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CHOW CHOW: THE MOST POPULAR VEGETABLE IN NEH REGION

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Chow chow [*Sechium edule* (Jacq.) Swartz.] also known as chayote is an underutilized crop of the family Cucurbitaceae grown in a cool region. It is unique among the cucurbits by bearing a single seeded fruit and exhibiting vivipary. When the fruit reaches maturity, the seed emerges and starts germination. Chow chow is an herbaceous, monoecious, self-compatible, perennial vine with tuberous roots. The Chromosome number is 2n = 2x = 28. The Centre of origin is Central America but considerable diversity is also found in the NEH region. The Crop is highly cross pollinated due to its monoecious nature. The mode of pollination is insects. Fruits are botanically known as pepo. Fruit length varies from 10-18 cm and 7-11cm in diameter. Considerable variations are found in chow chow in respect of fruit size, shape, colour, ridges, spines and nutritional composition of the fruits. Fruits are found in different shapes *viz.* pyriform, oval, ellipsoid, oblong etc. Fruit is also found in different colours *viz.* cream, pale yellow, light green, dark green etc (Rai *et al*., 2006, Sanwal *et al*., 2010). Immature fruits, tender stems with soft leaves and tuberous roots are eaten as a vegetable and all have great nutritional value and good health benefits. (Kanaujia *et al*., 2020). Fruits can also be used for making pickles, candy, sambar etc. Tuberous roots are used like potatoes. Fruits are rich in carbohydrates (4.5-5.5 g $100g^{-1}$), protein (0.8-1.0 g $100g^{-1}$), fiber (0.7-0.8 g $100g^{-1}$), minerals especially calcium (15-16 mg $100g^{-1}$) Phosphorus (16-17 mg $100g^{-1}$) and vitamins especially vitamin A (5-6 mg $100g^{-1}$) and vitamin C (10-15 mg $100g^{-1}$) (Verma, *et al.*, 2014, Mishra and Das, 2015, Shulee *et al.*, 2022). It is very popular among the tribals of the NEH regions owing to its hardiness, profuse fruiting with minimum care and multiple uses. In the NEH region, chow-chow is grown in kitchen gardens of every tribal as an important component of their daily diet. In India, chow chow is mainly grown in NEH region and some extant in Mandi in Himachal Pradesh, Madurai and Nilgiri in Tamil Nadu, Bengaluru in Karnataka, Koraput region in Odissa and Darjeeling in West Bengal (Singh *et al.*, 2012, Singh *et al.*, 2015).

In the recent past, the crop has gained importance as it possesses several medicinal properties due to richness in polyphenols flavonoids especially in leaves (3.5 mg g^{-1} dried leaves), roots (3.05 mg g^{-1}) and stems (1.93 mg g^{-1}). Fruits are good for the bones, the heart and the brain. Fruits also prevent constipation and reduce blood pressure and cholesterol. Infusions of leaves are used to dissolve kidney stones. Besides, fruit extract also has anti-hypertensive, anti-bacterial, anti-fungal, anti-oxidant, anti-inflammatory, anti-proliferative properties against cervical carcinoma, mouse lung fibrosarcoma and mouse macrophage leukaemia, anti-hyperglycaemic, anti-convulsant and central nervous system depressant activity. (Aung, 1990).

Varieties

In India, there is no released improved variety in chow chow. Different types of local cultivars of chow chow are being grown in various parts of the country. SAS, Nagaland University collected about 40 genotypes from different states of the NEH region and evaluated them under the DUS

project. Picture of important genotypes are given here to show variations in shape, size colour and spine of fruits of important genotypes.

Climate and soil

Chow chow is grown at medium to high altitudes (800-2000 m asl). It grows luxuriantly under high rainfall conditions (1500-2500mm). Moderate climate, high humidity (80-85%) and 12 hrs day length is considered best for chow chow cultivation. The optimum range for growth, flowering and fruit set of chow chow is 16-25°C. It is very sensitive to high temperatures. If the temperature goes above 30°C, it results in flower drops and production of small fruits. There may also be a decline in flowering and fruit set. And in severe cases, the leaf may become yellowish colour and may wilt in die. A shade net may be used under higher temperatures. Chayote can grow in a wide range of soil. It is best grown in well drained, sandy loam, rich in organic matter soil with a pH range of 5.5 to 6.5.

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Variations in shape, size, colour and spine of fruits of important genotypes

Planting

In lower hill, the crop is planted in February-March. In high hills, the crop is planted in April-May. The whole fruit which is already germinated is used as planting material for chayote. A mature fruit containing a single germinating seed is planted. About 1500-1600 germinated fruits are required for planting in one hectare of land. Germinated fruits are placed horizontally with the root portion at the base and the shooting part facing upwards and then covered with the soil. Deep planting will lead to fruit rot. Sowing is done in pits. Pits of 50 x 50 x 50 cm are dug up and filled with a mixture of 10 kg well decomposed manure, top soil and basal dose of fertilizers 20 days before planting. Spacing is maintained 3.0 m from row to row and 2.0 m from plant to plant. Before transplanting of chayote, the soil can be drenched with chloropyriphos 20EC @ 2 ml L^{-1} to check the infestation of termites.

Germinated mature fruit planted in pits

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Field layout of chow chow

Manures and fertilizers

The experiment conducted at SAS, Nagaland University found that chow chow responds very well to manures and fertilizers application. The dose of fertilizers depends upon the soil type and climate. About 15-20 tonnes/ha of well decomposed FYM should be mixed in the pits at least 20 days before sowing. Besides that, about 100 kg N, 60 kg P and 60 kg K/ha should be applied. Half dose of nitrogen, entire P and K should be applied in the pits at the time of sowing as basal dose. The remaining quantity of nitrogen is applied in two split doses at 30 and 60 days after sowing before flowering as a top dressing. (Kanaujia *et al*., 2020).

Intercultural operations

The soil should be kept loose for better plant growth and yield. The field should be kept weed free entire growth period. Weeding and hoeing are important cultural practices which affect crop growth and fruit development. In the early stage of the crop, weeds should be removed by hand weeding. Three weeding are necessary to keep the crop weed free. First weeding may be given 20-30 days after planting. Two more weeding are given at 20-30 days intervals. Mulching in chow chow not only improve water retention and ground temperature in the soil but also improve soil organic matter content. In chow chow, it is always advisable not to allow the fruit to touch the ground. They generally grow downward straight. Chow chow should be trained in a bower system. The bower system can be constructed by placing bamboo poles followed by criss-cross wire netting. The crop is trained when the plants are about 30 cm. Plants are supported by stakes so that they grow straight to the bower and spread the branch. The height of the bower should be about 2.0 m. Staking also prevents pest and disease infestation, easy harvesting and easy spraying of chemicals. It also helps in better utilization of light and air. Removal of old and dried leaves in old plant improves sunlight penetration and results in higher growth and yield. Chow chow needs ample soil moisture for good growth. But in NEH region, the chayote is grown as rainfed. From transplanting to till the plants are established, light irrigation must be given. Irrigation is necessary during dry spells. Continuous rain may lead to the wash away of the upper part of the soil so earthing up should be done at the time of weeding. The crop is semi-perennial in nature lasting 2-3 years. Hence, vines should be pruned at the end of the season leaving only a small portion of about 1 m.

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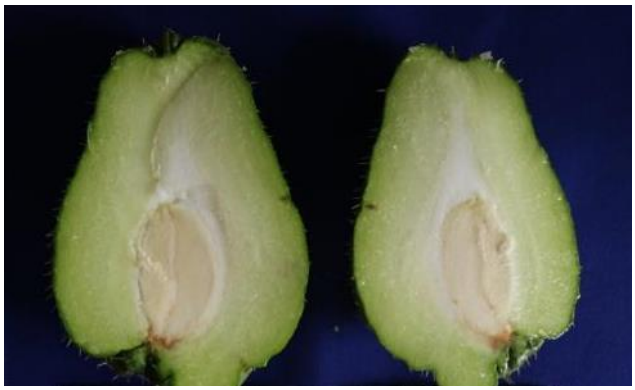
Bower system constructed by tribal people

Harvesting and yield

Chayote may flower after 80-90 days but it may not give fruiting if the temperature is not favourable. In high hills, fruiting starts from July to August till October but in foothills fruiting may start in October. Manual harvesting of immature fruits is usually followed. Fruits should not be allowed to become over mature. A minimum of 8-10 picking can be done in one season. About 30-40 fruits are produced from a single plant. Fruit weight varies from 300-600g. Chow chow produce 15-20 kg fruits plant^{-1} and 200-250 q ha^{-1}. Seed length at physiological maturity is 3-5 cm. Chayote has a shelf life of 3-4 weeks at room temperature after that start sprouting (Das and Mishra, 2019). Tuberous roots are dug out from 2nd year onward when vines are completely dry.



Fruits and seeds of chow chow

Crop protection

Chayote is very susceptible to powdery mildew. White patches/spots first appear on leaves and stem. Then it becomes yellow and shrivelled and later defoliation occurs. Excess moisture should

be checked and at least 3 applications of fungicides like Bavistin (0.1%), Karathane (0.05%,) Sulfex (0.2%) etc. at weekly intervals. Downy mildew also damages the crop. It is prevalent in the area of high humidity. The application of fungicidal spray of Dithan M-45 (0.2%) once a week is effective in controlling this disease. Fruit flies and aphids are major pests of chayote that suck sap from the leaves causing yellowing and curling of leaves. Aphids are also vectors of the mosaic virus. It can be controlled by spraying Imidacloprid @ 0.01 % or neem oil @ 4 ml L^{-1}.

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NUTRITION OF *Clarias magur*: A GUIDE TO OPTIMAL FEED PREPARATION FOR GROWTH AND HEALTH

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Introduction

The *Clarias magur*, more popularly known as the Asian walking catfish or Magur, is one of the preferred catfish in Indian aquaculture. It has gained widespread popularity among aquaculture enthusiasts because of its remarkable adaptability, hardiness and the fact that it can breathe atmospheric air. Because of its rapid growth rate and good feed conversion efficiency, *Clarias magur* is a practical option for commercial aquaculture. However, the availability of seed and feed are major constraints in magur culture. There are several attempts to breed the magur in captivity. Understanding on dietary preferences&requirements of the Magur, feeding pattern in different life stages, and nutrients required for breeding and growth are essential for formulating stage-specific feed for magur. Feed is a major factor for getting optimum growth in short culture periods, that is an essential criterion for getting profit from aquafarms. This article covers the nutritional requirements and feeding management of *Clarias magur* in farm ponds.

Fig1: *Clarias magur* brooders

Understanding the Basics of *Clarias magur* Nutrition

The growth and development of fish are greatly aided by a healthy diet. *Clarias magur* feeds on a broad variety of foods since it is an omnivore. Magur mostly needs protein, carbohydrates, lipids, vitamins, and minerals for proper nutrition. Magur can get all the nutrients it requires from a diet that comprises both plant and animal products.

Food and Feeding Habits of *Clarias magur*

Clarias magur is an omnivore, preferring animal-based material in the wild, and it feeds on a variety of feed materials like insects, aquatic vegetation, small mollusks, fishes, other invertebrates, and

decaying organic matter (Table 1). The fish is a voracious feeder and are mainly active at night hours. Shammi and Bhatnagar (2002) reported that they occasionally feed on algae and higher plants at the pond bottom. Larvae prefer zooplanktons, while fingerlings mostly feed on insects, crustaceans, and detritus and adults consume mainly smaller fish, insects, smaller and larger crustaceans, worms, dead and decaying organic matter etc. (Yadav, 1999). Some researchers have classified magur as a non-piscivorous air-breathing catfish as the juveniles are mostly insectivorous (Landge, 2001). Proteins, essential amino acids, and lipids found in insects like beetles and grasshoppers help the fish to meet its energy and muscle-building needs. Algae and water hyacinth, two examples of aquatic plants, are rich in the vitamins, minerals, and fibre that support a healthy digestive tract and immune system. Omega-3 fatty acids, which are essential for the fish's brain and general growth, may be found in smaller fish. *Clarias magur* may keep his bones and teeth healthy by regularly eating little fish, which are rich in calcium and phosphorus. However, the fish can remain dormant in adverse conditions and can stay without food for several months.

Table 1: Food and Feeding habits of magur (*Clarias magur*)

Sl No.	Stage	Size	Food
1.	Post larvae	10-15 mm	Zooplankton like Cyclops and Diaptomus; Cladocerans (Moina and Daphnia)
2.	Fry	20-30 mm	Oligocheates, Ostacodes, Insect larvae, Eggs, Filamentous algae etc.
3.	Fingerlings	30-100 mm	Insects, Zooplankton, Water bugs, Aquatic larvae, Chironomous larvae, Cladocera, Ostracoda and other dead and decaying organic matter
4.	Adults	Above 100 mm	Insects, Shrimps, Small fishes, Worms, Mussels, Dead and decaying organic matter etc.

Gut content analysis has been studied by some researchers to understand the food and feeding habits of *C. magur* and its food preferences according to the seasonal availability of prey in the wild. The study of food and feeding habits constitutes the basis of the development of suitable feed for the cultured animal (Oronsaye and Nakpodia 2005).

Nutrition and Feeding of Magur in Cultured Ponds

There are several difficulties that might arise when aquaculture systems rely primarily on natural feed sources. The number of natural feed supplies varies with the seasons and locations, which presents a problem. In addition, when using just natural feed sources, it might be challenging to guarantee that the fish are getting a balanced diet with all the required elements. Formulated feeds are used for this purpose. These feeds improve the development, health, and general performance of fish in aquaculture systems by catering to the unique dietary needs of each species. Aquaculture growers can have more control over the fish's nutrition and increase productivity by employing formulated feeds. This not only benefits the fish themselves by promoting faster growth and better health, but it also enhances the productivity and sustainability of the aquaculture sector as a whole. Providing a constant and nutritionally-balanced meal for fish is only one of the many benefits of employing formulated feeds in aquaculture systems. Pellets, powders, and liquid feeds are just a

few examples of formulated feeds used in aquaculture, and each has its own set of advantages. Aquaculture feed formulation entails choosing components and finding the optimal nutrient content depending on the dietary requirements of the fish species.

In cultured conditions, the fish accept rice bran, wheat bran, trash fish, and fish waste along with rice bran and commercial feeds (Siddiqui and Choudhury, 1996). The major nutrients required for artificial feeds are as follows

Protein

Proteins are a fundamental part of the Magur diet since they serve as the building blocks for cells, hormones, enzymes, and antibodies. Building muscle and expanding the body as a whole both require adequate amounts of protein. Their protein requirements are met by commercial feed formulations containing roughly 30-40% protein. Fish meal, soybean meal, and different animal by-products are all frequently used protein sources in the Magur diet. Overfeeding or underfeeding, both of which can be caused by an imbalance in the protein composition of the food, should be avoided at all costs.

Carbohydrates

Clarias magur gets most of his energy from carbohydrates. Carbohydrates in their diet aid in energy maintenance and serve to sustain several bodily functions. Carbohydrates play a crucial role in the digestion and absorption of nutrients, making them a crucial part of feed. Grain products like rice bran, maize, and wheat may be a key part of the Magur diets.

Essential Fats

Dietary fats are essential for nutrient absorption, energy storage, and maintaining overall health. Fats in the form of fish oil, vegetable oils, and lipid-enriched feeds play a significant role in promoting optimal growth, immune function, and reproduction in Magur.

Vitamins and Minerals

Vitamins and minerals are essential to the *Clarias magur's* health, just as they are to the health of people. Vitamins and minerals are examples of micronutrients that play crucial roles in metabolism, immunity, and other physiological functions. Vitamin A, vitamin D, vitamin E, and the B-complex vitamins, along with minerals like calcium, phosphorus, and iron, are essential for *Clarias magur* to maintain strong bones, a strong immune system, and resistance to disease. Similarly, vitamin E, vitamin D, zinc, and selenium are a must for a broodstock diet. For instance, vitamin C strengthens the immune system and provides resistance to disease.

Feed &Feeding Strategies for *Clarias magur* Farms & Hatcheries

The feeding techniques for *Clarias magur* include a variety of components, such as the frequency of feedings and the composition of the diet. Improving growth rates and decreasing feed waste are both results of using an effective feeding plan.

a. Feeding practices

Newly hatched larvae have heavy yolk sacs (2mm x 1.5mm), which will be consumed by 3 days. Weaning of magur spawn from yolk to external food can be initiated from 4^{th} day onwards with a little quantity of feed. Based on the biomass of the system, the feeding rate can be adjusted. The initial feeding can be done with zooplankton followed by *Artemia nauplii*, molluscan meat, Tubifex, and egg custard. Artemia flakes or frozen artemia nauplii are also accepted by magur early larvae.

The size of the live feed or particle size for the initial stages should be less than 50µm. For feeding 1-week-old fry, 50-60 µm particle size can be used. Later stages of fry can be reared with a feed size of 300 to 500 µm. As the size of the fish increases, the diameter of the feed needs to be increased while protein content can be decreased. From the 14th day onwards the fish will start accepting artificial feeds prepared out of fish protein hydrolysate (Chanu et al., 2018). The pelleted feed can be powdered or crumbled to a lower size to feed fry and fingerlings. The required protein percentage in the initial stage ranges between 45-60%. For fingerlings, the protein requirement is found to be 40.25% (Jindal, 2011). Protein requirement studies of brooders are not carried out in magur but a few studies showed that breeding performance is comparatively higher when brooders are reared in 35-40% protein (Sahoo et al., 2016).

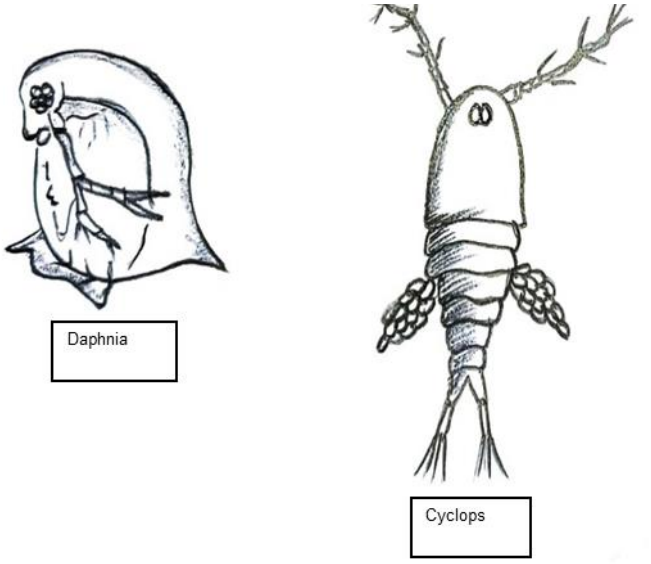

Fig 2: Examples of planktons available in the pond

Table 2: Nutritional requirement of *Clarias magur* at different life stages

Life stages	Protein (%)	Lipid (%)	Carbohydrate (%)	Vitamin & Minerals (%)
Larvae	45-52	7-9	15-20	1-2
Fry to Fingerlings	35-40	7-8	20-25	2
Fingerlings	30-32	6-8	25-30	1-2
Brooders	35-38%	6-8	20-25	2

b. Type of artificial feeds

The commonly used feeds in magur farms are sinking or slow-sinking feeds as magur is a bottom feeder. For larvae, usually dust feed, small crumbles, and pellets of 1-2 mm die size are being fed. The cost of catfish feed is higher compared to carp fish feed, and farm-made feeds with locally available ingredients can also be used for rearing catfish. Water stability is a major factor in this case. Farmers use trash fish/ fish waste and rice bran in 8:2 ratios to prepare farm-made feed for magur fingerlings. Recently, farmers are using chicken waste and de-oiled rice bran in different ratio to feed juveniles and brood stock fishes. But, the fat deposition in abdominal regions is a disadvantage of

the high inclusion of chicken waste, and the use of chicken waste directly into a pond is currently prohibited by the Govt.

Fig2: Various feed ingredients and pelleted feed

c. Feeding frequency& feeding rate

The best way to provide nourishment for a *Clarias magur* is to feed it several timesa day. In general, fish should be fed three to four times daily, however, this should be flexible depending on the weather and the fish's habits. Overeating, cannibalism, wastageof nutrients,etc can be avoided by dividing the daily feed amount into many smaller meals. During the fry to fingerling stages 5% feeding rate is adapted for magur and 2-3% of body mass is found to be sufficient for bigger fish.

d. Tailoring feed for growth stages

Clarias magur, like any other organism, has variable nutritional needs at various phases of its life cycle. *Clarias magur* dietary demands may change at various stages of life to accommodate changing growth and development. Fry requires a high-protein diet for explosive development and growth. Their energy demands and organ development are best served by a diet that includes a balance of proteins, carbs, and lipids as they mature into fingerlings. To be healthy and strong, adult Magur needs a balanced diet rich in protein, carbs, fats, vitamins, and minerals. Better results in terms of size, weight, and general health may be achieved by adjusting the feed mix to correspond with the growth stage.

Benefits of Optimized Nutrition

Providing *Clarias magur* with a nutritionally balanced diet yields numerous benefits:

1. Enhanced Growth: Proper nutrition accelerates growth rates, reducing the time required for the fish to reach market size.
2. Improved Health: A well-balanced diet boosts the immune system, making fish more resistant to diseases and stress.
3. Better Reproduction: Adequate nutrition is essential for reproductive success, resulting in higher survival rates of offspring.
4. Optimal Body Composition: Balanced nutrition ensures the development of healthy muscle and tissue, leading to high-quality fillet production.

Feeding Management

Overfeeding and underfeeding may be detrimental to health and wasteful of resources; both can be avoided with careful feed control. *Clarias magur's* diet may be fine-tuned with the aid of regular monitoring of feed consumption, growth rate, and general health. Feeding can be done in several

ways in a catfish farm ranging from hand feeding to feeding through automatic feeders. For smaller ponds (<0.5 ha), hand feeding is the low-cost feed-distributing practice, whereas in a larger pond (>0.5ha) bag, basket, tray, or automatic feeders can be used. As magur feeds from column to bottom, basket or tray feeding will be the better option. This will reduce feed wastage, hence improving water quality. The tray feeding will give an estimate of the feed intake and health status of the animal.

Different feeding methods in magur farms a. Manual ball feeding b. Bag feeding c. Tray feeing in cement ponds

Challenges and Future Directions

In spite of the significant advancement that has been made, there are still issues to be resolved regarding the nutrition of *Clarias magur* feed. Producing nutritious feeds at a reasonable price is a major obstacle. Scientists are always looking into new feed components and environmentally friendly feed production techniques to find a solution to this problem.

Potential Feed Innovations

Researchers are opening up new feed alternatives for *Clarias magur* as aquaculture technology develops. Insect meal and single-cell proteins are two examples of alternative protein sources that potentially replace conventional feed components in a way that is both sustainable and environmentally friendly.

Conclusion

Successful cultivation of *Clarias magur* requires a thorough understanding of its nutritional needs and feeding practices, which may be thought of as both an art and a science. Farmers may help their fish grow by giving them a diet that includes all the essential nutrients, including protein, carbs, lipids, vitamins, and minerals. There are promising prospects for both farmers and customers in the future of *Clarias magur* farming as we learn more about Magur nutrition and investigate novel feed alternatives.

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DARJEELING MANDARIN PRODUCTION CONSTRAINTS AND FUTURE PROSPECTS IN DARJEELING HILLS

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Introduction

Mandarin *Citrus reticulata* Blanco commonly known as "suntala" is the pride of Darjeeling hills due to its delightful aroma and flavour. Mandarin, also referred to as Darjeeling orange, is a citrus fruit that is unique to the Darjeeling district (Singh et al., 2003). Currently, both fruit quality and production have severely decreased. Insect pests and diseases are the major constraint in obtaining good quality fruits and high yield of Darjeeling mandarin. It is primarily caused by improper orchard management practices, particularly with regard to nutrient management (macro and micronutrients), weed control, and the wise selection of intercrops, particularly in the fruit bearing orchards. Any cash crop's ability to produce and be productively is closely correlated to how well it is managed for pest and disease along with its nutrient input. Lack of high-quality planting material, frequent, severe pest and disease attacks, and a lack of technical expertise in cultivation-related areas are some of the main causes of low productivity. Therefore, there is a pressing demand for the development of high-quality planting material as well as the organic control of serious pest and disease problems.

Factors responsible for mandarin orange decline

1. Inadequate plant material of good quality

Most of the time, hill farmers grow mandarins from seeds. The majority of the seeds harvested come from mother plants that were afflicted by diseases like Citrus tristeza virus (CTV) and Citrus mosaic virus (CMV). As a result, plants that have been impacted by disease are not healthy, and their productivity declines over time.

2. Insect pest constrains

The common insect-pests damaging mandarin orange in Darjeeling are citrus psylla, citrus leaf miner, citrus fruit flies, citrus trunk borer, Lemon butterfly and Aphids.

a. Citrus psylla (*Diaphorina citri*)

Both the adults and nymphs of this pest suck the sap from the tender parts of the buds, leaves, branches and inject a toxic substance into them. The nymphs excrete a white crystalline waxy pellet on which black sooty mould may develop which reduces the photosynthetic area. In case of severe attack leaves get distorted, curled up and ultimately fall resulting in complete defoliation of the plant. This pest acts as a vector for spreading the **'citrus greening'** disease.

b. Citrus leaf miner (*Phyllocnistis citrella)*

This pest causes damages both in nursery and in grown up stages of the citrus plant. It the larvae attack tender leaves and feed in the epidermal layers of the leaf by making serpentine mines in which air gets trapped and gives them silvery appearance. The affected leaves turn pale yellow, get

distorted and crumpled. Such leaves gradually dry and die away. The attack of this pest also encourages the development of **citrus canker** disease.

c. **Citrus fruit flies (*Bactrocera dorsalis*)**

The female adult fruit fly punctures the ripening fruits by penetrating its needle like ovipositor and lays the eggs inside. On hatching, the maggots feed on pulp. Fruits at colour break stage are more prone to its damage. Infested fruit shows many dark green depressions due to punctures caused by insertion of ovipositor by female fly. Later on, the damaged area around the punctures becomes enlarged and yellow. On squeezing the infested fruit, a number of jets of juice come out, as there are many holes on a single fruit. Rotting of the fruit occurs due to fungal and bacterial infection through the puncture hole and due to feeding by maggots, resulting in premature fruit fall.

d. Citrus trunk borer (*Monohammus versteegi*)

The trunk borer insect is very serious pest of citrus plants. The grub of the trunk borer insect bores the tree trunk near ground level horizontally up to the pith and then tunnels vertically and again horizontally for exit. The attacked tree gradually dries up with leaves turning yellow and drop off prematurely.

e. Lemon Butterfly (*Papilio demoleus*)

It is the most destructive pest in nurseries. The caterpillars feed on the young foliage at the nursery stage and also on young flushes of grown up trees. The caterpillar feed voraciously on leaf lamina leaving behind only the midrib. In case of severe infestation, entire tree is defoliated. The fully grown caterpillars are green in colour.

f. Aphids (*Toxoptera citricida*)

Nymphs and adults suck sap from tender leaves and shoots. Affected leaves turn yellow, get curled, deformed and dry up. Growth of young shoots is adversely affected. Plant growth is stunted. Sooty mould is produced on honeydew excreted by aphids. Infestation of aphids at the time of flowering is associated with reduced fruit set. Black aphids and peach green aphids are vector of **citrus tristeza virus** (CTV).

3. Disease constraints

The major diseases of Darjeeling mandarin are Gummosis disease, powdery mildew, citrus canker disease, citrus greening and citrus tristeza.

a. Gummosis disease (Causal organism: *Phytophthora palmivora*, *P. citrophthora*, *P. nicotianae var. parasitica*)

This is a highly destructive plant disease causing rotting of bark at collar region and root, oozing out of gums from bark and defoliation of leaves. This disease is responsible for causing low productivity and short life span of Darjeeling mandarin. In severe cases, the bark is destroyed by complete rotting, the trunk exhibits a characteristic girdling and the tree eventually dies.

b. Powdery mildew (Causal organism: *Acrosporium tingitaninum*)

It is observed that, white powdery patches of mildew on upper part of young leaves and on twigs. In some cases, all aerial parts of the plants and fruits were infected by the pathogen. In severe infections, young fruits also get covered by mildew growth and drop off prematurely.

c. Citrus canker disease (Causal organism: *Xanthomonas axonopodis pv. citri*)

The disease appears on leaves, twigs, petioles, branches, fruits, fruit stalking including thorns. At initial stage minute water soaked lesion appears as yellow spot and gradually enlarges upto 2-4 mm in diameter and appears as raised brown brownish corky pustules on leaves and other parts of the plant. On leaves, the pustules are surrounded by a characteristic yellow halo. A characteristic yellow halo surrounds the spot till it becomes old. Cankered fruits drop off prematurely. Canker lesions are confined to the rind only and do not penetrate into the flesh of the fruit.

d. Citrus greening (Huanglongbing, HLB)

Citrus greening disease is found to be widely distributed in Darjeeling. It is distinguished by the yellowing of the veins and adjacent tissues followed by yellowing or mottling of the entire leaf. This is followed by premature defoliation, dieback of twigs, decay of feeder rootlets and lateral roots, and decline in vigour and finally the death of the entire plan The disease is caused by a phloem limiting gram-negative bacterium (*Candidatus liberibacter asiaticus*) and transmits through the vector, the Asian citrus psyllid, (*Diaphorina citri*).

e. Citrus tristeza

The plant showed necrosis in the phloem, yellowing of seed lings, chlorosis of leaves and stem pit ting. This may be due to Citrus Tristeza virus disease transmit ted by brown citrus aphid (*Toxoptera citricidus*).

Future prospects

1. Scientific methods for orchard management, such as careful use of macro- and micronutrients, control of pests and diseases, along with intercropping and the application of organic manure. It is urgently necessary to revitalise an ageing orchard by planting new, disease-free, healthy seedlings.
2. The farmers must be given an education and training programme on the prevalence and control of pest and disease of mandarin oranges through instruction and demonstration.
3. The policy makers should plan and implement appropriate strategies to reduce the constraints of mandarin grower of this region. Further, extension agencies working in the study area should also come up with appropriate technologies addressing the problems and constraints of mandarin growers in the region so that the pride fruit of this region may regain its production and productivity to its maximum.

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YIELD LOSS MODELING IN PLANT DISEASE MANAGEMENT

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Abstract

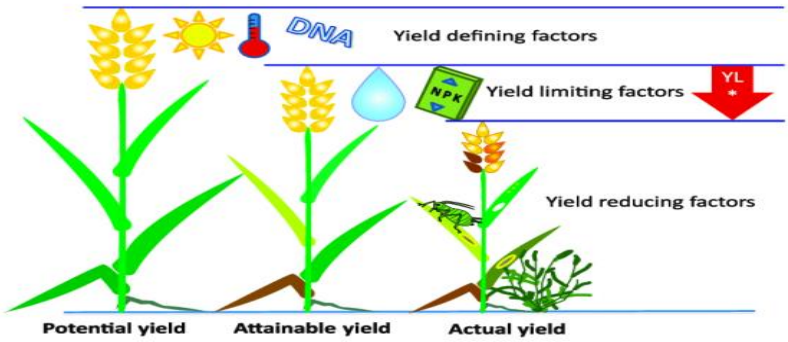
Yield loss modeling plays a pivotal role in understanding the complex interactions between plant pathogens, host plants, and environmental conditions, providing valuable insights for informed decision-making in disease management. These models integrate biological, environmental, and agronomic factors, allowing researchers and practitioners to assess the potential effects of varying disease severities and management interventions. It highlights the key components of such models, including disease progress curves, host-pathogen interactions, and the influence of environmental variables. Additionally, the discussion will encompass the benefits of yield loss modeling, such as aiding in disease forecasting, optimizing disease control strategies, and contributing to sustainable agricultural practices.

