Special Issue 4

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National Conference of "Nurturing Agricultural Advancement And Sustainability 2024" (NAAAS 2024)

Zoom Mode (Online) (10-11 Feb 2024)

Jointly organized by the Society of Agriculture Research and Social Development (New Delhi) & Sampoorna International Institute of Agri. Science & Horticultural Technology, Maddur in association with the University of Mysore, Mysuru.

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Preface

Vigyan Varta An International E-Magazine for Science Enthusiasts (E-ISSN: 2582-9467) is an online multidisciplinary magazine covering all the domains of science. It publishes all types of writings including popular articles, newsletters, meeting reports, success stories, etc. that undergo a peer review by the strong editorial team that we have. It had its inception in May, 2020 and has successfully completed 4 volumes with 12 issues each year. Currently, the magazine is in its 5th volume and apart from publishing articles, our magazine has also conducted skill development workshops and webinars for the academic community. Vigyan Varta has a vision of creating and developing scientific writing skills and acumen among young researchers.

It's a privilege for us to collaborate and bring out our fourth special issue in the National Conference of "Nurturing Agricultural Advancement And Sustainability 2024" (NAAAS 2024) in Zoom Mode (Online) (10-11 Feb, 2024) jointly organized by the Society of Agriculture Research and Social Development (New Delhi) & Sampoorna International Institute of Agri. Science a& Horticultural Technology, Maddur in association with the University of Mysore, Mysuru. The conference has given notable insights on varied topics of agriculture and allied sciences and has enabled scientists, students, researchers, and academicians round the country and abroad to bring their work to the forefront.

This special issue highlights articles from diversified fields of agriculture and gives a concise overview of innovative topics to the readers.

We are happy that NAAAS 2024 has given us a chance to be its media and publication partner and help in popularizing the art of writing popular articles among the scientific community. We look forward to more such informative and insightful special issues in future as well.

Happy Learning!!

Jai Hind.

Suvangi Rath

Miss Suvangi Rath
Founder-Editor & Proprietor
Vigyan Varta

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Crop Diversification: A Sustainable Approach to Higher Yield

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Diversified crop rotation, inter-cropping, Soil degradation, Ecological sustainability, Anthropogenic

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ABSTRACT

Across the globe, farming systems become more efficient with the implementation of diversified crop rotation, or DCR. It might enhance system production and improve soil conditions. In a range of crop rotations, improved soil properties such as enhanced soil water absorption and storage and a higher population of beneficial soil organisms may boost yield tolerance to drought and other severe growing conditions. The study explores the different types of crop rotation and inter-cropping, role of diversified crop rotation and inter-cropping, highlighting their importance in improving soil quality, soil health, increase crop productivity, controlling pests and disease, soil degradation from global cropping system, nutrient & moisture utilization from different depth of soil and optimizing resource use. The review, which draws from a wide range of sources, looks at case studies and empirical data that highlight the benefits of intercropping and varied crop rotation for soil health, biodiversity, and overall farm resilience. The ability of soil to function, within ecosystem boundaries, to sustain crop and animal productivities, maintain or enhance environmental sustainability, and improve human health globally is known as soil health. In agro-ecosystems, the soil health can change due to anthropogenic activities, such as preferred cropping practices and intensive land-use management, which can further impact soil functions. Crop rotations involving a variety of crops improve soil and ecological sustainability, reward farmers, and lower production risk and uncertainty.

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INTRODUCTION

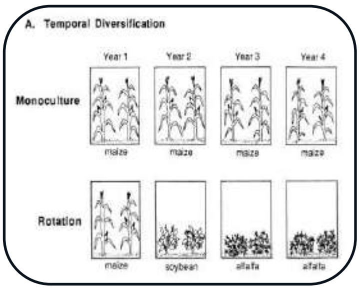
The process of adding new crops or cropping systems to a farm's agricultural output while accounting for the varying returns from value-added crops with complementing selling prospects is known as crop diversification. Two sustainable agricultural techniques that have been used for millennia to improve agricultural production, preserve soil health, and foster overall farm resilience are crop rotation and intercropping. We examine the basic ideas, historical background, and current uses of crop rotation and intercropping in this review, highlighting their importance in contemporary agriculture. Crop rotation has its origins in traditional farming methods from long ago, when farmers realized the advantages of switching up the crops in their fields. Early farming groups saw that replanting the same crop in the same spot resulted in lower yields and more susceptibility to pests and illnesses. In response, they started using the innate symbiosis between plant species by seasonally rotating various crops. Systematic crop rotation systems were developed as a result of these.

The global population has nearly doubled in less than 50 years thanks to the green revolution, which heavily relies on chemical inputs like pesticides, fungicides, fertilizers, and herbicides for effective crop production. *(Armanda et al., 2019)*. The proper cropping sequence should be chosen by farmers to increase soil fertility. Increased crop yield can lower the likelihood of global worming in agricultural fields by lowering carbon loss and greenhouse gas emissions *(Cha-un et al., 2017).* Crop rotation increases soil organic carbon and has a favorable impact on lowering greenhouse gas emissions, including carbon dioxide. *(Singh and Kumar, 2021).*

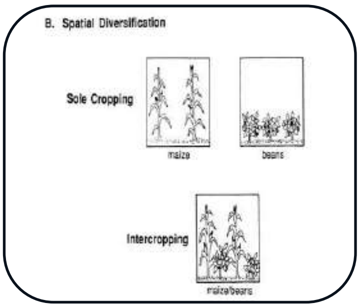
Crop Rotation Types: -

Crop rotation is one method of achieving temporal crop diversification; intercropping is one way to accomplish spatial crop diversification.

1. **Temporal cropping system:** A single field's crop sequence is displayed. There is a comparison between four years of nonstop maize and a rotation of soybeans, alfalfa, and maize.



2. **Spatial crop diversification:** Spatial arrangement: Refers to the way that crop plants are distributed in a field. For example, they may be randomly distributed, when seeds or propagules are randomly broadcast or they may be sown in rows, in a regular pattern when drillers are used. (Liebman *et al*., 2005)



Every season, you might plant a new plant in the same field, or you could create zones and plant various plants in each zone. Let us examine the most common sequences of one to five years.

a. Plans for One-Year Crop Rotation

(i) Mustard with maize, (ii)Wheat and rice, (iii) Mustard with rice.

b. **Plans for Two-Year Crop Rotation**

(i) Fenugreek, sugarcane, mustard, and maize, (ii) Peas, maize, potatoes, and sugarcane, (iii) Spelt, clover, and oats.

c. **3-Year Plans for Crop Rotation**

(i) Mung, rice, wheat, and mustard, (ii) Wheat, corn, sugarcane, cotton, oats, and peas, (iii) potatoes and roots, foliage, and other plants.

d. 4-Year Plans for Crop Rotation

(i) potatoes and roots, the bean family and brassicas, and any other plant, (ii) Brassicas, potatoes, legumes, onions, and roots, (iii) legumes, brassicas, tomatoes, and roots.

e. 5-Year Plans for Crop Rotation

(i) Winter brassicas, tares, onions, and grazing rye/phacelia, (ii) root vegetables (carrots, parsnips), potatoes, mustard, legumes, brassicas, sweetcorn, and cucurbits.

What is Inter cropping and its several types:

Growing multiple crops simultaneously in a predetermined row arrangement on the same field is known as intercropping. Three rows of intercrops can be planted after the main crop is planted in one row. Productivity per unit area rises as a result. Intercropping comes in several forms:

I. **Row Intercropping**: Row intercropping is the practice of planting component crops in alternating rows. It aids in making the most use of available land and suppressing weeds in the early stages of the primary crop.

II. Intercropping in strips: Strip cropping is the practice of growing two or more crops in wide strips so that they may be handled independently of one another. But there's enough proximity between the crops for interaction.

III. **Relay intercropping:** It Involves planting a second crop after the first has bloomed but before it is harvested. Say, rice, cauliflower, onions, and summer gourds.

Role of diversified crop rotation and inter cropping:

- ***Soil Quality improvement (Physical and Chemical Properties):*** The pioneers in creating and sustaining soil health practices have been scientists and agricultural practitioners. By emphasizing long-term sustainability, scholars and agricultural producers can help minimize unintentional soil depletion. Agricultural production techniques including crop rotation, diversified crop cultivation, and related intercropping have an impact on soil health and quality from a range of temporal and geographical viewpoints. *(Shah et al., 2021)*

  Cropping systems, which affect soil health and quality from several geographical and temporal dimensions, include crop diversification, crop rotation, intercropping, and associated agronomic methods used in agriculture. *(Vukicevich et al., 2016).*

- ***Increase in Crop Productivity:*** By maximizing soil health, nutrient availability, and insect management, crop rotation increases crop output. It improves soil fertility, structure, and microbial activity while preventing nutrient depletion and lowering insect and disease load. Together, these elements support higher yields and greater crop production. Genetically modified cultivars have been tested in agriculture to satisfy the needs for food requirements, industrial applications, and environmental security in order to maximize crop variety with the best cultivar choices. For instance, a novel cultivar of cassava with the PTST1 or GBSS gene can lower the amount of amylose in its root starch (Bull *et al.*,2018).

- ***Disease resistance:*** The primary goal of crop rotation in conventional arable rotations is often to lower the prevalence of illnesses, pests, or weeds that are challenging to eradicate using pesticides. Two- or three-crop short rotations are commonly used. Crop rotation is a useful strategy for reducing the accumulation of some diseases, mainly nematodes and fungi, but to a much lesser degree, viral and bacterial illnesses. (Curl *et al*., 1963).

  In some circumstances (such as Criconemoides ornatus Raski with peanut [Arachis hypogaea L.]), short rotations are ineffective and the host crop must not be present for several years. In contrast, short rotations, such as maize-soybean, are effective. (Kurtz *et al*., 1984).

- ***Soil degradation from global cropping systems:*** Crop rotation, which alternates between plants with deep and shallow roots, can enhance soil fertility and structure. Consequently, there may be a lower chance of flooding downstream due to less erosion and increased infiltration capacity. Global soil degradation in agriculture is a result of numerous anthropogenic practices used in different cropping systems, including intensive tillage, the use of fossil fuels, the draining of wetlands, the adoption of heavy machinery in farming operations, fertilization, and pesticide management. Soil health is also threatened by other factors such as wind and water erosion, the loss of organic matter in peat and mineral soils, compaction, sealing, pollution, salinization, desertification, floods, landslides, and a decrease in biodiversity. (*Stolte et al., 2015*).

- ***Weed management:*** Monocropping encourages certain weeds to survive and associate. Weeds that are attached to and related with crops, like Avena fatua in wheat, can be effectively controlled by crop rotation and inter-cropping. Avena in wheat is broken by wheat-pea and gram. Crop rotation with legumes controls cuscuta. Crop rotation with low land rice may efficiently suppress weeds such as Cyperous rotundus. By employing the Shannon-Wiener diversity index, Covarelli and Tei (1988) investigated structural variations in the weed flora of continuous maize (Zea mays L.) and maize-wheat rotational cropping systems. Upon six years (two or three cycles of the rotations), more variety was noted in the rotations compared to the monoculture (*Liebman et al., 1993).* Quackgrass (Elymus repens) and other perennial grass weeds need to be carefully managed before sod is planted, or else they will probably spread during the sod phase of the cycle. Furthermore, annual weeds might produce a large number of seeds during the sod crop's establishment, counteracting the predicted decrease in the weed seed bank. (*Charles et al.,2009).* Crop rotation's effects on weeds take longer to manifest than those of tillage or cultivation, but over the course of many years, a well-thought-out rotation strategy may significantly reduce the density of weeds. One important strategy organic farmers may use to replace labour and

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expensive inputs with brain capacity is rotation planning. This idea also applies to diseases, insects, soil nutrients, and overall soil health in addition to weeds.

CONCLUSION:

As people's concerns about providing high-quality food with little environmental effect grow, diversified crop rotations are becoming more and more popular as a technique for ensuring sustainable agricultural production. DCR interrupts the cycle of disease, promotes the interactions of beneficial soil bacteria, and minimizes the amount of weeds. DCR enhances soil's chemical and physical characteristics while raising agricultural production and land-use efficiency. (Kabita et al.,2021). Crop rotation and intercropping techniques together have the potential to improve weed management, which should be actively pursued. It is recommended that scholars devise and examine cropping systems that incorporate both temporal and geographical variety. (*Elizabeth et al., 1993).*

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Seaweeds, their Culture and Importance: A Mini Review

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ABSTRACT

Seaweeds, which are macrophytic algae, represent a primitive category of plants that lack true roots, stems, and leaves. The majority of seaweeds fall into one of three divisions: Chlorophyta (green algae), Phaeophyta (brown algae), and Rhodophyta (red algae). In nature, there are approximately 900 species of green seaweed, 4000 red species, and 1500 brown species. The highest diversity of red seaweeds is observed in subtropical and tropical waters, while brown seaweeds are more prevalent in cooler, temperate waters. Due to the insufficient natural stocks of seaweed to meet industrial demands, cultivation of these crucial resources has become imperative. Asia leads the world in seaweed cultivation, with over 80% contributed by China, Korea, and Japan. Despite India's extensive coastline of more than 17,000 km and 821 seaweed species, seaweed cultivation was not previously pursued. However, recent developments have seen an increase in seaweed cultivation in certain coastal districts of the Tamil Nadu state. The Central Salt Marine Chemical Research Institute and Central Marine Fisheries Research Institute have developed cultivation techniques for commercially important seaweed species in India. This has prompted the involvement of Self-Help Groups, Village Youth Groups, and NGOs in promoting seaweed cultivation as an alternative livelihood for coastal communities. Given the international market demand,

ample manpower, and growing interest, seaweed cultivation in India has a promising future and can be developed into a successful cottage or cooperative sector industry. Given the substantial international market demand, along with the presence of sufficient manpower and interest within the country, seaweed cultivation holds significant promise and has the potential to evolve into a thriving cottage or cooperative sector industry.

INTRODUCTION

Seaweeds, often overlooked but immensely versatile, have played integral roles in various aspects of human life for centuries. With over 220 species, they offer a wealth of valuable resources and culinary delights. Approximately 145 species are esteemed for their culinary qualities, enriching cuisines worldwide with unique flavors and rich nutritional content. From centuries-old dietary traditions in Japan and China to modern global markets, seaweeds like Nori, Kombu, and various green varieties such as *Enteromorpha*, *Ulva*, *Caulerpa*, and *Codium* have been cherished for their culinary applications (Naik and Naik, 2020). Whether consumed fresh in salads or incorporated into cooked dishes alongside rice, seaweeds add depth and complexity to culinary creations.

Beyond their role in the kitchen, the commercial value of seaweeds extends into various industries worldwide. Extracts such as agar-agar, agarose, and carrageenan, derived primarily from red seaweeds, find widespread applications, particularly in the food and pharmaceutical sectors (Chowdhury *et al.* 2022). Agar, renowned for its versatile properties, serves not only as a food additive but also as a laxative and a capsule coating in pharmaceuticals. In laboratory settings, agar gums are utilized to produce agarose, facilitating crucial scientific techniques like electrophoresis—a testament to seaweed's indispensable role in scientific progress. Seaweeds' medicinal properties, ranging from anti-viral and anti-cancer effects to bone-replacement therapy and cardiovascular surgery, highlight their significance as a "medical food" of the 21st century, cementing their importance in both traditional and modern contexts.

