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STUDY ON APPLICATION OF DIFFERENT INDIGENOUS TECHNOLOGICAL KNOWLEDGE (S) (ITKS) IN INSECT PEST AND DISEASE MANAGEMENT FOR SUSTAINABLE PRODUCTION

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Abstract
The detrimental effects due to excessive use of chemicals have brought the urgent need for health hazard-free and environment-friendly sustainable agriculture. Indigenous technological knowledge (ITK) can play a vital role in organic agriculture specifically for pest and disease management. ITKs are eco-friendly and compatible with other management practices, contributing towards harmful pesticide residue-free agricultural products. But, due to rapid urbanization, the conservation of long earned ITKs are losing track which brings the urgency of collection, documentation as well as scientific validation of ITKs. Therefore, in this article a sincere effort has been made to highlight some of the ITKs followed by different farmers of various regions of India for sustainable pests and disease management in agricultural and horticultural crops.

Keywords : chemicals, environment friendly, indigenous technological knowledge, pesticide residue

Introduction

The use of chemical pesticides to control various pests and diseases of agricultural as well as horticultural crops had been started largely since 1800 with the introduction of certain arsenical insecticides and Bordeaux mixture fungicide. It is quite evident that the residual effect of some pesticides poses serious health risks to humans and other living beings in addition to unwanted environmental degradation. The detrimental effects of chemical pesticides have arisen the urgent need for organic farming. Therefore, it is necessary to develop holistic approaches for plant protection in agricultural and horticultural crops to make them environment friendly, cost-effective, profitable and socially acceptable to the farmers (Dutta *et al.,* 2015). Non-chemical, sustainable as well as ITK-based pest control and crop protection measures are increasingly gaining popularity over chemical control in many nations, including India. According to Das and Samant (2015), the term Indigenous Technical Knowledge (ITK) is used to describe the common, distinct and traditional local knowledge developed by the farmers or indigenous people of various geographic regions over the globe with their native language, cultural tradition, belief, rituals and rites, covering a wide range of fields such as crop production, weed management, animal raising, natural resource management, food preparation, insect pest management and so on. The ultimate aim of traditional knowledge is to restore long-term natural resources for sustainable production.

Role of ITKs in maintaining plant health

ITKs based pest and disease management in different crops is an age-old practice which have also been found compatible with other management operations. Scientists are persistently trying hard to find out alternative pest and disease control measures for sustainable agriculture as the excessive and imbalanced application of chemical pesticides have posed a serious threat to the environment, human and animal community. ITKs are considered as an impressive aspect as well as an indispensable part of an eco-friendly pest and disease control to obtain sustainable crop production. However, very few systematic research works have been executed to bring ITKs as an effective and important aspect in agriculture for plant health management. However, a number of scientists had made sincere attempts to record different indigenous knowledge practiced by the farmers of various geographic regions for efficient pest and disease control in different crops. Some well documented plant protection measures through ITKs have been discussed under the following heads.

Table 1: Insect pest and disease management through ITKs in agricultural crops

Applied ITKs	Controlled insect pests and diseases	Reference
Summer deep ploughing	Controls soil burrowing nematodes, white grubs, etc.	Shakrawar *et al.* (2018)
Waste material burning in field	Generated heat sterilizes the soil and kills the harmful microorganisms as well as controls damping off in the nursery	Shakrawar *et al.* (2018)
Spraying of diluted onion or garlic extract	Prevents grasshopper as well as other leaf residing insects on Maize	Shakrawar *et al.* (2018)
Spraying of neem solution (neem leaf extract:water @ 1:6)	Controls mostly all types of insects	Shakrawar *et al.* (2018)
Spraying of fermented solution consisting of cow dung @ 5 kg + cow urine @ 5 lt + lime @ 150 gm + 100 lt of water	Controls aphids as well as bacterial and viral diseases	Shakrawar *et al.* (2018)
Pulling of rope dipped in kerosene oil synchronously over the standing rice crop	Controls the insects like hopper, stem borer, caseworm, rice hispa etc. Pulling of the kerosenized rope over the crop damages the eggs of stem borer. Moreover, case worms cannot able to respire within the case because of the presence of oil film over the water surface	Hazarika *et al.* (2009) and Shakrawar *et al.* (2018)
Introduction of bamboo perches	Bamboo perches mainly act as a perching tool for predaceous birds and thereby manage several rice pests. This ITK has also been added in the Bio Intensive Pest Management (BIPM) practice of rice (AAU, Jorhat)	Hazarika *et al.* (2009)

Applied ITKs	Controlled insect pests and diseases	Reference
Leaf clipping of rice seedlings	Controls stem borer infestation by removing stem borer egg masses	Hazarika *et al.* (2009)
Broadcasting of 5-10 kg rice husk or 8 kg wood ash per acre + 3-5 lt kerosene. Applied in the early morning	Controls stem borer attack	Hazarika *et al.* (2009)
Placing the sticks of banana leaves in rice field	Attracts gundhi bug during milky stage	Shyam *et al.* (2019)
Application of fermented solution made with 5 kg cow dung + 5 lt cow urine + 150 gm lime + 100 lt of water	Controls khaira disorder, bacterial and viral diseases in paddy	Shakrawar *et al.* (2018)
Spraying of cow dung slurry in paddy (slurry is kept for 3-4 hours to settle down the course particles. Top solution is filtered and then sprayed)	The bactericidal action of cow dung helps to minimize the bacteria population of *Xanthomonas sp*. and thereby controls the bacterial blight of paddy	Shakrawar *et al.* (2018)
Application of solution prepared with 2 kg fresh papaya leaves extract + 3-4 lt of water. After overnight soaking followed by filtering with a clean cloth, the solution is diluted in 50-60 lt water and 250 ml soap solution is added in diluted solution	Controls brown spot disease in rice	Roy *et al.* (2015) and Shakrawar *et al.* (2018)
Spraying of ash + water mixture at the panicle initiation stage	Controls brown spot in rice. Ash is alkaline in nature and contains hydrocarbon and/or sulphur which in turn prevent the dissemination of fungal infection	Saha and Dutta (2013)

Table 2: Insect pest and disease management through ITKs in horticultural crops

Applied ITKs	Controlled insect pests and diseases	Reference
Application of fish washed water at the base of lemon tree	Controls citrus trunk borer. Fishy smell of water acts as an insect repellent	Deka *et al.* (2006) and Gohain *et al.* (2019)
Application of kerosene to the trunk of mandarin tree followed by plugging the holes made by insects using mud or cow dung	Controls trunk and stem borer. Sealing of holes after kerosene application kills the insect larvae	Barooah and Pathak (2009) and Gohain *et al.* (2019)
Application of smoke in morning and evening in cucurbitaceous plants	Controls fruit sucking moth including fruit borers and other pests	Deka *et al*. (2006) and Gohain *et al.* (2019)

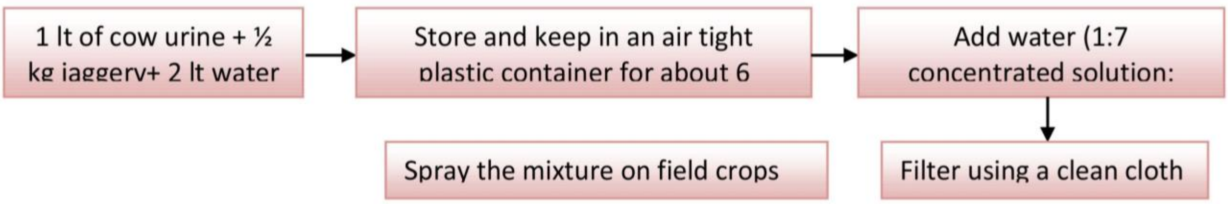
Applied ITKs	Controlled insect pests and diseases	Reference
Application of wood ash at the base leaves of brinjal, okra, and spinach	Controls the attack of aphids, leaf minor, thrips and beetles	Saha and Dutta (2013) and Gohain *et al.* (2019)
Burning of rice husk, twigs etc. in the pit before planting in coconut and areca nut plantation	Controls termite attack	Gohain *et al*. (2019)
Spraying of boiled tobacco leaf extract on vegetables	Controls lepidopteran pests	Saha and Dutta (2013) and Gohain *et al.* (2019)
Turmeric powder application in the seed bed of vegetable crops like tomato, cabbage, cauliflower etc.	controls red ants as well as fungus infestation	Gohain *et al.* (2019)
Rubbing the seeds of chilli, tomato, brinjal etc. with kerosene and ash mixture before sowing	controls red ants attack	Gohain *et al.* (2019)
Regular smoking with rice straw and chilli powder at the fruiting stage of vegetable crops	Controls fruit fly	Saha and Dutta (2013)

ITKs in controlling stored grain pests

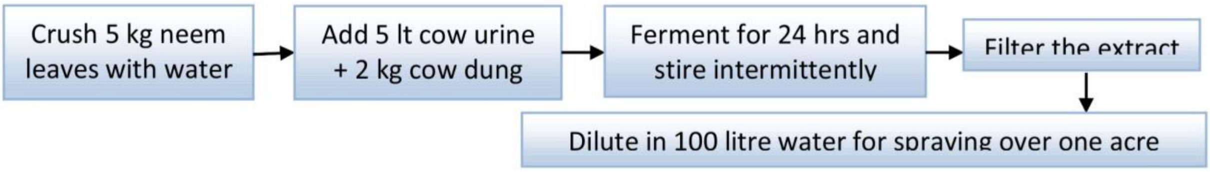
- Use of neem leaves for storing food grains like rice and pulses to control storage pest damage (Shakrawar *et al.,* 2018).
- Placing of curry leaves in grain storage control several stored grain pests (Deka *et al.,* 2006).
- 6-12 inch thick rice husk layer on the top of grains stored in bamboo storage bin or dulito reduce rice moth infestation (Kalita and Hazarika, 2019).
- Putting some dried chillies in pulse container minimize bruchids (beetle) attack.
- Thorough mixing of ash @ 20 g (10 tsp) per kg okra seed manages storage pests of okra (Gohain *et al.,* 2019).

