial waste water and landfill etc. Main products of the anaerobic digestion are biogas and slurry. Biogas comprises of 60-65% methane, 35-40% carbon dioxide, 0.5-1.0% hydrogen sulphide, rests of water vapours, etc. Biogas is non-toxic, colour less and flammable gas. It has an ignition temperature of 650 - 750 ^{o}C. Its density is 1.214 kg m^{-3} (assuming about 60% Methane and 40% CO_2). Its calorific value is 20 MJ m^{-3} (or 4700 kcal.). It is almost 20% lighter than air. Biogas, like Liquefied Petroleum Gas (LPG) cannot be converted into liquid state under normal temperature and pressure. It liquefies at a pressure of about 47.4 kg cm^{-2} at a critical temperature of - 82.1 °C. Removing carbon dioxide, hydrogen sulfide, moisture and compressing it into cylinders make it easily usable for transport applications & also for stationary applications. Already CNG technology has become easily available and therefore, bio-methane (purified biogas) which is nearly same as natural gas, can be used for all applications for which CNG is under used.

Bio-CNG

The application of biogas is not just confined to domestic use but with its purification, we can run CNG vehicles. The pure form of biogas is known as bio-CNG or bio-methane. Purification means removal of CO_2, water vapour, H_2S, etc. Bio-CNG or bio-methane contains about 92-98 % of methane and only 2-8 % carbon dioxide. The calorific value of Bio-CNG or bio-methane is about 13,000 kCal kg^{-1}, which is 2.7 times higher than that of raw biogas and calorific value of conventional CNG is 12500 kcal kg^{-1}. Property of the Bio-CNG or bio-methane is same as conventional CNG. It is an ideal fuel for automobiles and power generation. The low emission levels of Bio-CNG or bio-methane also make it a more environment-friendly than conventional CNG.

Conversion of Biogas to Bio-CNG

Being Non-combustible constituent of biogas, carbon dioxide does not contribute to the combustion; in fact it lowers the heating value of biogas and increases the compression and transportation costs. Biogas can be said Bio-CNG after the separation of carbon di oxide and hydrogen sulphide from it. The separation process is known as purification of biogas or scrubbing of biogas. Purification is the important phase in conversion process. There are various methods of purification of biogas, i.e., water scrubbing, adsorption (physical and chemical), cryogenic separation, membrane technology, biological upgrading, pressure swing absorption.

Fig 1: Biogas scrubbing system developed at ICAR-CIAE Bhopal

(Source: CRP on EA, Annual Progress Report 21-22)

Table 1: Comparison of Bio-CNG with Conventional CNG

	Bio-CNG	Conventional CNG
Source	Renewable	Non renewable
Calorific Value	13,000 kcal/kg	12500 kcal/kg
CO_2 Emission	less	High
Cost	Rs. 45-50 /kg	Rs. 65-70 /kg

Bio-CNG plants in India:

Asia's largest Bio-CNG plant is Gowardhan bio-CNG plant which is situated in Indore (M.P.) and plant inaugurated by Prime Minister of India on 19th Fabruary 2022. Plant capacity is 550 tone bio-CNG per day and also produces 100 metric ton compost bio-fertilizers per day. Gas produced from plant is proposed to run 400 buses for public transport in Indore city.

Another example of bio-CNG plant is the Banas, Asia's largest milk processing cooperative located at Palanpur in the state of Gujrat, India. At this site, a 3500 cubic meter biogas reactor for the production of bio-CNG and organic manure has been installed. The gas produced from plant is delivered to bio-CNG filling station established on roadside to refill CNG vehicles. Everyday 100 CNG vehicles are being served by Banas bio-CNG plant. Waste product is used for bio-fertilizer at farmer's land. Everyday this unit produces about 8 tons of solid fertilizers and 70,000 liters of liquid fertilizer.

Fig 2: Banas Bio-CNG plant

(Source: https://www.theblogtimess.com/post/cattle-dung-to-bio-cng-and-bio-fertilizer)

Need to switch on Bio-CNG or Bio-methane:

There are many benefits of bio-CNG are as follows:

1. It's a renewable energy
2. It produces less carbon as compared to fossil fuel
3. Bio-CNG is mainly produced from MSW and agriculture waste.
4. It is non-polluting gas.
5. Approximately half the cost of gasoline and diesel - and less than other types of CNG fuel.
6. Bio-CNG has higher calorific value than conventional CNG.
7. Waste product, i.e., slurry can be good source of organic manure.

Summary

Considering properties, characteristics, waste utilization & environmental benefits of Bio-CNG from biogas, bio-CNG has evolved as future fuel. Bio-CNG offers excellent opportunity of farm waste management. In Indian scenario, where population of livestock's is 305 million in 2021, Bio-CNG has a great potential in transportation sector.

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Effective Strategies for Management of Yellowing of Wheat Crop

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Wheat (*Triticum aestivum*) is one of the important staple crops of India which is cultivated in the *Rabi* season. It contributes to a significant share in total wheat production of over 107 million tons (Anonymous 2023) Major wheat growing states in India includes Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Gujarat and Bihar. However, crop production is constrained by various biotic and abiotic stresses, which leads to less productivity in terms of grain yield and flour quality. Among them yellowing of crop is a major problem in all the wheat-growing areas. It is caused by many factors like bad weather, un-recommended varieties, heavy irrigation, poor-quality of irrigation water, nutrient deficiency, yellow rust or insect-pests etc. Therefore, many farmers start spraying of fungicides at an early stage, which increases cost of production. The following are major reasons are responsible for yellowing of wheat (Anonymous 2023a).

Irrigations and quality of irrigation water

The heavy soils have lower water infiltration rate and it does not percolate below root zone after heavy irrigation or rain. This results in oxygen deficiency in the root zone and roots are not able to work properly resulting in yellowing of crop. All the plants show yellowing of leaves from tips towards base. For preventive measure, the field should be laser levelled before sowing the crop. Heavy irrigations should be avoided and weather conditions may be taken into consideration while giving irrigation. So fields should be divided into 8 and 16 parts per acre in heavy and light soils respectively. The provision for drainage of excess water is also necessary. In some areas, the ground water is poor in quality and not suitable for irrigation. The application of such water may result in yellowing of the crop. Therefore, farmers are advised to make testing of irrigation water from authorised laboratories. If water is in poor quality, then apply the recommended dose gypsum before irrigation of the crop. Impure and pure water can be used alternatively or by mixing with each other (Anonymous 2023a).

Weather

Sometimes, the crop is adversely affected by poor weather conditions. If there is a sudden decrease in temperatures, then crop may be turned yellow. Frost is another reason for the yellowing of wheat. The effect of bad weather will be visible in the whole region. The crop usually recovers from the effect of poor weather in due course of time but farmers should apply need based timely irrigation (Anonymous 2023b).

Nutrient deficiency

Nitrogen deficiency: The lower leaves become yellow and start drying from the leaf tips inward. The primary causes of nitrogen deficiency are insufficient fertilizer doses, leaching due to heavy rains and the presence of heavy amounts of crop residue, which immobilize nitrogen. Apply the recommended dose or soil test basis nitrogenous fertilizers. In salt affected soils, apply 25 % extra nitrogenous fertilizers.

Zinc deficiency: The leaves become yellow or chlorotic in the middle. The plants remain stunted and crop gives bushy appearance. In zinc deficient fields, apply 25 kg of zinc sulphate (21%) per acre. The zinc deficiency can also be corrected by foliar spray of 0.5% zinc sulphate. Prepare the solution for spray by dissolving 1 kg zinc sulphate and half kg unslaked lime in 200 litres of water per acre. Two or three sprays at 15 days interval may be given depending upon the severity of deficiency.

Manganese deficiency: It generally appears in light soils under rice-wheat rotation. On the middle leaves interveinal chlorosis appears with light greyish yellow to pinkish brown specks of variable size confined largely to 2/3 lower portion of the leaf. Later, the specks join with each other forming a streak or band in between the veins. However, the veins remain green. Whole of the plant may die in acute deficiency conditions. In manganese deficient soils, give one spray of 0.5% manganese sulphate solution (1 kg

manganese sulphate in 200 litres of water) 2-3 days before first irrigation. Give three more sprays at weekly intervals on sunny days. Do not grow durum varieties in sandy soils, as these varieties are prone to manganese deficiency.

Sulphur deficiency: It generally starts from the young leaves with fading of the normal green colour. The topmost leaves become light yellow except the tip, while the lower leaves retain green colour for a longer time. It mostly occurs more in sandy/light soils and very severe when rains continue for a long time in the early growth period. In sulphur deficient soils, where phosphorus has been applied through DAP instead of single superphosphate, apply 100 kg of gypsum or 18 kg bentonite-sulphur (90%) per acre before sowing the crop. Gypsum can also be applied in standing crop if deficiency of sulphur is observed.

Insect-pests

Termite: The termite attacks the crop at seedling stage mostly in sandy soils. Affected plants turn yellow and dry up completely. Such plants can be easily uprooted. For prevention, the seed should be treated with recommended insecticides like 1g Cruiser 70 WS (thiamethoxam) or 2 ml Neonix 20 FS (imidacloprid + hexaconazole) or 4 ml Dursban/Ruban/Durmet 20 EC (chlorpyriphos) per kg seed. If severe damage is observed after germination, then broadcast 7 kg Mortel 0.3 G (fipronil) or Dursban 20 EC (chlorpyriphos) @1.2 litre per acre by mixing with 20 kg moist soil per acre before first irrigation.

Pink stem borer: At seedling stage, the larvae enter the stem by making holes. The crop looks yellow and finally the central shoot is killed (dead hearts). If incidence of this pest is high in previous rice crop, then do not sow wheat in such fields during month of October. Apply irrigation to crop during daytime so that predacious birds eat maximum number of larvae. In case of severe infestation broadcast 7 kg Mortel/ Regent 0.3 G (fipronil) or 1.0 litre Dursban 20 EC (chlorpyriphos) after mixing with 20 kg moist soil before irrigation or spray 50 ml Coragen 18.5 SC (chlorantraniliprole) using 80-100 litre water per acre.

Yellow rust: It is a fungal disease which produces powdery yellow pustules in lines on the leaves. By touching the infested leaves, yellow powder sticks to hands. The disease first appears in patches on few plants in the hilly areas. The cool and damp weather conditions i, e temperature of about 10-15°C, high humidity and intermittent rainfall or dew favours disease development. The disease spreads through wind currents that causes airborne spores to travel long distances and infect healthy plants, The lack of crop rotation: Growing the same type of wheat varieties for many years can increase disease severity.

Preventive measure

Select varieties that are region specific and resistant to yellow rust and other diseases

- Avoid early sowing of crop in sub-mountainous regions and susceptible varieties should not be sown there.
- The self-grown wheat plants and alternate host plants should be removed as early.
- Good agronomic practices, such as proper planting density, appropriate irrigation and timely weed control, can help prevent yellow rust incidence
- Follow mixed cropping and crop rotation with suitable crops such as legumes, mustard, and barley to break the disease cycle by reducing the amount of inoculums in the soil
- Avoid excessive application of nitrogenous fertilizers
- Farmers should regularly monitor their crop, whenever the disease symptoms appear then spray the crop with 200g Caviet 25 WG or 120g Nativo 75 WG or 200ml Ampect Xtra 25.5 SC or 200 ml Opera 18.3 SE or 200 ml Custodia 320 SC or 200 ml Tilt 25 EC in 200 litres water per acre. At early stage, give only spot application of fungicides. Any of these fungicidal (alternately) spray may be repeated if required again.

Nematodes: Sometimes yellowing of the crop may be occurred due to attack of nematodes. However, this type of yellowing occurs in patches. The root system of such plants is reduced in size and becomes bunchy. The leaves of the affected plants become yellow and small knots are formed on the roots. The plants remain

stunted and give a bushy appearance. Either effected plants do not produce ears or they produce small ears with poorly filled grains. In nematode infested fields, make deep ploughing during hot months. Follow crop rotation with non-cereal crops. Apply 13 kg Furadan 3G per acre before sowing the crop in the fields' nematodes infested.

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Development of Agriculture in India through Agri-Entrepreneurs

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Agriculture plays a vital role in the Indian economy, employing a significant portion of the population and contributing to food security and rural development. In recent years, the emergence of Agri-entrepreneurs has brought about a transformative change in the agricultural sector. This paper explores the development of agriculture in India through the contributions of Agri-entrepreneurs and highlights their role in driving innovation, technology adoption, and sustainable practices.

Empowering Farmers

Agri-entrepreneurs have empowered farmers by bridging the gap between traditional farming practices and modern techniques. They provide farmers with access to advanced technologies, improved farming methods, and quality inputs such as seeds, fertilizers, and machinery. By promoting knowledge-sharing and skill development, Agri-entrepreneurs help farmers enhance their productivity and profitability, ultimately leading to the socio-economic development of rural communities.

Technological Advancements

Agri-entrepreneurs have been at the forefront of integrating technology into agriculture. They have leveraged innovations like precision farming, IoT (Internet of Things), data analytics, and automation to optimize resource utilization, monitor crop health, and enhance overall farm management. These technological advancements have led to increased efficiency, reduced wastage, and improved crop yields. Agri-entrepreneurs have played a pivotal role in bringing such cutting-edge solutions to the doorstep of Indian farmers.

Market Linkages

One of the significant challenges faced by farmers in India is the lack of direct market access. Agri-entrepreneurs have addressed this issue by establishing direct market linkages between farmers and consumers, eliminating intermediaries and ensuring fair prices for agricultural produce. They have created platforms for farmers to sell their products directly to consumers, hotels, restaurants, and export markets. This not only increases farmers' incomes but also ensures the availability of fresh and quality produce to consumers.

Sustainable Agriculture Practices

Agri-entrepreneurs are driving the adoption of sustainable agriculture practices in India. They promote organic farming, crop diversification, water conservation, and efficient use of resources. Through education and training programs, they create awareness about the importance of environmental stewardship and the long-term benefits of sustainable practices. Agri-entrepreneurs also encourage the use of renewable energy sources, such as solar-powered irrigation systems, to reduce dependence on fossil fuels and mitigate the environmental impact of agriculture.

Start-up Ecosystem

The rise of agri-entrepreneurs has contributed to the growth of a vibrant start-up ecosystem in the agricultural sector. Entrepreneurial ventures focusing on agri-tech, farm management, agricultural logistics, and value addition have proliferated in India. These start-ups attract investment, generate employment opportunities, and foster innovation. The government and various organizations have also launched initiatives and incubation centres to support agri-entrepreneurs, providing them with funding, mentorship, and a conducive environment to thrive.

Women Empowerment

Agri-entrepreneurship has emerged as a pathway for women's empowerment in rural areas. Women-led agri-enterprises are providing employment opportunities and financial independence to women. By promoting women's participation in agricultural activities, agri-entrepreneurs are breaking gender barriers and challenging traditional norms. The increased involvement of women in agriculture not only boosts the sector's productivity but also enhances gender equality and social development.

Policy Reforms and Government Support

Recognizing the significance of agri-entrepreneurship in agricultural development, the Indian government has implemented policy reforms and provided support to encourage entrepreneurship in the sector. Initiatives like the Atam nirbhar Bharat Abhiyan and the Start-up India campaign have created a favourable environment for agri-entrepreneurs to flourish. The government has introduced schemes for easy access to credit, subsidies, research and development grants, and infrastructure development, enabling agri-entrepreneurs to overcome challenges and scale their operations.

Conclusion

Agri-entrepreneurs have emerged as catalysts of change, revolutionizing the agriculture sector in India. Their contributions in empowering farmers, adopting technology, creating market linkages, promoting sustainable practices, and fostering a thriving start-up ecosystem have had a profound impact on agricultural development. The combined efforts of agri-entrepreneurs, government support, and policy reforms are paving the way for a more resilient, productive, and sustainable agriculture sector in India. It is imperative to continue nurturing and promoting agri-entrepreneurship to achieve long-term agricultural growth, rural prosperity, and food security.

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A Concept Note on Integrated Environment Management

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Integrated Environment management (IEM) is designed to ensure that the environmental consequences of development proposals are understood and adequately considered in the planning process. The term environmental is used in its broad sense, encompassing biophysical and Socio-economic components. The purpose of IEM is to resolve or integrate any negative impacts and to enhance positive aspects of development proposals. (Department of Environmental Affairs 1992)

The definition of IEM according to the Department of Environmental Affairs and tourism, (1998) is: "A philosophy which prescribes a code of practice for ensuring that environmental consideration are fully integrated into all stages of the development process on order to achieve a desirable balance between conservation and development." The vision for IEM, according to the Department of Environmental Affairs and Tourism, (1998), is to lay the foundation for environmentally sustainable development based on integrated and holistic environmental management practices and process.

The Basic Principles of IEM

- ✓ (Informed decision – Making
- ✓ Accountability for information on which decisions are taken.
- ✓ Accountability for decisions taken.
- ✓ A broad meaning given to the term environment (i.e, one that includes physical, biological, social, economic, cultural, historical & political component)
- ✓ An open, participatory approach in the planning of proposals.
- ✓ Consultation with interested and affected parties.
- ✓ Due consideration of alternative options.
- ✓ An attempt to mitigate negative impacts and enhance positive aspect of proposals.

Integrated Environmental management

Sustainable urban development requires an integrated approach and the thematic strategy advocates that national and regional authorities support municipalities in achieving more integrated management at the local level. This approach is supported by both the Council and the European parliament. Integrated approaches include long term strategic visions and link different policies at different administrative levels to ensure coherency. Integrated environment Management also means tackling related issues together such as urban management and governance, integrated spatial planning, economic wellbeing and competitiveness, social inclusion, and environmental stewardship. For example the implementation of community law on urban air quality not only has implications for pollution control and traffic management, but also requires combined effort to address city and town center management, spatial planning and urban design, health impacts and social justice (taking account of the different social group's affected and disproportionate burdens of environment impacts)

Benefits of Environment Management System

- ✓ Improved organization of operational environment protection.
- ✓ Legal certainty by way of systematic identification and evaluation of laws and constraints coast savings as a result of systematics and pro-active through and action.
- ✓ Improved environmental performance of organization to include the environmental quality of products and services.
- ✓ Increased confidence of customers, authorities banks, insurance companies and the public in the organization environmental performance.
- ✓ Employee identification and motivation
- ✓ Enhanced image & competitive ability.

Why Integrated Environmental Management (IEM)

Municipal authorities are responsible for a range of different function. These are performed or managed by many different part of their organizations, after with limited resources. Integrated environment management (IEM) after to improve the consistency and coherence between different policy from an environmental perspective and a means to maximize the effectiveness of those policies within available budgets. It can also offer greater transparency in policy development and encourage a greater public insolvent and acceptance. Integrated Environmental Management is entirely consistent with the Lisbon Strategy for innovation, competitiveness, growth and employment and experience demonstrates that establishing a system of IEM can help to promote the objectives of sustainability. Possible benefits of an IEM system may include some or all of the following.

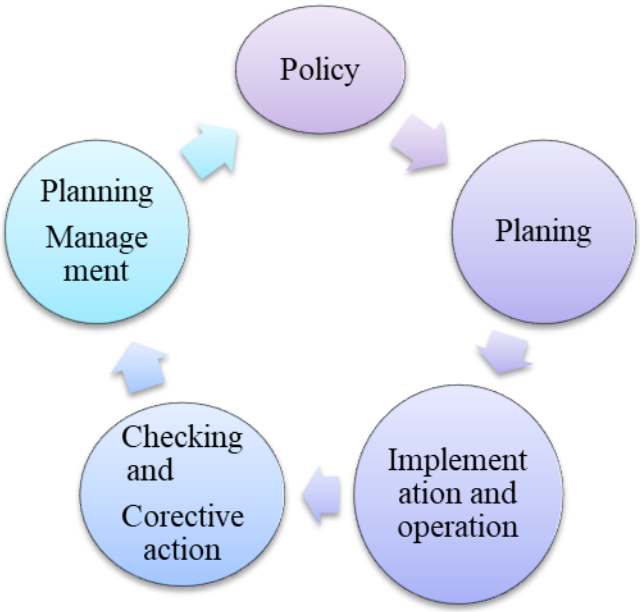
Achieve compliance with the existing environmental legislation efficiently and cost effectively.

- ✓ Improved cost – effectiveness of different policy measures.
- ✓ Improved reputation/ fame and " Competitiveness" of the city (local authority)
- ✓ Enhanced environmental awareness of citizens, local authority staff and stakeholders.
- ✓ Enhanced partnership and communication between the citizens and the leaders of the city, creating networks.
- ✓ Cost savings through reduced resources and utilities, improving economic competitiveness through cutting cost.
- ✓ Harmonization of reporting responsibilities.
- ✓ Contribute to national and European objectives on the environment and Lisbon strategy to make Europe a more attractive place to work and invest'.

Integrated Environmental Plan

The IDP and the Integrated Environmental Plan

The IDP is a strategic planning instrument which guides and informs all planning, budgeting, management and decision making in municipality. According to the Municipal system Act (32 of 2000), all municipalities (i.e. Metro District Municipalities and Local Municipalities) have to undertake an integrated development planning process to produce integrated development plans (IDPs). As the IDP is a legislative requirement it has a legal status and it supersedes all other plans that guide development at local government level.



Local Environmental Management Issues

Apart from the potential environment issues from the manage IDP, the municipality recently completed its first state of the Environment Report as well as a Environmental legal compliance Audit of its functions and facilities the key priority areas and identified issues within these document were summarized and grouped according to the frame work for environment management local authority level during a workshop held on 1st April 2004 with senior Management of MLM.

Issues to cover

Beyond the key elements it is important to demonstrate what issues could be addressed by an integrated approach. Based upon available information and experience to date, an IEM system could tackle some or all of the following topics of relevance to sustainable urban development. The list is not exhaustive but illustrates what others have included in their IEM planning.

- ✓ Improving water quality
- ✓ Improving waste management
- ✓ Increasing energy efficiency and use of renewable energy
- ✓ Reducing greenhouse gas emission
- ✓ Improving outdoor air quality
- ✓ Improving urban transport
- ✓ Preventing and reducing noise and protecting quiet areas
- ✓ Better local governance
- ✓ Better land use and planning
- ✓ Increasing biodiversity and green space
- ✓ Reducing environmental risks

Implementation Programmes

The implementation programmes include the following

(1) Community Based planning and Management Programme (CBPP)

This programme will aim to promote and co-ordinate community ownership of their environmental resources.

(2) Management Programme (MANP)

This programme will aim constantly manage and control environmental impacts through strategic studies.

(3) Public Awareness and Training Programme (PATP)

This programme will aim to create awareness the general public regarding various environmental issues as well as ensure training for bath the community.

(4) Standard and Guidelines Programme (STGP)

This programme will aim to provide standards, guideline and or manuals for any procedural activities to address the environmental issues.

(5) Law enforcement Programme (LAWP)

This programme will aim to formulate and enforce such policy positions, by laws and law enforcement procedures as is required to address the identified environmental issues.

(6) Organization Structuring Programme (ORGP)

This Programme will aim to create effective coordinating structures to address the various environmental issues.

(7) Equipment and Technology Programme (EQPP)

This Programme aim to upgrade and replace municipal equipment and Technology which are not resources efficient or which might have negative impacts on the environment.

(8) Conservation Programme (CONP)

Promote, co-ordinate manage the conservation of resources within the municipal area.

(9) Rehabilitation programme (RHBP)

Promote, co-ordinate and manage the rehabilitation of area which have been degraded within the municipal area.

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Success Story: Kalaburagi farmer Sri. Lakshmikant Hibare converts barren land into a self-sustainable natural farm

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The farmer Lakshmikant Hibare S/o Digambarao Hibare is a matriculate progressive farmer from Hagaraga Village, about 15 km from Kalaburagi city, is a living example for the farming community as he has adopted agroforestry along with various scientific technologies and techniques for conservation of natural resources, while earning a good income cultivating in his three acres of land. The untiring efforts of the farmer have helped him convert his barren piece of land into a self-sustainable green farm.

Laxmikant Hibare originally from Maharashtra, Laxmikant's father moved to Karnataka many years ago to settle down. "Soon after class 10th I took up various odd jobs to make ends meet. It was a difficult time growing up. I managed to get a job as a typist while simultaneously working on trying to cultivate the land. My father had a total of seven acres of land, of which only about three acres was fertile and cultivable. As the years went by, the land was divided between my father and his brother, and what remained with my family was barren land," he shares.

He explained that it takes at least 15 years to 18 years to procure usable sandalwood from the plantation. Meanwhile, farmers from across the district and students from agriculture & other colleges visit his farm to take his advice and to learn more about his farming techniques. He says 'In the beginning faced big hurdles due to lack of knowledge about natural farming, marketing issues and proper guidance but later he found success after adopting organic method of cultivation with the support and guidance from the KVK, Kalaburagi scientists especially the Senior Scientist and Head Dr. Raju G. Teggelli, who helped him through various stages. "It was on their advice that I learnt all about forest farming and started growing crops following their instructions," he adds. Forest farming is the cultivation of high-value specialty crops under a forest canopy that is intentionally modified or maintained to provide shade levels and habitat that favour growth and enhance production levels. Now he is growing different varieties fruits, sandalwood and along with various other crops and components in organically.

He is practicing natural farming for 15 years, by way of using organic agricultural methods, which now has 850 sandalwood trees and red sanders trees, 850 drumstick tree, 225 java plum trees, 225 Lucknow-49 guava plants, 225 Thai orange trees, 225 grapefruit (red orange) trees and 125 Mahogany timber plants and 125 meli dubia trees, amla, turmeric and moringa along with fruits plantations, was once a barren land, without water. The farmer has also planted lemon trees and fever nut trees as border fencing. Though he has a bore well and a water harvesting pond on the farm, he has installed a drip irrigation system for water supply.

Lakshmikant Hibare has adopted the organic way of farming and composting process for improving soil fertility and important factor is he is nothing procured from outside. Manure, jeevamrutha, compost every agri-input required for farm operations

is generated at his own farm in-situ. He has different lowcost units in his farm like bio digester tank, vermicompost, like jeevamrutha, panchagavvya, gokrupamrutha, waste decomposer, Agni astra, brhamstra, neemastra, dashaparni kashaya, neem oil, goatry unit, farm pond etc., besides growing seasonal fruits and vegetables, Lakshmikant Hibare has established a poultry farm that breeds a special variety of chicken, BV-380. The farmer earns between Rs. 40,000 and Rs. 50,000 per month by selling eggs, vegetables and fruits from his farm. Lakshmikant Hibare, who planted sandalwood and red sanders two years ago, also runs a nursery and bee keeping successfully for additional sources of income for his family.

He also has innovative way of reaching the customers for selling his produce. He says, "I find it easier to directly sell to the customer by using various social media. This way, the middleman is completely eliminated and I get a sense of what customers are actually looking for. I am part of a many WhatsApp groups where customers directly deal with the farmer to buy the produce." Laxmikant serves close to 1000 customers *via* WhatsApp and says that some stores in and around the village also stock up on his fruits and vegetable produce. In diversifying and growing various seasonal crops, Laxmikant has been able to retain a steady income. "The Lucknow Guava, when in season, earns me close to Rs 80,000 and the moringa crop, close to Rs 1.5 lakhs a season," he says.

Achievements: He had been honoured by Government of Karnataka prestigious **"Krishi Pandit"** award during 2019-20 under organic farming category**,** he was received **"Best farmer"** pakwada award from Bank of Baroda, Kalaburagi Regional Office, Zonal level award during 2020-21 and leading newspaper Vijaya Karnataka **'Super Star Farmer'** Award (Instituted by the noted Kannada Daily Vijaya Karnataka during 2019) held at Kalaburagi and He was recognized as district level "Negilayogi" Karnataka Rakshna Vedike, Kalaburagi during 2020 and many organization honoured for his tremendous achievement in organic cultivation. His success story published in many leading magazines and TV channels in different languages of the India.

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Performance Evaluation of Post Hole Digger

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Post hole digger is a tool used to dig holes in the ground, for general purposes such as setting fence and planting of horticultural saplings. It consists of a rotating vertical metal rod with one or more blades attached at the lower part that cut or scrape the soil. In operation, the tool is jabbed into the ground with the blades in the open position. The handles are then operated to close the blades, thus grabbing the portion of soil between them. The tool is then pulled out and the soil is deposited by the side. This process is repeated until the hole is deep enough.

Treatment details

T1: Digging of pits by manual method (farmers practice)

T2: Digging of pits by hand operated post hole digger

T3: Digging of pits by tractor operated post hole digger

Conventionally digging a deep or larger diameter hole requires more labour, drudgery and time. So, in order to reduce these losses, we procured commercially available tractor operated post hole digger. It is the fastest method to dig holes by PTO driven implement, made for all types of soil and easy to transport. It is ideal for digging with less time and efforts. Pits of depth up to 36 inches with a well-defined circumference and neat finishing can dug in less than 20 seconds. Removed soil is placed around the pit which makes it easier to fill back after plantation/erection. It can be used for planting saplings of mango, coconut, lemon, teak, and pomegranate, erection of fencing poles, plantation crops, and forest species. Time for preparing the planting hole/pit refers to the total time taken to erect the auger, rotate and at same time move the auger to penetrate the soil surface, lift up the auger, and tilt the auger to its rest position. Measurement for the time duration immediately started when the operator shifted the hydraulic control lever to erect the auger and terminated when the auger was at its rest position and the clamping covering mechanism at the convenient height position to the operator.

Plate 1. Glimpse of manual method and mechanical method of digging of pits

Table 1: Specifications of tractor operated post hole digger

Sl No	Parameters	Details
1	Name of the equipment	Post hole digger (Tractor operated)
Specifications of equipment		
2	Overall dimensions (L X B X H), mm	2391x840x1430
3	Auger diameter, mm	450
4	Weight, Kg	240
5	Cost of the equipment, Rs.	1,40,000
6	Power source	Tractor operated
7	Horse power required, Hp	>40
8	Fuel used	Diesel
9	Labour required	1 operator, 1 helper

Table 2: Specifications of hand operated post hole digger

Sl No	Parameters	Details
1	Name of equipment	Post hole digger (hand operated)
Specification of equipment		
2	Cost of the equipment, Rs.	30,000
3	Weight, kg	9
4	Number of bids	Two
5	Power source	Self-propelled 2.7 HP petrol engine
6	Fuel used	Petrol
7	Speed	300 rpm
8	Labour required	1 operator

Results and Discussion: The specifications and performance data of the commercial post hole digger are as given in Table 1, 2 and 3.

Inference: Performance evaluation and frontline demonstration of post hole digger for digging of pits was conducted in the research plots of ZARS, V.C. Farm, Mandya and farmers' fields at various villages of Mandya (T&D). The post hole digger demonstrated at farmers field for planting of horticultural, plantation and forest species for about 18 ha. Farmers are happy with performance of the machine and also appreciated the reduction in labour charges and cost of operation.

Plate 2. Glimpse of post hole digger demonstrated at farmer's field

Table 3: Comparative performance of tractor operated post hole digger

Sl No	Parameters	Tractor operated post hole digger	Hand operated post hole digger	Farmer's practice
1	Type of soil	Sandy clay	Sandy clay	Sandy clay
2	No. of pits/h	180-200	40-60	6-8
3	Effective working diameter, mm	450	75	450
4	Working depth, m	0.90-1.55	0.30-0.45	0.30-1.55
5	Time taken for making a pit, sec	20	60	600-900
6	Effective field capacity, ha/h	0.032	0.042	0.0022
7	Fuel consumption, l/h	4.30	0.95	-
8	Cost of operation, Rs/h	495	125	65

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A Sustainable Revolution: India's Transition to Natural Farming

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The remarkable agricultural growth experienced by the country in the 1960s, following the emergence of the Green Revolution, ushered in a new era in Indian agricultural history. The primary objectives of the Green Revolution technology were to enhance agricultural production through the adoption of high-yield crop varieties and hybrids and the increased use of fertilizers and plant protection chemicals (Sebby *et al.*, 2010). India scored an impressive position in the food production as a result of these efforts. However, it also confronted a rather dreadful ranking in the hunger index (Menon *et al.*, 2008).

Regrettably, the Green Revolution also posed some detrimental effects on Indian agriculture. The adoption of a mono-cropping system, excessive and frequent application of fertilizers and pesticides, resulted in substantial harm to the soil's natural processes, reduced crop's diversity, raised the overall cost of cultivation, depleted groundwater reserves, led to the loss of biodiversity, increased human health issues, malnutrition, and diminished soil's fertility, rendering extensive areas barren. Consequently, small-scale farmers were compelled to invest in these costly inputs, exposing themselves to significant financial risks and trapping them in a cycle of debt (Eliazer *et al.*, 2019). Given the evident environmental and ecological consequences of pesticides, it is unsurprising that government regulations have now been strengthened.

Moreover, concerns about the potential health impacts of pesticidal residues have in-turn motivated many individuals to opt for pesticide-free products. Despite the existence of regulations to ensure legally permissible maximum residual levels of pesticides in food, there has been a growing movement to eliminate pesticides from agriculture. Therefore, the restoration of soil health through a shift away from chemical-intensive agriculture has assumed paramount importance in striving for sustainability in agricultural production.

Chemical Fertilizers: A Double-Edged Sword

According to the "Fertilizer Association of India" in 1951-52, India produced a modest 0.20 million tonnes of fertilizers. By 2021-22, this number had skyrocketed to a staggering 43.7 million tonnes. Simultaneously, fertilizer consumption surged from 0.069 million tonnes to an astonishing 29.79 million tonnes over the same period. While chemical fertilizers undoubtedly contributed to an increased crop production, their drawbacks were severe as discussed ahead:

- **Soil Hardening**: Excessive use of chemical fertilizers over time resulted in soil hardening, diminishing its natural properties.
- **Reduced Fertility:** Continuous reliance on chemical fertilizers led to reduced soil fertility, creating dependence on external inputs.
- **Environmental Hazards:** Chemical run-off from farms polluted water bodies, while ammonia and nitrous oxide emissions contributed to air pollution and greenhouse gases.
- **Health Risks:** Exposure to chemical fertilizers posed health hazards to both the farmers and the consumers.

The Global Call for Sustainable Farming

The adverse effects of chemical farming practices spurred a global demand for sustainable agricultural alternatives. One such approach gaining momentum is "Natural Farming," which initially gained recognition in Japan and has since captured worldwide attention.

Natural Farming: A Sustainable Alternative

Nature farming, first proposed as an alternative to chemical farming in 1935 by Japanese

philosopher Mokichi Okada, is an agricultural approach that prioritizes sustainability and environmental responsibility. According to the International Nature Farming Research Centre in Nagano, Japan, their approach is grounded in the following principles:

- Fertilizers are seen as a source of soil pollution and a cause of reduced soil productivity.
- Excessive fertilizer use is believed to trigger pest outbreaks.
- The nutritional status within plants is considered a key factor in the difference in disease occurrence between plants that are resistant and those that are susceptible.
- Nature farming proponents argue that vegetables and fruits produced using their methods have superior taste compared to those grown using chemical farming practices.

Unfortunately, the followers of Okada, the founder of this approach, were unable to produce yields substantial enough to persuade a significant portion of the country to adopt nature farming techniques. Then Masanobu Fukuoka proposed the new concept of natural farming Key principles of natural farming include:

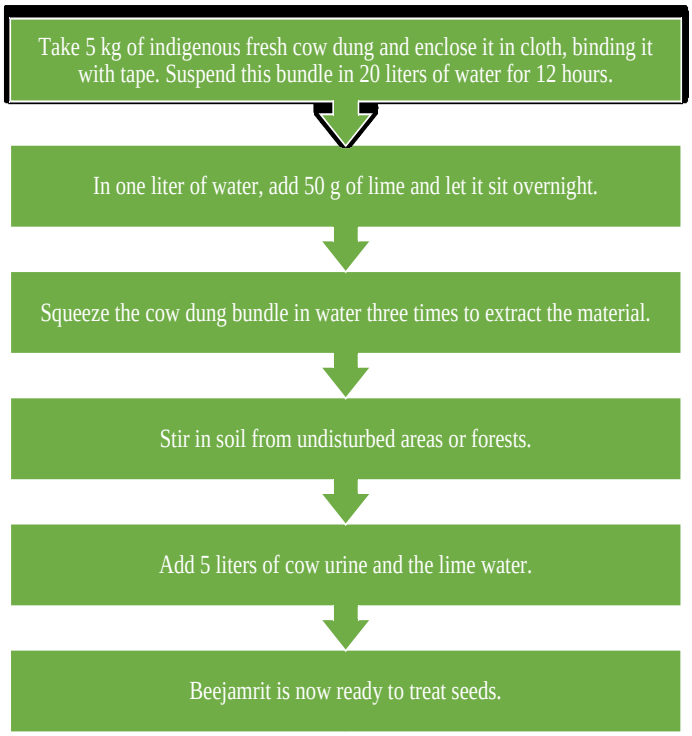
- **Exclusion of Synthetic Chemicals:** Natural farming avoids synthetic chemicals, emphasizing natural and organic inputs to enhance soil health and fertility.
- **Local Knowledge and Resources:** It harnesses local knowledge and resources, promoting self-sufficiency and community engagement.
- **The Role of Cows:** Cows play a central role in natural farming, providing essential inputs like cow dung, cow urine, jaggery, and pulse flour. These materials enrich the soil and enhance crop growth.
- **Mulching Techniques:** Natural farming incorporates mulching techniques to retain moisture, suppress weed growth, and improve soil structure.
- **Symbiotic Intercropping:** The practice encourages the cultivation of multiple crops in harmony, fostering a diverse and resilient agricultural ecosystem.