Importance of seaweed aquaculture

The challenge of food security looms large as we approach 2050, with a projected global population of 9 billion. Seaweed aquaculture emerges as a promising solution to address this pressing issue while also tackling global health concerns and fostering a sustainable circular bio-economy. The concept of Ocean Domestication holds immense potential as a means to bolster food production and could mark a pivotal milestone in human history. Seaweed aquaculture stands out for its multifaceted benefits to environmental protection (Jiksing *et al*. 2022). It bolsters the food web, shields coastlines from erosion, aids in bioremediation by purging pollutants like nitrogen and phosphate, and contributes to CO2 sequestration. In the realm of pharmaceuticals and medical applications, macroalgae showcase impressive antibacterial and antifungal properties. They harbor compounds with promising potential in cancer treatment, exhibiting potent cytotoxic effects against human cancer cell lines. There's optimism regarding their therapeutic utility in combating Adult T-cell leukemia (ATL) and as antioxidants and anti-inflammatory agents. Algal biofuels emerge as a renewable energy source with numerous advantages over terrestrial fuels, boasting higher energy content, rapid growth rates, and complementarity rather than competition with terrestrial biofuels. Seaweeds, rich in lipids conducive to oil production, offer an ideal ingredient for formulating cosmetics products (Jiksing *et al.* 2022). Furthermore, the burgeoning algal industry holds promise for job creation across a spectrum of fields, spanning research, engineering, construction, farming, marketing, and financial services.

Products Procured from Seaweeds

a. Agar, derived from specific red algae families, is widely used across industries. It serves as a crucial medium in biomedical laboratories and as a gelling agent in confectionery. In food processing, it stabilizes cheese and provides protective coatings for canned products (Naik and Naik, 2020). Agar also clarifies beverages in brewing and acts as a laxative in pharmaceuticals. Its versatility extends to ion exchange resin production, cosmetics, and applications in paper and textiles.

b. Alginic acid, a key component of alginates, is widely used across industries. Derived from alginic acid, alginates like sodium and calcium alginate find extensive application in pharmaceuticals. In this sector, alginic acid acts as an emulsifier, filtering agent, and base for ointments (Naik and Naik, 2020). Alginate gauze serves as a hemostatic plaster, and alginate functions as a slimming agent by promoting a feeling of fullness. Additionally, ammonium alginate wool acts as a microbial filter in laminar flow hoods.

c. Carrageenan, extracted from red seaweeds like Gigartinaceae, Soliriaceae, and Hypneaceae, finds extensive use in the food industry. It is utilized in bakery, confectionery, and culinary products, including condiments, syrups, whipped creams, ice desserts, and cheese. Carrageenan also plays a role in clarifying fruit juices and improving the quality of wheat flour for pasta and bread making. Its importance in food production is evident, with the sector accounting for nearly 70% of the global carrageenan market (Chowdhury *et al*. 2022).

d. Mannitol, a crucial sugar alcohol found in brown algae, serves diverse purposes. Sourced primarily from algae like *Fucus vesiculosus* and *Sargassum* spp., it is used in pharmaceuticals for tablet preparation, diabetic diet formulation, and chewing gum production (Chowdhury *et al.* 2022). Mannitol also finds applications in explosives, pyrotechnics, and acts as a plasticizer in resin production.

e. Liquid seaweed fertilizer (LSF) is a mineral-rich extract commercially available under various names. Studies show it enhances germination, seedling vigor, and fruit development in crops like groundnut, maize, gingelly, and tomatoes. Patented since 1912, brands like "Maxicrop," "Bioextract," 'Marinure,' 'SM-3,' 'Trident,' and 'Algifert' emerged. In India, SPIC markets LSF as 'Cytozyme' (Chowdhury *et al.* 2022).

f. Seaweed offers a promising solution to the challenge of producing feed for livestock amidst diminishing cultivable land and water scarcity. Its use as animal feed dates back to ancient times, with European farmers traditionally utilizing seaweed for livestock. In Norway, Ascophyllum serves as pig meal, while Rhodymenia palmata is known as "cow weed" in Brittany and "horse weed" in Norway. Dried and processed seaweeds have been utilized as animal feed in Europe and North America (Kang *et al.* 2021).

g. Seaweeds, rich in protein, carbohydrates, vitamins, and minerals, offer numerous benefits when added to animal feed. Studies show they enhance milk production in cows, egg pigmentation in chickens, and overall health in horses and pets. Research from various countries explores seaweeds as supplementary animal feed. Pioneering studies by the ICAR-National Dairy Research Institute in collaboration with CMFRI focus on using Sargassum spp. for cattle feed (Naik and Naik, 2020; Chowdhury *et al.* 2022).

1. Methods of Cultivation

There are two main methods of cultivation of seaweeds; one is that by means of vegetative propagation by using the parts/fragments from the mother plant and the other one includes the usage of different kinds of spores such as zoospores, monospores, tetraspores and carpospores.

1.1. Vegetative Propagation

In the intricate art of seaweed cultivation through vegetative propagation, the humble thallus emerges as the seed material, harvested delicately from intertidal realms during the ebb of low tide. Intriguingly, the cultivation process unfolds on substrata meticulously crafted from 2 x 2-meter nets, distinguished by their 20-centimeter mesh, fashioned from either resilient nylon or the eco-friendly fibers of coir, derived from the husks of the noble coconut palm. These nets, or ropes extending up to 10 meters in length, cradle the precious fronds, each weighing approximately 5 grams, ensconced delicately within the twists and turns of their mesh or between the embraces of the rope's strands, spaced at 10-centimeter intervals along the elongated lines or nestled within the confines of the 2-square-meter nets (Kasim *et al.* 2020). These "seeded" conduits, whether ropes or nets, find their buoyant abode tethered to floating rafts or steadfast structures nestled upon the seabed's embrace, particularly in the sheltered embrace of bays, serene lagoons, or the gentle embrace of shallow coastal domains. To orchestrate the symphony of their motion upon the aqueous stage, an ensemble of floats and sinkers comes into play, delicately poised either upon the water's shimmering surface or in its silent depths. Indeed, an array of techniques for the vegetative propagation of seaweeds exists, each tailored to the unique tapestry of the site's landscape, the rhythm of the farming season, and the whims of the species being cultivated. Among them, the net tube method emerges as a beacon of innovation, unveiling elongated sleeves of nylon nets, each spanning 10 meters in length and 6 centimeters in diameter, bearing the semblance of intricate "net tubes," meticulously seeded with vegetative fragments. Anchored to sturdy bamboo poles, these ethereal tubes dance upon the azure expanse, awaiting their moment of harvest, typically orchestrated after a reverent passage of 60 days.

1.2. Reproductive Method

Seaweed cultivation in India embraces innovative techniques utilizing reproductive units like zoospores and carpospores for propagation. A notable success story involves the liberation of carpospores from *Gracilaria edulis* onto diverse substrata, nurturing them in a specialized nursery, and subsequently transplanting them into their natural habitat. Remarkably, the germling stage is attained within a mere 13 to 17 days, enabling three harvests from the same seed stock within a span of 105 to 135 days. The optimal cultivation window for *Gracilaria edulis* along the southeast and southwest coasts of India aligns with the months from November to March (Kasim *et al.* 2020).

CONCLUSION

The carbon fixation potential of photoautotrophic algae offers a promising avenue for mitigating CO_2 emissions, which have surged by 35% globally since 1990. Seaweed biomass along the Indian coastline exhibits a remarkable capacity to utilize 9052 tons of CO_2 per day, vastly surpassing emissions of 365 tons per day, indicating a substantial sequestration potential of 8687 tons of CO_2 per day by seaweeds. By 2020, India's mariculture potential for seaweed is projected to reach 2 million tons. To curtail seaweed import and seaweed polysaccharide dependency, a phased strategy prioritizing large-scale seaweed cultivation, particularly through integrated multitrophic aquaculture (IMTA) in shelf areas, bays, and estuaries, is recommended. For intertidal mariculture, *Gelidiella acerosa* emerges as an optimal species, while *Kappaphycus alvarezii* and *Gracilariopsis lemaneiformis* are suited for deep and brackish water environments, respectively. Scaling up mariculture operations using *Gracilaria edulis*, *Gelidiella acerosa* for agar production, *Kappaphycus alvarezii* for carrageenan, and *Ulva* and *Caulerpa* for their nutraceuticals and secondary metabolites holds immense potential in combating major greenhouse gas emissions and addressing ocean acidification. This approach not only addresses environmental concerns but also provides seaweed farmers with alternative livelihood opportunities.

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How House Flies Affect Human Health and Control Strategies to Get Rid of Flies

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ABSTRACT

Musca domestica (Muscidae: Diptera) is the most common fly all over the world. More than 100 pathogens may cause diseases in humans and animals by houseflies. These pathogens included infantile diarrhea, anthrax, cholera, ophthalmia, *Bacillary dysentery*, typhoid, and tuberculosis. Houseflies also transmit many helminthic eggs as *E. vermicularis*, *S. stercoralis*, *T. trichiura*, *T. caracanis*, Trichomonas, Diphyllobothriam, hymenolepis, taenia, and Dipylidium species. Their indiscriminate feeding habits, often involving feces and garbage, allow them to transfer pathogens on human food and surfaces, thereby contributing to the spread of diseases. House flies pose health risks and require effective control strategies. These include sanitation measures, physical exclusion methods, and traps and insecticides. Integrated pest management (IPM) approaches have proven effective in managing infestations while minimizing environmental impact and human health risks.

INTRODUCTION

House flies are global pests that cause annoyance and infection. Control methods include reducing immature stages before they disperse. Adult flies can travel long distances, but larval habitats are restricted due to wet organic material. Urban pest control has limited target source reduction, and even in cities, environments

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like rubbish and animal corpses are not easily controlled. The house fly is recognized to be a filth fly because its juvenile stages develop in dung, corpses, decaying rubbish, and other similar environments. House fly larvae may live in various settings as long as they are wet and contain adequate organic nutrients. Similarly, adult house flies consume various meals and may quickly grow their population due to their short developmental cycle and high reproduction rate. House flies contain hundreds of various kinds of harmful organisms, including bacteria, fungus, and viruses. Some infections are ingested and grow in the fly, whereas others spread mechanically by clinging to setae and other exterior structures. Because flies not only walk on food, but also excrement and puke on it, there is plenty of potential for house flies to contaminate meals.

Identification characteristics of flies

Adult house flies have reddish eyes, and sponging mouthparts, are 3–8 mm in length, and can be recognized by the presence of four dark stripes on the dorsum of the thorax and the pronounced upward bend in the fourth longitudinal wing vein (vein M1+2). The basal portion of the abdomen is usually yellowish, especially along the sides, with males typically showing greater lateral yellowing than females. A dark longitudinal band runs along the median dorsal region of the anterior abdominal segments. The eyes of females are much more widely separated than those of males. House flies are found most commonly and abundantly at animal production facilities but also occur in urban settings where the larvae develop in a wide range of decaying vegetable materials, feces, and household garbage.

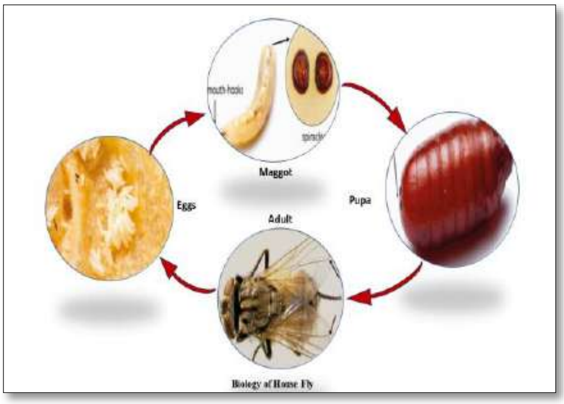
Biology

Musca domestica consists of egg, larva, pupa, and adult (complete metamorphosis).

Eggs: Housefly eggs are small (1 mm), white, and deposited on or just under the surface of moist substrates. Eggs generally hatch 6-12 hours after deposition.

Maggots: House fly larvae, also known as maggots, move to dry areas to pupate. In summer conditions, the pupal stage of these larvae lasts for 3 to 6 days. The third instar of the house fly is creamy white and measures between 5 to 8 mm. It has blackened, internal mouth-hooks. These larvae can develop in a variety of decaying plant substrates, such as crop residues. Regardless of the substrate, fly larvae must consume live microorganisms to complete their development.

Pupae: The reddish-brown puparium (4-7mm) of the house flies with hardened spiracles at the rear.



Feeding mechanism

Adult house flies have a mouthpart called **"sponging"** which allows them to consume only liquid food or they must regurgitate contents onto solid food to soften them before they can eat. When flies exude a droplet of regurgitate, it is called bubbling (Stofolano 2019). This phenomenon is thought to eliminate excess water from their bodies and may also help them regulate their body temperature (Gomes *et al*. 2018). However, these droplets can be deposited on surfaces where flies rest, leading to accumulations of both regurgitation and fecal spots. This deposition of regurgitation and fecal spots can play a role in the transmission of pathogens and is often used in monitoring programs as an index of fly abundance.

Reproduction

Female flies typically mate only once and usually do so within 36 hours of emerging from their pupae. Although the material that attracts flies is often used in baits, it is not found in all fly populations. Under laboratory conditions, if given nutritious food, flies can lay their first batch of eggs 3-5 days after emerging. In a single gonotrophic cycle, a female fly can lay between 100-150 eggs. Since flies can produce up to six batches of eggs under such conditions, an individual female fly can lay up to **900 eggs** in her lifetime. While protein is essential for egg maturation, flies can develop eggs even with brief, intermittent bouts of protein feeding.

Longevity

Female flies that are kept under ideal laboratory conditions can live up to six weeks (Haselton *et al*. 2004). However, field studies that used mark-release-recapture methods indicate that wild flies have much shorter lifespans than those in the laboratory. For instance, the estimated lifespans of flies in the wild range from 1 to 6 days on poultry farms, 3 to 19 days on dairy farms, and 2 to 7 days in refuse dumps. These findings suggest that some production systems may be more conducive to fly longevity than others. For instance, the short lifespans of flies in landfills and poultry farms may be due to the poor food resources available in those environments, while dairies provide a wider variety of nutrient-rich foods.

Dispersal

Most flies remain on or near the facility. They are, however, capable of moving longer distances and can create problems when they disperse from the production site to residential areas, schools, and businesses (Lole 2005; Winpisinger *et al.* 2005).

Acquisition, retention, and transmission

House flies are commonly found in microbe-rich environments where they pick up microbes such as protists, viruses, and bacteria. A single house fly can carry up to **100 different pathogenic microbes**. Flies pick up these microbes from surfaces they come in contact with, including refuse, animal waste, wounds, and exudate. Pathogens on the surfaces of flies can be transmitted to animals through physical contact or by being dislodged by fly grooming.

When flies ingest bacteria, the location and persistence of the bacteria within the digestive tract impact transmission potential. Ingested bacteria harbored in the crop and midgut are either digested and destroyed or survive to be excreted and, possibly, transmitted. Transmission of pathogens by flies to human food items is of growing concern. Fly populations flourish in livestock facilities and the threat to human and livestock health is intensified when poor sanitation and insufficient manure management allow flies to have unrestricted access to pathogen sources such as waste and excrement. House fly dispersal between farms and nearby residential and urban centers facilitates bacterial transmission to humans and therefore poses a public health risk.