Some scientifically validated ITKs

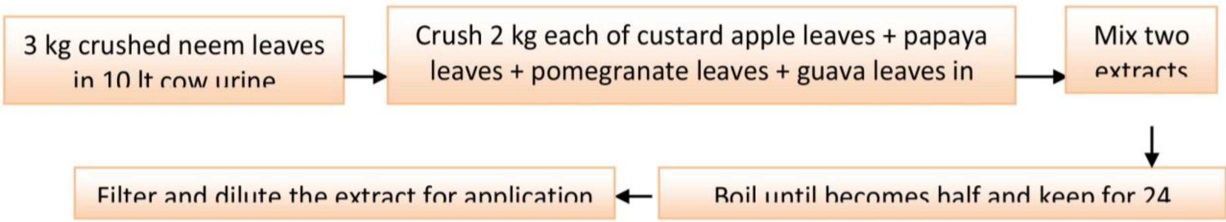
(i) An indigenous pesticide used to be prepared by the farmers of West Bengal by using cow urine and jaggery. Pradhan *et al.* (2017) exhibited the scientific rationale behind this ITK that the toxicity of the mixture kills the insect pests that come in contact with it.



(ii) An extract made with neem leaf extract along with cow dung and urine has been proved beneficial against sucking pests and mealy bugs. It can also be used in vegetable crops (NCOF, Gaziabad, 2011-12).



(iii) 2-2.5 litre diluted mixture of neem leaf extract, custard apple, papaya, pomegranate and guava can be used successfully for controlling sucking pests, pod or fruit borers (NCOF, Gaziabad, 2011-12). The extract can be stored for 6 months.



Conclusion

In the context of the present situation where everybody is so concerned with the ill effects of harmful chemicals on the health and environment, documentation along with scientific validation of the ITKs can play a major role in the development of agricultural science. There are several constraints for poor adaptability of ITKs such as inadequate knowledge of farmers and farm women regarding the processing methods of locally available natural resources for preparation of indigenous pesticides, inappropriate preparation method and dose of application, lack of documentation and validation of ITKs etc. ITK based crop protection measure not only serves as an alternative to chemical pesticides but also helps in restoring the biodiversity of natural enemies. In addition to that, the effectiveness and transfer of indigenous technologies can lead to the formation of effective modules, more specifically the integrated pest and disease management modules for major field crops. At last, we can conclude that presently it is an urgent requirement to integrate the scientifically validated ITKs along with the recommended package of practices for wider acceptability as well as sustainable and cost-effective farming system.

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METHOD OF MAKING LOW COST FRUIT FLY TRAPS AND INSTALLATION AT FARMERS' LEVEL

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India is a major tropical and subtropical fruit producer. Fruit flies are one of the major important insect pests in India causing considerable yield losses in fruit orchards ranges from 5 to 80%. India holds nearly 200 species of fruit flies of the world. Management of fruit flies is challenging because the eggs are inserted into the fruits. On hatching the larvae feed on the inner edible portion of the fruits resulting in decay and secondary infection. The infested fruits eventually drop and the larvae move into the soil to pupate in a suitable pupation site. Thus, they may escape contact with insecticides. Studies are also in progress to manage the economically important fruit flies. Several management practices developed from time to time to reduce the fruit flies infestation to a great extent. Trapping have been found to be useful both for monitoring and management. Several ways of preparing the lure traps have been found and demonstrated to farmers to make the traps at farmers' level. Methyl eugenol lures is one of the leading lure traps for fruit flies in several places which works effectively against all kinds of fruit flies.

Materials required

- plastic water or soda bottles of one litre
- Galvanized utility wire
- Glass beaker
- cotton rope or wooden piece of two inches
- Ethyl alcohol
- Methyl eugenol
- Any insecticide
- Aluminum foil
- Sharp knife
- Gloves

Targeted insect pest

Fruit flies in orchards

Methyl eugenol lure preparation

A mixture of ethyl alcohol 60 ml + methyl eugenol 40 ml + any insecticide 20 ml (6:4:2) is used in the preparation of methyl eugenol lure. The lure mixture is prepared in a glass beaker of sufficient volume. A half-inch thick cotton rope or wooden piece should be made cut in to two inch pieces and are used for soaking in methyl eugenol lure which are tied tightly at both ends with a thin string. The cotton ropes or wooden pieces should be dipped in the solution for 24 hours. The soaked cotton ropes or wooden pieces should be wrapped in aluminum foils until they are used as lures and aluminum foils should be removed while using the lures in the bottles. Safety to humans while preparing the lure mixture is based on the insecticide used and concentration of the chemicals used in preparing the lures.

Traps preparation

Fruit fly traps at farmer level can be made from plastic water or soda bottles. Take an empty one liter water or soda bottle and make window-like holes with one inch width on two sides at the lower portion of its mouth with sharp knife to allow flies to enter. Make a small hole in the bottle cap. A thin wire or thread about 10 inches is inserted through the hole in the cap and the outside of the cap, the wire or thread is tied to hang the bottle. As above, the wire or thread inside the bottle should be made suitable for fitting the lure inside.

Methyl eugenol traps installation

Hang the traps in semi shaded area of about five meters from the ground level at various places in the orchards and be sure that the lure does not obstruct the window cuts made on sides. The lures inside the bottles should be replaced with fresh lures for every fifteen days interval. The time to start installation of traps may vary depending on the crop. In general installation of traps should start before the adult fruit flies become active i.e. when some adult flies have been detected or found in traps or five to six weeks before fruit ripens, and sometimes even before the flowering stage which occurs before fruit formation. Timely remove all trapped flies during each observation and destroy them away from the field.

Number of traps per hectare

If traps are used for monitoring the flies, two to three traps are enough for one hectare field but for control eight to twelve traps are needed.

Importance of fruit fly traps

- Only small amounts of insecticide chemicals are used.
- Lures are generally not attractive or harmful to beneficial insects which are natural enemies to fruit flies.
- Lures have low risk to human health as well as to environment.
- Waiting periods are not required after harvesting the crop, as lures are not applied directly to fruit.

Precautions to be followed

- Always label the traps with the date and the lure placed should be changed according to the recommendation.
- Dispose properly the used lure materials.
- Wash the hands between handling the lures.
- Minute traces of other chemicals can render the lure completely ineffective so don't mix any other chemicals in the bottles while using lures.
- Make sure that lure making rooms are well ventilated and lighted.
- Gloves should be worn during preparation and lure making materials should be used only for lure making.

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ARTIFICIAL LIGHTS: TYPES AND USES FOR INDOOR PLANTS

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Introduction

The interest and investment in indoor plants have been soaring in recent years and became more than just a trend with the pandemic being the main driving force. People of varying ages and genders continues to show keen enthusiasm and willingness to engage and even invest more for indoor plants post pandemic. The benefits of owning an indoor plant are numerous and extensively known. The most intensive effort needed in keeping an indoor plant is the care and maintenance of the plants which differs greatly among the different types of plants. The performance of the plants is influenced by certain environmental factors including temperature, light, moisture, and humidity.

Lights for indoor plants

Light plays an important role in the development of plants. Growth in plants is induced by the process of photosynthesis which is driven by the presence of adequate amount of light. The resultant photosynthetic activity produces sugars which is assimilated by the plants for their growth and development. The light factors including quantity, intensity and spectrum all play a significant role in the physiological development of plants. Light spectrum for plant response ranges from the UV (280–400 nm) to the far-red (700–800 nm) regions and light quality influences plant growth and development more than light intensity and photoperiod. (Ahmed *et al*., 2020). However, the requirement of these light factors often varies from one plant to another.

In common indoor plants, the absence of proper light leads to pale green or yellowing of leaves that eventually drops off or leaf size is significantly reduced. Variegated leaves often exhibit solid or monotonous green color due to accumulation of chlorophyll pigment. The plants become spindly especially in case of succulents, plants are long and skinny as it strives to reach adequate light source. The overall growth of plants is restricted with slowed or stunted growth due to the lack of energy that is supplied through the process of photosynthesis that occurs in the participation of light.