Introduction

Agriculture, a critical component of global food production, plays an indispensable role in sustaining human life and supporting economies worldwide. However, the agricultural sector faces numerous challenges, including unpredictable weather patterns, pest and disease outbreaks, soil degradation and resource limitations. These challenges often lead to yield losses, which can significantly impact food security, economic stability and environmental sustainability. Yield loss models are analytical frameworks that help predict and quantify the potential reductions in crop yield caused by various stressors.

What is the need of yield loss models?

Yield loss models can be used to evaluate what factors will contribute to yield losses. These can be used to estimate yield losses. These models can be used to determine what are the factors that can contribute more to yield losses.



* YL= Yield loss due to weeds, pathogens and insect pests

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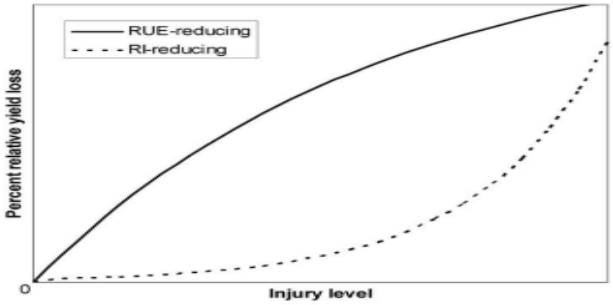
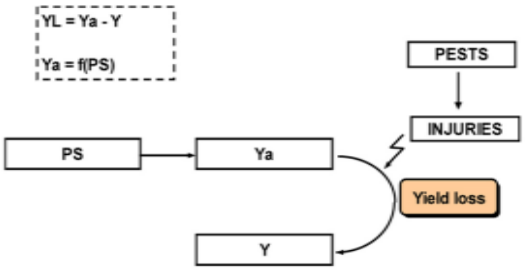
Damage functions

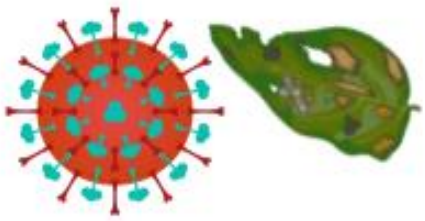
The relationship between injury levels and the yield loss they cause is one important quantitative component analyzed when addressing yield losses. This relationship is called a damage function.





DM- PS reducer/Light stealer

We should agree with the fact that we are surviving because of plants. Plants possess leaves, stem and roots. Leaves play an important role in synthesizing food through the process of photosynthesis.



DM-Assimilate sapper

There are some biotrophic fungi like rust and powdery mildews uptake photo assimilates from plant species. These fungi are called as assimilate sappers. Along with these there are some sucking pests like aphids, leafhoppers and planthoppers etc also act as assimilate sappers.

Traditional methods

Simple linear regression

Simple linear regression is used to estimate the relationship between two quantitative variables. Regression means dependence of one variable on another variable.

Formula is Y= a+bX (a is intercept and b is slope)
Here Y= Dependent variable (Yield)
X= Independent variable (Virulence of pathogen)

Let's say a researcher is interested in understanding the relationship between the amount of fungicide applied to a crop and the resulting disease severity. The researcher hypothesizes that as the amount of fungicide applied increases, the severity of the disease should decrease.

Multiple regression

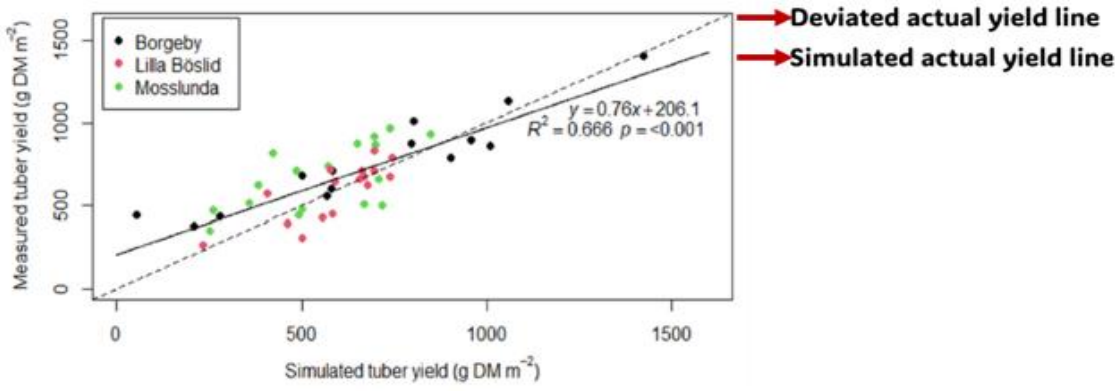
Multiple linear regression is used to estimate the relationship between two or more independent variables and one dependent variable.

How strong the relationship is between two or more independent variables and one dependent variable (e.g. How rainfall, temperature, and amount of fertilizer added affect crop growth). Y=a+b1X1+b2X2+b3X3+……bn Xn Here Y=Crop growth (dependent variable) X1,X2, X3…….Xn = Independent variables (rainfall, temperature, and amount of fertilizer)

Actual yield modelling

In general, simulated actual yields for the period 2001–2017 showed good agreement when compared to the actual yield measured in the field for the same period. The linear regression analysis showed that simulations accounted for 66.6% of this variation (r 2), with a slope of 0.76 and an intercept of 206.1 g DM m-2 ($p < 0.001$, n = 47, d.f. = 45).

The casual sensitivity analysis carried out to assess the effect of disease growth rate and time of infection on the actual yield showed a marked response to both variables. Simulations showed that even at relatively small r, yield reductions difference between the attainable yield and the actual yield) were substantial but, as r values increased, the magnitude of the reduction decreased. On the other hand, the magnitude of yield reductions remained constant as the time of infection (onset of epidemic) took place earlier in the growing season.



Disease progress curves and time of infection

All DPCs recorded in the untreated plots (period 1993–2017) reached 100% severity, with variations in the start of the infection and in the slope of the curve. The logistic model fitted most of the DPCs well, with coefficients of determination (r 2) above 0.9 in 88% of the total DPCs, and the remaining

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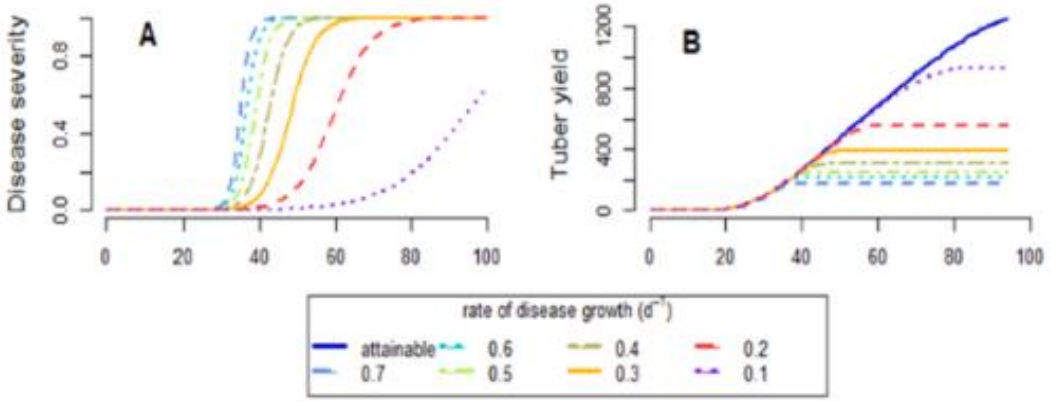
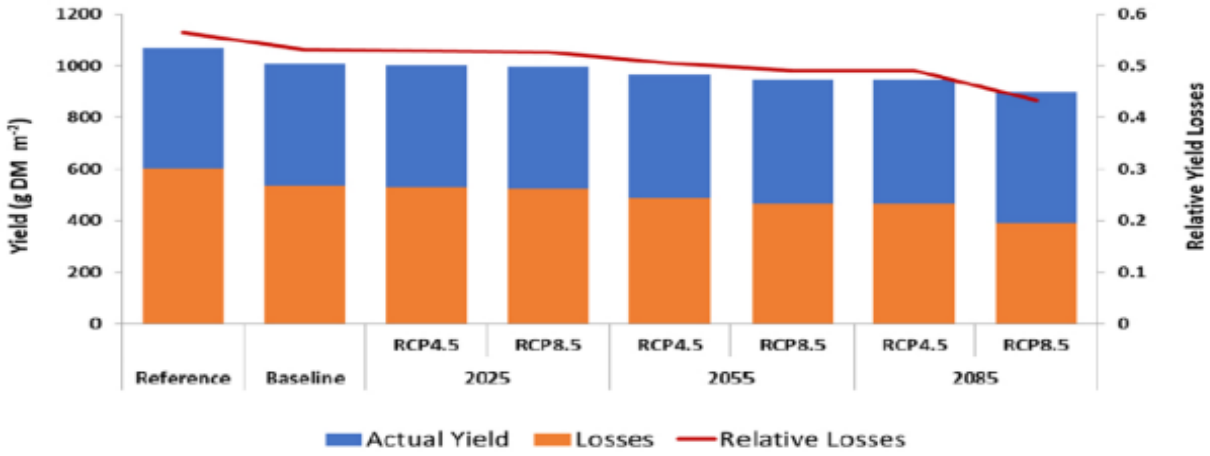
cases with values above 0.8 (except one single case, with a r 2 of 0.73). The rate of disease growth parameter (r) ranged from 0.17 d-1 to 0.77 d-1, with an average and standard deviation of 0.43 d-1 and 0.16 d-1, respectively.



Scenario analysis

Actual yield (with late blight), yield loss caused by P. infestans and relative yield loss (yield loss divided by the attainable yield, in relative units) estimations for two emission scenarios. The height of each column (actual yield + losses) represents the attainable yield.



Conclusion

Yield loss modelling stands as a crucial tool driving informed decisions and sustainable practices in agriculture, mitigating uncertainties and maximizing productivity. Its role in shaping resilient food systems remains pivotal for the future of global food security. In order to address these challenges and mitigate their adverse effects, the development and application of yield loss models have emerged as essential tools in modern agricultural management.

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AGROFORESTRY: GROWING A GREENER FUTURE WITH SUSTAINABLE LAND USE

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Abstract
As the world grapples with climate change, deforestation, and unsustainable land use practices, agroforestry has emerged as a powerful solution to address these pressing challenges. Combining agriculture and forestry, agroforestry offers a win-win approach that nurtures nature while promoting sustainable land use. This innovative practice is gaining traction worldwide, promising a greener future for our planet.

Introduction
Agroforestry is a sustainable land use practice that involves growing trees and crops together in a way that benefits both the environment and the people who farm the land. It is a system that mimics natural forests, with multiple layers of vegetation and diverse species, but with a focus on producing food, fuel, and other products. One of the main benefits of agroforestry is that it can help reduce the negative impacts of agriculture on the environment. Trees can capture carbon from the atmosphere and store it in their biomass, which can help mitigate climate change. They also help prevent soil erosion, improve water quality, and provide habitat for wildlife. Agroforestry can also be a more profitable and resilient way of farming. The diversity of crops and tree species can create a more stable and varied income stream for farmers, and the trees can provide shade and protection for crops, reducing the need for expensive inputs like fertilizers and pesticides.

Agroforestry, generally refers to land used system or farming system in which trees or shrubs are grown in association with agricultural crops, pastures or livestock and in which there is ecological and economic interaction between the trees and other components. Agroforestry practice is a distinctive arrangement of components in space and time. It is a specific local example of a practice, *e.g.* Taungya. It is characterized by environment, plant species, and arrangement, management, social and economic functions.

Agroforestry systems practice in India
1. Taungya system: Food crops are interplanted with trees in a unit area of land for 2-3 years. Food crops cease to exist on the land when the tree crops close canopy. The system has proved effective in providing food for forestry workers and forage for cutting by cattle rearers.

2. Integrated Taungya: Similar to Taungya farming, but here, when the tree canopy is closed, livestock grazing substitute raising of agricultural crops.

3. Improved fallow in shifting cultivation: Introduction of cover crops on the farmland in an effort to minimize soil degradation associated with agriculture.

4. Alley-cropping (hedge row intercropping): In this system, arable crops are grown between hedgerows of planted shrubs and trees, preferably leguminous species that are periodically pruned to prevent shading of the companion crops and the pruning applied as mulch for the crops.

5. Alley farming: Trees, shrubs and other perennials are planted with agricultural crops to supplement the woody plants in the rows.

6. Trees on farmland: The farmers plant or retain trees on their farmland, both for food, income, soil improvement and environmental amelioration and for shade during the adverse weather condition.

7. Scattered trees also known as parkland system: This system is characterized by well grown scattered trees on cultivated and recently fallowed land. These parklands develop when crop cultivation on a piece of land becomes more permanent. The trees are scattered far apart so that they do not compete with their neighbours. Parkland trees are deep rooted, have capacity to fix nitrogen, produce litter that decomposes well and add as much as possible to soil organic matter.

8. Boundary planting: Fast growing trees are planted on the boundary of field, terraces and streams banks, works as live fences, erosion control structures.

9. Shelterbelts: Agroforestry system in which food crops are planted between rows of trees belts planted as shelter. The trees and shrubs are planted in one or more rows at right angle to prevailing winds.

10. Windbreaks: Here, double rows of trees are planted around the boundary of a food crop farm on the windward side. Each windbreak is 150m long with 100 trees planted at escapement of 3m x 3m.

11. Home Garden: Tropical home gardens consist of an assemblage of plants which may include trees, shrubs, vines and herbaceous plants growing in or adjacent to a homestead or home compound.

12. Multipurpose trees on cropland (Trees on farmland or farm forestry): Farmers intentionally leave few trees on farms when clearing the land in the practice. The trees commonly left are those of economic importance to the farmers.

13. Trees in social conservation: Woody plants, whether in hedges or not, planted to stabilize the soil on terrace edges and other conservation.

14. Aqua forestry: This system is a practice that links trees with aquaculture. Trees are planted around fishponds to provide fodder for herbivorous fish.

15. Apiculture (Api silviculture): Carefully chosen woody species grown for their nectar-producing flowers and pollen valued by bees can boost wax and honey production.

16. Protein bank: Woody perennial vegetation judiciously used helps to supply forage during dry seasons or years of low rainfall.

Advantage of Agroforestry

Biodiversity and Ecosystem Resilience

One of the key advantages of agroforestry is its ability to promote biodiversity and ecosystem resilience. By fostering a diverse range of plant and animal species, these integrated landscapes create thriving habitats for wildlife. The presence of trees in agroforestry systems supports pollinators and beneficial insects, contributing to natural pest control and reducing the need for chemical inputs.

Carbon Sequestration and Climate Change Mitigation

In an era of rising carbon emissions, agroforestry serves as a natural climate change mitigation strategy. Trees are adept at sequestering carbon dioxide from the atmosphere, locking it away in their biomass and the soil. Agroforestry systems act as carbon sinks, offsetting greenhouse gas emissions and playing a crucial role in combating climate change.

Soil Health and Erosion Control

Conventional agricultural practices often lead to soil degradation and erosion. Agroforestry, on the other hand, nurtures soil health through the addition of organic matter from trees and diverse vegetation. This enriches the soil's nutrient content, enhances water retention, and reduces soil erosion. As a result, agroforestry contributes to the long-term sustainability of farming landscapes.

Food Security and Livelihoods

Agroforestry is a boon for smallholder farmers in developing regions, as it offers increased resilience and diversified income sources. The combination of tree crops, annual crops, and livestock ensures a more stable and dependable food supply. Additionally, trees provide products such as fruits, nuts, and timber, offering valuable sources of income for farmers.

Water Management and Conservation

Agroforestry plays a vital role in water management and conservation. Tree roots act as natural filters, preventing water runoff and protecting water sources from pollution. By regulating water flow and maintaining soil moisture, agroforestry helps prevent droughts and floods, contributing to a more sustainable water supply for communities.

Restoration of Degraded Lands

Agroforestry has the potential to rehabilitate degraded lands and wastelands, transforming them into productive and ecologically rich areas. By reintroducing trees and vegetation, these once barren lands can regain fertility and provide essential ecosystem services, such as improved air and water quality.

Conclusion

Agroforestry is more than just a farming practice; it is a holistic approach to sustainable land use and environmental conservation. By blending agriculture and forestry, agroforestry offers numerous benefits that extend far beyond traditional farming methods. From mitigating climate change and restoring biodiversity to supporting livelihoods and enhancing food security, agroforestry holds the key to a greener future. Embracing this innovative land use system presents an opportunity for individuals, communities, and nations to foster a harmonious relationship with nature while securing a sustainable and prosperous tomorrow.

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COLD PLASMA TECHNOLOGY: A SUSTAINABLE APPROACH FOR ENHANCING SAFETY AND SHELF LIFE WITH A SPECIAL FOCUS ON FISH AND FISHERY PRODUCTS

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Abstract

Cold Plasma Technology emerges as a sustainable paradigm for fortifying food safety and extending shelf life. This innovative approach harnesses non-thermal, ionised gases to treat food surfaces, offering efficient decontamination without compromising quality. Utilising various sources like dielectric barrier discharge and plasma jets, it enhances packaging materials' properties without altering bulk characteristics. In fish packaging, in-package plasma therapy exhibits promise by producing reactive species, inhibiting pathogens, and minimising spoilage during low-temperature storage. Advantages include reduced microbial burden, improved barrier properties, and potential reductions in chemical preservatives. While promising, challenges such as high implementation costs and regulatory considerations warrant careful exploration of its long-term impact on food quality.

Introduction

The etymology of the term "plasma" may be traced back to its Greek origin, where it derives from a word that conveys the concept of "something moulded or fabricated." The designation of "the fourth state of matter" was initially attributed to Sir William Crookes in 1879. Irving Langmuir, in 1928, coined the term "plasma" to denote the particular state of matter observed in the positive column of a glow discharge tube. Plasma is a separate state of matter that is characterised by unique properties, setting it apart from solids, liquids, and gases. The formation of plasma occurs when a gas is exposed to elevated temperatures or strong electromagnetic fields, resulting in the ionisation and dissociation of its constituent atoms into charged particles. The process of ionisation imparts distinctive characteristics to plasma, including its capacity to transmit electrical current and exhibit magnetic field interactions. Plasmas are observed in many natural occurrences such as lightning, stars, and auroras, as well as in artificial devices such fluorescent lights, plasma TVs, and fusion reactors (Adhikari and Khanal, 2013).

Cold Plasma Technology

Cold Plasma Technology is a rapid and efficient method that has many of the characteristics that the food industry looks for in a decontamination intervention to ensure food safety. Cold plasma is a non-thermal method for food applications. It is a recent advancement in post-harvest technology (Mishra *et al.* 2017). Cold plasma (CP) is an effective way for addressing the limitations of biopolymer materials for food packaging applications, such as their hydrophobicity, poor barrier capabilities,

and thermos-mechanical properties (Perera *et al.* 2022). Plasma technology is a cutting-edge and ecologically friendly approach with several applications in food packaging. A range of food packaging materials, such as plastic films, coatings, and laminates, may be treated using cold plasma technology without compromising the material's bulk properties. It is a promising technology for improving food product quality, safety, and shelf life, reducing food waste, and encouraging sustainable packaging practises in the food industry.

Classification of Plasma:

1. **Hot plasma:** It is also known as thermal plasma. It is a sort of plasma in which the electrons and ions are in thermodynamic equilibrium due to the high temperature. This indicates that the distribution of energy among particles follows a pattern determined by temperature.
2. **Cold Plasma:** It is also known as non-thermal plasma. Cold plasma treatment, as opposed to thermal techniques that employ heat, uses ionised gases to deactivate microorganisms and decrease pollutants on the surface of food goods. This makes it an interesting alternative for the food sector since it satisfies the requirement for efficient decontamination without depending on high temperatures, which may have an adverse impact on food quality. The food is exposed to ionised gases, which produce a variety of reactive species such as ions, electrons, and radicals. These energetic particles may efficiently sanitise the food surface by breaking down and neutralising dangerous germs and pollutants (Mishra *et al*., 2017).

Source of Cold Plasma

1. **Dielectric Barrier Discharge (DBD):** Dielectric Barrier Discharge (DBD) is a non-equilibrium gas discharge in which an insulating medium is used inside the discharge region. Applying an alternating current high voltage between two electrodes is a typical way for producing plasma, and it often results in a cold plasma with low temperatures (about 1-10 eV) and high density. Because of its capacity to effectively create reactive species while remaining in a non-equilibrium state, this kind of cold plasma source is used in a variety of applications. These properties are especially beneficial for operations such as surface treatment, sterilisation, material modification, and others (Jiang *et al.*, 2022).
2. **Gliding arc discharge:** Two or more metallic electrodes are linked to a high-voltage AC or DC transformer. A plasma plume is created when a high voltage is applied. This arc is then pushed away by the gas flow and passes along the electrodes until it collapses (Jiang *et al.*, 2022).
3. **Plasma Jet:** It consists of two coaxial electrodes through which high-speed gas flows. Free electrons are accelerated by the radiofrequency (RF) field and collide with gas molecules. These collisions produce reactive species such as excited atoms and molecules and free radicals. These reactive species are blasted at high velocity from the nozzle, generating a plasma jet. Because of its capacity to create and direct reactive species for diverse reasons, this technique has applications in domains such as materials processing, surface treatment, and biological applications (Jiang *et al.*, 2022).
4. **Corona discharge plasma jet:** There is a large electric field present in this sort of plasma jet to enhance the ionisation energy of electrons that are created. This strong electric field accelerates the ionisation of gas atoms or molecules in the surrounding environment. Because of its capacity to generate a highly reactive environment, this kind of plasma jet is

often utilised for applications such as surface treatment, sterilisation, and chemical reactions (Jiang *et al.*, 2022).

5. **Microwave (MW) / Radio frequency (RF) plasmas:** A gas is often placed inside an oscillating electromagnetic field produced by an induction coil or external electrodes to produce RF plasma. Under low pressure, microwave and radio frequency capacitively linked plasmas (MW/RF CP) are often formed. Because of their regulated and adaptable nature, these plasmas have applications in a variety of sectors, including materials processing, thin film deposition, and surface modification (Jiang *et al.*, 2022).

In package plasma treatment

In-package plasma therapy is a method that improves the quality and safety of fish during low-temperature storage. The fish are exposed to a plasma gas, which produces reactive species such as ozone and reactive oxygen species, which may efficiently inactivate pathogens and spoilage germs (Albertos *et al.*, 2017).The basic procedures for doing in-package plasma therapy on fish maintained at low temperatures are as follows:

1. **Preparation of the Plasma System:** Install the in-package plasma treatment equipment in a controlled environment, such as a food processing plant or cold storage room.Ensure that the system has been calibrated and is producing the requisite plasma gas and reactive species.
2. **Selecting the Packaging:** Select packaging materials that are suitable with plasma treatment. Polyethylene, polypropylene, and laminates with barrier qualities are often utilised to prevent gas leakage.
3. **Preparation of Fish for Packaging:** To eliminate all possible sources of contamination, carefully clean and gut the fish.To guarantee consistent treatment, the fish are sorted by size and quality before being cooked into fillets.
4. **Packaging the Fish:** Place the prepared fish in the appropriate packing materials (for example, 270 m-thick Commercial polyethylene terephthalate trays).Seal the packaging firmly with a high barrier film of 50 m thickness to prevent plasma gas escape and to maintain a regulated environment, and then utilise a dielectric setup to produce a plasma discharge within the trays.
5. **Plasma Treatment:** Place the packed fish in the plasma treatment chamber or system. Furthermore, the packages are sandwiched between two spherical electrodes made of aluminium plate. Polypropylene sheets (2 mm thick) were utilised as a dielectric barrier and to stabilise the discharge.In order to expose the fish to the plasma gas and reactive species, activate the plasma generating process.The electrode separation was then set to 35 mm tray height. The voltage provided to the positive electrode was regulated by a set-up transformer with a fixed frequency of 50 Hz and a variable transformer as its input. The samples were then treated for 5 minutes in triplicate at two different voltages of 70 and 80 kV.The duration and intensity of the treatment will be determined by the equipment used and the target degree of microbial elimination.
6. **Monitoring and Quality Control:** To guarantee the effectiveness of the treatment, carefully monitor the plasma gas concentration and the inside conditions of the

packaging during the treatment.Implement quality control procedures to evaluate the treatment's efficiency in lowering microbial burden.

7. **Post-Treatment Inspection:** After the plasma treatment, carefully check the fish to verify they have not been destroyed or harmed by the procedure.
8. **Storage at Low Temperature:** Transfer the plasma-treated fish to a low-temperature storage facility (around 4 °C) to maintain freshness and extend shelf life.

Application of Cold Plasma Technology

This technology is applied in many fields, such as biotechnology, Surface modification, biomedical, textiles, Environmental Remediation, Agricultural and food Industry:

1. **Food industry**: This method is used to preserve highly perishable goods, such as fish and fisheries products. It is particularly susceptible to microbial degradation and protein and lipid oxidation because to its high moisture content, high-quality protein that comprises all nine necessary amino acids, and unsaturated fatty acids. As a result, cold plasma may aid in the reduction of microbiological contamination and oxidative processes, hence increasing the shelf life of these items. Its distinct features make it an attractive food preservation solution (Rathod *et al.*, 2021).
2. **Surface Disinfection**: Cold plasma may be used to disinfect packing surfaces before they come into touch with food. This reduces the danger of microbial contamination and increases the shelf life of packed items (Singh *et al.*, 2021).
3. **Innovative Packaging Solutions**: Incorporating cold plasma technology with materials such as cellulose, polyethylene terephthalate (PET), and polylactic acid (PLA) can result in the development of advanced packaging solutions with anti-microbial properties, increased shelf life, and less reliance on chemical additives (Ranjha *et al.*, 2023).
4. **Surface roughening**: The etching effect causes surface roughening, which is an application of cold plasma technology. By producing this etching effect, cold plasma treatment may be utilised to purposely affect the surface properties of materials, including biopolymer films. Depending on the intended results and qualities of the treated materials, this application may have a variety of advantages in industries such as packaging, materials science, and manufacturing (Hoque. *et al.*, 2022).
5. **In packaging applications**: Mechanical properties of the films, such as tensile strength and elongation at break, are critical needs for maintaining food quality and integrity throughout handling, storage, and transportation (Hoque. *et al.*, 2022).
6. **Biomedical:** CAP produces reactive oxygen and nitrogen species, as well as electric fields, which promote angiogenesis (the development of new blood vessels) and the migration and proliferation of wound healing cells. It may also boost the synthesis of growth factors, which help in tissue healing. Furthermore, the antibacterial properties of CAP aid in the prevention of infections, which is essential for effective wound healing. Furthermore, the capacity of CAP to trigger apoptosis in cancer cells makes it a possible supplementary therapy for cancer treatment (Khanikar and Bailung, 2021).

Advantages / benefits of using cold plasma technology in fish packaging:

Cold plasma treatment destroys or inactivates bacteria, moulds, and other microorganisms on the surface of fish and inside packaging. This reduces the danger of bacterial development and

deterioration, extending the fish's freshness and edibility (Ansari *et al.*, 2022). Cold plasma treatment may improve the barrier qualities of packing materials against gases such as oxygen and moisture by altering their surface properties. This may aid in the preservation of the packed product's quality and freshness (Hoque *et al.*, 2022). It may be able to minimise the requirement for chemical preservatives or antibacterial agents in food items using cold plasma technology, resulting in clearer labelling and healthier alternatives for customers (Kaur *et al.*, 2022). Because of protein breakdown and the generation of volatile chemicals during storage, fish products may generate strong odours. These odours may be reduced via cold plasma treatment, making the fish more palatable to customers. Cold plasma may impair enzymatic activity in fish, resulting in texture, nutritional value, colour, and flavour alterations. Cold plasma technology helps retain the quality and sensory qualities of fish or fish products by slowing down enzymatic processes (Nwabor *et al.*, 2022). Cold plasma therapy may improve the shelf life of fish products or prawns (*Litopenaeus vannamei*) by suppressing microbial growth and delaying breakdown processes, minimising waste and post-harvest losses during refrigerated storage (Nwabor *et al.*, 2022).

Disadvantage of using cold plasma technology in fish packaging

Implementing cold plasma technology may be costly, with large upfront equipment and maintenance costs. The expense of incorporating this technology into the fish packaging process may exceed the advantages, particularly for small enterprises or organisations with limited resources (Domonkos *et al.* 2021).Cold plasma systems need power to operate, and the energy consumption might be rather considerable depending on the magnitude of the operation. This might raise total manufacturing costs and have a negative effect on the environment.Cold plasma therapy may be unable to permeate the whole thickness of certain fish products or packaging material, particularly in complicated or larger packaging systems. This might result in unequal treatment and leave certain regions vulnerable to rotting (Domonkos *et al.*, 2021).The use of cold plasma technology in food packaging may be subject to a variety of rules and regulations. Food safety and packaging requirements might complicate implementation and need extra testing and validation (Vasile and Baican, 2021).Because the technique is relatively new in the context of food packaging, long-term research on its impact on fish products may be restricted. Concerns may emerge over the influence of extended exposure to cold plasma on the sensory and nutritional characteristics of the fish.

Conclusion

Cold Plasma Technology emerges as a promising and sustainable strategy for enhancing safety and extending shelf life, particularly in the context of fish and fishery products. Through its ability to mitigate microbial contamination and oxidative deterioration, Cold Plasma demonstrates remarkable potential in ensuring food safety and preserving product quality. The non-thermal nature of this technology further underscores its eco-friendly profile, making it an attractive choice in the pursuit of environmentally conscious food processing methods. As research continues to unveil the multifaceted benefits of Cold Plasma, its integration into the seafood industry holds great promise for a safer and more sustainable future in food preservation.

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DECIPHERING BACTERIAL HOST-PATHOGEN INTERACTIONS IN PLANTS

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Introduction

In the intricate tapestry of nature's interactions, the dynamic interplay between bacteria and plants represents a compelling saga of adaptation, survival, and competition. Within this realm, the relationship between bacterial pathogens and their plant hosts stands as a pivotal battleground, where both sides employ cunning strategies to gain dominance. This interaction not only shapes the fate of agricultural yields but also holds the key to understanding fundamental principles of host-pathogen dynamics in ecological systems.