In the mid-1990s, Subash Palekar pioneered the concept of zero-budget natural farming (ZBNF) in India. This innovative approach aims to reduce production costs by replacing expensive chemical fertilizers with natural resources like cow dung and cow urine. ZBNF operates on the principle of not purchasing any external inputs from the market, effectively rendering production costs negligible. The adoption of Green Revolution technologies, including synthetic fertilizers and pesticides, has led to adverse consequences such as a decline in soil fertility, the erosion of sustainability, and disruption of beneficial soil microorganisms. In contrast, ZBNF harnesses the power of cow dung, where just 1 gram contains 300-400 crore beneficial microbes. This cow dung-based solution, known as jeevamrit, serves as a natural culture to promote soil health and enhance crop productivity. An intriguing claim associated with ZBNF is that a single cow can provide sufficient nutrients for a thirty-acre farm, highlighting the efficiency and sustainability of this farming method. Despite widespread interest and support from various organizations, universities, and scientists, there is a debate regarding the "zero budget" terminology. Critics argue that farmers still need to invest in equipment such as pumps, pipes, and other machinery for their agricultural operations, making it inaccurate to describe the system as "zero budget." In response to this contention, ZBNF has been renamed as Subash Palekar Natural Farming.

Fundamentals Practices of Natural Farming

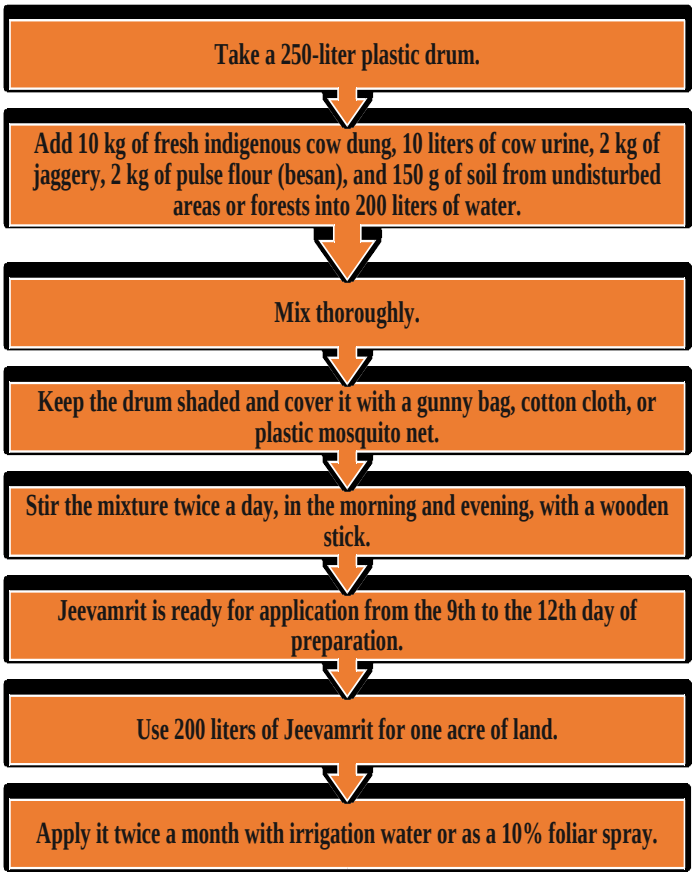
Beejamrit: Safeguarding Seedlings

Beejamrit is invaluable for treating seeds, seedlings, and young plants, protecting them from fungus and soil-borne diseases. To make Beejamrit: mix it with seeds by hand, shade dry, and then sow. For leguminous crops, simply dip the seeds and quickly dry them. Like Jeevamrit, Beejamrit contains beneficial bacteria beneficial for plant protection and growth stimulation.



Jeevamrit: The Elixir of Soil Health

Jeevamrit, known by various names, serves as a natural defence against fungal and bacterial diseases. It can be applied through irrigation or as a foliar spray and stored for up to a year. To create Jeevamrit, follow these steps:



Acchadana: The Power of Mulching

Mulching involves covering topsoil with crop waste, dried leaves, or cover crops. This practice shields soil from erosion, improves aeration, conserves moisture, enhances water retention, encourages soil fauna, maintains soil nutrient levels, and controls weed growth.

Whapasa: Balancing Air and Water

Whapasa represents the ideal state where both air and water molecules coexist in the soil. Adequate aeration is crucial for proper plant growth and development. It enhances soil aeration, humus content, water-holding capacity, and soil structure, particularly beneficial during drought periods.

Ghanjeevamrit: Nurturing Soil Fertility

Ghanjeevamrit enriches soil with beneficial organisms that fix and mobilize NPK (nitrogen, phosphorus, and potassium). It's prepared by mixing 100 kg of indigenous cow dung, air-dried for 4-5 days, with 1 kg of jaggery, 1 kg of pulse flour, 3 liters of cow urine, and 250 g of soil from undisturbed areas. After preparation, Ghanjeevamrit can be used as cakes in fields. Prior to sowing, apply it at a rate of 250 kg per hectare as per the recommended dose.

Neemashtra: Nature's Insect Repellent

Neemashtra, a liquid-based formulation of neem and cow urine, serves as a natural pesticide. It effectively controls insect-pests like aphids, jassids, mealybugs, thrips, whiteflies, small caterpillars, and other sucking pests. Prepare it by mixing fresh neem leaves or neem seed kernels with cow urine, cow dung, and water.

Agniashtra: Combatting Borers and Caterpillars

Agniashtra is a botanical formulation prepared using neem leaves, chili fruits, garlic, and cow urine. It's used to manage stem borers, fruit borers, and different types of caterpillars in crops. Prepare it by boiling the ingredients and then dilute for spraying.

Brahmashtra: Nature's Defense Against Pests

Brahmashtra, another cow urine and botanicals-based formulation, acts as a natural pesticide against insects like pod borers, fruit borers, thrips, aphids, and jassids. It's prepared using a mix of

leaves and cow urine, and it's effective in high-infection scenarios.

Mixed Leaf Extract (Decoction): A Natural Sucker and Borer Buster

This formulation is made using leaves from various trees like custard apple, papaya, pomegranate, and guava. It effectively manages sucking pests and various pod and fruit borers.

Chilli-Garlic Extract: Tackling Caterpillars

Chilli-Garlic extract is a formulation that uses chili, garlic, neem, and Ipomea carnea leaves. It helps control various caterpillars, including leaf rollers, stem, fruit, and pod borers.

Dashparni Extract: All-Purpose Pest Management

Dashparni extract, a concoction of various plant species, indigenous cow urine, cow dung, and spices, is effective against a wide range of insect pests in crops and orchards. It's fermented and stored for long-term use.

These traditional farming techniques provide eco-friendly alternatives to chemical-intensive agriculture. By harnessing the power of nature and incorporating these practices, farmers can protect their crops, nurture soil health, and contribute to sustainable and environmentally responsible agriculture.

Natural Farming in India: The BPKP Initiative

Bhartiya Prakritik Krishi Padhati (BPKP), a component of the Paramparagat Krishi Vikas Yojana (PKVY) since the fiscal year 2020-21, is dedicated to the promotion of traditional indigenous farming practices, notably including Zero Budget Farming. This scheme places a primary focus on the exclusion of all synthetic chemical inputs and encourages on-farm biomass recycling, particularly through practices such as biomass mulching, the utilization of cow dung-urine formulations, and plant-based preparations.

Under the BPKP initiative, financial assistance amounting to Rs 12,200 per hectare is provided for a period of three years. This support covers activities such as cluster formation, capacity building and continuous guidance from trained experts, certification processes, and residue analysis. To date, the BPKP program has extended its coverage to approximately 4.09 lakh hectares of agricultural land across eight states in India, with a total fund allocation of Rs. 4980.99 lakh being released for its implementation.

Table. 1: The State-wise details of funds released under BPKP

Sl. No.	States	Area in Ha	Amount released (Rs in lakh)
1.	Andhra Pradesh	100000	750.00
2.	Chhattisgarh	85000	1352.52
3.	Kerala	84000	1336.60
4.	Himachal Pradesh	12000	286.42
5	Jharkhand	3400	54.10
6.	Odisha	24000	381.89
7.	Madhya Pradesh	99000	787.64
8.	Tamil Nadu	2000	31.82
Total	**409400**	**409400**	**4980.99**

Conclusion

Natural farming has evolved into a much transformative farming model, especially beneficial for small and marginal farmers, offering a solution to the challenges they face. This approach addresses farmer's distress while prioritizing the well-being of both the environment and the farmer's themselves. By eliminating the need for costly external inputs and relying on locally available resources, natural farming significantly reduces the production costs for farmers. It's fundamental advantage lie in its capacity to restore ecosystem and soil health. It nurtures the land by encouraging the revival of vital microorganisms and fostering a sustainable farming environment. As a result, it not only safeguards the livelihoods of small and marginal farmers but also contributes to the broader goal of preserving our ecosystem. Furthermore, natural farming places the health of farmer at the forefront, promoting practices that are not only economically viable but also conducive to their physical well-being. This holistic approach represents a promising path towards a more sustainable and resilient agricultural future for India.

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Seed Bomb- The Need of The Hour

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Propagating a native species by the use of seed balls, also known as seed bombs, is a simple and long-lasting method because it creates an ideal environment for seed germination and allows for more time for seedlings to multiply. Masanobu Fukuoka, a Japanese pioneer in natural farming, he discovered the method of making seed balls. The concept of aerial replanting was inspired by the traditional Japanese custom of tsuchidango (earth dumpling). Tamilarasan *et al.*, (2021) reported that the seed ball technique proved to be low cost and can be used to recover vegetation in deforested areas. This technique can overcome biotic and abiotic stresses which hinder seed germination and viability. It can be effectively utilized for better seedling establishment, vigour and survival even in resource-limited conditions. Under non- irrigated condition, seed ball performed better then control. The nutrients in the seed ball medium provided additional nutrients and growth promoting factors for enhancing the establishment and survival rate of the seedlings.

Suitable time for seed ball preparation and propagation

Seed balls can be propagated before monsoon on damp soil based on climatic calendars of the respective country. By October, winter-planting seed balls should be ready. Seed ball propagation should be done after two to three days of rain in drier areas. At monsoon, coastal seed ball propagation should begin. Late propagation may fail

Criteria for selection of site: A site survey should be conducted before selection of plant species for making seed balls. In coastal areas neem seed may not germinate and grow easily. The seeds should be collected from local vendors or from forest areas. The viability and germination percentage of seeds should be assessed before making a seed ball. In annual grass or legume species, seed should not be older than one year.

Suitable species for seed ball propagation

Seeds of native species from same climatic conditions must be selected for making seed balls. This improves the chances of germination. Native trees species should be selected for propagation along highways, avenue plantation etc. Along railway tracks tree *sps.* are not advised, as during cyclone or monsoon it may fall on it. Deep rooted, non-palatable, nature ornamental shrubs are most suitable for these areas. In tree *sps.* viz. Neem, Ficus sps. seeds may be collected, shade dried and propagated in same year.

Pre-treatment of Seeds

Some seeds remain dormant in soil after propagation due to the immature embryo, chemicals on seed coat or hard seed coat. These types of seeds require pretreatment. Annual grass and herbaceous legume seeds do not require pretreatment. In leguminous trees, mechanical scarification, hot water scarification, soaking in cold water and acid scarification improves the seed germination. After scarification seeds should be shade dried to remove the traces of moisture. It reduces the chances of pre germination of seeds in seed ball.

Preparation of Seed Balls

Well drained native soil should be collected and sieved from 0.075 mm (200 no.) sieve to get clay particles. Clay, organic fertilizer and perlite

/Vermiculite should be mixed well as per convenience in the ratio of 1:0.5:0.25. A culture of beneficial microorganism's viz. N fixers, P solubilizers and mobilizers should be added for improving the germination of seeds and growth of seedling even in adverse conditions. By adding *Trichoderma sp.*, the occurrence and infestation of root zone pests and diseases can be reduced. Water must be added in the seed ball substrate to prepare dough. If dough is very sticky, coco peat may be mixed. 1 kg substrate can make 90-100 balls of 0.5 to 1inch that may accommodate 2-4 seeds depending on the size of seed. In 5000 kg of substrate 5,00,000 seed balls can be prepared in advance before propagation. Seed balls must be air dried for 24-48 hours in a shade before sowing or storing.

Methods of seed balls application

Dibbling Method: In the first method, called "dibbling," a dibbler (either a metal rod or a bamboo stick) is used to drop seed balls in a hole or cavity at regular intervals. To find a level area, usually a plain landscape can be selected. Such places include the side of the road, a garden, a patch of grass, etc. Depending on the desired plantation and the desired number of tiers or rows of propagation, the seedballs can be propagated in a variety of shapes and patterns, such as a triangle, a square, a single hedge, a double hedge, etc.

Broadcasting/Aerial Throwing: In order to grow the most grass possible on knolls and other inhospitable, strewn landscapes, it is advised to use aerial throwing. Seed balls can be dispersed by hand or by being dropped from a helicopter or a drone; neither ploughing nor digging of pits is necessary. Seeds need a particular climate for optimum germination and survival, and it covers a wide region in a short amount of time. Aerial broadcasting along steep slopes is not advised since the seed balls could be lost in the rain. As a result, it might be difficult to keep track of how many seeds germinated and how many of them became healthy seedlings.

Distance to maintain in seedball propagation

Depending on size and canopy of tree, seedballs must be propagated at specific distance. Distance to be maintained in seed ball propagation:

Sl. No	Height of plant	Preferable position for plantation	Distance to maintain
1.	Tall	On Boundary	10m x 10m
2.	Medium	Roadside	7m x 7m
3.	Short	Block Plantation	5m x 5m

Precautionary measures taken after propagation

Grazing should be controlled to get better survival ratio of germinated seedlings. In waterlogged land, small bunds can be prepared near germinated seedlings to prevent deterioration of seed. In case of long break in rain fall, light irrigation should be done.

Counting & monitoring of germinated sapling

After 45 days of propagation 1st monitoring should be done to check the germination and calculate germination ratio. Along with this, information of rainfall, nature of area, slope, mode of propagation etc. can be recorded.

Future Prospects in Seed Bomb Technique Aerial Seeding: An Effective Afforestation Method

Spraying seeds from a drone, plane, or helicopter is called "aerial seeding," and it's used to quickly and effectively reduce erosion risks and suppress the growth of invasive plant species. Aerial seeding is commonly used to spread various grasses and legumes to large areas of land in need of vegetative cover after fires. Aerial seeding, the practice of broadcasting seeds from aircrafts, has been used for nearly 80 years. It was first performed in 1926 in Hawaii to recover large areas of burned tropical forest. The main goal of aerial seeding projects has been the re-establishment of specific ecosystem services, rather than the reconstruction of viable, resistant, and resilient ecosystems that are representative of biodiverse reference communities.

Benefits of aerial seeding using seed bomb

Drones can readily reach places that are difficult to reach by humans. This is a common argument used to persuade nations to implement aerial seeding programmes. When the globe needs to guarantee effective coverage of a large region in a short length of time, seed bombardment by drones is increasingly being regarded a viable choice. Not only do high-tech drones make forest restoration easier on humans, but they also boost crop yields through aerial planting. What's more, seed bombing is a gentle technique for plants. Aerial reforestation is the most efficient method of treatment when wet soil and undulating land render other methods ineffective. Because it does not lead to soil compaction, aerial application reduces runoff. Most of the benefits of this planting strategy will accrue to tropical forests since they are more efficient carbon sinks and host a greater variety of plant and animal life.

Conclusion

Numerous global threats are pushing humanity nearly to the brink of devastation and catastrophe. These include pandemics, economic hardship, food insecurity, poverty, climate change, conflicts, land and water degradation, and biodiversity loss. Unhealthy planet leads to an unhealthy economy. Environmental degradation causes climate change, biodiversity loss, and new diseases. Forests and trees can help solve these challenges and create sustainable economies. The UN Strategic Plan for Forests goal of increasing forest acreage by 3% by 2030 is not on track (FAO, 2022). Afforestation projects manage forests and counteract global warming and climate change by helping huge populations survive (Mohan *et al.,* 2021). Forests and trees can provide global, cost-effective, egalitarian, and fast solutions. Forests and trees can maintain nature, improve human well-being, and create money, especially for rural people. Seedball propagation greens fractured and degraded lands cheaply. Seedballs can quickly cover enormous areas. It's inexpensive, sustainable, and effective for planting in challenging areas. Seedball intervention works well in grazing-free environments. This method overcomes biotic and abiotic factors that prevent seed germination and viability. Even in resource-limited situations, it improves seedling establishment, vigour, and survival (Tamilarasan *et al.,* 2021).

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Sustainable Pest Management

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Pest management is a range of methods and practices employed to manage and regulate the population of species classified as pests. These are typical organisms which negatively affect human activities, such as agriculture, residential and commercial environments (Cook et al., 2006). The aim of pest management is to minimize the physical and economic damages caused by these pests.

Table: 1 Lists of some common pests and methods for eco-friendly control.

Pest	Eco friendly Control Method
Aphids	Use of ladybugs or lacewings (Biological Control) Neem oil (Organic Pesticide)
Caterpillars	*Bacillus thuringiensis* (Bt) (Biological Control), Hand picking (Mechanical Control)
Whiteflies	Yellow sticky traps (Mechanical Control) *Encarsia formosa* (Biological Control)
Slugs and Snails	Hand-picking and barriers (Mechanical Control), Nematodes (Biological Control)
Colorado Potato Beetle	Crop rotation (Cultural Control), *Bacillus thuringiensis* (Bt) (Biological Control)
Mice and Rats	Traps (Mechanical Control), Predatory cats or owls (Biological Control)
Mosquitoes	Removing standing water (Cultural Control), *Bacillus thuringiensis var. israelensis* (Bti) (Biological Control)
Weeds	Mulching (Cultural Control), Hand-pulling (Mechanical Control)
Fungus Gnats	Yellow sticky traps (Mechanical Control), *Bacillus thuringiensis var. israelensis* (Bti) (Biological Control)
Powdery Mildew	Milk sprays (Organic Pesticide), Resistant plant varieties (Use of Resistant Varieties)

Principles of Eco-friendly Pest Management

Eco-friendly pest management, often referred to as Integrated Pest Management (IPM). It is an approach that emphasizes the use of a combination of strategies to manipulate or manage the pest populations in a way that is economically viable, environmentally sound, and socially acceptable.

The principles of IPM include:

1. **Monitoring and Identification**: Regular monitoring and accurate identification of pests are essential to determine whether pest management actions are required. Monitoring can help to detect pest infestations prior to significant damage.
2. **Prevention:** IPM emphasizes the prevention of pest problems through various strategies, such as crop rotation, intercropping, and the use of resistant varieties.
3. **Threshold Levels:** IPM is an approach to focused on keeping pest populations below levels those causing economic damage.
4. **Multiple Tactics:** IPM employs a combination of all available pest management tactics, including biological control, habitat manipulation, and the judicious use of pesticides.
5. **Evaluation:** Regular evaluation is conducted to assess the effectiveness of pest management actions and make necessary adjustments (Barzman et al., 2015).

Eco-friendly Pest Management Techniques

Amendment of Cultural Practices

Cultural practices like crop rotation, intercropping, use of pest-resistant varieties, timely sowing, and proper sanitation can disrupt the life cycle of pests, reducing their impact. Altering traditional practices may involve using pest-free seeds or transplants, changing planting dates to avoid peak pest populations, and proper crop residue management. All these changes can lead to healthier crops less susceptible to pest infestations, enhancing productivity while mitigating environmental impact.

Crop Rotation

The practice of growing different types of crops in the same area in sequential seasons, is a

beneficial pest management strategy. It interrupts the pest cycle, making the environment less favorable for pests that are specific to certain crops. Absence of their preferred host continuously, their population is kept under control. crop rotation enhances soil structure, fertility and strengthens the crops' natural defense mechanisms against pests and diseases, ensuring better yields.

Agro-Ecosystem Structure

Agro-ecosystem Structure helps in understanding the entire ecosystem's dynamics, including pests, their natural enemies, and the relationships between different organisms and environmental factors. By promoting biodiversity, farmers can create a more resilient and balanced ecosystem. Planting diverse crops or maintaining natural habitats around the farm can attract and sustain beneficial organisms, such as predators and parasites of pests. These beneficial organisms can help control pest populations naturally, reducing the need for chemical pesticides.

Planting, Sowing and Harvesting Time

Certain pests may be more prevalent and active during specific periods; hence, adjusting the sowing dates can help avoid peak pest activity. Likewise, harvesting at the right time prevents the overexposure of crops to pests, reducing potential damage. An understanding of the pest's life cycle and the crop's growth stages is crucial for this strategy. With proper timing, farmers can exploit the vulnerable stages of pests while protecting the most sensitive phases of crop growth.

Plant Population Density

Closely spaced plants can create a microclimate favorable for certain pests and diseases, due to increased humidity and decreased sunlight penetration. Conversely, very sparse planting can lead to increased weed pressure and make crops more susceptible to pests that prefer isolated plants. Maintenance of optimal plant population density and proper spacing can minimize pest problems. This management approach also ensures that plants are not competing with each other for resources, which can make them more vigorous and less susceptible to pest attacks.

Fertilizer and Water Management

Balanced use of fertilizer and water is another critical strategy in pest management. Over use of fertilization, especially nitrogen, can lead to lush, succulent growth that attracts pests. On the other hand, under use of fertilization can result in weak plants that are more susceptible to pest attacks. Similarly, Over-irrigation can create a favorable environment for pests like fungi and insects that thrive in moist conditions, while under-irrigation can stress plants, making them more vulnerable to pests. Micro irrigation such as drip irrigation and scheduling watering based on soil moisture levels, can help in managing pests effectively.

Tillage

Tillage, the process of preparing soil for planting through mechanical agitation, can significantly influence pest populations. It can disrupt the life cycle of pests by exposing overwintering pests to harsh weather and predators, destroying their habitat, and burying crop residues that might harbor pests or diseases. On the other hand, minimum tillage or zero tillege farming can also contribute to pest management. By preserving soil structure and moisture, zero tillege farming can encourage beneficial soil organisms that help control certain pests.

Mulches

Mulches create a physical barrier that prevents pests from reaching the crops. Mulches can effectively reduce a variety of pests, including insects, nematodes, and weeds. Organic mulches, such as straw, leaves, or compost, can enhance soil health by adding nutrients and improving soil structure, promoting the growth of beneficial microbes that can suppress soil-borne diseases. In contrast, reflective mulches can repel certain insects and reduce the spread of virus diseases transmitted by these pests.

Biological Control

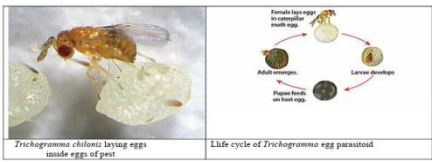
The use of living organisms-predators, parasites, and pathogens to control pest populations are included in biological control. Predators, such as

lady beetles and spiders, directly consume pests. Parasites, like parasitic wasps, lay their eggs inside or on pests, eventually killing them. Pathogens, including certain bacteria, fungi, and viruses, cause diseases that can reduce pest populations (Eilenberg, Hajek, & Lomer, 2001).

Biological Control Agents

Predators: Predators like Coccinellid beetles in vegetable ecosystem, Spiders in rice ecosystem, dragon flies, damsel flies, lady bird beetles, lacewings, birds etc., have proved helpful in protecting crops.\Ladybird beetles - grubs and adults feed on aphids and other soft bodied insect pests. *Cryptolaemus montrouzieri* feeds on mealy bugs on citrus, guava, grapes, coffee, mango, custard apple and green shield scale on mango, guava. Ground beetles target Coconut black headed caterpillar and rice brown plant hopper . The larvae of Green lace wing (*Chrysoperla carnea*) feed on soft bodied insects like aphids, jassids, white flies, mealybug etc.

Parasitoids: Parasitoids are small insect which feed on larvae of insect and complete their life cycle within them. It includes a number of species of wasps, fly etc. which lay eggs in or on the bodies of their insect host, and complete their life cycles on host bodies ultimately killing the host. Parasitoids may be of different types viz., egg, egg-larval, larval, pupal, adult depending on the developmental stage of the host in/on which it completes its life cycle. Examples are different species of Trichogramma, Bracon, Chelonus, etc. Egg parasitoids deposit their eggs in the eggs of the host and whose progeny emerge from the host eggs.



Trichogramma chilonis laying eggs inside eggs of pest — Life cycle of *Trichogramma* egg parasitoid

Trichogramma chilonis is used against sugarcane borer pests, rice leaf folder.

Cultural Control: Cultural control techniques include crop rotation, intercropping, and sanitation (Cook et al., 2006). Crop rotation has been successfully used to control pests like the corn rootworm, which relies on continuous corn planting. By rotating corn with other crops, farmers can break the rootworm's lifecycle and reduce its populations. Intercropping, such as planting legumes in cereal crops, can disrupt pest colonization and reduce pest densities.

Table 2: Cultural Operations for controlling pests

S. No.	Techniques	Pest can be Managed
1	Crop rotation	Corn Rootworm
2	Hand Picking	Tomato Hornworm
3	Use of Resistant Varieties	Colorado Potato Beetle
4	Interplanting	Cabbage Moth
5	Sanitation (removal of diseased/infested plant matter)	Peach Borer
6	Mulching	Squash Bug
7	Proper Water Management	Mosquito Larvae
8	Soil Solarization	Nematodes
9	Timely Harvesting	Fruit Flies
10	Planting Time Adjustment	Bean Beetle
11	Companion Planting	Aphids
12	Use of Pest-Resistant Seed Varieties	Stem Borers
13	Fallowing	Cutworms
14	Cover Cropping	Soil-Dwelling Pests
15	Mechanical Weed Control	Various Weed Pests
16	Proper Fertilizer Application	Various Soil Pests
17	Synchronized Planting	Various Crop Pests
18	Destruction of Infested Plant Debris	Various Overwintering Pests

Challenges in Implementing Eco-friendly Pest Management

Major challenges of Implementing Eco-friendly Pest Management is the cost. While it can be cost-effective in the long run, the initial costs can be high, deterring farmers from adopting them. The availability of resources, both human and material, is another hurdle. For example, biological control methods require a thorough understanding of pest biology and ecology, and may require specialized materials or organisms that are not readily available. Gaps in knowledge pose a significant challenge. Knowledge of pest biology and ecology, as well as the long-term impacts and effectiveness of various control methods.

Conclusion

Eco-friendly pest management is vital for sustainable agriculture and environmental conservation. Despite challenges in implementation, the potential solutions and emerging trends promise a positive future.

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Health Virtues of Flaxseeds

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India ranks third in the world in respect to area and production of linseed/flaxseed (*Linum usitatissimum* L.) and very popular in vegetarian diets. The seeds are oval, flat, glossy and pointed at one end. They are increasingly becoming part of our diets and it is essential to know how this super food helps us in various ways. Not only do flaxseeds help in weight loss, they also have a variety of other uses that can be useful for us. This crop is traditionally cultivated to produce edible and industrial fibre. Flaxseed has very nutritionally and functionally beneficial. Bioactive constituents in flaxseeds may prevent or alleviate diseases such as cardiovascular ailments, strokes, diabetes, cancer, etc. in addition, is evident from various clinical and epidemiological studies. However, flaxseed contains low quantities of adverse healthy compounds such as cadmium, cacogenic glycosides, inhibitors of trypsin that are commonly removed through thermal and mechanical processes, including cooking in microwaves, autoclaving and boiling. Its oil is believed to initiate mental and physical endurance by fighting fatigue and controlling aging process. The effects of flaxseed and flaxseed oil are similar to the effects of Vitamin C, which helps boost the immune system and protects against diseases. Moreover, linseed is endowed with immense benefits. Aside from eating purpose, its oil is used to make eco-friendly paints, varnishes, coating oils, linoleum, pad and printing inks, leather and soap. Oil cake is a good feed for milch cattle, which prevents them from many diseases (Anonymous 2023, Hussain 2009 and Lei *et al* 2022 and Anonymous 2018)

Medicinal properties of linseed (Anonymous 2023b, Anonymous 2017) and Kalia *et al* 2015))

Controls cholesterol: Rich in soluble and insoluble fibre helps in reducing cholesterol levels. It reduces bad cholesterol and increases good cholesterol content. Including flaxseeds in your diet can help in reducing the risk of cardiovascular issues. It is also effective in proper functioning of the intestines.

Promotes fertility: One of the best sources of lignin, which can balance female hormones, flaxseeds boost fertility and reduces premenopausal symptoms thanks to their ability to balance female hormones.

Improves blood sugar: Daily intake of flaxseeds improves the blood sugar level of people suffering from diabetes. Not only this, flaxseeds are also good for those suffering from a pre-diabetic condition as it helps in bringing blood sugar levels in control. Adding one tablespoon of flaxseed in your diet daily can help you get control of this condition.

Fights prostate cancer: It has the ability to assist in the fight against prostate cancer and disrupt the events leading to cancerous cell production. A great source of omega-3 fatty acids, which can help reduce inflammation and reduce the risk of certain cancers.

Low in carbohydrate: Flaxseeds are rich in fibre and very low in carbohydrates. The grains are high in soluble and insoluble fibre, which is good for our colon health as it helps in detoxification, fat loss, and can help reduce sugar craving.

Great source of omega-3: Flaxseeds are also a great source of omega-3 fatty acids, which can help reduce inflammation in the body and reduce the risk of certain diseases. Additionally, flaxseeds are also a great source of vitamins and minerals, including magnesium, phosphorus, and manganese.

Great for skin and hair: Flaxseeds are great source of essential fats as well as B-vitamins that helps in getting healthy hair and skin. B-vitamins and essential fats help to reduce dryness and flakiness. Along with this, flaxseeds also help in improving conditions like acne and eczema. Using 1-2 tbsp of flaxseed oil every day for the same purpose is extremely useful.

Good for eye health: Due to the many nutrients like B vitamins, flaxseeds are good for eye health those can help reduce dry eye syndrome. It also contains omega-3 fatty acids, which helps maintain a healthy tear film, reduce inflammation in the eye, which can lead to better eye health.

Accelerates weight loss: Flaxseeds can also help reduce inflammation and cholesterol levels, which are

both risk factors for heart disease and stroke. This helps in bringing a sufficiency level to your body.

Helps against gluten allergy: These are great for those suffering from gluten sensitivity or celiac disease. Along with this, flaxseeds are good for those who have an allergy from omega-3 fatty acids found in fish.

Full of antioxidants: Antioxidants help in regeneration and repair of body cells. Flaxseeds are loaded with polyphenols known as lignin, which provide us with antioxidant benefits. These include hormone balance, cellular health and anti-aging.

Helps in digestive health: Flaxseeds are good for digestive health as they contain both soluble and insoluble fibres, which is good for our digestive tract. Including one teaspoon of flaxseed in your daily diet can help you with issues like constipation. The soluble in flaxseeds helps to regulate digestion, while the insoluble helps to keep the digestive system moving. This helps to prevent constipation, bloating, and other digestive problems.

Other natural compounds: The flaxseed contains three types of compounds, each characterized by its own biological activity and properties: polyunsaturated fatty acids (PUFA), soluble dietary s (mucins), and lignans, which are phytoestrogens. The flaxseeds contain 35-45% oil, which contains 9-10% of saturated fatty acids (palmitic and stearic), about 20% monounsaturated fatty acids (mainly oleic acid), and more than 70% alpha-linolenic fatty acids acid. The protein content in seeds of flax varies from 20-30%. The content of dietary reaches 28% by weight of whole seed, Vitamin E in the flaxseeds is mainly in the form of gamma-tocopherol (9.2 mg/100 g of seeds). As the richest source of lignans in the vegetable world, flaxseed (up to 0.7-1.5% dry weight of seed) is primarily composed of Seco-iso-lariciresinol Diglucoside (SDG). Various studies have shown that SDG offers several health benefits, including protective effects against cardiovascular diseases, diabetes, cancer, and mental stress. These health benefits have been attributed to the antioxidant properties of SDG. Omega-3 and omega-6 fatty acids are the two groups of omega fats. There are three types of omega-3 fatty acids which are of nutrition importance namely, Linolenic acid, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). All three fatty acids have been shown to reduce the risk of cardiovascular disease.

Conclusion

Linseed/flaxseed contains many health benefits that can add up to new possible medicinal use of the crop. We can fight many diseases by adding little amount of linseed consumption in our diet regularly. The unexplored outcomes heart health, weight loss, hormonal imbalance, digestive health, anti-cancerous properties are yet to be improvised in near future.

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Role of Startup India in Agribusiness

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Startup India is a flagship initiative of the Government of India, intended to catalyse startup culture and build a strong and inclusive ecosystem for innovation and entrepreneurship in India. It was first addressed by the PM Narendra Modi on 15th August 2015 at Red Fort, New Delhi and launched on 16th January, 2016, these are managed by a dedicated Startup India Team, which reports to the DPIIT.

Vision

To move India towards becoming one of the most vibrant startup ecosystems in the world.

It provides various benefits to startups, such as tax exemptions, financial support, and access to incubators. To avail of these benefits, startups must register with the Startup India program.

Additionally, it is becoming more and more evident that agritech startups can provide relevant and innovative solutions to the challenges faced across the agricultural value chain.

Key Pillars of Support for Startups in Agribusiness

1. **Simplification and Handholding**

Easier compliance, easier exit process for failed startups, legal support, fast tracking of patent applications and a website to reduce information asymmetry

2. **Funding & Incentives**

Exemptions on Income Tax and Capital Gains Tax for eligible startups; a fund of funds to infuse more capital into the startup ecosystem and a credit guarantee scheme.

3. **Incubation & Industry-Academia Partnerships**

Creation of numerous incubators and innovation labs, events, competitions and grants.

Importance of Startup India in Agribusiness

1. Compliance Regime based on Self-Certification: To reduce the regulatory burden on Startups thereby allowing them to focus on their core business and keep compliance cost low
2. Startup India Hub: To create a single point of contact for the entire Startup ecosystem and enable knowledge exchange and access to funding
3. Rolling-out of Mobile App and Portal: To serve as the single platform for Startups for interacting with Government and Regulatory Institutions for all business needs and information exchange among various stakeholders
4. Legal Support and Fast-tracking Patent Examination at Lower Costs: To promote awareness and adoption of IPRs by Startups and facilitate them in protecting and commercializing the IPRs by providing access to high quality Intellectual Property services and resources, including fast-track examination of patent applications and rebate in fees.
5. Relaxed Norms of Public Procurement for Startups: To provide an equal platform to Startups (in the manufacturing sector) vis-à-vis the experienced agripreneurs/ companies in public procurement
6. Faster Exit for Startups: To make it easier for Startups to wind up operations
7. Providing Funding Support through a Fund of Funds with a Corpus of INR 10,000 crore
8. Credit Guarantee Fund for Startups: To catalyse agripreneurship by providing credit to innovators accross all sections of society
9. Tax Exemption on Capital Gains, Tax Exemption to Startups for 3 years, Tax Exemption on Investments above Fair Market Value

10. Organizing Startup Fests for Showcasing Innovation and Providing a Collaboration Platform: To galvanize the Startup ecosystem and to provide national and international visibility to the Startup ecosystem in India
11. Launch of Atal Innovation Mission (AIM) with Self-Employment and Talent Utilization (SETU) Program: To serve as a platform for promotion of world-class Innovation Hubs, Grand Challenges, Startup businesses and other self-employment activities, particularly in technology driven areas
12. Harnessing Private Sector Expertise for Incubator Setup: To ensure professional management of Government sponsored / funded incubators, Government will create a policy and framework for setting-up of incubators across the country in public private partnership
13. Building Innovation Centres at National Institutes: To propel successful innovation through augmentation of incubation and R&D efforts
14. Setting up of 7 New Research Parks Modeled on the Research Park Setup at IIT Madras
15. Promoting Startups in the Biotechnology Sector: To foster and facilitate bio-entrepreneurship
16. Launching of Innovation Focused Programs for Students: To foster a culture of innovation in the field of Science and Technology amongst students
17. Annual Incubator Grand Challenge: To support creation of successful world class incubators in India

Funding

- **Startup India Seed Fund Scheme:** Financial assistance to startups for proof of concept, prototype development, product trials, market entry, and commercialization
- **Startup India Investor Connect:** It is a platform that connects startups with investors to facilitate investment opportunities through AI based matchmaking. Through this, entrepreneurs will be able to directly reach out to multiple investors using one single application and pitch their startup idea.