Artificial lighting

Plants can utilize both natural and artificial source of light, which is advantageous to indoor plants as they cannot always get the location that receives adequate sunlight. Artificial light enables plants to be grown in anywhere in the house even during the winter months. In outdoor condition in a natural environment, plant receives full spectrum of light wavelength which can be utilized by the plants. In contrast, indoor lighting generally provides light only along limited wavelengths generally red and blue lights. Red light encourages flowering whereas blue light is responsible for

Fig: zz plant under LED light by Walmart stimulating foliage growth. These lights according to requirements can be provided to the plants indoor through various sources.

Types of artificial lights

There are different types of artificial light that can be used for growing indoor plants depending on the growing conditions and requirements. These are

1. Incandescent lights

Incandescent lights emit more of the red wavelength of the color spectrum that is known to boosts flowering and providing them exclusively would deprive the plants of the blue light required for foliage growth. Thus, it is more preferred to be used it in combination with other light source that emits blue wavelength. Incandescent light bulbs are easily available and low cost; however, they also produce a lot of heat which can be detrimental to plants when exposed too close to it. They will also cost high energy consumption as they have very low energy efficiency.

2. Fluorescent lights

Fluorescent lights produce both the red and blue spectrum of light and have lower heat output. The lamps come in various shapes and are considered the most economical light especially for indoor plants. They have high energy efficiency and will not cost as much energy consumption. However, they are often fragile and do not last long as much compared to other lights. Mercury lamps are also classified as fluorescent lamps with similar principle but producing more red light of the spectrum.

3. Halogen lights

Halogen lights for plants are brighter and last longer than the incandescent lights. They also produce more of the red spectrum and is not so much preferred for foliage indoor plants as they are more beneficial for flowering. They also produce heat so care must be taken to leave some space between the lamp and the plants. They can be used as supplemental light in combination with other source.

4. High Intensity Discharge (HID) lights

The high intensity discharge (HID) lights are often used in large-scale commercial hydroponic installations. The HID grow lights, come in two different forms i.e. High Pressure Sodium (HPS) and Metal Halide (MH) where MH is used during vegetative stage and HPS during the flowering stage. They are less expensive and easily available but considered less efficient.

5. LED lights

LED plant lights work by using electroluminescence and a semiconductor to make light-emitting diodes produce light. The LED lamps are capable of producing light of the red, blue and orange spectrum which can be regulated for the development of plants. They are energy efficient reducing energy consumption, highly-customizable and the most popular option among growers for artificial lights in the recent years (García-Caparrós *et al*., 2019). The use of LED lights in modern agriculture has gained more attention especially for indoor plants and hydroponic culture. They are considered to be very durable and low heat generation. However, the initial cost can be a bit high although it is the most acceptable option for artificial lights.

Fig : Different artificial lights comparison (pic credit: foodiegardener.com)

Choice of indoor plants

The indoor plants that are known to enjoy low light conditions are mostly the ones that thrives well under artificial lights. Plants like peace lily, zz-plant, philodendron, dracaena, pothos, peperomia, spider plant, aglaonema and bromeliads would be the best options.

Conclusion

Artificial lighting may not necessarily be required in a room that receives full and bright sunlight. But it supplements for those that do not get the sufficient sunlight required especially during the winter months. Since the duration, quantity and spectral composition can be regulated, it can present the grower more control over the lighting options and adjust the light exposure as per their requirements. In this case, it is essential to find out the adequate amount of light required for a particular plant.

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EMPOWERING FEMALE FARMERS TO END HUNGER AND POVERTY: BRINGING A PROGRESSIVE INDIA

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Introduction

About 80 percent of the world's food is produced by small-scale farming. Women make up on average 43 percent of this agricultural labour in developing countries. They are the majority in some countries. In South Asia, more than two thirds of employed women work in agriculture.

Agriculture sector employs 80% of all economically active women in India. They comprise 33% of the agriculture labor force and 48% of the self-employed farmers. In India, 85% of rural women are engaged in agriculture, yet only about 13% own land. The situation is worse in Bihar with only 7 per cent women having land rights, though women play an important role in various agricultural activities. Economic Survey 2017-18 says that with growing rural to urban migration by men, there is 'feminisation' of agriculture sector, with increasing number of women in multiple roles as cultivators, entrepreneurs, and labourers. Bihar's agriculture sector is highly feminized, with 50.1% of the total workforce engaged in farming activities being women **('Women in the informal economy of Bihar' – ADRI)**. 70% of all women engaged in cultivation are from households witnessing migration. **(Report released in 2014 by IHD, New Delhi)**. About 60-80% food is produced by rural women.

Gender Inequality in Agriculture

Some think that gender inequality in agriculture does not exist but men and women farmers do not benefit the same and here are the five reasons why:

1. Land Rights: Women are less likely than men to own their own land and if they do, the plots tend to be much smaller.

2. Resources: Women farmers face more difficulty in access to credit to purchase inputs and face more barriers in receiving, training or extension services.

3. Unpaid work: Women's household labour burden is generally not taken into account and without social development initiatives, women farmers are more likely to lose out on a higher income as a result of a greater time spent caring for children or the elderly.

4. Employment: Women farmers are often left out of opportunities such as contract farming schemes.

5. Decision-Making: Women farmers' decision-making power is relegated to the household. Women are under-represented in producer cooperatives or worker groups, including in internal decision making and dispute resolution bodies, which remain male-dominated.

The dream of socio–economic empowerment of women will not be complete without empowering those who are living at India's last periphery. The ones whose day starts before sunrise and continues after sunset. These are the women farmers of India, whose voices often go unheard owing to their gender, and who struggle to establish their identity at a grassroots level due to patriarchal traditions and gender socialization. Women's work in agriculture is in addition to her role as a wife, a daughter-in-law and as a mother. However, gender-based discrimination continues in multiple ways: women are not recognized as farmers in Indian policies thereby denying them of institutional supports of the bank, insurance, cooperatives, and government departments.

These voices need to be heard at both the policy and implementation levels if we are to realize the dream of a progressive India. Women farmers in India perform most of the big farming jobs, from sowing to harvesting, yet their access to resources is less than their male counterparts. Closing this gender gap is essential in order to accelerate the pace of growth in the agriculture sector.

How women's economic empowerment can help the world:

Women's economic empowerment could reduce poverty for everyone. In order to achieve it, we need to first fix the current broken economic model which is undermining gender equality and causing extreme economic inequality. The neoliberal model has made it harder for women to have better quality and better paid jobs, address inequality in unpaid care work, and women's influence and decision-making power is constrained. To achieve women's economic empowerment, we need a human economy that works for women and men alike, and for everyone, not just the richest 1%.

Policy, Schemes and Planning: Need of the Hour

To address the issue of women inequality and encourage their empowerment, the International Council of Agricultural Research (ICAR) called women the backbone of the Indian economy. While emphasising women contribution towards agriculture and primarily, the ministers also mentioned several policies and schemes by the Central government that was aimed at benefitting women in the farming community. It has been justified in several instances that women contribution in agriculture extends way beyond the contribution made by their counterparts. However, the credit given to them is far lesser. Women education plays a huge part in this regard. Even though they are contributing more time to the fields, they are eventually dependant on their husbands, brothers, fathers or sons to avail legal benefits and abstain from indulging in the necessary paperwork. Therefore, formulating policies that would enable women to upgrade their knowledge and skills in farming would come in handy. Secondly, rural awareness programmes aimed particularly at women and their development would be a step forward. A provision of a door-to-door facility for making identity proofs and bank accounts will help them spare some time for their families and home.

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LEMON GRASS FARMING

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Lemongrass is a good profit making aromatic crop. Scope for lemongrass farming is due to its increasing demand in world market because of its aromatic, flavouring and medicinal properties. Lemongrass oil is marketable produce which have greater demand from countries such as Japan, West Europe and USA. The government policies are in favour of increase in Agribusiness sector. It provides about 36 % subsidy on loans for agriculture business. Therefore, business of extraction of essential oil is expanding. It is a good profit making option for places having poor soil condition, high alkalinity hilly areas, degraded forest, mined and industrial waste land.

Lemongrass can be grown in different climatic condition in Maharashtra. It can tolerate temperature for some extent. The average rainfall required for lemongrass cultivation is about 500-750 mm. So, it can be cultivated in many regions of Maharashtra state. It can be grown on variety of soils such as loamy, sandy loam to poor laterite soil. It can be grown on slopes of hill and baren lands.

Lemongrass farm is easy to maintain as it grows as other crops. It doesn't get affected by pest or insect. In some case, if it gets attacked by insect or pest, it can be easily controlled by spraying insecticide. After sowing, we can get yield for upto 5-6 years. It gives 3-4 cuttings per year. Cost of cultivation of lemon grass is less as compared to other crops.