At the heart of this botanical battleground lie the mechanisms underlying bacterial invasions into the complex world of plants. Bacterial pathogens wield an arsenal of genetic adaptability and molecular weaponry to infiltrate the plant's defense fortifications. Meanwhile, plants, in their enduring evolutionary journey, have evolved an intricate defense network, a sophisticated array of sentinels and defenders aimed at repelling these microbial invaders.

The Elegance of Plant-Bacterial Interactions

Plant-pathogenic bacteria engage in a multifaceted tango with their hosts, employing a repertoire of tactics to gain entry and establish residence within the plant. Their entry points might be the natural orifices of the plant or the opportunistic breaches caused by wounds, where they exploit vulnerabilities in the plant's defenses to gain a foothold. Once inside, these invaders deploy a range of virulence factors, deploying toxins, effectors, and enzymes that dismantle the plant's immune responses, thus orchestrating their colonization.

In a mesmerizing counter-act, plants have honed a defense mechanism reminiscent of a finely orchestrated symphony. They possess a sophisticated array of defense mechanisms, including Pattern Recognition Receptors (PRRs), allowing them to discern the footprints of pathogens by detecting Pathogen-Associated Molecular Patterns (PAMPs). This initiates a cascade of responses, triggering the activation of defense genes and the synthesis of antimicrobial compounds. Yet, this defense concert is often met with the microbial cunning of bacterial pathogens, who deploy effector molecules to subvert plant cellular processes and facilitate their invasion.

The Dynamics of Specificity and Disease Manifestation

The complexity of the bacterial-plant interaction is further amplified by the varying degrees of specificity exhibited by pathogens towards their hosts. Some bacterial agents display a broad spectrum, infecting an extensive range of plant species, while others exhibit a remarkable specificity, targeting particular plants or even distinct tissues within a single plant. The success of infection hinges not only on the pathogen's ability to breach the plant's defenses but also on environmental factors that favor disease manifestation.

For instance, the notorious *Pseudomonas syringae* show cases its prowess by infecting an array of plants, spanning from Arabidopsis thaliana to tomatoes and beans. This adaptable pathogen deploys an assortment of effectors that cleverly manipulate plant immunity, paving the way for successful infection. Understanding such intricate molecular dialogues at the interface between bacteria and plants serves as a cornerstone for developing disease-resistant crop varieties through innovative genetic modifications and strategic breeding approaches.

Host pathogen interaction

Effectors play a crucial role in the interplay between plant hosts and bacterial pathogens by mediating suppression of plant immunity as well as triggering defense responses. Here are details on effector-mediated suppression and defense:

1. Effector Delivery

Bacterial pathogens translocate effectors into plant cells via specialized secretion systems, such as the Type III secretion system (T3SS) or Type IV secretion system (T4SS). These effectors can be delivered directly into the plant cell cytoplasm or the extracellular space.

2. Effector Suppression of Plant Immunity

PTI Suppression: Pathogens secrete effectors to suppress PTI, the initial immune response triggered by the recognition of PAMPs. Effectors can directly inhibit PRRs or downstream components of PTI, disrupting signal transduction pathways and dampening the plant's defense responses.

Manipulation of Signaling Pathways: Effectors target key components of plant defense signaling pathways, including mitogen-activated protein kinase (MAPK) cascades, calcium signaling, and hormone-mediated pathways. By interfering with these pathways, effectors suppress the activation of defense-related genes.

3. Effector Triggered Susceptibility (ETS):

Host Manipulation: Some effectors target specific host proteins or cellular processes, enabling pathogens to exploit host resources and manipulate cellular functions to their advantage.

Effector Mimicry:Pathogens may produce effectors that mimic host proteins, thereby disrupting normal cellular functions and manipulating plant physiology for their benefit.

4. Effector Triggered Immunity (ETI)

Recognition by R Proteins: In certain cases, plants have evolved resistance (R) proteins that can recognize specific pathogen effectors or their activities within the host cell. This recognition leads to ETI, a robust defense response aimed at restricting pathogen growth.

5. Hypersensitive Response (HR)

ETI activation often results in the hypersensitive response (HR), characterized by rapid localized cell death at the infection site. The HR limits pathogen spread and acts as a form of programmed cell death to contain the infection.

6. Diversity and Evolution of Effectors

Effector Repertoire: Pathogens possess diverse effector repertoires, enabling them to target different aspects of plant immunity and physiology.

Evolutionary Arms Race: The ongoing evolutionary arms race between plants and pathogens drives the diversification and adaptation of effectors. Plants develop new R proteins to detect effectors, while pathogens evolve effector variants to evade recognition.

7. Genomic Analysis and Effector Identification

Bioinformatic Tools: Genomic analyses and bioinformatic tools aid in identifying putative effectors by identifying sequences with characteristics such as secretion signals or presence in pathogenicity islands.

Functional Studies: Experimental approaches, including gene knockout or over expression studies, help elucidate the roles of specific effectors in modulating plant-pathogen interactions.

Effector-mediated manipulation of plant immunity highlights the sophisticated strategies employed by bacterial pathogens to colonize plants, while the plant's ability to recognize these effectors and mount defense responses underscores the evolutionary arms race driving the adaptation of both parties in this intricate host-pathogen interaction.

Conclusions

In the intricate dance between bacterial pathogens and their plant hosts, the multifaceted interplay of effectors orchestrates a captivating saga of evasion, manipulation, and defense. The mechanisms by which effectors mediate suppression of plant immunity and trigger defensive responses epitomize the ongoing evolutionary arms race that defines these dynamic interactions.

Effector proteins serve as pivotal tools wielded by bacterial pathogens, enabling them to breach the fortress of plant defenses. By subverting or suppressing the plant's immune signaling pathways, effectors create a conducive environment for colonization and nutrient acquisition within the host. Their ability to mimic host proteins or manipulate cellular processes highlights the intricate strategies employed by pathogens to exploit the vulnerabilities of their plant hosts.

However, in this intricate struggle for dominance, plants have evolved an arsenal of defense mechanisms, including the recognition of pathogen effectors by specific resistance proteins. This recognition sparks a robust defense response, triggering the hypersensitive response (HR) and restricting the spread of pathogens. The intricate interplay between effectors and plant immunity underscores the sophistication of the plant's defense strategies honed by millions of years of evolution.

As genomic analyses unveil the diverse repertoire of effectors and their functions, researchers gain insights into the intricacies of these interactions. Understanding the molecular dialogue between effectors and plant defenses offers a pathway to unraveling the complexities of host-pathogen interactions, paving the way for innovative strategies to combat bacterial diseases in plants.

The relentless evolutionary arms race between plants and pathogens, epitomized by the diversity and adaptation of effectors, continues to shape these interactions. The ongoing pursuit of deciphering effector functions and their impact on plant physiology signifies a frontier of research crucial for sustainable agriculture, crop improvement, and the development of resilient crop varieties resistant to bacterial pathogens.

In the captivating narrative of host-pathogen interactions, the role of effectors serves as a focal point, illuminating the intricate mechanisms that govern the delicate balance between disease susceptibility and resistance in the plant kingdom. It is within this intricate tapestry of molecular dialogues that the future of agricultural sustainability and food security lies, driven by the quest to unravel the mysteries that define these captivating biological interactions.

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PER VAGINAL SUCCESSFUL MANAGEMENT OF RARE CASE OF DYSTOCIA IN MURRAH BUFFALO DUE TO DICEPHALIC MONSTER

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Introduction

Developmental abnormalities in a growing fetus that result in distortion of organs and body systems are often referred to as fetal anomalies or congenital abnormalities. One particular type of congenital abnormality is known as a "dicephalus monster," which is essentially a conjoined twin with anomalous growth during embryonic development. While reports of fetal anomalies and monstrosities are relatively common in cattle, they are less frequently observed in buffalo. These fetal monsters can be caused by a variety of environmental, biological factors, or agents known as teratogens. Teratogens are substances or influences that can disrupt normal fetal development. Examples of teratogens include radioactive substances like X-rays, temperature fluctuations, hormonal imbalances, infectious agents, and nutritional deficiencies. The period during which the developing embryo is most susceptible to the effects of teratogens is known as organogenesis. Abnormal duplications of the inner cell mass in an embryo can lead to congenital fetal abnormalities characterized by partial duplication of body structures. While varying degrees of fusion can occur, anterior duplications are more commonly observed in ruminants and swine. Dystocia, which is difficult or obstructed labor, often occurs as a consequence of such fetal monstrosities, mainly due to a mismatch in size between the fetus and the maternal pelvis. In this case study, we report a rare instance of dystocia caused by a live dicephalic fetus, meaning a fetus with two heads, in a pleuriparous Graded Murrah buffalo. Remarkably, the buffalo successfully delivered the dicephalic fetus vaginally, despite the challenges associated with such a rare and complex situation.

CASE HISTORY AND CLINICAL FINDINGS

A pluriparous Graded Murrah buffalo, approximately 6 years of age, in its third parity with a full-term pregnancy, was brought to a mobile ambulatory veterinary clinic in Tuni. The owner reported that the animal had been straining for the past 8 hours with no progress in parturition, even after the first water bag had ruptured. The buffalo presented with both forelimbs protruding from the vulva. Following proper lubrication, per vaginal examination was conducted, revealing a fully dilated cervix and an abnormal fetus with two heads in the birth canal, in an anterior longitudinal presentation and a dorso-pubic position. Further vaginal examination disclosed a deceased fetus with a duplication of the neck, head, and mouth, where both necks were joined at the thoracic inlet. Since there was sufficient space for manipulation, it was decided to relieve the dystocia per vaginally. Various other clinical parameters were measured for the animal, including rectal temperature, pulse rate, and respiratory rate. The animal's temperature was found to be elevated and recorded at 103°F, the mucous membranes were observed to be pink, the pre-scapular lymph node size was normal, and the respiratory rate was depressed.

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Figure: Dead Male Dicephalus Monster

TREATMENTAND MANAGEMENT

After administering caudal epidural anesthesia (5 ml; 2% lidocaine hydrochloride), the birth canal was thoroughly lubricated with a sodium carboxymethyl cellulose slurry. Subsequently, both forelimbs that were protruding from the vulva were pushed back, and snares were applied to both heads. Traction was then alternately applied to each head, followed by simultaneous crossed traction, until both heads passed through the cervix. Once both forelimbs were brought near the vulva, four-point traction was applied to both the forelimbs and heads using snares and eyehooks, respectively. This approach resulted in the successful per vaginal delivery of the deceased male dicephalic fetus. A post-mortem examination of the deceased fetus revealed a duplication of the neck, trachea, and esophagus, while the rest of the organs appeared normal. To manage pain and prevent secondary bacterial infections, the buffalo received a course of antibiotics (inj. Enrofloxacin 2g), along with anti-inflammatory (inj. Melonex 20 ml) and antihistamine (inj. Anistamin 10 ml) medications via intramuscular injection for five days. The animal made an uneventful recovery within three days.

CONCLUSION

Per vaginal delivery of a dicephalic fetus is typically very difficult and is usually achievable only through fetotomy or cesarean section. However, in this particular case, we were able to accomplish per vaginal delivery due to the fully dilated cervix and the large bony pelvis of the dam.

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FRUIT AND VEGETABLE PROCESSING: GATEWAY OF INCOME GENERATION FOR FARMERS

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Abstract

India is known as fruit and vegetable basket of the world. It is second largest producer of overall fruits and vegetables production in the world, but processes only 1.5% of total production. India is world's largest producer of bananas, papaya, mangoes and guavas, second largest producer of potatoes, green peas, tomatoes, cabbage and cauliflower. Fruits and vegetables provide enormous health benefits and are important for the prevention of illnesses as they contain a variety of nutrients including vitamins, minerals and antioxidants. Consumption of recommended number of fruits and vegetables each day can reduce the risk of chronic diseases. In view of production and health benefits of fruit and vegetable, linking production to processing can be one of the strategies to compensate the post-harvest losses of fruits and vegetables, double the farmers' income.

Introduction

Agricultural industry refers to enterprises that process agricultural raw materials into edible or consumable forms. This process also allows agricultural processing waste to be used to extract natural bioactive compounds for use in the pharmaceutical and other industries. Agro-processing plants create new opportunities for farmers and boost income and job creation. However, the fruit and vegetable processing industry is characterized by seasonality, perishability, and variability of raw materials. In such industries, raw materials can only be sourced during certain seasons, but processing operations may continue during the off-season. The processing of raw materials by the agricultural industry requires faster handling, storage, and distribution. Since the quality of raw materials obtained for processing also varies, emphasis must also be placed on post-processing management. Due to these characteristics, sourcing tends to be more restricted and industry is more accessible and viable closer to the source of raw materials.

Food processing is the set of methods and techniques used to transform raw ingredients into food or food into other forms for consumption. The fruits and vegetable are processed by applying primary and secondary processing.

Primary processing on farm as a livelihood activity for farmers

Primary processing has been seen by many development agencies and government institutions as an important method to improve the livelihoods of farmer communities. It has the potential to improve nutritional status and food security, and also to improve incomes to individual farmer and/or the wider village community. Minimal processing is the primary processing technique involving mild heat treatment and preservation of food items using various methods that cause least change while process. Minimal processing renders produce highly perishable, required chilled storage. No heat is applied to maintain fresh like characteristics. Simple primary processing

operations like sorting, trimming, grading, washing, peeling, surface drying and packaging can be used to prepare fruit and vegetables for immediate marketing. The available equipment and technologies for various unit operations of primary processing include farm level fruit and vegetable washing machine, basket centrifuge, shrink packaging of fruit and vegetable and hydro cooler-cum-washer for fruits and vegetables, vegetable dryer, tamarind dehuller and deseeder, pomegranate aril remover cumin cleaner-cum grader, turmeric washing and polishing machine.

Figure1

Sealing of product in an impermeable membrane after the process of removal of air inside the membrane is the process of vacuum packaging and this process is considered as modified atmospheric packaging which is widely used and accepted technique. This method is mainly used to increase the stability of food product more than that of normal refrigeration life and also prevent the browning reaction occurs on the surface of the high perishable products during cutting or damaging by several actions.

Primary crop processing provides numerous benefits to farming households: for example, some types of processing can be easily integrated into normal household activities, particularly at a small (kitchen) scale of operation, where existing equipment, knowledge and skills of household members can be used; processing provides nutritional benefits to the household by preserving foods for periods of shortage; income from sales of processed commodities can be used to directly improve livelihoods, or to expand to other types of crop processing that may require investment in different equipment or training, but give higher returns and greater opportunities for long-term improvement to farmers' livelihoods.

Entrepreneurship and employment generation for farmer via processing of fruits and vegetable

Fruit and vegetable processing offers the opportunity for farmers to make a diverse range of products that can both increase incomes by having more products to sell, and also spread the income over a longer period than just harvest time. Many farming households have the knowledge and skills to preserve their crops, often handed down through the generations. However, the introduction of primary processing can build on and enhance local knowledge and skills by integrating new ways of processing or new types of simple technologies that provide for better preservation techniques, greater processing efficiencies and yields, and less wastage.

The fruit and vegetables can be processed into different value-added products by secondary processing techniques. Fruits and vegetables are perishable commodity. The shelf-life extension and value addition of these commodities by drying or dehydration is the simplest process of preservation. Dehydrated products are available through the year and has huge potential in exports. The fruits and vegetable drying process involves sorting, grading, washing, peeling, cutting, pretreatment, drying, cooling and packing. The fruits such as mango, fig, pineapple, peach, berries, pomegranate and vegetables such as onion, ginger, garlic, peas, carrot, beans are in high demand in dehydrated form. The farmers can use simple dryers for drying these commodities and can get income from it.

Fruits and vegetables are processed to prepare pickles, sauces and chutney. Manufacturing of pickle has developed as an industry in the country. Mango pickle, cauliflower, turnip, carrot (mixed vegetable), anola, lime/lemon pickle are the commercial products available in the market. Locally cultivated fruit or vegetable can be processed by farmers using common salt, spices and vinegar. Salt is mostly used as preservative in pickles in combination with acid. Minimum concentration of salt to act as preservative is about 12%.

Figure 2

The value-added products such as juice, concentrate, fruit based carbonated juices, canning, pulp extraction, preserves and candies, beverages like squashes, ready to serve (RTS) drinks and appetizer etc from different fruits and vegetables. Pulp and juice processing are important agro-industrial activities for the food production sector as they add economic value to fruits, avoid fruit wasting and minimize losses during commercialization of unprocessed fresh fruits. Pulp and juice processing also constitute an alternative way by which fruit growers sell their products.

Establishing simple processing unit for production of dried fruits and vegetables, tomato pulp, fruit juices, pickles, sauces and chutneys can open up the doors of employment opportunities. New skills and expertise to operate new types of equipment that are learned in order to undertake primary processing are also transferable, and may open up job opportunities for members of farming families.

Export opportunities

Fresh packaged grapes, pomegranates, mangoes, bananas, oranges account for larger portion of fruits exported from the country while onions, mixed vegetables, potatoes, tomatoes, and green chilies contribute largely to the vegetable export basket. Modern pack house facility with automatic forced air system for precooling is available in all the commercial production areas. The

Government of India specifically encourages Agri exports from the country. It is considered vital to achieve the goal of doubling farmer's income.

Farmers Producers Organization (FPOs) establishment

Small producers from village can collectively establish Farmers Producers Organizations (FPOs) which can process locally cultivated fruits and vegetables in value added forms and get good income from it. Sahyadri Farms, one of such Farmer Producer Company began with the mission to ensure that the small-landholding farmers of India shall get fair compensation for their produce. There is a huge opportunity in harnessing the potential of fruits and vegetables processing in India in the form of frozen (IQF), canned, pulp, puree, paste, sauces, snacks, dressings, flakes, dices, dehydration, pickles, juices, slices, chips, jams and jelly.

Conclusion

The interest in fruits and vegetables and their products is increasing worldwide.The gap between supply and demand increases from year on year. As a result, minimally processed or secondary processed fruits and vegetables may continue to grow in the fruit and vegetable industry. Farmers need to grab this opportunity by fruit and vegetable base minimally processed/value added products processing to increase income.Processing of food produce can provide financial, social and nutritional benefits to individual smallholder families; it can provide opportunities for women to become more involved in commercial activities and more generally contribute towards the development process; and these benefits in turn can have an overall positive effect on local communities.

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SHORTEST FLOWERING DURATION IN DRAGON FRUIT (*Hylocereus costaricensis* [F.A.C. WEBER] BRITTON AND ROSE) CV. ROYAL MOROCCAN REDUNDER THE LATERITIC ZONE OF BIRBHUM, WEST BENGAL, INDIA: NEW REPORT

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Abstract

Dragon fruit is apropitious, long day, tropical epiphyticcactus with a beautiful one-time night blooming flower and nicknamed as 'Wondrous Fruit' of the 21st century, 'Queen of the Night' and 'Noble Woman'. It is a powerhouse of antioxidants, phenolics, flavonoids, anti-proliferation and medicinal properties, various vitamins, minerals and dietary fibres. All such beneficial factors make dragon fruit a plant of high economic potential as an exotic super fruit crop that is being traded in national and international markets, fetching higher prices. However, the initial investment for dragon fruit farming is relatively high; consequently, first-year production is crucial to mitigating the initial investment. Generally, dragon fruit flowers after 14 months after planting; however, the earliest flowering (10 months and 13 days) after planting were observed in the lateritic zone of Birbhum district, West Bengal. As dragon fruit flowers in eight flowering flushes, the earliest initiation of flowering may significantly increase the number of flowering flushes and ultimately the total production.

Introduction

Dragon fruit (*Hylocereus costaricensis* [F.A.C. Weber] Britton and Rose) is a diploid (2n = 22) and belongs to the family Cactaceae. It is a promising and tropical epiphytic cactus, originated from Central America. It is a long day plant with beautiful one-time night blooming flower and nicknamed as 'Wondrous Fruit' of the 21st century and "Queen of the Night" or "Noble Woman". It is also a powerhouse of anti-oxidants, phenolics, flavonoids and anti-proliferation properties. The fresh fruit contains 82.5-83.0 % moisture, 0.16-0.23 % protein, 0.21-0.61 % fat and 0.7- 0.9 % fiber. The 100 gram of fresh fruit pulp contains calcium (6.3- 8.8 mg), phosphorus (30.2- 36.1 mg0, iron (0.5-0.61 mg) and vitamin C (8-9 mg). According to reports, it promotes gastrointestinal health, boosts immunity and aids in the management of chronic conditions. It is also a rich source of various vitamins, minerals, nutritional fibres and finest alternative for treating obesity, managing diabetes, decreasing cholesterol, etc. All these beneficial factors make dragon fruit a plant of high economic potential as exotic fruit crop and is being traded in national and international markets fetching higher prices.

In India, dragon fruit is cultivated in an area of 400 hectare mainly in Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Chhattisgarh, Odisha, West Bengal, Andhra Pradesh, Andaman & Nicobar Islands, Mizoram and Nagaland. In West Bengal, it is taking wing in both the northern and southern

districts mainly in the plains of Darjeeling, Alipurduar, Cooch Behar, Malda, Murshidabad, Nadia, North and South 24 Parganas and Birbhum districts. The initial investment for dragon fruit cultivation is relatively high; consequently, first year production is directly related to mitigating the initial investment. Under West Bengal condition flowering starts after 14 months of planting with eight number of flowering flushes per pillar (Parveen *et al*, 2018; Devi *et al*, 2023).The Department of Horticulture under School of Agriculture at Seacom Skills University has observed the earliest flowering (10 months and 12 days) after planting the cuttings. As dragon fruit flowers in eight flowering flushes, the earliest initiation of flowering may significantly increase the number of flowering flushes and ultimately the total production.

Location of the site

The field observation was conducted at the dragon fruit orchard (23°42'5'' N latitude, 87°38'22'' E longitude and 9.75 m above mean sea level) of Seacom Skills University, Kendradangal, West Bengal, India.

Climatic and soil

The sub-tropical climate with characteristics of high summer temperature, erratic rainfall, high humidity and short-mild winter. Red Lateritic soil which belong to the class of sandy loam with medium fertility and neutral in reaction.

Source of planting material and planting

Dark green and fully matured cladode are collected from Department of Fruit Science, Bidhan Chandra Krishi Vishwavidyalaya, Nadia, West Bengal. The cladode cuttings were processed according to Chettri *et al* (2022), with 30cm cutting length and were treated with IBA at 6000ppm for better rooting and shooting and planted into the polybags filled with the media. Four plants per pillar were transplanted on 10th September 2022 maintaining a distance of 2.5 m x 2.5 m spacing. Fertilizers were applied according to Parween and Hasan (2019) at the rate of FYM 20kg along with N_{450} P_2 $O_{5\ 350}$ K_2O_{300} g per pillar as scheduled.

After care

Generally, hand weeding and mulching with paddy straw were done. Irrigation was done immediately just after planting and to provide sufficient moisture during dry season at 6-7 days interval. As the cladodes were fully grown, the hanging and the vertically growing cladodes were pruned at 35 cm from the edge of the ring. Lateral or side shoots, dead, diseased and overcrowded cladodes were removed periodically.

Conclusion

Maturity of cladode selected for preparing cutting, pruning of hanging and vertically growing cladodes at specific length and withholding the irrigation at specific period before the flowering may trigger the earliest flowering in the first year of dragon fruit plantation.

Further research can be taken up on the efficacy of cladode of different maturity, pruning intensity and moisture stress can be tried to study the flowering behaviour of dragon fruit in the future.

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ECO-ENZYME: MULTIPURPOSE LIQUID FROM KITCHEN GARBAGE

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Kitchen garbage is a type of organic waste generated in the kitchen while preparing the food for consumption and wastage food after consumption i.e leftover food, includes fruit waste, vegetable waste, staple food, egg shell, bones, meat etc. [1]. Growing population, urbanization and economic growth lead to increased food consumption and finally resulted to increased quantity of kitchen garbage production each year. India having the population in excess of 1.3 billion produces an amount of 0.5 kg organic waste per individual per day [2]. In case of food waste generation by India, the high income, middle income & lower income group was reported to produce 90, 68 & 63 kg of food waste per person per year, respectively according to Food Waste Index Report 2021 of UNEP (United Nations Environment Programme) [3]. Global food waste was reported to contribute 8 to 10% of the total green house gas (GHG) emissions annually [4]. The management of Organic waste including kitchen garbage is one of the major challenges in the present era. As a common disposal method, mostly the organic wastes consisting kitchen wastes end up in landfills which are hazardous for environment due to emission of GHG & other harmful gases, further, it also produce toxic leachate which can degrade groundwater. Composting practice is considered one of the recommended methods because of its cost-effectiveness and efficiency alongside other management options. “Eco-enzyme” which is biologically processing of kitchen waste is one such alternative method.

What is eco-enzyme?

Eco-enzyme is an organic solution produced from fresh kitchen waste using organic sugar (brown sugar, jaggery, molasses etc.) and water through fermentation process. It is also known as Garbage Enzyme.

Preparation of eco-enzyme

In order to prepare eco-enzyme, raw kitchen waste (fruit peels, vegetable peels, fresh leaves etc.), organic sugar (jaggery, brown sugar, molasses etc.), and water are mixed together in a ratio of 3:1:10 and kept for 3 months in an air tight container having ability to expand e.g. plastic container. The container is kept in a well-ventilated, cool and dry place. The air tight container provides anaerobic condition. Upon starting of the fermentation process gases been released resulted to pressure built up in the container. Hence, in the first month, the cap of the container/plastic bottle to be loosen daily or in two days so that the gases will be released out of the container to avoid damage. The extra sugars in the form of brown sugar or molasses etc. help the growth of microbial

colonies, as microbes require more energy to digest the complex food sources. Organic sugars are favoured over refined sugars because of its high mineral content that provide food for microbial fermentation. After 3 months, the fermented solution is ready to use.

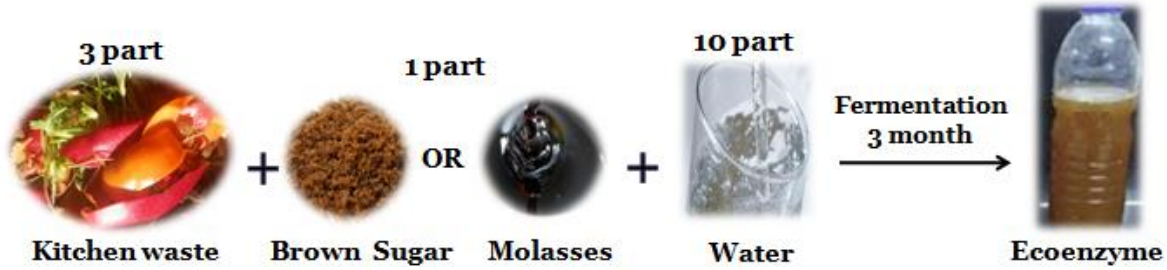

Fig 1: Ecoenzyme preparation

Characteristics of eco-enzyme

The colour and odor of the eco-enzyme varies based on the raw organic material used. Utilising more vegetable based raw material resulted to pungent smell while fruit peels make a fragrant smell. Biochemical analysis showed the presence of alcohol (0.15ml/ml), acetic acid (4.8g/ml) along with majorly amylase, lipase and protease group of enzymes. There may be presence of other enzyme in small quantity based on the raw material e.g. papain enzyme in case of papaya peel etc. [5]. Microbiological analysis of Eco Enzymes indicated possible presence of bacteria, fungus and yeast such as *Trichoderma viride*, *Pseudomonas*, *Saccharomyces cerevisiae*, *Yersinia*, *Rhizopus stolonifera* and *Aspergillus niger* etc. It is likely the presence of few other species in dead condition due to acidic environment of the eco-enzyme solution [5]. The quantitative features of the different parameters changes with time, types of kitchen waste/organic waste and natural sugar used in the fermentation process. The fermentation or catalysis process for eco-enzyme production releases ozone gas (O_3) which will reduce greenhouse and global warming effects. The eco-enzyme solution also contains nitrate (NO_3) and carbonate (CO_3), made by enzymatic conversion of ammonia to nitrate and CO_2 to carbonate, respectively. Generally, the pH of eco enzyme ranges from 4.5 to 7.5. The eco-enzyme's pH can differ based on the constituent used in its production.

Applications of eco-enzymes

In general, eco-enzymes are utilized for cleaning and disinfection but have various others applications (table 1). Below, few major applications of eco-enzymes are discussed.

Table 1. Various application of eco-enzyme with different dilution rate

S.N.	Application	Dilution rate (eco-enzyme : water)	Reference
1.	For cleaning of toilet bowl	No dilution	[7]
2.	For cleaning of the garden pond & tank water	No dilution	[8]
3.	For cleaning and removal of stains from kitchen sink & stove	1:10	[7]
4.	For removing black mould from different surfaces	1:300	[9]
5.	For seedling and planting	1:1000	[7]
6.	For carpet cleaning	1:30	[7]

S.N.	Application	Dilution rate (eco-enzyme : water)	Reference
7.	For cleaning of refrigerators, cabinets and other household applications	1:400	[7]
8.	Treatment of aquaculture sludge	1:9	[10]
9.	As hand sanitizer	5:40	[11]
10.	domestic waste water treatment	1:9	[12]

Table taken from Benny et al. paper [13] and updated

Plant growth promoter, organic fertilizer and biopesticide

Eco-enzyme can be used as organic fertilizer, plant growth regulator and biopesticide. Eco-enzyme, which is a result of decomposition of organic matters rich in carbon, nitrogen, phosphorus, potassium and other nutrients good for plant growth and development. Nitrate and carbonate present in the eco-enzyme can improve soil fertility. Various microbes present in the solution also useful for improving soil health. Studies indicated accelerated plant growth when using eco-enzyme (table 1). Eco-enzyme also known to have antimicrobial properties [6] and can be used as biopesticides.

Disinfectant and cleaning agent

Due to high pH of the eco-enzyme, it is used for household purpose for cleaning floors. Stains and oil blots removal can be attributed to the action of lipase enzyme present in the organic solution. The disinfectant characteristic of an eco-enzyme is mainly because of alcohol and/or acetic acid present in the solution. Alcohol (ethanol) and/or acetic acid are produced by the metabolic process of bacteria by the fermentation of the fruit or vegetable waste. Number of studies showed eco-enzyme as potential disinfectant and cleaning agents (table 1).

Wastewater treatment

Hydrolytic enzymes present in the eco-enzyme solution act on the wastewater polymeric molecule by dissociating them into monomeric or simpler unit and microbes exploit these intermediates for their metabolism resulted to complete degradation of the substances. Growth of microbes become more rapid due to increased availability of intermediates led to more enzymes production which in turn degrade the substrate. This becomes a cyclic process and finally leads to improve the quality of wastewater. In Indonesia, eco-enzyme treatment showed to improve quality of river water. Many available literatures indicating the application of eco-enzyme for wastewater treatment (table 1).

Conclusion & Future scope

Eco enzymes are multipurpose organic solution with application like biofertilizers, biopesticides, cleaning & disinfecting solution etc., which costs much lesser compared to commercial cleaning agents, fertilizers and insecticides. It is completely ecofriendly and has the potential for resolving management of solid waste and therefore issue of climate change. There are many studies on production of eco-enzymes on batch scale and its utilization but stable, continuous and industrial scale production yet to be found. Furthermore, discovery of additive is needed which can reduce the fermentation time. Apart from technical challenge, eco-enzyme faces major challenges in the form of lack of awareness which result into meager demand and production.