Agripreuners who are eligible to apply under the Startup India scheme?

- Any Indian citizen aged 18 or above can apply for the scheme.
- The Date of Incorporation of the company should not exceed ten years
- The Company should have been incorporated as a Partnership Firm, Private Limited Company, or a Limited Liability Partnership (LLP)
- The annual turnover of the company should not exceed Rs.100 crore in any of the financial years since incorporation
- The Company or Entity should have been formed initially by the promoters and not by splitting up or reconstructing an existing business.
- The startup should have a plan for developing or improving a product, process, or service and have a scalable business model with a high potential for creating wealth & employment.

Registration and Approvals of Agribusiness

- Startups are required to obtain approval from the DPIIT
- Recommendation of an incubator from any post-graduation college
- Recommendation from an incubator from any post-graduation college
- Recommendation from an incubator recognized by Central Government
- A patent filed and published in the Journals of the Indian Patent Office in the specific area of product service.
- Funding letter from the state government or central government of any scheme to promote innovation

Partnership Share

For partnership startups, 51% of the shares should be owned by a woman or individuals

belonging to the Scheduled Case and Scheduled Tribe categories. They should not have defaulted on any credit payments.

Focus area for Agri startup

Big Data: Startups are leveraging drones or tractor-based solutions to get data on field, pertaining to both weather and agricultural data to determine risk. Growing smartphone penetration will enable precision decision-making in farming activity to farmers and help drive increased productivity and revenue while reducing unit-costs. Eg.: Agrostar, RML Agtech are in building ground-breaking image recognition technology that enables farmers to receive real-time data on the pest or disease that has affected a crop.

Farming-As-A-Service (FAAS): Agri equipment renting. Eg.: EM3 Agriservices offers farming services and machinery rentals to farmers on a pay-for-use basis. Other startups include, Goldfarm, Ravgo, Oxen Farm Solutions and Farmart.

Market Linkage Models: Innovations to help farmers with timely and accurate estimation of sowing and harvesting in sync with consumer demand patterns. Eg.: MeraKisan.com helps consumers in India to order fresh food and goods sourced from local farmers.

Fintech for Farmers: Farm income is mostly in cash and it presents an opportunity for Fintech startups to digitize payments for farmers through payment gateways linked to their accounts. Such startups can also create the credit profile environment for funders and lenders.

IOT for Farmers: Smart farming in agricultural business including concepts like high-precision crop control, data collection, automated farming techniques will remove inefficiencies and bolster productivity. Information on crop yields, rainfall patterns, pest infestation and soil nutrition can be used to improve farming techniques over time

Others

1. Gramophone
2. CropIn
3. Ekgaon
4. RML
5. Fasal
6. Bijak
7. DeHaat
8. FreshoKartz
9. FarmERP

Conclusion

Startup India is Govt. initiative who are registered under this scheme and benefited by tax exemptions, financial support, and access to incubators.

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Harnessing the Power of AI in Agriculture: A Growing Revolution

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In an era of rapid technological advancements, Artificial Intelligence (AI) is making its mark across various industries, transforming the way we work, live, and interact with the world. Agriculture, often seen as a traditional sector, is not immune to this wave of innovation. The integration of AI in agriculture holds the promise of revolutionizing farming practices, increasing efficiency, sustainability, and productivity in a world where the demand for food is ever-growing. This article explores the profound impact of AI on agriculture, from precision farming and crop management to sustainability and food security.

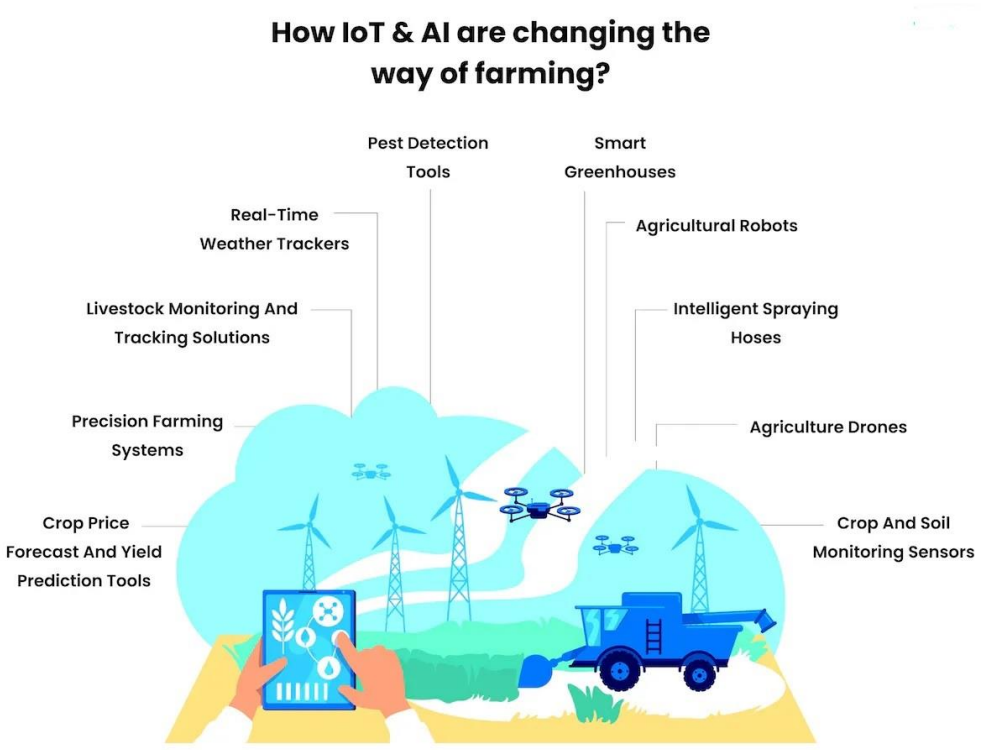

Figure 1: Application of AI in Agriculture (source: Kamal)

Need for Innovation in Agriculture

To understand the significance of AI in agriculture, it's essential to grasp the challenges that the industry faces. The global population is expected to reach nearly 10 billion by 2050, and with it, the demand for food will skyrocket. To meet this demand, agriculture must undergo a transformation that increases productivity while minimizing its environmental footprint. Traditional farming methods often rely on intuition and experience, leading to inefficiencies, overuse of resources, and unsustainable practices. Climate change further complicates matters, as unpredictable weather patterns can devastate crops and disrupt traditional planting and harvesting schedules. This is where AI steps in as a game-changer, offering data-driven insights and automation that can help farmers overcome these challenges.

Precision Farming: A Data-Driven Approach

Precision farming, also known as precision agriculture, is a prime example of how AI is reshaping the agriculture landscape. This approach leverages data collected from various sources, including satellites, drones, and sensors, to make farming practices more precise and efficient.

Data Collection and Analysis

AI systems are capable of collecting and analyzing vast amounts of data related to soil conditions, weather patterns, and crop health. Sensors in the field can provide real-time information on soil moisture, nutrient levels, and pest infestations. Satellite imagery and drones offer high-resolution views of entire farms, enabling farmers to monitor their fields with unprecedented detail.

Decision Support Systems

The data collected is then processed by AI algorithms to provide farmers with actionable insights. Decision support systems can recommend optimal planting times, irrigation schedules, and even identify areas of the field that require specific attention. This not only increases crop yield but also reduces resource waste by ensuring that water and fertilizers are applied precisely where needed.

Predictive Analytics

AI can predict disease outbreaks and pest infestations based on historical data and real-time information. Farmers can take proactive measures to prevent or mitigate these issues, reducing the need for chemical treatments and minimizing environmental impact.

Automation

Autonomous tractors and drones equipped with AI can perform tasks like planting, harvesting, and monitoring crops. This reduces labor costs and the risk of human error while maximizing efficiency.

Figure 2: showing automation of data collected from different sources

Crop Management and Monitoring

AI-powered crop management and monitoring systems are transforming the way farmers care for their crops. These systems offer:

Crop Health Assessment

AI can analyze images captured by drones or smartphones to identify signs of disease, nutrient deficiencies, or stress in plants. Early detection allows for targeted interventions, preventing the spread of diseases and optimizing resource use.

Weed and Pest Control

Machine learning algorithms can distinguish between crops and weeds, enabling automated weed removal processes. Additionally, AI can identify and track pests, helping farmers implement timely and precise pest control measures, reducing the need for chemical pesticides.

Irrigation Optimization

AI systems can calculate the exact amount of water required by crops based on environmental conditions and soil moisture levels. This minimizes water waste and ensures that crops receive the right amount of hydration.

Crop Harvesting

Robotic harvesters equipped with AI can pick and sort crops with great precision. This reduces labor costs and ensures that crops are harvested at the peak of their ripeness.

Figure 3: Role of AI in crop management and monitoring

Sustainability and Environmental Impact

AI-driven agriculture isn't just about increasing productivity; it's also about sustainability and reducing the environmental impact of farming.

Resource Efficiency

By optimizing resource use, AI helps reduce the overuse of water, fertilizers, and pesticides. This not only lowers production costs but also minimizes the pollution of water bodies and soil.

Reduced Emissions

AI-driven automation and optimized logistics reduce the need for heavy machinery and transportation, decreasing greenhouse gas emissions associated with traditional farming.

Biodiversity Conservation

AI can be used to identify areas on a farm that can be set aside for wildlife conservation, promoting biodiversity within agricultural landscapes.

Challenges and Concerns

While AI presents numerous opportunities in agriculture, it also comes with its own set of challenges and concerns.

Data Privacy and Security

Collecting and storing vast amounts of sensitive data about farms and crops raises concerns about data privacy and security. Unauthorized access or breaches could have significant consequences.

Access and Adoption

Not all farmers have access to the technology and resources required to implement AI systems. Ensuring equitable access to AI-driven agriculture is essential to prevent disparities in the industry.

Ethical Considerations

The use of AI in agriculture raises ethical questions, such as the potential for job displacement as automation increases. Balancing technological progress with the well-being of rural communities is a critical consideration.

Environmental Impact

While AI can help reduce the environmental impact of farming, there is also the risk that the production and disposal of AI hardware could contribute to electronic waste and pollution.

Conclusion

AI is ushering in a new era of agriculture, one that is data-driven, efficient, and sustainable. The integration of AI technologies in agriculture, from precision farming and crop management to sustainability and environmental impact reduction, holds immense promise. It has the potential to transform traditional farming practices into highly efficient, environmentally friendly, and economically viable systems. As the global population continues to grow, the demand for food will only intensify. AI can be a crucial ally in meeting this demand while simultaneously addressing the challenges of climate change, resource scarcity, and sustainability. However, it's essential to navigate the challenges and ethical considerations associated with AI adoption in agriculture to ensure that the benefits are shared equitably and that farming communities continue to thrive in this AI-driven future. The future of agriculture is digital, and AI is at the forefront of this agricultural revolution, promising a brighter and more sustainable future for farming and food production on a global scale.

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Drone Technology in Horticultural Crops

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Unmanned Aerial Vehicles (UAVs) is known as Drones that are regarded as pilotless aircraft techniques utilized in various areas such as Industrial monitoring system, shooting, battleground observation, space ambulance, product liberation and several more applications. It is controlled by specific point and useful as diminutive distance flying areas. In Horticulture, there are various functions of drone tools like crop supervising, crop quantity and verve considerations, crop record, production of recommendation records, meticulousness drenching, and examination of farm infrastructure, high declaration mapping and examination of individual areas, crop scratch measurement and insurance claim forensics. In general, UAVs are equipped with the cameras and sensors for crop monitoring and sprayers for pesticide spraying.

Drones are preferred over full size aircrafts due to major factors like combination of high spatial resolution and fast turnaround capabilities together with low operation cost and easy to trigger. These features are required in precision agriculture where large areas are monitored and analyses are carried out in minimum time. Using of aerial vehicle is possible due to miniaturization of compact cameras and other sensors like infrared and sonar (Dutta and Goswami, 2020).

Agricultural drones allow users/farmers to watch their fields from the sky and depiction intending problems on the farm such as irrigation issues, soil dissimilarity as well as pest and fungal infestations, having determined these issues, the farmer can come up with better results to develop crop supervision and production. The current research shown that almost 85% of drone machinery is mostly used by military and rest 15% used by civilians for various applications. However, with the rapid growth of technology, it is reported that growth of Drones technology is increasing 25-32% every year especially in the area of Agriculture. Lots of researchers and drones manufacturing companies are either coming up or in process of releasing varied models of drones specially made up for agriculture (Rana and Mahima, 2020).

Applications of Drones in Horticulture crops

a) **Soil health monitoring:** Drone collect and process data received from monitoring that can help check, control, and maintain the soil's health. It can also provide the essential nutrients to the soil to improve their health and well-being. Through its operations of 3D mapping and data processing, drones achieve this operation of analysing soil health.

b) **Crop health monitoring:** Drones can be used for monitoring the conditions of crops throughout the crop season so that the need-based and timely action can be taken.

c) **Fertilizer spraying:** The drone operators are free to monitor the drone spraying fertilizers that keep insects, pests, and worms away and increase crop life longevity.

d) **Seeding process:** Seeding, especially, requires manual labour as it is a time-consuming procedure. To ease this tiring process, drone technology is employed to sow the seeds of the copious varieties of crops.

e) **Analyzing deficiencies:** Drones helpto analyse, identify, and survey the crops for any deficiencies. Their high-resolution cameras and sensors, additionally instilled with lasers, help to perform these operations quickly.

f) **Plantation:** Drones can help in planting trees and crops, which was done by farmers before. This technology will not only save labor but also help in saving fuels.

g) **Avoid overuse of chemicals:** Drones can prove to be especially effective in reducing the

overuse of pesticides, insecticides, and other chemicals.

Benefits of using drones in Horticulture crops

1. **Security:** The drones are operated by trained drone pilots. So, there are no chances of their misuse.
2. **High efficiency:** Drones do not have any operational delays and can work double the speed of human labour.
3. **Water-saving:** In comparison to traditional spraying methods, agricultural drones use ultra-low volume (ULV) spraying technology, thus saving more water.
4. **Low cost and easy to maintain:** Agri drones are sturdy, low in cost, and require minimum maintenance. Some of the key features include a detachable container, low-cost frame, precise spraying of pesticides (Singh, 2023).

Conclusion

The Horticulture sector needs revolutionary changes to meet the demands of ever-growing population, farmer's welfare and the emerging uncertainties at national and international level. Drones have great potential to transform Indian horticulture. With the advancement of technology in the future, the production of drones is expected to become economical. It provides real time and high quality aerial imagery compared to satellite imagery over agricultural areas. Also, applications for localizing weeds and diseases, determining soil properties, detecting vegetation differences and the production of an accurate elevation models are currently possible with the help of drones. Drones will enable farmers to know more about their fields. Therefore, farmers will be assisted with producing more food while using fewer chemicals. Nearly all farmers who have made use of drones have achieved some form of benefit. They can make more efficient use of their land, exterminate pests before they destroy entire crops, adjust the soil quality to improve growth in problem areas, improve irrigation to plants suffering from heat stress and track fires before they get out of control. I conclude that we should effectively adopt and leverage the potential of drone technology and bring awareness in the farmers, for transforming the agriculture sector and life of millions of farmers in India.

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Navigating Climate-Smart Agriculture: A Sustainable Future for Farming

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Climate change is one of the most pressing challenges of our time, posing significant threats to agriculture and food security worldwide. Rising temperatures, shifting weather patterns, and more frequent extreme events like droughts and floods are jeopardizing crop yields and livelihoods of millions of farmers. To combat these challenges, there is a growing need for innovative and sustainable agricultural practices, and this is where Climate-Smart Agriculture (CSA) comes into play.

What is Climate-Smart Agriculture?

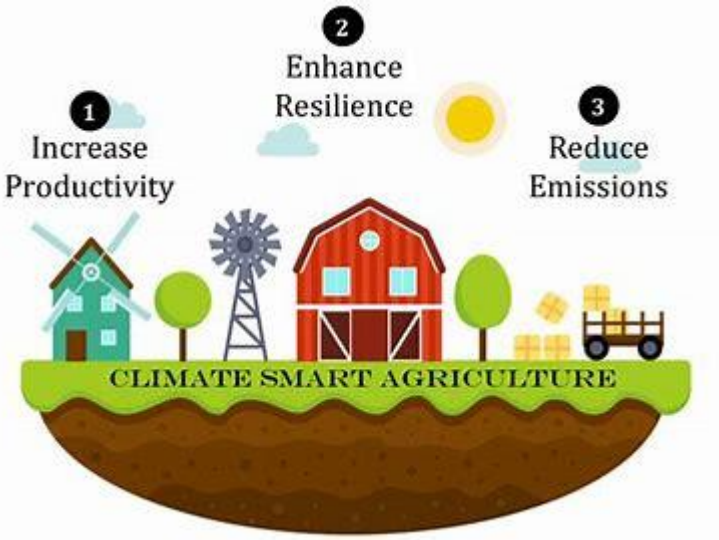
Climate-Smart Agriculture is an approach that aims to address the interlinked challenges of food security and climate change by simultaneously increasing agricultural productivity, building resilience to climate change impacts, and reducing greenhouse gas emissions. CSA is not a one-size-fits-all solution but rather a set of principles and practices tailored to local conditions, crops, and communities. Its core components include:

Sustainable Intensification: CSA promotes efficient resource use, such as water, energy, and fertilizers, to enhance agricultural productivity without degrading the environment. This involves adopting precision agriculture techniques, improved crop varieties, and sustainable soil management practices.

Adaptation: CSA emphasizes building resilience in agriculture to cope with climate variability and extremes. This can involve diversifying crops, adjusting planting dates, and investing in climate-resilient infrastructure such as irrigation systems.

Mitigation: Reducing greenhouse gas emissions from agriculture is another vital aspect of CSA. This can be achieved through practices like conservation tillage, agroforestry, and livestock management improvements.

Benefits of Climate-Smart Agriculture



Enhanced Food Security: CSA helps increase agricultural yields and food production, making it easier to meet the growing global food demand, even in the face of changing climate conditions.

Climate Resilience: By making farms more resilient to extreme weather events, CSA ensures that farmers can continue to produce food even when faced with challenges like droughts, floods, or heatwaves.

Sustainable Resource Use: CSA promotes efficient and sustainable resource management, reducing the environmental footprint of agriculture and safeguarding natural resources for future generations.

Economic Benefits: Adopting CSA practices can lead to improved farm incomes and livelihoods, as well as create opportunities for rural development through value-added processing and marketing.

Biodiversity Conservation: CSA often integrates ecological principles, which can help conserve and enhance biodiversity on farms.

Challenges and Implementation

Implementing Climate-Smart Agriculture faces several challenges, including:

Knowledge and Awareness: Many farmers, especially smallholders in developing countries, lack access to information and resources needed to adopt CSA

practices. Capacity-building and knowledge dissemination are crucial.

Resource Constraints: CSA practices often require initial investments in technology, infrastructure, and training. Access to credit and financial resources can be a limiting factor for some farmers.

Policy and Institutional Support: Governments and institutions need to create an enabling environment for CSA by developing supportive policies, incentives, and regulations.

Scaling Up: To realize the full potential of CSA, it must be scaled up across regions and countries. This involves not only farmer adoption but also research, extension services, and private sector engagement.

Approaches and technologies to Mitigate Climate Change:

Renewable Energy Sources: The adoption of renewable energy technologies, such as solar panels, wind turbines, and hydropower, continues to grow. These sources generate electricity without producing greenhouse gas emissions, helping reduce reliance on fossil fuels.

Energy Storage Solutions: Advanced energy storage technologies, including lithium-ion batteries and emerging options like solid-state batteries, improve the efficiency and reliability of renewable energy systems by storing excess energy for later use.

Carbon Capture and Storage (CCS): CCS technology captures carbon dioxide (CO_2) emissions from industrial processes and power plants and stores them underground to prevent them from entering the atmosphere.

Electric Vehicles (EVs): The widespread adoption of electric vehicles reduces greenhouse gas emissions from the transportation sector, especially when coupled with a cleaner grid powered by renewable energy sources.

Smart Grids: Smart grids enable better management and distribution of electricity, optimizing energy use and reducing wastage, which can lower carbon emissions.

Nuclear Energy Innovations: Advances in nuclear energy, such as small modular reactors (SMRs) and thorium-based reactors, offer potential low-carbon alternatives to traditional nuclear power.

ioenergy and Biofuels: Sustainable bioenergy sources, such as biomass and algae-based biofuels, provide alternatives to fossil fuels and can help reduce carbon emissions in the transportation and industrial sectors.

Carbon Removal Technologies: Technologies like direct air capture (DAC) and enhanced weathering aim to remove CO_2 from the atmosphere, helping to offset emissions.

Green Building Design: Sustainable building practices and materials, along with improved insulation and energy-efficient HVAC systems, reduce energy consumption and carbon emissions in the construction sector.

Climate-Resilient Agriculture: Innovations in agriculture, such as precision farming, drought-resistant crops, and regenerative farming practices, help sequester carbon in soil and reduce emissions from agriculture.

Carbon Pricing: Implementation of carbon pricing mechanisms, such as carbon taxes or cap-and-trade systems, encourages businesses and individuals to reduce their carbon footprint.

Artificial Intelligence (AI): AI is used in climate modeling, weather prediction, and optimizing energy systems for greater efficiency, contributing to climate change mitigation efforts.

Sustainable Transportation: Beyond EVs, advancements in public transportation, high-speed rail, and urban planning promote low-carbon transportation options.

Circular Economy: Promoting a circular economy reduces waste and encourages recycling and reuse, thereby reducing emissions associated with manufacturing and disposal.

International Collaboration: Global cooperation and agreements, like the Paris Agreement, aim to coordinate efforts to combat climate change on a large scale.

These technologies and strategies are continually evolving and are essential components of global efforts to mitigate the impacts of climate change.

Conclusion

Climate-Smart Agriculture is a promising approach that offers a path forward in the face of climate change and its impact on agriculture. By embracing CSA, we can increase food security, build resilience in farming communities, reduce greenhouse gas emissions, and promote sustainable land management. However, its successful implementation requires a concerted effort from governments, farmers, researchers, and the private sector. Through collaboration and innovation, CSA can play a vital role in ensuring a sustainable and secure future for our global food system. It's not just a choice; it's a necessity in our changing world.

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Success Story: Mixed Fruit Jam Production Brings Smile to the Entrepreneur

T. S. Ganesh prasad
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Name: Smt.Pankaja Girish C. T.

Age: 42

Address: Balale Village, Kodagu, Karnataka

Mobile: 8762549313

Qualification: Bachelor of Arts

Land holding: 10 Acre

Smt. Panakja Girish C. T., a graduate, home maker with an agriculture background dream of starting a unique venture in agriculture. Athma Nibhar Bharat (self-sufficient), creating employment opportunity and doubling the farmers income has been the manthra promoted by govt of India. This aim made her strong and motivated her to do something for the nation.

Training & Motivation

As a house maker in an agriculturist family, she used to actively help her husband in all her agricultural activities. She was inclined towards home-based economic activity and decided to pursue mixed jam preparation through the Forestry College, Ponnampet. she availed a 2-5 days training programme at Dr. Ganesh Prasad T. S. and Dr. Bhagirati L., Professor, KSNUAHS, Shivamogga, on value addition mixed jam preparation were started. She was provided opportunity for exposure visits and other training programmes to agricultural universities, KVK and kisan melas which increased her confidence and knowledge.in the year 2020, she came in contact with the college of forestry, Ponnampet and KVK through the capacity building skill development training programme on jam preparation. Her active participation and interest in the training fetched her certificate from Agriculture Skill Council of India in march 2021. ICAR-KVK, Kodagu provided opportunity to her to work at their facility for production of oyster mushroom spawn,

Ready to fruit bags and value addition.

Impact in the area

She Started Mixed Jam preparation with 10 bottle spending Rs. 300/- only and gradually increased the number and is currently producing a total of 900 bottles per month. Currently, she is utilizing the existing facilities available for production of JAM for fresh market, value addition of mushroom (Rasam powder, varieties of pickle, Dry mushroom, Kashaya powder and Chutney powder) She is now selling 5-10 kg harvested oyster mushroom (ready to cook) per day and sold about 12-20 ready to fruit bags, which sells like a hot cake among the consumers and has also Employed three rural women.

She earns annually about Rs.1.38 Lakh from sale of Mushroom, Ready to fruit bags and value-added products. Now she has also started a honey extraction and Spices. She has also served as a one of

the resource persons in grama panchayath office at baale and trained around 150 farm women.

Production details	Quantity per month	Net income gain (Rs.)
Fresh oyster mushroom	60-75 kg	8500
Ready to Fruit bags	180-240 bags	36500
Value added products	10 kg	25800
Oyster mushroom spawn	150 kg	12500

Awards & recognitions

- She has been selected by national institute of agricultural extension management for training programme under RKVY-RAFTAAR – startup Agri business incubation programme (SAIP)
- She has appeared in various newspaper like shakti and vijayavani and TV interviews

Contributing/enabling factors including people/ institutions responsible for the motivation and other similar detail/ underlying message.

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On-Farm Aerobic and Anaerobic Composting Methods

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Composting is the microbiological decomposition of organic matter into a relatively stable humus-like material. Composting is a common practice to dispose of and recycle the agro-wastes to valuable organic manures. In this process, various microorganisms, including bacteria and fungi, break down organic matter into simpler substances. Compost is a dynamic, earthy, smell less, granular, humus rich and stabilized (no Composting and Manuring further decomposition) material obtained after the composting

The environmental conditions prevailing within the composting system i.e., oxygen, temperature, moisture, material disturbance, organic matter and the size and activity of microbial populations affect the effectiveness of composting process.

Stages of composting

The composting consists of the following stages:

1. Mesophilic
2. Thermophilic
3. Curing

Mesophilic Stage

As soon as we pile keep the wastes and ensure proper conditions, the heap begins to heat up right away and the composting begins. This first phase of composting is called mesophilic stage. In this stage, the temperature remains below 45°C and microorganisms multiply and break down the easily available carbohydrates. The pH begins to drop as acids are produced. The pile become active and a series of processes are set in motion.

Thermophilic Stage

After mesophilic, the next stage is thermophilic which last for several weeks. As active composting takes place, temperature in the centre of pile rises to about 50-65°C. At this temperature range, heat loving (thermophilic) bacteria vigorously degrade the organic materials. Temperature will remain in this range as long as decomposable materials are available and oxygen is adequate for microbial activity. Many important processes take place during this stage. As the organic matter degrades, its particle size is reduced. Pathogens are destroyed as the heat in pile is more (above critical temperature 55°C). Fly larvae and weed seeds are destroyed when the temperature rise above to 63°C.

Curing

During this stage, the stability comes in the decomposed materials. The growth of actinomycetes and fungi which digest hemicellulose is enhanced. This stage is critical for developing disease-suppressiveness of composts.

Types of composting

Based on the nature of the decomposition process, composting may be divided into three categories *viz.*,

i. Anaerobic: In the absence or limited supply of O_2
ii. Aerobic: In the presence of O_2
iii. Vermicomposting: enzymatic degradation of organic materials by earthworms.

Anaerobic composting

Decomposition occurs where oxygen (O_2) is absent or in limited supply. Under this method, anaerobic micro-organisms dominate and develop intermediate compounds including methane, organic acids, hydrogen sulphide and other substances.

Anaerobic digestion of particulate organic matter takes places in three steps

i. Solubilization of organic solids
ii. Conversion of complex organics into volatile acids
iii. Formation of methane from volatile acids

Merits

- Little work involved
- Fewer nutrients lost during the process
- Gaseous by-products can be made use of.

- More concentrated source of nitrogen.

Demerits

- The intermediate compounds accumulate and are not metabolized further.
- Many of these compounds have strong odours and some present phytotoxicity, hence it should not be directly used
- As it is a low-temperature process, it leaves weed seeds and pathogens intact.
- The process usually takes longer than aerobic composting.

Aerobic composting

Decomposition takes place in the presence of ample O_2. In this process, aerobic microorganisms break down organic matter and produce carbon dioxide (CO_2), ammonia, water, heat and humus, the relatively stable organic end product.

Major reactions involved in the aerobic composting process include

i. Solubilization of solids
ii. Organic matter oxidation
iii. Autooxidation of cells

Merits

- Although aerobic composting may produce intermediate compounds such as organic acids, aerobic micro-organisms decompose them further.
- The compost has little risk of phytotoxicity.
- Processing time is shorter because heat generated accelerates the breakdown of proteins, fats and complex carbohydrates such as cellulose and hemi-cellulose.
- As it is high temperature process, it destroys pathogens and weed seeds
- More efficient and useful than anaerobic composting for agricultural production

Demerits

- More nutrient loss from the materials

Methods of composting

Berkeley method of hot composting (developed by Robert D. Raabe at University of California, Berkeley)

Time required for composting: 18 Days

Type of Composting: Aerobic

Procedure

- Build the compost heap of 1m x 1m x 1.5m with composting materials having C:N of 25-30:1.
- No turning for first 4 days.
- Compost is turned from outside to inside and vice versa to mix it thoroughly for every 2nd day for 14 days.

Indore method of composting (developed by A. Howard & Y.D. Wad at Institute of Plant Industry, Indore)

Time required for composting: 4 months

Type of Composting: Aerobic

Nutrient Composition

N: 0.8%, P: 0.3%, K: 1.5%

Raw materials

Plant residues (all the weeds, pruning's, stalks, stems, fallen leaves, chaff, and fodder leftovers), Animal dung and urine, Wood ashes and Water

Procedure

The waste materials are cut into small pieces and spread in layers of 10-15 cm thickness either in pits or in heaps of 1 m wide, 1 m deep and of convenient length. It is properly moistened with cow dung using earth. To ensure 50 % moisture sufficient water should be sprinkled to wet the composting materials. Periodically three to four turnings are given. To get proper aeration, the material is covered with a layer of 2 to 3 cm soil. Under the aerobic process of decomposition 40 to 50 % organic matter and nitrogen are lost at initial stage. Adequate level of moisture is to be maintained. The site of composting should be at the high level to avoid rain water stagnation.

Coimbatore method of composting (developed by Manickam in 1967)

Time required for Composting: 4 – 5 months

Type of Composting: Anaerobic decomposition to start with, following by aerobic fermentation.

Nutrient Composition: N=0.8%, P=0.3%, K=1.5%

Raw materials

1. Farm wastes (weeds, straw, leaves)

2. Vegetable refuse 3. Animal dung

Size of the pit

1. Length: 3.6 m (according to the volume of the wastes)

2. Breadth: 1.8 m 3. Depth: around 1 m 4. Water

Procedure

Fill crop residues & farm wastes in pits of 4m X 2m X 1m depth to a thickness of about 15 cm. 5 cm cow dung slurry is spread over this layer to increase its biodegradation. Follow the same in alternate layers till the height reaches 0.5 m above ground level. Cover this with soil or mud to prevent the entry of rain water. After 35 to 40 days turning of material is done to make it an aerobic process. Thereafter the compost will be ready within 4 to 5 months.

NADEP method of composting (developed by N.D. Pandharipande from Maharashtra)

Time required for composting: 4 months

Type of Composting: Aerobic

Nutrient Composition: N: 0.8%, P: 0.4%, K: 1.5%

Raw materials

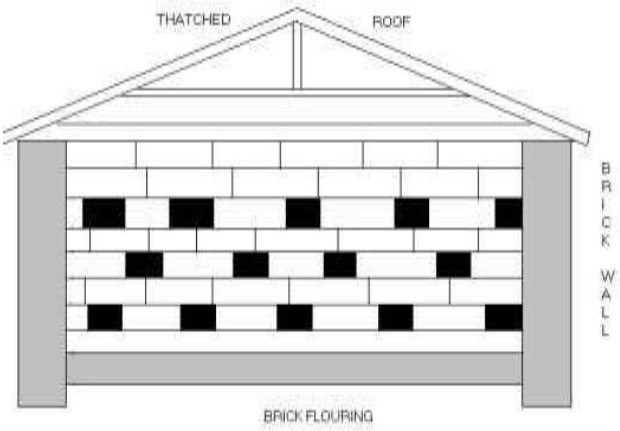
Agriculture waste (Weeds, crop residues, forest litter), Cattle dung/biogas slurry, Fine sieved soil and Water

Size of the tank: 10 x 5 x 3 feetFilling the tank:

- **First layer:** 4 - 6 inches of stems and sticks are spread at the bottom to facilitate aeration. It is followed by a 4 - 6 inches layer of agricultural wastes (about 100 kg).
- **Second layer:** Slurry that is made using 4 - 5 kg of cow dung and 100 - 125 litres of water is sprinkled over the dry wastes to facilitate microbial activity.
- **Third layer:** 60 kg of sieved dry soil is spread evenly over the second layer for moisture retention.

Procedure

The entire tank needs to be filled by the same process within 24 hours (not more than 48 hours) of



time. After 15-30 days the volume of the materials gets reduced to 2 feet and is refilled with the layers of the dry wastes, slurry, and sand. The entire mass is covered with a thatched roof to prevent the loss of moisture from the tank. Leave it undisturbed for 3 months. Meanwhile, water is added for every 1 - 2 weeks to maintain the moisture percentage in the tank. If the tank develops any cracks, those can be filled with the slurry to maintain the quality of the compost.

Bangalore method of composting:

Dr. L. N. Acharya in 1939 at **Indian Institute of Science, Bangalore** had initiated the work of composting the town refuse and night soil. This process is also called **Hot Fermentation Mechanism of composting or the Bangalore method**. It has been adopted to solve effectively the problems of safe disposal of night soil and producing high quality compost.

Time required for composting: 6-8 months

Type of Composting: Anaerobic

Nutrient Composition: N - 1.5%, P - 1%, K - 1.5%

Pit preparation

Pits/trenches should be dug 1 m deep while length and breadth can be varied according to the land availability and volume of wastes to be composted.

Procedure

Wastes are dumped into the trenches to make a layer of 15 cm. Then night soil is discharged over this and spread to a layer of about 5 cm. The trench is filled with town waste and night soil in alternate layers, until it reaches to 15 cm above the ground level, with a final layer of town refuse on the top. It could be made dome shape and covered with a thin layer of soil to prevent breeding of flies and moisture loss. Sewage

water may be sprayed over the layer of refuse. This system provides a method of disposal of various kinds of waste including slaughter house waste, sewage, sludge etc. This heterogeneous mass is allowed to remain as such without turning and watering for about 3 to 4 months.

Benefits of Compost

- ✓ Most plant nutrients in compost are in an organic form.
- ✓ Nutrients are released slowly over a long period of time
- ✓ Excellent soil conditioner
- ✓ Increase soil organic matter and water holding capacity of the soil
- ✓ Improve manure handling
- ✓ destruction of weed seed and pathogen
- ✓ Lower risk of pollution.

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Management of Pest in Organic Agriculture

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The interaction between living organisms and their environment is crucial for a plant's health. Plant's health is more at risk in monocultures and on-farm diversification provide a balanced tri-tropic interaction between plants, pests and predators. This is may be treated as well-managed ecosystem and the way for successful reducing the level of pest or disease population. Plant health condition depends to a large extent on the fertility of the soil. When nutrition and pH is well balanced, the plant becomes stronger and is therefore less vulnerable to infection. Climatic conditions, such as suitable temperatures and sufficient water supply, are further factors which are crucial for a healthy plant. If one of these conditions is not suitable, the plant can become stressed. Stress weakens the defense mechanisms of plants and makes them easy targets for pests and diseases. One of the most important points for an organic farmer is therefore to grow diverse and healthy plants.

Prevention practice and monitoring

Knowledge about plant health and pest and disease ecology helps the farmer to choose effective preventive crop protection measures. Some important preventive crop protection measures are the following ones:

Use of well adapted and resistant varieties

- select varieties which are well adapted to the local environmental conditions as it allows them to grow healthy and makes them stronger against infections of pests and diseases.

Use of dirt-free healthy seed and planting material

- Use disease free seeds from reliable sources prior to inspected for pathogens and weeds at all stages of production.