Harvesting of lemon grass is done by cutting the stems that is about 6 mm to 1 cm. First harvesting can be done after four months of cultivation and preceeding harvesting after 3 months. It yields about 20-25 tonnes herbage per hectare which yield 80-100 kg oil.

The distillation unit can be set up in farm for extraction of essential oil. The oil extraction is done by steam or hydro-distillation. The oil content is about 0.5-0.6 %. The price of lemon grass is varies from 1400-2000 according to quality of oil.

Government also provides scheme for lemon grass farming. Government provides maximum subsidy of Rs. 2000 per acre for cultivation. Also provides 50% subsidy for installing distillation unit.

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AN OVERVIEW OF EMERGENCE DISEASE REPORTED IN TILAPIA WITH SPECIAL REFERENCE TO TILV

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Introduction

Indian fisheries constitute about 6.3% of the global fish production, and this sector contributes to 5.15% of the agricultural GDP with 1.1% of the total GDP. The Indian subcontinent is predominantly dependent on freshwater aquaculture for its fish production. India is the second largest aquaculture producer in the world. From long back, Indian major carps (IMC) stood as primary candidate specimens in dominating freshwater aquaculture contributing approximately 75% of production. As the demand for fish is increasing, diversification of species in aquaculture by including more species for increasing production levels has become necessary as part of Blue Revolution. Tilapia is the second most cultured finfish species after carps and is cultivated in more than 100 nations (FAO). China is the leading nation (around 30%) followed by Indonesia and Egypt in tilapia production (FAO), while the USA is the top importer. The craze for farming this fish has been increasing worldwide for the past three decades because it is the richest and cheapest source of protein. Even in India, tilapia production was documented to be 18,000 tonnes in 2016 and estimated to reach 22,000 tonnes in 2020. Tilapia farming is practiced at various levels ranging from artisanal to commercial levels. Depending on the intensity of management, the culture of tilapia ranges from rural subsistence farming to large-scale commercial operations. Generally, earthen ponds are the most widely employed culture system of aquaculture worldwide. Besides, tilapia is even cultured in concrete tanks and raceways as intensive and semi-intensive systems. Furthermore, cage culture is mainly implemented in reservoirs, lakes, rivers, and estuaries (NFDB). However, there are many constrained and challenges to this farming due to climate change, alteration of water quality parameters, and evolution of emerging diseases such as TiLV, TiPV, etc., affecting the global tilapia production and socioeconomic conditions as well as indirect employment opportunities in developing countries.

Advantages of farming Tilapia : In Southeast Asia, the farming of tilapia is more interested and earns a huge profit due to the following reasons:

1. Tilapia is generally a hardy species with a wide range of adaptability to various production systems, including extensive, semi-intensive, and intensive.
2. Its rapid growth in a short time.
3. Its high breeding efficiency and survivability.
4. Genetic selection and targeted breeding advances improved these characteristics, such as WorldFish's genetically improved farmed Tilapia (GIFT).
5. Its demand in the market
6. Other advantages include tilapia can control the mosquito population to some extent as mosquito larvae are being eaten by tilapia.

Figure 1. Farm-reared Nile tilapia (*Oreochromis niloticus*)
(Photo courtesy: Laishram Soniya Devi).

In the India scenario, aquaculture of tilapia farming has been accelerating over the last few years because of encouragement offered in the form of Genetically Improved Farmed Tilapia (GIFT) by the Government of India through the Rajiv Gandhi Centre for Aquaculture (RGCA, 2017). On the other side, ICAR-CIFA is exploiting the opportunities of cage culture of Tilapia and Pangasius in lakes. Besides, tilapia (*Oreochromis* sp. shown in figure 1) is available almost all over the nation, predominately in the freshwater and slightly in the brackish water ecosystem. Due to its numerous advantages, it has emerged as the dominant aquaculture species of the 21st century.

Overview of diseases in tilapia

Tilapia is considered a highly resistant fish to infectious diseases in the earlier days. However, the emergence of various diseases as key limiting factors hinders the growth of intensively farmed tilapia and leads to immense economic losses. Amongst important diseases threatening culture tilapia intensively, bacterial and viral diseases are the serious loss factors. The commonly important bacteria that cause disease in tilapia include *Streptococcus* sps, *Flavobacterium columnare*, *Francisella* sps, *Edwardsiella tarda*, *E. ictaluri*, Motile Aeromonads. The virus that can cause disease in tilapia are betanodavirus and tilapia larvae encephalitis virus (TELV), Tilapia parvo-like Virus (TPLV), and Infectious Spleen and Kidney Necrosis Virus (ISKNV). Moreover, parasitic infestation has also been reported in tilapia like *Ichthyopthirius multifiliis*, *Trichodina* sp., *Icthyobodo* sp., *Gyrodactylus* sp. and *Clinostomum* sp. (Walakira et al., 2014). Recently, the emergence of novel TiLV disease in our nation is agitating the tilapia industry.

Tilapia lake virus

TiLV is a recently described virus affecting wild and farmed tilapines. TiLV was officially identified in 2014 in Israel by Eyngor and his group. At the same time, Ferguson and his colleagues also identified this virus from the diseased fish in Ecuador. Subsequently, owing to the transboundary migration of fish and vectors that carry the virus, this disease has been noticed in three continents: Asia, Africa, and South America, including 18 countries. In the case of India, this disease was first recorded in the year 2018 by Behera and his colleagues. Before TiLVD was named, it was also commonly known by various names such as syncytial hepatitis of tilapia (SHT), Summer Mortality Syndrome (SMS), and one-month mortality syndrome.

Global distribution

TiLVD has been reported in 18 countries and provinces. The disease was first recognized in Israel in 2011. Now, the disease has been reported in several other countries, including Ecuador, Colombia, Thailand (2015), Egypt (2015), the United Republic of Tanzania (2015); Uganda (2016), India (2016), Mozambique, Indonesia (2016), Taiwan Province of China (2017), the Philippines (2017), Malaysia (2017), Bangladesh (2017), Peru (2017), Mexico (2018) and most recently in the USA (2019) as shown in figure 2.

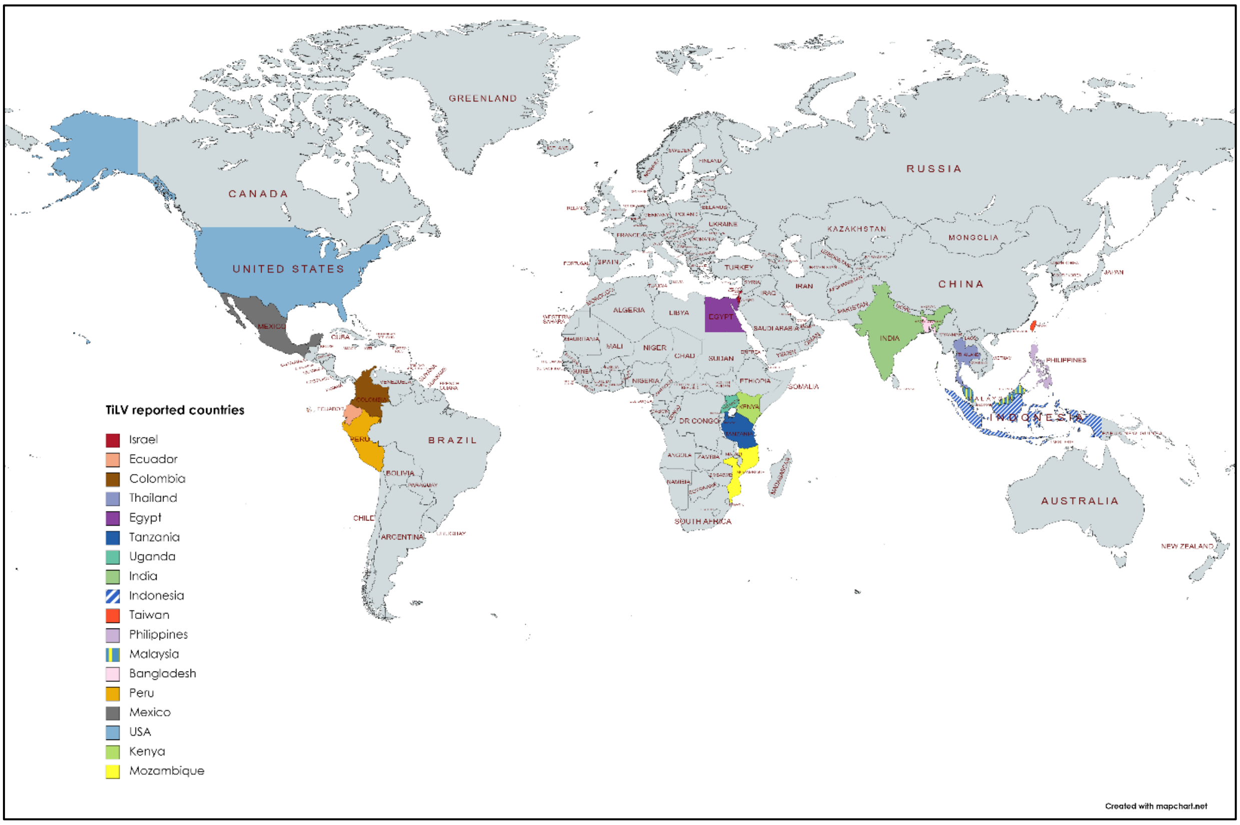

Figure 2. World map showing the geographical regions with reported TiLV cases (Credit: mapchart.net).