Control Measures

1. Sanitation is the most effective and important step in reducing pest population. you can make your house less attractive to flies by cleaning up all food waste and crumbs (from humans and pets), securing all garbage in trash cans with liners and lids, and emptying your garbage and recycling frequently.

2. Perform regular inspections of your outdoor spaces to ensure there are no house fly breeding grounds. Periodically check for potential breeding grounds such as rotting food or stagnant water and address them properly.

3. Screen windows and doors to keep flying pests out.

4. Use indoor or sticky tape to manage pests inside the house.

5. Hang pesticide-free traps outdoors near problem areas- barns, kennels, and garbage bins to capture nuisance flies.

6. Light traps are another way to get rid of house flies. These work by attracting the flies to light in the back of the trap and trapping them or using an electric zap to kill them.

7. Fly parasites are small, harmless (to humans and animals) beneficial insects that nature has programmed to attack and kill filth flies when in their immature pupal stage. Females of various species seek out developing fly pupae using chemical cues. Once found, the wasp stings the fly's pupa to paralyze it and then deposits an egg on or in the pupa. After the egg hatches, the wasp larva slowly eats the immature fly, pupates, and emerges as an adult wasp. For best results, release 500 parasites per large animal (horse, cow, etc.) or 5 per cubic foot (manure or compost pile).

8. Organic diatomaceous earth is a mild abrasive that works within 48 hours of contact to kill soft-bodied maggots. It may also be applied to moist areas where it is found to be effective in reducing breeding sites.

9. Using botanical insecticides as a last resort is recommended due to their fewer harmful side effects and quicker breakdown in the environment, as they are derived from plants with insecticidal properties.

CONCLUSION

The housefly is a mechanical vector of transmission of pathogens including parasites, bacteria, fungi, and viruses. The combination of different methods for the prevention or eradication of houseflies should be implemented to stop human or animal diseases. In high-risk areas, health education, proper environmental sanitation, and personal hygiene are strongly advocated to overcome the menace caused by houseflies.

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Borah and Das (2024)

Economic Empowerment of Farm Women through Pig Farming in West Garo Hills District of Meghalaya

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Pig farming, women empowerment, Rani, Lumsniang

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ABSTRACT

Pig is an important livestock component in rural tribal areas in Garo Hills of Meghalaya. Pig farming has immense potential to ensure nutritional and economic security especially to women and other weaker sections of the society. It acts as a way of women empowerment in rural areas and enhances the socio-economic status of the women pig farmers. Rearing of good crossbred pigs increases production level and thus gives more income to farmers. Rani and Lumsniang are two crossbred pigs developed by ICAR having production potentiality also in traditional low input rearing system. Krishi Vigyan Kendra, West Garo Hills introduced these two varieties at farmers field in West Garo Hills district of Meghalaya and helped the farmers to improve their livelihood.

INTRODUCTION

Pig plays an important role in the economy of the West Garo Hills district of Meghalaya and is the most promising activity to contribute to the livelihood and nutritional security of the rural families in terms of animal protein. The district is predominantly inhabited by tribals and 70% of the people depend on agriculture as a main source of livelihood. Due to preference for pork in their diet, almost every tribal household in West Garo Hills rear at least one or two pigs in backyard. But still there is a huge gap between the demand and availability of pork. The main reason for insufficiency in pork production in the district is that the pigs reared by the farmers are mostly of nondescript type, whose productivity is relatively poor and hence the pork production is hardly adequate for the population. Therefore, suitable pigs breed having the capacity to attain good body weight gain while fulfilling the preference of the local people was the need of the time. In view of these facts and realizing the need for the development of pigs and their role for the economic upliftment of the farmers in the region, Hampshire crossbred pigs (Rani and Lumsniang) were introduced in West Garo Hills, Meghalaya by KVK under its OFT programme.

Rani (Ghungroo X Hampshire) is a crossbred of indigenous Ghungroo breed and Hampshire pigs having 50% inheritance from both and was developed by ICAR- National Research Centre on Pig, Rani, Guwahati.Ghungroo is well known for its high prolificacy and adaptability to low input production system and Hampshire is a breed with good body weight gain. Likewise, Lumsniang (Hampshire X Khasi Local) is a crossbred of Khasi local pig (Niang Megha) with Hampshire pig and developed by ICAR-RC for NEH Region, Umiam, Meghalaya. Both these two pig breeds have the ability to survive on low input production system.

Rani Pigs

Lumsniang Pigs

DISTRICT PROFILE

West Garo Hills is one of the largest districts of Meghalaya located in the western part of the State. The district being relatively lower in altitude to the rest of Meghalaya, experiences a fairly high temperature for most part of the year. The average rainfall is 2800-3300 mm of which more than two-thirds occur during the monsoon, winter being practically dry. The district is situated approximately between the latitudes 90° 30' and 89° 40' E, and the longitudes of 26° and 25° 20' N. Agriculture is the main occupation of the people of West Garo Hills district and rice, maize, cashewnut, arecanut and turmeric are the principal crops along with Jhuming and piggery and poultry farming for livelihood security for the people of the district.

KVK INTERVENTION

First KVK, West Garo Hills conducted “On Farm Trials (OFT)” on the performance of Ghungroo X Hampshire (Rani) and Hampshire X Khasi Local (Lumsniang) pigs in Garo Hills for a period of three years and recommended these pig breeds as suitable in the climatic condition of Garo hills even on existing low input rearing systems with good production potentiality and adaptability.Since then,KVK, West Garo Hills provided Rani and Lumsniang piglets to farmers and farm women of the district for demonstration purpose under its Front Line Demonstration (FLD) programme and different projects like "Tribal Sub Plan (TSP)" and "National Innovations on Climate Resilient agriculture (NICRA)".Training was organized by KVK for all the beneficiaries about housing, feeding and disease management in respect of pig farming.

REARING MANAGEMENT OF "RANI/ LUMSNIANG PIGS" AT FARMERS' FIELD

Pigs were reared in low-input production system. Feeding was done with locally

available materials like rice bran, broken rice, kitchen waste, colocasia, vegetables, tapioca, sweet potato, banana stem, etc. along with mineral mixtures supplementation. Different feeds are mixed and boiled to make the feed more palatable. Low-cost pig sheds were constructed with locally available materials like wood, bamboo, and thatch. The deworming schedule against endoparasites was followed regularly. Vaccination against Swine fever (SF) was done at yearly intervals and treatment at the time of sickness of the pigs was provided by KVK from time to time.

Productive and reproductive performances of Rani and Lumsniang pigs in Garo Hills

Parameters	Rani	Lumsniang
Age at sexual maturity (months)	10.6	13.5
Age at first farrowing (months)	15.3	18
Litter size at birth	9.7	9.1
Litter size at weaning	8.6	7.8
Litter weight at birth (Kg)	9.96	8.93
Litter weight at weaning (Kg)	71.35	64.35
Body weight at 6 months (Kg)	58.50	48.91
Body weight at 9 months (Kg)	77.5	65.30
Farrowing interval (days)	196	212
Gross Income (Rs) (1Male& 3 Female)	101689/-	86200/-
Net Income (Rs)	66864/-	50284/-
B:C ratio	2.92	2.4

A WAY TO WOMEN EMPOWERMENT

Without participation of women, the rural economy cannot be sustainable. Women play a significant role in the agricultural labour force and in agricultural activities, although to a varying degree. For the economy to improve and prosper, women's empowerment becomes a prerequisite. In Garo Hills of Meghalaya, 70% tribal women are engaged in agricultural activities. Livestock and poultry reared in their backyards are managed by women only. They are the real workforce both at home and in the farm combining a multitude of activities. Even if uneducated, they are naturally endowed with native wisdom. Pig farming holds significant potential for women's empowerment in rural area of Garo Hills. Pigs have immense potential to ensure nutritional and economic security especially to women and other weaker sections of the society. It provides income for women, strengthening their role in families as well as in local communities (Jaiswal *et al*. 2022). Many rural Garo women have established small units of Rani and Lumsniang pigs as an income generating activity and contribute to their economic independence and household expenditure like basic needs, healthcare, children's education, household infrastructure and ensure food security to their families. Gangadhar (2020) and Borah *et el.* (2020) reported the same observation about the income generation by women through pig farming.

CONCLUSION

Pig farming has proven to be economically viable, providing reliable source of income, particularly for rural farmers, farm women and rural youths. In Garo Hills of Meghalaya, pig farming holds significant potential for women's empowerment. By rearing good crossbred pigs that are suitable for NEH region like Rani and Lumsniang, farm women can get more production and more profit. By actively participating in this profitable venture, tribal Garo women attain economic empowerment; contribute to household income and play a vital role in fulfilling the region's pork demand.

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Smart Sustainable Agriculture for Food, Fodder, Employment, Economic and Energy Security in Villages Through Rainwater Security

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ABSTRACT

Mahatma Gandhi, often referred to as the Father of the Nation, emphasized the importance of holistic development in rural areas to achieve self-sufficiency. He believed that the Earth provides abundant resources to fulfill human needs but not human greed. This includes readily available natural resources such as light, water, soil, air, and biodiversity, which should be efficiently harnessed, conserved, and utilized for village development. The primary challenges faced by villages include inadequate water, soil, and energy security, limited employment opportunities, economic instability, and food and fodder insecurity. Approximately 60% of India's population resides in villages, with agriculture as their primary occupation. Gandhi believed that the comprehensive development of agriculture was crucial for uplifting the rural economy.

INTRODUCTION

Indian agriculture heavily relies on rainfall, with 70% of the country's 141 million hectares of cultivated land dependent on it (Singh *et al*. 2019). However, rainfall in India is unpredictable, unevenly distributed, and often untimely, and there is a lack of infrastructure for rainwater harvesting. Water scarcity is a significant limiting factor for crop production in rainfed areas. Plant composition reveals that carbon, oxygen, and hydrogen, derived from air and water, constitute 96% of a plant's composition. While air is abundant, the timely availability of water for crop production remains a challenge.

Water security in villages

Water is essential for various activities, including drinking, sanitation, industry, power generation, fishing, and, most importantly, agriculture. Water plays a critical role in transpiration (99%) and photosynthesis (1%). Both soil and water are vital natural resources directly affecting agricultural production. Studies from Orla Research Institute (USA) indicate that agriculture contributes to 28% of soil degradation while overgrazing and deforestation account for 35% and 28%, respectively. Sustainable soil and water conservation efforts should consider perception, priority, prediction, production, and planning while safeguarding the environment (Moges and Taye, 2017).

A three-pronged strategy for soil and water conservation is essential:

1. Preventing erosion in high-potential areas using eco-friendly technologies.
2. Preserving and protecting areas rich in biodiversity through improved soil and water conservation practices.
3. Restoring productivity in degraded lands.

The National Commission for Integrated Water Resource Development (1999) reported that 72% of water is required for agriculture, with 7% for domestic use, 8% for industry, and 4% for power generation. The primary objectives of water resource development include:

1. Stabilizing agricultural production in drought and flood-prone areas.
2. Improving crop yields and crop intensity.
3. Cultivating commercial crops for export.
4. Enhancing production during non-rainy seasons.
5. Introducing perennial crops.
6. Generating employment opportunities.
7. Creating income sources.

Major water sources include rainfall, rivers and canals, tanks, lift irrigation, and groundwater. Rainfall is the most significant global water resource, with varying levels across continents. In India, rainfall primarily depends on the southwest monsoon, varying by region and state.

Rainwater harvesting:

Rainwater harvesting involves collecting and storing rainwater for future use. It comprises three components: catchment area, storage area, and command area. Rainwater harvesting can be implemented in various settings, including residential buildings, farms, and villages.

Rainwater harvesting in houses:

Rainfall on rooftops can be filtered and stored in sumps for future use. Rainwater is the purest form of water, with minimal contaminants. The chemical composition of rainwater typically includes a slightly acidic pH (5.0-6.5), low total soluble salts (73 microSiemens/cm), and traces of essential nutrients (Das *et al*. 2005).

Rainwater harvesting in farmers' fields:

In situ rainwater harvesting techniques vary based on soil types. For red sandy soils, methods include fall plowing, vegetative barriers, deep tillage, ridges and furrows, and mulching (Sarvade *et al*. 2019). Black clay soils may benefit from fall plowing, vegetative barriers, scooping, compartment bunding, and more.

Rainwater harvesting structures:

To maximize rainwater retention, water storage structures are essential. Farm ponds are suitable for arable areas, while nala bunds/check dams are suitable for non-arable areas. Lining farm ponds with plastic helps conserve water (Ammar *et al*. 2016). The size of a farm pond depends on non-rainy day water requirements.

Rainwater harvesting in villages with existing tanks:

Tanks offer economic returns when water is stored and managed efficiently. Tanks serve multiple purposes, including rainwater collection, solar electricity generation, fish farming, groundwater recharge, pottery, rural sports, and employment generation (Somerville *et al*. 2014) Solar panels on tank water spread areas can supply electricity to villages, generate income, and serve as rainwater harvesting structures.

CONCLUSION

In conclusion, comprehensive strategies for water resource management and rainwater harvesting are crucial for addressing water security and promoting sustainable development in Indian villages. These initiatives can provide economic, environmental, and social benefits to rural communities.

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Importance of Forensic Entomology in Criminal Investigations

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ABSTRACT

Forensic entomology plays a crucial role in criminal investigations by utilizing the knowledge of insect biology and behaviour to provide valuable information for estimating the post-mortem interval (PMI), identifying the location of death, and assisting in the resolution of criminal cases. The primary focus of forensic entomology is the study of insects associated with decomposing human remains. In the early stages of decomposition, different insect species colonize the body in a predictable sequence, influenced by factors such as climate, season, and geographic location. By analysing the insect community and the developmental stages found on the corpse, forensic entomologists can estimate the time elapsed since death, contributing to a more accurate determination of the PMI. Forensic entomology is particularly valuable when traditional methods of determining the time of death, such as rigor mortis or body temperature, are unreliable or unavailable. Establishing a timeline for the events leading up to a crime can help to confirm or disprove alibis and greatly reduce the number of potential suspects.

INTRODUCTION

Forensic entomology is a branch of forensic science that involves the study of insects to aid in legal investigations. In particular, forensic entomologists use their knowledge of insect biology, behaviour, and ecology to provide information on cases involving death, decomposition, and other legal issues. Forensic entomology is the scientific study of the invasion of the succession pattern of arthropods with the developmental stages of different species found on the decomposed cadavers during legal investigations (Verma and Paul, 2016).