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IMPACT OF COVID-19 ON AGRICULTURE

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"Indian farmers consistently face challenges such as imbalanced monsoon patterns, unpredictable rainfall, severe natural disasters, disrupted supply networks, and increasing inflation. This was insufficient. These difficulties are now compounded by the lockdowns imposed due to the COVID pandemic and the impending locust attack".

God bless our Annadatas!

Abstract

The COVID-19 pandemic has proven life-threatening, causing detrimental impacts on global economies. It has posed numerous concerns to the sustainability of the agriculture sector, which is highly vulnerable, as it challenges the security of food supply. To efficiently manage the pandemic, it is imperative to enhance our understanding of the risks, vulnerability, resilience, and systemic alterations of agricultural systems. The agricultural markets experienced negative impacts both domestically and internationally, affecting key sectors such as horticulture, poultry, and dairy. In India, there was a decrease of 2.7%, 5.7%, 19.6%, 6.6%, and 13.6% in the production of agricultural, horticulture, poultry, dairy industries, and fisheries, respectively, during the year 2020-2021 compared to the previous year. Himachal Pradesh, a state located in the north-western region of the Himalayas, experienced a yearly decrease of 15% in agricultural output and 18% in horticulture output. The agricultural marketing effect score awarded by NABARD in India during the 2020-21 year likewise decreased by 3.37. The primary objective of this essay is to acquire a comprehensive understanding of the impact of the pandemic on agriculture and related industries.

Introduction

The agricultural sector has been crucial in alleviating poverty, promoting food security, and increasing farmers' income. Agriculture, the fundamental sector in human development, pertains to ensuring food security. The loss of employment, particularly among those who were already impoverished, has had a detrimental impact on food security and nutrition due to the significant decline in purchasing power. The global community has been experiencing numerous outbreaks of various epidemics, such as the Spanish Flu of 1918, Ebola, HIV/AIDS, and others. India has faced numerous diseases, including the plague, smallpox, and polio. It has been noted that quarantines and isolations have a detrimental effect on various activities and ultimately on the economy as a whole. Furthermore, the occurrence of infectious diseases has a detrimental effect on agricultural activity, leading to an escalation in both hunger and malnutrition.

Effects of the COVID-19 pandemic on worldwide agriculture

According to the World Bank, 80% of the global impoverished population residing in rural regions rely on agriculture as their primary source of sustenance. The epidemic has primarily impacted the agrarian economies of countries such as India, Vietnam, Bangladesh, etc., where agriculture contributes 12-16% to their GDP. The primary focus of the global impact was on the agricultural commodities markets, namely the time delay between trading and actual delivery pricing of agricultural produce. The imposition of mobility constraints at international borders and within countries has resulted in a labour shortage, particularly in nations heavily dependent on migrant workers. Consequently, this has had a global impact on the availability of food and its prices. The COVID-19 pandemic generated a demand shock that had a negative influence on worldwide agriculture markets. The decrease in demand resulted in a simultaneous decrease in both production and producer pricing. As a result of the economic recession, biofuel prices experienced a sharp decline in 2020, which was subsequently mirrored by the prices of their primary sources, maize and oilseeds. The pandemic has unquestionably resulted in higher levels of food poverty due to economic losses and disruptions in the local supply chain.

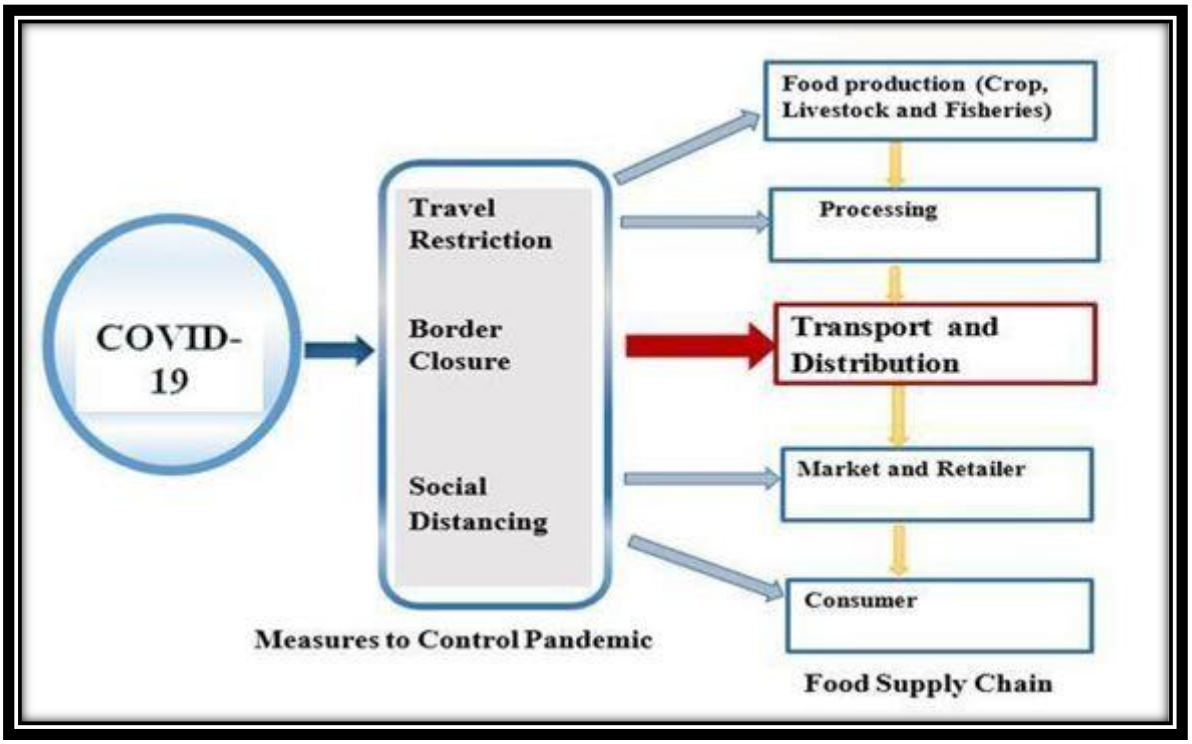

Fig- Impact on Global Agriculture

Indian response to Covid : Agriculture version

The COVID-19 pandemic led to a lockdown in India, causing disruptions in food markets and necessitating changes in consumer consumption patterns. Multiple surveys have indicated that the combination of the lockout and abrupt decreases in income have raised significant worries for food and nutrition security in India. In May 2020, there was a rise in the number of products being brought to the markets due to the need for urgent sales and the implementation of market reforms. These measures protected farmers from experiencing a decrease in pricing. Non-urban areas and rural regions experienced a greater increase in prices compared to metropolitan areas. According

to the NABARD report for 2020-21, agricultural production has fallen in 263 districts, increased in 108 districts, and remained steady in 189 districts out of a total of 560 districts. There was a decrease in the production of agricultural (2.7%), horticulture (5.7%), poultry (19.6%), dairy (6.6%), and fisheries (13.6%) in the year 2020-21. The largest decrease in agricultural production, compared to prior years, occurred in Telangana with a loss of 23%. In terms of horticultural crops, the greatest decline was observed in Himachal Pradesh at 18%, followed by Chhattisgarh at 17.9%. Manipur experienced the highest decrease in the dairy industry, with a fall of 16.7%. An upsurge in farm gate prices was observed in 129 districts of India, while a decline was recorded in 303 districts. A decrease in the availability of agricultural inputs was observed in 323 districts across India, while it stayed unchanged in 211 districts. Agricultural input prices rose in 300 areas across India. The food grain procurement was negatively affected in 247 districts, while it stayed unchanged in 245 districts. The COVID-19 pandemic has had a similar effect on farmers' capacity to transport their produce to Agricultural Produce Market Committees (APMCs) or Mandis. The availability of financing to farmers through the Kisan financing Card (KCC) was significantly impaired in 330 districts. The microfinance activities experienced a decrease of 6.15%.

The prices of agricultural inputs have increased due to reduced availability caused by supply disruptions, market closures, and a fall in farmers' purchasing power. Farmers are having difficulties in marketing their produce.

The Centre and State Governments have collaborated well to address the complaints of farmers. Both parties have implemented a range of daily policies, including subsidies such as crop insurance for farmers, unrestricted access to agricultural financing, and unemployment benefits for rural landless/migrant workers under MANREGA.

The government is employing all available measures to safeguard the well-being of farmers by consistently raising awareness among them about the importance of wearing face coverings and practising social separation while working in the fields.

To strengthen a harvest season with no obstacles, the government has granted an exemption for the transportation of agricultural machinery during the shutdown.

1) Enhancements in the electronic National Agriculture Market (e-NAM)

The introduction of the new features on the National Agriculture Market platform was seen as a positive step towards reducing overcrowding in mandis. Their objective is to enhance agricultural marketing by minimizing the necessity for farmers to personally visit the wholesale mandis in order to sell their gathered produce.

2) Technical assistance

The Kisan Sabha App, developed by CSIR, aims to establish a connection between farmers and a system for managing supply chain and freight transportation. This app was recently launched to provide support to farmers during the lockdown period.The app's objective is to offer cost-effective and prompt logistics assistance to farmers, thereby reducing the involvement of intermediaries and establishing direct connections with institutional buyers to enhance their profit margins. The Kisan Rath app was introduced to assist farmers and traders in locating transportation vehicles for the conveyance of agricultural and horticultural produce.

3) Enhancement of contract farming

Several governments have implemented a progressive approach that facilitates investors and farmers to engage in contract agricultural agreements, in response to the ongoing uncertainty caused by the pandemic. As an illustration, the Consumer-Farmer Compact in Telangana has been guaranteeing the availability and accessibility of food during the COVID-19 pandemic. Within this arrangement, consumers provide assistance to farmers by fulfilling their agricultural requirements; in exchange, farmers guarantee that consumers may obtain food in a convenient manner.

4) Allocations for direct transfers

Enhancing the disbursements for Direct Benefit Transfer (DBT) to farmers under the PM KISAN scheme and encompassing all those who have actively engaged in agricultural activities during the shutdown period. Most farming households have been partially reimbursed for the losses incurred during the months of March and April. It has afforded them some protection against the deflationary impact observed on agricultural prices as a result of the extended lockdown.

Future of Agriculture in India

1) Farming as a Viable Livelihood

Agriculture is experiencing a decline, not in terms of food supply, but in its appeal as a profession. One unfavourable harvest, whether caused by unpredictable rainfall, pests, or other factors, might leave the majority of farmers without any financial cushion.

It is important to note that food and agriculture are distinct entities. Expenditures on food encompass all aspects of its value chain, including processing, preparation, and serving in restaurants, among others.

Indian farmers receive compensation just for their agricultural produce, rather than for the food that is ultimately consumed.

Rainbow revolution holds the key

The primary obstacle to overcome is the decrease in productivity. Statistics indicate that India's average cereal output per hectare is significantly lower compared to numerous other nations. Moreover, there exists a substantial disparity between different regions. To overcome the decreasing productivity obstacle, it is necessary to initiate a transformative revolution by transitioning from the wheat-rice cycle to alternative cereals and pulses. However, this is inadequate and must be supplemented with a substantial investment in public infrastructure.

3) Per drop more crop

The second significant obstacle lies in the limited availability of two crucial resources for agriculture - arable land and water. Due to the increasing population, the dispersion of farms is causing a decrease in the amount of cultivable land available per person. India's per capita water availability is significantly lower than that of other prominent agrarian nations. In light of this situation, it is imperative to transition to micro-irrigation in order to optimise the utilisation of limited water resources.

4) R&D is the future

A significant obstacle to increasing farm production is the absence of innovative technologies and significant advancements following the green revolution. Although the National Agriculture Research System has been instrumental in the green revolution, there has been a lack of significant

advancements in research in recent years. A primary factor contributing to this issue is the insufficient allocation of financial resources. The private sector has made no significant contributions to research and development. The government should therefore attract commercial companies by offering them incentives to actively participate in agricultural research and development.

A way Forward

Some practical recommendations that could be beneficial during times of global and national emergencies are as follows:

- Reducing trade restrictions to promote market stability.
- Enhancing market transparency by promptly distributing relevant market information.
- Implementing optimal procedures and standardising steps to streamline border processing.
- Seeking options to enhance farmers' access to alternative labour resources.
- Implementing regulations to oversee the appropriate management and commercialization of agricultural products.
- Collaborating with commercial sectors to identify alternate supply chain solutions.
- In the future, crises such as COVID-19 provide an opportunity to improve the capabilities of the agriculture industry to withstand and recover from challenges, while also promoting long-term environmental and economic viability.

Summary

The COVID-19 pandemic is a worldwide health emergency that has had severe repercussions on the global economy, both directly and as a result of essential actions taken to control the transmission of the disease. The food and agriculture sector was seeing these repercussions. Although food supplies were delayed in several nations, the procedures implemented to control the virus's transmission hindered the distribution of agricultural and food items to both domestic and international markets. Governments handled many demands, including addressing the health issue, mitigating the economic repercussions, and ensuring the efficient operation of the food system.Although the pandemic presented significant difficulties for the food system in the immediate future, it also provided a chance to expedite changes in the food and agriculture industry to enhance its ability to withstand various challenges, such as climate change.

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IMPACT OF SECONDARY AGRICULTURE (AGRO-PROCESSING) ON FARMERS INCOME

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"Secondary agriculture is witnessed as a booming segment of the Indian economy. It consists of technologies and operations that enhance the value of primary agriculture. Secondary agriculture encompasses several sectors such as nurseries, bio-pesticides, bio-fertilizers, agro-processing, fruit and vegetable processing, micro, small and medium enterprises, beekeeping, agro-tourism, by-product utilisation, waste utilisation, and many more. This sector holds immense potential for generating employment possibilities for many young individuals in the country. By incorporating value addition in these sectors and their by-products, farmers can potentially increase their revenues by two to four times.Hence, the objective of doubling farmers' income can be accomplished by transitioning to secondary agriculture. In India, the potential for secondary agriculture is significant due to the abundant production, sufficient manpower and infrastructure, the transition of people towards value-added and processed foods, guaranteed market availability, and consumer demand. Therefore, the implementation of secondary agriculture might greatly benefit the Indian economy, social standing, and environmental protection. This article states the various elements, significance, and advantages of secondary agriculture. It also explores the different types and classifications of secondary agriculture enterprises, as well as some of the established secondary agriculture models".

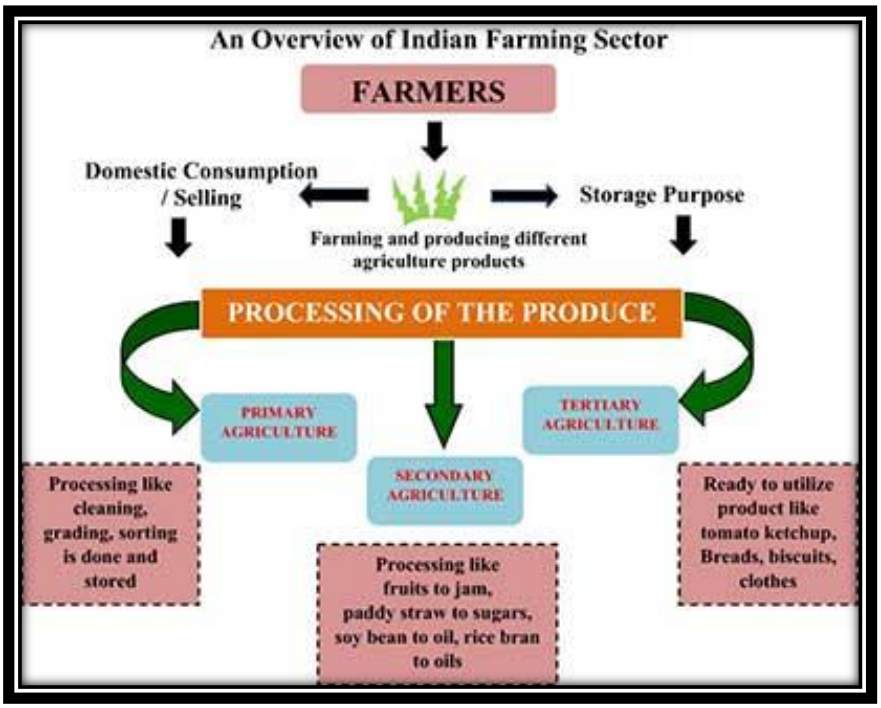
Introduction

Agriculture is the primary sector that holds the utmost importance in the Indian economy. The agricultural industry makes up over 50% of the national income and around 17% of the total GDP. However, the compensation received by farmers does not meet the required standards. The average wholesale price at which a commodity is sold from the producer to the seller provides a good indication of the farmer's situation. Based on the 3rd Advance projections from the Department of Agriculture, Cooperation & Farmers Welfare (2020-21), the agricultural output of cereals and pulses in India is 305.44 million tonnes, while the production of oilseeds is 36.56 million tonnes. India holds the top position globally in the production of milk, ghee, pulses, ginger, bananas, guavas, papayas, and mangoes. It also ranks second in the production of rice, wheat, and various other fruits and vegetables. Agriculture can be categorised into three distinct sectors: primary, secondary, and tertiary. Primary agriculture encompasses activities such as cultivating crops and harvesting from

natural resources, whereas secondary agriculture involves the manufacture or procedures that enhance the value of raw materials. Only a small fraction, approximately 8-10%, of the whole agricultural produce in India passes through the process of value addition. Milk has the greatest increase in value, whereas fruits and vegetables demonstrate the lowest. The limited increase in value is caused by the absence of suitable types of raw materials that can be processed, the seasonal aspect of production, insufficient awareness and expertise, inadequate post-harvest infrastructure including processing, cold chain, transportation, and proper storage facilities.

Our nation has made adequate advancements in primary agriculture. However, in order to fulfil the goals of doubling farmers' income and increasing the value addition of agricultural produce, it is necessary to focus on the field of secondary agriculture. The term "secondary" pertains to subsequent activities or operations at a higher level. Therefore, secondary agriculture refers to agricultural operations that are carried out at an elevated level. It involves the acquiring of raw materials and human resources that are readily accessible in the local area.

Secondary agriculture refers to the practice of enhancing and increasing the worth of primary agricultural products through processing and value addition. Secondary agriculture has a crucial role in achieving a twofold increase in farmers' income. This aims to employ primary agricultural products and by-products, as well as other locally available biological resources, in order to promote rural industrialization and create employment opportunities. Engaging in activities such as beekeeping, mushroom cultivation, lac cultivation, agroforestry (including bamboo), mariculture, etc., along with primary processing at the village level, will enable the expansion of land use vertically to enhance farm income.



What is Secondary Agriculture

Secondary Agriculture comprises of manufacturing and process that increase the value of primary agriculture, it encompasses all the post-production processes that occur prior to reaching the final

consumers. It includes the value addition of primary products which provides two to four times higher income to farmers. The concept of secondary agriculture was comprehended upon the submission of the report by Ashok Dalwai Committee in February 2018. The study focused on enhancing the value of primary agriculture and establishing agricultural enterprises in rural India through farm-linked activities and secondary agriculture.

Advantages of secondary agriculture

- It serves as an additional source of income and contributes to the improvement of job opportunities in rural areas.
- It serves as a complement to many basic agricultural activities.
- It facilitates the effective allocation of agricultural resources.
- It optimises the utilization of renewable agro-bioresources.
- Redistribution of funds from urban to rural areas.
- Facilitates the utilisation of untapped resources into productive purposes

Need of Agro-processing

India has the potential to increase farmers' income by doubling down on agro food processing. The agricultural value chain plays a crucial role in connecting the agriculture and manufacturing sectors with the end customers. It helps to minimize post-harvest losses by establishing infrastructure and enhances the value of agricultural products through advanced processing technology. The value contributed, as it is returned to farmers through the value chain in addition to the value gained from waste reduction, can greatly enhance farmers' income.

Historically, attempts have been made to enhance the income of farmers by strategies such as boosting food production, implementing innovative methods to improve productivity, offering incentives in the form of higher crop prices and subsidies, and making public investments in agriculture. Although these efforts have resulted in a 3.7-fold growth in our agricultural output since gaining independence, this has not been accompanied by a proportional rise in farmers' income. The majority of small and marginal farmers, who make up 82 percent of all farmers, have still to witness the significant increase in their income. As farmers are positioned at the lowest point of the value chain and lack any ability to negotiate, they consistently endure financial losses due to various factors, such as inadequate post-harvest storage, transportation, and processing facilities. Internationally, all prominent economies had sophisticated food processing systems with significant levels of processing (ranging from 70-80 percent, compared to 10 percent in India) and hence more value added per agricultural worker. India, although it excels in producing several agricultural commodities, falls behind several countries in terms of the value added per worker in agriculture.

Therefore, it is crucial for the government to accelerate its progress towards enhancing the value of agriculture by implementing food processing techniques. In order to do this, it is necessary to incorporate small and marginalised farmers into the food processing value chain, not just as producers but as entrepreneurs involved in primary and secondary processing operations that generate profit.

Food processing contributes to an increase in farmers' revenue through various means:

a) Minimization of post-harvest losses through the use of effective storage and transportation methods:

In India, almost 40 percent of the total food wastage is attributed to post-harvest and in-transit losses, which is higher than the global average of 28 percent. These losses have a substantial

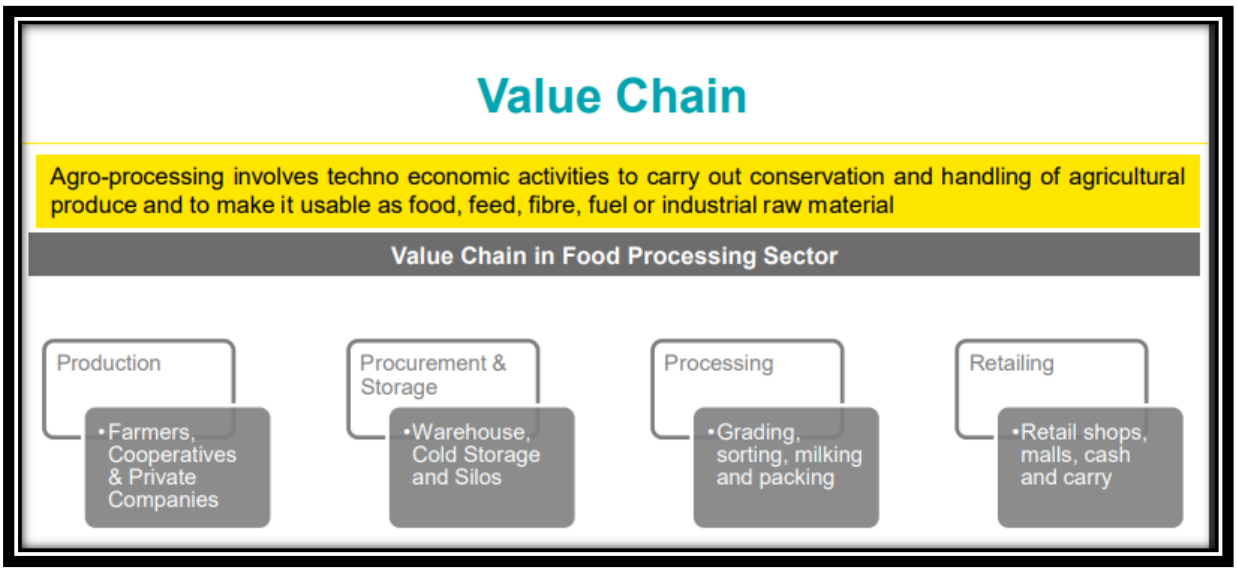
negative impact on the revenue of farmers. The impact is particularly pronounced in high-value products, such as fruits and vegetables, which prevents farmers from enjoying the advantages. Efficient storage and transportation facilities, such as cold storage, aid farmers in mitigating food losses by preserving produce for prolonged durations. This also enables the conversion of the harvest into monetary value during periods of higher pricing. In order to attain the required outcomes, it is imperative that the storage and transportation facilities are both easily accessible and economically viable. The cluster strategy, which involves shared infrastructure, is a proven paradigm that has achieved success.

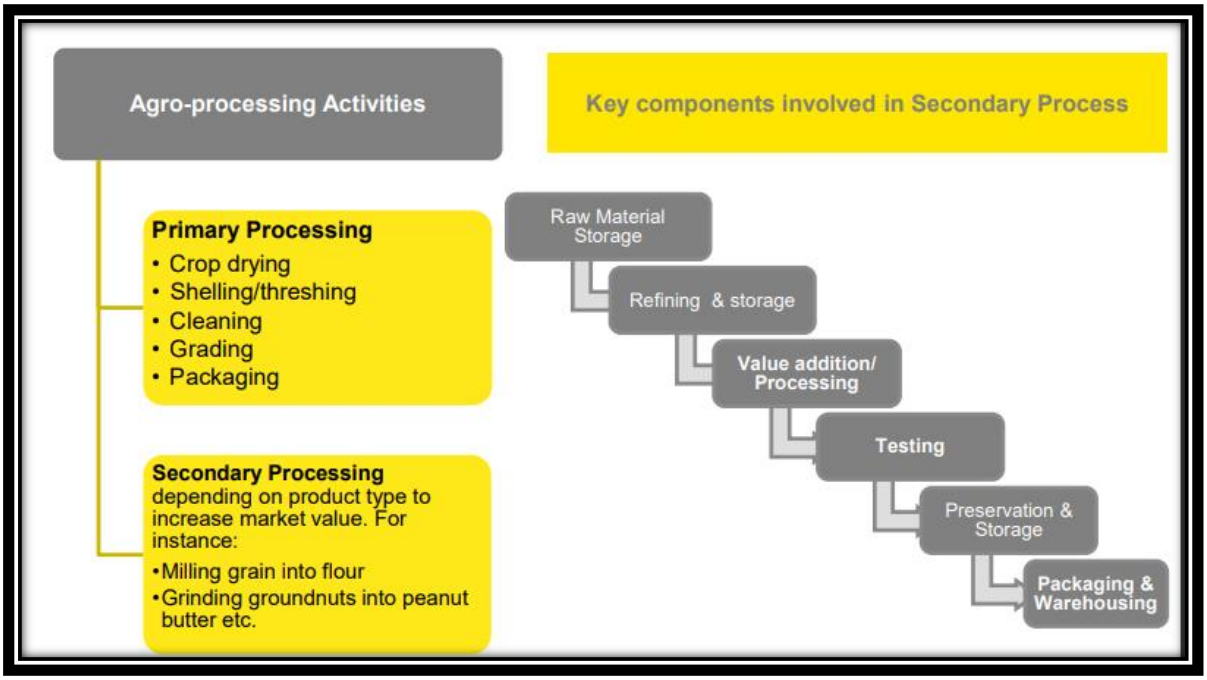
b) On-site agricultural processing

Farmers involved in cultivating low-value crops have the opportunity to enhance their income and add value to their produce by engaging in primary and secondary processing, which results in the creation of more valuable products. This procedure has been universally validated. Small-scale enterprises in numerous African countries thrive by converting sorghum into beer or cassava into garri and snack items. In India, notable instances involve the production of papad, pickle, and chutney, which have emerged as significant revenue streams for numerous farmers, especially women residing in rural regions. The incorporation of additional farmers and the diversification of the product range can yield significant benefits for a substantial number of farmers through on-site processing activities. The Indian government has granted approval for approximately 63 agricultural processing clusters in close proximity to farms under the Scheme for Agro-Marine Processing and Development of Agro-Processing Clusters (SAMPADA Yojana).

c) Value chain linkages

It involve establishing direct connections between farmers and major food manufacturers, enabling farmers to sell their fresh goods directly to secondary or tertiary processors in the food industry. A recent study conducted in the Krishnagiri cluster of Tamil Nadu revealed that farmers who are connected to the processing industry experienced an average increase in income of approximately 49% compared to farmers operating in non-processing sector areas.





Conclusion

The method of food processing in India has the capacity to augment the revenue of farmers by substantially increasing the value of agricultural produce. By involving farmers in processing activities, improving storage and transportation, and establishing market connections, it is feasible to create opportunities for increasing farmers' revenue. In the aftermath of the COVID-19 pandemic, we are observing an increased inclination among consumers towards processed food. Anticipated private sector investment in the sector is likely to result in increased prospects for integrating farmers into the value chain of major companies.

It is imperative to make a concerted effort to guarantee that the advantages are effectively delivered to the designated recipients - specifically, small and marginal farmers. Currently, there is a pressing need for a policy intervention or action plan.

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MULTIPLEXED GENOME EDITING: PIPELINE, APPLICATION AND ITS FUTURISTIC APPROACH IN CROP IMPROVEMENT

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Abstract
Genome editing is a powerful tool in crop improvement that allows scientists to precisely modify the DNA of plants. The most commonly used genome editing technology is CRISPR-Cas9, which enables targeted changes to specific genes. This technology has significant implications for crop breeding and improvement, offering advantages such as increased precision, efficiency, and speed compared to traditional breeding methods. It's worth noting that the use of genome editing in crops is a topic of ongoing debate and regulatory scrutiny. Cereal crops, including staples like rice, wheat, maize, and barley, play a crucial role in global food security. Ethical considerations, environmental impact assessments, and potential unintended consequences are important aspects that need to be carefully addressed as this technology is applied to crop improvement.

Introduction
The use of genome editing tools is described as a gradual process, indicating a progressive adoption and integration into research and breeding practices. Genome editing technologies are positioned as valuable tools for functional genomics studies (Adhikari et al. 2023). Genome editing technologies, including CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats), TALEN (Transcription Activator-Like Effector Nucleases), and ZFN (Zinc Finger Nucleases), are recognized as advanced tools with great potential for crop improvement (Dongariyal et al., 2023). RNA-guided CRISPR-associated (Cas9) nucleases are specifically highlighted for their prominence in genome editing due to their healthiness and ease of re-programmability. This indicates their versatility and applicability in targeted genetic modifications. The integration of genome editing technologies into functional genomics studies and breeding programs is emphasized, showcasing the versatility of these tools in understanding gene function and accelerating the development of improved wheat, rice, and maize (Brauer et al., 2020; Chandra et al. 2022). Genome editing is not only used for research purposes but is also actively contributing to breeding programs. This implies that edited traits are being incorporated into new crop varieties to enhance desirable characteristics such as yield, disease resistance, and nutritional content.