Genome

It is an icosahedral, negative sense, single-stranded enveloped RNA virus of 55 – 100 nm diameter. It belongs to the family Amnoonviridae under the Genus *Tilapinevirus* (ICTV, 2019) with a genome size of 10.323 kb composed of ten segments that can code ten different proteins.

Mode of transmission

TiLV is very contagious, and mainly tilapine cichlids are highly vulnerable to this infection. The virus can survive in both fresh and brackish water environments. The virus can be transmitted either horizontally or vertically; yet, direct horizontal transmission is the chief route of transmission that has been confirmed through co-habitation studies.

Susceptible stages

Earlier stages of tilapia, such as egg, spawn, fry, and fingerlings, are more susceptible to the infection, causing mortality up to 90%. However, in medium and large-sized fish also, mortality has been recorded.

Pathology

Target organs: Liver, brain and eyes are the key target tissues for TiLV infection. The presence of syncytial hepatitis is considered to be chief indication of TiLV-infected fishes. TiLV has been detected in several other organs such as spleen, anterior kidney, gills, heart, mucus as well as muscle. Worldwide, TiLV infections are causing mortalities in the range of 20-90%. Interestingly, most of the fishes exhibited mortality within the first week of infection showing high virulence of TiLV and mortality continued for the subsequent 2-3 weeks. Experimental infection study on TiLV using Nile and Red tilapia was reported by Tattiyapong *et al*. and the study revealed the variation in susceptibility of the species in which cumulative mortality of 86 % and 66 %, respectively was recorded.

Generally, TiLV disease outbreak is related to seasonality i.e., in summer. However, in few countries like India, this disease's outbreak occurs mainly in the rainy season. This is due to the fact that temperature has a crucial role in TiLV infection. For instance, most of the reported outbreaks occurred during an elevated water temperature (27 ^oC to 32 ^oC). Apart from temperature, other stress factors like high stocking density and low dissolved oxygen that result in stress in tilapia can also contribute to rapid viral infection of the host.

Diagnosis

Clinical signs

TiLV disease fish is associated with general clinical signs like lethargy, emaciation, swimming at the water surface, skin erosions redness, haemorrhages, discoloration (darkening), abdominal swelling, ocular alterations including exophthalmia opacity of the lens and in advanced cases, ruptured lens. It has been estimated that mortality within the first week of infection range from 6.4 to 90%, with fingerlings and juveniles being more vulnerable. The disease caused by the virus reported from different countries has shown different clinical signs and these are not disease-specific signs; hence we should not use these clinical signs for disease confirmation.

Molecular-based diagnosis

The confirmation of the virus can be done based on the following any of this molecular approach such as PCR (Polymerase chain reaction) technique, real-time PCR (an advanced form of PCR where amplification can be visible from the monitor's display), LAMP (Loop-mediated isothermal amplification). All these techniques are sensitive, accurate, and rapid methods that can be detected within a short period of time. Several PCR-based methods are available, ranging from RT-PCR (Reverse transcriptase PCR) to real-time RT-PCR (q-PCR). The semi-nested RT-PCR method is the most widely employed of all the above described and can detect as minimum as 7.5 copies. More recently, a LAMP technique has been developed to detect this virus.

Cell culture-based diagnosis

Isolation, identification, and propagation of TiLV using a cell culture technique is the most efficient mode. This virus can be detected using E-11 (a cell line derived from Snakehead fish), and primary tilapia brain cells by observing CPE (cytopathic effect) within 3-10 days.

Prevention

According to FAO guidelines, the following strategic steps can be implemented as preventative measures to stop the spread of TiLV infection in the culture system. These include ensuring high levels of biosecurity in the culture system, such as screening tilapia seed against TiLV before introduction in the culture system, i.e., TiLV-free seed for stocking. Following disinfection, the

facility can be restocked with stocks that are certified to be SPF (TiLV-free) and/or SPR (TiLVD-resistant); quarantine and movement controls; zoning and compartmentalization are management strategies to prevent the spread of disease and facilitate international trade.
There are basically three premises/zones:

- Affected premises (or area): the location of the TiLVD outbreak, including any nearby properties (such as a farm) or geographically isolated areas. A presumptive or verified positive case based on diagnostic results exists in the affected premises or area.
- Buffer zone: a location next to a region that has been afflicted; it needs to be closely monitored to stop the disease from spreading to the unaffected area.
- Free zone: the region that is unaffected. Using surveillance, one can identify the incidence of TiLVD in communities and identify its early onset.

Control of the vector: For other fish viruses, piscivorous birds have been demonstrated to act as mechanical vectors through their faeces or regurgitated food, but TiLV has not been identified in these cases.

Risk factors

TiLV and the fish host are both impacted by various environmental factors, which have a significant role in the occurrence of disease outbreaks. Environmental elements may impact TiLV proliferation and have a meaningful impact on how the disease manifests clinically. The fish host is affected by environmental factors such as temperature fluctuations, poor water quality, high stocking densities, and stress from handling and transportation. Stressed fish are more vulnerable to illness due to less-than-ideal culture conditions. Tilapia are being cultured to be tolerant of various environmental factors, including high salt. For instance, the red tilapia can withstand salt up to 32 ppt (parts per thousand), the blue hybrid tilapia 20 ppt, and the Nile tilapia 25 ppt. Conversely, Tilapia are less tolerant of cold water and typically cease eating when the temperature drops below 18 ^{o}C. Only Nile tilapia is thought to supply more than 70% of the commercial tilapia produced. Table 1 provides a list of the ideal water quality characteristics for this species.

Table 1. The optimal water quality parameters for Nile tilapia

Growth condition	Optimum	Range
Temperature (^{o}C)	27–30	12–38
Salinity (ppt)	5–10	<25
Dissolved oxygen (mg/L)	>5	
pH	6-9	5-10
Ammonia (NH3) (mg/L)	<0.1	
Nitrate (NO3 -) (mg/L)	<27	

Control

Since the outbreak of this disease, there have been no such control measures to contain the TiLV disease outbreak. Further, no evidence has been made to control this disease in the tilapia culture system. However, general preventive measures can be taken up in order to contain the outbreak of the disease caused by TiLV in aquaculture, such as following better management practices like the use of disinfectants, use of quarantine facilities, strict biosecurity measures, avoiding stress factors by keeping culture pond or tank with optimal water quality parameters such as DO, temperature, total alkalinity etc.

Conclusion

Owing to the contribution of tilapia's protein to food security, particularly within a short cultured period, tilapia is widely known as "Aquatic chicken". TiLV is an emerging disease in tilapia aquaculture. TiLV is most likely proving difficult to control because of the high vulnerability of young tilapines to the disease and due to the fact that there are currently no available TiLV vaccines or anti-viral drugs. This situation is further compounded by a lack of knowledge regarding the pathogenicity of TiLV. Therefore, the only chance of TiLV management can be possible through farm-level management interventions like better husbandry and biosecurity measures, of which the implementation of rapid, accurate, and cost-effective diagnostic tools will be crucial. Further, the genome of this virus is composed of RNA, which is more prone to mutation; hence early detection and proper mitigatory measures should be taken care of in order to avoid the further spreading and devastating effects of this disease.

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PRESENT STATUS OF FISHERIES OF MAHARASHTRA

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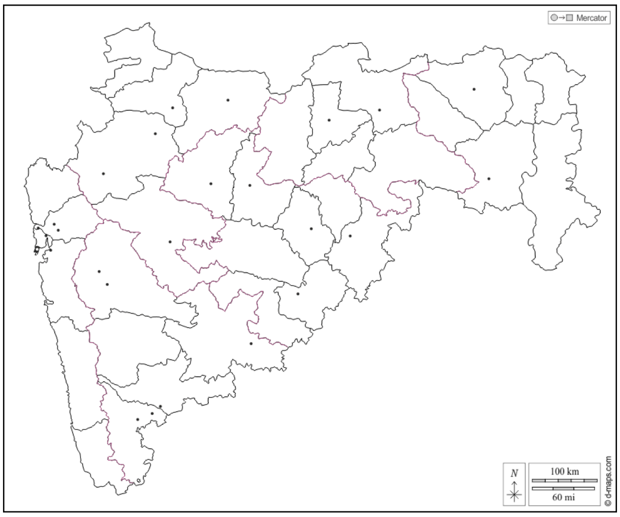
Introduction

Maharashtra is India's second-most populated and third-largest state by land, located in the western part of the country. Maharashtra is believed to be derived from the word rathi, which means "chariot driver." With the construction of the first Buddhist caves in the 2nd century BC, Maharashtra became part of recorded history. The name Maharashtra was first reported in the 7th century by Huan Tsang, a contemporary Chinese traveller.