One of the primary applications of forensic entomology is estimating the time since death, known as the post-mortem interval (PMI). Insects colonize a body in a predictable pattern, and by studying the developmental stages of these insects, entomologists can estimate the time of death. Insects colonize a corpse in a specific order, known as the succession of insects. By studying which species are present at different stages of decomposition, entomologists can provide valuable information about the conditions and timeline of events surrounding death. Different regions and environments have unique insect species and climate conditions that can influence the decomposition process. Forensic entomologists take these factors into account when analyzing insect evidence. Insect evidence can be used in various criminal investigations, such as homicides, to establish timelines, identify the location of a crime, or determine if a body has been moved. Entomological evidence may also help in cases involving animal attacks or abuse. Forensic entomologists may be called upon to provide expert testimony in court. They present their findings and interpretations to help judges and juries understand the significance of insect evidence in a particular case. Entomologists must have a deep understanding of insect life cycles, behaviour, and ecology. This knowledge allows them to interpret the information gathered from the insects found at crime scenes accurately. Proper collection and preservation of insect specimens are crucial for accurate analysis. Entomologists work closely with crime scene investigators to ensure that insect evidence is collected and handled appropriately.

History of Forensic Entomology:

The book "The Washing Away of the Wrongs: Forensic Medicine in Thirteenth-century China" written by Sung T'zu in 1247 and translated into English by B.E. Mc Knight in 1981 is one of the books of reference on the origin and application of knowledge of insects in a murder case. It was reported in the book that a man was murdered in a rice field after being inflicted with multiple injuries. It was suspected that the injuries were caused by a sharp metal object. The investigator of the murder asked the suspects (rice farmers) to assemble their sickles on the ground. One of the sickles attracted blowflies, probably because of the traces of blood tissues on the sickle. The owner of the sickle was interrogated and he confessed to the killing of the man.

Knowledge of the insect life cycle is the core of forensic entomology which remains effective in law court. To exemplify, Bergeret (1855 as cited in Amendt et al., 2004) reported that the French courtroom witnessed the first application of forensic entomology in 1850. In that report, it was written that the mummified child was found behind a chimney during the house renovation. The insects found on that mummified corpse were admitted as evidence that the current occupants were not the culprits and they were acquitted. During that time under review, forensic examiners did not have clear knowledge of insect biology but rather their perceptions were based on casual observation. Yovanovich and Megin were recognized as the first forensic examiners because they evaluated insect succession on corpses, properly establishing the science of forensic entomology (Amendt et al., 2004). Dead animals, including human corpses, begin to deteriorate minutes after death due to the changes in the physiological circulation which have come to a halt, thus leading to putrefaction. Insects especially flies are accepted as the evidence of this deterioration since they are the first to detect the change and arrive on the carrions. In addition, beetles arrive on the carrions a few days after death to feed on the soft and dried tissues which aid in skeletonizing the carrions (Abajue et al., 2013). Smith (1986) categorized these insects into four carrion ecological communities

1. Necrophagous insects- these are insects that feed on the carrions.
2. Predators and parasites of necrophagous insects- these are insects that solely feed on other insects or arthropods on the carrion.
3. Omnivorous insects- these include insects such as wasps, ants, and some beetles feeding on both the carriers and their colonizers.
4. Adventive species- these are insects such as springtails and spiders that use the corpse as an extension of their environment.

Forensic entomology utilizes insects in the first two groups. They are mainly insect species from Coleoptera and Diptera Orders. Their succession on carrions/corpses can be distinguished into different phases over the various stages of decomposition despite being controversial. About taxonomic composition and facts, African carrion communities comprised at least three hundred species of arthropods in about forty taxonomic families, primarily of insects. There are some challenges in the study of insects associated with carrions in Africa, especially in Nigeria. One of them is the proper identification of insects at the species level based on the morphological features of the adults. While very few of the identification keys can be meticulously found, the keys to the larval stages may not be found through meticulous work. The challenge is a heavy liability that poses an enormous task on forensic entomology as it does right now and makes few carrion researchers rear the larvae to the adult stage. However, this procedure may be hampered as the larvae may die during the rearing process. On the contrary, developed countries in the United States and the United Kingdom have developed molecular methods of identification, enabling the identification of all stages including eggs, thereby linking (with ease) the immature stages to adult identity. This calls for molecular advancement in places where crude methods of identification are still very much operational.

Insects Silently Give Us Valuable Information about a Crime:

Insects can be used to determine the geographical origin of a crime or a victim by analysing the species present and their distribution. Different regions have distinct insect fauna, and studying these patterns can help investigators identify the likely location of a crime. Insects can be used to trace the movement of a body after death. By studying the colonization patterns of insects at different stages of decomposition, forensic entomologists can provide information on whether a body has been moved and potentially help reconstruct the events surrounding a crime. Forensic entomologists, in collaboration with toxicologists, can analyze insects for the presence of poisons or toxins. This can be crucial in cases where poisoning is suspected, providing evidence of the substances involved. Insects can play a role in investigations related to drug smuggling. They may be attracted to substances used in the drug trade or inadvertently transported along with illegal shipments, offering clues to investigators. Insects found on a suspect, their belongings, or at a crime scene can be analysed to establish associations. This can be particularly useful in linking individuals to specific locations or activities. While time of death estimation is a primary focus of forensic entomology, the field provides a reliable method for determining the postmortem interval, which is crucial information for investigations.

Forensic entomology can also be applied to historical cases or cold cases where the remains are discovered long after the crime occurred. Insects associated with the remains can still provide valuable information about the circumstances surrounding the death.

Medico legal significance of insects

It focuses on the criminal component of the legal system and deals with the necrophagous (or carrion-feeding insects) that typically infest human remains. Medico Legal category relates to death investigations talks about the time since death i.e., Post Mortem Interval (PMI), Movement of the corpse, Manner and cause of death and Association of suspects with the death scene (Sukontason et al., 2004). Insects can talk about (A) Whether the body was moved after death (B) the Presence and position of wounds on the body (C) Length of time of abuse or neglect in living victim (D) If the victim used drugs or was poisoned (E) Whether the body was disturbed (F) Post Mortem Interval (PMI) (Gupta et al., 2011).

Examples of Arthropods which are Indicators of Forensic Entomology

Coleoptera: Majorly insects that are the forensic indicators belong to the order Coleoptera, Diptera and Hymenoptera. The coleopteran insects which are involved majorly in forensic entomology are Necrobia (Cleridae), Dermestes (Dermestidae), Geotrupes (Geotrupidae), Hister (Histeridae), Necrodes, Silpha (Silphidae), Aleochara (Staphilinidae).

Diptera: Several flies (Dipterans) are involved in forensic indication such as Lucila, Calliphora (Calliphoridae), Drosophilla (Drosophilidae), Fannia (Fannidae), Musca, Muscina (Muscidae), Conicera, Megaselia (Phoridae), Piophila (Piophilidae), Sarcophaga (Sarcophagidae), Hermetia (Stratiomyidae).

Hymenoptera: Similarly, like Coleoptera and Diptera orders, Several Families of Hymenoptera are also used as forensic indicators. Several insects like Alysia (Ichneumonidae), Nasonia (Pteromalidae) are most effective in forensic use.

Five stages of decomposition fuelled by Insect activity:

Fresh Stage: Begins at death. Flesh flies, blow flies, ants eating fly eggs, and predatory wasps. The first sign of bloating is due to putrefaction by anaerobic bacteria.

Bloat (Days 2-7): Swells due to gases produced by bacteria. Temperature rise of the corpse, Flies still present.

Decay (Days 5-15): Gases subside, and decomposition fluids seep from the body. Bacteria and maggots break through the skin. Predatory beetles such as rove and blister beetles are attracted, with an unpleasant odour, larvae begin to pupate and the Corpse is reduced to about 20 % of its original mass.

Post-Decay (Days 10-23): Carcass reduced to hair, skin and bones, fly population reduced by other arthropods. Hide beetles are dominant in dry environments, mites and predatory beetle populations increase.

Dry (Skeletal) (days 18-90): Does not always occur especially if the corpse is in a wet region. Maggots will stay longer and hide beetles will not appear. In wet environments, the hide beetles are replaced with reduviid insects. The corpse is reduced to at least ten percent of the original mass and only bone and hair remain.

Determination of PMI

PMI means Postmortem Interval (the time between death and the discovery of the body). Determination of PMI is based on two major principles. **1. Succession 2. Life cycle**

Succession wave	Principle insect fauna	State of corpse	Age of corpse
1	Flies (blow flies)	Fresh	First 3 months
2	Flies (blow flies and flesh flies)	Odour	
3	Dermestid flies	Fats are rancid	3-6 months
4	Various flies and beetles	Ammonia and fermentation	4-8 months
5	Mites	-	6-12 months
6	Dermestid beetles	Completely dry	1-3 years
7	Beetles	-	3 + years

Recent Advances in Forensic Entomology

Entomo-toxicology can be defined as the study of detection of poisons, toxins, or drugs from various insect developmental stages. The entomological evidence collected from crime sites can be used to determine the cause of death due to poisoning. Insects feeding on the corpse could be used in determining if any toxic substances or drugs were present in human tissues before death. Insects and insects remain (empty pupal cases or dead insects) can be vital in gaining entomo-toxicological data in case of highly decomposed or mutilated dead bodies when important tissues/ organs have been destroyed.

Molecular Techniques: Advances in DNA analysis have greatly impacted forensic entomology. Researchers have been using molecular techniques to identify species, determine the age of the insect specimens, and even link insects to specific locations or individuals.

Machine Learning and Data Analysis: Application of machine learning algorithms and advanced data analysis techniques has become more prevalent. These technologies help in the interpretation of complex entomological data and enhance the accuracy of postmortem interval estimations.

Urban Forensic Entomology: With an increasing focus on urban environments, researchers have been investigating how factors such as temperature variations, pollution, and other urban stressors impact the colonization patterns of forensic insects. This information can help improve the accuracy of estimations in urban forensic cases.

Remote Sensing Technology: Remote sensing technologies, such as satellite imagery and drones, are being used to study and monitor large-scale decomposition events. This can aid in the search and recovery of human remains in vast or challenging terrains.

Instant Insect Identification (DART-HRMS technology):

For the first time, the University of Albany has applied a technique called direct analysis in real-time with high-resolution mass spectrometry, or DART-HRMS, for the examination of Calliphoridae fly eggs. DART-HRMS, developed by Dr. Chip Cody of JEOL, is an ambient ionization mass spectrometry technique for the samples to be directly analysed without any time-consuming sample preparation steps, and perhaps most importantly without destroying the sample. The technique has demonstrated the possibility of almost instant differentiation between various insect species based on the amino acid profiles of the eggs (For instance alanine, isoleucine and proline were common but glutamine and tryptophan were only present in the eggs belonging to *P. regina*).

Molecular identification of insect species

The traditional methods used for morphological identification are outmoded and obsolete, moreover, practically impossible for some species and unreliable for immature life stages. These limitations lead scientists to evolve a molecular approach based on Polymerase Chain Reaction-Restriction fragment length polymorphism (PCR-RFLP) of the mt-DNA. Mitochondrial COI and COII genes are suitable molecular markers because, relatively, a high degree of genetic variations has been reported in this region. Due to difficulties associated with identification by phenotypic characteristics, molecular identifications are preferred techniques, for example, DNA barcoding and PCR-RFLP are preferred for accurate and quick identification. Techniques of molecular biology are being used to identify and differentiate insect species which helps in the estimation of PMI. PCR-RFLP analysis is also used for the identification of closely related species of forensic importance from different life stages, and it is an easy, fast and low-cost technique for routine diagnostic purposes (Amendt 2004; Benecke and Wells, 2001; Jangir and Sharma, 2019).

Human DNA identification from larval gut portion Techniques for molecular identification of species of insects or detecting and distinguishing human DNA in insects' gut which feed on human corpses have recently been developed to increase the efficacy of the field. Maggot's crops are suitable sources to obtain DNA for the identification of both the insects and their gut contents. Human STR profile could be obtained from maggots feeding on decomposing tissues (if a skeleton could not be found) in an advanced decaying stage when collecting samples from the corpse is not possible (Wells et al. 2001).

Wide range of applications and multifarious approaches of forensic entomology

1. Estimation of time since death in humans (Post Mortem Interval)
2. Biogeographical location (site or place of death)
3. Movement of the dead body (displacement)
4. Determination of primary and secondary crime scene
5. Mode/ manner of death, Cause of death-Entomotoxicology
6. Possible criminal misuse of insects
7. Negligence of older persons at home
8. Negligence of newly borne babies in the hospitals
9. Traffic accidents with no immediately obvious cause
10. Entomotoxicology -detection of possible poison/drug through insect evidence
11. Human DNA identification through a larval gut portion
12. Wildlife forensic entomological examination and investigation
13. Trafficking of narcotic plants in border areas

CONCLUSION:

Forensic entomology is a specialized field within forensic science that harnesses the power of insect biology to provide valuable information in legal investigations. By studying the colonization patterns, developmental stages, and behaviour of insects associated with decomposing remains, forensic entomologists can contribute to the estimation of post-mortem intervals, determination of the location of a crime, and understanding of the

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circumstances surrounding a death. The discipline plays a crucial role in the justice system by offering objective and scientifically based evidence that can aid investigators, lawyers, and the judicial system in making informed decisions.

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Global Agricultural Production and the Economic Impact of Climate Change

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ABSTRACT

In contrast to earlier issues with the environment, climate change appears to be more extensive, intricate, and unexpected. The financial implications of warming temperatures on world agricultural output are the subject of this review. There are many different causes and impacts of climate change, and its detrimental repercussions are becoming more apparent to the populations of low-income nations. Increasing agricultural productivity can help feed the people, but this is frequently achieved in unsustainable ways. One of the primary causes of greenhouse gas emissions is also increased agricultural production. We emphasize some of the most significant links between population growth, agricultural productivity, and climate change in this study.

INTRODUCTION

The economic crisis unrestrained rivalry for resources from nature, and a quickly shifting economic landscape provide many difficulties for the food and agriculture industries. Managing the escalating competitiveness and the constantly shifting external environment is getting harder. It is crucial to have the capacity to react quickly to evolving environmental legislation and its effects. Undoubtedly, one of the industries most impacted by climate change is agriculture. In addition to being heavily involved in climate change, the food and agriculture sectors are also particularly susceptible to its consequences. The goal of technological advancement is to lessen the effects of climate change, which makes hiring, retaining, and training competent workers more crucial than ever. (Komives *et al.*, 2019).

The Food and Agricultural Organisation (FAO) defines stable food security as having adequate, safe, and nutritious food that satisfies everyone's dietary requirements and tastes and is available to them both physically and financially (WHO 2018). The research that is now available suggests that the effects of climate change on agriculture and food security are already having an impact on the fight against famine and starvation. Famine is particularly dangerous in nations where a large percentage of people depend heavily on agriculture for their income and where farming practices are more susceptible to precipitation and abrupt temperature swings (Ripple *et al.*, 2019).

Methods

The primary objective of the article is to conduct a thorough analysis of the subject by analysing pertinent international and scholarly literature. There are connections between subsistence security, food security, and climate change on a national and international scale. The outcomes of pertinent past research projects might be explored and synthesized using qualitative research. There are no formal guidelines for analysing qualitative data, and the methodological investigation of the data procedure for analysis is frequently restricted. Authors should think about the range of keywords and subjects that will be utilized to support initial scoping activities and subsequent literature studies when formulating research questions.

Changing climate and water issues

The majority of individuals agree that human activity is most likely to blame for the recent trends in global warming. Furthermore, this opinion has been publicly supported by the major international scientific organizations (FAO, IPCC, NASA, etc.). Scientists are certain that the greenhouse gases Report Phrase produced by human activities will be a major factor in the future decades-long rise in global temperatures. Figure 1. illustrates how the mean temperature changed from 1961 and 2018. It is reasonable to anticipate additional growth based on the observed tendency, as the trend line created on the global average effectively illustrates.