Use of suitable cropping systems

- Mixed cropping systems: can limit pest and disease pressure as the pest has less host plants to feed on and more beneficial insect life in a diverse system
- Crop rotation: reduces the chances of soil borne diseases and increases soil fertility.
- Green manuring and cover crops: increases the biological activity in the soil and can enhance the presence of beneficial organisms

Use of balanced nutrient management

- Moderate fertilization: steady growth makes a plant less vulnerable to infection. Too much fertilization may result in salt damage to roots, opening the way for secondary infections.
- Balanced potassium supply contributes to the prevention of fungi and bacterial infections

Input of organic matter

- Increases micro-organism density and activity in the soil, thus decreasing population densities of pathogenic and soil borne fungi.
- Stabilizes soil structure and thus improves aeration and infiltration of water.
- Supplies substances which strengthen the plant's own protection mechanisms.

Adopt suitable cultivation methods

- Facilitates the decomposition of infected plant parts.
- Regulates weeds which serve as hosts for pests and diseases.
- Protects the micro-organisms which regulate soil borne diseases.

Maintain proper water management

- No water logging: causes stress to the plant, which encourages pathogens infections.
- Avoid water on the foliage, as water borne disease spread with droplets and fungal disease germinate in water.

Conservation and promotion of natural enemies

- Provide an ideal habitat for natural enemies to grow and reproduce.
- Avoid using products which harm natural enemies.

Selection of optimum planting time and spacing

- Optimal planting time is chosen.
- Sufficient distance between the plants reduces the spread of a disease.
- Good aeration of the plants allows leaves to dry off faster, which hinders pathogen development and infection.

Adopt clean cultivation

- Remove infected plant parts (leaves, fruits) from the ground to prevent the disease from spreading.
- Eliminate residues of infected plants after harvesting.

Monitoring

Regular monitoring of pests, diseases and weeds is the basis for effective management. Information regarding specific pests, diseases and weeds helps in monitoring process.

Typical signs and of pest attacks on crop plants

Most crop pests belong to the insects, mites and nematodes. However, mammals (like elephants, monkeys or voles), and birds (like sparrows, starlings and crows) can also damage crops. Insect damage can be categorized as biting and chewing (e.g. caterpillars, weevils), piercing and sucking (e.g. aphids, psyllids) and boring (e.g. borer, leaf miner) species. Some are slow moving (e.g. caterpillars), fast moving (e.g. fruit flies), hidden (e.g. stem borer), or easy to observe (e.g. caterpillars, weevils).

- **Pest damage is often species-specific**: leaves with holes or missing parts is an indication of caterpillar or weevil damage; curled leaves is an indication of aphids; damaged or rotten fruits are often caused by larvae of fruit flies; withering plants can also be caused by larvae of noctuids or the stem borer; and branches or trunks with holes may be an attack by lignivorous insects.
- Mites are very small and cannot be seen with the naked eye. However, some mite species (spider mites) weave a typical tissue on attacked plant parts and can, therefore, easily be detected. If mites are present on plants, leaves and fruits become yellowish.
- Nematodes are also very small and therefore, they are not easy to observe with the naked eye. They mostly attack plant roots; plants become yellow, wither and die.

Typical signs of disease attacks on crop plants

Most crop diseases are caused by fungi, bacteria or viruses.

Fungi cause estimated at two-thirds, of infectious plant diseases. They include all white and true rusts, smuts, needle casts, leaf curls, mildew, sooty moulds and anthracnose. In addition, they are responsible for most leaf, fruit, and flower spots, cankers, blights, wilts, scabs, and root, stem, fruit, wood rots among many others. Parts of plants or the total crop plant can wither and die.

Bacteria cause any of the four following main problems.

- Some bacteria produce enzymes that breakdown the cell walls of plants anywhere in the plant. This causes parts of the plant to start rotting (known as 'rot').
- Some bacteria produce toxins that are generally damaging to plant tissues, usually causing early death of the plant. Others produce large amounts of very sticky sugars; as they travel through the plant, they block the narrow channels preventing water getting from the plant roots up to the shoots and leaves, again causing rapid death of the plant.
- Finally, other bacteria produce proteins that mimic plant hormones. These lead to overgrowth of plant tissue and form tumors.
- Viruses mostly cause systemic diseases. Generally, leaves show chlorosis or change in colour of leaves and other green parts. Light green or yellow patches of various shades, shapes and sizes appear in affected leaves. These patches may form characteristic mosaic patterns, resulting in general reduction in growth and vigour of the plant.

Curative method

The natural enemies of pests are other organisms (fungi, bacteria, viruses, insect predators, and insect parasitoids) which kill pest. Therefore, the organic farmer should try to conserve natural enemies already present in the crop environment and enhance their impact. This can be achieved with the following methods:

- ✓ Minimize the application of natural pesticides (chemical pesticides anyway are not per-mitted in organic farming).
- ✓ Allow some pests to live in the field which will serve as food or host for natural enemies.
- ✓ Establish a diverse cropping system (e.g. mixed cropping).
- ✓ Include host plants providing food or shelter for natural enemies (e.g. flowers which adult beneficial insects feed on).

Mechanical control

Light traps can be used to catch moths such as armyworms, cutworms, stem borers and other night flying insects. Light traps are more efficient when placed soon after the adult moths start to emerge but before they start laying eggs.

Colour and water traps can be used to monitor adult thrips. In some cases, thrips can even be reduced by mass trapping with colored (blue, yellow or white) sticky traps or water traps in the nursery or field. Yellow sticky traps can be used to control whiteflies, aphids and leaf mining flies.

Fruit bagging prevents fruit flies from laying eggs on the fruits. In addition, the bag provides physical protection from mechanical injuries (scars and scratches). Bagging works well with melon, bitter gourd, mango, guava, star fruit, avocadoes and banana (plastic bags used).

Biological control

Biological control is the use of natural enemies to manage populations of pests (such as ladybird beetles, predatory gall midges, hoverfly larvae against aphids and psyllids) and diseases. This implies that we are dealing with living systems, which are complex and vary from place to place and from time to time. If populations of natural enemies present in the field are too small to sufficiently control pests reared natural enemies are released in the crop to boost field populations and keep pest populations down. There are two approaches to biological control through the release of natural enemies: Preventive release of the natural enemies at the beginning of each season and curative release when pest populations start to cause damage to crops. Bacteria such as Bacillus thuringiensis (Bt). Bt has been available as a commercial microbial insecticide since the 1960s. Viruses such as NPV (nuclear polyhedrosis virus), effective for control of several cater-pillar pest species. Every insect species, however, requires a specific NPV-species. Fungi that kill insects, such as Beauveria bassiana. Different strains of this fungus are commercially available. Fungi that work against plant-pathogens. Some examples include: Trichoderma sp., widely used in Asia for prevention of soil-borne diseases such as damping-off and root rots in vegetables.

Natural pesticides

Some plants contain components that are toxic to insects. When extracted from the plants and applied on infested crops, these components are called botanical pesticides or botanicals.

- ➢ Most botanical pesticides are contact, respiratory, or stomach poisons. Therefore, they are not very selective, but target a broad range of insects. This means that even beneficial organisms can be affected. Yet the toxicity of botanical pesticides is usually not very high and their negative effects on beneficial organisms can be significantly reduced by selective application.
- ➢ Botanical pesticides are generally highly bio-degradable, so that they become inactive within hours or a few days.
- ➢ Some commonly used botanicals are: NEEM: It contains several insecticidal compounds. The main active ingredient is azadiractin, which both deters and kills many species of caterpillars, thrips and whitefly. Both seeds and leaves can be used to prepare the neem solution.

- Pyrethrum: Pyrethrum is a daisy-like Chrysanthemum. Pyrethrins are insecticidal chemicals extracted from the dried pyrethrum flower. The flower heads are processed into a powder to make a dust. This dust can be used directly or infused into water to make a spray. Pyrethrins cause immediate paralysis to most insects,
- Chilli pepper: Chillies and capsicum pepper have both repellent and insecticidal effects. To make the chilli extract grind 200 g of chillies into a fine dust, boil it in 4 L water, add another 4 L of water and a few drops of liquid soap. This mixture can be sprayed against aphids, ants, small caterpillars and snails.
- Garlic: Garlic has antifeedant (insect stop feeding), insecticidal, nematocidal and repellent properties. To make the garlic extract, grind or chop 100 g garlic into 0,5 L of water. Allow mixture to stand for 24 hours, add 0,5 L of water and stir in liquid soap.

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Emergent Preservation and Packaging Techniques for Food Storage

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Food storage is a fundamental method of ensuring food safety, minimizing waste, and maintaining a healthy lifestyle. It involves the proper handling, preservation, and containment of food items to prevent spoilage and contamination. Efficient food storage methods are essential for the food industry to extend the shelf life of perishable goods and maintain their quality. Food preservation is a vital aspect of human civilization, ensuring the availability of nutritious and safe food throughout the year. It is the process of treating and handling food to stop or slow down spoilage, loss of quality, edibility, or nutritional value, and thus allowing for longer storage, which ultimately reduces food wastage. Food packaging plays a vital role in preserving the quality and safety of food items, extending their shelf life, and ensuring they reach consumers in optimal condition. Food packaging serves several essential functions, making it an integral part of the modern food supply chain. Some of the emerging food preservation techniques through packaging are:

Modified Atmosphere Packaging and Its Variants

In the realm of fruit preservation and processing, innovative techniques are reshaping the industry. Modified Atmosphere Packaging (MAP) has been a go-to method for preserving fresh-cut fruits like pomegranate arils, apples, kiwifruits, honeydew, and pineapples. Conventionally, MAP involves using approximately 3 to 5% O2 and 5 to 10% CO2 within the package, which slows down the deterioration of the product and extends its shelf life. What's noteworthy is the recent trend of combining MAP with other methods, such as physical, chemical, or radiation techniques, ushering in a new era of fruit preservation. Particularly intriguing is the use of essential oils with antimicrobial properties, such as eugenol, thymol, or menthol, in conjunction with MAP. These oils not only aid in preserving the fruits but also enhance their texture and color. By inhibiting the action of cell wall degrading enzymes, they effectively reduce weight loss and delay undesirable color changes, ensuring the fruits stay fresh and appealing for a more extended period. Additionally, the introduction of aromatic compounds like hexanal, 2-(E)-hexenal, and hexyl acetate represents a significant advancement. These compounds not only extend the shelf life of fruits but also enhance their safety by exhibiting antimicrobial properties against gram-negative bacteria.

This dual-action approach not only prolongs the freshness of the product but also addresses critical food safety concerns, making these techniques highly promising for the food industry. Incorporating these cutting-edge methods into fruit preservation not only ensures a consistent supply of fresh, high-quality fruits but also contributes significantly to reducing global food wastage. Continued research and innovation in this field hold the potential to revolutionize fruit preservation, ensuring consumers worldwide have access to fresh and safe fruits for a longer time.

Active and Intelligent Packaging

Active Packaging

Active packaging systems actively interact with the packaged food or the environment, offering functionalities that extend the product's shelf life and maintain its quality. These packages release active substances or absorb undesirable elements, thereby preserving the freshness and safety of the food.

Examples of Active Packaging:

- Oxygen Scavengers: These remove oxygen from the package, slowing down oxidation and spoilage.
- Ethylene Scavengers: These absorb ethylene gas, which is responsible for the ripening of fruits and vegetables.
- Antimicrobial Films: These release antimicrobial agents, inhibiting the growth of bacteria and molds.
- Moisture Regulators: These control humidity levels within the package, preventing moisture-related deterioration.

Intelligent Packaging

Intelligent packaging, also known as smart packaging, incorporates sensors, indicators, or labels that provide real-time information about the condition of the packaged product. These technologies enable constant monitoring of factors like temperature, freshness, and authenticity, offering valuable data throughout the supply chain.

Examples of Intelligent Packaging:

- Time-Temperature Indicators: These change color or display messages when a certain temperature threshold is exceeded, indicating potential spoilage.
- Gas Sensors: These detect specific gases emitted by food products, providing insights into freshness.
- QR Codes and RFID Tags: These allow consumers and producers to access detailed information about the product's origin, processing, and expiration date.

Edible Films and Coatings

In the field of food preservation, ground-breaking techniques involving edible films and coatings are revolutionizing the way we maintain food quality and safety. Unlike traditional packaging, these methods involve applying thin layers of edible materials directly onto food surfaces, forming a protective shield that extends shelf life and preserves sensory and nutritional attributes. These edible films and coatings are typically made from bio-based materials known as biopolymers, sourced sustainably from food industry residues and undervalued protein components like corn zein, gelatin, and casein, as well as lipids such as shellac resin and triglycerides, and polysaccharides like starch, chitosan, and carrageenan. Chitosan, a polysaccharide abundant in nature, is a notable example and has gained attention for its non-toxicity, biocompatibility, antimicrobial properties, and ability to form films. The application of these edible films and coatings, often enriched with active compounds, is particularly prominent in the preservation of fish and fishery products.

Techniques such as dipping, spraying, or using fluidized beds are employed to apply these coatings directly onto the food surface. By inhibiting the growth of spoilage and pathogenic microorganisms, these coatings effectively maintain or enhance the quality and sensory attributes of fishery products throughout their storage period. This inhibitory action leads to a significant extension of the products' shelf life, making these innovative preservation methods vital in the food industry.

The challenge of preserving the quality of fresh-cut fruits, exacerbated by their high water content, has been a significant issue in conventional packaging systems. The primary culprits behind rapid deterioration are gases, contaminating bacteria, and molds. Fresh-cut fruits are especially vulnerable due to increased enzymatic activity induced by wounds, affecting cell walls and membranes. However, a promising solution lies in the development of edible films. These innovative films serve as barriers, effectively minimizing water loss and controlling gaseous exchange. They prove invaluable in mitigating the adverse effects of ethylene-mediated senescence in respiring fruits. What makes edible films particularly noteworthy is their adaptability; they can be enhanced to perform multiple functions. For instance, by incorporating antimicrobial agents, these films have the potential to eradicate spoilage-causing microbes, enhancing the fruits' shelf life significantly.

Furthermore, these films can be tailored to introduce various flavors, adding a layer of versatility to their functionality. In essence, the development of these edible films marks a crucial advancement in the preservation of fresh-cut fruits. By addressing issues related to water loss, gas exchange, and microbial contamination, they not only extend the fruits' shelf life but also enhance their overall quality. This innovation represents a vital stride in the evolution of food packaging, ensuring that consumers can enjoy high-quality, fresh fruits for more extended periods.

The edible coatings could be single, bilayered or multilayered, i.e., composite coatings formed by depositing one type of material (like polysaccharide/protein) followed by deposition of another type (like lipid) and this imparts better protection from microbial spoilage, controls water loss/gain, and gaseous exchange from the surface

layers. The principal benefit of the barrier films could be improved by enhancing the coating properties by incorporating nanosized organic or inorganic materials, biological, or synthetic matrices to fabricate nanocomposite films that exhibit better barrier, mechanical, and functional properties and thus lengthen/maintain the quality of the fresh produce for longer periods desirable for storage and transportation time lags. The novel edible films can be value-added by addition of functional ingredients as encapsulated nutraceuticals like vitamins, water-insoluble flavonoids, and other flavor/color enhancing phytochemicals, antioxidants like anthocyanins, carotenoids for avoiding discoloration of the cut surface and antimicrobial agents like bacteriocins (natural), biogenic nanoparticles of silver, titanium, or zinc (inorganic synthesized) to curb the growth of spoilage causing microbes. Overall, these advancements in edible films and coatings signify a dynamic and sustainable approach to food preservation, offering a promising future where food items can be stored longer, reducing waste and ensuring higher quality for consumers. As research in this field progresses, these techniques are poised to play a pivotal role in the evolution of food preservation and packaging.

Nanocomposites for Packaging

Nanocomposite materials represent a cutting-edge advancement in materials science, encompassing various dimensional forms such as one-dimensional, two-dimensional, three-dimensional, and amorphous structures. These materials are characterized by their composition of distinctly different components, intricately mixed at the nanometre scale. In comparison to conventional packaging materials, nanocomposites offer a plethora of additional advantages.

Firstly, nanocomposites exhibit enhanced strength and elasticity, making them ideal candidates for robust and durable packaging solutions. Their improved biodegradability is a significant environmental boon, aligning with the global shift towards sustainable materials. Additionally, nanocomposites allow for superior control over gaseous molecules, a crucial feature for the development of high-performance packaging materials.

Traditionally, nanocomposite materials consist of three primary components: the matrix material, the filler, and the filler interface material. What sets nanocomposites apart is that at least one of these components is in the nanoscale order, which opens up a realm of possibilities for innovative applications in various fields, including advanced packaging solutions. The meticulous combination of these components at the nanoscale not only enhances the material's overall properties but also paves the way for the development of next-generation packaging materials that are not only stronger and more environmentally friendly but also offer precise control over the preservation environment. This groundbreaking technology represents a significant leap forward in the evolution of packaging materials, promising improved performance and sustainability for the future.

Bio-Based and Biodegradable Packaging

Bio-Based Packaging

Bio-based packaging materials are derived from renewable resources such as plants, agricultural residues, or biomass. Unlike conventional plastics, which are derived from fossil fuels, bio-based materials are sourced from nature. Common sources include corn, sugarcane, potatoes, and other plant-based polymers.

Advantages

- Sustainability: Bio-based materials are renewable and reduce dependency on finite fossil fuel resources.
- Lower Carbon Footprint: They typically have a lower carbon footprint compared to conventional plastics.
- Biodegradability: While not all bio-based plastics are biodegradable, some are designed to break down naturally, reducing their impact on the environment.

Biodegradable packaging

Biodegradable packaging materials are designed to decompose naturally in the environment, primarily through the action of microorganisms, into

natural substances like water, carbon dioxide, and biomass. These materials are often used for single-use items like food packaging, disposable utensils, and bags.

Advantages

- Reduced Environmental Impact: Biodegradable materials break down over time, reducing litter and pollution.
- Waste Management: Biodegradable packaging reduces the strain on landfills and waste management systems.
- Versatility: Biodegradable materials can be used for various applications, including packaging, agricultural films, and disposable items.

Challenges and Considerations:

- Biodegradation Conditions: Biodegradable materials require specific conditions to break down effectively, such as adequate moisture, temperature, and microbial activity. In some environments, they may persist if these conditions are not met.
- Certification Standards: The lack of standardized certifications for biodegradable products can lead to confusion. Certifications like "OK Compost" provide assurance of biodegradability.
- Land Use: The production of bio-based materials may compete with food production and raise concerns about land use and resource allocation.

Conclusion

In conclusion, emergent preservation and packaging techniques offer a holistic approach to food storage. By combining advanced technologies, sustainable practices, and intelligent systems, these methods not only prolong the shelf life of food but also ensure its safety, quality, and environmental responsibility. As research continues and these techniques become more widespread, they hold the promise of transforming the future of food storage and consumption.

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Dragon Fruit: An Advanced Potential Crop

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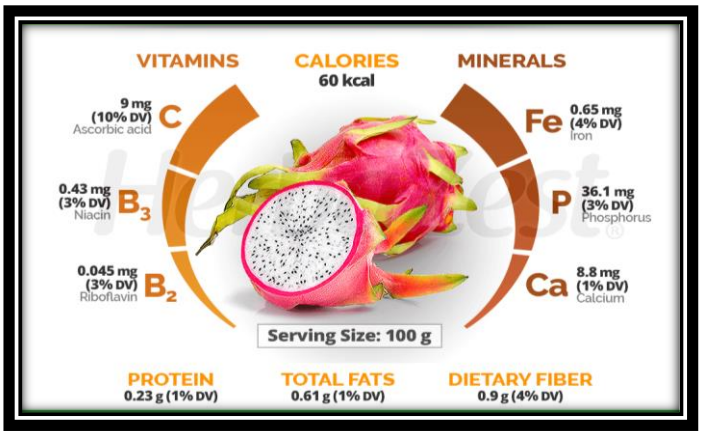
Dragon Fruit is said to have originated in the tropical and subtropical forests of Mexico and Central and South America. Gradually, the fruit spread to other tropical and subtropical regions of the world. Currently, dragon fruit is cultivated in at least 22 countries including Australia, China, Israel, Malaysia, Nicaragua, Taiwan, Sri Lanka, and Vietnam. According to some accounts, the French took the fruit from Nicaragua and Colombia, while other accounts state that the French brought it with them from Guyana (South America) in1870 as an ornamental plant. In fact, the French introduced the fruit to Vietnam over a hundred years ago. Today, Vietnam is the world's leading exporter of dragon fruit, with revenues from dragon fruit making up 55 percent of the country's fruit export turnover. The fruit is popular across Southeast Asia. It is increasingly being cultivated in several countries including Thailand, Indonesia, Israel, Northern Australia, Southern China, Philippines and Hawaii (Deccan exotics 2017).

Introduction

Dragon fruit (*Hylocereus undatus*) is popular in South East Asia. It is an edible vine cactus species belonging to the family Cactaceae which has received worldwide recognition first as an ornamental plant and then as a fruit crop. It is also called as Pitaya, Strawberry pear, thangloy (Vietnamese), pitayaroja (Spanish), and la pitahaya rouge (French) (Kirti J. *et al*.2020). Being a native of Southern Mexico, Guatemala and Costa Rica, dragon fruit was introduced in India during the late 90s and still the area under its cultivation is gradually increasing. Farmers in the Indian states of Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Orissa, West Bengal, Andhra Pradesh and Andaman & Nicobar Islands have already taken up its cultivation, and the estimated total area under dragon fruit cultivation in these regions may be less than 400 ha. Majority of the dragon fruits presently available in Indian markets are imported from Vietnam, Thailand, Malaysia and Sri Lanka.

Pitaya are fast-growing, perennial, vine-like cacti. They have triangular (3- sided), green, fleshy, jointed, many-branched stems. Each stem segment has 3 flat, wavy wings, with corneous margins and may have 1-3 small spines, or are spineless. The stem section of pitaya forms aerial roots which adhere to the surface upon which they grow or climb (St. Vincent and Grenaddines, 2009)

Nutritional composition of dragon fruit



(Source: St. Vincent and Grenaddines, 2009)

Varieties of dragon fruit

There are three main varieties depending on its appearance.

1. Red skin with white flesh

2. Red skin with red flesh

3. Yellow skin with white flesh

White flesh/pink skin (*Hylocereus undatus*) – The most common of the three varieties of dragon fruit; fruit are slightly to significantly less sweeter than the pink- or red-fleshed pitaya fruit.

Colored flesh/pink skin (*Hylocereus polyrhizus*) – This is sweeter of the two pink skinned varieties; fruit are larger than those of the yellow-skinned dragon fruit.

White flesh/yellow skin (*Selenicereus megalanthus*) – Typically the sweetest of the three varieties of dragon fruit with relatively smaller sized fruits.

Potential health benefits of dragon fruit

- Dragon fruit is reported to possess many medicinal properties; red fleshed varieties of the fruit are rich in antioxidants like flavonoids, phenolic acid, and betacyanin. These natural substances protect your cells from damage by free radicals molecules that can lead to diseases like cancer and premature aging.
- This fruit is potentially effective in preventing colon cancer and diabetes, neutralize toxic substance (such as heavy metals) and reduce cholesterol and high bood pressure (Gunasena *et al*., 2007). However, it must be noted that many of these remedial properties are reported based on traditional uses and not based on properly designed clinical studies.
- Extracted oil from two varieties of dragon fruit seeds and analyzed it for fatty acid profile. Essential fatty acid, namely, linolic acid and linolenic acid, formed a significant percentage of the unsaturated fatty acids of the seed oil extract. Both varieties contained about 50 % essential fatty acid and had two oleic acid isomers. Essential fatty acids are important in that they are necessary substracts in animal metabolism and cannot be synthesized in vivo.
- It's naturally fat-free and high in fiber. It makes for a good snack because it can help keep you full for longer between meals.
- It may help lower your blood sugar. Researchers say this might be partly because it replaces damaged cells in your pancreas that make insulin, the hormone that helps your body break down sugar. But the studies were done on mice, not people.
- It contains prebiotics, which are foods that feed the healthy bacteria called probiotics in your gut. Having more prebiotics in your system can improve the balance of good to bad bacteria in your intestines. Specifically, dragon fruit encourages the growth of the probiotics lactobacilli and bifidobacteria. In your gut, these and other helpful bacteria can kill disease-causing viruses and bacteria. They also help digest food.
- It can strengthen your immune system. Dragon fruit is high in vitamin C and other antioxidants, which are good for your immune system.
- It can boost your iron levels. Iron is important for moving oxygen through your body and giving you energy, and dragon fruit has iron. And the vitamin C in dragon fruit helps your body take in and use the iron (Ariffin*et al*., 2009).

Table 1: Botanical description of Dragon fruit cultivation

Common Name	Dragon fruit, Pitaya
Botanical Name	*Hylocereusundatus*
Family	Cactaceae
Origin	South Mexico
Temperature	20-30^{o} C
Soil	Well drained red yellow pedzolic, lateritic soil and reddish-brown earth
pH	5.5-6.5
Propagation	Seed and Vegetative (Cutting)
Spacing	3 x 3, 4 x 3, 3.7 x 3.7 m
Trellising	Vine has to be train to climb concrete or wooden posts, fence, walls and tree for support. post size is 100-150 mm diameter and 2 m high and should be buried 40 cm in the ground
Planting time	Beginning of rainy season
Fertilizers	20 kg FYM, 540 g N, 720 g P and 300 g K
Flowering	April to May
Maturity	Color change green to pink
Harvesting	June to December
Yield	10 – 12 t/ha
Insect-Pest	Ants, scale insect, mealy bug, snail, slugs
Disease	Soft watery stem rot, Brown spot, anthracnose


Stem with spine


Flowering


Fruiting

Table 2 : Physical and chemical properties of two varieties of dragon fruit (Wichienchot *et al.* 2010)

Fruit characteristics	White flesh	Red flesh
Avg. fruit length (cm)	13.4	12.7
Avg. fruit diameter (cm)	9.4	6.6
Avg. fruit flesh weight (g)	305	215
Avg. fruit skin weight (g)	100	75
Sweetness (^{o}Brix)	12.5	14.8
Glucose (g/100 g)	35.3	40.1
Fructose (g/100 g)	23.8	15.8
Oligosaccharides (g/100 g)	8.6	8.9

Conclusion

There is a potential of dragon fruit cultivation in most of the countries where it is currently grown. This crop could be an asset to smallholders as well as for the establishment of large scale plantations. Dragon fruit is suitable for growing in region that have spells of dry weather with supplementary irrigation. The farmers in these areas will benefit immensely if the species is improved and cultural practices studied for its incorporation into the existing farming system. Dragon fruit has been used for the preparation of different value-added products, nonetheless, there is a dispensable gap in promoting the products in the global market. Good quality dragon fruit product can be prepared from fully ripened variety. If quality product from dragon fruit are developed, it might be welcomed by the consumers who have affinity for dragon fruit round the year due to rich in nutritive value which could help to improve economic status of farmers.

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Technological Transformation in Agriculture

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Technological transformation in agriculture sector shows much positive impact in terms of productivity, security and supply chain. The most effective way to improve the lives of millions in poverty is to support agriculture in developing countries. Most of the world's poor are farmers, and those who are not spend much of their income on food. Transforming a country's agriculture sector can create jobs, raise incomes, reduce malnutrition, and kick-start the economy on a path to middle-income growth. In fact, almost every industrialized nation began its economic ascent with an agricultural transformation. Recent examples include Brazil, China, and Vietnam, each of which at least doubled the value of its agriculture sector within 20 years of starting its transformation. There is drastic transformation of Agriculture over the past 40 years. The practices are evolving to enter into new era of technology. Agricultural sector is the backbone of every economy in the world. There is high demand of food and this is a challenge because there are constraints in supply due to climate change and high labor cost. Every decade, there is a continuous revolution of technology in agricultural industry.

Modern agricultural technology increases employment, efficiency in production of food, saving on time and reduction in cost. Farmers gain significant benefits from high innovation of technology. Farming is part of entrepreneurship and a business that fully dependents on the nature. The drivers of agricultural transformation are multidimensional, interrelated, and change over time, but they can be organized into categories to provide a better opportunity for pragmatic diagnostics and decision making on national priorities. However, agriculture is not all about success, farmers are also faced by challenges that are unavoidable. These problems are caused by enormous changes in climate because of increase in greenhouse emissions that lead to global warming, use of fossils fuel, deforestation and other factors.

Technological transformation refers to the application of modern agricultural technology to increase productivity. Agriculture production can be supported by the adoption of modern farming technologies such as agriculture equipment, better-quality seed varieties, and fertilizers based on the inorganic compounds. Once the farmer gain complete knowledge related to the latest technology as well as its potential, latest agricultural technology interventions convert long-term steadiness. Adaptation of modern technology in agriculture sector changes the way of farming in different ways such as a farmer can govern his irrigation systems as well equipment related to irrigation from his phone as well as from computer also instead of monitor each field by driving and Crop sensors utilizes its capability in order to maximize the productivity by applying the fertilizers in effective fashion. There are many augmenting factors or drivers to lead the agriculture in front way for enhancing the yield as well as quality by adopting the following tactics or strategies.

Change agents identified and mobilized

The success of any agricultural transformation relies on how well millions of smallholders and small- and medium-size enterprises can be helped to change farming practices as quickly and effectively as possible. The critical enabler, without which an agricultural transformation is likely to fail, is a frontline "change agent" that helps farmers modify their practices. Change agents are people who farmers trust and interact with regularly.

There are major technological innovations that include: Global Positioning System (GPS) and Geographical Information System (GIS) in precision Agriculture. Modern technology has been made easy by the contribution of the two technologies GIS and GPS. These two keeps the records of data for reference. It has allowed precise agriculture for data collection, farm planning, field and yield mapping and also used to give direction to automation in the field. GPS aid in spatial variability of soil and save on fertilizer. It's also

important in monitoring the farm when there is a heavy rain or fog.

Water and Soil Sensor

The modern farmers are equipped with smart crop sensors that help them in read and detect the health of crops, nitrogen level, soil PH, and moisture content in soil. It aids the farmers with information in order to determine the amount of water, pesticides and fertilizers needed by the crops. It makes use of available resources and hence minimizes the cost and wastage. Furthermore, it remains a very great challenge in farming to ascertain the type of fertilizer that work best in different soil, quantity and when to apply the fertilizer. The sensor is designed as that it can prescribe the quantity of fertilizer, pesticides and water that the crops needed.

Farm Machinery

Farmers have been facing high cost of labor, which demand for better methods to minimize the cost of labor. The innovation of machinery such as combine harvesters and planters simplifies the task and reduces the cost of labor. The automation of autopilot sprayers and tractors boost efficiency of the farm production.

Farm Automation

Farm automation also known as 'intelligent agriculture' is a technological form which improves farm productivity by automating crop production and cattle production cycles. Agricultural automation addresses important issues including population growth, labor shortages on plantations, and changing consumer tastes. The advantages of automating conventional farming processes are enormous, as they address concerns such as consumer desires, labor shortages, and farming's environmental footprint.

Modern Irrigation

Farmers are moving towards new technology by use of modern irrigation techniques in their crops. By the use of developing boreholes and dams in dry regions, farmers are getting benefit of pumping water to irrigate the crops. This increase the production and supply of food throughout the year.

Modern Greenhouse

The heat from the sun is used by plants (solar radiation) to grow. The heat from sun is used to generate optimal temperature for the crop growth. Greenhouse farming generates favorable climate for production of horticulture, such as vegetables and flowers throughout the year. With automated irrigation systems and soil sensors is used to figure out the problems arising from green house. The increasing demand of food requires high growing of the crops. Greenhouse technology helps in availability of production of food and makes full use of the available resources.

Indoor Vertical Farming

Why indoor vertical farming? Since our population is growing rapidly and the demand of food is also increasing, there is need of high supply. To feed the billions of people, it requires more innovative ways of growing food. Vertical farming is one of the best innovations. Crops are grown vertically stacked layers, which allow preservation of space and high productivity. It is practiced in urban areas due to very limited space.

Satellites, Drones and Aerial Imaging

Satellites, Drones and Aerial imaging are becoming advanced in taking the farm to high quality images. This equipment's aid the farmers to analyze the crops while they are at the comfort of their home, as if they are actually in the farm. They access the crops' status from a distance. The drones can be used to spray the pesticides on the crops.

Agricultural Robots

In today's world, farmers are using robots in performing human-related tasks that are complex. The agricultural robots are highly tailor-made with sensors and affixation that perform particular task, such as planting and harvesting as well. Agriculture is quickly becoming an exciting high-tech industry, drawing new professionals, new companies and new investors. The technology is developing rapidly, not only advancing the production capabilities of farmers but also advancing robotics and automation technology.

At the heart of this phenomenon is the need for significantly increased production. As per the UN estimates, world population will rise from 7.3 billion today to 9.7 billion in 2050. The world will need a lot

more food, and farmers will face serious pressure to keep up with demand.

Agricultural Robot Applications

Agricultural robots automate slow, repetitive and dull tasks for farmers, allowing them to focus more on improving overall production yields. Some of the most common robots in agriculture are used for: harvesting and picking, weed control, autonomous mowing, pruning, seeding, spraying and thinning, phenotyping, sorting and packing, and in utility platforms, etc. Harvesting and picking is one of the most popular robotic applications in agriculture due to the accuracy and speed that robots can achieve to improve the size of yields and reduce waste from crops being left in the field.

Block chain and Big Data

We believe that the utilization of Block chain in agricultural sector will become increasingly popular as a way to improve transparency in supply chain, minimize the risk of shortage of foods, and encourage more productive transactions.

Artificial Intelligence

It helps in precision agriculture. Artificial Intelligence helps the farmers to detect diseases, controlling pests in crops and monitor soil PH. Like human intelligence, the machine can accomplish tasks that are complex. It has become so difficult for the farmers to predict the climate due to global warming. The farmers cannot determine the sowing period, but with the aid of Artificial Intelligence farmers can smile. They may get the firsthand information to know the weather changes by the use of weather forecast.

Conclusion And Way Forward

The evolving technology in agriculture is gaining substantial benefits in high productivity, less cost of production, increase in efficiency and increase in income. There is high demand of food due to the increasing population. The farmers face difficulties in climate change and high cost of production, but it will never stop them from producing. Successful agricultural transformations have focused on the farming household, providing opportunities for farmers to earn a better income. For some, that will mean raising farm productivity or shifting the mix of production to include higher-value crops and livestock. For others, the right choice will be to do less farming and take advantage of employment options off the farm.

The modern technology is important for the farmers to minimize the constraints. Farming is not only known about weather and high production but also involves data collection and embracing the modern technology. As technology continues advancing agriculture becomes progressively worthful. Modern agriculture will not only help the farmers to automate their activities but helping farmers to shift to precision agriculture. Therefore, agricultural transformation is essential to the future well-being of developing nations and also to a world with more equitable economic development.

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Nutraceutical Properties of Black Rice and Genetic Regulations

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Rice (*Oryza sativa* L.) is a major cereal crop that is relied by more than half of the world's population as their primary source of nutrition. It is a member of the *Poaceae* or *Gramineae* family. With dozens of varieties being cultivated all over the world, this cereal has a broad genetic diversity. With a production of 117.47 million tonnes, it is grown in an area of 43.86 million hectares in India (DAC&FW, 2019-20). The majority of rice consumed worldwide is white, however numerous unique varieties that include colour pigments, are black rice, red rice, and brown rice. Their names were given by the colours of their kernels, which are black, red, and purple due to deposition of varying degree of anthocyanin contents in various levels of the pericarp, seed coat, and aleurone. Anthocyanin deposition is what gives black rice its dark grain colour (Reddy et al., 1995).

Black rice is one of the coloured rice variants that has drawn the most attention because of its sensory qualities, high nutritional content and most importantly, its advantageous health aspects. Purple rice, forbidden rice, heaven rice, imperial rice, king's rice, and treasured rice are additional names for black rice. Its local name in Manipur, is Chakhao meaning

delicious rice. Manipur black rice bagged the GI tag in 2020.

Chakhao is mainly consumed as kheer which is creamy, aromatic and has a nutty flavour. Because of its great nutritional value and healing qualities, many people believe that this rice is a cure for all illnesses. This rice comes in several cultivars that have a long history of cultivation in Southeast Asian nations including Thailand, China, and India. In Manipur, black rice comes in four landrace varieties: Chakhao amubi, Chakhao angouba, Chakhao poireiton, and Chakhao pungdol amubi. In comparison to other rice varieties, black rice is about six times richer in antioxidant activities, high protein content (8.16%), low-fat content (0.07%), is gluten-free, gut-friendly, and a natural cleanser with numerous medicinal properties (Jha et al., 2017). Black rice is rich in lysine and tryptophan, two important amino acids, as well as dietary fibre, functional fats, vitamins B1, B2, and E, folic acid, and phenolic compounds (oryzanols, tocopherols, and tocotrienols). It is low in calories and high in macro and micronutrients including iron, zinc, calcium, phosphorus, and selenium. Compared to other rice varieties growing in northeast India, black rice has a higher protein and nutritional content.