On the basis of their languages, western Maharashtra and Gujarat were merged into a single state named Mumbai after independence. The present Maharashtra state was established on May 1, 1960, with Mumbai as its capital. The largely Marathi-speaking districts of Marathwada (Aurangabad Division) from the erstwhile Hyderabad state, as well as the Vidarbha region from the Central Provinces and Berar, were added to the state.

Maharashtra is divided into five regions based on geography, history, and political attitudes.

- Berar or Vidarbha (Nagpur and Amravati divisions).
- Desh or Western Maharashtra (Pune division), and
- Konkan (Konkan Division)
- Marathwada (Aurangabad Division).
- Northern Maharashtra and Khandesh (Nasik Division).

Rainfall is extremely significant in the lives of people who work in agriculture. The Konkan and Sahyadrian regions of Maharashtra receive the majority of the rainfall. Rainfall frequency varies from year to year, as do extreme weather conditions throughout the summer months, adding to the peasants' misery. The state's yearly rainfall ranges from 400 to 6000 mm and occurs for 3 to 4 months each year. High temperatures are common throughout the months of March, April, and May, which are frequently accompanied by thunderstorms.

Fisheries Resources of Maharashtra

In Maharashtra, a total of 4.50 lakh peoples are employed in the fishery sector, with 54,901 active fishermen working mainly in the marine sector. Maharashtra has a 720 km long coastline along the Arabian Sea that is divided into 7 coastal districts, including Thane, Palghar, Mumbai City, Mumbai Suburban, Raigad, Ratnagiri, and Sindhudurg. In the seven districts, there are 25 fishing zones and 173 fish landing centers and a 1.12 million km^2 region suitable for marine fishing (Lakra *et al*., 2021). In addition, the state has 0.10 lakh hectares ideal for brackishwater fishing (DOF, Government of Maharashtra, 2020).

Table 1: Fisheries resources of Maharashtra

Marine		Inland	
Length of coast line (Km)	720	Total inland water bodies (lakh Ha)	3.48
Continental Shelf ('000 sq km)	112	Rivers & canals (Km)	16,000
Number of Fish Landing Centers	152	Reservoirs (Lakh ha)	2.73
No of Fishing villages	456	Tanks & ponds (lakh Ha)	0.59
No of fishermen families	81,492	Flood plain lakes/derelict waters (lakh Ha)	-
Fisher-folk population	3,86,259	Brackish water (Ha)	2,699

Source: DADF Annual report 2019-20

The department currently operates 28 hatcheries and 42 fish seed production units. In Maharashtra, there are around 29 Fish Farmers Development Agencies (FFDAs) and 4 Brackish Water Fish Farmers Development Agencies (BFDAs) dedicated to the development of freshwater and coastal aquaculture. FFDA and BFDA currently cover 36,602 hectares and 1,539 ha of water spread area, respectively. FFDA and BFDA have trained thousands of farmers to achieve average fish production of 1712 kg/ha/year for FFDA and 600 kg/ha for BFDA (DOF, Government of Maharashtra, 2020).

Fish production of Maharashtra

Maharashtra's total fish production in 2019-20 was 5.61 lakh tons (1.18 lakh tons Inland and 4.43 lakh tons Marine) (Handbook on Fisheries Statistics, 2020), placing the state fifth rank in the country in terms of fish production, accounting for 5.81 percent of total fish production. On average, it produces 1.5 lakh metric tons of fish each year. Marine fisheries contribute about 76.11 percent of total fish production across a huge continental shelf area, while inland production accounts for roughly 23.89 percent of total fish production.

Table 2: State wise fish production of India (2019-20)

State	Coastline (Kms)	Continental shelf area ('000 sq. Kms)	Production (In '000 tonnes)		Rank in production
			Inland	Marine	
Andhra Pradesh	974	33,227	36.1	5.64	1
West Bengal	158	17,000	16.19	1.63	2
Gujarat	1600	1,84,000	1.58	7.01	3
Tamil Nadu	1076	41,000	1.74	5.83	4
Maharashtra	**720**	**1,12,000**	**1.18**	**4.43**	**5**
India	8118	5,30,227	104.37	37.27	

Source: Director of Fisheries, States Government / UTs Administration

Fish seed production in Maharashtra

In earlier days fry were collected from wild waters for culture. The urgent need for seeds to fill the expanding aquaculture industry resulted in technology breakthroughs in induced spawning of cultivable species during the period from 1700 to 1900. Indian scientists achieved the first success in induced breeding of Indian major carp through hypophysation in 1957 and Chinese succeeded in Chinese carp in 1958. Likewise, the penaeid shrimp species and the giant freshwater prawns used in culture were also hatched under control in hatcheries. The first scientifically designed fish farm was constructed by the then Madras fisheries department at Sunkesula in Krishna district (now Andhra Pradesh) during 1911.

In Maharashtra, there are 42 Fish Seed Centers, which include 28 Hatcheries, which are facilitated with Chinese Circular Hatcheries, to provide Indian Major Carp and Common Carp quality fish seed to state pisciculturists and 15 Rearing Units. The majority of these fish seed hatcheries either produces less than their capacity or are unusable due to administrative constraints.

Captive nurseries, rearing units, and pen or cage rearing units have yet to be established at each of the reservoirs in the state.

Table 3: State-wise Fish Seed Production in India

State	Production (2019-20) (lakhs Fry)
Andhra Pradesh	5358
West Bengal	124550
Gujarat	26083.7
Tamil Nadu	19426.88
Maharashtra	**13662.7**
India	521706.1

Source: Director of Fisheries, States Government / UTs Administration

Brackish water Aquaculture in Maharashtra

Maharashtra has around 80,000 hectares of brackish water suitable for shrimp production. In Maharashtra, about 12,445 ha of land is suitable for brackish water culture, of which 1,056 ha are developed. The state of Maharashtra has two coastal regions: the North Konkan region and the South Konkan region (Ratnagiri and Shindhudurg districts of konkan region). The majority of developed farms are small and isolated. In the region, there are no licensed shrimp hatcheries or shrimp feed mills. These two areas' coastal soils have a high porosity, which means they require a lot of water and energy.

Table 3: Present potential tapped and possible potential area in India

State	Area(ha)	Cultured area(ha)	% of Area Cultured
Andhra Pradesh	150000	52147	34.76
West Bengal	405000	59000	14.56
Gujarat	370000	4500	1.21
Tamil Nadu	56000	6250	11.16
Maharashtra	**80000**	**1400**	**1.75**
India	1,199,900	155598	12.96

Source: Mission Brackish Water/Saline Aquaculture-2022, NFDB

Reservoir fisheries in Maharashtra

Maharashtra has 1845 large and medium reservoirs with a total size of 2.73 lakh hectares. In reservoir fisheries, there is a large gap between potential and actual yield that can be addressed by scientific fisheries management practices. Modern technologies like cage culture, as well as established practices like pen culture, species enhancement, and stocking fast-growing fish species, can be used to tap into the reservoir fisheries resource. The productivity of reservoirs can be significantly increased by adopting methods such as cage culture.

Table 4: Distribution of small, medium and large reservoirs in India

State	Small		Medium		Large		Total	
	No.	Area(ha)	No.	Area(h)	No.	Area(ha)	No.	Area(ha)
Andhra Pradesh	2 898	201 927	32	66 429	7	190 151	2937	458 507
West Bengal	4	732	1	4 600	1	10 400	6	15 732
Gujarat	676	84 124	28	57 748	7	144 358	711	286 230
Tamil Nadu	8895	315 941	9	19 577	2	23 222	8906	358 740
Maharashtra	**-**	**119 515**	**-**	**39 181**	**-**	**115 054**	**-**	**273 750**
India	19134	1 485 557	180	527 541	56	1 140 268	19370	3 153 366

Source:https://annamalaiuniversity.ac.in/studport/download/marine/resources/Aquaculture_in_Reservoiur.pdf

Conclusion

India, in general, and Maharashtra in particular, have been slow in expanding its aquaculture resources. Potential water resources are unused, implying a large opportunity for growth in this field. On the basis of the lessons learned by neighboring nations, significant efforts must be made to expand aquaculture. Policies promoting cross-border exchanges must be loosened, particularly at the grass roots. "The wheel need not be invented" AGAIN AND AGAIN. Aside from technological advancement, a comprehensive approach that takes into account technical, environmental, and socioeconomic concerns is required.