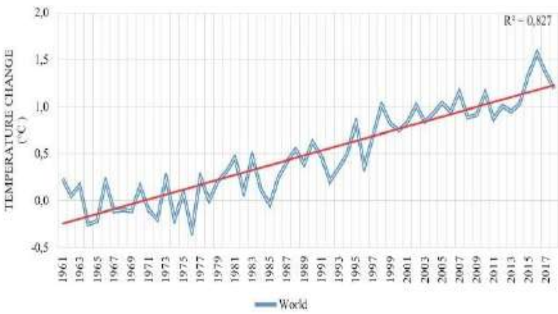

Fig 1. Global temperature change (FAO 2020)

Water is a vital component of food production processes and has a significant impact on crop productivity and food output. It also contributes significantly to food security. The results of water management will be impacted by changes in water supply, demand, and quality brought on by climate change. (Bates *et al.*, 2008).

Complexities of climate change effects

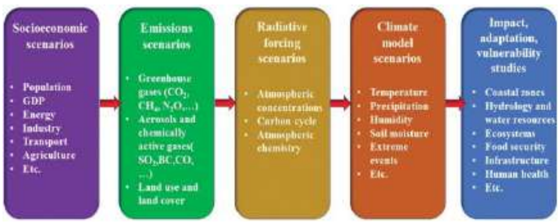

Fig 2: A sequential approach to climate change (Patz *et al.*, 2005).

A basic framework outlining the origins and consequences of human activity-related climate change is presented in Fig 2. Based on forecasts from the world's climate model regarding GHG emission scenarios, the WHO has complete estimates of the diseases and deaths caused by catastrophic climate change by 2030.

CONCLUSION

The growth of urbanisation increasing water shortages, and an absence of technical advancement continues to be the most pressing issues facing emerging nations as a result of climate change. The support that knowledge and technology transfer have been able to provide emerging nations is still lacking. It is possible to lessen or even completely prevent the detrimental effects of warming temperatures on food security by developing effective adaptation techniques. Adaptation efforts in the agriculture system are meant to lessen the system's susceptibility to climate change and increase its adaptability. Collaboration between government agencies and the scientific community, as well as group and multidisciplinary initiatives, are essential to finding solutions to these issues. The way that global civilization and the environment interact has changed significantly as a result of adaptation to global warming and its detrimental repercussions.

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Livestock Economy - Status and Challenges of Small Ruminants in Karnataka

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ABSTRACT

Farmer, the backbone of our nation depends mainly on domesticated animals for almost all the On-farm activities. Even after scientific advancement brought in the green revolution and mechanization, unlike other developed countries, a maximum number of farm families in India depend on livestock for hard farm work. It's because, 70 % of India's livestock is owned by landless, marginal, and small farmers who are unable to afford costly mechanized items so, till today livestock animals remain the major source of farm power in rural India. The livestock sector is likely to emerge as an engine for agricultural growth in the coming decades.

INTRODUCTION

The livestock sector is highly critical to the growth and sustainability of the Indian economy. Animal husbandry has long been intertwined with agriculture in India, and it plays a vital role in the rural economy. Since agriculture is seasonal, the landless and farmers with negligible landholdings depend upon livestock to utilize their labour during lean agricultural seasons. Livestock is a source of protein, livelihood, and draught power. Diverse enterprises such as apiculture, sericulture, and pisciculture have been practiced traditionally for many years. Livestock acts as a buffer to crop failure and sudden monetary losses. Indian farmers practice mixed farming, a crop and livestock production system in which one enterprise's output becomes the input for another, resulting in resource efficiency**.** Livestock benefits farmers in a variety of ways, including income, employment, food, and social security; and is considered a moving bank because of its potential to dispose of during emergencies and monetary crises.

Contribution to the National Economy

As per the 20th Livestock Census 2019 of India, the total livestock population was 535.78 million comprising cattle (35.94%), goats (27.80%), buffaloes (20.45%), sheep (13.87%), and pigs (1.69%). Mithun, yaks, horses, ponies, mules, donkeys, and camels taken together contribute 0.23 percent of the total livestock population. The total poultry population stood at 851.81 million. Livestock provides livelihood to two-thirds of rural communities in India. The livestock sector employs about 8.8 percent of the country's population. The livestock sector grew at a CAGR of 8.24 percent during 2014-15 to 2018-19 (*www.vikaspedia.in*). As per the estimates of National Accounts Statistics (NAS) 2020, the contribution of livestock to total agriculture and allied sector's GVA at constant prices has increased from 24.32 percent (2014-15) to 28.63 percent (2018-19). The livestock sector contributed 4.19 percent of the total GVA in 2018-19.

Sheep Scenario in Karnataka:

Sheep and goats are two important livestock species in India and are called small ruminants, they make a significant contribution to the agrarian economy, particularly in arid, semi-arid, and hilly regions where crop cultivation alone is not that productive. Since income from crop farming alone is insufficient and unstable, sheep and goats help a large number of landless, marginal farmers, and small farmers for augmenting their livelihood options. Small ruminants have numerous advantages over large ruminants, which include increased production efficiency, easier marketability, lower hazards, more adaptability to various habitats, and lower absolute feed requirements per animal.

In India, sheep are seen mainly in arid and semi-arid agro-climatic zones. Telangana has the highest population of sheep followed by Andhra Pradesh and Karnataka. There are about 42 registered sheep breeds in India. The important indigenous breeds are Deccani, Nellore, Bannur, Ballari, Hassan, Mecheri, Vembur, etc. Some of the important exotic sheep breeds are Merino, Rambouillet, Polworth, South Down, Suffolk, Dorset, etc. As per 2019 Livestock Census, the total sheep population was 74.26 million, accounting for 14 percent of the country's total livestock population.

India is one of the world's top exporters of sheep and goat meat. During the fiscal year 2019-20, India exported 14,128.85 MT of sheep and goat meat to the rest of the world, valued at Rs. 646.69 crores /US $90.77 million, and the major export destinations were the United Arab Emirates, Qatar, Kuwait, Saudi Arabia and Oman (*www.apeda.gov.in*). Meat export should be viewed as a value-added method to crop production, as crop residues and agri-byproducts are mostly transformed into meat for export in modern meat facilities for international trade and increased profits. Though, India is one of the largest exporters of sheep and goat meat in the world, the per capita meat intake in India is dismally low, at around four kg per year, compared to the world average of 35 kg.

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Karnataka is one of the most prominent sheep and goat-producing states in the country. Karnataka stands third in terms of sheep population in the country, with 11.1 million sheep. The major sheep breeds in Karnataka are Deccani, Ballari, Hassan, and Bannur. In Karnataka, sheep breeds are mostly reared for meat. The sheep of indigenous breeds gain a maximum weight of 25 to 30 kg in two years under the traditional grazing regime. The Bannur sheep breed is very popular in Karnataka and its meat is renowned for its flavour. A few breeds generate wool of poor quality and in small quantities, resulting in low market value. The annual wool production is only 500 to 750 grams per sheep.

Goat scenario in Karnataka

In India, goat rearing is an important allied enterprise sustaining the livelihoods of marginal and small farmers, especially the landless laborers of rural society. A goat is considered a “poor man’s cow”. Goats are one of the most important meat-producing animals in India, and their meat (chevon) is among the finest and has huge domestic demand. As per the 20th Livestock Census 2019, the total goat population was 148.88 million, accounting for 27.7 percent of the country’s total livestock population. The total goat population has increased by 10.14 percent over the previous Livestock Census (2012). The total goat population in rural and urban areas was 142.44 million and 6.44 million, respectively, up by 10.35 percent and 5.78 percent from the previous Livestock Census (2012). Among the States in India, Rajasthan (20.8 million) had the highest population of goats followed by West Bengal (16.3 million), and Uttar Pradesh (14.5 million). In 2018-19, India produced 9,37,640 tonnes of goat meat. Goat meat contributed 13.72 percent to the total meat production in the country.

Karnataka ranked 10th position with the production of 32,400 tonnes of goat meat, contributing 2.95 percent to the country’s goat meat production (2018-19). India is the largest exporter of sheep and goat meat in the world. The major export destinations included the United Arab Emirates, Qatar, Kuwait, Maldives, Saudi Arabia, and Oman. The country has exported 8,695.97 MT of sheep and goat meat worth Rs. 447.58/- crores during the year 2021-22.

Marketing of Small Ruminants

There would be more than 2,000 markets in India to transact livestock. Livestock markets are under the jurisdiction of the state governments although the direct operation and supervision would generally fall within the purview of the local bodies. There are a few privately owned markets.

Regulation of markets

As early as 1928, the Royal Commission on Agriculture recommended setting up regulated markets for trading agricultural produce including livestock products. Various states Governments and union territories have promulgated respective Agricultural Produce Markets Acts (APMA) and notified their intention to cover various agricultural, livestock, and horticultural produce.

Marketing of live animals

Marketing of live animals is still in a primitive way and it is yet to receive adequate attention. Shepherds raise sheep and goats as a profession for livelihood. Sheep are raised in Northern states mainly for wool production and in other parts for meat production. Goats are raised to get milk and also meat and in certain parts, hair (mohair). Thus, none of the species of livestock are being raised for meat production alone.

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Major constraints in the marketing of small ruminants: The major constraints in marketing of small ruminants are listed below:

- ✓ Small ruminant markets are mostly weekly and rarely bi-weekly.
- ✓ Overcrowding and scattering of animals of all types and classes all over the yard makes it difficult to see all the animals of the required type together in one glance.
- ✓ Facilities like a milking shed, and weigh bridges, are yet to be provided even in regulated markets.
- ✓ Prevalence of underhand dealing – hatha system in the sale and purchase of animals.
- ✓ Exploitation by middlemen/brokers, traders, and commission agents still exists even in regulated markets.
- ✓ Non-payment of sale proceeds.
- ✓ Stolen animals are marketed.

CONCLUSION

Enormous growth opportunities and scope exist in the Indian small ruminant industry; all that is required is the right approach in an appropriate direction. Overall, our nation is in urgent need of concentrating on all fields of the livestock sector to cope with the ever-increasing population. Demand for milk, meat, and eggs would be adequately met from the domestic supplies if current trends in production growth are sustained, At the same time, we have to concentrate on protecting the population of the local breeds, which are on the verge of extinguishing. The demand for livestock products is income elastic and is rising continuously. Attentions are needed in supplying fodder and healthy feed to animals to get a high yield (mutton).

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Precision Farming – The Need of Today's Farming Community

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ABSTRACT

There has been drastic increase in our population after independence and consequently the per capita availability of food is decreasing day by day. Many factors like climate, topography soil type etc. are influencing agricultural production. For quality and quantity of agricultural production, there is urgent need to adopt more scientific methods of cultivation; and precision agriculture has been recognised as one of them. Precsion agriculture may be defined as information and technology-based farm management system to identify and analyse the spatial and temporal differences within fields for optimum productivity and sustainability and protection of the land resource by minimizing the production costs. In others words, it may be referred as site-specific farming or satellite farming which combines the knowledge of applying the right quantity of inputs at the right time and in the right place to get better and quality yield. It is an approach in which the inputs are utilized in a precise manner to obtain increased average yield compared to our traditional practices. Out of total 328 million hectares geographical area in India, 97.85 million hectares i.e., 29.83% was found degraded during the year 2018-19, So in order to face unavoidable challenges coming out due to change in climate and global food system, precision farming is the need of the present era. The increase in agriculture production can be possible through increasing the

efficiency of labour, land &time, reducing production cost, timely and accurate dose of agrochemicals, use of Global Positioning System (GPS), Geographic Information System (GIS), sensor technologies, proper crop management and precision irrigation system etc. However, there are certain obstacles such as small and fragmented land holding, lack of local technical expertise, Heterogeneity of cropping systems, Lack of success stories pertaining to precision farming, misperception/ unfavourable perception of users, infrastructure and institutional constrains etc in the adoption of precision farming in developing countries particularly in India.

INTRODUCTION

Precision agriculture (PA) as the name indicates refers to the application of precise and correct quantity of inputs like water, fertilizers, pesticides etc. at the correct time to the crop for increasing its productivity and maximizing yield i.e., the use of inputs based on the right quantity, at the right time and in the right place. This type of management is also commonly known as "Site-Specific Management.

Precision Farming or Precision Agriculture is generally defined as information and technology-based farm management system to identify, analyse and manage spatial and temporal variability within the fields for optimum productivity and profitability, sustainability and protection of the land resources by minimizing the production costs. In other words, it means **doing the right thing, in the right place, in the right way and at the right time** which includes managing crop production inputs like water, seed fertilizer pesticides etc. to increase yield quality profit and to reduce agricultural waste. The purpose of precision farming is to match agricultural inputs and practices according to crop and agro-climatic conditions in order to improve the accuracy of their applications. It is needed to increase productivity, prevent soil degradation inn cultivable land, reduce chemical use in crop production and efficiently utilization of water resources. Now the question is what type of equipment are used in precision farming?

Equipment/Tools used in Precision Farming:

According to Tiwari (2023) Precision Farming is a combination of application of different technologies which are mutually interrelated and responsible for developments. These tools are being discussed as below:

- **Global Positioning System (GPS):** It is a set of 24 satellites in the Earth orbit which sends out radio signals that can be processed by a ground receiver to determine geographic position on the earth. It has a 95% probability that the given position on the earth will be within 10-15 meters of the actual position. The system allows precise mapping of the farms; and the appropriate software informs the farmer about the status of his crop with the information of which part of the farm requires inputs such as water or fertilizer and/or pesticides etc and in which quantity.

- **Geographic Information System (GIS):** It is the software which imports, exports and processes spatially and temporally geographically distributed data.

- **Grid Sampling:** It is the method of breaking a field into grids of about 0.5-5 hectares and soil sampling within the grids is useful to determine the appropriate rate of application of fertilizers. Several samples are taken from each grid, mixed and sent the same to the laboratory for analysis of available nutrients in the soil.

- **Variable Rate Technology (VRT):** The existing field machinery with added Electronic Control Unit (ECU) and on-board GPS can fulfil the variable rate requirement of inputs. Spray booms, the Spinning disc applicator with ECU and GPS have been used effectively for patch spraying. During the creation of nutrient requirement map for VRT, the profit maximizing fertilizer rate should be considered more rather than the yield maximizing fertilizer rate.

- **Yield Maps:** The yield maps are produced by processing data from adapted combine harvester which is equipped with a GPS, i.e. integrated with a **yield recording system.** Yield mapping involves the recording of grains flow through the combine harvester, while recording the actual location in the field at the same time.

- **Remote Sensors:** These are just the categories of aerial or satellite sensors which indicate variations in the colours of the field corresponding to changes in soil type, crop development, field boundaries, roads, water, etc. The arial and satellite imagery can be processed to provide vegetative indices which reflect the health of the plant.

- **Proximate Sensors:** These sensors can be used to measure soil parameters such as Nitrogen status, soil pH and crop properties as the sensor attached tractor passes over the field however, in order to analyse the data collected by other Precision Agriculture technology components and to make it available in usable formats such as maps, graphs, charts or reports, the computer support is essential along with specific software support.