Major achievements: Genome editing in crop improvement
Genome editing technologies, particularly CRISPR-Cas9, TALEN, and ZFN, have been applied to wheat, rice, and maize to improve various traits (Qi et al., 2016; Brauer et al., 2020; Chandra et al. 2022; Dongariyal et al., 2023). Here's a brief overview of how these technologies are being utilized in each of these major cereal crops (Table 1; Figure 1):

- **Wheat**
  1. **Disease resistance**: Genome editing has been employed to enhance resistance against prevalent diseases affecting wheat, such as rust and powdery mildew. Editing specific genes involved in the plant's defense mechanisms can contribute to increased resistance.
  2. **Yield improvement**: Researchers are targeting genes associated with grain size, spike development, and other yield-related traits to enhance wheat productivity. This includes modifying genes involved in the regulation of flowering and seed development.
  3. **Nutritional content**: Genome editing is being explored to improve the nutritional content of wheat, such as increasing the levels of essential nutrients like iron and zinc. This has implications for addressing malnutrition in regions heavily dependent on wheat as a staple.
- **Rice**
  1. **Drought and flood tolerance**: Genome editing is used to enhance rice varieties' tolerance to environmental stresses, including drought and flooding. This involves modifying genes related to water-use efficiency and response to water stress.
  2. **Disease and pest resistance**: Editing genes associated with susceptibility to diseases and pests, such as bacterial blight and stem borers, can lead to the development of rice varieties with improved resistance.
  3. **Grain quality**: Researchers are using genome editing to modify genes responsible for rice grain quality, including aroma, texture, and cooking properties. This contributes to the development of rice varieties with preferred sensory and culinary characteristics.

Table 1. Potentials of genome editing tools for precise improvement of major cereal crops.

S. No.	Target Gene/proteins	Gene ID	Crop	Gene function	Improved trait
1.	Acetolactate Synthase	*TaALS*	Wheat	Aryloxyphenoxy propionate-type herbicides	Herbicide resistance
2.	APETALA2/Ethylene Response Factor	*TaDUO-B1*		Suppression of cell division	Enhanced grain yield
3.	Semi-Dwarf-1	*OsSD1*	Rice	Controls plant height	Reduced plant height
4.	Cytochrome P450	*CYP71A1*		Catalyses tryptamine to serotonin	Insect resistance
5.	KRN2	*ZmKRN2*	Maize	Loss of function increases kernel rows	Increased grain yield
6.	Growth-related genes	*GRGs*		Negative regulator of plant growth	Improved grain yield
7.	Waxy genes	*Wx*		Elongation of glucose polymer in amylose	Waxy corn and higher yield

- **Maize**
  1. **Yield enhancement**: Genome editing is applied to improve maize yields by targeting genes involved in plant architecture, flowering time, and grain development. This includes modifications to enhance the efficiency of photosynthesis and nutrient uptake.

2. **Pest resistance**: Maize crops are susceptible to various pests, and genome editing is used to confer resistance by targeting genes that regulate susceptibility to insects and diseases.
3. **Biofortification**: Similar to wheat and rice, maize is also a target for biofortification efforts. Genome editing is employed to increase the content of essential nutrients in maize kernels, addressing nutritional deficiencies.

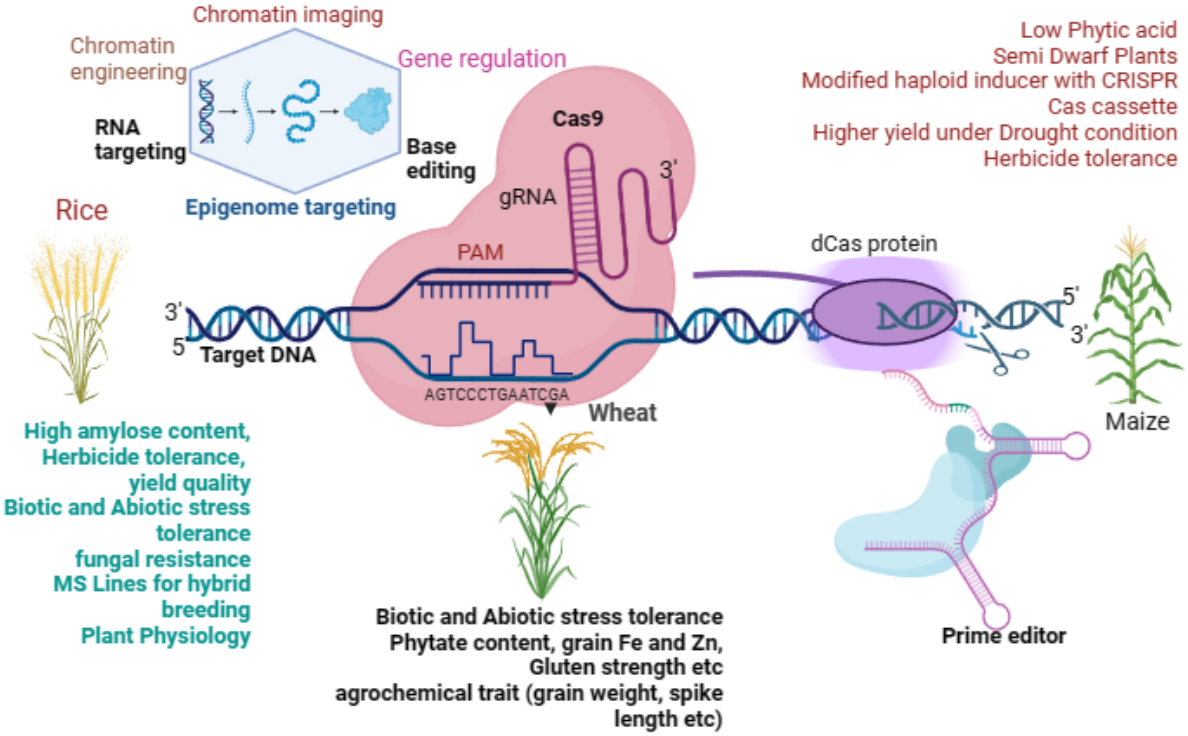

Figure 1. Potentials of genome editing tools in improvement of major cereal crops.

Limitations of genome editing tools in cereal crops

While genome editing technologies have revolutionized crop improvement, there are certain limitations and challenges associated with their application in major cereals like wheat, rice, and maize (Qi et al., 2016; Chandra et al. 2022; Dongariyal et al., 2023). Some of these limitations include:

1. **Off-Target effects**: One of the significant challenges in genome editing is the potential for off-target effects, where unintended modifications occur at locations similar to the target sequence. This can lead to unpredictable and undesirable changes in the genome.
2. **Genetic mosaicism**: Genetic mosaicism refers to the presence of edited and unedited cells within the same organism. In crops, this can result in plants with a mix of edited and unedited tissues, affecting the consistency of the desired traits.
3. **Regulatory challenges**: The regulatory framework surrounding genetically modified organisms (GMOs) can pose challenges to the adoption of genome-edited crops. The classification of genome-edited crops and the extent of regulatory oversight vary among countries, which can impact the commercialization and acceptance of edited crops.
4. **Complex traits and polygenic inheritance**: Some traits of interest in major cereals are controlled by multiple genes and exhibit polygenic inheritance. Editing multiple genes

simultaneously to achieve complex trait modifications can be technically challenging and may require the development of advanced editing strategies.

5. **Long-term stability**: The stability of edited traits over generations is an important consideration. Ensuring that the edited traits persist and remain stable in subsequent generations is crucial for the long-term success of genome-edited crops.

Researchers and scientists are actively working to address these limitations through ongoing advancements in genome editing technologies, improved delivery methods, and a better understanding of plant genetics. As the field continues to evolve, overcoming these challenges will contribute to the successful integration of genome-edited crops into agriculture.

Conclusion and Future Prospects

While the futuristic approach of genome editing in crop improvement holds tremendous potential, ethical, regulatory, and social considerations will play a crucial role in shaping its broader acceptance and implementation. Ongoing research, technological advancements, and collaborative efforts will be essential for realizing the full benefits of genome editing in agriculture. In summary, genome editing in wheat, rice, and maize is a versatile tool for crop improvement, addressing challenges related to yield, resilience to environmental stresses, and nutritional content. Ongoing research and advancements in genome editing technologies continue to shape the future of agriculture for these essential cereal crops.

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GROUNDWATER RECHARGE THROUGH WASTE WATER – AN OVERVIEW

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Natural replenishment of underground water occurs very slowly; excessive exploitation and mining of groundwater at greater than the rate of replenishment causes declining groundwater levels in the long term and leads to eventual exhaustion of the groundwater resource. Artificial recharge of groundwater basins is becoming increasingly important in groundwater management and particularly where conjunctive use of surface water and groundwater resources is considered in the context of integrated water resources management. Groundwater's major beneficial uses include municipal water supply, agricultural and landscape irrigation, and industrial water supply. The main purposes of artificial recharge of groundwater have been :

(a) to reduce, stop, or even reverse declines of groundwater levels .
(b) to protect underground freshwater in coastal aquifers against saltwater intrusion.
(c) to store surface water, including flood or other surplus water, and reclaimed municipal wastewater for future use.

Groundwater recharge is also incidentally achieved in irrigation and land treatment and disposal of municipal and industrial wastewater via percolation and infiltration. There are several advantages in storing water underground via groundwater recharge including:

(a) The cost of artificial recharge may be less than the cost of equivalent surface water reservoirs.
(b) The aquifer serves as an eventual natural distribution system and may reduce the need for transmission pipelines or canals for surface water.
(c) Water stored in surface reservoirs is subject to evaporation, taste and odor problems due to algae and other aquatic productivity, and to pollution, which may be avoided by soil-aquifer treatment (SAT) and underground storage.
(d) Suitable sites for surface water reservoirs may not be available or may not be environmentally acceptable.
(e) The inclusion of groundwater recharge in a wastewater reuse project may provide psychological and esthetic benefits as a result of the transition between reclaimed municipal wastewater and groundwater.

This aspect is particularly significant when a possibility exists in the wastewater reclamation and reuse plans to augment substantial portions of domestic or drinking water supplies. Groundwater recharge with recycled wastewater presents a wide spectrum of technical and health challenges that must be carefully evaluated. The lack of specific criteria and guidelines governing the artificial recharge of groundwater with recycled municipal wastewater is currently hampering the implementation of large-scale groundwater recharge operations. Thus, policies and guidance for planning and implementing new groundwater recharge projects are needed, and would serve as

the basis on which future and current groundwater projects would be designed and evaluated. Inadequate water supply and water quality deterioration represent serious contemporary concerns for municipalities, industries, agriculture, and the environment in many parts of the world. Factors contributing to these problems include continued population growth in urban areas, contamination of surface water and groundwater, uneven distribution of water resources, and frequent droughts caused by extreme global weather patterns. Recharged groundwater may be an eventual source of potable water supply, groundwater recharge with recycled municipal wastewater may often involve treatment beyond the conventional secondary wastewater treatment level. In the past, several apparently successful groundwater recharge projects were developed and operated using primary and secondary effluents in spreading basins. However, because of the increasing concerns about protozoan cysts, enteric viruses, and trace organics in drinking-water, groundwater recharge with recycled wastewater in industrialized countries now generally entails further treatment after conventional secondary treatment. For example, surface spreading operations practiced in the USA to reclaim wastewater commonly include primary and secondary wastewater treatment, tertiary granular-medium filtration and, finally, chlorine disinfection.

Techniques of groundwater recharge

Two types of groundwater recharge are commonly used with reclaimed municipal wastewater: surface spreading or percolation, and direct aquifer injection.

- **Groundwater recharge by surface spreading**

Surface spreading is the simplest, oldest, and most widely applied method of artificial recharge . In surface spreading, recharge waters such as treated municipal wastewater percolate from spreading basins through the unsaturated soil and ground (vadose) zone. Infiltration basins are the most favored methods of recharge because they allow efficient use of space and require only simple maintenance. In general, infiltration rates are highest where soil and vegetation are undisturbed.

- **Direct injection to groundwater aquifer**

Direct subsurface recharge is achieved when water is placed directly into an aquifer. In direct injection, highly treated reclaimed water is pumped directly into the groundwater zone, usually into a well-confined aquifer. Groundwater recharge by direct injection is practiced:

(a) where groundwater is deep or where the topography or existing land use makes surface spreading impractical or too expensive, and
(b) when direct injection is particularly effective in creating freshwater barriers in coastal aquifers against intrusion of saltwater.

In arid climates where the practice of groundwater recharge is most imperative, recharge will occur through such means as dry riverbeds and spreading basins, and in most situations there will be an unsaturated zone between the surface and the aquifer.

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It has also become apparent that common wastewater handling and reuse practices in developing nations (which are frequently unplanned and uncontrolled) generate high rates of infiltration to underlying aquifers in the more arid climates. This incidental infiltration is often volumetrically the most significant local 'reuse' of urban wastewater, but one which is rarely planned and may not even be recognized. It both improves wastewater quality and stores it for future use, but can also pollute aquifers used for potable water supply. The topic has major implications in terms of future approaches to groundwater and wastewater management in many rapidly-developing urban centers. Wastewater is very popular with poorer farmers, because of its continuous availability, large organic load and high plant nutrient content. But there are instances of indiscriminate practices of very high public health risk, such as irrigation with raw sewage and cultivation of crops eaten uncooked. There may also be longer-term hazards if industrial effluent is present, such as build-up of toxic elements (notably lead, chromium, boron, etc.) in soils, reduction of soil fertility and possible uptake into the food chain, but these important inter-related topics are outside the current scope. A high priority will always be to improve wastewater characterization as an aid to the assessment of groundwater pollution hazard. Where potential problems associated with persistent contaminants that pose a threat to groundwater quality become apparent (such as high salinity or certain toxic industrial organic and inorganic chemicals), the best approach will be to evaluate their origin within the overall sewerage system and establish the feasibility of control at source or separate collection and disposal.

The impact of wastewater infiltration on specific groundwater supply sources will depend not only on its impact on the shallow aquifer system, but also on their siting relative to wastewater infiltration area, their depth of water intake and the integrity of well construction. With careful control of such factors (and under favorable circumstances in terms of aquifer vulnerability and wastewater quality), compatibility between wastewater reuse and groundwater supply interests can be achieved through:

- Increasing the depth and improving the sanitary sealing of potable waterwells.
- Establishing appropriate source protection areas for such waterwells .

● Increasing groundwater monitoring for the indicators.
● Using irrigation wells to recover most of the wastewater infiltration and provide a 'hydraulic barrier' for the protection of potable water supplies.

To increase the supply of groundwater, artificial recharge of groundwater basins is becoming increasingly important in groundwater management and particularly where the conjunctive use of surface water and groundwater resources is planned. Use of reclaimed wastewater including groundwater recharge for a variety of applications has been implemented and it is safely undertaken provided appropriate planning, treatment, water quality control, assessment, and precautions are followed. The most controversial group of chemical contaminants in wastewaters is the organic substances, which are always present and most difficult to measure and assess. These are mostly natural products, most of which are not likely to be harmful as well as industrial chemicals, and disinfection byproducts. Most discreet industrial chemicals and many disinfection byproducts are measurable by sophisticated instrumental methods, and procedures are available to assess exposure risks in many cases; however, often insufficient experimental toxicology data are available to perform detailed risk assessments. Most of the primarily natural organic chemicals and their derivatives have been historically not readily identifiable; however, great progress is now being made in their characterization. In general, operational standards for water reuse projects have tended to rely on use of treatment trains designed to give significant reduction of difficult to define organic chemicals using a non-specific chemical indicator such as TOC along with measurements and criteria for specific chemicals, (e.g., benzene or nitrosamines). This approach can show that a large portion of the organic chemicals of most types has been removed by the treatment technology, and in addition that specific measurable hazardous chemicals do not exceed limits. If the final TOC is low enough then it is logical that insignificant amounts, if any, of the difficult to define substances of unknown concern remain.

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ORGANIC MULCHES AS AN ALTERNATIVE FOR WEED MANAGEMENT

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Abstract
Organic mulches can suppress annual weeds and offer other important benefits, such as organic matter, nutrients, moisture conservation, soil protection, and moderation of soil temperature. Drawbacks include costs and labor of application, limited efficacy on perennial weeds, delayed soil warming, and the potential to carry weed seeds and harbor pests.

Hay, straw, and fresh-cut forage or cover crops are among the most versatile and widely-used organic mulches. They can suppress weed germination and emergence when applied at reasonable rates, are fairly easy to apply, reduce evaporative losses of soil moisture while allowing rainfall to reach the soil, and provide other benefits. Caution is needed to avoid bringing in weed seeds or herbicide residues with hay from off-farm sources. Tree leaves, chipped brush, and other forest-based mulches are often beneficial to small fruit and other perennial crops, but may not be an economical option for weed control at a multi-acre scale. This article explores in greater depth the properties, uses, advantages, and disadvantages of a variety of organic mulch materials.

Introduction
Modern agriculture mostly experiences significant yield loss as a result of numerous biotic and abiotic variables. The gap between the supply and demand of food is caused by low agricultural productivity combined with a steady population growth. The weed problem is one of the main biotic variables impacting agricultural production, and it affects practically all crops and agroclimatic zones. In developed, emerging, and least developing countries, weed losses to yield average 5%, 10%, and 25% (Oerke, 2006).

That could, however, result in a 100% yield loss if it is not checked promptly. The majority of modern agriculture depends on scarce resources. As a rival to the crop, weeds take advantage of its vital resources, such as sunlight, water, nutrients, and land. Additionally, it offers insects and other pathogens a place to live. Additionally, it releases harmful compounds that impede crop growth. Weeds give crop competition from above and below. Because weeds return after a few days, manual weed treatment is therefore an expensive and short-term solution. Herbicide-based chemical weed control leaves residue toxicity in the soil and affects environmental health. Furthermore, weeds become resistant to a pesticide when it is applied repeatedly. Farmers are looking for appropriate substitutes for chemical and manual weeding in this situation. One such appropriate cultural strategy that may be applied to weed control in a way that is safe for the environment is organic mulching.

Using organic mulch

It involves applying elements derived from nature to the soil's surface with the intention of preventing erosion, maintaining soil fertility and hydration, managing weed growth, controlling soil temperature, and so forth. These substances decompose biologically. As a result, they gradually deteriorate naturally and enhance soil health.

Organic mulch types

There are a plethora of organic materials that are effectively employed as mulching alternatives. Among them are sawdust, compost/manure, alfalfa, seaweed, coir, cocoa bean hulls, corn cobs, peanut hulls, dried leaves, bark (softwood and/or hardwood), hay, wood chips, municipal tree debris, pine needles, chopped leaves, etc.

Using organic mulch to control weeds

- When organic mulches are put on the soil's surface, they prevent sunlight from penetrating the soil, which is necessary for photosynthesis and, consequently, prevent weed seeds—particularly those belonging to the dicot category—from germinating.
- Organic mulches stop weed seeds from penetrating the soil from the outside and coming up.
- Several organic residues emit compounds known as allelopathic, which are poisonous to a wide variety of weeds (Saha et al., 2018). Rye straw, for example, releases a poisonous chemical that harms weeds with little seeds more than those with large seeds.
- Because organic mulches have a cooling impact on the soil, they prevent the growth of certain weeds that are sensitive to high soil temperatures (between 85 and 100 degrees Fahrenheit), such pigweeds, purslane, galinsoga, etc.
- Applying organic mulch immediately following crop harvest helps suppress weeds that emerge later.
- Organic mulches enhance the growth and ability of winter crops to compete with weeds by regulating soil temperature, enhancing soil organic matter, and preserving soil moisture.
- Organic mulches reduce the amount of available oxygen, which impacts weed seed germination.
- The thickness of the mulch layer increases the unavailability of O2 (Benvenuti et al., 2001).
- The use of live mulch, which involves planting vegetation either prior to or subsequent to crop growth, effectively covers the soil's surface, preventing weeds from sprouting.

The necessity of applying organic mulch

- Because organic residue decomposes quickly, replenishing organic matter should be done on a regular basis. The types, degree of weed dominance, etc., should be taken into consideration while determining the thickness of organic mulching. While large seeded broadleaf weeds and grasses can be effectively controlled with organic mulching at a thickness of 7–10 t/acre, small seeded broadleaf weeds are suppressed by this layer of mulching at a thickness of 3-5 t/acre. Because the organic mulching layer (1-2 t/acre) retains soil moisture and provides vital nutrients, it permits weed emergence and growth.
- Before spreading the mulch material over the soil's surface, sufficient care should be taken to ensure that it is free of weed seeds. Applying the appropriate amount and timing of mulch is crucial for efficient weed control. Crop growth can be impeded by the improper choice

and timing of organic mulch applications. For example, because straw mulch reduces soil temperature, it is detrimental to tomatoes, melons, and other plants. Furthermore, mulching with straw breaks down rapidly, which limits the effectiveness of the method for controlling weeds for a brief amount of time.

- To lessen crop-weed competition for resources, organic mulching should be applied following adequate crop establishment and removal of existing weed flora from the field. Mulch with a high C: N content, such as sawdust, slows down crop growth by immobilising nitrogen.
- Harvesting live mulch is recommended once the crop-weed competition has ended. If not, it will rival the crop for resources.

Figure 1. (a) Garlic mulched with hay immediately after planting in October; photographed in April. (b) Tomato mulched with hay after the crop became established, several weeks before the photo was taken. The mulch delayed weed emergence and provided favorable conditions for crop growth

Restrictions

- It is only appropriate to use organic mulching for small-seeded annual weeds. It is useless or barely effective against perennial weeds with big seeds.
- Organic mulches are easily penetrated by perennial weeds.
- Over mulching reduces the amount of oxygen available in the soil, which eventually inhibits crop germination and root development.
- Organic mulching works better in the summer than in the winter since it lowers soil temperature.
- Some weeds grow because organic mulches can't completely screen sunlight, leaving gaps for light to enter.
- Mature perennial weed seeds are carried by organic mulches like straw, hay, compost, leaves, grass clippings, tree bark, etc., and if they sprout, they are extremely hard to eradicate.

- It is important to note that controlling weeds growing through mulches is more challenging than controlling weeds growing through bare soil.
- Applying organic mulches by hand requires a lot of labour. Because of this, small-scale farming can afford it more than other options.
- Organic mulching effectively controls weeds and invites disease and pest issues (bugs, termites, etc.) in many crops, including lettuce and brassicas. However, unless they are grown on a farm, their large quantity requires expensive transportation.

A few novel and intriguing organic mulching techniques for controlling weeds

Dust compacted by hydro

One novel and modified organic mulching approach that shows potential for managing weeds is hydro-compacting dust. mixed with an adhesive made of polyvinyl alcohol and organic fibres. This sticky material compacts organic matter into a disc when water is added (Massa et al., 2019). It successfully stops sunlight from penetrating and stops weeds from emerging.

Hydro-compacting organic dust or disc has various advantages, such as: It is more resilient than typical organic wastes.

This tiny material has no opening that allows light to pass through, making it an extremely effective weed-controlling alternative with little to no negative environmental impact.

Mulching newspapers

Hay, leaf, and grass clippings are placed on top of two to three layers of black and white newspapers. It successfully inhibits the growth of weeds. Moreover, it breaks down later and strengthens the soil to support crop growth. Shredded newspaper can also be utilised. Harrington and Bedford (2004) claim that weed control is superior to plastic mulching when shredded newspaper is sandwiched between two sheets of brown paper.

On the other hand, windy places are generally avoided when using newspapers.

Mulch made of jute

It is a hairy mulching disc with a centre hole that allows plants to emerge that is placed on the soil's surface. The size of the plant determines the hole's size. Its main use are in weed control and soil moisture preservation. It guards against weeds damaging plant roots.

Cardboard mulching

This type of mulching uses cardboard that has been shredded or laid in layers. It is buried beneath grass clippings or compost. It pulls weeds, including grass. It is a completely biodegradable method of controlling weeds.

In summary

Organic mulching is a very promising solution for efficient weed management from the agricultural field, despite the fact that it cannot completely protect the crop from weeds due to a number of constraints. Organic mulching should be tried through various multilocational trials, especially in dryland areas, given its role in environmental safety and some additional benefits besides weed management. Possible outcomes should be interpreted for their recommendation as the appropriate and environmentally safe option of managing agricultural weeds.

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ARTIFICIAL INTELLIGENCE IN AGRICULTURE

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Abstract
Artificial Intelligence in agriculture is an emerging subject and plays a pivotal role in sustaining the food security of the growing population across the globe. Artificial Intelligence is the ability of an automated machine to learn like a human being, process it and produce intelligent solutions. The machines are trained using large datasets with the ability of reasoning and perception to make decisions that under the supervision of human beings can bring about brilliant results. AI-based applications help monitor crop and livestock health to suggest proficient management practices and also perform manual labour. Despite its slow rate of adoption in the current scenario, the usage and benefits of AI if correctly understood are envisaged to take agriculture to the next level.

Introduction
The 21st century is an actively emerging era in terms of science and technological advancement. The need for development in science broadened due to the rising population and increasing human needs for trade, medicine, and food security. With population growth, the number of mouths to feed increases which is why smart agriculture is required for enhanced productivity. To satisfy the needs and demands of the global 8 billion population, the agriculture sector incorporates innovative practices and embraces technological advancements. Modern agriculture has come a long way from hand ploughs to bullock-drawn ploughs, and from bullock-drawn ploughs to tractors. Artificial intelligence provides plenty of opportunities for ease of work in modern agriculture.

Artificial Intelligence
Artificial intelligence is the computer-based ability of a computerised machine, a robot, a mobile phone or any electronic device that can perform tasks with the intelligence of human beings. Intelligence like that of human beings in the domain of AI refers to the capability of reasoning, learning from the past, comprehending, deciphering meaning, and using language (Copeland, 2023). This does not mean that this kind of intelligence can encompass all forms of human capabilities in performing everyday tasks. Artificial intelligence has few limitations but despite that, it has been successfully implemented in chatbots, voice, face, fingerprint, handwriting recognition, virtual assistance, problem-solving and diagnosis of medical conditions.

The popularity of artificial intelligence is increasing day by day and the forms of applications are being developed year after year. Artificial intelligence is basically built on models that simulate human thinking and behaviour by training those using large datasets for efficient and intelligent decision-making (Biswal, 2023). The domain of the application of Artificial Intelligence is an ever-evolving arena. As of now in 2023, e-commerce, education, robotics, navigation, healthcare, human

resources, gaming, social media, automobiles, marketing, astronomy, transport, and data security are powered by AI tools.

AI applications in agriculture

The earliest forms of AI in agriculture developed a few decades back that revolutionized traditional farming. To combat certain constraints of traditional farming such as heavy manual labour, AI models help to determine the best management practices using big data. Some of the important uses are described as follows (Lenniy, 2023):

1. **Automated irrigation:** Weather conditions and soil moisture levels sensors combined with AI help in deciding the amount of water required for irrigation purposes. These practices can conserve water at the same time promote sustainable agriculture.
2. **Leak detection in irrigation:** Machine learning algorithms can detect patterns of water flow/pressure changes that are indicative of possible leaks. This is essential to prevent crop damage and water waste by providing early detection in real-time.
3. **Climate-smart agriculture:** AI can monitor weather changes and analyze the weather conditions to help farmers decide the type of crop to be planted during a particular time.
4. **Soil monitoring:** AI detects the soil nutrients present in the soil to enable farmers to make crop-specific adjustments.
5. **Disease and pest infestation detection:** Computer vision models scan images of manifestation of pest and disease attack, which is scrutinized to identify the causal organisms. This is essential for farmers to take necessary actions such as isolation or spraying of insecticides/pesticides/fungicides.
6. **Livestock Health Monitoring:** AI tools help in identifying odd livestock behaviour. They keep track of diet and environmental effects on livestock health.
7. **Predictive analysis and Yield mapping:** Using 3D mapping, drones, and sensors, the collected data can be used to predict yields accurately by the use of algorithms.
8. **Weeding and Harvesting operations:** Computer vision scans the colour, shape, and size of leaves to be able to recognize weeds. Detectors enabled robots to recognize and remove weeds. With the same technology, harvest-ready crop images are trained into the computer system which helps the robots recognize when the crop is ready. Robots can work longer hours with enhanced precision.
9. **Sorting and grading harvests:** Diseases can be spotted in crop harvests through computer vision and the healthy ones can be sorted out. The harvests can be graded according to size, colour and shape to enable farmers to sell them at different prices.
10. **Security:** Farms need to be protected from animals and rodents so surveillance systems and computer visions can detect potential threats.

Benefits

The human race has resorted to trusting AI to carry out their daily tasks without which it is impossible to bear the workload and perform them proficiently in a limited time.

1. Agriculture had struggled so far due to lack of labour which when substituted by automated device applications resulted in enhanced performance.
2. AI solves complex problems to reduce the disadvantages posed by traditional farming.

3. With the help of AI, appropriate management practices can be followed that decrease expenditure while maximizing the agricultural output.
4. The need for AI has been felt in every step of the agricultural production and marketing process right from site selection to making the products available to the consumers.
5. Smart bots and intelligent automation perform time-consuming operations so that time can be utilized for decision-based tasks that necessitate human judgment.
6. Challenges due to environmental change are addressed by AI-powered tools.
7. Real-time monitoring of crop, soil and livestock health is revolutionizing modern agriculture.

Challenges

AI adoption has been quite slow in the field of agriculture as farmers are not very ready to adapt to new technologies. It is not only the adherence of farmers to traditional methods but also the failure of extension and agri-tech workers to convince and explain the benefits of adopting AI-based tools. The challenges that are required to overcome are:

1. **Cost:** In the long term, AI-based technology is cost-effective but initially, the investment required is expensive. It is quite impossible as of now, especially in developing countries to adopt AI as the small to medium scale farmers that comprise most of the farming population do not have sufficient finances to support their establishment.
2. **Reluctance:** Lack of knowledge and unfamiliarity with any innovation creates hesitation to fully embrace AI. The farmers in developing countries do not have strong educational background to help them understand the benefits of adopting new methods so they are not open to innovation which is also the factor behind the slow adoption.
3. **Infrastructure:** Farms do not have the required infrastructure for practising the use of AI-powered tools. To build up the infrastructure agri-tech workers and software companies need to convince the importance and utility of the infrastructure for successful implementation of the AI-based tools.
4. **Data:** For AI models to work efficiently, large, high-quality data is required which involves continuous training, research, and analysis to make the models familiar to work in different environments. Giving the entire responsibility to AI to make decisions can in certain cases be detrimental so supervision is required.
5. **Privacy:** Computer-based tools are susceptible to cyber-attacks which make the farmers insecure about hackers disturbing their goods supply. Precision agriculture implementation is also susceptible to legal queries due to the lack of proper regulations concerning the usage of AI.

Conclusion

AI works like a human brain by learning about the issue, gaining enough information about it, and training itself to solve the problem. The development in technology has increased proficiency while reducing the limitations of farming and challenges to sustainable development. Having emerged only a few decades ago, AI remains an explorative field with numerous possibilities for the future of agriculture. One of the great transformations that AI brings to agriculture is to change the identity of farmers from being manual labourers to managers and planners of smart agriculture systems. AI in sync with drones, automated machines and other technologies along with the required

infrastructure can address the challenges and work together in improving their tools to reap maximum benefits.

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BUILDING A STRONGER RURAL INDIA: SKDRDPs VISION

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Abstract
Founded in 1982 in rural Karnataka, the Shri Kshethra Dharmasthala Rural Development Project (SKDRDP) has been a driving force of positive change for over four decades. Led by Dr. D. Veerendra Heggade, this registered NGO has extended its impact across Karnataka and into Kerala. SKDRDP's holistic approach prioritizes rural prosperity, small and marginal landholders, and sustainable farming practices. With a focus on agriculture, financial inclusion, women's empowerment, community development, and health insurance, SKDRDP has uplifted countless lives. Its enduring commitment to rural development promises a brighter future for marginalized communities in rural India.