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ROLE OF HERBS ON THE IMMUNITY OF FISHES

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Introduction

Aquaculture is a steadily growing industry world over (Anjusha *et al.*, 2019). In 2018, world aquaculture fish production reached 82.1 million tonnes, 32.4 million tonnes of aquatic algae and 26 000 tonnes of ornamental seashells and pearls, bringing the total to an all-time high of 114.5 million tonnes. Global capture fisheries production in 2018 reached a record 96.4 million tonnes, an increase of 5.4 percent from the average of the previous three years. Global catches in inland waters accounted for 12.5 percent of total capture fisheries production (FAO, 2020). This rapid growth process leads to an increase in bacterial, viral, fungal and parasitic diseases together with some environmental interactions (Yilmaj *et al., 2018*). Mainly, it is seen that the aquaculture industry has been significantly affected by viral and bacterial disease (Zhu F., 2020). There are two broad categories of diseases that affect fish, infectious and non-infectious diseases. Infectious diseases are caused by pathogenic organisms present in the environment or carried by other fish. In contrast, non-infectious diseases are caused by environmental problems, nutritional deficiencies, or genetic anomalies; they are not contagious and usually cannot be cured by medications (Sanil, 2020). The immune system protects an organism against diseases by identifying and eliminating the pathogen and suppressing the emergence of tumors. Another important role of the immune system is to participate in processes that maintain stable conditions (homeostasis) during development and growth and following inflammatory reaction or tissue damage (Magnadottir, B., 2010). Fish immune system is composed of innate and acquired mechanisms of defense (Biller *et al.,* 2018). The innate immune response involves a concerted network of induced gene products, preformed immune effectors, biochemical signalling cascades and specialised cells (Alexander *et al.,* 2018). The major components of the innate immune system are macrophages, monocytes, granulocytes and humoral elements, like lysozyme (Magnadóttir, 2006). At global level, people understood the bad effect of antibiotics and now they are shifting over to natural products (Fauci, 1993 & Citrasu 2010). Herbs contain many types of active components, like polysaccharides, alkaloids or flavonoids (Ardó et al., 2008). The herbal-compound extracts act as immunostimulants to enhance the immune response of fish viz. lysozyme, complement, antiprotease, meloperoxidase, reactive oxygen species, reactive nitrogen species, phagocytosis, respiratory burst activity, nitric oxide, total hemocytes, glutathione peroxidase, and phenoloxidase, against bacterial, fungal, viral, and parasitic diseases (Hai, 2015). The use of synthetic chemicals and drugs in disease control, has so far not produced excellent results, rather it has encouraged the emergence of disease resistant strains of pathogenic organisms (Oniovasa *et al.,* 2017). Probiotics are beneficial bacteria which not only capable of inhibiting pathogens, but also regulating the host immune system (Hoseinifar *et al.,* 2018). Traditional medicinal plants are most promising alternative source to control various diseases in aquaculture. Also their modes of administrations were proved to be more effective for enhancing innate and adaptive immune system against fish diseases (Hodar *et al.,* 2021). An immunostimulant is a naturally occurring compound that modulates the immune system by increasing the host's resistance against diseases that in most circumstances are caused by pathogens. The immunostimulants also have additional effects such as growth enhancement and increase in the survival rates of the fishes under stress (Arulvasu *et al*., 2013). Moreover, different parts (e.g. leaf, flower and rhizome) and forms (e.g. crude, extract and active ingredient) of plants are used to modulate specific biological functions (e.g. growth promoter, anti-stress, immunostimulants, appetite stimulation, antibacteria, anti-parasite and anti-virus) (Tadese et al. 2021). The adoption of these drugs in aquaculture appears to be only profit-driven and unsustainable, as they causes several other constraints such as fish pathogen drug resistance, immune suppression, environmental pollution, and accumulation of chemical residues, which can be potentially hazardous to the public health (Mariappan *et al*., 2020). Therefore, the use of functional supplements, such as plants, can also improve growth and feed assimilation contributing to a better optimisation of aquaculture resources (fish meal inclusion) (Reverter *et al*., 2021).

Role of Herbs

Herbal Drugs as Growth Promoters

Herbal products increased the growth and efficiencies significantly and reduced the osmotic stress. Medicinal plants have been proven as growth promoters. Firstly, they enhance digestive enzymes, and thus boost survival and growth rates of aquatic animals. The herbal growth promoters help to induce the transcription rate. This process leads to increased RNA, total amino acid and, finally, increases production of proteins in the cells (Citarasu, 2010). According to Lee and Gao (2012) also, herbs perform their initial activity in feeding as a flavour and thereby influence eating patterns, the secretion of digestive fluids and total feed intake. In another way, olfactory feed ingredients enhance the growth through their ability to act as feeding enhancers for fish to eat more feed than normal (Adams, 2005 & Syahidah, et al., 2015).Vitamin C and E levels in the hepatopancreas, and both sodium and potassium levels and muscle of freshwater prawns increased when the prawns were fed diets supplemented with herbs (Hai., 2015).

For instance, in an experiment, the roots of herb mulethi (Glycyrrhiza glabra Linn.) when mixed with the supplementary diet (groundnut oil cake and rice bran in 1:1) of fingerlings of an Indian major carp Cirrhinus mrigala (Ham.) at three different levels indicated significantly higher ($P<0.05$) the growth per day in per cent body weight, average wt. gain, food conversion ratio (FCR), gross conversion efficiency (GCE) and specific growth rate (SGR) in all the three treatments as compared to control (Kumae *et al.,* 2007).). *Channa punctatus* were fed daily twice with experimental feed containing ginger at 5% body weight for 60 days. The maximum mean increase in final weight after feeding of ginger based diet is 174.92g due to presence of carbohydrates, vitamins, carotenoids, minerals, tannin, fiber, alkaloids, flavoids and saponin as compared to the control diet without ginger (Pandit *et al.,* 2020).). Inclusion of 15% ginger in the diet of African catfish generally increased the growth optimally and reduced the serum biochemical indices to the minimal level required by the fish (Olaniyi *et al.,* 2020).In conclusion, the present results demonstrated that *Zingiber officinale* extract at a 0.2% level can effectively improve the growth and health status of Common Carp *(Cyprinus carpio)* (Mohammad *et al.,* 2020). The 750 g/kg of SPI protein (soy protein isolate) at 200 g/kg inclusion level can be replaced with the inclusion of 164 g/kg NPI (neem seed protein isolate) in the diet of *Labeo rohita* fingerlings while maintaining the analogous (P> 0.05) growth performances (Gopan *et al*., 2021). Similar study performed on Mozambique tilapia (Oreochromis mossambicus) with experimental feed containing dietary essential oil (citrus EO) extracted from sweet orange peel (Citrus sinensis) at different concentration showed better growth performance, increased immunity and also improved disease resistance to *S. iniae* infection in tilapia. Thus it can be used as an antibiotics replacer for controlling diseases in tilapia feed (Acar *et al.,* 2015). Hwang *et al*. (2013) tested the effect of green tea methanol extract (*Camellia sinensis*) in diets of black rockfish (*Sebastess chlegeli*). In their study, green tea was found to be a promising source in enhancing the growth, survival rate, feed utilization and protein content in fish body (Syahidah A. *et al.,* 2015).

Herbal Drugs Act as Immunostimulant

An immunostimulant is a chemical, drug, stressor or action that enhances the defense mechanisms or immune response, thus rendering the animal more resistant to diseases. (Citarasu., 2010). The thymus, spleen and kidneys are the main target organs of medicinal plants, which mainly promote the maturation and development of animal immune organs. In addition, medicinal plants can directly promote antibody production and participate in the specific immune response. Many medicinal plants can promote the production of cytokines that mediate specific/non-specific immunity, including interleukin, interferon and tumour necrosis factor. Medicinal plants display more biological activity than single compound because of their richness in secondary metabolites (SMs), such as essential oils, saponins, phenolics, tannins, alkaloids, polypeptides and polysaccharides (Tadese et al. 2021). Phagocytic activity is a primitive defense mechanism and an important characteristic of the fish immune system. (Neumann et al. 2001). This parameter usually shows an increase after oral administration of immunostimulants. Herbal medicine extracts can enhance phagocytosis in various fish species. Neutrophils were higher in fish fed ginger (*Zingiber officinale*) at 1% compared to ginger (*Z. officinale*) 0.5% and 1.5% (Brum *et al*., 2017, Kuebutornye *et* al., 2020.

Ginger (*Zingiber officinale*): Ginger is considered to have broad-spectrum prophylactic and therapeutic functions (Swain *et al.,* 2018). Ginger under the Zingiberaceae family (Bharathi *et al,* 2020). It is effective for the control of a range of pathogenic bacteria, as a deworming substance, anti-inflammatory and anti-oxidative substance. In addition, ginger is effective as an immunomodulatory agent in animals and fishes, and helps to reduce the losses caused by disease in aquaculture (Swain *et al*., 2018). Its underground rhizomes are the medicinally useful part (Mascolo *et al*., 1989 and Ajeel *et al*., 2013). Ginger (Zingiber officinale) is an herbaceous perennial plants that contains zingiberene as main component (Ali et al, 2008, Hodar *et al.,* 2021), along with the mixture of zingerone, shogaols, gingerols as well as sesquiterpenoids (Hodar *et al.,* 2021Ginger administration at 10 g/kg diet is beneficial in mitigating oxidative stress and immunosuppression of rainbow trout (*Onchoryncus mykiss*) during Oxytetracyclin administration (Zargar *et al,* 2020). Ginger powder, 10 g/kg ginger powder incorporated diet showed better growth response in terms of higher weight gain and specific growth rate in striped catfish, *Pangasianodon hypophthalmus* (Swain *et al.,* 2018).