- **Precision irrigation systems**: Commercial use in sprinkler irrigation by controlling the irrigation machines motion with GPS based controllers is being realised now a days. Wireless communication and sensor technologies are being developed to monitor soil and ambient conditions along with operation parameters of the irrigation machines (i.e. flow and pressure) to achieve higher water use efficiency.

- **Precision farming on arable land:** The use of PA techniques on arable land is the most widely used and advance technology among the farmers. The Controlled Traffic Farming (CTF) is a whole farm approach that aims at avoiding unnecessary crop damage and soil compaction by heavy machinery and reduces costs imposed by standard methods. The CTF methods involve confining all field vehicles to the minimal area of permanent traffic lanes with the aid of decision support systems.

Laser Land Leveller:

Uneven soil surface has a major impact on the germination, stand, and yield of crops due to inhomogeneous water distribution and soil moisture. Therefore, land levelling is a precursor to good agronomic, soil, and crop management practices. The advanced method to level or grade the field is to use laser-guided levelling equipments i.e., levelling the field within certain degree of desired slope using a guided laser beam throughout the field. Reza

(2009) reported that the laser- controlled land levelling system consists of following five major components:

(i) **Drag Scrapper/bucket:** The drag bucket can be either 3-point linkage mounted on or pulled by a tractor. This system is preferred as it is easier to connect the tractor's hydraulic system to an external hydraulic by the 3-point-linkage system.

(ii) **Laser transmitter:** The laser transmitter mounts on a tripod which allows the laser beam to sweep above the field.

(iii) **Laser receiver:** The laser receiver is a multi-directional receiver that detects the position of the laser reference plane and transmits this signal to the control box.

(iv) **Control box:** The control box accepts and processes signals from the machine mounted receiver and displays these signals to indicate the drag buckets position relative to the finished grade.

(v) **Hydraulic system:** The hydraulic system of the tractor is used to supply oil to raise and lower the levelling bucket.

The system includes a laser-transmitting unit that emits an infrared beam of light that can travel up to 700m in a perfectly straight line. The second part of the laser system is a receiver that senses the infrared beam of light and converts it to an electrical signal. The electrical signal is then directed by a control box to activate an electric hydraulic valve. Several times in a second, this hydraulic valve raises and lowers the blade of a grader to keep it following the infrared beam. Thus, the Laser levelling of a field is accomplished with a dual slope laser that automatically controls the blade of the land leveller to precisely grade the surface to eliminate all undulations tending to hold water. Laser transmitters create a reference plane over the work area by rotating the laser beam 360 degrees. The receiving system detects the beam and automatically guides the machine to maintain proper grade. The laser can be levelled or sloped in two directions; this is all accomplished automatically without the operator touching the hydraulic controls.

Laser land levelling is very beneficial over conventional land levelling in terms of reduction in time and water for irrigation, uniform distribution of water, less water consumption in land preparation, precise levelling and smothering soil surface, uniform moisture environment for crops, lesser weeds in the field, good germination and growth of crop, uniformity in crop maturity as well as reducing seed rate, fertilizers, chemicals and fuel requirements. Besides, the precise land levelling saves more than 35 % irrigation water, reduces weed in the field, increases field areas about 3.5 %, reduce farm operating time by 10 %, facilitates top soil management, saves labour costs, saves fuel/electricity used in irrigation and increases productivity up to 50 percent.

Mechanized Direct Seed Sowing:

Uniformity in plant growth is strongly influenced by the seedling uniformity, general qualitative characteristic similar in terms of growth in height, thickness, fresh crop weight, floral primordial evolution and health of the hybrid variety. Besides, the sowing technologies are also very important because they can be used to sow the majority of treated vegetable and flower seeds which aim to destroy the germs of diseases or pests (seed disinfection) or prevent their contamination after seeding. Because the seed treatments can be performed, either chemically (e.g., wetting or dusting with different chemicals) or physically (e.g., heat, cold, UV rays, X-rays, etc.) depending on the species. Therefore, in the sowing process, it is proper to use automatic sowing equipments for safely seeding process and reducing the intoxication risks with deadly substances. Similarly, a mechanical transplanter performs three functions namely opening the soil in the form of narrow furrow; placing seedlings vertically upright in it, and then closing and compacting the soil around these seedlings without damaging them.

Soil mapping is traditionally done by experienced soil surveyors who know the area well, spend much time in the field, take auguring at regular intervals, and in this way draw a field soil map that can be later digitized and printed. Soil map is a geographical representation showing diversity of soil types and/or soil properties (soil pH, textures, organic matter, depths of horizons etc.) in the area of interest i.e., it is typically the end result of a soil survey inventory, i.e. soil survey. Soil maps are most commonly used for land evaluation, spatial planning, agricultural extension, environmental protection and similar projects. Traditional soil maps typically show only general distribution of soils, accompanied by the soil survey report. Many new soil maps are derived using digital soil mapping techniques which are typically richer in context and show higher spatial detail than traditional soil maps. Soil maps produced using (geo) statistical techniques also include an estimate of the model uncertainty, and In this context, soil maps are only visualizations of the soil resource inventories commonly stored in a Soil Information System (SIS) of which the major part comes from Soil Geographical Database. The Soil Information System is basically a systematic collection of complete (values of the target soil variables available for the whole area of interest) and consistent gridded or vector soil property and/or class maps with an attached report, user manual and/or metadata. It is in the most cases, a combination of polygon and point maps linked with attribute tables for profile observations, soil mapping units and soil classes. Different elements of an SIS can be manipulated and then visualized against the spatial reference (grids or polygons). For example, soil profiles can be used to make spatial prediction of different chemical and physical soil properties. In the case of pedometric mapping, both predictions and simulations (2D or 3D — geographic location plus soil depth) of values are visualized and used for GIS modelling.

Digital Soil Mapping (DSM) in soil science also referred to as predictive soil mapping or pedometric mapping, is the computer-assisted production of digital maps of soil types and soil properties. Soil mapping, in general, involves the creation and population of spatial soil information by the use of field and laboratory observational methods coupled with spatial and non-spatial soil inference systems. The international Working Group on Digital Soil Mapping (WG-DSM) defined digital soil mapping as *"the creation and the population of a geographically referenced soil databases generated at a given resolution by using field and laboratory observation methods coupled with environmental data through quantitative relationships.*

Digital Soil Mapping tries to overcome some of the drawbacks of the traditional soil maps that are often focused only on delineating soil-classes i.e., *soil types*. Such traditional soil maps: do not provide information for modelling the dynamics of soil conditions and are inflexible to quantitative studies on the *functionality* of soils.

Use of Precision Technology Uses in Crop Scouting:

Crop scouting also known as field scouting, is the very basic action of traveling through a crop field while making frequent stops for observations. Crop scouting is done so that a farmer can see how different areas of his or her field are growing. If there are problems during the growing season, the farmer can work to mitigate them so that those problems do not affect yield at the harvesting time. Should problems go unnoticed or uncared for during the growing season, they can potentially limit the total yield, thus reducing the revenue from the sale of the crop or other intentions for the crop, such as livestock feed. There are many different methods of crop scouting, while the traditional methods can include walking through the field and observing plants manually, particular pieces of equipments are still used including field notes so the farmer can keep account of plants and the areas that need more attention, keeping a pocket knife and bags for sample taking, and finally a hand magnification lens so that the farmer can get a close look and better idea of the health of his or her plants. Crop and field scouting are crucial for each stage of the crop lifespan. Pre-seeding field scouting can show a farmer weed populations including what weeds are growing and what growth stage the weeds are in the fields. When it's time to seed, field scouting can show the farmer information to lead them to choose what seed depth or seed rate they should plant at, as well as early indicators of seed treatments or selection. After the seeding is completed, frequent scouting will help to show farmers damaged seeds, early signs of pests and many other factors. When the crops begin to germinate and become established and rooted, continued scouting can help to prevent weed damage, pest damage and post-spray pesticide or fertilizer performance. It is important to keep scouting on regular intervals through the plant's life, as this scouting could reveal pest issues, soil moisture issue and a variety of other risk that could be fought against. Crop Scouting tells farmers a huge amount about their plants, and can help them to improve yield, and maximize crop efficiency. As precision agriculture technologies have advanced, farmers have been helped greatly when it comes to crop scouting. For example, instead of field notebooks, there are several different mobile apps that are compatible with different types of mobile devices including tablet computers and smartphones that help the farmers to keep accurate logs of their fields besides giving them opportunity to cross compare these notes with previous years or different areas of the fields. With the advancement of global positioning systems (GPS) and unmanned aerial vehicles (UAVs), the farmers don't need to walk through their fields, and help them to show information that humans cannot see with the naked eye.

Use of GPS in Crop Scouting: -

Global positioning systems are extremely useful tool when it comes to the advancement of crop scouting in precision agriculture. Crop scouting has always relied on farmers' remembering where they have scouted and taking note of that, although with the use of GPS, farmers now have an accurate recording of up to one foot of where they have been. Bakshi (2020) has rightly remarked that with this precise location data, they can make notes and have specific locations of where pests, poor soil temperature or moisture are located. With the preciseness of global positioning systems, the farmers can also accurately mitigate threats that they find in their fields. GPS has now been incorporated into many different pieces of technology which help farmers to scout their fields much more efficiently and accurately. An example of these technologies includes different apps that are available for tablets or smartphones. These apps help the farmers not only to mark their exact location in a field, but also make field notes, compare notes from previous years and much more. These apps can help to show them where exactly on an aerial photo of their farm target areas of issue are, as well as helping in making future decisions based on past crop issues they have had.

Use of Unmanned Aerial Vehicle (UAV) in Crop Scouting:

The UAV's are one piece of technology that have been developed and used for agricultural

purposes in the last one decade. They are more efficient, easy to use and very effective. Two main models of UAV's viz; **fixed wing platform** which is very similar to a plane (although it is scaled down and controlled with a remote control or GPS) and **multi-copter** similar to a helicopter (although it generally has more propellers). The more propellers that are added to a multi-copter typically provide more stability and power to the machine which is easier to fly and manoeuvre in different weather conditions. Typically, multi-copters are preferred on smaller farms where landing space is limited, while planes are usually better suited for extremely large farms. The UAV's have assisted the agricultural sector by combining their technology with that of infrared cameras which help a farmer to get a bird's eye view of his or her farm and see the crops from a whole new perspective. They are also capable to use these infrared cameras to provide a variety of different information including what species are in their fields (weed and crop scouting), moisture levels of the soil or plants, plant development stages, plant health and much more. These UAV's give farmers a more holistic view of what is happening in their fields and with the use of these UAV's, farmers are able to better understand their crops not just o field by field basis, but on a plant-by-plant basis and thus, help the farmers to undertake more accurate farming practices resulting in better yield.

Precision Maps:

Precision maps are an extremely useful tool in precision agriculture and are becoming more and more commonly used in the agriculture industry. The maps assist farmers by showing them precise locations in the field and providing them specific information about that location. A precision map is a map that is made up of geo-referenced data that can be used to show information about a precise location in a field, as well as information on crop moisture levels, soil nutrients levels, crop yield and much more. Precision maps work by using a variety of different physical sensors along with GPS information to analyse variables such as crop or soil moisture, crop yield, and more. The farmer can use this type of information to accurately locate areas of need, low crop yield or low moisture levels and can take action accordingly. Precision maps can help to save farmers' money by preventing overspray because if a farmer utilizes precision maps, he or she will be able to mitigate their sprayings by spraying only pesticides/fertilizers or replanting seeds in areas of need. This helps to not only to save the farmers' money, but also helps in conserving the environment. There are many different types of precision maps which can be generated by farmers and can be used alongside each other to show many different things about field conditions that a farmer would not otherwise be able to easily see with his or her own eye. Precision maps can help them in a variety of different ways in their decision-making process. When a farmer is using and utilizing precision maps to their full potential, they can make less guesses about what they think about soil nutrient levels or potential crop yield; and hence can use precision maps to make judicious and strategic choices for their fields. These maps may also help to make decisions including fertilizer or pesticide application, field conditioning, or crop rotation etc.

Some Other Typical Mapping Tools are:

- **A Grain Moisture Sensor-** This sensor detects grain moisture levels and can tell the farmer if an area of crops needs more or less irrigation.

- **A GPS Antenna-** A GPS or Global Positioning System antenna is a piece of equipment that receives signals from global positioning satellites to provide and record specific locations.

- **A Grain Flow Sensor-** This sensor helps to determine the volume of grain that has been harvested.

- **GPS Receiver and Yield Monitor-** the Yield Monitor and GPS receiver work together to gather the information collected by the sensors and collect them in one central location while geo-referencing the data.

- **Grain Elevator Speed Sensor-** this sensor is very similar to a grain flow sensor and gathers data of grain flow measurements, although having both sensors in place help to improve the accuracy of measurements. Although there are still a great deal of other tools and pieces of equipments that are used in precision mapping, these five are the most basic pieces of equipment and sensors that are used for this type of mapping. A variety of other sensors can be added to equipments for more accurate readings or a different variety of readings.

Site specific Input Application:

Site-specific management is used to detect and measure the differences within fields, record these differences at specific locations and then use this information to guide changes in management or inputs. Site-specific farming is managing the areas within fields, rather than using the same management on the entire field. To conduct site-specific farming, a producer must be able to do three things namely **know where you are i.e.,** the location where the input has to be applied, **gathering information at that location i.e.,** information about locations within fields can be gathered by using sensors or by sampling, and **Site-Specific Application** in which Variable-rate controllers are available for whatever inputs are needed for site-specific management.

Weed Management:

The basic parts of site-specific weed control technologies comprise three key elements viz. **weed sensing system,** (that recognises weed species), **weed management model** which applies knowledge and information about crop–weed competition, population dynamics, biological efficacies of control methods, decision-making algorithms, optimising treatments according to the density and composition of weed species, economic goals and environmental constraints and as well as **precision weed control tool,** (a sprayer with individual controllable boom sections or a series of controllable nozzles that enable spatially variable applications of herbicides).

Insect-Pest and Disease Management:

Insect pests and diseases are significant issues in crop protection. For this reason, improved sensors for precision farming are constantly being improved. Such modern technology includes pest detection sensors which detect disease and insect pest occurrence on crops and provide real-time data from the field. The Farmers can use various sensors for insect pest detection on crops which range from simple to the most complex like **Low-power Image Sensors, Acoustic Sensors (**An acoustic sensor is an insect pest detection sensor which works by monitoring the noise level of the insect pests).

Sensors for Early Detection of Disease in Crop:

Crop diseases, if not treated timely and properly can significantly reduce the yield, thus endangering global food security. For this reason, disease protection is the most important task for every farmer. Since early detection can successfully control disease, so the farmers can use modern farm measures to protect their crop. These measures include direct and indirect disease methods. Direct detection methods are mainly laboratory-based techniques of disease detection. The most common are **polymerase chain reaction (PCR), immunofluorescence (IF), fluorescence in-situ hybridization (FISH), enzyme-linked immunosorbent assay (ELISA), flow cytometry (FCM), and gas chromatography-mass spectrometry (GC-MS)**. Although providing accurate data, these methods can't be fully used for on-field disease detection. Unlike direct, the indirect methods are used directly in the field. Based on plant stress and levels of plant volatility, indirect method sensors can identify biotic and abiotic stresses, as well as pathogenic diseases in crops. These are optical sensors which based on thermography, fluorescence imaging and hyperspectral techniques are able to predict plant diseases.