Introduction

In the heart of rural Karnataka, a beacon of hope and development has been shining for over four decades. The Shri Kshethra Dharmasthala Rural Development Project (SKDRDP), a registered non-governmental organization (NGO), emerged in 1982 in the village of Dharmasthala, Belthangady taluk, Dakshina Kannada district, Karnataka. Founded and chaired by Dr. D. Veerendra Heggade, a Padma Vibhushan awardee, SKDRDP's inception marked the beginning of a transformative journey towards rural prosperity. Since then, this organization has extended its influence not only throughout Karnataka but also into the Kasaragod district of Kerala, touching countless lives and winning numerous accolades, including the prestigious Ashden Gold and Scotch Foundation awards.

SKDRDP's Roots: The Genesis of a Movement

SKDRDP started as an experiment, catering to 18,000 families in Belthangady taluk. This initial foray was a pilot program that would prove to be a stepping stone towards broader rural development initiatives. These initiatives extended their reach to cover the entirety of Dakshina Kannada district. SKDRDP's success was the result of its ground breaking approach to rural development that prioritized the welfare of the local population, empowering them in a holistic manner.

The SKDRDP Mission: Fostering Sustainable Growth

The mission of SKDRDP is clear and far-reaching: empower small and marginal landholders within the informal sector, promoting sustainable farming practices, and economic self-reliance. This organization is dedicated to fostering harmony in villages by improving infrastructure and facilitating individual and community self-development. The core focus is on empowering the unreached, minorities, and women, nurturing entrepreneurial skills, and promoting tolerance.

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SKDRDP's Key Initiatives: A Holistic Approach to Development

SKDRDP's multi-pronged approach to development encompasses various sectors, including financial inclusion and microfinance, women's empowerment, community development, agricultural development, small-scale industrial development, and employment generation. These initiatives address diverse aspects of rural life, ensuring a comprehensive and sustainable transformation.

1. **Agricultural Development:** Agriculture is a fundamental livelihood for many in rural India, and SKDRDP recognizes its importance. The organization runs programs to promote sustainable farming practices, offering farmers knowledge and capacity building, financial support, and social support. By focusing on these three pillars, SKDRDP empowers farmers to enhance their agricultural practices, increase their yields, and achieve financial stability.

Components

- ✓ Pragathi Bandhu" model unites 5-8 farmers into Self-help Groups, concentrating on farm development through shared labor.
- ✓ CHSCs (Custom hiring Service Centres) and farm mechanisation
- ✓ Organic and Sustainable Agriculture: encourages small millet farmers to adopt organic farming.

Fig 01: SKDRDP supported CHSCs

- ✓ Kamadhenu Goshala: on conserving indigenous cattle breeds, genetic material development, and promoting these breeds.

2. **Financial Inclusion and Microfinance:** SKDRDP has played a pivotal role in facilitating financial inclusion in rural areas. It serves as a Banking Correspondent (BC) and Business Facilitator (BF) for several banks, including State Bank of India, Union Bank of India, Syndicate bank and others. Through this role, SKDRDP acts as a bridge between Self-Help Groups (SHGs) and formal banking institutions. It enables rural communities to access banking services at their doorstep, making it convenient and accessible for even the remotest villages. Currently, it has over 6,61,587 active SHGs with nearly 53,87,445 lakh members.


Fig 02: SHG weekly meetings and performance

3. **Women Empowerment:** SKDRDP's commitment to women's empowerment goes beyond financial aid. The 'Jnanavikasa Program' is a flagship initiative aimed at equipping rural women with the skills and resources they need to shape their futures and improve their living standards. It fosters a sense of responsibility in women, encouraging them to make independent decisions and take control of their lives. In addition, the 'Gelathi' counseling program provides support for family-related conflicts, addressing marital, family, psychological, and legal issues. This program enables women to overcome personal challenges and lead more fulfilling lives.
4. **Community Development Programs:** SKDRDP's community development efforts are participatory in nature. It involves local communities in decision-making and implementation processes, ensuring that projects align with their needs and priorities. The projects span across education, healthcare, creation of community assets, rural infrastructure development, and community welfare. By engaging the community in these initiatives, SKDRDP ensures that the benefits are more inclusive and sustainable.
5. **Sampoorna Suraksha Health Insurance:** Recognizing the financial challenges faced by poor families during unexpected health crises, SKDRDP introduced the 'Sampoorna Suraksha' health insurance program. This initiative operates on the principle of mutual help, where members contribute to ensure financial assistance during severe illnesses or accidents. The program has tied up with insurance companies to provide coverage for hospitalization expenses, maternity costs, death compensation, accident coverage, and more. It helps alleviate the financial burden on families, allowing them to access necessary medical treatment without falling into debt.

To effectively manage its extensive initiatives, SKDRDP operates through various departments, each dedicated to specific aspects of its mission. These departments include Employee Control and Human Resource Development, Agriculture, Business Correspondence, Community Development, Communication, Sampoorna Suraksha, Nirantara, National Pension Scheme, Financial, Stationery, Customer Higher Service Control, SIRI, Self Help Group, Suvidha, Sevaprathinidhi, Janajagruthi, Jnanvikasa, and more.

Conclusion

Shri Kshethra Dharmasthala Rural Development Project (SKDRDP) stands as a beacon of hope and progress in rural India. Its holistic approach to development addresses the multifaceted challenges faced by marginalized communities. By promoting financial inclusion, women's empowerment, health security, agricultural development, and more, SKDRDP has made a profound impact on countless lives. With its unwavering commitment to rural development, SKDRDP continues to empower communities and individuals to build a brighter future, transforming the landscape of rural India for generations to come.

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LADY BIRD BEETLE (*Coccinella septempunctata*): A POTENTIAL PREDATOR OF APHIDS

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INTRODUCTION

Ladybird beetle is an essential predator of the aphids that consume them. The development of pesticide resistance or resurgence as well as their toxicity to non-target organisms is the main causes of the focus on biological control. Chemical insecticides have a negative impact on both good and bad insects. In biological management, natural enemies (predators or parasitoids) are used to keep pest numbers below dangerous levels. In most cases, biological control is the most effective and environmentally beneficial method of pest management. Aphid-eating ladybirds, often known as "aphidophagous" insects, are the biological pest controllers of aphids. In order to maintain the pest defender ratio, a biological control strategy that uses predators to diminish or minimise pests and their effects is used.

Coccinella septempunctata Linn. (Coleoptera: Coccinellidae), the seven-spotted ladybird beetle or C7 (Wheeler & Hoebeke, 1995), is a common predator (Tribe Coccinellini)of aphids, mealy-bugs, scale insects, whiteflies, etc. (Omkar & Pervez, 2004), with aphids as most accepted prey. Though of Palearctic origin, it is ubiquitous, with wide adaptability to different climes and food habitats. The word Lady in the ladybird beetle is derived after Lady Mary (Majerus, 1994). The ladybird beetles are members of the Coccinellidae family. The order Coleopteran, suborder Polyphaga, series Cucujiformia, and family Coccinellidae all belong to the super family Cucujoidea. Chilocorine, Coccinellinae, Coccidulinae, Scymninae, Sticholotidinae, and Epilachninae are some of the subfamilies. Five of these subfamilies are predatory, and the Epilachninae subfamily is phytophagous in nature. The spread of coccinellid subfamilies spans essentially the entire planet. These beetles have been documented in over 6000 different species worldwide (Vandenberg, 2000). Under the name Coccinella, 36 species from Europe were described by Linnaeus in 1758. Latreille founded the family in 1807, and it was later split into the aphisdophagous and phytophagous groups (Redtenbacher, 1843).

The popularity of ladybird beetles is due to a variety of factors. First of all, a lot of ladybirds have striking colour patterns. As a result of their predatory behaviour, mostly against homopterous insects (such as aphids and scale insects) and phytophagous mites, which are damaging to a variety of agricultural and forest plants, 90% of the approximately 4200 Coccinellid species are thought to be helpful (Shah, 1985).

Phylum	Arthropoda
Class	Insecta
Order	Coleoptera

Family	Coccinellidae
Genus	*Coccinella*
Species	*septempunctata*

Species

There are two subspecies within the species *C. septempunctata*: *Coccinella septempunctata brucki* Mulsant, 1866 and *Coccinella septempunctata septempunctata* Linnaeus, 1758, as recognized by the Integrated Taxonomic Information System (ITIS, 2009). About 150 species of lady beetles occur in California. These include at least 12 *Coccinella* species of which the seven spotted lady beetle may be the most common.

Host species

Primarily, *Coccinella septempunctata* Linn. is feed on various species of aphids such as mustard aphid (*Lipaphis erysimi*), potato aphid (Macrosiphum euphorbiae), melon or cotton aphid (*Aphis gossypii*), green peach aphid (*Myzus persicae*) and chrysanthemum aphid (*Macrosiphoniella sanborni*) etc.

General characteristic and Distribution

The seven-spot ladybird (*Coccinella septempunctata* Linn.), is a cosmopolitan species that originated in Northern Africa, Asia, and Europe. There have been a number of targeted importations in the India due to its potential as a biological control agent for crop insect pests. The species can be found in Europe, North Africa, Australia, Cyprus, European Russia, the Caucasus, Siberia, the Russian Far East, Belarus, Ukraine, Moldova, the Transcaucasia, Kazakhstan, Middle Asia, Western Asia, Middle East, Afghanistan, Mongolia, China, North and South Korea, Pakistan, Nepal, North India, Japan, Sri Lanka, southeast Asia, and tropical Africa.

Coccinella septempunctata is a generalist species with a wide prey range .Males are smaller than females (Omkar & Bind, 1993). Eleven-segmented antennae are longer in females than in males comprising of various sensillae, like chaetica, trichoidea, basiconica, campaniformia, ampullacea and scolopalia. Sensillae trichoidea are more abundant on males, whereas basiconica are more in female antennae. *Coccinella septempunctata* exhibits polymorphism with typicals and melanics showing varied elytral patterns. Melanics consume more aphids and are also more fecund with higher body temperature than typical. The preoviposition and oviposition periods were shorter with more number of eggs per batch in melanics than in typicals. Thus, melanics were superior than typicals, however, the latter were more hardy to higher ambient temperatures possibly due to low internal temperatures (Rhamhalinghan, 1987).

Predatory potential

Ladybird beetle (*Coccinella septempunctata* Linn.) has greater potential to feed on aphid population. On the basis of scientific research, they feed approximately 45-60, 95-105, 160-180 and 300-330 aphids in 1^{st}, 2^{nd}, 3^{rd} and 4^{th} instar grub, respectively. A fully matured *Coccinella septempunctata* Linn. consume approx. 355- 415 aphids in our entire life cycle.

Bio-control agent

Biological control or "biocontrol" is the use of living organisms to suppress the population of a specific pest organism, making it less abundant or less damaging than it would otherwise be. The antagonists used for this purpose are natural enemies of the pests, and are called "biological control

agents". In biological control, natural enemies of pests are used to control them. Biological control is generally the most environmentally safe and economically profitable pest management method. Aphid-eating ("aphidophagous") ladybirds are used for the biological control of aphids. Population dynamics theory based on predator-prey interactions predicts that naturally occurring aphidophagous ladybirds are not able to control aphid populations effectively in nature and agro-ecosystems. First, because females will never deplete a site with aphids where they lay their eggs since their offspring would starve. Secondly, because the development and reproduction of these ladybirds takes much longer than that of their prey, and as a result, they cannot keep up with the population growth of aphids. Several types of professional biological control are distinguished With respect to conservation biological control in agro-ecosystems, the contribution of aphidophagous ladybirds varies largely. They will never attain long term suppression of aphids, but may well reduce within-season aphid densities by reduction of peak aphid densities

Life cycle (Bionomics)

The ladybird beetle (*Coccinella septempunctata* Linn.) goes through four developmental stages: egg, grub, pupa and adult to complete our entire life cycle. Its female laid clusters of bright yellow, smooth, long and cigar shaped approximately 40-45 eggs on plants, usually near to the prey. Like the majority of ladybird species, *C. septempunctata* attaches its eggs at one end to keep it upright. The egg measures about 1.21 mm and 0.50 mm in length and breadth, respectively. Its eggs hatched within 3-5 days in field condition while, 2 days at 35°C and 10 days 15°C days under controlled conditions. Its newly emerged grubs are dull coloured and with sluggish activity. Its larvae passed through four larval instars and moult three times in entire grub development. Its 1st, 2nd, 3rd and 4th instar grub develop within 2-4, 2-3, 1-3 and 2-4 days, respectively. Its grubs taking approximately 7-15 days to develop in to pupa. Ladybird beetle (*C. septempunctata* Linn.) complete its entire life cycle from egg stage to adult emergence within 20 to 30 days.

Role of predators in eco-system

1. Predators have greater potential to feed harmful pests in eco-system.
2. Predators maintain the insect-pests population below economic injury level.
3. Predators maintain the food chain or food web in eco-system.
4. Predators have profound effects throughout their ecosystems.
5. Predators can also control harmful insect that have gained resistance or resurgence to insecticides.
6. Predators can be easily used in the field by rearing them in the laboratory 7. Predators are the indicator of healthy ecosystem.

CONCLUSION

Ladybird beetle (having remarkable place for naturally biological control agent of the various aphid species such as mustard aphids (*Lipaphis erysimi* Kalt). It is a voracious feeder and may be numerous where prey is plentiful and broad spectrum insecticide use is limited. It is considered as most efficient predator, checking the population of aphids in field. It is an effective predator if aphids are abundant but are thought to be less effective at low pest density.

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STARTING A SUCCESSFUL DAIRYING ENTERPRISE: SOME GUIDELINES

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Successful dairy business depends on the comprehensive knowledge and first-hand experience in breeding, feeding, disease control, reproduction and overall management of the ability to sell farm products in a proper way with application of sound business policy. Although, most regions of our country are suitable for setting up dairy business, it widely exists in traditional form. Adoption of newer technologies might cause good growth in the existing dairy enterprise as dairy farming in India is a traditional business where the products fetch an easy market round the year. It is eco-friendly and the by-products of dairy farm can be used to fertilize agricultural lands and vegetable garden, allowing opportunities for unemployed educated youth to easily setup small scale dairy farm business for self-employment and income generation. The availability of highly productive milch breeds across the country with wider adaptability to different climates and readily available agricultural loans from banks and NGO's are suitable to start the business.

How to Start?

- The main resource required for dairy enterprises are land, labour, water, working capital, machinery and equipment, livestock and managerial ability and decide a particular aim (purpose, market)
- Make a study on suitability of the farm, land / area suitability of the farm buildings and fixed equipments, availability of capital and supply of right type of labour
- Visit some operating commercial dairy farms in your area, work for a minimum of six months. Or else you can also get training from Agricultural/Veterinary Universities, Krishi Vigyan Kendras, Animal Husbandry Department of State, State Institute of Rural Development
- Analyse farming systems practiced and discuss. This will help to broaden your knowledge in different areas (housing, feeding, breeding, marketing, treatment and overall management of animals)
- Make a note of day to day routine operation of the farm
- Visit your nearest veterinarians and discuss about the possibilities of dairy farming in your area
- Make a plan of the feed and fodder source. If you want to cultivate or buy from other available sources
- It is better to train labour for specific dairy farm jobs like milking, cleaning, feeding, register and routine record maintenance etc.
- Keep a track on the demand and price in market of the farm products

Budgeting : A dairy enterprise budget is a plan for future use of resources or planning for the upcoming years. It tells us the type of dairy animals to be kept, feeds and fodder crops to be grown and estimated production receipt and expenses of various resources. It is a financial statement of receipt and expenses involved in production of a product for a selected period of time. A partial budget is budgeting of one enterprise, cost and return analysis while a total budget is budgeting of the entire system. Budget estimates for starting a farm involve a) purchase of high yielding animals b) Herd strength for a destined time c) Feeding d) Farm irrigation and yield e) Housing f) Labour requirements g) Fixed capital h) Working capital etc.

Breeds : There are some native breeds of cows that are high yielding such like Sahiwal, Tharpakar, Gir etc. Crosses of Holstein Fresian and Jersey breeds are well adapted in our country. Selection and buying of animals should be done with the help of an experienced veterinarian. Purchase freshly calved animals in their second lactation. Before purchasing, ascertain actual milk yield by milking the animal three times consecutively. While, buffalo breeds like Murrah, Surti, Mehasana etc. also give good milk. The fat percentage of cow's milk varies from 3-4.5% and is lower than Buffaloes (7-12%). It is advisable to start with high yielding (8-10 kg/day) cows/buffaloes. Good milk yield (above 10 lit/day) accompanied by sufficiently longer lactation length (300days) and intercalving period of 13-15 months are desirable. There are differences in the quantity of milk produced in different agro-climatic regions of the country. These differences are due to differences in production potential of cows and buffaloes, animal husbandry practices, soil climate conditions, agricultural practices etc.

Fig. 1. Jersey Crossbred Cows

Minimum economic size : It is always advisable to start with few animals initially. Once the trick of running the business is fully understood, then starts with a comfortable number. Under Indian condition a commercial dairy farm should consist of minimum 10 animals. Purchase of second animal/second batch should be done after 5-6 months from the purchase of first group of cows. Cull old animals after 6-7 lactations. This strength can easily go up but one has to review the capability of a farmer and the market potential before expansion.

Housing : A good housing of dairy animal play an important role to maintain the overall health, productive and reproductive performance of the animal. It should reduce heat gain from outside and enable heat loss from the body by radiation and conduction during summer and protect from cold during winters. The animal houses should be designed that they are cheaper and provide protection form extreme weather conditions. Loose housing for dairy cattle under tropical conditions are recommended. This type of housing is suitable to most parts of the country except

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temperate Himalayan region and heavy rainfall areas. Loose housing systems are cheaper to construct. Expensive fittings and design on permanent basis should be avoided. For proper production you should give your animal required space inside the house. Generally 3.5 sqm is the covered floor space requirement per cows while the open paddock is 7sqm. However, ensure availability of all types of essential facilities like milking barn, shed for milch/dry cows, maternity pens, sick animal shed, calf shed, young stock shed and bull shed are required. Other ancillary buildings for stores, offices are essential. A lot of capital should not be invested in making animal shed initially. With the progress of the farm extend infrastructure gradually as per the Master plan.

Fig 2. A typical Loose Housing System

Fig 3. Machine Milking

Labour : Hiring efficient labour is essential. Involvement of family members, help in cutting down the cost. Train a labour for a specific work. Know that one labour is sufficient for 10 milking cows.

Feeding : Feed cost constitutes 60% of the total cost of producing milk so it is imperative to get the most out of the feed fed. High quality nutritious feed ensure proper growth and good health of the animals. Always try to feed them as per their physiological requirements. Green fodder and grasses help the animal to produce more milk and reduce feeding costs. Along with quality feeds and fodder, provide the animals with sufficient amount of clean and fresh drinking water. Dairy bovines require high proportion of forages in their ration. They include both leguminous, non leguminous crops in the form of green chops, silage, hay and straw but, one should take care of the palatability depending upon the maturity, stem-leaf proportion and preservation methods used for these plants. Leguminous fodder like Lucern, Berseem, Cowpea are rich in proteins, minerals and vitamins while non leguminous fodder plants like Maize, Jowar, Oats and Bajra are low in protein but rich in energy. Milk yield cannot sustain by roughages alone therefore, concentrates like cereal grains, oilseed cakes, rice bran wheat bran, pulses etc. have to be included. Concentrates are rich in proteins (above 15% CP) and total digestible nutrients. The dry matter requirement of a cow is 2.5kg per 100kg body weight which has to be supplied by roughages (2/3) and concentrates (1/3). Production ration include 1kg concentrates for 2.5 kg milk produced.

Fig. 4. Milk feeding of the calves through bottles

Health Care and Management : Maintain proper hygiene of the farm animals so as to prevent cows from diseases. Routine vaccination and deworming should be done. Avoid mixing of new animals with the existing herd on arrival. New animals should be quarantined. In case of illness report the veterinarian immediately. Separate the sick animals from the healthy ones and wait for advice from the veterinarian. Dung and other waste should be disposed far away from the farm.

Vaccination Schedule and Deworming schedule

Disease	Vaccine	Dose	Time of vaccination (Age)	Immunity duration	Product ®
Foot and mouth disease (FMD)	Polyvalent FMD vaccine	3ml SC	6 month	Repeat annually	RAKSHA-HS+BO: Combined vaccine for HS & BQ (Indian Immunological); Raksha FMD vaccine (Hoechst/BAIF); Clovax (Intervet)
Haemorrhagic Septicaemia	HS vaccine	5ml SC	6 month	Repeat annually	Raksha H. S. Vaccine, Prescription, Indian Immunology Ltd
Black Quarter	BQ vaccine	5ml SC	6 months	Repeat annually	Raksha HS + BQ, Indian Immunology Ltd
Anthrax	Anthrax Spore Vaccine	1 ml SC	6 months in anthrax enzootic area	Repeat annually	Raksha anthrax, Indian immunological; Biothrax; Anthrax Vaccine, Virbac
Brucella	Brucella abortus strain 19 vaccine	2ml SC	Female calves between 4 to 8 months of age	Once in life	BRUVAX: Brucella abortus (Strain 19) vaccine (Live) , Indian immunological Ltd.
Roundworms		Oral	10 days	monthly up to 6 month	Fenbendazole (Panacur®); Albendazole (Valbazen®)

Marketing: Before the start of the business one needs to acquaint with the types of marketing. The farmer must know where he wants o sell his items based on the demand of the product either to cooperatives, sweet/tea shops or dairy processing units. If one is producing the product, where will he sell his products and at what price? Is he involving the middleman or selling directly to retail markets. Milk being a perishable item, proper cold chain should be maintained at the producer level. Ensure hygiene during production of milk.

PROJECT: Starting a Dairy Farm with 10 Milch Cows

Assumptions:

1. Type of animals: Crossbred
2. Animal body weight: 500kg has been taken as an example
3. Dry matter requirement (2.5%) =12.5kg
4. Parts of dry matter supplied by roughages and concentrates
    - 12.5kg DM = 2/3 by roughage (approx 8.5kg); 1/3 by concentrates = 4 kg).
    - Now, 8.5 kg DM from roughage will divide to 2/3 by dry fodder (5.6kg) and green 1/3 (2.9kg).

- Considering DM in dry fodder (wheat straw) as 90%, therefore 5.6kg DM will be supplied by 5.6x100/90 = 6.2kg.
- If we suppose 12% DM is there in green fodder (Maize) then, 2.9 x 100/12 = 24.16kg.
- Concentrates DM is 90%, so 4x100/90= 4.44 kg

5. Milch:Dry: 75:25
6. Av Milk Yield (lit/day): 8-10
7. Lactation days: 280
8. Dry days: 60
9. Productive life is upto 7 years
10. Cost of animals (Rs/animal): Rs 60,000- 70,000
11. Covered floor space/animal (sqft): 40
12. Covered floor space/calf (sqft): 20
13. Cost of construction of animal shed /sqft: Rs 150
14. Cost of equipment/animal: Rs 1500
15. Cost of fodder cultivation/acre/season: Rs 5000
16. Veterinary aid: 1000/animal/year
17. Cost of concentrate feed: Rs 25/kg
18. Cost of dry fodder: Rs 4.50/kg
19. Labour: Family labour
20. Land: Own
21. Sale of Male calf: Rs 5000/calf
22. Sale of manure: Rs 50/quintal

A. Fixed Cost

Herd Expense

Cow: 10

Cost of 10 cows@ Rs 60,000/- : Rs 600000

Construction Cost of animal shed

Covered land@ 40 sqft for 10 animals @Rs150 sqft =Rs 60000/-

Construction of office room etc = Rs50000

Equipments and miscellaneous = Rs. 25000/-

Total Fixed cost: Rs 600000 + Rs 60000 + Rs50000 + Rs 25000 = Rs 735000

Interest of fixed cost @12% = Rs 88200/-

B. Recurring Cost

Feeds and Fodders per day

Items	Cost/kg	Milch period (Kg)	Total cost (Rs)	Dry Period (Kg)	Total cost (Rs)
Concentrates	25	4	100	1.5	38
Green	Self grown	24	Self grown	15	Self grown
Dry	4.50	6.2	27.9	10	45
Total	**29.50**	**34.2**	**128**	**26.5**	**83**

Items	Cost/kg	Milch period (Kg)	Total cost (Rs)	Dry Period (Kg)	Total cost (Rs)
Feeding cost/year for 10 animals			**128x300x8 milch = Rs 307200**		**83x60x2 dry = Rs 9960**

Calf feed @ Rs 48/Kg; Average 2kg intake/day x 55 days (8 calves) = Rs 42240/-
Veterinary Aid/treatment: Rs 10000/year
Total Recurring cost = Rs 307200+Rs 9960+ Rs 42240+ Rs 10000 = Rs 369400/-

C. Income (Rs)

Days in Milk = 8 milk and 2 in dry
Days in lactation= 280 days
Total milk produced (av. 8 lit/animal) = 280x8=2240 lit/animal
Therefore, 8 animals produce 2240x8 = 17920 lit of milk
Income from sale of milk (@Rs 40/lit) = 19200 x 40 = Rs 716800/-
Income from sale of male calf (4): 5000x4=Rs. 20000
Total income = Rs 716800+Rs 20000 = Rs 736800/-
Profit= Rs 736800 - Rs 369400/- = Rs 367400
= Rs 367400 - Rs 88200 (Interest on fixed cost) = Rs 279200/-
Profit per animal= Rs 27920/-
Profit/month/animal= Rs 2327/-

Conclusion

High cost incurred in infrastructure and feeding cost is the main constraint. But the cost can be cut down by growing own feed and fodder. In a small farm, family members are sufficient to take care but, in commercial scale one has to employ experienced persons with regular salary. Inadequate management of feeding, health and lack of quality control during different stages will affect the profitability of the farm.

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THE FUNCTION OF BIOFLOC SYSTEMS IN THE CYCLING OF NUTRIENTS

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Introduction

The raising and production of fish or other aquatic creatures, particularly for human consumption, is known as aquaculture. Aquatic farming mostly involves the cultivation of fish, mollusks, crustaceans, and aquatic plants. Additionally, farming suggests some kind of involvement in raising procedure to improve output, including consistent feeding, covering, and shielding from adversaries. Culturing of various aquatic creatures is one method of raising out of all the aquatic species that may be cultivated; shrimps are the most significant and lucrative. Because over the last few decades, disease outbreaks have had a significant impact on prawn culture. For To In order to resolve this, many approaches may be used, including Biofloc Methods. In the aquaculture system, it is a promising environmentally friendly method that encourages waste retention and turns it into Biofloc, a natural food source.

The term "Biofloc" refers to the collection of microorganisms, including rotifers, nematodes, algae, fungi, ciliates, flagellates, and metazoans. These organisms transform into microbial proteins after using up all the nitrogen.

In aquaculture, Biofloc Technology is referred to as the "Blue Revolution." Based on the creation of microorganisms in situ, this approach serves three primary purposes: it increases nutrition, competes with pathogens, and maintains water quality by absorbing nitrogen compounds. Biofloc technology is the application of microbe aggregates, or Biofloc inoculum, to enhance water availability, quality, disease prevention, and waste treatment. The Bioflocs that are employed, which are nothing more than aggregates of bacteria, algae, protozoa, and other organisms along with detritus, or dead organic particles, are the foundation of Biofloc technology. Bioflocs typically have a diameter of 0.1 to a few millimeters and are light and porous. The biofloc technique is a sustainable method. Because the biofloc technique is renowned for having high stocking densities with minimal to no water exchange, it has drawn attention recently. In aquaculture, biofloc technology has emerged as a viable method for maintaining the highest possible water quality. This is accomplished by adding carbon sources to the water and fostering the growth of dense heterotrophic bacterial communities. The biofloc in the culture tanks removes waste particles from the water, making the culture or pond pure even if it includes more bacteria and other aggregates. Generally, the overall amount of dissolved and suspended particles in the Biofloc tanks will be within typical ranges. A rise in water turbidity and a fall in light penetration might have an impact on microalgae development. Biofloc serve as both a food supply for organisms that have been raised and an absorber of dissolved inorganic nutrients, which helps to preserve the quality of the water. One way to maintain the ideal C:N ratio (12–15:1) in an aquaculture system is to lower the feed's protein % or add other carbon sources. When the C:N ratio is at its ideal, organic substrates are

metabolized while inorganic nitrogen gets immobilized within bacterial cells. Twenty to twenty-five percent of the protein provided to fish or prawns in a normal Brakishwater pond is used by the animals; the remaining protein is wasted and becomes organic nitrogen in the excrement, ammonia, and other metabolites. Bacteria are crucial to the biofloc treatment of culture tank fluids because they help to maintain the water quality parameters. Certain bacteria participate in the nitrogen cycle by fixing nitrogen, while other microbes aid in ammonification, or the breakdown of materials. The microorganisms found in culture tanks or ponds have an indirect or direct impact on the growth, feeding, and survival rates of fish kept in captivity. The existence of some pathogenic microorganisms can occasionally cause illnesses and fish death. Most often, photoautotrophic microorganisms like algae and heterotrophic microorganisms like bacteria, rotifers, ciliates, protozoans, and nematodes are linked to the flocs. The majority of nitrogen and phosphorus intake occurs in bacteria, which have an advantage over phytoplankton since they can digest more nutrients because of their greater surface-to-volume ratio. The bacterial population in culture tanks is primarily responsible for maintaining the water's purity. The cultivated species and carbon sources influence the microbial diversity linked to biofloc. Then, distinct microbial communities can be observed in various types of culture. In contrast to the bacteria found in culture tanks containing just *Oreochromis niloticus*, distinct types of microbes may be seen in a mixed culture of *Oreochromis niloticus* and *Pampus argenteus*. Furthermore, the function of microorganisms within the culture tanks may be determined. With Biofloc technology, more light penetrates since the biofloc aids in removing trash from cultured tanks. Larger light penetration in culture tanks treated with Biofloc can sometimes enhance the performance of the organisms being raised, but it can also occasionally lead to the appearance of potentially hazardous microorganisms like filamentous bacteria. When carbohydrates are broken down by bacteria, inorganic nitrogen is eliminated, protein is produced, and various-sized bioflocs are formed.

Benefits of the Biofloc system

1. A zero or minimum water exchange system can preserve the culture system's biosecurity.
2. Heterotrophic bacteria have the ability to eliminate toxic metabolites such as NO2 and NH3.
3. Manageable and environmentally friendly.
4. As the shrimps consume feed and then gather flocs, their protein consumption doubles.
5. The probiotic effect.
6. The humoral and cellular immune systems are stimulated by the microbes in biofloc.
7. Lowers production costs by 15% to 20%

The Biofloc system has three disadvantages

1. Increases in energy and aeration costs;
2. Requires greater technical know-how and system comprehension; and
3. Limited advancement because of inadequate facilities.