Black rice pigment

The deep purple colour of Black rice is due to the presence of anthocyanin, water-soluble plant pigments that give leaves, fruits, grains, and flowers a variety of appealing colours, the majority of which are red, blue, purple, and dark purple. They are phenolic chemicals that are produced from flavonoids and have significant biological functions in plants. The accumulation of anthocyanin in plants has various

functions, including resisting UV radiation, participating in hormone regulation, and responding to biotic and abiotic stress, and is beneficial to human health. Different rice plant parts, but most intriguingly in the rice caryopsis, have been found to contain anthocyanins, which produce an enticing hue. The composition and concentration of the pigments in the rice caryopsis fluctuate, giving the plant's colour a wide range from brown to red to purple to black. The distinction in colour is brought about by various anthocyanin and proanthocyanidin mixtures. The quantity of total anthocyanins (TAC) in rice bran determines how dark it appears; in contrast, the amount of total proanthocyanidins (TPC) determines how red the rice bran appears. Changes are seen at various developmental phases, either in the rice caryopsis or in the extracted pigment between plants accumulating anthocyanin and proanthocyanin, as well as in non-pigmented rice. The pigmentation increases as the rice caryopsis matures.

Biosynthesis of anthocyanin

The genes encoding the proteins involved in the anthocyanin biosynthetic pathway have been extracted from numerous plants, and this pathway has been well characterized. A complex consisting of MYB-type transcription factors (TFs) of SG5 and SG6, basic helix-loop-helix (bHLH) TFs of the IIIf subgroup and WD-repeat proteins, as well as the MYB-bHLH-WD40 or MBW complex, is responsible for regulating the transcription of these biosynthetic genes (Hichri et al., 2011). The C-terminus and variable region of this complex's MYB TF, which has two conserved imperfect repeats (R2 and R3) at its N terminus, are in charge of regulatory action. Through interaction with the R3 region of its R2R3 MYB partner, the bHLH TF is essential for the formation of transcriptional complexes at the promoters of anthocyanin biosynthesis genes (Xu et al., 2015). Finally, rather than serving a direct regulatory role, the WD40 protein functions as a scaffold protein onto which the complex is formed and stabilizes the interaction between the MYB and bHLH TFs. Studies have shown that WD40 proteins, such as the flavonoid biosynthesis regulator *TRANSPARENT TESTA GLABRA1* (*TTG1*), are expressed in tissues that may either accumulate or lack flavonoids and have pleiotropic effects on additional processes, such as the formation of trichomes and root hairs and the production of seed mucilage (Ramsay and Glover, 2005). Similar to WD40 proteins, bHLH TFs can control one or more branches of the flavonoid biosynthesis pathway as well as additional functions such as determining the destiny of epidermal cells, often in a partially overlapping manner. Furthermore, a hierarchy of bHLH TFs controls the anthocyanin biosynthetic pathway so that an upstream bHLH stimulates the expression of a downstream bHLH gene encoding the MBW complex component (Petroni and Tonelli, 2011). MYB TFs have a more limited range of function and are responsible for the differential accumulation of flavonoids in different plant organs and tissues by regulating the specificity of MBW complexes for their cognate target genes in response to environmental factors and developmental stage (Gonzalez et al., 2008). As a result, different combinations of TFs are needed for each type of tissue and stage of development since the expression patterns of distinct MYB genes control the spatial and temporal regulation of the flavonoid biosynthesis pathway. Notably, the majority of rice cultivars lack these flavonoid pigments, presumably as a result of intentional selection for whiter grains. It has been discovered that several rice genes are involved in the manufacture of anthocyanins. For instance, seven potential regulators, including the *R2R3-MYB* gene *OsC1* and the six bHLH genes *OsB1*, *OsB2* (also known as *OsKala4*), *OsRa, OsRb, OsPa,* and *OsPs* were identified and characterized for their role in the spatial and temporal regulation of anthocyanin biosynthesis. Recently, *OsC1*, which is essential for the synthesis of anthocyanins in the leaf sheath, apiculus, stigma, and hull, was shown to be the target of artificial selection for loss of pigmentation during rice domestication, leading to green leaf sheaths in the majority of cultivated rice plants. Oikawa et al. (2015) found that *OsKala4* controls the anthocyanin production in the pericarp. The ectopic expression of *OsKala4* in the pericarp and the subsequent transcriptional activation of anthocyanin biosynthesis genes in this tissue are the results of a rearrangement in the *OsKala4* promoter region. Additionally, Sun et al. (2018) found that *OsC1*

and *OsKala4* combined activity stimulates anthocyanin production in several organs, including the apiculus, hull, and leaf sheath, but not in the pericarp. *OsKala4* regulates anthocyanin accumulation in this tissue in collaboration with other MYB-like TFs other than OsC1, as shown by the reddish-brown pericarp that occurs from ectopic expression of *OsKala4* in the absence of *OsC1*. According to earlier research, the introduction of the alleles of three genes such as *OsKala1, OsKala3*, and *OsKala4* from the black pericarp "Hong Xie Nuo" into the white pericarp "Koshihikari" causes a complete transformation of the white pericarp into the black pericarp. *OsKala1* and *OsKala4* encode a dihydroflavonol reductase (DFR) and a bHLH TF, respectively. *OsKala3* is believed to encode the MYB TF in the MBW complex (Maeda et al., 2014), although it is still unclear what molecular process causes the rice to be black.

Nutritive value

Iron, vitamins A and B, fibre, protein, necessary amino acids, and other nutrients are all found in black rice. Black rice is very nutrient-dense. This rice is minimal in sugar, salt, and fat and devoid of gluten and cholesterol. Protein content and quality are higher than in any other rice variety. There are 18 amino acids in it. It is helpful for individuals worried about getting enough iron on a plant-based diet because it is a naturally good source of iron. Black rice has a high concentration of minerals, including calcium, sodium, magnesium, and potassium. Studies in the past have shown that the antioxidant activity and phenolic content of black rice is higher than those of white rice.

Conclusion

Black rice is considered to be a rich source of nutrients with various health benefits. Anthocyanin which is present in black rice has many biological functions. By increasing anthocyanin content, resistance to biotic and abiotic stress can be increased. Transgenic breeding targets to increase anthocyanin content in rice to enhance rice quality and nutritional value. Genes involved in the biosynthesis pathway of anthocyanin have been studied and identified. A better understanding of this pathway is necessary to proceed with advanced breeding techniques.

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Fodder Preservation Techniques – Hay and Silage Making

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The seasonal nature of green fodder availability and a number of farm by products necessitate their preservation to feed the animals throughout the year. For example, green fodder is available in surplus during rainy season and in winter, while paddy and wheat straw and other crop residues are available during harvest seasons. Contrary to this, it is too difficult to meet the requirements of the animals in summer. Hence, it is essential to conserve the seasonal surplus for feeding the animals throughout the year. Hay (dried fodder) making and silage (wet fodder) making are the two preservation methods, of which ensiling is preferred on the basis of fodder quality.

Hay Making

Hay making is the most common and easy method of preserving the seasonal excess of the green fodder and the only method of preserving farm by products. Legume hay, non-legume hay and mixed hay are the major three types of hays used to feed the livestock. Hay is different from straw, because the straw is obtained from the crop after the seed formation, while for hay making the crop is harvested at flowering stage.

The basic principle of hay making is to reduce the moisture content in the green forage sufficiently so as to permit their storage without undergoing fermentation or becoming moldy or further nutrient losses. The moisture content in hay must be less than 15 per cent at storage time. Hence, crops with thin stems and many leaves are better suited for hay making as they dry faster than those having thick and pithy stems and small leaves.

Harvesting

Leguminous fodder crops should be harvested at their flower initiation stage or when crown buds start to grow, while grasses should be harvested at their pre-flowering or flower initiation stage. Harvesting should be done preferably when air humidity is low. The harvest has to be taken up after the dew has dried.

Curing

Field methods

Windrow

- ✓ The harvested material occupies one third to half of the field
- ✓ Drying is faster than in swath, because of the opening of the stomata in the lower layers

Swath

The entire field is the spread area. The harvested fodder has to be allowed for curing in the field itself, and has to be turned after every 4-5 hours. By the evening the moisture content could have reduced from 75 per cent to 40 per cent and it has to be loose heaped in windrows. Next day it requires 1 or 2 turnings. The moisture content by the second day afternoon could have reduced to 25 per cent provided the sunshine is not interrupted. Normally 70-75 sunshine hours are required for drying the grass in the-field method. For rainy season hay curing sheds are recommended.

Mechanical Methods

Fence method

Drying frames made of wire fencing with angle iron posts are used. It is more suited for berseem and lucerne, The hay possessed green colour and pleasant aroma. In mechanical drying, the protein loss is only 2-3 percent and it is directly proportional to drying time.

Artificial drying

Forage can be dried in barn by flowing hot air through the forage. This method avoids nutrient losses and enables harvesting of forage irrespective of the prevailing weather conditions. However, it is expensive and beyond the reach of small and marginal farmers.

Baling of hay

The dried forage should be collected and baled when the moisture concentration becomes lower than 15 per cent. Baling the hay helps in storage and requires less space.

General guidelines for hay making

- ✓ Crops with thick and juicy stems should be dried after chaffing and conditioning, which will speed up the drying process and slow down the loss of nutrients;
- ✓ Hay should be raked only a few times during drying to avoid shattering of leaves and bleaching of hay
- ✓ Legumes should be raked in the morning hours to avoid leaf shattering;
- ✓ After drying and curing, baling and/or stacking should be done as early as possible.
- ✓ Storage under a roof is preferred;
- ✓ Storage of hay before sufficient drying may cause fire due to spontaneous combustion
- ✓ Storage of hay with higher moisture results in mould growth, make it unfit for feeding
- ✓ High moisture content at stacking time results in dry matter and nutrient losses of 15 to 50 per cent.

High quality hay is light grey color, leafy, pliable & free from mustiness.

Chemical changes in the fodder on hay making

After harvest, respiration continues leading to the conversion of soluble sugars to CO_2 and H_2O. This not only results in the loss of nutritive value and digestibility but also increase cellulose and lignin percentages. The plant enzyme act on protein and occurrence of proteolysis lead to production of amino acids. This again reduces nutritive value and keeping quality. Hence quick drying under sun light is preferred.

Losses in hay making

- ✓ Nutrient losses due to late cutting.
- ✓ Shattering of leaves and finer parts especially in legumes.
- ✓ Loss of soluble nutrients due to leaching caused by rain during drying
- ✓ Continuous and excessive rainfall results in fermentation and mould growth.
- ✓ Excessive exposure to sunshine leads to loss of chlorophyll and carotene (bleaching).

Merits of hay

- ✓ Hay can be prepared quicker and easier than silage
- ✓ It is best among dry fodders as it has high nutrient content
- ✓ Conveniently fed to the animals during lean period
- ✓ Cost of making hay is low

Demerits of hay

- ✓ Hay is less digestible and nutritious than silage
- ✓ Less tasty
- ✓ More nutrient loss
- ✓ High risk of catching fire
- ✓ Difficult to make hay during bad weather condition

Silage Making

Silage refers to any wet and/or green fodder, preserved by organic acids, chiefly lactic acid, that is produced naturally by bacterial fermentation of sugars in the plants under anaerobic conditions. The basic principle of silage making is to convert the sugars in the ensiled fodder into lactic acid, this reduces the pH of the silage to about 4.0 or lower, depending on the type of process. In this way, the biological activities responsible for spoilage are inhibited. To attain this, the early establishment and maintenance of anaerobic environment is essential. Stored material is highly acidic and has a lower feeding value compared to the original green fodder in the field.

Storage structures for silage

A silo is a structure designed to store and preserve high moisture fodder such as silage. The selection of a silo is made on the basis of required capacity, climatic conditions and economic considerations.

Types of silos

Horizontal silos

Trench silos are commonly used for easy handling of the silage. Trenches of different sizes, with depths up to 4 m are used. 700 kg fresh silage per cubic

meter can be preserved. The ground water table should be below the maximum depth of the silo.

Bunker silos

These are used instead of trench silos, when the ground water table is high.

The basic difference between trench and bunker silos is only that the former is below ground level, whereas the latter is above ground level.

Vertical silos

- ✓ Pit silos are circular or rectangular vertical pits with a depth of 3-8 m. The ground water table is lower than the depth of the pit. Circular pits are preferred as the silage can be compacted much better than with a rectangular pit. Both earthen and masonry structures can be used, but losses are lower and silage quality is higher in the masonry structure. Pit silos are most suitable and economical for storage of smaller quantities. Their cost and the losses are lower than with the trench silos.
- ✓ Tower silos are used instead of pit silos in areas with high ground water tables. They are generally of the so-called 'pacca-structure'. The cost of these tower silos is a major limitation for their adoption.

Use of additives in silage making

For grasses, fodders or crop residues that are rich in sugars, sufficiently dried (i.e. above 25% DM) and with a crude protein level under 20 per cent, there is no need to use additives. Additives not only upgrade the silage quality, but they also reduce the risk of failure to preserve the forage. The most common ones are organic acids, molasses and preservatives such as salt and sodium metabisulphite. Most of the undesirable bacterial activity can be prevented by adding an organic acid to the crop. By adding molasses (15 litre in 15 lit water) to one ton of silage, the pH can be quickly reduced to below 4.0. Salt adds flavor and reduces water activity.

Guidelines for preparing and using silage pit

Harvesting

Crops and plant material rich in soluble sugars such as maize, sorghum, oats, sugarcane tops, hybrid napier grass and other grasses are highly suitable. High or medium quality grasses and fodders containing between 15-35 per cent dry matter results in high or medium quality silage. This is found at the dough stage in maize, at flowering in sorghum, ear emergence in pearl millet, milk stage in oats and at flowering stage in most of the grasses. Green to semi-green forage use the oxygen present for respiration, results in high quality silage. Partial wilting of legumes is necessary to reduce the water concentration to about 70 per cent. For proper filling and compaction, grasses, particularly those having thick and pithy stems, should be chaffed to 2-3 cm size.

Silo preparation

The structure must be thoroughly cleaned and if the bottom and sides of the silo are kachcha, a 10 cm layer of straw or waste fodder is spread on them. In all cases, such layer is advisable in cemented pits. Chopped fodder should be filled layer by layer of about 50 cm each within a day or two and compacted properly to remove trapped air. If fodder contains little soluble sugars which is the case in legumes, liquid or dried molasses should be sprinkled on top of each layer to increase the fermentation. The entire pit should be filled in the same manner up to a height of about 1.5 to 2 metres above the ground, in order to avoid water collection in the pit. Trampling must be more thorough near the sides and edges of a trench silo.

Closing the silo

After properly shaping-up the mass on the top layer (dome shape), the silage pit should be covered as soon as possible with a layer of straw or waste fodder, and subsequently with a plastic sheet of 250 to 275 micron thickness to prevent oxygen from coming in. Fermentation starts within hours after closing the silo, and accelerates over next 2 to 3 days. It terminates after about three weeks. Organic acids, primarily lactic and acetic acid, ethanol and gases such as CO_2, CH_4, NO_2 and NH_3, are produced during fermentation process. The fermentation process will be complete in 4 to 5 weeks and after that the mass becomes stable.

Opening the silo

While opening the silo, the cover should be removed properly and a plastic sheet is taken out in a section of the pit, taking care that the minimum possible surface is exposed to atmosphere. Some moldy material may be found on top and also on the side, which should be removed before taking the silage for feeding.

Characteristics of good silage

- ✓ No mould growth
- ✓ Golden / greenish yellow
- ✓ Pleasant fruity odour or acceptable aroma
- ✓ Free flowing and non-sticky texture
- ✓ 3-4% increased palatability
- ✓ Increased nutritive value
- ✓ pH around 4.0 – 4.5

Losses in silage making

The losses resulting from silage making are the sum of respiration losses, fermentation losses, effluent losses, and losses due to prolonged fermentation and moulding.

Advantages of silage making:

- ✓ When harvested at or before the flowering stage, more nutrients can be available for animal feeding
- ✓ Losses due to shattering, leaching and bleaching during hay making are avoided
- ✓ Silage making is less affected by adverse weather conditions as compared to hay making.

Disadvantages of silage making:

- ✓ It requires labour for filling of the silo
- ✓ Construction of a silo requires an investment
- ✓ Handling and transportation require more effort as compared to hay
- ✓ Nutrient losses are generally 10 per cent over losses with green fodder
- ✓ Slight carelessness at the time of ensiling may result in heavy losses due to aeration
- ✓ Marketability of silage is very low.
- ✓ Feeding of silage just before milking may give some silage smell in the milk, so milch animals should be fed with silage after milking.

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Impact of Herbicide Application on Soil Properties

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Herbicides are the chemical compounds used to control undesired plants, such as weeds, in crop fields, forests and various other ecosystems. While herbicides can be effective tools for weed management, however, the long-term consequences of herbicide usage on soil properties is a subject of significant importance in agriculture, environmental science, and land management. The application of herbicides can have various effects on soil properties, depending on the type of herbicide used, application rate, frequency of application, environmental conditions and the specific characteristics of the soil (Fig. 1). This influence can have both positive and negative effects on soil health and, consequently, crop productivity and environmental sustainability. Herbicide applications may not directly affect soil water retention, but changes in vegetation due to herbicide use can influence the way water is captured,

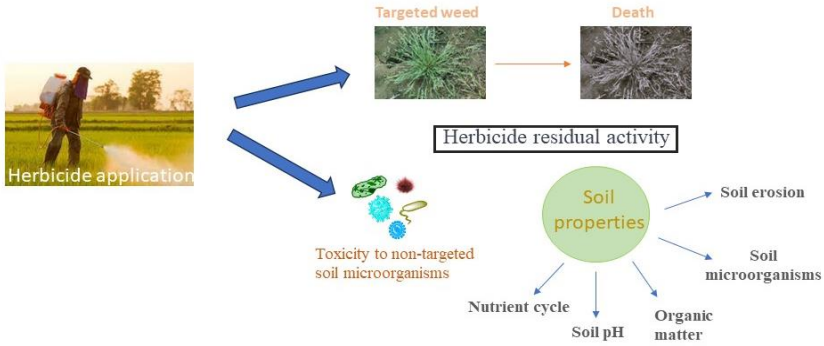

Fig 1: Impact of herbicide on environment

stored, and released in the ecosystem. While considering the impact of herbicide application on soil properties various key factors need to be consider.

Soil pH

The effect of herbicide on soil pH can vary significantly depending on herbicide formulation. The persistence of herbicides in the soil can have a long-term impact on soil pH. Over time, the repeated use of certain herbicides can accumulate and gradually influence soil pH. Some herbicides are acidic in nature, for example, herbicides containing glyphosate lower the soil pH. Lowering soil pH can impact the availability of certain nutrients, potentially making them less accessible to plants. Other herbicides containing sodium carbonate or potassium carbonate can increase soil pH, due to which essential nutrients may become less available to plants. However, different types of soils (e.g., sandy, loamy, clay) can react differently to herbicide applications in terms of pH changes. Sandy soils are generally more prone to pH changes than clay soils, which have a higher buffering capacity.

Organic matter

Herbicides affect organic matter in the soil by accelerating its decomposition commonly synthetic herbicides, particularly those that are persistent in the environment for a long time. Microorganisms that break down organic matter may be affected, leading to reduced organic matter content over time. For example: Glyphosate, a widely used herbicide, can influence soil microbial communities and potentially impact organic matter decomposition. Moreover, the use of some herbicides can alter soil structure and reduce its ability to retain organic matter. This can lead to organic matter being more easily washed away during rainfall or irrigation. However, organic farming practices mitigate these effects and promote soil health as synthetic herbicides are not used in this practice lead to improvements in soil organic matter over time.

Nutrient cycle

Nutrient cycles are important to maintain the ecosystem in balance, as it is a system where energy and matter are transferred between living organisms and non-living parts of the environment. The use of herbicides can have various effects on nutrient cycles in ecosystems. These effects can be both direct and indirect and can vary depending on the specific herbicide used.

- Nitrogen cycle: Some herbicides can affect nitrogen cycling by inhibiting the growth of nitrogen-fixing bacteria in the soil. These bacteria are essential for converting

atmospheric nitrogen (N_2) into a form that plants can use (ammonium or nitrate).

- Carbon cycle: Herbicide application influence the carbon cycle by altering the composition of vegetation. Changes in plant communities can lead to variations in the quantity and quality of organic matter entering the soil, which, in turn, can affect decomposition rates and the release of carbon dioxide into the atmosphere.
- Phosphorus cycle: Herbicides may not have a direct effect on the phosphorus cycle itself. However, they can indirectly impact phosphorus availability by altering the composition of plant communities. Some plant species are better at extracting phosphorus from the soil, and changes in vegetation can affect the cycling of this nutrient.

Soil microorganisms

Herbicidal persistence in the soil for extended periods, lead to an imbalance in the soil microbial community, which may affect soil health and fertility. Some microorganisms may be more resistant to herbicides than others. This can lead to shifts in the composition of microbial communities, favouring those that are herbicide-resistant while reducing the population of sensitive species. Moreover, microbes play a crucial role in nutrient cycling processes, such as nitrogen fixation. Herbicide-induced changes in microbial populations can impact these processes, potentially reducing the availability of essential nutrients for plants. However, some microorganisms are capable of degrading herbicides. In such cases, herbicides can serve as a carbon source for these microorganisms. However, the ability of microorganisms to degrade herbicides depends on their specific metabolic capabilities and the chemical structure of the herbicide.

Soil biota

The use of herbicides can have both direct and indirect effects on soil biota such as earthworms, insects and beneficial invertebrates that inhabit the soil. These effects can be both positive and negative, depending on various factors, including the type of herbicide, its concentration, application method, and the specific organisms in the soil. Some herbicides have direct toxic effect on beneficial soil organisms, including earthworms, which play essential roles in soil health and nutrient cycling. Moreover, herbicides can also indirectly affect soil biota by altering the plant community. When herbicides are applied to control weeds, they can change the composition of the vegetation in an area. This, in turn, can influence the types and quantities of organic matter that enter the soil and affect the microbes that rely on the organic matter for energy and nutrients.

Soil erosion

The use of herbicides can have both direct and indirect effects on soil erosion. When herbicides are applied to an area, they can kill or suppress plants, reducing vegetative cover. This reduction in vegetation can increase the vulnerability of soil to erosion. In addition to this, herbicides may also harm the root systems of plants. Healthy plant roots help bind soil particles together and prevent erosion. When herbicides damage or kill these roots, it can weaken the soil's ability to resist erosion. Furthermore, herbicide use can result in changes in soil properties. For example, some herbicides can lead to soil compaction, which can reduce water infiltration and increase runoff, potentially leading to increased erosion.

Conclusion

In conclusion, it is crucial to emphasize that the effects of applying herbicides to soil properties can be complex and multifaceted. Proper soil testing, sustainable farming practices, including crop rotation, cover cropping, soil conservation as well as consideration of non-chemical alternatives, can help to mitigate potential negative impacts of herbicide use on overall soil health. Additionally, responsible herbicide use, following label instructions and considering the potential impact on the environment, is essential for minimizing any adverse effects. Different herbicides may have distinct effects, so it's essential to consider the specific herbicide and soil conditions in any given situation. Furthermore, detailed research and field trials are necessary to assess the specific effects of various herbicides on soil biota.

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Issue of Intentional Pesticide Poisoning on A Global Scale

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Pesticide is generally defined as a chemical or biological agent which is used to combat pests such as weeds, molluscs, insects, plant pathogens, nematodes, microbes, and weeds that damage food, have a tendency to spread or act as a vector for disease, or are just an annoyance. Elemental sulfur dust, which was used in Sumeria about 4,500 years ago, was likely the first known pesticide. However, over the past few decades, agricultural highly hazardous pesticides (HHPs), have become more prevalent in rural regions of developing countries. Unfortunately, because these pesticides are easily accessible, people who try to poison themselves often choose to use them. Pesticide-induced self-poisoning is responsible for around 14-20% of suicides worldwide, resulting in an estimated annual fatality rate of 318,000-360,000 individuals. Surprisingly, China alone accounts for more than 50% of these fatalities annually. In another case of Sri Lanka, pesticide poisoning was recognized as the leading cause of mortality in government hospitals, surpassing all other causes. According to studies in 2016, the suicide rate in India among women is the fourth greatest globally, whereas it ranks 62nd among men. As of October 2019, India had registered a total of 318 pesticides for usage. Among these, 18 were classified as extremely hazardous (Class Ia) or highly hazardous (Class Ib) based on the toxicity criteria established by the World Health Organization. Compared to other drugs that people often use to harm themselves, like analgesics and sedatives, HHPs have a high case fatality rate. There were probably a lot more cases than that because many cases are still not recorded. It was further estimated that 30 million people were acutely poisoned by pesticides at work every year, but most of those cases were not reported because the people who were poisoned did not go to the hospital. In the three decades following the publication by the WHOs, few limited-scale surveys on pesticide poisoning have been documented. However, there is currently a lack of contemporary assessments about the prevalence of pesticide poisoning on a worldwide scale. In order to prevent the unneeded loss of life, it is imperative to employ efficacious strategies aimed at diminishing the occurrence of pesticide poisoning episodes in developing nations. This is mostly the responsibility of developing countries, especially those in the Asia-Pacific area, where about 95% of deadly pesticide accidents happen.

Most of the deaths are caused by organophosphates, organochlorines, and aluminum phosphide. The inhibition of AChE by organophosphate chemicals leads development of intermediate syndrome and respiratory paralysis followed by death. While, organochlorine pesticides have been found to be highly toxic to the central nervous system and have the ability to sensitize the myocardium to catecholamines. Severe inflammation of the pharynx, corrosive damage to the gastrointestinal tract, necrosis of the renal tubules, necrosis of the liver, and pulmonary fibrosis result from paraquat ingestion. Rodenticides encompass several chemical compounds, such as thallium, barium carbonate, superwarfarins, and phosphides, specifically aluminum and zinc phosphide. Alopecia is an unconventional characteristic observed in cases of thallium toxicity. While the vast majority of superwarfarin exposures are non-fatal, protracted hemorrhage is possible. Ingestion of barium carbonate can result in profound hypokalemia and impairment of the respiratory muscles. Aluminium phosphide is a potent poisonous substance associated with a death rate that varies between 37% and 100%. This substance hinders the activity of mitochondrial cytochrome c oxidase, resulting in adverse effects on the respiratory and cardiac systems. Pyrethroids and insect repellents, such as diethyltoluamide, are generally considered to have low toxicity; yet, they have the potential to induce harmful effects on the pulmonary and central nervous systems. Ethylene dibromide, a potent fumigant pesticide, is known to cause severe oral ulcerations, followed by liver and renal toxicity, and has a high fatality rate.

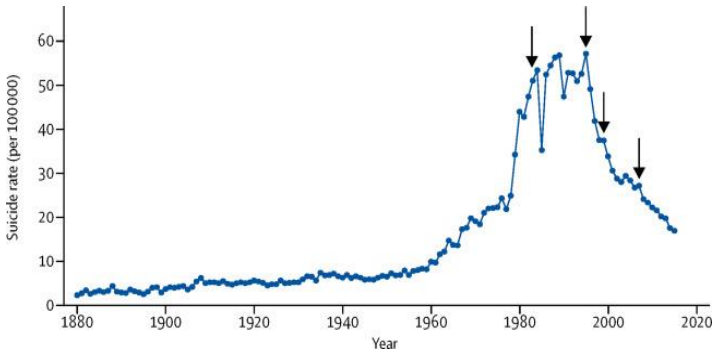

Fig. 1 Data of suicide in Sri Lanka during 1880–2015.

Precautionary measures or recommendations to be implemented

- Medical management: It is imperative to provide extensive education to physicians practicing in remote and rural areas regarding early diagnosis and appropriate management strategies, including the utilization of supportive care and antidotes, when accessible. For example, ensuring proper skin decontamination is crucial, as it helps prevent any potential secondary contamination of healthcare personnel.
- Restriction of HPPs: Restricting access to prevalent, extremely lethal pesticides is among the most effective strategies for preventing suicide. The implementation of national bans on HHPs in various countries has resulted in significant decreases in both pesticide-related suicides and overall suicide rates, particularly in cases where pesticide self-poisoning is a prevalent method of suicide, Srilanka and Bangladesh are the best examples who implemented this strategy as shown in Fig.1. Significant reduction in number of suicides after banning of several HPPs clearly indicate the importance of this strategy.
- Legislative: National regulatory actions should be taken to review the use of pesticides in agricultural activities. HHPs should be replaced with new chemicals but only after the proper testing. The registration of pesticides could be subject to periodic reviews, and its validity could be limited to no more than five years. Implementing a heightened level of caution when registering new pesticides, including the potential toxicity associated with self-inflicted harm as well as accidental exposure, would diminish the likelihood of substituted pesticides that are just as lethal as those that have been prohibited.
- Sustainable management practices: Enhancing understanding and promoting consciousness on pesticide-related matters. Promoting sustainable and organic practices in agriculture, trying to minimize the usage of pesticides.

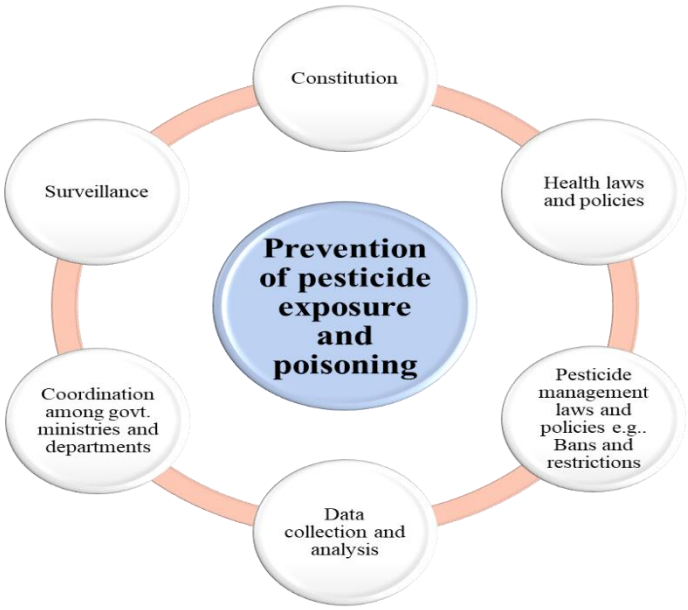

Fig. 2 Multiple approaches or strategies towards prevention of intentional pesticide poisoning

In conclusion, a combination of enhanced medical management, improved community use of pesticides, and government regulation to remove HHPs from agricultural practice will be necessary to prevent pesticide suicide. The implementation of aggressive resuscitation techniques and the timely administration of available antidotes are crucial factors in mitigating mortality rates. Also, numerous scholars emphasize the necessity for further investigation to ascertain the efficacy and feasibility of various approaches aimed at preventing suicides through pesticide poisoning.

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Role of Anther Culture in Haploid Production

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Anther culture is a type of tissue culture technique used to produce haploids and dihaploids. It is simpler than the pollen culture technique. It uses microspores or anthers for plant regeneration.The first successful report of anther culture was published in the 1970s by Guha and Maheshwari on pollen grains of Datura. Since then it has been used in numerous species (around , mainly rice (O. sativa) and tobacco (N. tabacum). During the process, the anthers are excised at a critical stage from an unopened flower bud aseptically. Then, they are cultured on a nutrient medium for the formation of callus tissue or embryoids that give rise to haploid plantlets through embryogenesis or organogenesis. In this article, we will cover more on the procedure of anther culture, the benefit of producing haploids, applications of anther culture, and its advantages and disadvantages.

Procedure of Haploid production

- Select unopened buds of about 17-22mm length, ensuring that the size of the sepal is equal to the petal size.
- Transfer the buds to sterilized airtight plastic bags.
- Move the selected buds to the laminar airflow chamber for surface sterilization.
- Surface sterilize the buds with 70% ethanol for 10 seconds and 20% sodium hypochlorite for 10 minutes.
- Wash the buds three times with distilled water.
- Transfer the buds to a sterilized Petri plate.
- Separate the stamen from the bud using a scalpel.
- Remove the filaments from an anther.
- Transfer the anther onto a solid or liquid nutrient medium and incubate it for 3-4 weeks at 24-28°C in the dark.
- Haploid plantlets will appear from the anther culture within 3-4 weeks through embryogenesis and organogenesis.
- Incubate the culture at 24-28°C for 12-18 hours in light and 6-12 hours in the dark.
- Once the plantlets reach about 50mm tall, transfer them to a pot containing bio compost followed by washing.
- Cover the pot with a sterilized glass beaker and remove it after some weeks to transfer the plant to a larger pot.

Factors Affecting The Anther Culture

- **Genotype of the donor plant:** Some plant species or varieties respond better than others. Thus, the genetic makeup of the plant matters a lot in how anthers respond to the in vitro environment.
- **Anther wall:** It provides nourishment during the developmental stages of the anther.
- **Anther stage:** Pre-mitotic, mitotic and post-mitotic stages are preferred stages for anther culture.
- **Physiological status of donor plant:** Buds from younger plants are preferable for anther culture.
- **Anther pretreatment:** Pretreatment of flower buds with high-temperature stimulate embryogenesis. For example, the bud of Nicotiana tabacum undergoes a pretreatment at a temperature of 5°C for a period of 72 hours.
- **Temperature and lights:** To stimulate embryogenesis, anther culture requires optimal conditions that involve culturing at high temperatures (35 °C) for up to 48 hours. However, the suitable temperature varies for each plant. For example, the ideal temperature for the production of embryoids in Datura stramonium is 20°C, while for Nicotiana tabacum it is 25°C.
- **Culture medium:** The induction of haploid plants in the culture medium is reliant on essential elements such as sucrose, iron, vitamins, coconut milk, and

hormones/growth regulators (such as auxins or cytokinins).

How Does Haploid Production Help Plants Growers

- Elimination of plants with lethal genes from the gene pool.
- Since haploids carry only one allele, any recessive mutations and characteristics are apparent in the process.
- Haploids allow the production of homozygous diploid plants.
- Haploid production shortens the time for inbreeding for superior hybrid genotypes.
- Breeding experiments typically require a lengthy period of time, ranging from 5 to 20 years, to develop new varieties or improve existing ones. In contrast, producing haploid plants can significantly reduce the time (by 2-6 years) required for various stages of crop improvement.

Applications Of Anther Culture

- Massive application in mutation studies and cryogenic studies.
- To study secondary metabolite content
- Extensive application in crop improvement and plant breeding.
- Enables the rapid development of homozygous inbred lines, without the need for traditional selfing methods such as bud pollination which can be time-consuming.
- Anther culture has application in transformation or transgenic plant formation, which can be done in lesser time compared to conventional approaches.
- Haploids can be used to produce monosomies, nullisomics, and other aneuploids.

Advantages

- Simple technique
- Less time consuming
- A high frequency of haploid plants, which is easily identified by their smaller sterile flowers.
- Easy to induce cell division in most species
- No requirement for a very high level of expertise.

Disadvantages

- Not all plants produced are haploid
- It is hard to remove the anthers in some species
- Moderate expertise is needed
- In cereals and other monocots, albinism is frequent.
- There's a risk of chimera and callus formation from the anther wall.

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Livelihood and Nutritional Security Through Adoption of Mushroom Farming in Uttar Pradesh: An Overview

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Food and Agriculture Organization (FAO) have recognized mushroom as food item contributing to the protein nutrient to the diet of developing countries like India, where there is heavy dependence on cereal diets. The significant feature of mushroom is that this nutritious and tasty food is cultivated entirely from waste products and converts a wide spectrum of agricultural and industrial waste into substrate on which the growth of mushroom is supported. After harvesting the mushroom, the solid residual left is organic compost with natural nutrients to further enrich the soil. In addition to converting the waste into valuable products, it enhances the income and provides additional gainful employment to the producers. Edible mushrooms cultivation is becoming increasingly successful in many regions of India because of suitable climatic conditions, short growing cycle, low input requirements, huge immunotherapeutic benefits for production and easy production technology.