- **Thermography Disease Detection Method:** Thermography sensors measure the differences in surface temperature of the plant leaves and canopy. The sensor captures infrared radiation emitted from the plant surface. If there is a pathogen infection, the plant surface temperature will increase due to the transpiration reduction. Based on the change in temperature, the sensor can analyse disease presence. Thermography sensors can detect the changes due to the disease before it even appears. Precision disease control is limited due to its high sensitivity to the change of environmental conditions during measurements. Another problem is that the thermography method can't be used to identify the type of infection.

- **Fluorescence Disease Detection Method:** Sensors using the fluorescence method measure the chlorophyll fluorescence on the leaves and measure the incident light and the change in fluorescence parameters. It measures changes in chlorophyll and photosynthetic activity, thus detecting the pathogen presence. Although fluorescence measurement provides sensitive detection of abnormalities in photosynthesis, the practical application of this technique in a field setting is limited.

- **Hyperspectral Disease Detection Method:** Sensors implementing the hyperspectral method use a wide range of spectrum, between 350 and 2500 nm, to measure plant health. They measure the changes in reflectance that are the results of the biophysical and biochemical characteristic changes experienced upon infection. Hyperspectral cameras collect the data in three dimensions, with X- and Y- axis for spatial, and Z- for spectral, thus providing more detailed and accurate information about plant health. In order to monitor a large field area, sensors are usually fitted to an unmanned aerial vehicle (UAV). Hyperspectral sensors are used for early crop disease detection, thus allowing a farmer quick and timely crop protection.

- **Gas Chromatography Disease Detection Method:** This is a non-optical sensor used for crop disease detection and is used to determine volatile chemical compounds released by the infected plants. Pathogens on plants release specific volatile organic compounds (VOCs) that are characteristic of each pathogen type. The same thing happens when the plant is stressed due to mechanical damage. In this regard, sensors using gas chromatography can accurately identify the type and nature of infection. The only lack of this method is required sampling of pre-collected volatile organic compounds for a longer time before data analysis, which severely limits its on-field application.

- **Drones and Satellite Imagery:** Advances in drone and satellite technology benefit precision farming because drones take high-quality images, while satellites capture the bigger picture. Light aircraft pilots can combine aerial photography with data from satellite records to predict future yields based on the current level of field biomass. Aggregated images can create contour maps to track where water flows, determine variable-rate seeding, and create yield maps of areas that were more or less productive.

However, there are certain following bottlenecks in the adoption of precision farming particularly in developing countries like India:

- Culture and perceptions of the users
- Small farm size
- Lack of success stories
- Heterogeneity of cropping systems and market imperfections
- Land ownership, infrastructure and institutional constraints
- Lack of local technical expertise.
- Lack of information
- There is a need for the creation of awareness among the farming
- community.
- Cost may be incurred in the process is quite high.

CONCLUSION:

Hence, it can be concluded that precision farming is need of the present hour as it saves farmers' time, money, labour, resources and helps them in making judicious use of agricultural inputs in farming and consequently improving their socio-economic status.

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Role of Artificial Intelligence in Rural Development- A Conceptual Paper

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ABSTRACT

Artificial Intelligence (A.I.) is becoming an important part of our life. It stands for simulation of human intelligence in the form of machine learning which permits the people to perform various tasks like understanding natural language, recognizing patterns, solving problems, making decisions etc. It not only plays a vital role in our daily life but also in the economy of nation as well. AI system can be classified into main categories namely narrow/weak AI and general/strong AI; while the former is designed for specific well-defined tasks, the latter possesses human like intelligence and can perform a variety of tasks. AI has a wide range of applications in various fields such as agriculture, industries, health care, finance, automotive, entertainment etc. and has significantly impacted rural development by addressing various rural communities. The main examples of AI technologies in agriculture are precision farming, use of drone technology in sowing, plant protection measures, monitoring of crops etc. In health care sector, it helps increasing computation of complex things and complex problems in lesser time. In the field of education, it helps in personalized and remote learning besides assisting in extension services, resource management, rural finance, disaster management and creating job opportunities for our unemployed educated youth.

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INTRODUCTION

With passage of time, artificial intelligence has become a part of our life. We use Artificial Intelligence (A.I.) technology in our day to-day life. Alan Turing- A great Mathematician and Computer Scientist was the first who conceptualized AI in his article entitled "Computing Machinery and Intelligence" in the year 1950, in which he introduced the idea of machine learning, genetic algorithms, reinforcement learning and the Turing Test. John MacCarthy in 1956 invented the word "Artificial Intelligence" when he organized the Dartmouth Conference. Artificial intelligence not only plays a vital role in our daily life but also in economy as well. We see numerous machines and AI tools used in different industries to ease the workload and reducing the drudgery of people working in the industrial sector. However, AI is not limited to industrial sector only but also to primary and tertiary sectors. In primary sector, AI had been introduced to the agriculture and allied sectors where the use of drone technology, ICT tools, GPS, GIS, Precision farming, monitoring of livestock etc. is now known to farm as well as non-farm sectors. Majority of the population lives in the rural areas, thus the rural areas or rural people are the building blocks of any nation. Therefore, the development of the rural areas is necessity for the development of whole nation. Artificial intelligence is a new key to open the door for the rural development.

Artificial Intelligence (AI) stands for simulation of human intelligence in the form of machines which permits the people to perform various tasks like understanding natural language, recognizing patterns, solving problems, making decisions etc. AI systems can be classified into two main categories viz; **Narrow or weak AI** and **General or Strong AI**. The former is designed for specific well-defined tasks but lacking general intelligence whereas the latter possess human-like intelligence and can perform a variety of tasks. Examples of narrow AI include voice assistants like Siri and Alexa, recommendation algorithms on streaming platforms, and image recognition software.

AI technologies and techniques encompass various subfields, including:

- **Machine Learning (ML):** A subset of AI that involves training algorithms to learn from data and make predictions or decisions. Common ML techniques include supervised learning, unsupervised learning, and reinforcement learning.

- **Deep Learning:** A type of machine learning that uses neural networks with multiple layers (deep neural networks) to analyze and process complex data, such as images, text, and speech.

- **Natural Language Processing (NLP):** The field of AI focused on enabling machines to understand, interpret, and generate human language. NLP applications include language translation, sentiment analysis, and chatbots.

- **Computer Vision:** The area of AI that enables computers to interpret and understand visual information from the world, such as images and videos. It is used in tasks like image recognition, object detection, and facial recognition.

- **Robotics:** AI is used to control and enhance the capabilities of robots, enabling them to perform tasks in various domains, from manufacturing to healthcare and exploration.

- **Reinforcement Learning:** A machine learning paradigm where agents learn to make decisions by interacting with an environment and receiving feedback in the form of rewards or punishments. It is often used in autonomous systems like self-driving cars and game-playing AI.

AI has a wide range of applications across industries, including healthcare (diagnosis and treatment planning), finance (algorithmic trading and fraud detection), automotive (autonomous vehicles), and entertainment (video game AI and content recommendation). As AI technologies continue to advance, they are likely to play an increasingly prominent role in shaping the future of many aspects of society and the economy. However, ethical and societal considerations, as well as concerns about the impact on jobs and privacy, are important aspects of the ongoing development and deployment of AI.Artificial Intelligence (AI) has significantly impacted rural development by addressing various challenges and improving the quality of life for rural communities. Here are several ways in which AI can be applied to rural development:

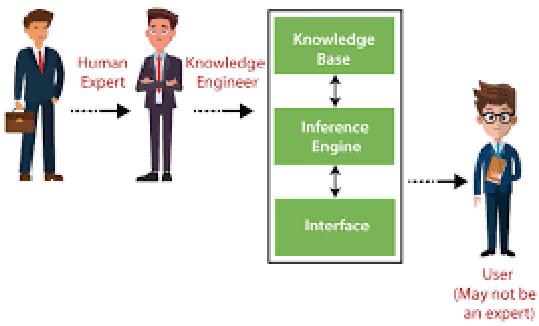
AGRICULTURE:

Robots in the field of agriculture are designed for various purposes/applications like prediction of crop yield, irrigation, soil monitoring, livestock monitoring etc. and accordingly has enabled the farming community to produce more qualitative output with less inputs. Some of the examples of AI technology in agriculture are as follows:

- **Precision Farming-** AI-driven systems can analyse data from sensors, satellites and drones to provide farmers with insights about soil health, weather patterns and crop conditions which enables the farmers in precise irrigation, fertilization, pest management, optimizing crop yields etc.

- **Use of Drone Technology-** Drones are now gaining popularity in the agriculture sector with their variety of uses like sowing, pesticide spray, monitoring of crop, insect-pest, disease and livestock, services etc. Drones are used to provide physical access to various markets which are faraway or in the remote areas by lifting the produce from the place of production and delivering the same to the markets and ultimately to the point of consumption instead of selling their produce in the local markets to fetch better prices for their produce.

- **Information and Communication Technology (ICT) Tools-** ICT platforms are used by the farmers to find solution to their problems which focus on improvement of agriculture and rural development. The examples of AI platforms used as ICT tools are social media apps, expert system, Internet of Things (IoT), cyber extension etc. The working of the expert system has been briefly discussed as under: -



User interface- It is the component that permits the user to put questions to the system and obtains the feedback of those questions from the system. Its function is to present questions and information to the user and supply the user's response to the inference engine. The user interface checks all the responses to ensure that they are of the correct type. Whenever the user enters an illegal response, the user interface informs the user

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that his input is invalid and prompts him to correct it.

Knowledge base-It is the component that contains the knowledge obtained from the domain expert used to solve a problem must be represented in a fashion that can be coded into the computer and then be available for decision making by the expert system. It works on 'IF' and 'THEN' principle.

The knowledge domain comprises of factual and heuristic knowledge. While **factual knowledge** is typically found in textbooks or journals, **heuristic knowledge** is more experiential, more judgemental, mostly individualistic and underlines the art of guessing/supposition.

Inference engine- It is the component which tries to proceed logically towards a better solution. The main advantage of inference engine is that inference application uses logical reasoning which more closely resembles with human reasoning.

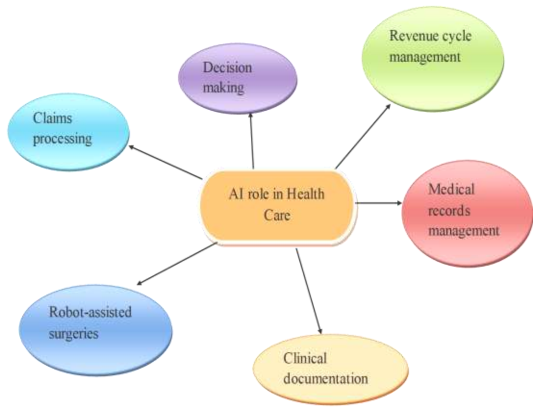
Some of the expert systems are **Exowhem (for Wheat)**, **Rice Expert System**, **Maize Expert System** etc. The other AI platforms are:

- **Farmer Wise-**Developed by International Crop Research Institute for the Semi-Arid Tropics, Patencheru, Hyderabad (ICRISAT) that provides farmers with real-time recommendations for irrigation, fertilization, and other farming practices.

- **Soil Sens-** Soil Sens is an AI-powered platform developed by IIT Bombay that helps farmers optimize their irrigation and fertilization practices by getting automatic alerts on the phone. It can be used across all crops and all soils and providing different products at affordable prices.

HEALTHCARE: Artificial intelligence has become a new wing in the healthcare sector in the recent years for monitoring patients, drug discoveries and clinical trials, robot-assisted surgeries, cancer treatment etc. Besides, AI also offers various advantages such as;

- Ease in computation of complex things.
- Increased efficiency and accuracy.
- No human error.
- Diligent worker.
- Quick problem solving.
- Computation of complex problems in lesser time.
- Can do multiple tasks simultaneously.



- **Telemedicine-** AI-powered telemedicine solutions can connect rural communities to healthcare professionals providing access to medical consultation and monitoring for chronic conditions. Through smart watches, we can check our health status by linking the additional devices needed like sleep parameter, oxygen level, stress levels, skin temperature, calories consumption etc.

- **Disease Prediction-** AI can analyse health data to predict disease outbreaks and provide insights for proactive healthcare planning. In the time of pandemic i.e. Covid-19, doctors were leveraging/exploiting AI powered image technologies such as X-rays and CT scan to diagnose Covid-19 among people. Similarly, CNN (Convolutional Neural Network) which is a type of deep learning neural network architecture commonly used in computer vision is used for imaging purpose. Likewise, 4CE is an International Consortium consisting of 96 hospitals in five countries for Electronic Health Records (EHR) data-driven studies of the Covid-19 pandemic for sharing data with one another. The goal led by i2b2 (Informatics for Integrating Biology & the Bedside) group is to inform doctors, epidemiologists and the public about Covid-19 patients with data acquired through the health care process.

EDUCATION:

Education is one of the key factors towards the upliftment of the people as well as of the nation. AI provides digital learning platform for the students as well as teachers to learn different things in an innovative and effective way. For example,

- **Personalized Learning-** AI-driven educational platforms can adapt to individual students' learning styles helping to improve educational outcomes in rural schools.

- **Remote Learning-** AI can facilitate access to high-quality educational resources and remote learning opportunities for students in remote areas.

But with advancement of the technology, we cannot feign ignorance towards certain issues/constraints faced by both students and teachers in adoption of AI. For instance, in rural areas the students face the problems of non-availability of phones/laptops, internet connectivity, how to use the technology and from which platform to learn. Similarly, the teachers also face these problems when they are not well-versed with the technologies and are not able to impart proper education to the students. Besides, there are other issues of gender inequality in rural India. However, the Education Technology (EdTech) enterprises are coming up with the ways to tackle these problems in the rural areas with the help of Conversational AI. For example, Conve Genius, an EdTech social enterprise in India founded by Viprav Chaudhary during Covid-19, was observed to boost the outreach of EdTech platforms by leveraging the use of Conversational AI for online education purpose like instructors can upload their educational videos in regional languages, helping teachers to understand students' needs based on the data gathered from their queries, easing learning as teachers can converse with their students in any surrounding through text messages or multimedia files, students can clarify their doubts through FAQ chatbots, facilitating students, parents and teachers on different levels through personalized learning and provide a good solution to remote learning.

INFRASTRUCTURE AND SERVICES:

- **Smart Infrastructure-** AI can enhance infrastructure management by optimizing energy use, traffic control, and waste management leading to more efficient and sustainable services in rural areas.

- **Public Transportation-** AI can improve public transportation systems in rural areas making them more accessible and efficient. This could include optimization of bus routes by analysing the passenger data using historical and current information.

AGRICULTURE EXTENSION SERVICES:

- **Chatbots and Virtual Assistants:** Chatbots are the conversational virtual assistants who automatically interact with end users. AI-powered chatbots and virtual assistants can offer agricultural guidance to the farmers in answering their questions and offering recommendations on farming practices.

NATURAL RESOURCE MANAGEMENT:

- **Forest and Wildlife Conservation-** AI can aid in monitoring and protecting natural resources by using remote sensing, image recognition and data analysis to track deforestation, poaching and illegal logging.