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NANOPARTICLES: A PARADIGM SHIFT IN SUSTAINABLE PLANT PATHOGEN MANAGEMENT FOR AGRICULTURAL ADVANCEMENT

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Introduction

The agricultural landscape is continually challenged by the imperative to safeguard crops against an array of menacing plant pathogens. These threats not only jeopardize crop yields but also impede efforts toward global food security. Historically, the arsenal against plant diseases has heavily relied on chemical interventions, which, while effective, often carry ecological and health consequences. However, in recent years, a revolutionary shift has emerged in agricultural science—nanotechnology. This burgeoning field has opened new vistas for managing plant pathogens more efficiently and sustainably. At the heart of this innovation lie nanoparticles, with their unique physical and chemical properties, offering a promising avenue for mitigating plant diseases while minimizing environmental impact.

The impact of nanoparticles on plant pathogens is remarkable, owing to their dimensions typically ranging from 1 to 100 nanometers. Their diminutive size encapsulates extraordinary attributes—high surface area-to-volume ratio, heightened reactivity, and unparalleled penetration capabilities. These distinctive characteristics empower nanoparticles to engage more effectively with plant pathogens, ushering in a myriad of potential mechanisms for disease management.

A cornerstone application of nanoparticles in plant pathology is their antimicrobial potency. Metal nanoparticles, including silver, copper, and zinc oxide, showcase robust antimicrobial activity against a diverse spectrum of plant pathogens. They disrupt pathogen cell membranes, impede crucial enzymatic processes, and interfere with fundamental cellular functions, consequently curtailing disease progression. Additionally, carbon-based nanoparticles, such as carbon nanotubes and graphene oxide, exhibit promise in combatting plant pathogens by inducing oxidative stress and disrupting cellular structures.

Furthermore, nanoparticles serve as versatile carriers for delivering various compounds—fungicides, herbicides, and plant growth regulators. These nanoformulations act as protective shields, preserving these compounds from degradation and facilitating targeted delivery to afflicted plant tissues. This not only diminishes environmental contamination but also amplifies efficacy, necessitating reduced quantities for effective disease management.

Expanding the scope beyond disease management, nanoparticles play a pivotal role in disease diagnosis and monitoring. Nanobiosensors and nanoprobes offer rapid and sensitive detection of plant pathogens by pinpointing specific biomarkers or nucleic acid sequences associated with diseases. These cutting-edge tools provide real-time monitoring capabilities, enabling swift decisions in disease management to avert extensive crop damage.

However, the widespread adoption of nanoparticles in plant pathogen management confronts multifaceted challenges. Concerns about the environmental fate of nanoparticles, potential toxicity to non-target organisms, and the risk of pathogen resistance loom large, demanding comprehensive evaluation. Collaborative efforts among researchers and regulatory bodies are imperative to comprehensively assess the risks and benefits associated with nanoparticle utilization in agriculture.

Types of nano particles reported for management of plant pathogens

1. Metal Nanoparticles (e.g., Silver, Copper, Zinc Oxide): Metal nanoparticles exhibit potent antimicrobial properties against a wide range of plant pathogens. They disrupt pathogen cell membranes, interfere with enzymatic processes, and inhibit essential cellular functions, effectively suppressing disease development.

2. Carbon-Based Nanoparticles (e.g., Carbon Nanotubes, Graphene Oxide): Carbon nanoparticles have shown promise in controlling plant pathogens by inducing oxidative stress and damaging pathogen cellular structures. They possess unique properties that hinder pathogen growth and proliferation.

3. Silica Nanoparticles : Silica nanoparticles have been studied for their antifungal activity against various plant pathogens. They can inhibit spore germination and mycelial growth, thus impeding the progression of fungal diseases.

4. Polymeric Nanoparticles: Polymeric nanoparticles serve as effective carriers for delivering various bioactive compounds such as fungicides, herbicides, and growth regulators. They protect these compounds from degradation and enable targeted delivery to specific plant tissues, enhancing their efficacy.

5. Lipid-Based Nanoparticles: Lipid nanoparticles have been explored for their potential in managing plant diseases. They can encapsulate and deliver bioactive compounds to targeted sites, offering controlled release and improved efficacy against pathogens.

6. Chitosan Nanoparticles: Chitosan nanoparticles exhibit antifungal properties and have been used in plant disease management. They possess the ability to disrupt fungal cell walls, inhibiting fungal growth and reducing disease severity.

7. Metal Oxide Nanoparticles (e.g., Titanium Dioxide): Metal oxide nanoparticles, like titanium dioxide, have shown antimicrobial activity against plant pathogens. They can induce oxidative stress and damage pathogen structures, limiting their growth.

8. Nanobiosensors and Nanoprobes: While not directly involved in pathogen management, nanobiosensors and nanoprobes facilitate rapid and sensitive detection of plant pathogens. They detect specific biomarkers or nucleic acid sequences associated with diseases, aiding in early diagnosis and monitoring.

These various types of nanoparticles offer diverse mechanisms for managing plant pathogens, including antimicrobial activity, targeted delivery of bioactive compounds, and enhanced diagnostic capabilities. Their unique properties contribute to innovative strategies aimed at improving crop health and increasing agricultural productivity while minimizing adverse environmental impacts.

Table 1. Lists of few nanoparticles used in management of plant disease

Type of Nanoparticle	Specific Bacterial Pathogen Controlled	Source of Nanoparticles
Silver Nanoparticles	*Xanthomonas campestris, Pseudomonas syringae*, *Fusarium oxysporum*	Chemical synthesis, Plant extracts
Copper Nanoparticles	*Pseudomonas syringae, Botrytis cinerea*	Chemical synthesis, Plant extracts
Zinc Oxide Nanoparticles	*Xylella fastidiosa, Alternaria solani*	Chemical synthesis, Biosynthesis
Carbon Nanotubes	*Xanthomonas oryzae, Phytophthora infestans*	Chemical synthesis, Others
Graphene Oxide Nanoparticles	*Ralstonia solanacearum*	Chemical synthesis, Others
Silica Nanoparticles	*Erwinia amylovora*	Chemical synthesis, Plant extracts
Polymeric Nanoparticles	*Pseudomonas syringae*	Chemical synthesis, Others
Lipid-Based Nanoparticles	*Xanthomonas campestris*	Chemical synthesis, Others
Chitosan Nanoparticles	-	Chemical synthesis, Biosynthesis
Titanium Dioxide Nanoparticles	*Xanthomonas oryzae*	Chemical synthesis, Others
Nanobiosensors and Nanoprobes	Various bacterial pathogens (for detection/monitoring)	Fabrication, Others
Bio-Nanoparticles	Various bacterial pathogens	Biosynthesis

Targeted pathogens and application methods

In the context of nanoparticle-based management of pathogens in plants, the target sites for application can vary based on the type of pathogen and the desired mode of action of the nanoparticles. Here are some common target sites for managing plant pathogens:

1. Foliar Surface:

Target Pathogens : Fungal spores, bacterial cells present on the leaves.

Application: Nanoparticles can be sprayed directly onto the leaves to inhibit pathogen growth, disrupt cell membranes, or induce oxidative stress, thus controlling disease development on the plant's surface.

2. Root Zone:

Target Pathogens: Soil-borne pathogens affecting root health.

Application: Nanoparticle solutions or formulations applied through soil drenching or soil incorporation to target pathogens in the soil and protect the roots from infections.

3. Seed Coating:

Target Pathogens: Seed-borne pathogens or those affecting seed germination.

Application: Nanoparticles coated onto seeds to protect them from pathogens, enhancing seedling vigor, and reducing transmission of diseases.

4. Inside Plant Tissues:
Target Pathogens:Pathogens that infect plant tissues internally.
Application: Nanoformulations or targeted delivery systems designed to penetrate plant tissues, delivering antimicrobial or antifungal agents directly to the affected sites, thus combating internal infections.

5. Pathogen-Specific Biomarkers or DNA Sequences:
Target Pathogens: Specific pathogens detected using nanobiosensors or nanoprobes.
Application: Nanoparticle-based sensors or probes designed to detect and bind to particular biomarkers or DNA sequences of pathogens, aiding in early and precise pathogen detection.

Understanding the target site for nanoparticle application is crucial as it determines the efficacy and specificity of the treatment. Nanoparticles can be engineered or formulated to target specific sites, delivering antimicrobial or diagnostic agents precisely where they are needed, thus enhancing their effectiveness in managing plant pathogens.

Conclusion
The utilization of nanoparticles in the management of plant pathogens marks a significant leap forward in agricultural science. This innovative approach offers a multifaceted and targeted strategy to combat various diseases that plague crops, thereby revolutionizing plant disease management. Through their unique physicochemical properties, nanoparticles serve as versatile tools deployed across different applications and target sites within plants, exhibiting remarkable efficacy against a spectrum of pathogens.

Nanoparticles, whether in the form of silver, copper, zinc oxide, or carbon-based variants like graphene oxide and carbon nanotubes, present diverse mechanisms of action. These encompass antimicrobial activity, disruption of cellular structures, and targeted delivery systems for specific compounds. Such capabilities allow for tailored treatments, mitigating pathogen proliferation while minimizing environmental impact and reducing reliance on conventional chemical interventions.

Moreover, the ability of nanoparticles to precisely target pathogens at various sites within plants be it the foliar surface, root zone, internal plant tissues, or even pathogen-specific biomarkers underscores their versatility and effectiveness. This targeted approach not only minimizes collateral damage to non-pathogenic organisms but also enables early and accurate disease detection through nano-sensing technologies.

However, while the potential of nanoparticles in plant disease management is promising, challenges persist. Concerns regarding nanoparticle stability, environmental impact, long-term effects on ecosystems, and potential toxicity demand rigorous scrutiny and continuous research. Collaborative efforts between scientists, policymakers, and stakeholders are imperative to address these challenges and pave the way for responsible and sustainable nanoparticle utilization in agriculture.

In conclusion, nanoparticle-based interventions represent a frontier in modern agriculture, offering tailored and effective solutions for combating plant pathogens. The ongoing advancements in nanoparticle technology hold immense promise in bolstering global food security, ensuring healthier crops, and fostering sustainable agricultural practices for a better future.

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EXPLORING THE DIVERSE VARIETIES OF QUAIL

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Abstract
Quails, a unique and diverse group of birds, have made a significant impact on the poultry industry. Their introduction to India in the 20th century brought forth various species, with Japanese and Bobwhite quails gaining popularity in domestication. These birds have not only offered a source of meat and eggs but have also enriched the world of aviculture, with button quails finding their place in aviaries. The Bobwhite quail is well-known for its distinct "bob-white" call and is a primary game bird in the southern and eastern United States. Button quails are favored for their adaptability and suitability for aviaries, while Japanese quails are known for their adaptability to different enclosures. The classification of Japanese quails includes several varieties from the United States and India. CARI in Izatnagar, India, has contributed to the development of improved quail varieties, catering to various poultry-related needs.

Introduction

Quails are small birds belonging to the Pheasant family with a rich history. They were first domesticated in Japan in 1595 and later introduced to India in 1974, originating from California. In India, two significant species exist: the black-breasted quail found in jungles and the brown-colored Japanese quail. These birds are known by different names in various Indian languages. Quails have gained recognition globally and are classified into several types, with Japanese and Bobwhite quails being the primary domesticated varieties.

Bobwhite Quails

The Bobwhite quail is the most common and notable species, recognized for their distinctive "bob-white" call. They hold the title of the top game bird in the southern and eastern United States and thrive in habitats like brush, fields, woods, and eastern Rocky Mountain areas. Remarkably, these birds have extended their range beyond the United States and can also be found in Canada and Mexico.

Button Quails

Button quails, originally from Southeast Asia, Australia, and Africa, are the most commonly kept quail species. They are known for their adaptability to outdoor aviaries and their habit of foraging for seeds on the enclosure floors. These quiet and affable birds are known to perch on branches and take dust or sand baths for cleanliness. Their compatibility with other aviary dwellers makes them suitable for various enclosure sizes.

Japanese Quails

Japanese quails are prevalent in East Asian habitats and have been discovered by quail farmers due to their substantial numbers. While they prefer grassland environments, their adaptability extends to enclosures with sand for dust baths and bushy branches for camouflage.

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California Quails

California quails are well-suited to California's diverse habitats, including chaparral, coastal sagebrush, and high desert areas. They are known for their skittish behavior, moving in groups and producing a distinct "chi-ca-go" call. These birds maintain a primarily vegetarian diet, consuming seeds, flowers, leaves, and birdseed from convenient sources. They are also opportunistic feeders, consuming mites, beetles, and caterpillars. In arid habitats, they obtain moisture from insects and water-containing vegetation.


Bobwhite quail


Button quail


Japanese quail


California quail

Varieties of Japanese Quails

Japanese quails were initially employed in Japan for both egg and meat production, leading to their name. Their scientific name is *Corturnix corturnix japonica*, and they have a broad distribution in Europe, Asia, and Africa as migratory species. While they were initially raised as pets or singing birds, their popularity in meat and egg production grew by 1900. In the United States, Japanese quails exhibit a range of varieties, including Texas, English white, golden range, red range, Italian, Manchurian, Tibetan, Rosetta, Scarlett, roux dilute, and golden tuxedo. In India, you can find the White Breasted Japanese Quail, the White line of Japanese quail, and the Golden line. Among these, five important varieties stand out:

1. **Pharaoh:** Exhibiting a mixture of feather colors with black and predominant brown, the males have a rusty brown face and throat, while the upper breast is cinnamon. In females, the face, throat, and upper breast are light cinnamon with black, while the lower breast is tan.
2. **British Range:** A dark feather-colored variety in which both males and females share a similar pigmentation, also known as Rosette. They exhibit a lighter orange/tan color throughout their bodies and are sometimes referred to as American Range in the UK.
3. **English White:** This variety features white feathers with dark eyes, and most individuals have black or brown spotting.
4. **Manchurian Golden:** These birds have golden to wheat straw-colored feathers with brown stripes, primarily caused by a single dominant gene for yellow. The gene can be lethal if homozygous, and there are light and dark variations of Manchurian.
5. **Tuxedo:** A bi-color variety with a white ventral surface, including the neck and face, and a black remaining body. This pattern results from a combination of chocolate and recessive white genes. Additional varieties, including Dark British Range and Roux quail (Dilute), are also present.

Pharaoh **British Range** **English White** **Manchurian Golden** **Tuxedo**

New Varieties

CARI in Izatnagar has developed and maintained several improved quail varieties, including CARI Uttam (broiler), CARI Pearl (white egger), CARI Ujjwal (white breasted), CARI Sweta (white feathered), CARI Brown (brown feathered), and CARI Sunheri (brown feathered, white breasted). Each of these varieties has specific characteristics related to body weight, egg production, hatchability, and daily feed consumption, making them suitable for various poultry-related needs.

Varieties	Developed from	Body weight	Daily Feed Consumption
1. CARI Uttam	Pharaoh	240 gms	26-28 gms
2. CARI Pearl	White Breasted Brown	140 gms (285-295 eggs)	25 gms
3. CARI Sweta	English White	160 gms	25 gms
4. CARI Ujjawal	Tuxedo	175 gms	25-28 gms

Conclusion

The diverse varieties within Japanese quails, both in the United States and India, demonstrate the adaptability and versatility of these birds. CARI's contributions have further advanced the development of improved quail breeds to meet specific poultry requirements. In summary, quails, with their fascinating history, varied species, and utility in meat and egg production, continue to be a valuable asset to the poultry industry.

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WHY NEED FOR OPTIMIZING FERTILIZER USE TO SUSTAIN SOIL HEALTH?

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"*If we pollute the air, water and soil that keep us alive and well, and destroy the biodiversity that allows natural systems to function, no amount of money will save us.*"
~ David Suzuki, environmental activist

"Healthy soil is the foundation for profitable, productive, and environmentally sound agricultural systems. Soil is a complex ecosystem where living microorganisms and plant roots bind mineral particles and organic matter together into a dynamic structure that regulates water, air, and nutrients. In an agricultural context, soil health most often refers to the ability of soil to sustain agricultural productivity and protect environmental resources. A healthy soil provides many functions that support plant growth, including nutrient cycling, biological control of plant pests, and regulation of water and air supply. These functions are influenced by the interrelated physical, chemical, and biological properties of soil, many of which are sensitive to soil management practices. Benefits of healthy soil translate into better plant growth, pest control, nutrient optimization, and adequate supply of essential water and air".

Fertilizers are added to crops in order to produce enough food to feed the human population. Due to the inappropriate use of mineral fertilizers (i.e. when used in both excess or deficiency), mostly concerning nitrogenous and phosphate, many productive soils have been thwarted in their ability to function, as shown not only by chemical indicators but also by physical and biological ones. High-yielding seeds required increased use of fertilizers and their application, which was positive in the short term but started to show disadvantages over a period of time. Thus, improper fertilizing technology might have a negative effect on soil health and soil-related ecosystem services. Imbalanced use of chemical fertilizers can alter soil pH, and increase pests attack, acidification, and soil crust, which results in a decrease in soil organic carbon and useful organisms, stunting plant growth and yield, and even leading to the emission of greenhouse gases. Soil pH started increasing due to the use of alkaline chemicals and led to an increase in heavy metals in the soil. Increased toxicity destroyed beneficial pathogens, and a decrease in the yield was due to a decline in the fertility of the soil. The golden period lasted for around thirty years before crop yields became stagnant and started dropping in the mid-1990s. The impact on environmental pollution from excessive fertilizer use also led to soil and water acidification, contamination of water, and increased greenhouse emissions.

Even after all this time, farmers in agrarian states still look at fertilizers as urea and phosphates. Their knowledge of fertilizer application is limited to nitrogen, phosphorus, and potassium. Unscientific use of NPK continues to have a detrimental impact on nutrients in the soil and has led to reduced crop yields across the country. The problem is a vicious cycle, and to counter the

decreasing yields, farmers continue to pump nitrogen and phosphorus into the soil, leading to further degradation. Part of the problem lay with the policy on highly subsidized urea. The almost three fourths of its price subsidized resulted in overuse and continues to alter the soil chemistry even today. Soil health remains an area of concern for the government and it is putting in efforts and investment to arrest soil degradation and decline in fertility.

Losses due to over uses of chemical fertilizers

Decreased response of crops to fertilizers

Soils in agro-ecosystems should be able to supply a certain minimum level of plant-available N and other essential nutrients at different growth stages of crop plants. In principle, the concept of optimum fertilization aims at a dynamic balance between nutrient requirement to obtain high yields and nutrient uptake by crops. This is achieved by maintaining synchrony between nutrient demand of the crop and the supply of nutrients from all sources including fertilizer and soil throughout the growing season of the crop. Application of optimum doses of all nutrients is important, but due to fundamental coupling of C and N cycles, optimization of fertilizer N management is more closely linked to build-up of SOC and soil health. When N inputs are below the optimum rate at which maximum yield is obtained, applied N stimulates crop growth, increasing crop residue inputs to the soil and thereby increasing SOC. Additionally, when fertilizer N inputs are above the optimum level, added N imparts no change in crop residue production but increases residual inorganic N, which alleviates microbial N limitation and thereby enhances mineralization of SOC. However, crop response to N fertilization is site-specific because there exists large spatial and temporal variability in soil N supply, which is in part due to historical differences in management. Regional blanket fertilization recommendations cannot account for this variability. Thus, site-specific nutrient management strategies based on principles of synchronization of crop N demand with N supply from all sources including soil and fertilizer N can ensure high yields along with maintenance of soil health. These can not only account for site-to-site variability in optimum fertilizer rate but also resolve uncertainty regarding response of SOC build-up to fertilizer application.

Nitrogen fertilization can increase crop yields and N uptake compared to without N fertilization. It is not unusual to achieve higher crop yield with increased N fertilization rate due to increased soil N availability. Crop yields, however, can remain at similar level or decline with further increase in N rates after reaching the maximum yield. Sainju and Alasinrin (2020) observed that annualized grain and biomass yields of barley and pea (*Pisumsativum* L.) and their C content maximized at 80 kg N ha^{-1} and then declined, as N rate increased to 120 kg N ha^{-1}. Similarly, malt barley yield and N uptake increased from 0 to 40 kg N ha^{-1} and then declined with further increase in N rates in no-till and conventional till malt barley-fallow rotation.

Soil health deterioration

Chemical fertilizer overuse can contribute to soil acidification and soil crust, thereby reducing content of organic matter, humus content, beneficial species, stunting plant growth, altering pH of the soil, growing pests, and even leading to the release of greenhouse gases. Over-use of chemical fertilizers leads to soil acidification because of a decrease in organic matter in the soil. Nitrogen applied to fields in large amounts over time damages topsoil, resulting in reduced crop yields. Sandy soils are much more prone to soil acidification than clay soils. Clay soils have an ability to buffer the effects of excess chemical fertilization. Another increasing concern is that incessant use of chemical

fertilizers on soil depletes essential nutrients. As a result, the food produced in these soils have less vitamin and mineral content. According to data produced by the U.S. Department of Agriculture Nutrient Data Laboratory, foods grown in soils that were chemically fertilized were found to have less magnesium, potassium and calcium content.

Clay soil buffers excess chemical fertilization better than others

Increasing chemical fertilizers can deplete the soil of essential nutrients

Soils containing higher concentration of acids such as hydrochloric and sulfuric acids, creates a damaging effect on soil referred to as soil friability. Different acids in the soil dissolve soil crumbs, which help to hold together the rock particles. Soil crumbs result from the combination of humus, or decomposed natural material such as dead leaves, with clay. These mineral-rich soil crumbs are essential to soil drainage and greatly improve air circulation in the soil. As the chemicals in chemical fertilizers destroy soil crumbs, result is highly compacted soil with reduced drainage and poor air circulation and this can upset the health of plants.

Nutrient imbalances

The NPK consumption ratio increased to 8.2:3.2:1 in 2013-14 as against recommended ratio of 4:2:1 (Dwivedi, 2017). The situation was grimmer in major agricultural states like Punjab and Haryana where NPK ratios were as high as 31.4:8:1 and 27.7:6.1:1, respectively (GOI, 2016). Though it has improved to 6.1:2.5:1 in 2017-18, it does not necessarily imply that usage of NPK fertilizer in agriculture has come down (Vishandass, 2019). Imbalanced use of N, P and K leads to loss of soil fertility over a period of time, which affects efficiency of fertilizer use and crop productivity. Imbalanced use of fertilizer without soil testing is creating a hazardous health impact both to soil and human. Poor soil health significantly affects small and marginal farmers who often lack the education or resources to make the best management decisions for their soils (Testen et al., 2018). In a 16-year long-term field experiment, Chu et al. (2007) observed that balanced application of N, P, and K fertilizers had a higher microbial biomass and activity than in the P- and N-deficient treatments. Balanced fertilization resulted in higher dehydrogenase activity than under nutrient-deficiency fertilization. In a 33-year long-term experiment in a brown soil in China, long-term N and P, as well as N, P, and K, fertilizer application treatments exhibited greatly increased soil microbial biomass C and dehydrogenase activity compared to in the only N treatment (Luo et al., 2015). Similarly, in a 21-year long-term experiment, Zhong et al. (2010) observed that balanced fertilization with N, P, and K promoted the soil microbial biomass, activity, and diversity and thus enhanced soil health, crop growth, and production. In a wheat-maize cropping system in a fluvo-aquic soil in the North China Plain, Gong et al. (2009) reported that balanced application of N, P, and K fertilizers for

18 years showed higher C and N contents of the light and heavy fractions, as well as more culturable microbial counts, than in unbalanced N and P, P and K, or N and K fertilizer treatments (Rahman et al., 2012). The problem is more severe in intensively cropped regions where farmers use excessive nitrogen fertilizer to attain yield levels harvested earlier with less fertilizer (Singh et al., 2013; Dwivedi, 2017).

Effect on microbial organisms

Use of mineral fertilizers over time decreases the numbers of naturally occurring bacteria and fungi, as well as worms, found in soil is a serious problem to plants, which depend on these organisms for proper development. One of the many negative effects of excess fertilizers has to do with the depletion of beneficial organisms. Many chemicals used to protect crops from harmful pests often kill beneficial insects. Changes of soil pH adversely affects the health of naturally found soil microorganisms. These altered levels of acidity in the soil eliminate microorganisms that are beneficial to plant and soil health as they help to increase the plants' natural defenses against pests and diseases. These helpful microorganisms consist of antibiotic-producing bacteria and mycorrhizal and other fungi, which are found in healthy soil. Also, the overuse of chemical fertilizers jeopardizes health of bacteria that fixes nitrogen balance in the soil. Over-fertilization reduces the biodiversity resulting from ammonia deposition in forests and waters. High N fertilization reduces mycorrhizal root colonization and inhibit symbiotic N fixation by rhizobia.

Bearing additional financial burden to farmers and Government

Fertilizer prices have been rising globally due to supply snags, production woes, and more recently the war, which has disrupted trade with Russia, a big supplier of every major type of crop nutrient. The surge in fertilizer costs is threatening to stoke food inflation assuming farmers continue to cut back and crop yields suffer. Over application and increasing cost of chemical fertilizer increases cost of production and thereby reducing farmers net profit. Urea is being provided to the farmers at a statutorily notified Maximum Retail Price (MRP). The difference between the delivered cost of fertilizers at farm gate and net market realization by the urea units is given as subsidy to the urea manufacturer/importer by the Government of India. As far as phosphatic and potassic (P&K) fertilizers are concerned, Government is implementing Nutrient Based Subsidy (NBS) Scheme w.e.f 1.4.2010. Under this scheme, a fixed amount of subsidy decided on annual basis, is provided on each grade of subsidized P and K fertilizers depending upon its nutrient content. The subsidy is given by Government of India to the P & K fertilizer companies which are therefore able to provide fertilizers to the farmers at a subsidized MRP, which is lower than it would have been. Accordingly, farmers across the country who are procuring fertilizers at MRP, is availing the benefit of subsidy. The fertilizer rally is increasing their fiscal burden. India, which relies heavily on fertilizer imports, is set to spend about $20 billion to shield farmers from higher prices, up from about $14 billion budgeted in February, 2022.

Ways to overcome the issue

- **Use of SHC for applying correct doses**: Soil Health Card (SHC) assessment provide soil nutrient status of land holding of each farmer and advise corrective dosage of major fertilizers, micronutrient and soil amendments to maintain soil health and obtain a better yield. A group of farmers under United States Department of Agriculture (USDA) developed a soil health monitoring tool named Soil Health Card (SHC). It is simple and effective

extension tool for soil health monitoring. To protect soil health and for sustainable agriculture, the Government of India also launched similar type of SHC scheme in the year 2015. This SHC scheme carries crop wise recommendation of nutrients and fertilizer required for the individual farms.

- One approach of tackling this issue is increasing legislature and regulations. Laws and regulations should target reducing the runoff of fertilizers, finding ways to curb erosion, and potentially even altering the composition of fertilizers to make them eco-friendlier.
- An additional potential way to reduce overusing fertilizers is exploring genetically modified crops. If scientists can engineer crops that can grow with less nutrients and fertilizers, would this be acceptable?
- Organic products have been on the rise, as of lately. The practice of organic agriculture, which uses few pesticides, fertilizers, or genetically modified organisms. The organic approach would suggest using organic fertilizers, such as compost, as opposed to inorganic fertilizers.
- Use of organic fertilizers is better, although, these are also not without risk, but their slow release of nutrients is beneficial to building a healthy soil environment and decreasing the hazard of runoff into nearby lakes and streams.
- Applying fertilizers in the proper amount, at the right time of year and with the right method can significantly reduce how much fertilizer reaches water bodies.
- Keeping animals and their waste out of streams keeps nitrogen and phosphorus out of the water and protects stream banks.
- Organic farming methods are not the only example of sustainable nutrient management: agro-ecological approaches, including conservation, low-input, and minimum tillage agriculture, are all recognized as “nature-positive” and regenerative practices.
- Educating and training farmers on good management practices is one of the most important approach.
- Financial incentives and political buy-in will be necessary to overcome the many obstacles in the way of nitrogen-light farming methods.

Summary

If managed properly, fertilizers and animal manures benefit crop production without causing soil health problems. In any management scenario, the manager must be aware of the possible negative consequences of mismanagement. The optimum use of fertilizers (N, P, K) offers a triple win – for the economy, for human health, and for the environment.

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PELAGIC SEA PIKES OF GUJARAT

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INTRODUCTION

India is a leading nation in the Indian Ocean region in marine fish harvest from the wild with an estimated production of 3.49 million tonnes (CMFRI, 2023). Marine fisheries sector in India accounts for more than 40% of its total fish production essential in supplying protein-rich food to the country's population at a reasonable cost, and generates lucrative foreign exchange earnings through seafood export (CMFRI, 2023).Gujarat evolves as one of the five major fish producing states in the country (HoFS, 2022). The state is naturally gifted with abundant marine fishery resources with a 1600 km of long coastline, 2.00 lakh km^2 of the Exclusive Economic Zone (EEZ) and1.64 lakh km^2 of continental shelf area. Gujarat was always a top producer of marine fishery resource in the past few years but recently in the year 2022 the state has shifted to fourth position in the marine fish harvest with a landings of 5.03 lakh tonnes. Pelagic resources contributed 38% of the landings in the state followed by demersal (28%) and crustaceans (28%) resources. Mechanized sector contributed highest share followed by motorized and non-motorized (CMFRI, 2023).

Family Sphyraenidae is a well-defined group commonly known as Barracudas or Sea Pikes due to their elongate form with a projecting lower jaw resembles as pike and voracity, is comprised of a single genus *Sphyraena* with 26 valid species reported globally (Fricke *et al.,* 2023). In India, eleven species namely *Sphyraenaacutipinis, S. barracuda, S. jello, S. putnamae, S. qenie, S. fosteri, S. obtusata, S. flavicauda, S. chrysostaenia*, *S. helleri* and *S. arabiansis*have been reported (Rajesh *et al.,* 2020; Abdussamad *et al.,* 2015). Similarly in Gujarat, five species namely *S. obtusata, S. jello, S. barracuda*, *S. acutipinnis* and *S. putnamae*have been documented (Azeez *et al.,* 2021).They are widely distributed in all equatorial, tropical and warm temperate seas and are highly carnivorous and voracious predator holding an important position in the marine food web as apex predators. They are reported to inhibit at varying depths ranging from 5 to 200 m. Their stream lined body indicating swift swimming ability reaching up to 12 m/sec. These fishes are mostly pelagic, live solitary or in schools and are capable of adaptation to diverse ecological condition (Akadje *et al.,* 2013; Allam *et al.,* 2004; Senou, 2001; Whitehead *et al.,* 1986; De Sylva, 1963).These fishes are exploited by various fishing gears such as trawl nets, gillnets, outboard ring seines and purse seines (Meshram *et al.,* 2022). In Gujarat, multiday trawlers account for nearly 75% of the barracudas landed followed by outboard gillnetters (Azeez *et al.,* 2021).

STATUS

The landings of barracuda in India has increased from 11,410 tonnes to 43,309 tonnes in the past three decades (1993-2022) (Figure 1). The all-time high landings of barracuda was reported in 2018 (46,370 tonnes). The landings in 2022 has showed an increase of14.73% compared to previous year 2021 (CMFRI, 2023; CMFRI, 1995). In Gujarat, barracudas are one of the most important resources contributing around 9% of the large pelagic resources of the state. The average production of the

group during 2010-2019 was 3,259 tonnes. Fifty percent of the barracuda landings in the state was comprised of *Sphyraenaobtusata* and *Sphyraenajello,* apart, several other species such as *S. barracuda*, *S. putnamae* and *S. acutipinnis* also form a part of barracuda landings in the state (Azeez *et al.,* 2021). The barracudas are locally called as *Jeeri, Jeera*or *Mal Jeera* in Gujarati language.