Present Scenario of Mushroom Production and Consumption in India

Scientific mushroom cultivation in India started in 1962. At present, the total mushroom production in India is approximately 0.258 million tons in 2021. The state-wise mushroom production is highest in Bihar while Punjab, Maharashtra, Uttar Pradesh, and Orissa are the other leading states. In India, five mushroom species viz., white button mushroom (*Agaricus bisporus*), oyster (*Pleurotus spp*.), paddy straw mushroom (*Volvariella volvacea*), milky mushroom (*Calocybe indica*), and shiitake (*Lentinula edodes*) are under commercial cultivation. Even though cultivation technologies of many other mushroom species were standardized at Indian council of Agricultural Research- Directorate of Mushroom Research (ICAR-DMR) Solan, the commercial markets are still dominated by *Agaricus bisporus*, *Pleurotus spp*. and *Volvariella volvacea.* These three mushrooms are contributing about 96% to the total mushroom produced in India.

In India, mushroom consumption is about 70gram per capita. In China, per person per year consumption of mushroom is about 22 kg, whereas the global average consumption is approaching 6 kg per person per year. Thus, there is an ample scope of promoting mushrooms in our country. In the coming years, the demand for mushrooms is going to increase and hence need for cultivation overcollection.

Status of Mushroom Production and Consumption in Uttar Pradesh

By and large, Uttar Pradesh is a traditional area for mushrooms which are found growing widely in the forest areas. Mushroom varieties available in the local market as fresh mushrooms collected during rainy season are: Agaricus, Auricularia, Clitocybe, *Lentinula edodes*, *Pleurotus*, *Schizophyllum commune*, *Termitomyces*, *Tricholoma* and *Volvariella*. The natural production of mushrooms is, however, not substantial to meet the requirement and ensure round the year supply of mushrooms. There is a long gap during winter when no mushroom appears naturally.

There are three types of mushrooms cultivated in the state, namely, white button, oyster, and Milky mushroom. The total production of mushrooms in Uttar Pradesh is around 24 metric tonnes, which includes approximately 17 tonnes button, 5 tonnes oyster and Milky1 tonne and others 1 tonne mushroom. The modern technology in commercial cultivation of mushroom was introduced under a few externally aided projects implemented in the state. Mushrooms are popular for their mushroom delicacy,

flavour as well as food value. Mushroom cultivation is an important component of diversification in agriculture. There is a vast untapped potential and need to promote awareness about mushroom production as well as mushroom consumption.

Nutraceutical Components of Mushroom

Edible mushrooms have nutritional components and bioactive compounds in them. Secondary metabolites (including terpenoids, polyphenols, sesquiterpenes, alkaloids, lactones, sterols, and sesquiterpenes) are a subset of the bioactive compounds found in mushrooms. A variety of bioactive polysaccharides or polysaccharide protein complexes derived from medicinal mushrooms seem to improve innate and cell-mediated immune responses as well as demonstrate anticancer effects in both animals and people. Numerous of these mushroom polymers have been noted to have immunotherapeutic effects in the past by promoting tumor cell growth suppression and death.

The most well-known and effective mushroom-derived compounds with anticancer and immunomodulating activities are polysaccharides. The anticancer polysaccharides extracted from mushrooms are acidic or neutral, have potent antitumor activity, and have chemical structures that vary greatly. Glycans with antitumoral properties range widely, from homopolymers to extremely complex heteropolymers. In other words, mushroom polysaccharides do not directly kill tumor cells; rather, they have an anticancer effect through triggering the immunological response of the host organism. Many edible mushrooms' anticancer, immunomodulating, anticholesterolemic, antioxidant, and neuroprotective properties can be attributed to -glucans. Additionally, they have been shown to be effective immune stimulators in humans and have the potential to treat several disorders. The human immune system is vividly stimulated by fungal -glucans, and they protect against pathogenic microorganisms as well as the negative impacts of environmental pollutants and carcinogens that damage immune systems.

The functional components of mushrooms include bioactive proteins, which are also highly prized for their potential as drugs. Non-immune proteins or glycoproteins called lectins attach particularly to the carbohydrates on cell surfaces, and numerous mushroom lectins have recently been identified. They are active in a wide range of pharmaceutical processes and have immunomodulatory, antitumoral, antiviral, antibacterial, and antifungal characteristics. Some of them have extremely strong antiproliferative effects on specific tumor cell lines. A new class of bioactive proteins called fungal immunomodulatory proteins, which were discovered in mushrooms, have shown promise as adjuvants for tumor immunotherapy due to their ability to inhibit tumor invasion and metastasis.

Eating mushrooms can provide a source of polyunsaturated fatty acids, which may help lower blood cholesterol. Ergosterol, a primary sterol generated by edible mushrooms, has antioxidant effects. A diet high in sterols has been found to be crucial for the prevention of cardiovascular problems. These antioxidants are biologically active and provide strong defense against cancer, heart disease, and degenerative disorders. Linoleic acid, an important fatty acid for humans, participates in a variety of physiological processes; it lowers blood pressure, triglyceride levels, cardiovascular disease, and arthritis.

Scope of Mushroom Production in Uttar Pradesh

Primary substrates required for mushroom cultivation are crop residues. Chief crops grown here are rice, wheat, maize, millet, pulses, sugarcane, and oilseeds. Rice and Wheat are the major food grain crops cultivated in Uttar Pradesh. The total production of the state including cereal grains, pulses, oilseeds, and sugarcane is approx. 58.32 million tonnes producing an agro-residue to the tune of 60.0 million tonnes.

Further, the state has a high area of temperate to sub-tropical zones, and tree biodiversity which is helpful for cultivating various types of mushrooms. The inhabitants of the state already have the habit of mushroom consumption by collecting it from the wild. Moreover, the mushroom industry would offer an employment opportunity for the unemployed and educated youth, landless farmers, and women. The

agro climate conditions prevailing in many parts of the state provide ample scope for the cultivation of mushrooms. The mushroom production in the state is very low against the potential of the state for mushroom growing as ample raw material is available, manpower is available, and temperature profile of the state is suitable for mushroom cultivation throughout the year. Moreover, mushroom consumption habits of the local inhabitants/ tribals of the state are helpful in dissemination of mushroom cultivation in the state.

For better promotion of mushrooms there is a need for systematic and integrated efforts in the areas of human capital, awareness generation, research, and development (R&D), hubs for quality seed (spawn) and compost production, and scheme/ policies to popularize mushroom cultivation. By doing so, farmers would be able to earn more from limited areas in a sustainable manner and the result would be production of quality food with health benefits from agro- residues. The compost left after cultivation can be recycled into the soil, thereby improving soil health and promoting lesser use of fertilizers. There is a need for concerted and integrated efforts by farmers, entrepreneurs, marketers, scientists, policy makers and administrators to promote production and consumption, to plug the loopholes and to learn from the success of other countries. Looking to the future, it is clear there are significant benefits and opportunities for continued growth of mushrooms in the state. To ensure proper markets it is important that mushrooms become a part of our kitchen in both rural and urban areas and do not just remain an item in the menu of social functions. Market research worldwide shows that we can use strong health messages to drive increased consumption.

Conclusion

The climatic conditions and other resources available in the state for edible mushrooms along with market potential augur well for promoting the mushroom entrepreneurship in the state of Uttar Pradesh. The potency of mushroom cultivation as a tool for waste to wealth' fits well into the sustainable farming and increasing mushroom production seems a viable and attractive option. Growers, stakeholders, and state government collectively and Scope of Mushroom Farming is Uttar Pradesh could focus more on development of infrastructure of trainings and spawn production, development, and supply of ready to fruit bags, increasing markets, expanding consumer awareness, developing new products and technology, and building up networking with other agro-food industries. The production of edible mushrooms and extraction of bioactive molecules is a crucial component for the development of effective biotechnological approaches to access these metabolites. Numerous studies have demonstrated that some components found in mushrooms have exceptional abilities to prevent or treat a variety of ailments. Providing appropriate incentives, especially to new venture and small-scale entrepreneurs, for running business may ease the burden of grower's production costs. Developing mushroom cultivation as an agri-business activity requires a professional approach and systematic development of manpower, infrastructure, awareness, and hand- holding to ensure that there are no problems in the cultivation, processing, and marketing of the product.

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Integrated Farming System: An Approach to Boost Farm Income and Sustainability

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Integrated Farming System (IFS) is an approach to farming that combines various agricultural activities to optimize resource utilization and increase overall farm productivity and sustainability. The main goal is to integrate different farming components like crops, livestock, poultry, fish, and agroforestry in a synergistic manner. This holistic approach leads to improved income, reduced risks, and better environmental stewardship.

85% of the total farming community comprises of small and marginal farmers which is the core of Indian rural economy . Integrated farming system (IFS) is recognized as a solution to the continuous increase of demand for food production, providing stability to the income and nutritional security particularly for the small and marginal farmers with limited resources.

Components of IFS

IFS is a mix of farm enterprises such as crop, livestock, aquaculture, poultry, sericulture and agro-forestry to achieve economic and sustained agricultural production through efficient utilization of resources. The principle of IFS model is developed such as wastes generated from one component becomes an input for other system and hence there is efficient recycling of farm and animal wastes in the integrated system. There is increase in yield per unit area through intensification and diversification of crops. Apart from this IFS helps in controlling insect pests and diseases and weeds through natural cropping system management and there is less use of harmful agro-chemicals for farm production.

Possible IFS Development Models

The exact components of the integrated farming system can vary depending on the local environment the resources available and the specific goals of the farm .The over reaching principle is to create a sustainable and resilient farming system that optimizes the use of available resources and reduces the negative environmental impact of agriculture.

Fig. 1: Components of IFS

The IFS model combines various enterprises such as crops (field crops, horticultural crops), agroforestry (agri-silvi culture, agri-horticulture, agri-pastoral, silvi-pastoral, horti- pastoral), livestock (dairy, pigs, poultry, small ruminants), fishery, mushroom and bee culture in an synergistic way so that the wastes of one process become the input for other processes for optimum farm productivity.

In an IFS model, the field crops are grown for food production. Horticultural and vegetable crops can also provide 2-3 times more energy production than cereal crops and hence ensure nutritional security and income sustainability in the same piece of land. The crop residues after harvesting can be used for animal feed for dairy and goat production. The animal excreta from the animals can also be utilized as organic fertilizer or vermicomposting which in turn improves the soil fertility and thereby, reduces the use of chemical fertilizers. Again, the animal excreta can be dried, composted or liquid composted for the production of biogas and energy for household use.

The rice based integrated farming comprising of rice and fish in the low land area not only improves the fish production but also increases rice yield as fish improve soil fertility by increasing the availability of nitrogen and phosphorous. When the poultry of duck are raised over the ponds, the dropping are utilized by the fishes as nutrients and hence increases their production. Therefore, crop-fish-poultry farming gave the highest net income with an improvement in soil

health than single crop farming. By adoption and integration of various components like vegetables and fruit crops, reduce cost of cultivation and provide nutrients to the household. The IFS comprising of crop, dairy, fishery, horticulture and apiary and mushroom culture also provides employment generation throughout the year.

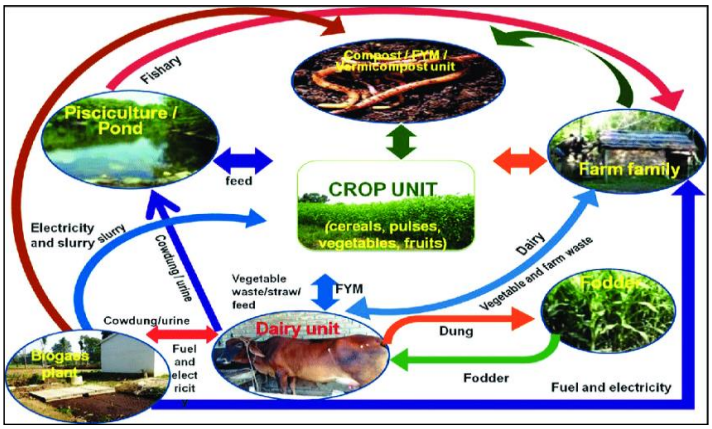

Fig2. Integrated Farming System Model

Advantages of IFS

- IFS increases productivity per unit area by virtue of intensification of crops and allied enterprises.
- Integration of different production systems provides an opportunity to solve malnutrition problems in our country.
- It improves soil fertility and soil physical structure from appropriate crop rotation and using cover crops and organic compost. It also minimizes the nutrient losses.
- It reduce weeds, insect pests and diseases through appropriate crop rotation.
- There is higher net returns to land and labour resources of the farming family.
- There is also regular stable income through the products like egg, milk, mushroom, vegetables, honey and silkworm cocoons from the linked activities in integrated farming.
- It reduces production of components through input recycling from the by-products of allied enterprises. The recycling of wastes for production helps to avoid piling of wates and consequent pollution

Conclusion

Integrated farming system fulfils the multiple objectives of making farmers self-sufficient by ensuring the family members a balance diet, improving the standard of living through maximizing the total net returns and provide more employment, minimizing the risk and uncertainties and keeping harmony with environment. India has the rich diversity of livestock, poultry, crops and horticulture. Utilization of our national resources efficiently is very much important for sustainable development. Thus, this system of farming is very promising for improving overall farm productivity, profitability, generating employment opportunities, conserving natural resources and maintain the sustainability of agroecosystem by effective recycling the farm by-products and efficient utilization of available resources. Integrating Farming System is the unique approach for overall upliftment of rural community and conserving the natural resources and crop diversity.

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Role of Agro Textiles in Agriculture Industry

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Agriculture is the oldest occupation of mankind. People have been involved in this profession since the beginning of creation and it is still one of the largest global industries. The word "agro textiles" is used to describe the uses of woven and nonwoven fabrics in agriculture. Agro-textiles have been used in the agriculture sector for thousands of years for the protection of products like plants, vegetables and fruits from weather, weed and birds. Globally, one of the major issues is food security due to the threat of climatic changes, at present most of the agricultural products are non-biodegradable and petroleum-based.[1] By utilizing biotechnology, the textile sector can bring a big revolution in the field of textile processing. Textile processing has led to the synthesis of a giant amount of cellulose fibres that can be used in several sectors going from biomedical to agriculture [3]With time we can notice a significant increase in environmental awareness and development of technology, substantial attention has been diverted to the application of textile fibers in agriculture. All natural cellulose-based agricultural products are environment friendly with low manufacturing cost. Agro textiles helps to protect crops from harsh weather, unwanted pests and birds. Agro-textile products like shade nets, harvest nets, and mulch mats can be used as these textile products are biodegradable and non-toxic.

Applications of agro textiles

There are many applications of agro-textile products like :-

Sunscreen – it is used to protect crops and greenhouses from high solar radiation. It also saves the crops from direct sunlight.[2]

Bird protection net – it is used to protect crops, seeds and fruits from the damage caused by birds and hailstorms.

Fruit covers – they are used to keep the fruit from decaying by the action of bugs and insects. They help in keeping the fruits safe.

Ground cover –in the field Weed creates problems in the growth of plant and also effect the quality of the fruit or grain. In order to avoid this problem of weeds mulch mats are used as they can cover the ground and only keeps the area open is for the plant.

Windshield – it is used to protect fruit plant from wind and also helps to prevent damage to the plants.

Root ball net – it is important for safe and speedy growth of young plants.

Insect meshes – these are very effective in keeping out the harmful insects from greenhouses.

Turf protection net – it is important to minimize soil erosion loss and improve land conservation.

Net for covering pallets – mesh nets are used transportation of fruits and vegetables to the market, they helps in ensuring safety of the fruits and also helps to stop the boxes from getting damaged and being turned upside down .

Fiber/Raw Materials Used in Agro Textiles

Natural Fiber:

1. Jute fibre
2. Cotton fibre
1. Wool fibre
2. Sisal fibre
3. Hemp fibre
4. Coir fibre

Synthetic Fibres:

1. Polyester

2. Viscose
3. Nylon
4. Polypropylene
5. Polyethylene

Man made fibers are preferred for agricultural sector compared to the natural fibers mostly because of their low price and high performance ratio, ease of transport, space saving storage and long service life. Currently, the agro-textile market is dominated by polyolefins or petrochemical-based agro-textiles. Natural fibers degrade so fast in the environment that their recovery from the field becomes difficult and unattractive even by efficient recycling or combustion, and their lifetime is usually limited to 1 or a maximum of 2 years. The development of bio-based agro-textiles will reduce the harmful impact on the environment and with extended durability is foreseen to initiate the growth in the bio-based economy.

The world is gradually preparing the shift toward a bio-based economy, and research for sustainable bio-based alternatives has already been initiated. This article provides insight into the various agro-textiles used in agriculture and the research going on in the area of agro-textiles it also offer alternative solutions to the current agro-textile market and problems. With the use of agro textiles we can reduce the usage of harmful pesticides and herbicides to render a healthy farming culture. Unique manufacturing techniques and properties of this blend of agrotextile sector products whose cost is lesser than that of pesticides and chemical herbicides have been discussed.

Textiles are flexible in its suitability in different geographical locations. So now it's our duty, to carefully and beautifully shape this technology, and contribute to a developed economy and a developed country.

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Integrated Pest Management (IPM) Practices for Major Insect Pests of Mulberry

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Mulberry forms the basic food material for silkworms and the bulk of the raw silk produced in the world are from mulberry silkworms. Mulberry leaf protein is the source for the silkworm to bio-synthesize the silk which is made up of two proteins, fibroin and sericin. Nearly 70% of the silk proteins produced by a silkworm is derived directly from the proteins of the mulberry leaves.

The mulberry cultivation plays a vital role in determining the cost of production of cocoons quality and quantities of silk. It is estimated that about 60% of the cost of cocoon production goes to mulberry leaf production. It also forms an unlimited source of food and shelter for a variety of pests, which cause considerable damage to foliage in varying intensities. Although more than 300 species of pests (insect & non-insect) have been reported to infest mulberry, a few soft bodied insects such as pink mealybug, thrips, broad mites etc. and defoliators such as leaf roller & Bihar hairy caterpillar are considered as major pests causing significant qualitative and quantitative damage.

Pink mealy bug: *Macconellicoccus hirsutus* , Pseudococcidae : Hemiptera

Diagnostic symptoms

- Malformation of apical shoots, retarded growth.
- Wrinkling and curling of affected leaves become dark green in colour.
- Due to secretion of honeydew, sooty mould develops all over the leaves. Leaves become brittle. Leaves become yellow on severe infestation.
- Symptoms are collectively called as Tukra (Bushy top).

Nature of damage

- Nymphs and adults of *M. hirsutus* suck the sap from tender leaves and buds by piercing the plant tissue. It causes hypertrophy of cells. The infestation occurs in the nodal joints and succulent apical region.
- Nutritive value of leaves, leaf yield and plant height are drastically reduced.
- The affected leaves when fed to silkworm cause a significant reduction in larval weight, cocoon weight, shell weight and shell ratio.

Season: Prevalent throughout the year with higher incidence during summer.

Biology

The mealy bug lays eggs (=250 no) in a loose cottony terminal ovisac. Freshly laid eggs are orange in colour, smooth a smooth and oval with slightly tapering ends. Eggs turn pink before they hatch. Mealy bug completes its life cycle in 23 – 29 days. Egg: 5 – 6 days; Nymph: 2 –3 months.

Management

1. Mechanical method

- Remove and destroy infested portions by burning or dipping in 0.5% soap solution.
- To prevent further infestation, top clip and burn all the apical tips in the garden when the silkworms are in IV moult.

2. Biological method

- Release of predatory lady bird beetles *Cryptolaemus montrouzieri or Scymnus coccivora* @ 250 or 500 adults respectively per year in two split doses at an interval of six months.

Note: Bio-control agents are available at CSRTI-Mysore (Ph: 0821-2903285), NBAIR, Bangalore (080-

23511982) and S.R.K.Bio-control Centre, Hosur, T.N (Ph: 09994622647).

3. Chemical method

- Spray Dinotefuran 20% SG (Dominant) @ 0.25 g/lit of water, 15 days after pruning (Safety Period: 20 Days).

Thrips: *Pseudodentrothrips mori*, Thripidae. Thysonoptera

Diagnostic symptoms

- Thrips affect the leaves of mulberry plant.
- Affected leaves show streaks in the early stages and beetles in the advanced stage of attack. Leaves turn to yellowish brown on maturity.

Type of damage

- Thrips injure the epidermal shoots.
- Early maturity, depletion of moisture, reduction in crude protein and total sugars are noticed in the affected leaves.
- Leaves become unsuitable for silkworm rearing.

Season : Throughout the year but high in summer

Biology

Adult : ♂ - Brownish yellow ♀ are larger than males. A female adult lays 30 –50 bean shaped yellow coloured eggs on the ventral side of the leaves.

Egg period : 6-8 days .Egg is oblong. Nymphs: pale yellow coloured. Four instars. – Duration 15 – 18 days.

Management

- Sprinkler irrigation disperses nymphs and adults.
- Release of Chrysopids 1000 eggs/acre two times at an interval of one week. Eggs available in the form of egg cards, which may be stapled / tied to terminal leaves.

Note: Bio-control agents are available at CSRTI-Mysore (Ph: 0821-2903285), NBAIR, Bangalore (080-23511982) and S.R.K Bio-control Centre, Hosur, T.N (Ph: 09994622647).

- Spray DDVP @ 1 l/ha to kill nymphs and adults. (Safety period: 15 Days).

Broad mite: *Polyphagotarsonemus latus*, Tarsonemidae, Acari

Diagnostic symptoms and type of damage

- The broad mites prefer young, growing tips of mulberry and as a result the younger leaves are badly damaged.
- The pest mainly attacks on the adaxial surface of the young leaves, which tends to cause the leaf to turn brown and curl upwards or downwards.
- The highest degree of infestation results in the leaf and shoot growth severely damaged by way of curling of leaf margins, firmness of infested leaves, necrosis of growing points, aborted buds and growth inhibition.
- In heavily infested mulberry garden single mulberry leaf contains 1000 to 4000 mites population, where as the ETL for broad mites is 5 mites/leaf.

Season: Throughout the year but high in summer

Biology

The broad mites complete a generation in 4-7 days under optimal conditions (at 25°C temp. & high

humidity). The life cycle has egg, larva, and adult stages. An adult female can lay approx. 30-40 eggs.

Management

1. Mechanical method

- Remove affected apical shoots during early stage of infestation.
- Water spray on the underside of the leaves to suppress the population.

2. Botanical & biological control method

- Spray Vidi Greenpath: 2 ml/litre with Adpro Shootin 0.3 ml/litre of water. Two sprays @ weekly interval.
- At early stage of infestation, release Blaptostethus pallescens (anthocorid) @ 1000 nymphs or adults per acre at weekly interval

Note: Bio-control agents are available at CSRTI-Mysore (Ph: 0821-2903285), NBAIR, Bangalore (080-23511982) and S.R.K.Bio-control Centre, Hosur, T.N (Ph: 09994622647).

3. Chemical method

- Spray wettable sulphur 80% WDG @ 3 g/litre of water. (SP: 5 days)
- Spray Cyenopyrafen 30% S.C (Commercial name KUNOICHI) 0.5 ml/litre of water. (SP: 15 days) or
- Spray Fenazaquin 10% EC (Magister) 1.5 ml/litre of water (SP: 20 days).

Mulberry leaf roller: *Diaphania pulverulentalis* , Pyraustidae, Lepidoptera

Symptoms

- Webbing of leaves and tender shoots.
- Skeletonization: The larvae web the leaves together and feed from inside on soft tissues and skeletonize them.
- Grown up caterpillars feed voraciously on tender leaves.
- Apical leaves are preferred for feeding resulting in stunting.
- Apical shoots are destroyed due to egg laying.
- Quality of leaf and yield is severely affected.

Season : October to February

Biology

Egg : 0.7mm, semi-transparent; ♀ moth lays 100-400 eggs. Eggs are laid one each along the leaf vein on the underside of mulberry leaf. Larvae: 5 instars. Life cycle : 18 – 25 days. Adult : Pale brown spots on yellow back ground of wings.

Management

1. Mechanical method

- Deep ploughing and flood irrigation will kill the pupae present in the soil.
- Use light traps to attract and kill adults.

2. Biological method

- Release *Trichogramma chilonis* egg parasitoids @ 1 Tricho card/week for four weeks.

3. Chemical method

- Spray 0.15% DDVP (76% EC) (@2 ml/*l*) 12-15 days after pruning (SP: 15 DAS).

Bihar hairy caterpillar: *Spilosoma oblique* , Arctidae, Lepidoptera

Diagnostic Symptoms

- Branches of mulberry plant without leaves

- Gregarious young caterpillars (Bihar hairy caterpillars) feed upon chlorophyll layer leaving alone the veins.

Type of damage

Adult moth lays 1000 – 2000 eggs. Later instar larvae voraciously feed on the mulberry leaves.

Season: October to February

Biology

Adults light brown with brick red abdomen peppered with dark row of spots laterally and dorsally, lay 1000 – 2000 eggs are laid on batches. Eggs hatch in 5 –7 days. Larvae : 6-7 instars Life cycle : 48 days.

Management

1. Mechanical method

- Collect and destroy egg masses and gregarious young caterpillars by burning.
- Deep ploughing exposes the pupae to the birds & scorching sun.
- Flood irrigation kills the pupae.

2. Biological method

- Release *Trichogramma chilonis* egg parasitoids @ 1 Tricho card/week for four weeks.

3. Chemical method

- Spray 0.15% DDVP (76% EC) (@2 ml/*l*) 12-15 days after pruning (SP: 15 DAS).

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Success Story: Entrepreneurship through Milky Mushroom Production

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Mushrooms are gradually becoming popular as they are rich in minerals, vitamins, very low on fat and sugar. They are good source of protein and contain many essential amino acids. It is also known to have medicinal value and certain varieties of mushrooms can inhibit growth at cancerous tumor. Mushroom production is labour and management intensive. There is ample scope for mushroom industry to thrive successfully and can become a atractive business for the unemployed rural youth, self-help groups, farm women who are in search of viable activities which are promising and giving good returns and an additional income source for the farmer. Mushroom cultivation can effectively utilize the crop residues for production of protein rich food and plays crucial role in management of agro residues. Mushroom cultivation is an eco-friendly activity, as it utilizes the wastes from agriculture which are available in huge quantities in every corner of the state and in turn produces fruiting bodies with excellent nutritional and medicinal attributes.

Krishi Vigyan Kendra (KVK), Lam, Guntur has been regularly organizing training programme on scientific cultivation of mushroom as a profitable enterprise for the last three years in collaboration with Agricultural Technology Management Agency (ATMA) Guntur. With the knowledge and skill gathered from the training programmes of KVK-ATMA, 5 trainees started mushroom cultivation units from 2020-21 onwards. Most of the beneficiaries started cultivation of mushrooms for their own consumption, ensuring nutritional security of the family.

Rama Krishna, a middle class man, a mechanic by profession, was finding it hard to make a livelihood by repair refrigerators and air coolers at Lam and Guntur. So, he was looking for a supplementary income generating activity and his friends suggested mushroom production is one such activity. On that time he saw KVK-ATMA Collaborative Skill Training for Rural Youth -STRY Training programme advertisement in news papers and he approached KVK for getting training on mushroom cultivation. He got 6 days hands on practice training at KVK on mushroom production technology in November-2019 at the time of valedictory function Dr. V. P. Chahal (ADG Extension) and Dr. Y. G. Prasad, Director ICAR-ATARI Zone-X has appreciated Ramakrishna and Presented Rs: 10000 for setting a low cost mushroom production unit while interacting with the participants.

Things really turned around for him when, as per the suggestions from KVK, he started the mushroom unit facility with low cost equipments and low-cost chaff cutter. Thereafter, he started preparing 15 mushroom beds once in two days with daily

production of 8 kg mushroom and earned and

average income of Rs. 48,000 per month with the sale of mushrooms at Rs.200 per kg. During Covid-

19 period when faced with difficulty in getting milky mushroom spawn during the high demand of mushrooms in Guntur district, he approached the KVK for setting a cheap lab for spawn production with low cost equipments for further strengthen the mushroom production unit in Local area.

Impact

Now he started to sell fresh mushroom in different melas organized by Government Organizations and NGO's. he started to give trainings to different SHG's members. After getting training from her, 3-4 members started producing mushroom in a small scale.

Economic gains

By selling mushroom monthly he is getting an income of Rs 38,800. She also created employment opportunity to two members. In future, he is planning to start value addition in terms of dried mushroom powder and other value added products. Now he has become entrepreneur and mushroom production is the main source of income to her family.

Name of the farmer	Village & Mandal	No. of beds/day	Mushrooms produced/day (Kgs)	Cost/kg	Income /month (Rs)
A. Ramakrishna	Damarapalli, Tadikonda	15	8	200	48000

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Turning Lockdown Dreams into a Thriving Integrated Agriculture Enterprise

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In the quietude of the pandemic-induced lockdown, while many were contemplating the uncertainties of life, Anish, a 23-year-old MBA student with an unwavering passion for agriculture, embarked on a journey that would transform his vision into a successful enterprise. It all began with a simple yet profound idea: the Miyawaki forest, a testament to his commitment to sustainable living and a future where every resource is valued.

Background and context

In the confines of his home, Anish nurtured the seeds of the Miyawaki forest concept, a dream fueled by his love for agriculture. Locked down with limited options, he saw an opportunity to create something extraordinary, to make the land beneath his feet come alive with the greenery of a Miyawaki forest. With the support of his mother, Mrs. Renuka, and a group of dedicated friends, he set out to turn his vision into a reality. Anish recognized the power of collaboration and community support in turning his agricultural dreams into a reality. He reached out to COODU (Community Organization for Oppressed and Depressed Upliftment), an organization dedicated to bringing about positive change in local communities. Their partnership played a pivotal role in achieving the dream of a thriving Miyawaki forest. Anish's unique strength lies in his ability to make the most of available resources. From converting waste into treasure to optimizing every inch of available space, he embodies the principle of resourcefulness. His determination to leave no stone unturned in the quest for sustainability was instilled during his school days when he was inspired by the words of a wise individual: "Do not waste anything." This lesson fueled his drive to utilize even the smallest piece of waste to create something of value.

The journey

The transformation of CKG farm began when the Anish decided to embrace integrated agriculture. They introduced a diverse range of farming practices that included animal husbandry, horticulture, Azolla production, and agro-tourism. The shift wasn't immediate, but it was driven by a deep commitment to sustainability. The family knew this was a long-term commitment, but they believed it was essential.

Miyawaki Forest

The goal at CKG Farm was to establish a thriving Miyawaki forest, covering an area of 450 square feet, with the purpose of creating a vibrant and pleasant microclimate.To set the stage for their ambitious undertaking, the team at CKG Farm commenced by carefully preparing the land. The initial step involved the removal of the topsoil layer, followed by excavating to a depth of 3 to 4 feet. This excavated soil was then enriched by blending it with organic manure, before being reintroduced to the land's surface. To facilitate the planting of trees, pits were thoughtfully created at suitable intervals. The soil was protected and moisture retained by applying mulch, and a drip irrigation system was thoughtfully implemented to ensure consistent watering.The CKG Farm's Miyawaki forest is now home to an impressive assortment of 130 trees. The carefully chosen species include Malaivembu, Pencil tree, Teak, Kumil, Guava, Fig, Amla, Castor, Passion fruit, and a variety of flowering plants, each playing its unique role in nurturing the microcosm.

Animal Husbandry

At their farm, the management of livestock involves the care and maintenance of five cattle, with a focus on preserving native breeds. The farm diligently collects cow dung, which is then utilized for the generation of biogas. This biogas, in turn, serves as a dependable source of fuel for cooking. It is noteworthy that, according to their observations, the biogas production demonstrates a consistent increase in output during the summer months compared to the winter season.

Horticulture

Within their horticultural endeavors, a total of 250 coconut trees stand tall, primarily cultivated for the purpose of extracting oil which is subsequently sold. In the heart of their coconut plantation, a specially designed pit has been constructed, serving a dual role. This pit is utilized for the decomposition of coconut fawns and, concurrently, it efficiently collects and retains rainwater for an extended duration.Intercropping is a vital component of this horticultural landscape. Among the coconut trees, a diverse array of banana varieties is strategically cultivated. These banana plants are provided with a unique source of nourishment—kitchen wastewater. This water supply is facilitated through drip irrigation sourced from both a well and a borehole.Additionally, the horticultural bounty of this farm extends to fig trees. The delectable fig fruits harvested from these trees are retailed at an impressive rate of Rs 200 per kilogram. This showcases the farm's commitment to sustainable agricultural practices and resourceful management of its horticultural assets.

Azolla Production

In their farm, Azolla (mosquito fern, duckweed fern, fairy moss, or water fern) was actively cultivated. Azolla was nurtured within specially designed green bags and utilized as feed for the poultry on the farm. Azolla, being a remarkably productive plant, exhibits rapid growth, often doubling its biomass in as little as 1.9 days, contingent on environmental conditions. In Asian rice fields, the yield from Azolla cultivation can reach impressive levels, with reported figures as high as 8-10 tonnes of fresh matter per hectare. Notably, Azolla pinnata in India has been reported to yield as much as 37.8 tonnes of fresh weight per hectare or 2.78 tonnes of dry weight per hectare, underscoring its significance as a valuable and prolific agricultural resource.

Farm Pond

Within the farm's premises, a dedicated farm pond has been meticulously constructed to fulfill the essential role of rainwater retention. The land's

strategic layout facilitates the systematic accumulation of rainwater into the pond, with its primary purpose being to serve as a vital water resource for irrigation during the dry summer months.

Agro Tourism

Embracing the concept of agro tourism, the farm has ventured into organizing single-day tours. The itinerary includes a trek through the scenic Thogaimalai region, followed by a visit to Karaivanam, home to a carefully nurtured grove boasting 2000 native trees. Finally, the tour concludes with an enriching visit to the CKG Farm. This entire excursion is thoughtfully curated and facilitated by the CKG Farm, providing visitors with a well-rounded experience of nature, agriculture, and sustainable practices.

Future Endeavors

Their forthcoming goals encompass a multifaceted approach towards enhancing their agricultural practices. These aspirations include:

- Scaling Azolla Production: Their immediate ambition is to significantly expand the cultivation of Azolla, elevating it to a larger scale.
- Optimizing Space Utilization: They plan to maximize space efficiency by implementing innovative strategies, such as growing pepper vines on coconut trees.
- Creating an Extensive Miyawaki Forest: One of their key objectives is to establish an expansive Miyawaki forest, enhancing biodiversity and sustainability.
- Rainwater Harvesting on Roofs: They aim to implement rainwater harvesting structures on their rooftops, harnessing precious rainwater for various agricultural needs.
- Direct Farm-to-Consumer Marketing: They aspire to establish a direct market for their farm products, allowing consumers to access fresh produce directly from the source.
- Promoting Organic Food: Their long-term vision involves spreading awareness and access to organic foods, promoting health and sustainability within their community and beyond.

Overcoming challenges

Switching from conventional farming to integrated agriculture required a significant shift in mindset, an investment in education, and substantial changes to their farming practices. Challenges were plentiful, especially during the initial phases of transitioning, but the Anish family's unwavering commitment and resilience saw them through.

Key players

The Anish family sought guidance and collaboration from experts in each of the integrated components: Miyawaki forest experts, animal husbandry specialists, horticulturists, Azolla production consultants, and agro-tourism professionals. These collaborative efforts were critical in guiding their transition.

Achieving success

Over the years, CKG Farm transformed into a true agricultural gem. The introduction of a Miyawaki forest improved biodiversity, and natural habitats were restored. Animal husbandry practices added to the farm's sustainability, providing both dairy and meat products. Horticulture expanded the farm's diversity, and Azolla production acted as a natural fertilizer source. Agro-tourism opportunities allowed the community to experience the farm's beauty and learn about integrated agriculture firsthand.

Impact and benefits

The transformation of CKG Farm brought about a host of positive outcomes. The farm's soil quality improved, water runoff and pollution reduced, and biodiversity flourished. The farm's productivity skyrocketed, not just in terms of food production but also from diversified income streams like agro-tourism and Azolla sales. The community embraced the farm as a place of learning, sustainability, and natural beauty.

Lessons learned

The Anish family's success story teaches us that integrated agriculture, when done right, can create a regenerative agricultural ecosystem. It's a reminder of the profound benefits of an integrated mindset in farming, where various elements of agriculture work in harmony to promote environmental health and community engagement.

Conclusion

CKG Farm is a living testament to the transformative power of integrated agriculture. The Anish family's journey from a conventional farm to an integrated agriculture paradise demonstrates the immense benefits of this approach. It's a story of sustainable success, environmental stewardship, and the power of an integrated mindset in farming.

By focusing on the journey of CKG Farm and its remarkable integration of Miyawaki forest, animal husbandry, horticulture, Azolla production, and agro-tourism, this article provides a compelling example of how a farm can create a harmonious and thriving ecosystem that benefits the land, the community, and the family.