RURAL FINANCE:

- **Credit Scoring-** AI can help rural individuals and small businesses access credit by assessing creditworthiness based on alternative data sources, such as mobile phone usage or crop yield data.

DISASTER MANAGEMENT:

- **Early Warning Systems-** AI can analyse weather and environmental data to provide early warnings about natural disasters, such as floods and droughts, thus, helping rural communities prepare and respond effectively.

JOB OPPORTUNITIES:

- **AI Development and Maintenance-** As AI technologies become more prevalent in various sectors. Therefore, there is a growing demand for AI developers, data scientists, machine learning engineers and AI researchers. Rural areas can benefit from this demand by training and employing individuals with the necessary technical skills.

- **Agricultural Jobs-** AI can improve agricultural practices with the help of precision farming and drones. This can lead to new job opportunities related to the operation and maintenance of AI-driven farming equipment and technologies.

- **Telemedicine and Healthcare-** The implementation of AI in healthcare can create jobs for healthcare professionals such as nurses, technicians, and administrators who are needed to support telemedicine services and AI-powered diagnostic tools.

- **AI Support Services-** The deployment of AI systems often requires technical support and maintenance. Rural areas can host businesses that provide AI system installation, troubleshooting and maintenance services which can lead to employment opportunities.

- **Digital Services-** AI can enable the growth of digital service industries in rural areas. For example, businesses related to web development, digital marketing, web-pages, e-commerce etc. need experts to handle or develop the websites in the digital service sector.

- **Training and Education-** There is a need for educators and trainers who can help rural residents acquire the skills necessary to work with AI technologies whether for using digital tools in farming, participating in online education or operating AI-based machinery.

- **Infrastructure Development-** As rural areas adopt AI technologies, there may be opportunities for construction and maintenance jobs related to building the necessary infrastructure such as setting up internet connectivity, sensor networks, servers etc.

- **Community Services-** AI-powered chatbots and virtual assistants can provide support and information to rural residents which may require individuals to operate and maintain these systems.

- **Local Entrepreneurship-** AI can enable rural entrepreneurs to start businesses related to AI applications and services. This can include creating AI solutions tailored to local needs or offering specialized services for the community.

The exact job opportunities can vary depending on the specific AI applications, local needs, and the level of technological adoption in each rural area. Furthermore, the creation of these job opportunities may also require investment in education and training so that the local workforce is prepared to take advantage of them.

CONCLUSION:

Therefore, it has been concluded that though AI can play a pivotal role in various aspects of rural development yet the successful implementation of AI in rural development requires considerations of infrastructure, accessibility, affordability and the involvement of local communities. In addition, addressing the concerns related to data privacy, ethics and skills development in rural areas is crucial for the potential adoption of AI technologies particularly in the rural areas. Furthermore, the collaboration among the various government organisations, NGOs, IT companies and local communities is very essential if we want to harness the full potential of AI for the rural development in our country.

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Biochar: The Versatile Soil Amendment for Improved Agriculture and Environmental Sustainability

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ABSTRACT

Biochar, a form of pyrogenic carbon derived from the combustion of organic materials, has shown promising results in improving soil properties and enhancing crop growth and yield, particularly under drought conditions. In this comprehensive article, we will delve into the world of biochar, exploring its production, impact on soil health and fertility, climate change mitigation capabilities, and more. By understanding the production process, tailoring biochars to specific soil conditions, and exploring nano-biochar applications, we can unlock the full potential of this versatile soil amendment. With ongoing research, innovation, and adoption, biochar has the power to revolutionize agriculture, create healthier soils, and contribute to a more sustainable future for generations to come.

INTRODUCTION

Biochar, a carbon-rich material produced through the pyrolysis of organic matter, has gained significant attention in recent years for its potential to enhance soil health, increase crop yield, and mitigate climate change. With its roots in ancient Amazonian agriculture, the benefits of biochar have been recognized for centuries. Today, researchers and farmers are exploring its applications in various agricultural and environmental contexts, seeking to unlock its full potential. In this comprehensive article, we will delve into the world of biochar, exploring its production, impact on soil health and

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fertility, climate change mitigation capabilities, and more. The global demand for food production continues to rise, placing increasing pressure on agricultural systems to enhance crop yield while facing challenges such as declining soil fertility and water scarcity. One potential solution to address these issues is the use of biochar as a soil amendment. Biochar, a form of pyrogenic carbon derived from the combustion of organic materials, has shown promising results in improving soil properties and enhancing crop growth and yield, particularly under drought conditions.

The Origins of Biochar

Biochar has a rich history dating back thousands of years in the Amazon Basin, where indigenous communities used it to create "terra preta," or dark earth. These fertile soils, enriched with biochar, have retained their high nutrient content and carbon storage capacity to this day. The knowledge of biochar's benefits was passed down through generations, but it was not until the work of scientists like Wim Sombroek that its potential was widely recognized outside the Amazon. Sombroek's research sparked interest in developing biochar as a modern soil amendment, leading to the exploration of its applications worldwide.

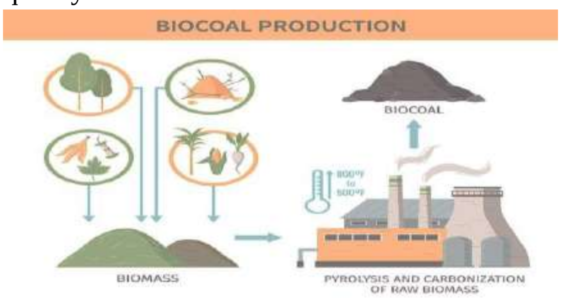
Understanding Biochar and its Lifecycle

Biochar is a specialized form of charcoal produced through the pyrolysis process, where organic matter, such as wood chips or agricultural residues, is heated in the absence of oxygen. This carbon-negative process not only reduces carbon dioxide (CO_2) emissions but also creates a stable form of carbon that enhances soil quality for centuries. The physical attributes of biochar, including its black color, lightweight nature, fine-grained texture, and large surface area, contribute to its unique properties and benefits. Once incorporated into the soil, biochar can persist for thousands of years, improving soil structure, nutrient retention, and water filtration.

The Impact of Biochar on Soil Health and Fertility

One of the primary applications of biochar is as a natural soil improvement aid. It has been found to enhance soil health and fertility by increasing nutrient retention, improving water filtration, and promoting beneficial soil microbes. The unique properties of biochar enable it to hold onto nutrients and moisture, making them readily available to plants. Additionally, biochar's ability to improve soil structure leads to better drainage and aeration, reducing compaction and enhancing plant responses. These benefits make biochar an ideal amendment for both agricultural and horticultural applications, enabling plants to withstand drought conditions and naturally improve the surrounding soil.

Soil degradation is a significant concern in global agriculture, and biochar offers a potential solution. It can help remediate degraded and contaminated soils by enhancing soil structure, reducing acidity, preventing nutrient leaching, improving porosity, and increasing water retention. Furthermore, biochar acts as a refugia for beneficial microbial populations, contributing to overall soil health. Additionally, biochar can be used in home composting, speeding up the composting process, reducing greenhouse gas emissions, and improving overall compost quality.



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The Impact of Drought on Crop Production

Drought stress is a significant abiotic stressor that can severely impact crop production, particularly in water-demanding crops like wheat and peppers. It disrupts seed germination, seedling development, and overall crop physiology, leading to reduced growth and yield. With the increasing frequency and intensity of drought events due to climate change, it is critical to develop strategies to mitigate the detrimental effects of drought on crop production.

The Importance of Soil Management in Drought Conditions

Soil management plays a crucial role in enhancing crop productivity, especially under drought conditions. High chemical inputs and intensive agricultural practices have led to a decline in soil fertility and the degradation of soil properties. This necessitates the adoption of sustainable soil management practices that can improve soil fertility, water-holding capacity, nutrient availability, and overall soil health.

The Role of Biochar in Improving Soil Properties

Biochar application has emerged as a promising strategy to enhance soil properties and mitigate the negative impacts of drought on crop production. Studies have shown that biochar amendments can increase soil organic carbon content, moisture retention, porosity, and cation exchange capacity. These improvements contribute to enhanced nutrient availability, microbial activity, and overall soil fertility.

Effects of Biochar on Soil Nutrient Retention

One of the key benefits of biochar application is its ability to improve soil nutrient retention. Biochar acts as a reservoir for essential nutrients, preventing their leaching and making them more available to plants. It can increase the retention of mineral nutrients such as nitrogen, phosphorus, and potassium, which are crucial for plant growth and development. Biochar amendments have been shown to significantly increase nutrient levels in the soil, leading to improved crop yield.

Biochar and Water Use Efficiency

Water scarcity is a significant challenge in agriculture, particularly in regions prone to drought. Biochar amendments have been found to enhance water use efficiency in plants by increasing soil water retention and reducing water loss through leaching. The porous structure of biochar allows it to absorb and retain water, making it available to plants during dry periods. This increased water availability contributes to improved crop growth and yield under water-limited conditions.

Biochar and Microbial Activity

Soil microbial activity plays a vital role in nutrient cycling, organic matter decomposition, and overall soil health. Biochar amendments have been shown to enhance microbial activity in the soil, leading to increased nutrient mineralization and improved nutrient availability for plants. The addition of biochar provides a favorable habitat for beneficial soil microorganisms, promoting their growth and activity. These microorganisms play a crucial role in enhancing soil fertility and plant growth.

Biochar and Crop Yield Under Drought Conditions

Numerous studies have demonstrated the positive impact of biochar on crop yield under drought conditions. Wheat, one of the most important staple food crops globally, has shown significant improvements in growth and yield with biochar amendments. Biochar application increases the availability of mineral nutrients, enhances water retention, and improves soil structure, leading to higher wheat yield even in drought-stressed environments.

Biochar and Pepper Yield in Sandy Soils

Peppers are another crop that can benefit from biochar amendments, especially in sandy soils with low nutrient retention capacity. Sandy soils are prone to nutrient leaching, which can result in nutrient deficiencies and reduced crop yield. Biochar amendments have been found to significantly increase pepper yield in nutrient-deficient sandy soils by improving nutrient retention, water availability, and overall soil fertility.

Optimizing Biochar Application Rates

The rate of biochar application is a crucial factor in maximizing its benefits in improving soil fertility and crop yield under drought conditions. Studies have shown that higher rates of biochar application generally result in greater improvements in soil properties and crop performance. However, the optimal biochar application rate may vary depending on soil type, crop species, and specific environmental conditions. It is essential to conduct site-specific trials to determine the most effective biochar application rate for a particular agricultural system.

Considerations for Biochar Production and Sourcing

The production and sourcing of biochar are important considerations to ensure its effectiveness as a soil amendment. The quality and properties of biochar can vary depending on the feedstock used and the pyrolysis conditions. It is crucial to select biochar produced from sustainable and renewable sources to minimize environmental impacts. Additionally, biochar should undergo thorough testing to ensure its safety and effectiveness as a soil amendment.

Biochar as a Climate Change Mitigation Strategy

In addition to its soil improvement capabilities, biochar offers significant potential for mitigating climate change. As a carbon sink, biochar sequesters carbon dioxide from the atmosphere, effectively reducing greenhouse gas emissions. By offsetting carbon emissions and promoting carbon sequestration, biochar plays a vital role in climate change mitigation efforts. Furthermore, biochar's ability to enhance soil fertility reduces the need for chemical fertilizers, which contribute to greenhouse gas emissions during their production. The combination of carbon sequestration and reduced fertilizer use makes biochar a compelling tool for regenerative farming and sustainable agriculture.

The Environmental Impacts of Biochar

Biochar offers several environmental benefits that can contribute to a more sustainable world. Its production process has the potential to sequester a significant amount of carbon annually, effectively reducing atmospheric carbon levels. Additionally, biochar can serve as a clean and renewable energy source, generating energy during the pyrolysis process as an alternative to burning fossil fuels. This energy generation reduces greenhouse gas emissions and supports the transition to a low-carbon economy. Furthermore, the use of biochar in agriculture can minimize the need for agrochemicals, protecting water resources and reducing pollution.

Biochar Engineering and Tailoring for Specific Applications

Biochar engineering focuses on designing biochars optimized for specific regions and soil types. By understanding the pyrolysis reaction conditions, biochar properties, and soil responses to biochar amendments, researchers aim to create tailored biochars that address specific soil needs. This iterative process involves producing biochars under controlled conditions, characterizing their properties, studying soil responses, and formulating biochars with favorable characteristics. Location-specific data and research findings contribute to the development of optimized biochar solutions. Future studies will shed more light on the specific effects of biochar on different soil types and crops, enabling farmers to make informed decisions about its application.

Nanobiochar: Expanding the Horizons of Biochar Applications

In recent years, the concept of nano biochar has emerged, where biochar is reduced to nanoscale dimensions to enhance its performance and applications. Nano biochar offers a higher surface area, increased porosity, and more surface functional groups, leading to improved contaminant adsorption, enhanced nutrient retention, and advanced sensing capabilities. The nanoscale properties of biochar enable it to play a significant role in water remediation, contaminant immobilization, and agricultural applications. Ongoing research and development in nano biochar hold great promise for addressing environmental challenges and promoting sustainable practices.

Biochar in Construction: Sustainable Building Materials

Biochar has also found applications in the construction industry, particularly in the development of sustainable building materials. Its unique properties, such as low bulk density, low thermal conductivity, and porous structure, make it an attractive additive for concrete production. Biochar can reduce the volume of cement powder and aggregate required, leading to lighter and more sustainable concrete. Additionally, biochar's thermal insulation properties and sound absorption capabilities contribute to energy-efficient and environmentally friendly construction practices. The incorporation of biochar in construction materials offers opportunities for reducing environmental impact and promoting sustainable development.

Challenges and Future Directions

While biochar shows great promise as a soil amendment and climate change mitigation strategy, there are still challenges to overcome and areas for further research. The effects of biochar on different soil types, crops, and environmental conditions require more investigation to develop tailored solutions. Understanding the interactions between biochar, soil biota, and plants is crucial for optimizing its application and avoiding unintended consequences. Standardization of biochar production methods and characterization techniques will also contribute to consistent quality and performance. Continued research and collaboration among scientists, farmers, and policymakers will drive the adoption of biochar as a sustainable solution for agriculture and environmental challenges.

CONCLUSION

Biochar offers a multitude of benefits for agriculture, soil health, and environmental sustainability. Its long history and modern applications demonstrate its potential to improve crop yield, enhance soil fertility, sequester carbon, and mitigate climate change. Biochar application offers significant potential in improving soil fertility and enhancing crop yield under drought conditions. Its ability to improve soil properties, nutrient retention, water use efficiency, and microbial activity make it a valuable tool for sustainable agriculture. By incorporating biochar into soil management practices, farmers can mitigate the negative impacts of drought and improve crop productivity. However, further research and field trials are needed to optimize biochar application rates and understand its long-term effects on soil health and crop performance. With proper implementation and management, biochar can contribute to building resilient agricultural systems capable of meeting the increasing global food demand in the face of climate change challenges. By understanding the production process, tailoring biochars to specific soil conditions, and exploring nano-biochar applications, we can unlock the full potential of this versatile soil amendment. With ongoing research, innovation, and adoption, biochar has the power to revolutionize agriculture, create healthier soils, and contribute to a more sustainable future for generations to come.

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