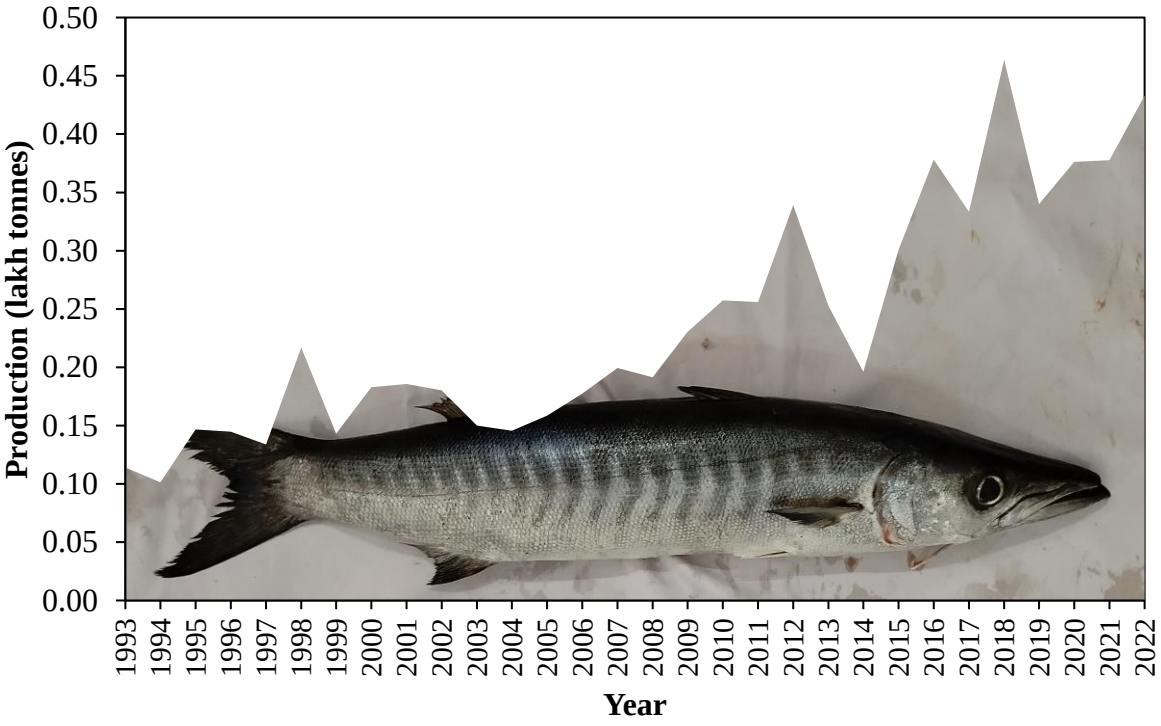

Figure 1. Three decadal landing trends of barracuda along the Indian coast (1993-2022)

1. TAXONOMIC CLASSIFICATION

Kingdom: Animalia
Phylum: Chordata
Class: Teleostei
Order: Carangaria
Family: Sphyraenidae
Genus: *Sphyraena*

Barracudas are generally distinguished by their long, pointed heads and their pike-like appearance. Mouth with large, sharp, flattened or conical teeth of unequal size on jaws and palatines. Gill rakers, if present, as short spinules, 1 or 2 at angle of gill arch; in some species, as platelets with or without distinct spines and their two dorsal fins widely separated. Pectoral fins are short (shorter than head) and caudal fin is forked. Lateral line well developed, nearly straight; scales cycloid (smooth to touch). Color of barracudas are usually grey to blue above, with silvery reflections, lighter to white below. Body sometimes with vertical or oblique bars or chevrons. Some species have longitudinal yellow or orange stripes or dark blotches (Morishita *et al.,* 2020;Senou, 2001;Fischer and Bianchi, 1984).Six species are part of one group that lacks gill rakers and has a comparatively large body size: *S. barracuda*, *S. forsteri*, *S. arabiansis*, *S. putnamae*, *S. jello* and *S. qenie* (Morishita *et al.,* 2020). Of which, *Sphyraenaputnamae* Jordan & Seale, 1905commonly called sawtooth barracuda has been

identified based on their 17-20 dark chevron patches crossing lateral lines (Figure 2), oblique in upper half and almost vertical in lower half, no gill rakers on first gill arch, second dorsal fin last ray elongated compare to penultimate ray and caudal fin forked and largely blackish without white tips from the Gujarat waters. (Morishita *et al.,* 2020; Fischer and Bianchi, 1984). The species has been listed earlier by Azeez et al. (2021) in the landings of large pelagics of Gujarat but no detailed description was provided.

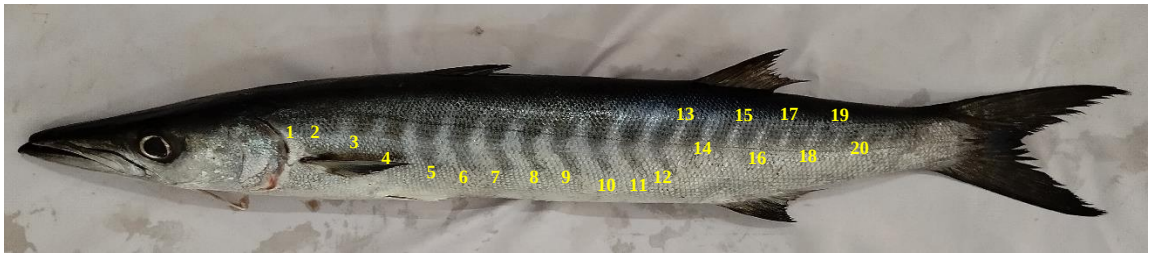

Figure 2. *Sphyraenaputnamae* collected from Veraval fish market, Gujarat

In recent years, the landings of *S. putnamae*, particularly in the trawl fishery have observed in Gujarat contributing to the barracuda resource of the state. *S. putnamae* is distributed widely in the tropical waters of the Indian and the Pacific Oceans and prefers to be near shore in lagoons, bays and reefs and are known to move in shoals (Senou, 2001). It is a nocturnal predator, that individually search for prey at night and moves in a group during the day (Senou, 2001; Schultz, 2019). The species feeds on wide variety of prey groups such as sardines, whitebaits, carangids, silverbellies, ribbon fish, flying fish, threadfin breams, goatfishes, eels, sciaenids, pufferfish, flatfish, barracudas, non-penaeid shrimps, squids and cuttlefish (Ghosh *et al.,* 2022). The species spawns during April to May and November to January (peak) (Rajesh *et al.,* 2020).

ECONOMIC IMPORTANCE

Barracudas are commercially important pelagic fishes and highly relish food resources (Meshram *et al.,* 2021).The price of the species ranges from 90-150 Indian rupees per kg depending upon the size and type of species. They are either consumed locally (domestic market) or exported in international market. The major foreign market of barracuda from India is France, United Kingdom and Netherlands (Volza, 2023).Barracudas are also used for preparation of fishmeal, which is further used as a feedin poultry and aquaculture industry (Chandrasekar *et al.,* 2017).

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EMPOWERING WOMEN IN THE FLORICULTURE INDUSTRY: BLOSSOMING POTENTIAL AND GROWTH

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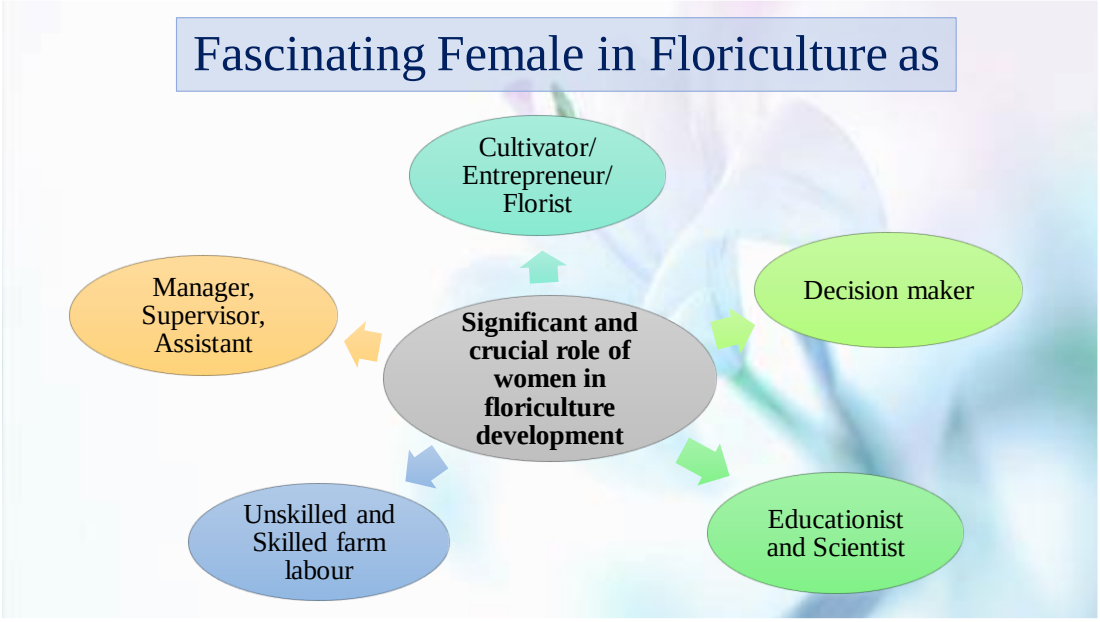
Abstract
Floriculture is considered a high-income agricultural sector and can potentially be used as a tool for socio-economic development. Our society depends on the use of flowers in various forms to perform our basic rituals. The domestic demand for fresh cut flowers, dried flowers, bouquets, flower crafts, corsages, buttonholes is increasing day by day and the government is encouraging women to take up floriculture on a commercial basis; floriculture has become a tool for women's empowerment. In our country, 65% of the total workforce is engaged in flower growing. To date, women are involved in almost all activities in floriculture, from pre-processing to harvesting, storage and marketing of flowers. Establishing flower gardens could also pave the way for women's livelihood and sustainable income. The added value of floriculture increases the economic value of floriculture products and the attractiveness of consumers and acts as a link between farmers and consumers. Women can start small businesses in flower handicrafts such as bouquets, garlands, boats, flower arrangements in containers, dry flower making etc. on a small scale, who have good opportunities to earn and improve their livelihood.

Keywords : flowers, women empowerment, floral crafts, business

INTRODUCTION

Floriculture is a high-income agribusiness and can potentially be used as a tool for socio-economic development in India. Many support networks have been developed by government agencies and non-governmental organizations to provide training, planting materials and infrastructure services to women growers. Women growing flowers in rural areas had the opportunity to interact with the outside business community and traders; They no longer dare to approach state officials and non-governmental organizations on behalf of their village to negotiate support for sustainable development projects. In addition, women learned to market value-added floral products (wreaths, bouquets, etc.) locally and near cities during festivals, cultural ceremonies and religious events. The goal of the government was to develop the floriculture industry as a source of income for the unemployed women of the country. Therefore, many unemployed women and housewives start small flower gardens. Compared to other crops, the income per unit of land is higher in flower gardens. The flower industry made the poor rural women more mobilized as a group to carry out various activities such as dairy cooperatives, savings and credit, floriculture groups, garden groups, etc. Small-scale flower cultivation in the countryside definitely gave energy and strength. Tribal women to improve their livelihood, economy and local ecology. The use of flowers in the country is increasing as the standard of living of Indians increases and flowers are used in many life events such as greetings, weddings and funerals as well as religious functions, mostly in the Buddhist and Hindu faiths. Most of the perfumes used in the world come from jasmine and rose oil, in addition, flowers play an important role in human life by improving the environment and symbolizing

emotions. Even with the best post-harvest techniques, the beauty and freshness of cut flowers will last only a few days, but the charm of dried flowers and leaves can be preserved for months to years at a lower cost if protected from damage caused by high humidity. It is mostly practiced by the poorer tribal women of western India. The mastery of floriculture is a low input, high output job that requires a lot of creative and artistic skills and long hours of persistence and thorough participation. Here, women can play a bigger role, moreover, these handicrafts are small industries that women can handle at home along with family responsibilities. Projects involving dried flowers and dried flower products can be very well received by rural women.



EXPLORING ENTREPRENEURIAL OPPORTUNITIES FOR WOMEN IN FLORICULTURE

- FLORICULTURE NURSERY
- FLOWER PRODUCTION
- LANDSCAPING ARCHITECTURE
- FLORIST SHOP
- FLOWER ARRANGEMENT
- DRY FLOWER & FLORAL CRAFT

1. **Role of women floriculture nursery :** Women are actively involved in the propagation and cultivation of flowers and plants. This includes tasks such as sowing seeds, taking cuttings, planting seedlings and caring for plants during their growth cycle. Many women play a role in the marketing and sales of nursery products. Some women working in floriculture engage with local communities through events, flower shows and garden clubs, promoting the community and sharing their knowledge**.**
2. **Role of women in flower production :** Women actively participate in the planting, care and maintenance of flower crops. Women often handle tasks such as weeding, pruning and pest control to ensure healthy plant growth. They are responsible for sorting and grading flowers according to size, color and quality, which is essential for market acceptance. They can also participate in activities such as washing, cutting, packing and preservative treatment of flowers to extend their shelf life.
3. **Role of women in landscape architecture**: Women in landscape architecture have contributed to the planning and design of various outdoor spaces, including parks, gardens, university campuses, urban landscapes and recreation areas. They bring their own unique perspectives to these projects, often emphasizing sustainability, community engagement and ecological restoration.
4. Women work as florists: The flower business is not gender specific and anyone who is passionate about flower arrangements and creative in flower arrangement can succeed in this industry. They can work as floral designers, creating beautiful and artistic floral arrangements for various occasions such as weddings, funerals, birthdays and special events. Some women with floristry backgrounds may choose to become event or wedding planners and incorporate their knowledge of floral design into their arrangement services.
5. **The Role of Feminine Flower Arrangement:** The focus is on the "lot of many flowers" in an Eastern/Western flower arrangement. A good knowledge of traditional styles lays the foundation for learning the basics of floral arrangements. In business, this has been realized in various flower bouquets, such as round or triangular baskets, balls, cascades, hand bouquets, etc., in which women play an important role either as entrepreneurs, teachers or flower sellers. Japanese ikebana is a creative art that brings the charm and beauty of landscapes, coastlines or lakeshores indoors. Female ikebana experts are highly paid for designing ikebana in five-star hotels and for weddings or special events, and are also involved in teaching the technique at ikebana schools.
6. **Dried flowers and flower crafts for women:** Dried flowers, flower parts and designs can be collected from natural sources of some flowering plants such as dahlias, marigolds, jute flowers, wild roses, wild lilies, helichrysum, lotus shoots, etc. The demand for dried flowers is growing at an impressive 8-10% and hence there is a lot of scope for Indian entrepreneurs. Dried flower products such as bouquets, cards, rugs, landscape frames, garlands, pomanders, etc. are also popular in the market. Potpuri constitutes a significant part of the export of dried flowers. The exclusive "Potpourrie", which is made from a dried flower with an added fragrance as an attractive room freshener, is very popular all over the world. Previously considered a woman's art and a grandmother's skill, it has now become a successful business with great export potential.

7. SUCCESS STORIES

Conclusion

Development of awareness among the youth and rural women about dehydration of flowers and preparation of value added dried ornamental products are very much essential at this juncture.

At this stage, it is very important to raise the awareness of young people and rural women about drying flowers and making dried decorative products with added value. The dried flower industry is big business that cannot suffocate small and medium-sized entrepreneurs - because the market is all about creativity and local knowledge. This gives a huge potential for small and medium enterprises to sell products in India. More important is the promise that this sector holds for rural women's employment. It will help increase the influence of women in rural areas by providing them with small-scale industries for livelihood. Artisan flower making is ideal for making dried flowers, decorating flowers, making flower bouquets, dried flower frames and accessories, and potpourri made from ornamental plants. A recent project to increase livelihoods and empower women. Women's groups can work with small processing companies to create new markets for valuable floriculture products.

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INTEGRATING NUCLEAR AND ISOTOPIC TECHNIQUES WITH PRECISION AGRICULTURE TO ADVANCE SOIL-WATER MANAGEMENT AND CONSERVATION

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Abstract
The purpose of this article is to provide an overview of the development and application of nuclear and isotopic techniques (NITs) in soil and water management and conservation in agro ecosystems and identify potential areas where the use of precision agriculture (PA) technologies can further improve NITs' efficacy in soil and water management, leading to innovative research and technologies that are specific to soil and water. NIT uses in soil and water research, however, can also improve PA. In order to address current and future concerns connected to soil (land) and water management/conservation in agricultural research, this article addresses NITs alone. This article is not a full examination of PA; rather, it only focuses on NITs as the fundamental informational building blocks for PA.

Keywords : Nuclear, Isotopic Techniques, Precision Agriculture, Soil-Water Management

Introduction

Increasing food security and maintaining environmental sustainability, particularly the preservation of a natural resources base (soil and water) and genetic resources (plant and animal resources), present the globe with a hitherto unheard-of dual task. By 2050, the current global population of 7 billion people will surpass 9 billion (UN-DESA 2013). The majority of this population growth will take place in developing and poor nations where there is already a food scarcity. To put it simply, to feed the expanding human population, the agricultural production that is currently being used will need to improve by 60%. There are currently 1.9 billion hectares of degraded soil in the world, and that number is growing at a rate of 5 to 7 million hectares annually. In addition to productivity loss and biodiversity loss, this soil and land degradation also has an influence on crucial soil/water ecosystem services, all of which are inextricably tied to long-term social, economic, and environmental effects. Additionally, a number of environmental factors can have an impact on water and land resources. Among these, climate change and variability have a significant impact. All of these are probably going to have detrimental effects and cause changes to agro-ecosystems, increasing the pressure on finite water and land resources to provide enough food for the present and future generations.

Combining soil, nutrient, and water management techniques that increase crop output while also fostering environmental sustainability is necessary for sustainable agricultural development. The most strategically significant concerns of managing and conserving soil/land and water in agro-ecosystems are addressed in this context by high-quality research and soil water-specific technology.

The purpose of this article is to (1) provide an overview of the development and application of nuclear and isotopic techniques (NITs) in soil and water management and conservation in agroecosystems and (2) identify potential areas where the use of precision agriculture (PA) technologies can further improve NITs' efficacy in soil and water management, leading to innovative research and technologies that are specific to soil and water. NIT uses in soil and water research, however, can also improve PA. In order to address current and future concerns connected to soil (land) and water management/conservation in agricultural research, this article addresses NITs alone. This article is not a full examination of PA; rather, it only focuses on NITs as the fundamental informational building blocks for PA.

Application and Development of NITs in Agriculture

- **Use of NITs**

NITs, also known as nuclear-based techniques, involve the use of radioactive (radiation-emitting) and stable (natural abundance and enrichment by artificial labelling) isotopes as well as radiation sources including neutron and gamma density sensors. For instance, the soil moisture neutron probe (SMNP) is a piece of transportable nuclear technology used to track changes in soil water content in order to create field water balances and plan irrigation systems. Gamma density probes are used to monitor changes in soil bulk density brought on by agricultural management techniques including tillage and animal stocking rates.

In order to improve soil fertility, crop productivity, and water use efficiency in crop and livestock production systems, isotopes are used as tracers to provide unique, precise, and quantitative data on nutrient and water pools and fluxes in the soil-plant-water systems. They are also used to evaluate the relative value of various soil-water management technologies tailored to different agro-ecosystems. NITs can also be used to identify specific chemical sources and pollutants coming from these systems. For instance, nitrogen (N) processes like nitrification and denitrification, biological N fixation, N utilisation efficiency, and sources of N pollution in ground and surface waters can all be measured using 15N-stable isotopic techniques.

Nuclear-based approaches are an addition to non-nuclear conventional techniques, not a replacement for them. When they provide comparative advantages over traditional methodologies, they are used in the context of agricultural research in greenhouse and field settings. However, they need knowledgeable and educated staff as well as enough lab space, measuring tools, and methods, or else financial support for analytical services. Regarding radioactive isotopes, careful adherence to safety guidelines and radiation protective practises is necessary. Like all other approaches, nuclear-based ones offer benefits and drawbacks. Therefore, it is the responsibility of the research team leader to evaluate the value and efficacy of nuclear-based approaches in achieving specific research goals while taking into consideration the team's resources.

Relevant Developments in Agroecosystems for Soil-Water Management and Conservation Research

A programme of activities that promotes sustainable soil and water management and conservation is required to increase food security and lessen the effects of climate change. This section gives a brief overview of the NIT-based investigations that were conducted in the three primary project areas of sustainable crop intensification, conservation agricultural systems development, and sustainable land (soil)/water management/conservation.

Sustainable Intensification of Crop Production

Increased demand for both nuclear and nonnuclear methods to develop better water and nutrient management practises in both rainfed and irrigated agricultural systems results from intensification of agricultural production on prime agricultural land. This requires more refined management of external inputs of water and nutrients. Several CRPs were carried out in chosen agricultural systems of the major agroecological zones of the world, applying an integrated approach to soil, water, and nutrient management. The experiments included careful management of external inputs (nutrients and water) to increase soil productivity in agricultural systems and improve their use efficiency. NITs like 15N, 32P, and 35S isotopes can be used as tracers to create fertiliser management techniques (such sources, timing, and placement) customised to local conditions and particular cropping systems that increase nutrient usage effectiveness and boost soil fertility. Additionally, it was shown that one of the most important criteria for guaranteeing the productivity and sustainability of the cropping systems is the choice of crop genotypes best adapted to the local soil/climate conditions. These NIT research, which were originally aimed at finding crop genotypes with higher nutrient usage efficiency, have shown significant promise for helping with the breeding and selection of acceptable germplasm with tolerance to certain abiotic stresses (drought, flooding, low nutrient status, salinity, aluminium [Al] toxicity, etc.). Recent developments highlight the importance of nutrient recycling from on-farm organic resources (such as animal dung and crop leftovers) and BNF inputs in smallholder farmers' integrated crop-livestock production systems.

Integrated Nutrient Management

Numerous areas of land all throughout the world, notably those in the tropical and subtropical parts of Asia, Africa, and Latin America, feature acid weak soils with poor soil fertility that are primarily hampered by nutrient imbalances, especially low N and P status. Furthermore, due to the rapid drop in soil organic carbon (SOC), intensive farming practises and insufficient application of nutrient sources (both mineral and organic) can result in severe land degradation, low crop yields, severe food insecurity, and extreme rural poverty. The creation and application of an integrated nutrition management method can restore such detrimental effects of SOC depletion. In order to provide a variety of nutrients for plant growth and soil microbial activity, an integrated nutrient management package is developed using not only synthetic fertilisers but also natural sources of nutrients like phosphate rocks, BNF, animal and green manures, as well as crop residue recycling. These are crucial in increasing soil fertility, increasing land productivity, and boosting soil organic matter and biodiversity.

Agricultural Water Management

Therefore, it is crucial for both rainfed and irrigated agriculture to manage agricultural water to increase crop water productivity (more crops per drop) and water use efficiency in crop production systems. For each unit of water transpired, the marketable yield of the crop can be increased, all outflows (such as soil evaporation, drainage, seepage, and deep percolation) can be reduced, and the effective use of rainfall, stored water, and water of marginal quality can be increased. Due consideration should be given to the interactions between soil and water in agroecosystems and how they affect both food production and the delivery of crucial ecosystem services. As a result, it is anticipated that soil and water management and conservation for sustainable crop production will require more intelligence and the adoption of PA. In order to preserve water and increase its use efficiency on farms and produce more crops per drop of water in regions with limited water

resources, a paradigm shift from supply-driven to more demand-driven water management will be required. The storage of rainwater in the root zone is essential for plant growth in rainfed circumstances, necessitating integrated land-water management techniques. Studies by the IAEA using NITs and related methods have shown that there is a lot of room to increase crop output and water usage effectiveness in rainfed agriculture. This can be done by properly integrating soil-water-plant technical choices such conservation agriculture practises (like zero or reduced tillage, mulching, crop residue retention, crop rotation, and intercropping), water collection methods, and enhancing the fertility state of the soil. Appropriate crop management, such as using crop varieties adapted to drought and salty conditions, deep-rooted crops to access soil water storage at deeper soil depths, or early flowering and shorter season crop varieties, as well as adjusting sowing dates or planting densities to suit local conditions, can further improve rainfed agriculture systems.
Rainfed agriculture can reduce soil or water losses by using conservation farming techniques like no-till, minimal tillage, linked ridges, and mulching. The dangers of rainfed agriculture can be greatly reduced by creating on-farm water storage facilities or by establishing water conservation zones to give supplemental irrigation to crops wherever practicable. If the preseason rainfall predictions can be forecasted with anticipated results of various management initiatives, these risks can be decreased even more.

Development of Conservation Agriculture Systems

In order to increase crop yield for food security as well as to improve soil quality and increase its resistance against deterioration and hazards linked with climate change impacts, conservation agriculture (CA) refers to the sustainable intensification of agricultural production systems. This is accomplished through the use of best management practises, which include (1) strategic application of the necessary quantity and ratio of vital plant nutrients at the appropriate times to meet crop nutrient demand and minimise losses, (2) minimal mechanical soil disturbance through tillage/cultivation, (3) retention of crop residues (mulching), and (4) the use of crop rotations/plant associations, including cover/green manure crops. Over 100 million ha of such conservation techniques are presently used to improve the food security of small farmers in the developing world.

Improving Soil Organic Matter and Enhancing Soil Quality

The improvement of soil fertility and quality, as well as an increase in crop output, are all facilitated by increasing and maintaining soil organic matter (SOM), which also contributes to the long-term sustainability of agricultural ecosystems. As a sink for atmospheric CO2, increased SOM also contributes significantly to the global C cycle. When the above-mentioned CA practises are combined and used continuously over time, it is possible to increase soil C sequestration on agricultural lands, maintain and increase SOM levels, and provide ecosystem services that will improve crop production and contribute to environmental sustainability.

Greenhouse Gas Emissions and Mitigation Options Including C Sequestration

In relation to the three GHGs—nitrogen dioxide (N_2O), carbon dioxide (CO_2), and methane (CH_4)—agricultural soil emissions of N_2O have drawn a lot of attention. The primary contributing reasons for higher N_2O emissions into the atmosphere are increased and inefficient use of artificial N fertilisers, dairy manures, and irrigation water, as well as high stocking rates (number of grazing cattle per hectare) and intensive farming. Depending on how the land is used, soil can either be a

source or a sink of CO_2 emissions, while livestock and flooded rice systems can be significant sources of CH_4 emissions. Farm management methods that include increasing fertiliser and water usage efficiency, sequestering more carbon, regulating animal grazing, and improving soil fertility are all necessary components of a holistic strategy to mitigation that will reduce both N_2O and CO_2 emissions from farmlands (physical, chemical, and biological). Non-isotopic approaches cannot accurately evaluate the complex nitrogen cycling activities that take place at the soil-plant-water interface, including plant N use efficiency and uptake, soil retention, and losses to groundwater and the atmosphere. The relative relevance of these processes can be quantified and identified with the aid of NITs like 15N. For instance, strategic use of organic materials and chemical fertilisers (i.e., applying the appropriate amount of N at the appropriate time and in the appropriate manner) may result in increased nutrient usage efficiency.

Sustainable Soil and Water Management/Conservation

A plan of action that promotes sustainable land (soil) and water management and conservation at a regional (landscape and watershed scale) is necessary to increase food security and lessen the effects of climate change. To maintain the supply of ecosystem services and environmental sustainability, natural resources base land (soil) and water must be managed in an integrated manner.

Development of Integrated Approaches for NIT and PA Applications in Soil and Water Management/Conservation

Innovations in soil, water, and nutrient management (SWNM) in agroecosystems can be further achieved by developing and implementing integrated approaches using NITs and chosen PA technologies and tools, thereby reducing much of the guesswork and developing a more effective knowledge- and information-based management. In practise, this integration will entail (1) using NITs to create SWNM practises, followed by the use of an appropriate PA technology to target the data generated to a particular geographic position (site, location, zone, region), and/or (2) using PA technologies to create recommendations on SWNM based on already-existing agroexpert databases, followed by the calibration/validation of the recommended management practises in field tests using NITs. It is planned to employ models in both situations to further transfer the technology to the intended beneficiaries and end users.

Future Prospects : Key Challenging Issues

In addition to a variety of nuclear-based and traditional (nonnuclear) strategies, the creation of novel soil and water management in agroecosystems through integrated approaches includes the use of a platform of technology and instruments for precision agriculture. These latter ones call for the development of sufficient infrastructures to support the developed technologies, data processing and modelling, and the distribution of the outcomes to the intended recipients. The selection and characterization of the experimental sites, particularly with regard to soil, climate, and crop data, will be greatly improved by novel PA technologies (targeting location/site and time and collection of spatial and timeseries data). This will allow the use of models and the extrapolation of the information to similar areas. In order to integrate large and complex sets of data obtained under a variety of specific natural and agro ecosystems, their application in area-wide (watershed) studies for developing land (soil) and water conservation calls for the collection of geospatial data, creation of time series databases, spatial mapping and analysis, and application of advanced

models. The experimental data can also be used to evaluate and improve on current models and create decision support systems to help people make more informed choices about solutions for long-term land and water conservation. The use of these integrated techniques necessitates the creation of cross-institutional, multidisciplinary teams with the necessary knowledge and abilities, as well as the cooperation of all parties involved in PA and soil/water management/conservation. However, these actions will necessitate closer coordination, more strategic networking, the use of appropriate PA tools and technologies, and modern ICT, which will raise the overall cost and complexity of the research endeavours. The establishment of coordination and close collaboration with current national space agencies and regional centres for space science and technology functioning under the scope of UNOOSA is therefore of the utmost importance. The development of innovative soil and water precision (target) management/conservation in agro ecosystems and contributing to sustainable agricultural development for food security and environmental sustainability are key requirements for the successful application of these technologies. This is done by building human and institutional capacity. The definition of the PA objectives and appropriate types and levels of technology, the assessment of the accessibility and affordability of the desired PA technology in the study area, and the availability of resources—including human resources with the ideal combination/blended of skills and expertise and financial resources—will all be necessary for the planning and use of PA technologies and tools.

Conclusion

It is anticipated that research teams would gradually use integrated techniques in a number of ways to promote the advancement of creative soil and water management/conservation for sustainable agriculture utilising both conventional and NIT approaches. Setting an entry point and a baseline in this situation will provide a continuous dynamic process that will be updated and expanded over time by incorporating more PA elements to produce value-added information services. The development of a DSS, which includes a socioeconomic evaluation, would be the last step. It would enable information to be provided to policy makers, who would then be able to formulate appropriate policies and regulations for adoption by farmers and other stakeholders involved in land and water management/conservation.

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