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From Farm to Table: The Successful Transformation through Organic Farming

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D. Gangatharan, a 59-year-old former mechanical engineer turned organic farmer, has paved a way for the sustainable and thriving future in agriculture. His remarkable journey from the world of machines to the lush fields of organic farming serves as an inspiration to all the generations. In this success story, we delve into the remarkable transformation of a man who turned his passion for farming into a flourishing business.

From Mechanical Engineering to Organic Farming

Gangatharan's story begins with an impressive academic background. He graduated with a B.E. in Mechanical Engineering from CIT, Coimbatore and spent 25 years as the principal of ITI Annur. However, his roots in agriculture ran deep as he had been assisting his father in farming alongside his education. At the age of 52, he felt that his true calling lays in the fertile soil and decided to make a monumental change in his life by taking voluntary retirement and dedicating himself to agriculture.

Embracing Organic Farming

Gangatharan's transition to organic farming was inspired by his attendance at Nammalvar and Zero Budget Natural Farming (ZBNF) training sessions. He then passionately embraced the principles of organic farming, vehemently denouncing chemical pesticides and fertilizers; and believed that organic farming not only nurtures the soil but also enriches it with essential micronutrients from compost, plant residues, and food waste.

Overcoming Challenges

However, Gangatharan's journey was not started without its hurdles. Initially, he faced criticism from those around him for his commitment to cultivate only organic crops. The early years were so tough with poor yields that he couldn't generate reasonable profits from his hard work. In addition, water scarcity was another major challenge, with an open well drying up during the scorching summer months. The slow degradation of farm manure due to insufficient moisture hindered the absorption of soil nutrients, and the scarcity of labour added to the difficulties.

Adding Value to Produce

Undeterred by these obstacles, Gangatharan then decided to add value to his produce as a strategy to improve profitability. He still believes that value addition is an essential key to make farming more

remunerative. In his five acres of land, he cultivates sugarcane, rice for household purpose and bananas, turmeric, teak, moringa, and various other crops for marketing. But these products would not just reach market in their raw form, but they undergo value addition before hitting the market.

Gangatharan makes country sugar out of that organic sugar cane. From one ton of harvested raw sugarcane, he extracts around 720 litres of sugarcane juice, from which he would obtain 120–130 kg of country sugar. To make country sugar, cane juice is first heated to a boil for three hours, and it is then transferred to another vessel, where it gets constantly stirred. Instead of using hydro powder, he is using one litre of cow's milk just after reaching the boiling point to impart natural white colour to sugar. The common method for clearing the scum formed while boiling the sugarcane juice is using cleansing lime (calcium bicarbonate) but he uses Bhendi and Aloe vera extract to remove that formed scum.

In scientific terms, on addition of these mucilaginous plant extracts during the boiling stage of sugarcane juice, the albumins present in the mucilage coagulates and carries the colloidal and suspended impurities present in the juice to the surface as the scum which are then removed. The natural plant-based materials are considered to be advantageous compared to chemical clarificants because of their natural origin, ecofriendly ness, local availability, so that plant materials can be collected in large quantities and simple method of extraction of mucilage. The production cost is also much lower compared with that of synthetic clarificants. Therefore, the application of plants mucilage as clarificants in jaggery production can get the market potential to meet the domestic and international requirements.

Innovative Farming Techniques

Gangatharan's farming practices are also innovative. He employs drip irrigation for his sugarcane, strategically placing it near its root zone to boost crop root length and survival even under challenging conditions. In shaded areas, he cultivates turmeric and ginger, which yield bountiful harvests.

Natural Remedies for Soil Health

For soil health, Gangatharan uses natural remedies such as Jeevamrutham and Bijamrutham. Jeevamrutham, made from cow dung, cow urine, country sugar, and horse gram flour, is used for foliar spray and fertigation. He strongly believes that it promotes biodiversity in the soil. Bijamrutham, on the other hand, is used to treat seeds and enhance seedling health.

Value-Added Products

Gangatharan's approach to value addition is remarkable. He produces organic country sugar, which got recognition for its quality and no-added chemical making process. His turmeric powder found its way into markets, while Moringa leaf powder has become a staple during dry seasons.

Sustainable Farming for the Future

Gangatharan's commitment to sustainable farming extended to planting fruit trees along his land's fence for generating year-round revenue, and protecting his farm from natural disasters as they serve as wind breaks. He admits that organic farming might yield lower quantities but provides higher quality produce. And this approach paid off, as he started receiving orders for his organic country sugar from countries like Canada and Vietnam, fetching impressive prices.

A Call to Embrace Organic Farming

Gangatharan's story serves as a testament to the potential of organic farming and the importance of value addition. He believes that farmers can secure better market value for their products by embracing organic practices. As his organic produce gains recognition both domestically and internationally, Gangatharan's journey stands as an inspiration for all those looking to embark on a path to sustainable and profitable farming. This remarkable transformation of Gangatharan to a successful organic farmer and entrepreneur showcases the power of dedication, innovation, and a deep connection with the land. Gangatharan has not only cultivated crops but also a future filled with promise and abundance.

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Transforming Agriculture with AI: Innovations and Applications

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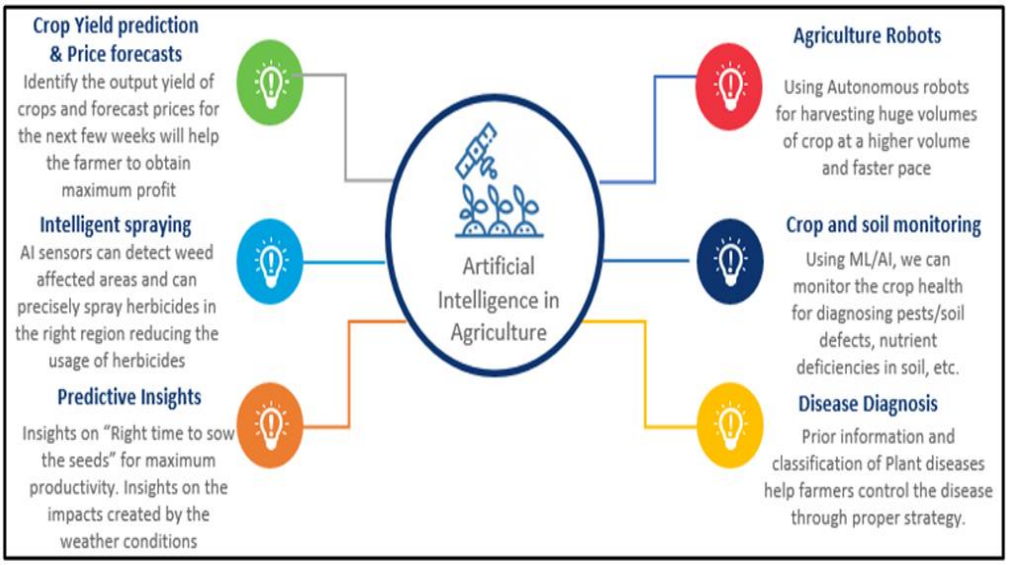


Artificial intelligence (AI) is playing a significant role in revolutionizing the agriculture industry. It offers innovative solutions to address various challenges faced by the agriculture sector, from optimizing crop production to increasing efficiency in farm management. Artificial Intelligence (AI) is a cutting-edge field of computer science and technology that focuses on creating systems and machines capable of performing tasks that typically require human intelligence. These tasks encompass a wide range of activities, including problem-solving, learning, reasoning, understanding natural language, and perceiving the environment. AI systems are designed to simulate human cognitive functions, enabling them to analyse data, adapt to changing conditions, and make decisions.

AI has experienced significant advancements over the years, driven by factors like the exponential growth in computational power, the accumulation of vast datasets, and the development of sophisticated algorithms. This progress has enabled AI to revolutionize numerous industries, from healthcare and finance to transportation and entertainment.

AI encompasses various subfields, each with its own set of techniques and applications. Machine learning, for instance, focuses on training algorithms to recognize patterns in data and make predictions, while computer vision enables machines to interpret and understand visual information. Natural language processing (NLP) empowers machines to comprehend and interact with human language, paving the way for applications like chatbots and language translation services.

The potential of AI is vast and continues to expand as researchers and engineers push the boundaries of what is possible. It has the capacity to improve efficiency, automate tasks, enhance decision-making, and solve complex problems across many domains. AI is being integrated into our daily lives through applications like virtual assistants, recommendation systems, and autonomous vehicles, demonstrating its transformative impact on the way we live and work.

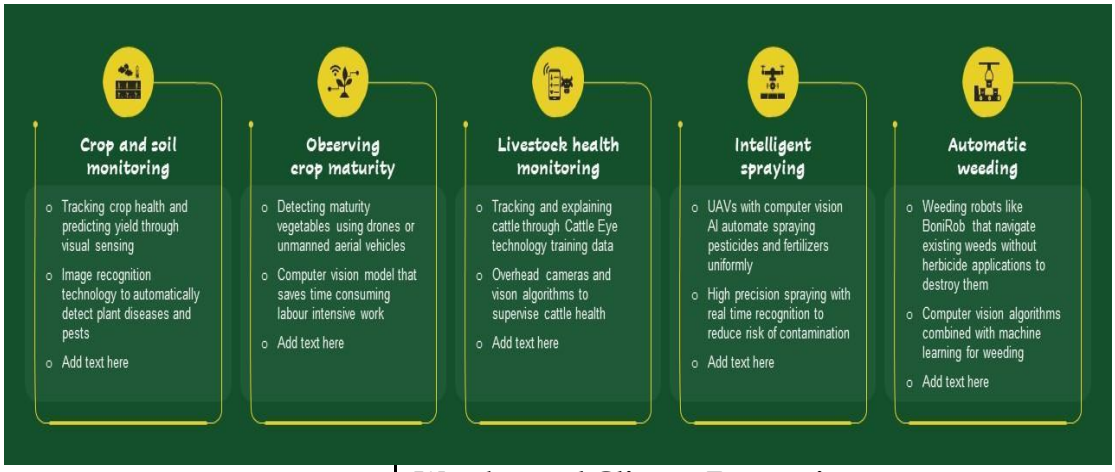
However, as AI capabilities grow, ethical and societal considerations become increasingly important. Questions about bias in AI, job displacement, privacy, and the responsible use of these technologies need to be addressed. The field of AI is dynamic, continuously evolving, and offers incredible opportunities for innovation and progress, making it one of the most exciting and influential areas in modern technology.

Here is some ways AI is being used in agriculture:

Precision Agriculture

AI technologies, such as drones and satellite imagery, are used to collect data on crop health, soil conditions, and weather patterns. This data is then analysed to make precise decisions regarding irrigation, fertilization, and pest control. This approach helps in optimizing resource utilization, reducing waste, and improving crop yields.

Crop Monitoring



AI-driven image recognition and computer vision systems can monitor and analyse the health and growth of crops. By identifying issues like disease, pests, or nutrient deficiencies early, farmers can take timely actions to protect their crops and improve overall productivity.

Predictive Analytics

AI can analyse historical data and current conditions to make predictions about crop yields and market trends. This information allows farmers to make informed decisions about planting, harvesting, and selling their crops.

Weed and Pest Control

AI-powered robots and autonomous machinery equipped with computer vision and machine learning can identify and selectively eliminate weeds or pests, reducing the need for chemical inputs and increasing the sustainability of agriculture.

Livestock Management

AI is used to monitor the health and well-being of livestock. Sensors, wearable devices, and computer vision systems can track animal behavior, health, and feeding habits, helping farmers manage their livestock more efficiently.

Supply Chain Optimization

AI helps optimize the supply chain by predicting demand, managing inventory, and ensuring the timely and efficient transportation of agricultural products to markets.

Soil Health Assessment

AI can analyse soil samples to assess their nutrient content and health, allowing farmers to make informed decisions about soil management and fertilization.

Weather and Climate Forecasting

AI models are used to predict weather patterns and climate changes, helping farmers prepare for extreme weather events and adapt their farming practices accordingly.

Farm Automation

Robots and autonomous vehicles equipped with AI technology can perform tasks such as planting, harvesting, and sorting crops, reducing the need for manual labour, and increasing efficiency.

Disease Detection

AI algorithms can detect diseases in plants and animals through image recognition and analysis of data from various sensors, preventing the spread of diseases and reducing losses.

Financial Management

AI-powered platforms provide financial and risk management tools to help farmers make informed decisions about investments, loans, and insurance.

Market Analysis

AI tools can analyse market trends and provide farmers with insights into when and where to sell their products for the best prices.

Incorporating AI into agriculture can lead to increased sustainability, reduced resource consumption, and improved productivity. As technology continues to advance, it is likely that AI will play an even more significant role in shaping the future of agriculture.

Conclusion

In conclusion, artificial intelligence (AI) is a transformative field with the potential to reshape

virtually every aspect of our lives and industries. It represents a convergence of cutting-edge technologies, including machine learning, neural networks, natural language processing, and computer vision, which enable machines to simulate human cognitive abilities and perform complex tasks. The impact of AI is already evident, and its influence will continue to grow in the coming years. AI is being applied across diverse sectors, including healthcare, finance, manufacturing, agriculture, transportation, and entertainment. It offers the promise of improved efficiency, cost reduction, automation of repetitive tasks, enhanced decision-making, and the ability to solve complex problems that were previously insurmountable. However, the adoption of AI also raises important ethical, social, and economic considerations. These include concerns about bias in AI algorithms, job displacement, privacy, data security, and the responsible use of AI in areas like autonomous weapons. Addressing these challenges is crucial to ensure that AI technologies are developed and deployed in ways that benefit humanity and avoid harm. The field of AI continues to evolve at a rapid pace, with ongoing breakthroughs and innovations. Researchers are constantly pushing the boundaries of what AI can achieve, and its future promises even more exciting developments. As we move forward, it is essential to strike a balance between harnessing the potential of AI for the greater good and safeguarding against potential risks and unintended consequences. In summary, artificial intelligence is a powerful and transformative technology that holds great promise for improving our quality of life and addressing complex global challenges. It is essential to approach its development and implementation with responsibility, ethics, and a clear focus on the best interests of society.

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Edible Packaging for Fruits and Vegetables

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Fresh fruits and vegetables are vital components of a nutritious diet, valued for their exceptional nutritional content. In India, approximately 25-30% of the total fruit and vegetable production is lost during postharvest stages, which include storage, handling, and transportation. This poses a significant challenge, affecting the income of growers and incurring a substantial economic cost for the nation. Hence, prolonging the postharvest shelf-life of fresh fruits and vegetables is crucial for the well-being of growers, processors, handlers, and for promoting nutritious dietary practices between consumers. Employing edible packaging as films and coatings for fruits and vegetables has proven to be an effective method for preserving their quality and prolonging their postharvest shelf-life. Although synthetic-wax coatings and synthetic plastic polymer-based packaging have been widely employed for preservation, it's crucial to emphasize that these synthetic materials are non-biodegradable and can pose risks to both consumers and the environment.

So, an eco-friendly approach to product development involves the use of bio-based materials. These materials are composed of elements derived from renewable sources like plants, animals, and microorganisms. When natural fibers are reinforced with biopolymers, they form what's identified as "green composites." These biodegradable biopolymer composites can be broken down by natural environmental elements such as microorganisms, heat, light, or air. Serving as sustainable alternatives, these biopolymers, whether used independently or in combination with nanomaterials and/or natural active agents, can be employed to develop edible films and coatings. Essential oils derived from plants, in addition to other natural compounds and nanomaterials, react as potent antioxidant and antimicrobial agents. These elements can be incorporated to augment the capabilities of these active films and coatings.

What is edible packaging

Edible packaging comprises a thin layer of food-grade material which restricts the transfer of lipids, gases, and water vapor between the food and its environment. It is rapidly evolving, incorporating edible compounds sourced from various renewable origins. These materials are designed to be integrated into food products and consumed along with them, making them naturally biodegradable and environment friendly. Tablet coatings, Hard-gel capsules, soft-gel capsules, or microcapsules create from edible materials can be classified as edible packaging. Their primary aim is to prolong the product shelf life. Developing and utilizing such packaging for fruits and vegetables holds immense promise. This is because of their versatility, allowing them to be created from a variety of materials, as well as their ability to carry active substances like antimicrobials and antioxidants. Additionally, they can include food additives like vitamins, natural extracts, fungicides, bacteriocins, enzymes, organic acids, etc. These additives work to minimize the growth of pathogenic microbe on the surface of the food while enhancing the sensory properties of the treated products. Edible packaging serves as a sustainable substitute to synthetic packaging and aids in maintaining the fresh produce quality by preserving their nutritional, biological, and sensory attributes. It effectively addresses issues like weight loss, lipid oxidation, enzymatic browning, and delayed respiration of fruits and vegetables

Type of edible packaging

Within the realm of active food packaging, edible packaging is considered sustainable and biodegradable. It stands out for its ability to enhance food quality, offering an advantage over synthetic packaging methods. The importance of edible packaging is found in how well it increases shelf life, preserves food quality, decreases waste, and increases the economic effectiveness of packaging materials.

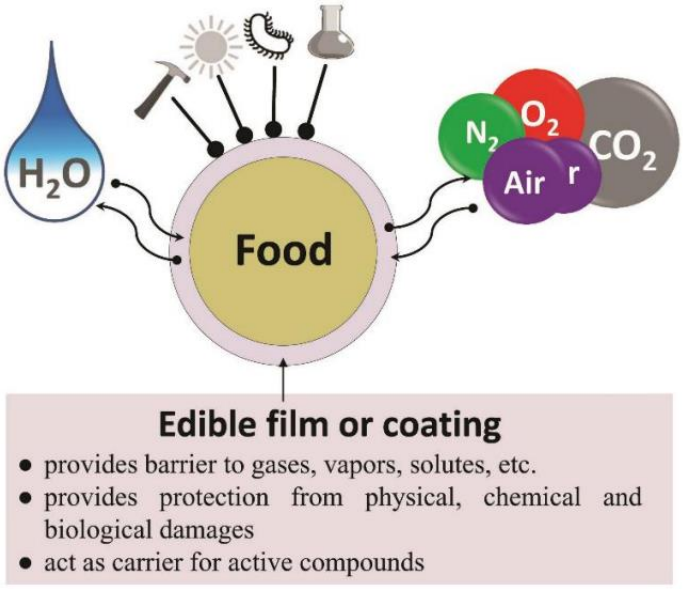

Fig 1. Important of edible packaging

There are two categories of edible packaging

1. **Edible film:** An edible film is a preformed, thin layer used as a wrapping for food products.
2. **Edible coating:** An edible coating is a fine layer of consumable substance, typically applied in liquid form onto the surface of food, often through methods like spraying or immersion or spreading in a solution of the edible material.

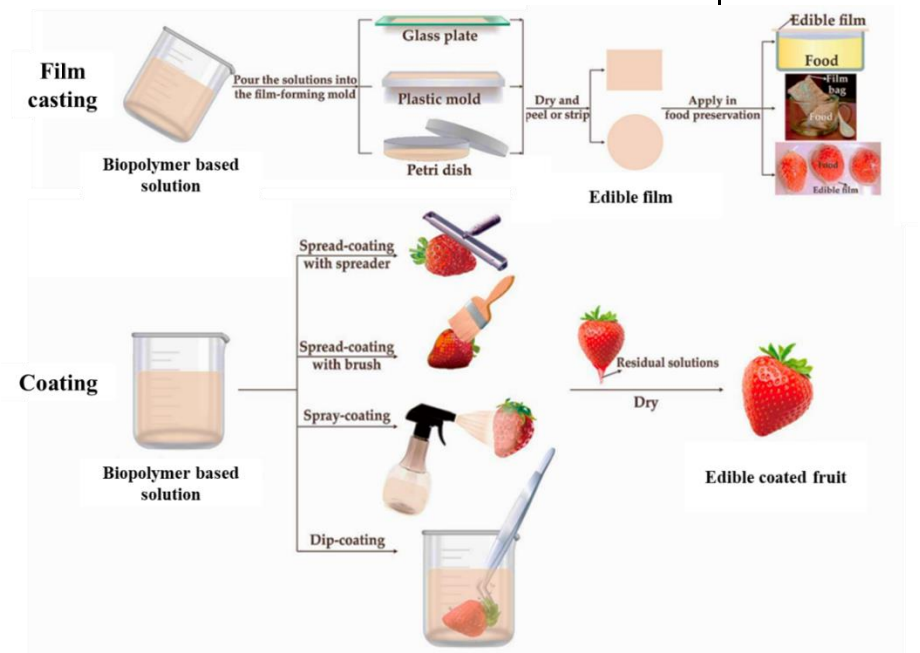

Fig 2. Manufacturing techniques for developing edible packaging. (Adapted from Zhao et al., 2021).

Edible films, typically around 254 µm thick, are independent structures frequently used in producing casings, capsules, bags, pouches, and wraps. In contrast, coatings are directly administered to the surface of the food. Unlike films, coatings are regarded as a crucial component of the food product, naturally meant to stay with the food item rather than being removed.

The selection of components for edible packaging largely depends on the particular food product being packaged. It's also crucial to consider the material composition from which the edible packaging is derived, as well as the processing method. Additionally, the packaging should be sensorily compatible with the food it contains. This ensures that it not only provides effective protection but also maintains the superiority and sensory attributes of the packed food.

Edible packaging materials

The materials used in edible packaging are sourced from consumable ingredients, specifically natural polymers that are safe for human consumption with no associated health risks. These ingredients can be changed into numerous forms of films and coatings, with variations primarily attributed to changes in their thickness. Edible packaging materials, designed for efficient biodegradability, predominantly consist of biopolymers. Ongoing efforts are directed towards enhancing and innovating their composition for improved performance and sustainability.

Biopolymers employed in edible materials can be categorized as follows:

Polysaccharide

The polysaccharides are a long-chain biopolymer constructed from recurring units of carbohydrates (monosaccharaides), linked together by glycosidic bonds.

Polysaccharides such as starches, chitosan, and gums are suitable for developing edible packaging because of their hydrocolloid properties and their capacity to gelatinize. Polysaccharide films exhibit

outstanding oxygen barrier properties, but a significant drawback is their limited resistance to moisture.

Protein

- Proteins based edible packaging can be sourced either from plant-based protein like zein, wheat gluten, soybean, and pea or animal-based proteins including whey protein, casein, collagen, and egg white.
- Protein-based edible films typically offer strong resistance to gases and possess favorable mechanical properties.
- In comparison to polysaccharide-based coatings, these films are more flexible. Still, owing to their hydrophilic properties, they tend to exhibit lower resistance to moisture.

Lipids

- Lipid-based components encompass materials like beeswax, carnauba wax, and various fatty acids.
- Lipid-based films are inherently extremely hydrophobic, which grants them exceptional resistance to moisture compared to films based on polysaccharides or proteins.
- Edible films and coatings derived from lipids typically do not contain a polymeric matrix.

Such edible materials are applied in a range of food applications, either independently or in combination with other components. They form a subset of biodegradable and bio-based materials, and have undergone extensive research as a substitute to conventional food packaging, particularly with regard to their film-forming characteristics.

Edible packaging for shelf-life extension

Edible films and coatings are pivotal in elevating the quality of fruits and vegetables. They function as a semipermeable protective barrier, safeguarding the produce from physical, chemical, and biological degradation. This includes reducing phenol oxidation, respiration, and transpiration rates, as well as modifying the gaseous environment, particularly levels of oxygen and carbon dioxide. Additionally, they contribute to retarding the ripening process of fruits and vegetables. The use of edible films and coatings can significantly enhance the visual and tactile aspects of product surfaces as well. They serve as a barrier, shielding fruits and vegetables from nutrient oxidation and light-induced chemical alterations, surface microbial growth, moisture migration. Furthermore, these films and coatings are capable of containing antioxidants, antimicrobials, coloring agents, and flavors. With this capability, the shelf life of the produce can be extended and safety measures can be enhanced.

Advantages of edible packaging

Edibility and biodegradability: Edible film and coating can be consumed directly with the fruits and vegetables, leaving no waste for decomposition, even if discarded, they have no adverse effects on the environment due to their natural ability to biodegrade. This makes them an environmentally sustainable and eco-friendly substitute for conventional packaging materials.

Organoleptic properties: Edible films and coatings improve the sensory properties of the fruits and vegetables, offering a range of flavors and colors while also adjusting surface attributes like water-repellency and water-absorption.

Improved quality: Edible films and coatings have the capacity to serve as a substitute for and potential reinforcement of the outer layers in treated products. They prevent the loss of ingredients, aromas, and moisture within the foods. Simultaneously, they enable controlled exchange of crucial gases such as ethylene, carbon dioxide, and oxygen which play a role in the respiration process and contributes to the enhancement of the fruits and vegetables quality.

Individual packaging: Edible films and coatings offer a practical solution for individually packaging small-sized foods like peas, beans, and similar items, a task that synthetic packaging may not be well-suited for.

Shelf-life: Edible films and coatings possess many functional properties, including antimicrobial, antioxidant, barrier, and mechanical attributes. These properties enable them to effectively delay the ripening process and increase the postharvest shelf life of the fruits and vegetables.

Conclusion

The global production of fruits and vegetables, coupled with the postharvest waste and plastic waste, poses a significant environmental challenge. With the rising demand for fresh and minimally processed fruits, edible packaging emerges as a promising resolution. It offers a multitude of benefits in maintaining fruit quality and extending shelf life, ultimately reducing food waste. The growing consumer preference for healthier and fresher food choices has propelled the usage of edible materials sourced from natural origins, including initiatives for valorizing waste, thereby representing a potential for a circular economy. Moreover, the adoption of edible packaging contributes toward the advancement of a circular bioeconomy, fostering sustainability within the food sector. This holistic approach holds promise in addressing both environmental and consumer demands.

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Farming Systems Approach: Real Time Way for Sustainability and Profitability in Agriculture

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The human population of India has increased to 1.385 billion at a growthrateof1.2% in 2020 and isestimated to increasefurther to 1.52 billion by 2036 with 70% of increase in urban areas. On the other hand, our national food grain production for past 3-4 years is hoveringaround 234 million tones. There are projections that demand for food grains wouldincrease to 355 million tonnes in 2030. The average size of land holding has declinedto 1.21ha during 2009-10 from 2.30 ha in 1970-71. Declining size of land holdings without any alternative income augmenting the opportunity is resulting in fall offarm incomeandcausing agrariandistress. The current scenario in the country indicates that area under cultivation may further decrease and more than 20% of current cultivable area will be converted into non-agricultural purposes by 2030.

Small and marginal farmers are the core of Indian agricultural rural economy consisting 80% of the total farming community but possessing only 36% of the total operational land holdings. The declining trend of per capita land availability poses a serious challenge to the sustainability and profitability of small and marginal farmers. Also, in agriculture majority of the farm holdings are dry lands and even irrigated areas depend on the monsoon. In this context, if farmers are only concentrated on crop production they will be subjected to a high degree of unsustainability in income and employment. The income from cropping system only for an average farmer is hardly sufficient to sustain his family. Hence, it is imperative to manage certain strategies forrural marginal farmers by combining the different enterprises to ensure profitability while preserving the environment and increase the productivity and supplement the income. Integrated farming system is a multi-disciplinary holistic approach to solve the problems of small and marginal farmers.

The need for farming systems approach in the present scenario is mainly due to high cost of farm inputs, fluctuation in the market price of farm produce, risk of crop harvest due to climatic vagaries and biotic factors. Environmental degradation, depletion in soil fertility and productivity, unstable income of the farmer, fragmentation of holdings and low standard of living add to the intensity of the problem. To meet the multiple objectives of poverty reduction, food security, competitiveness and sustainability, several researchers have recommended the Farming Systems Approach to research and development.

What is Farming Systems Approach and what it does

It is an approach for developing farm - house hold systems, built on the principles of productivity, profitability, stability and sustainability. All the components are complimentary and supplementary to each other and the development process involves participation of rural communities. The Farming Systems Approach emphasizes understanding of farm house hold, community interlinkages, reviews, constraints and assesses potentials and it combines improvements desired from better technology. It needs efficient support services and requires better policies. It is continuous, dynamic and interactive learning process based on analysis, planning, testing, monitoring and evaluation.

Concept of Farming Systems

Farming system concept was developed in1970 and it is designed to understand farmer priorities, strategies and resource allocation decisions and is anintegrated set of activities that farmers perform in their farms under their resources and circumstances to maximize the productivity and net farm income on a sustainable basis. In other words, it is an appropriate mixes of farm enterprises and the means available to

the raise them for profitability. In its real sense it will help in lifting the economy of agriculture and standard of living of the farmers of thecountry as a whole. Its goal is to develop sustainable land use system which will optimize resource use and increase income and employment for farm families. The integration is made in such a way that the output of one enterprise/ component should be the input for the other enterprises with high degree of complementary effects. Crop residues can be used for feeding to animal, while enhancing the agricultural productivity should be done through utilization of manure from livestock by intensifying nutrients that improve soil fertility as well as reducing the use of chemical fertilizers.

Farming System represents an appropriate combination of farm enterprises (Cropping systems horticulture, livestock, fishery, forestry, poultry etc.,) and the means available to the farmer to raise them for profitability. It interacts adequately with environment without dislocating the ecological and socio-economic balance on one hand and attempts to meet the national goals on the other.

Specific Objectives

1. To identify existing farming systems in specific areas and access the irrelative viability.
2. To formulate farming system model involving main and allied enterprises for different farming situations.
3. To ensure optional utilization and conservation of available resources and effective recycling of farm residues within system
4. To maintain sustainable production system without damaging resources/environment
5. To rise overall profitability of farm household by complementing main /allied enterprises with other

Keyprinciples of Farming systems are

Cyclic: Farming system is essentially cyclic (organic resources– livestock –land–crops). Therefore, management decisions related to one component may affect the others.

Ecologically sustainability: Combining ecological sustainability and economic viability, the integrated livestock–farming system maintains and improves agricultural productivity while also reducing negative environmental impacts.

Rational: Using crop residues more rationally is an important route out of poverty.For resource-poor farmers, the correct management of crop residues, together with an optimal allocation of scarce resources, leads to sustainable production.

Criteria for classification of Farming systems

Available natural resource base, including water, land, grazing areas and forest; climate of which altitude is one important determinant; land scape, including slope; farm size, tenure and organization; dominant pattern off arm activities and house hold livelihoods, including field crops, livestock, trees,aquaculture, hunting and gatheringand processing off farm activities; and taking into account the main technologies used, which determine the intensity of production and integration of crops, livestock and other activities.

Farming systems can be divided into eight broad categories depending on climate, resources and so on, available to the farmers in the regions. They are:

1. Irrigated farming systems
2. Wetland rice-based farming systems
3. Rainfed farming systems in humid areas of high resource potential
4. Rainfed farming systems in steep and high lands
5. Rainfed farming systems in dry or cold low potential areas
6. Dualistic (mixed large commercial and small holder)farming systems
7. Coastal artisanal fishing
8. Urban based farming systems, typically focused on horticulture and livestock production.

Key role of Farming Systems Approach in Agriculture is

- ❖ Food security
- ❖ Provide balanced food
- ❖ Quality food basket

- ❖ High productivity and enhanced farm income
- ❖ Effective recycling of resources
- ❖ Minimizing environmental pollution
- ❖ Employment generation

Farming Systems Strategies are

In view of serious limitations on horizontal expansion of land and agriculture, only alternative left is for vertical expansion through various farm enterprises required less space and time but giving high productivity and ensuring periodic income specially for the small and marginal farmers located in rainfed areas, dry lands, arid zone, hilly areas, tribal belts and problem soils. The location specific systems must be developed based on the available resources which will result into sustainable development of the region.

The following farm enterprises could be combined

- ❖ Agriculture alone with different crop combinations
- ❖ Agriculture+ Livestock
- ❖ Agriculture + Livestock + Poultry
- ❖ Agriculture + Horticulture + Sericulture
- ❖ Agroforestry+ Silvipasture
- ❖ Rice+Fishculture
- ❖ Rice + Fish + Mushroom cultivation
- ❖ Floriculture + Apiary (bee keeping)
- ❖ Fishery+ Duckery+ Poultry

For meaningful execution of integrated farm enterprises, the following activities should be under taken by multi-disciplinary team of extension professionals with farmer's participation and involvement at all stages.

Farming Systems Research for different Agro-Climatic zones in India

High altitude cold deserts: pastures with forestry, goats, rabbits and settled agricultural crops like millets, wheat, barley and fodders.

Arid and desert region: Animal husbandry with the camels, sheep and goats and growing fodder and field crops.

Western and central Himalayas: Horticultural crops as a major component and agriculture mainly on the hill terraces and slopes with maize, rice, wheat, pulsesand foddercrops.

Western Ghats: Major activity on plantation crops, cultivating rice and pulsesare the secondary agricultural activity. Cattle, sheep and goat are the livestock components which in most parts are maintain as large herds.

Delta and coastal plains: Rice cultivation with other enterprises like fishery, poultry and piggery etc., capture fisheries of marine ecosystem is a specialized enterprise.

Eastern Himalayas: Primitive crop husbandry with rice, millets and pulses etc.Agroforestry system is common. Piggery and poultry are the chief livestockactivity.

Indo-Gangetic plains: Intensive crop husbandry like rice–wheat–maize/mustard/pulses and livestock, dairy, cattle and buffaloes

Central and southern highlands: Cotton – sorghum – millets/pulses with dairy cattle, sheep and goats and poultry are the secondary livestock and animal husbandry enterprises.

Factors influencing Integration of Farm Enterprises

1. Soil and climatic features of the selected area.
2. Availability of the resources, land, labor and capital.
3. Present level of utilization of resources.
4. Economics of proposed integrated farming system.
5. Managerial skill of farmer.

Integrated Farming System (IFS)

IFS is a component of Farming system research introduces a change infarming techniques for maximum production in the cropping pattern and takes care of optimal utilization of resources. The farm wastes are better recycled for productive purposes in the IFS. Unlike the specialized farming system, IFS's

activity is focused round a few selected, interdependent; inter related and often interlinking production systems based on few crops, animals and related subsidiary professions. IFS envisage harnessing the complementarities and synergies among different agricultural subsystems, enterprises and augmenting the total productivity, sustainability and gainful employment.

An intensive IFS addresses two issues; reduction of risk with the monoculture activities and promoting enterprise diversification, value addition and development of alternative income sources with efficient utilization of farm resources and it brings about enterprise diversification for sustainability and additional benefits, better management of important farm resources like land, labour and capital etc., provides an opportunity for effective recycling of the product and by–products, helps to generate flow of cash to the farmers round the year by way of disposal of milk, fruits, fuel, manure etc., beside other agricultural output.

Goals of IFS are

- Maximization of yield of all component enterprises to provide steady and stable income.
- Rejuvenation of system's productivity and achieve agro-ecological equilibrium
- Avoid the build-up of insect-pests, diseases and weed populations through natural cropping system management and keep them at a low level of intensity.
- Reducing the use of chemicals (fertilizers and pesticides) to provide chemical-free healthy produce and environment to the society.

Different components of IFS

1) Field crops 2) Crop production 3) Vegetables 4) Fruit cultivation 5) Poultry farming 6) Livestock integration 7) Duckery 8) Aquaculture 9) Agroforestry 10) Bee-keeping 11) Mushroom cultivation and 12) Bio-gas plant.

The possible components to be included for sustainable IFS models in Andhra Pradesh are field crops (Rice in low land areas, ID crops in upland areas), Vegetables (seasonal vegetables includes leafy vegetables for year round production), fruit cultivation (Papaya, banana, guava, sapota, pomegranate, citrus etc.), Poultry farming (Desi chicks, Kadaknath, aseel, grama priya *etc.*,), livestock integration (Dairy, goatary, piggery etc.,), Aquaculture (Fish & Prawn farming in coastal and agency areas), Agro-forestry, Beekeeping, Mushroom cultivation (Oyster mushroom in rice grown areas, Button mushroom in cooler areas etc.,) and Bio-gas plant.

Integrated Farming System models for different farming situations are

Wetland situation: Rice based cropping system with poultry cum fish culture

Crop –poultry–fishery

Cropping with diary

Cropping with goat rearing

Cropping with aquaculture.

Irrigated areas: Cropping with diary, biogas and silviculture

Rainfed areas: Cropping with goat and silvipasture

Hill regions: Majority ofthe farmers in the region are maintaining fruit tree likeapple, dairy cattle and the

major sources of green fodder comes from lopping of the fodder trees and locally available grasses

Research on Integrated Farming Systems in ANGRAU - Regional Agricultural Research Station, Maruteru, Andhra Pradesh

The preliminary research investigations under IFS approach advocates the benefits of farm productivity improvement by 30-50 % and more than double increase in the employment generation than arable farming alone, depending upon the number and kind of enterprises integrated. Integrated farming system works as a system of systems, which ensure that the wastes and/ or by product from one enterprise become a resource for another enterprise with high degree of synergy and complimentary effects on each other. The harvested straw/ stover and fodder fed to the cattle produces milk. The livestock excreta and litter produced from poultry will be used as manure for crops and fishery.

By analyzing these facts an improved IFS model was designed, tested and validated for 0.6 ha (1.5 acre) area to support a farm family of five members at RARS, Maruteru under AICRP on IFS Scheme with the main objective of generating adequate income and employment for the small and marginal farmers and identifying appropriate cropping systems with high productivity which suits the specific needs of the Godavari zone and efforts will be made with the aim to double the real farm income. The IFS model, presently have different enterprises *viz.*, crop production, horticulture, dairy, fishery, poultry, boundary plantation and vermicompost/ recycling of farm waste. This IFS model is eco-friendly having great potential to small and marginal farmers of Andhra Pradesh.

The five years of research study on wetland IFS model developed at ANGRAU-RARS, Maruteru shows that this 1.5 acre model produced an average gross returns of Rs. 1,41,115 which is equivalent of Rs. 2,35,192/- per hectare model (Table 2). After meeting all possible cultivation expenses, the average net returns of Rs. 90,977/- which is equal to Rs. 1,51,629/- per hectare with B:C ratio of 1:2.82 in addition to 429 Man Days. This clearly shows that, the small and marginal farmers can reap profits of minimum one lakh after meeting his family and livestock requirements.

Future research thrust

- Need to study the sustainability of the identified systems under different topographical situations in the long run including high value crops.
- Need to study the nutrient dynamics of soil with continuous cropping and recycling of manurial resources with different systems over time.
- Modeling of the identified farming system options to suit a given agro–climatic and socio–economic situation.

Need to identify the constraints in adoption of identified farming systems by the farmers for further refinement.

Conclusion

- Efficient utilization of scarce and costly resources is the need of the hour to make crop production a viable pre position in the present day competitive scenario.
- Following the concept of IFS through supplementation of the allied agro–enterprises by recycling the waste of one enterprise in another is a right step inthisdirection
- It provides alternate and sustainable avocation to marginal and sub – marginal farmers. Fruit, mushroom, apiary, animal production and poultry have been more viable with them.
- The crop residues and biomass available in plenty in the crop production system need to be properly managed to harness full benefits
- Improving the integrated approach not only enhances farm income but also overcomes environmental pollution
- A better planning and utilization of the available resources will make bright prospects for the farm economy as a whole.

Table 1. Components of Wetland IFS model developed at ANGRAU-RARS, Maruteru

#	IFS Components	Unit area
1	**Crop Component**	**2900 m²**
	i) Paddy-Paddy-Pulse	**1600 m²**
	ii) Maize-Green gram-Sesamum	**400 m²**
	iii) Red gram + Green gram – Sweet corn	**400 m²**
	iv) Fodder Jowar – Berseem/Cowpea	**400 m²**
2	**Dairy Unit**	**250 m²**
	Two Crossbred Buffaloes and Cattle shed	**100 m²**
	Vermicompost units (2 Nos)	**150 m²**
3	**Fishery Unit**	**1200 m²**
	Fish fingerlings @ 7500/ha and Fish Pond (1.5 – 2.0m depth)	
4	**Poultry Component**	**100 m²**
	Poultry shed on four corners of the fish pond (15 Nos Units - 2 Nos)	
5	**Horticulture Unit**	**1550 m²**
	i) Fruit trees like Banana, Papaya, Guava etc, including boundary plantations ii) Need based intercropping of seasonal vegetables with 5 boxes of Apiary iii) Floriculture (seasonal flowers) and Bio-fencing of Karonda at boundary iv) Threshing floor and submersible pump	
	TOTAL AREA (1.5 acres)	**6000 m²**

Table 2: Economics of wetland IFS model over 5 years average study from 1.5 acre model

#	Components	Gross Returns (Rs)	Cost of Cultivation (Rs.)	Net Returns (Rs.)	B:C Ratio	Man Days
1.	Crop component	38,172	14,225	23,947	1:2.68	79
2.	Horticulture	18,193	5,250	12,943	1:3.47	55
3.	Poultry	6,886	1,950	4,936	1:3.53	24
4.	Dairy	42,852	22,750	20,102	1:1.88	255
5.	Fishery	20,546	5,500	15,046	1:3.74	14
6.	Value Addition	14,466	579	13,887	1:24.98	2
	1.5 acre	**1,41,115**	**50,138**	**90,977**	**1:2.82**	**429**
	I Hectare	**2,35,192**	**83,563**	**1,51,629**		

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Pest and Diseases Management in Castor

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Castor (*Ricinus communis* L.) is an important non-edible oilseed crop of the spurge (Euphorbiaceae) family and is believed to have originated in Abyssinia. Mainly grown in arid and semiarid regions. It has gained great potential as its oil is being used in aircrafts as lubricant and also for grease, hydraulic fluids, soaps, printing inks and for ayurvedic medicine also. India is the major producer in the world, castor seed with a production of 17.95 lakh tonnes (lt) during 2021-22 season, against 17.89 it in 2020-21 (Anon, 2022). Among states, Gujarat is leading with 6.52 lakh ha (13.45 lakh tonnes) under castor followed by Rajasthan 1.77lakh ha (2.76 lakh tonnes), Andhra Pradesh 0.16 lakh ha (0.064 lakh tonnes), and Telangana 0.022 lakh ha (0.037 lakh tonnes). According to government 2nd advance estimates, all India castor production in 2022-23 is at area 8.917 lakh ha, production 18.82 lakh tonnes. [Source: Directorate of Economics and Statistics (DES). * 2nd Advance estimates.

Development of location-specific varieties and hybrids with appropriate crop production technologies lead to increased production and productivity of the crop. However incidence of insect pests is becoming major obstacle in castor production. Castor is majorly grown in areas where mean monthly temperature across the growing season ranges from 22.7 to 34.3º C. These temperatures are favorable for the incidence of several insect pests viz., semilooper (*Achoea janata* L.), tobacco caterpillar (*Spodoptera litura* F.), shoot and capsule borer (*Conogethes punctiferalis* Guen.) and leaf hopper (*Empoasca flavescens* Fabr.) of castor causing severe economic losses. More than 60 species of insects and pests were reported to cause damage to the castor crop and the yield losseswere estimated to be about 40- 89%. Multitude of insect pests attack was reported at all phenological stages viz., seedling, vegetative and reproductive of the crop. The defoliators, viz., castor semilooper, Spodoptera &other hairy caterpillars, and sucking pests, such as jassid, whitefly, thrips and mites, cause huge damage to the castor crop.

Semilooper (*Achoea janata* L)

It occurs during August-January, also damages rose, citrus pomegranate, Tridax procumbens. *A. janata* is a pale reddish-brown moth, stoutly built with black hindwings having white band medially and three large white spots on the outer margins

A single female moth lays about 450 blue green rounded and ridged eggs singly @ 1 to 6 eggs per leaf. Egg period is 2 to 5 days The caterpillar feeds sparingly at first and feeds voraciously during later stages leaving only mid rib and veins. Defoliated leaves, in severe cases only mid rib and veins of the leaves Caterpillar is a semilooper, long, smooth, greyish brown in colour.

The first pair of prolegs is reduced and as such a semilooper. Caterpillar posess red or whitish side stripes. Full grown larva has black head, a red spot on the black loop and red anal tubercles and measures 60-70 mm in length, larval period is 11- 15 days. Pupation takes place in the soil or among fallen leaves. Pupal period is 10-14 days during warm weather, few months in cold weather.

Tobacco caterpillar (*Spodoptera litura* F)

It is found throughout the tropical and sub-tropical parts of the world, wide spread in India. Besides castor it feeds on tobacco cotton, groundnut, tomato, cabbage and various other cruciferous crops. Moth is medium sized and stout bodied with forewings pale grey to dark brown in colour having wavy white crisscross markings. Hind wings are whitish with brown patches along the margin of wing. Pest breeds throughout the year. Moths are active at night. Female lays about 300 eggs in clusters. The eggs are covered over by brown hairs and they hatch in about 3-5 days.

In early stages, the caterpillars are gregarious and scrape the chlorophyll content of leaf lamina giving it a papery white appearance. Later they become voracious feeders making irregular holes on

the leaves and finally leaving only veins and petioles and cause complete defoliation or skeletonized leaves.

Management of Semilooper and Tobacco caterpillar

- Collection and destruction of the infested material from the field.
- Plucking of leaves harbouring egg masses / gregarious larvae and destroying.
- Setting up of pheromone traps @ 4-8/acre for Spodoptera litura
- Erection of bird perches 5-6 per acre.
- Application of *Azadirectin* 1500 ppm i.e. neem oil 5 ml/L for management of early instars larvae.
- Natural enemie (*Snellenius maculipennis*) acts as larval parasite of semilooper whose cocoons may be seen attached to the ventral aspect of the posterior end of the host caterpillar. Avoid chemical spray when 1-2 larval parasitoids are observed per plant.
- Spray of Acephate 1.5 g/L or Thiodicarb 1.5g/L of water (if <25% defoliation)
- Spray Profenophos @ 2ml/ L or Flubendamide 0.2ml/L or Spinosad 0.3ml/L of water or chlrantraniliprole 0.3ml/1 of water (if >25% defoliation).

Shoot and capsule Borer *(Conogethis punctiferalis)*

It is a potential pest and occasionally becomes serious. It is active from September to February when crop is in flowering. It also damages ginger, cardamom, turmeric, guava, peaches, cacao, pear, mango inflorescence, sorghum ear heads, soapnut tree etc. Moth is medium sized having bright orange yellow-coloured wings with numerous black dots or spots.

The body length is about 10 mm while the wingspan is 22 mm. Female moth lays pinkish oval, flat eggs singly or in groups on tender parts of plant and developing capsules. Incubation period is 6 to 7 days Larvae bore into the shoots as well as capsules and destroy them. Occasionally the larva is found at the junction of the petiole with the lamina and rarely in thick mid rib.

The symptoms are Frassy matter at the bored shoots & Webbed seed capsules covered with dark excreta. Caterpillar is brownish with pinkish tinge and fine hairs arising from warts on the body. The head and prothorax are brown. Larval period is 12- 16 days Pupation ocurs inside the damaged stem or capsule, in a thin silken cocoon. Pupal period is 7-10 days. Total life history takes 25-33 days with three generations per year.

Management

- Collection and destruction the shoots and capsules infested by capsule borer.
- Sprayings should be commenced from the time of formation of inflorescence and again after 20 days.
- Spray Profenofos @ 2ml/L or Novaluraon @ 1ml/L of water, if at least 10% capsules are damaged.

Leafhopper (*Empoasca flavescens* Fabr.)

Light green or greenish yellow nymphs and adults suck sap from undersurface of leaf. As a result, the margins of leaf turn pale initially, later become yellowish and cause hopperburn or drying of leaves and showing brown necrotic patches in severe cases. Plants lose vigor and yield is affected. Peak infestation is during November to January.

Management

- When 10% of leaves in a plant show curling, spray Profenophos 2 ml/L of water.
- Under severe infested conditions spray Acetamirpide @ 0.2g/L or Clothionidin 0.1g/L of water.
- Atleast two sprays required at 15 days intervals based on severity.

Wilt (*Fusarium oxysporum f.sp. ricini*)

When seedlings are attacked cotyledonary leaves turn to dull green colour, wither and die subsequently. In matures plants the leaves becomes yellow and brittle, droop and drop off leaving behind only top leaves. Diseased plants are sickly in appearance. Cut opened stems will show

discolouration of the vascular bundles and presence of white mycelium on infected portion. Monocropping of castor in same field. Infected seed is the main cause for wilt.

Management

- Crop rotation with non host plants
- Seed treatment with thiram @ 3g/ kg or carbendiazim @ 2g/ kg seed.
- Seed treatment with biocontrol agent *Trichoderma viride* @10g /kg.
- Soil application of *T. viride* @2kg of talc formulation mixed in 100kg farm yard manure and incubate it for 15 days and apply to the soil before ploughing.
- Drenching with Copper Oxy Chloride @ 3 g/L of water.

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Repurpose Used Cooking Oil

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Fried food items are the first choice when we crave for something tasty. But over long run, taste doesn't come handy since the Food Business Operators (FBOs) often use same cooking oil for repeated frying. The consumption of Used Cooking Oil (UCO) poses adverse health effects since, some of the polar compounds are formed during frying. The quality of cooking oil is measured in terms of percentage of Total Polar Compounds (TPC) in the oil. These compounds are associated with several diseases such as hypertension, atherosclerosis, Alzheimer's disease, liver diseases and so on. What could be the best way to avoid these health issues without even wasting the UCO?

Energy needs of the world are increasing day by day. This has given birth for the idea of the fuel for the future: Bio-fuel. Bio-fuel is a sustainable, eco-friendly source of energy that can be created from UCO. On 10th August 2018, the Food Safety and Standards Authority of India (FSSAI) launched RUCO (Repurpose Used Cooking Oil). It is an initiative that enables the collection and conversion of UCO to bio-diesel. Large scale users of cooking oil, such as restaurants, hotels and food processing industries can be divided into three types of users.

User 1: This user uses the oil multiple times even if the oil has turned dark and greasy.

User 2: This user uses the oil till it is burnt out and turns dark. To reuse it further, he tops it up with new oil.

User 3: This user stops the usage of the oil after 1-3 cycles.

In the first two cases, the oil is extremely unfit for consumption and is a potential health hazard. The used cooking oil is not disposed at all, or it is disposed in an environmentally hazardous manner. Sometimes it is sold to soaps and detergent industries and sometime it even finds its way to smaller restaurants, dhabas and street vendors through spurious dealers who buy the UCO, filter it and resell it. So, the sole purpose of RUCO is 'to STOP and WATCH whether we can further use that oil for cooking'. If the standards of the UCO have reached the TPC of 25 per cent, it is time to dispose it off. Ideally, we should use the oil for frying only once. The oil used once can be filtered and used for curries and the leftover oil must be used within 2 days after frying.

Clogged pipe

TPC tester

People usually dispose the UCO and clog the drain pipes which is perhaps the most illogical thing to do. But now, there is an opportunity to earn money out of it. We can sell the UCO to bio-diesel aggregators who are registered with state or national bio-diesel board. They will further give the oil to bio-diesel

manufacturers which can later be used as fuel for vehicles. To facilitate this process of collection and conversion of UCO, FSSAI and BDAI (Bio Diesel Authority of India) have currently recognized 64 companies, 200 aggregators and some 26 plants in 101 locations. The FSSAI has directed the FBOs (food channels like McDonald's, KFC, Burger king, *etc*) to maintain a record of utilization and disposal of cooking oil by them. Especially for those who use more than 50 liters of cooking oil per day. Also, they have to monitor the TPC of the cooking oil regularly.

How does the model work?

The aggregators have their own vehicle with a driver and two helpers collecting UCO from eateries, hubs and restaurants, which is then converted into bio-diesel. RUCO has developed an app for Android and iOS users. The food business owner or oil discharger can request for a pick-up of the UCO on the app. The food business owners earn Rs 30 per kg for the waste oil that they give away under the project. The fuel recovery rate is mostly between 70 per cent and 90 per cent. It implies that 10 liters of oil with TPC of 25 per cent or below can generate 9 liters of clean fuel. RUCO is currently running in Gujarat, Delhi-NCR, Andhra Pradesh, Tamil Nadu, Maharashtra and Karnataka.

Collection and conversion of used cooking oil Biodiesel

We as an individual need to stand with RUCO to acquire its benefits since it not only ensures health benefits, but, spurs economic growth by ensuring job creation, foreign exchange saving, and aids a healthy environment.

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Blockchain Revolutionizing Tomato Supply Chain: Ensuring Safety and Quality

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Source:https://www.fruitnet.com/eurofruit/carrefour-rolls-out-tomato-blockchain-

Imagine the scenario: A person standing in the produce aisle of a local grocery store, contemplating which tomatoes to buy for tonight's salad. As he reaches for a plump, red tomato, a wave of uncertainty washes over. How to be sure that this tomato is safe to eat? With the increasing concerns about food safety, it's no wonder that consumers are becoming more cautious about the products they purchase. The tomato industry faces challenges in ensuring the freshness, nutritional value, and safety of tomatoes throughout the supply chain. Proper management is crucial to maintain the quality of tomatoes and prevent contamination or spoilage. Blockchain technology has emerged as a potential solution to enhance food safety in the tomato supply chain. It has the potential to revolutionize supply chain management by providing a trusted and tamper-proof record of every transaction and movement of goods.

By implementing blockchain technology, stakeholders in the tomato supply chain can track and verify the origin, quality, and safety of tomatoes at every stage. This technology enables real-time monitoring and recording of data, including information about cultivation practices, post-harvest treatments, transportation, and storage conditions. This level of transparency and traceability can help identify and address any issues related to food safety and quality promptly. It enables stakeholders to streamline processes, reduce paperwork, and eliminate intermediaries, leading to cost savings and improved operational efficiency. Additionally, blockchain can facilitate trust and collaboration among supply chain partners, as all participants have access to the same verified and immutable information.

Understanding the Tomato Supply Chain

The tomato supply chain encompasses the processes involved in bringing tomatoes from the farm to the table. It involves various stages, including cultivation, harvesting, postharvest handling, packaging, transportation, distribution, and retail. The complexity of the tomato supply chain arises from the numerous factors and activities involved, as well as the challenges in ensuring food safety and quality. One of the challenges in the tomato supply chain is postharvest loss. Factors such as limited access to good secondary markets, labour shortages, and inaccurate yield forecasting contribute to tomato loss. These losses not only impact the economic viability of the supply chain but also result in food waste. Traditional methods of supply chain management have limitations in addressing these challenges. Additionally, it argues that a holistic understanding of operations and supply chain management requires multiple approaches. Understanding the steps connecting producers and consumers is crucial for achieving this resilience.

The Need for Transparency and Traceability

Transparency and traceability are critical in the food industry due to several reasons. As they play a crucial role in ensuring food safety. Foodborne illnesses pose significant risks to public health, and transparent and traceable supply chains can help identify the source of contamination and prevent further spread. By tracking the movement of food products from farm to fork, it becomes easier to identify potential points of contamination and take appropriate measures to mitigate the risks. Additionally, transparency and traceability are essential in managing product recalls. In the event of a food safety issue or contamination, being able to quickly trace the affected products back to their source allows for targeted recalls, minimizing the impact on consumers and reducing financial losses for companies. Without transparency and traceability, it becomes challenging to identify the specific products that need to be recalled, leading to more costly recalls.

Consumer demand for more information about the products they consume is another driving factor for transparency and traceability in the food industry. Consumers are increasingly concerned about the safety, quality, and sustainability of the food they purchase. They want to know where their food comes from, how it was produced, and if it meets certain standards. To achieve transparency and traceability in the food industry, various technologies are being explored, such as blockchain and Internet of Things (IoT) platforms.

The Basics of Blockchain Technology

Blockchain technology possesses decentralized and immutable; It comprises of digital ledger that records data in a transparent and secure manner. One of the key features of blockchain is decentralization, i.e. there is no central authority controlling the network. Instead, it is maintained by a distributed network of nodes that validate and verify data. This decentralization ensures that no single entity has control over the data, making it resistant to censorship and manipulation. Another important feature of blockchain is immutability: Once a data is recorded on the blockchain, it cannot be altered or deleted. This is achieved through the use of cryptographic techniques, such as hashing and digital signatures, which ensure the integrity and authenticity of the data. As a result, blockchain provides a tamper-proof and transparent record of all transactions, enhancing trust and accountability. Figure 1 gives an outline on how block chain technology can be implemented in Tomato supply chain.

How Blockchain Enhances Transparency and Traceability

Blockchain technology has the potential to enhance transparency and traceability in the tomato supply chain. By utilizing a blockchain-based ledger, each step of the tomato supply chain can be recorded and tracked, such as the origin of the tomatoes, the conditions in which they were grown, the transportation process, and any quality control measures taken, providing a transparent and immutable record of the journey from farm to consumers. This recorded information is stored in blocks that are linked together in a chain, creating a decentralized and tamper-proof record.

Each step of the tomato supply chain can be recorded on the blockchain by assigning a unique identifier to each batch of tomatoes. This identifier can be linked to information such as the farm where the tomatoes were grown, the date of harvest, the transportation route, and the date of arrival at each destination. This allows for complete visibility and traceability of the tomatoes throughout the supply chain QR codes or RFID tags play a crucial role in providing consumer access to blockchain data. It is a convenient and user-friendly way for consumers to verify the authenticity and quality of the tomatoes. These codes or tags can be attached to the packaging of the tomatoes and scanned by consumers to access information about the tomatoes' journey. This information includes details about the farm where the tomatoes were grown, the use of pesticides or fertilizers, and any certifications or quality standards met.

Potential Challenges and Concerns

Blockchain technology offers numerous benefits, but its implementation also comes with potential challenges and concerns. One of the main concerns is data privacy. While blockchain provides transparency and traceability, it also raises questions

about the privacy of sensitive information. The decentralized nature of blockchain makes it difficult to control access to data, which can be a challenge in industries that require strict data privacy regulations, such as healthcare. Scalability is another challenge in implementing blockchain technology. The size of each block and the time it takes to create a new block can limit the number of transactions that can be processed simultaneously. This can be a significant hurdle in industries that require high transaction volumes.

Additionally, the consensus mechanisms used in blockchain systems, such as Proof of Work (PoW) and Proof of Stake (PoS), can also impact scalability. Negative attitudes towards blockchain, technical issues, high costs, and legal and regulatory uncertainties are some of the barriers that organizations may face. Lack of information technology infrastructure and unclear policy supervision can further hinder adoption.

Future of Tomato Supply Chain with Blockchain

The integration of artificial intelligence (AI), Internet of Things (IoT), and other technologies can further enhance monitoring and controlling of the tomato supply chain. This integration of blockchain technology in the tomato supply chain will possess a potential for significant long-term impact. IoT devices can collect real-time data on various aspects of the supply chain, such as temperature, humidity, and location, enabling proactive decision-making and quality control. AI algorithms can analyze this data to identify patterns, optimize processes, and predict potential issues, leading to improved efficiency and reduced waste. The combination of blockchain, AI, and IoT can create a comprehensive and interconnected system that enables end-to-end visibility and optimization of the tomato supply chain. Blockchain can also incentivize sustainable practices by providing rewards or tokens for environmentally friendly actions, such as reducing carbon emissions or implementing water-saving techniques.

Conclusion

The tomato supply chain confronts significant problems in terms of food safety, quality, and decreasing postharvest losses. Blockchain technology offers a viable answer to these concerns by increasing transparency and traceability across the supply chain. Stakeholders can reliably monitor the origin, quality, and safety of tomatoes at every stage by integrating blockchain, providing consumers with crucial information to make educated decisions. However, for successful integration, issues such as data protection, scalability, and adoption barriers must be solved. Combining blockchain with AI and IoT has the potential to establish a sustainable and integrated tomato supply chain that benefits both stakeholders and the environment in the future.

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From Farm to Fork: The Interplay of Horticulture and Food Technology

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Food production, processing, and distribution are greatly influenced by horticulture and food technology, two separate but related professions. Food technology is concerned with the creation and implementation of methods to process, preserve, and improve the quality and safety of food products, whereas horticulture is focused on the science and practise of growing fruits, vegetables, herbs, and ornamental plants. When these two disciplines work together, they provide a potent synergy that has a favourable effect on a number of different elements of our food supply chain. The integration of horticulture and food technology in India is ultimately a step towards a more robust, effective, and dynamic food system that can meet the various needs of the population of the country.

Horticulture guarantees the production of high-quality, fresh raw materials, but food technology makes these commodities available and practical for customers.

Collaboration and creativity are the basis of this alliance. Together, horticulturists and food technologists tackle the problems they face. They are committed to establishing crop types with better nutritional profiles and tastes, sustainable agricultural methods, and cutting-edge eco-friendly packaging.

Crop Quality and Production

Horticulture provides the raw materials for the food industry. Horticulturists maintain a dependable and high-quality supply of fruits and vegetables by developing new plant varieties, improving cultivation methods, and using sustainable farming practises. While reducing resource use and environmental effect, they work to boost crop yields.

Horticulturists and food scientists collaborate to make sure that these crops retain their quality from the farm to the consumer's plate. They assist in preserving the nutritional value, flavour, and texture of fresh products by improving food processing and packing. For instance, food scientists' inventions of freezing, canning, and drying techniques aid in extending the shelf life of perishable horticulture items.

Food safety and preservation

Food technology and horticulture both place a premium on food safety. To lessen the usage of chemical pesticides and to increase the safety of fresh produce, horticulturists practise excellent agricultural practises. In order to avoid contamination and spoiling, they also aim to improve post-harvest handling techniques.

Food scientists expand on these initiatives by creating cutting-edge methods for food preservation. To kill or inhibit dangerous bacteria, processes including pasteurisation, irradiation, and high-pressure processing are utilised. This prolongs the shelf life of food goods while ensuring their safety. Additionally, food technology is essential in the development of packaging materials and systems that safeguard food against tampering, physical harm, and environmental variables.

Nutrient enhancement and fortification

Food technology and horticulture can work together to increase the nutritional value of our food.

Crop types that have improved nutritional profiles can be created by horticulturists. For instance, they can try to develop fruits and vegetables that contain more vitamins, antioxidants, or important minerals.

Then, food technologists can use a variety of techniques to improve the nutritional value of processed meals. This involves fortification, the process of enhancing food products with necessary nutrients. For instance, iron addition to cereal items or vitamin D fortification of milk can correct nutritional deficits and enhance general health.

Waste reduction and sustainability

In the current food production environment, it is essential to reduce food waste and embrace sustainable practises. By increasing crop yields, minimising insect and disease-related losses, and using sustainable agricultural techniques like organic farming and precision agriculture, horticulturists can reduce waste at the source.

Food technologists can contribute to waste reduction by coming up with creative uses for extra or damaged horticulture goods. This involves transforming overripe fruits into juices, extra tomatoes into sauces, or misshaped veggies into soups and snacks. In order to lower post-harvest losses, they also create technology for better food storage, transportation, and packing.

Conclusion

In conclusion, the issues that face the horticulture and food technology industries are closely related, mostly because both industries rely on horticultural raw materials as a crucial component of their operations. These issues not only have an impact on each field alone, but they also have a domino effect on one another. It is crucial to understand that food technology and horticulture are not independent fields, but rather two interrelated facets of the larger field of food production and processing.

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Sorghum Anthracnose: The Global Notorious Intervention in Production and Productivity

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Sorghum (*Sorghum bicolor* (L.) Moench) is historically farmed in regions with high ambient temperatures and little soil moisture. It is a tropical crop that may have originated in northeast Africa and was domesticated between three thousand and five thousand years ago (Pedersen *et al*., 2003). Sorghum comes in after wheat, rice, maize, and barley as the world's fifth-largest cereal crop. Sorghum is a dual-purpose crop, producing stover and grain, both of which are very valued. Stover contributes around 50% of the overall crop value in the majority of the developing countries. Sorghum is regarded as a "poor man's crop". Since it provides the majority of the calories for rural residents who rely solely on grains and millets. Pests and plant diseases reduce the production of the sorghum crop. It is afflicted by root, stalk, foliar, panicle, and caryopsis diseases brought on by a variety of plant pathogens, including fungus, bacteria, and viruses (Prom *et al*., 2005). According to Sharma *et al*. (1978), downy mildew, rust, anthracnose, zonate leaf spot, leaf blight, grey leaf spot, sooty stripe tar spot, and rust are the most common sorghum foliar diseases of fungal origin in India.

Anthracnose, a disease caused on by *Colletotrichum graminicola*, is among the most significant and economically significant (Nicholson and Epstein, 1991). On the affected portion of the crop, anthracnose disease is indicated by the development of dark, sunken lenticular symptoms. Sorghum anthracnose was initially discovered in Togo, West Africa, in 1902 (Sutton, 1980), and it has subsequently been discovered in many other sorghum-growing areas throughout the world. Higher loss is caused by this disease in tropical and semi-arid regions where weather conditions favor *C. graminicola* growth, propagule dispersal, and sporulation. These conditions include high temperatures, relative humidity, and total rainfall.

Economic importance of disease

According to Hiremath and Lakshman (1990), the anthracnose disease is particularly worse in the Indian states of Andhra Pradesh, Maharashtra, Delhi, Madhya Pradesh, Uttar Pradesh, Tamil Nadu, and Karnataka. Serious yield losses might not happen if leaf symptoms don't show up until after the plant has reached maturity. *Colletotrichum* species affect infected plants and cause blight, spot disease, and damping-off in addition to anthracnose. It has been discovered that *C. graminicola* is a very variable pathogen.

Extent of damage

The anthracnose disease causes losses that differ according on the location. It is 50% in Georgia. It is 30% in Pakistan and 1.2 to 16.4% in India. Anthracnose-related losses often fell between 41% and 60%. Infected grains lose 51% of their weight when compared to healthy grains from plants the same age. In the highly sensitive cultivar. Grain losses from anthracnose to be as high as 88.7%.

Symptoms of the disease

Colletotrichum graminicola produces a wide range of symptoms on sorghum plants depends on the cultivar, inoculum load present in the location and weather parameters.

Symptoms on leaves: The host genotype affects the size and color of the symptoms, which move from lower to higher leaves. On a susceptible hybrid, typical symptoms emerged as tiny, semitransparent, water-soaked spots that ranged in shape from oval to elongate. Spots that ranged in color from red to orange to purple to tan grew into larger and turned tan, with a wider border. If lesions coalesce, the entire leaf could become blighted, giving it a "fired" appearance. Acervuli may cluster in concentric rings when they develop in huge numbers. Conidiospores and structures that resemble black hair (setae) develop in the acervulus. As seen in Figures 2A and B, a midrib infection may also manifest as a leaf infection.

Infection on stems: symptoms often appear on mature plants. When conidia from the leaf blight stage are splashed or wind-blown onto the stalks, infection ensues. A water-soaked browning of rind tissue in the lower internodes is the first sign of stalk infection. Infected tissue is intermingled with healthy tissue, and lesions take on a reddish colour (Fig. 2 C). Lesions on panicle and grains are initially water-soaked and, as they age, become tan or purple. They appear immediately below the epidermis and might be elliptical or bar-shaped. Areas of reddish, diseased tissue can be observed intermingled with healthy, white tissue if the panicle is dissected longitudinally. Infected tissue may develop black acervuli that spread to the seed (Fig. 2 D).

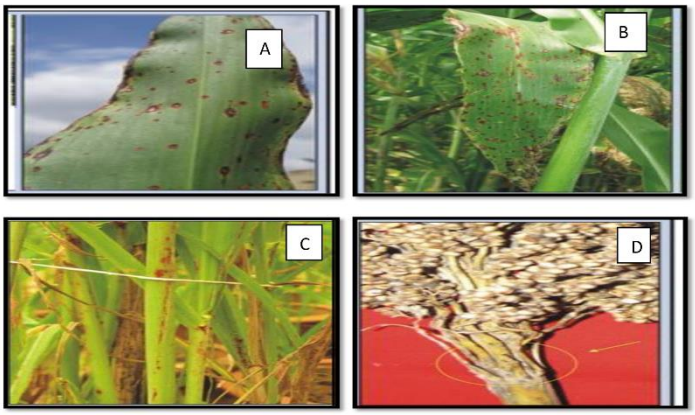


Fig. 2. Symptoms of anthracnose of sorghum A and B. Symptoms on leaves, C. Symptoms on stem and D. Symptoms on panicle

Pathogen

The pathogen was initially termed *Dicladium graminicola* by Cesati and then given the name *Colletotrichum graminicola* cereale. Wilson is currently known as the pathogen *Colletotrichum graminicola* (Ces.) Wilson (1914) renamed by waving on all the pathogenic species on cereals. *Glomerella tucumanensis* (Speg.) was named by Arx and Mullar (1954) as the fungus's ideal stage.

Morphological characters of pathogen

Colletotrichurn graminicola mycelium is submerged, branching, septate, hyaline, and either light brown or dark brown in color. It is distinguished by conidiomata known as acervulus that are present in the necrotic area of the lesion. On leaf and stem lesions, acervuli are black, rounded or elongated, and range in size from 70 to 300. Acervulus cells sporadically grow into setae, which are dark, somewhat inflated at the base, and tapered to the rounded, occasionally whiter tip. On this point, conidia can occasionally form. Conidiophores are many, brief, tightly packed, hyaline structures that are each 1-2 x 6-12 m in size and possess a single terminal conidium.

Morphological characters:

1. **Conidia**

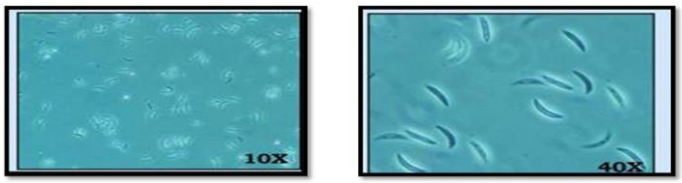
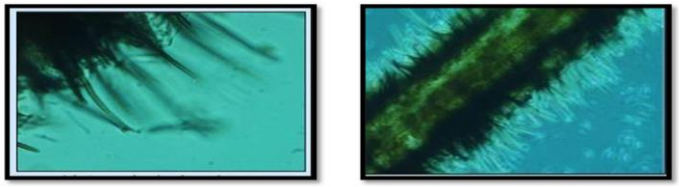


Fig.3 Conidia of *Colletotrichum graminicola*.

2. **Acervulus**



Acervulus in the culture **Acervulus on the leaf**

Fig. 3 Acervulus of *Colletotrichum graminicola*

Survival of pathogen

The pathogen may live on maize kernels for more than three years at 4°C during his three-year investigation on the survival of *C graminicola* in corn kernels. Disease may live for up to 2.5 years on sorghum seed but only for a maximum of 9 weeks in soil. Conidiospores are the source of inoculum for secondary infection and have a creamy to pinkish appearance when they are abundant.

Variability

This pathogen fungus had a wide range of variation. The pathogen's physical and cultural diversity make it difficult to identify it on a particular host. Furthermore, there is no set cultural condition that taxonomists adhere to and the phenotypic plasticity of the features in artificial culture varies widely. The presence, absence, and form of setae, the presence of sclerotia and appressoria, and the presentation of symptoms on the hosts have all been used to identify the pathogen in general terms (Sutton, 1992).

Management

For management of this disease is quite difficult due to its airborne nature and survives in various alternate and collateral hosts. Hence the most practical, cost-effective, and viable technique for managing plant diseases has been discovered to be breeding for resistance, but it cannot keep up with the emergence of increasingly aggressive pathogens. It is common knowledge that pathogenic diversity makes it difficult to find and use an efficient host resistance, which is a dependable and cost-effective method of managing plant diseases. when disease onset occurs at or prior to boot, a single application of pyraclostrobin-containing fungicide at or just prior to flowering reduces anthracnose, protects yield, and increases income. Rekha *et al*., 2015 studied effect of sowing dates on the sorghum disease severity on cultivars PC-6 and MP-Cheri. Although the first sowing date (1st July) had higher disease severity, yield were higher than of medium and late sown sorghum cultivars and thus did not cause significant yield loss.

Rewale *et al*., 2016 evaluated the bioefficacy of five fungal antagonists against the anthracnose of sorghum in-vitro *viz*., *Trichoderma viride*, *T. harzianum*, *T. longibrachiatum* and *T. koningii, Aspergillus niger* and two bacterial antagonists *viz*., *Pseudomonas fluorescens* and *Bacillus subtilis.* Results were exhibited significant mycelia growth inhibition of *C. graminicola* However, *T. viride* recorded significantly highest mycelial growth inhibition (79.62%), followed by *T. harzianum* (71.85%) and *T. longibrachiatum* (67.77%).

Rewale *et al*., 2018 evaluated all nine botanicals *In vitro* and all were found fungistatic against *C. graminicola*. However, significantly highest average growth inhibition was recorded with *A. indica* (70.73%), followed by *Z. officinale* (62.58%), *A. cepa* (54.43%), *P. hystrophorus* (49.81%) and *P. pinnata* (42.95%).

Conclusion

Sorghum anthracnose is foliar disease affect the photosynthesis responsible for the reduction yield and affect the quality parameters. A further option for treating sorghum anthracnose is the prudent use of pesticides. While currently required, chemicals are not a sustainable solution for crop health. For the management of disease, number of bacterial and fungal biocontrol agents have been employed. The development of a comprehensive system, including DNA-marker technology, for characterizing races, virulence pattern, organ specificity, and symptom types, identification of R genes, and tactical utilization and deployment of R genes in combination with other management options for economical and efficient management of the pathogen are some of the future research directions. Further, more diverse types of botanicals and foliar biocontrol agents need to be evaluated for developing eco-friendly and sustainable approach for management of this disease.

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