Turmeric (*Curcuma longa*) : Turmeric (*Curcuma longa*), is one of *Zingiberaceae* family (Aggarwal *et al*., 2007 & Chan*et al*., 2009, Ayoub *et al.,* 2019). Turmeric comes from the rhizomes of Curcuma longa (Chainani-Wu 2003, Koca *et al*., 2020). Curcumin and its derivatives have antimicrobial, antioxidant, anti-inflammatory, appetite-increasing, immunomodulatory, and gastro-protective effects on animal health (Johannah *et al*., 2018, Alagawany *et al.,* 2021).

Lysozyme activity, superoxide anion production, and serum bactericidal activity increased after 60-day dietary supplementation of *Labeo rohita* with *Curcuma longa* (Sahu *et al.,* 2008). Dietary supplementation of curcumin (100 mg/kg diet) could considerably improve hematological parameters of the common carp (*Cyprinus carpio*) (Yonar, 2018, Alagawany *et al.,* 2021). Fish fed on diets containing 5.0 g TP/kg consumed more diet (29.6±0.24 g feed/fish) than the other treatments (1.0g TP/kg and 2.0g TP/kg) (Abdel-Tawwab, 2017). The exposure of fenvalerate, there was significant damage at the haematological and biochemical levels in fish *Clarias batrachus*. But, after the administration of rhizome extract of turmeric orally, daily by gastric intubation method at the dose of 100 mg/Kg body weight per day for 15 days, there was significant normalisation in the haematological and biochemical levels in fish (Kumari *et al.,* 2020). Garlic extract 1.5% or 1% turmeric extract to gouramy is known to be effective as an attractant, and can increase the growth of test fish with the highest feed consumption value in the treatment of 1-1.5% garlic extract, the lowest conversion ratio value (FCR) and highest utilization efficiency was found in the treatment of 1.5% garlic extract or 1% turmeric extract (Afifah, *et al.,* 2021). Storage of Indian white fish, *S. Sihama* in ice (1:1) deveined with 5 % turmeric allowed a remarkably good maintenance of sensory, pH, biochemical and bacteriological quality involving an extension of its shelf life up to 14 days when compared with other groups (Rajasekara *et al.,* 2020).

Neem (*Azadirachta indica*) : It comes under the family, Meliaceae. The Neem has been reported to have anti- inflammatory, anti – ulcer, antipyretic, anti – malarial, antibacterial, antifungal and antiviral properties (Mukherjee., 1996 and Bharathi *et al.,* 2020). Neem (*Azadirachta indica*) also known as an Indian herbal doctor; its leaves, bark, fruit extracts are directly used in aquaculture. It contains more than 25 components including vepol, salannin which exhibit greater potential on virus, fungus and parasitic resistance in fishes (Hodar *et al.,* 2021). Water soluble extract of *A. indica* leaves was found to possess significant hypoglycemic, hypolipidemic, hepatoprotective, anti-fertility and hypotensive activities (Mousa *et al.,* 2008). Aqueous extract of neem leaves has been used on fish-farms to control of fish parasites and fish fry predators such as dragon-fly larvae. Generally, Neem extract is considered of low toxicity towards non-target aquatic life. (Onivosa *et al.,* 2017). Neem leaf extracts (1.035 g/l) affects the hematological, ionoregulatory, biochemical and enzymological parameters of *Cirrihinus mrigala* even during a short-term exposure (24h) (Saravanan. *et al*., 2011). *Azadirachta indica* (neem) plant extract at a concentration of 150 mg/L was used as an alternative to antibiotics for treating bacterial infection in *Oreochromis mossambicus* (Thanigaivel *et al*. 2015, Kuebutornye *et al.,* 2020). The 96-hr median lethal concentration (LC_{50}) of *Caligus* and fish (10.3 ± 2.5 g of body weight) were 2 and 20 ppm respectively. The in-vivo test indicated that 10 ppm of neem oil could result in 100% antiparasitic efficacy within 96 hr (Khoa *et al*., 2019). Dip treatment in goldfish with *Azadirachta indica* aqueous leaf extract exhibited a significant increase in serum glucose, cholesterol and total protein (Harikrishnan *et al*. 2009 and Raman 2017). Statistical analysis of growth parameters revealed that 15g/1000g neem test diet showed highly significant (p<0.01) gain in body weight (11g), total body length (9.7cm), fork length (3.6cm) and specific growth concentrations (0.43) of *L. rohita* as compared to other diet groups but at 5g/1000g test diet of neem showed maximum (2.75) mean value of feed conversion ratio.

Aloe vera : *Aloe vera* (*Aloe barbadensis* Miller) is a traditional medicinal plant belonging to the family Aloaceae (WHO 1999, Assis, *et al.,* 2020). A large part of the leaves of this plant (circa. 99–99.5%) contains water with the remaining solid constituents (approx. 0.5–1%) have been reported to comprise 75% of the active substance including water- and fat-soluble vitamins, minerals, enzymes, simple and complex polysaccharides, organic acids, and phenolic compounds. A wide variety of pharmacological effects such as anti-inflammatory, antiviral, antibacterial, antifungal, and anti-radioactive properties as well as immune system stimulant have been attributed to the plant (Mehrabi *et al.,* 2020). For 7 days, 192 fishes (*Piaractus mesopotamicus*) were fed with diets supplemented with 0% (control), 0.5%, 1.0%, and 2.0% of the plant extract and then inoculated with bacteria and sampled 3, 6, and 24 h later and concluded that *A. vera* offered for only 7 days had stress-reducing effects, stimulated innate immunity, protected triglyceride levels in blood, lipid depots in the liver and muscle, and directed the energy mobilization to visceral depots (Assis, *et al.,* 2020). Fishes (*Labeo rohita*) were fed @ 2% of total fish biomass daily with feeds supplemented with AVP (*Aloe vera* powder) @ 0% (T0), 1%(T1), 2%(T2) and 3%(T3), respectively. The best results were obtained at 3% AVP inclusion level, which resulted in 48.19, 21.37 and 24.59%, higher NWG, SGR and protein content over control with better feed conversion ratio and protein efficiency ratio (Kaur *et al.,* 2020). The fish of groups were treated by *A. vera* and *S. officinalis* extracts in doses 0 (positive control group was fed by commercial diet without plant extract), 0.5, 1, and 1.5% (supplemented diet) and 80 mg/kg body weight erythromycin for the next 10 days. The results showed that *A. vera* and S*. officinalis* had antibacterial components as Cineol, and *S. iniae* was sensitive to both *A. vera* (MBC=4.067 mg/ml) and *S. officinalis* (MBC=5.185 mg/ml) extracts. Accordingly, *A. vera* (1.5 %) is useful to treat *streptococcosis* (caused by *S. iniae*) and alter gill and liver histopathological lesions in rainbow trout (Tafi *et al.,* 2020).

Herbal Drugs as Antibacterial Agents

The antibacterial active principles of the herbals may lyse the cell wall, block the protein synthesis and DNA synthesis, inhibit the enzyme secretions and interfere with the signalling mechanism of quorum sensing pathway.(Citarasu., 2010). Herb extracts have great anti-bacterial activity against both Gram positive and Gram negative bacteria. Indian almond extract was an alternative antibacterial remedy against tilapia ecto-parasites and the bacterial pathogen A. hydrophila. *Aloe vera* extract itself possesses proven antibacterial component. *Cinnamon* was found to have an antibacterial activity antagonistic to A. hydrophila infection in Nile tilapia. *Zingiber officinale* was applied for treatment of Vibrio illness in fish.

Herbs as Antiviral Agents

The most important viruses that cause high mortality rates in fish aquaculture are infectious hematopoietic necrosis virus, infectious pancreatic necrosis virus, hirame rhabdovirus, yellowtail ascites virus, striped jack nervous necrosis virus, and iridovirus. The herbal activity compounds may inhibit or block the transcription of the virus to reduce the replication in the host cell and enhance the non-specific immunity. Therefore, strategies to control viral components through herbal plants to stimulate or manipulate innate immune response via targeting those cellular ingredients needed for viral multiplication are paramount than the conventional method of manipulating viral proteins (Tadese et al. 2021).

S. No.	Scientific name	Common name	Properties	References
1.	*Zingiber officinalis*	Ginger	deworming substance, anti-inflammatory, anti-oxidative, immunomodulatory	Swain *et al*., 2018

S. No.	Scientific name	Common name	Properties	References
2.	*Curcuma longa*	Haldi	antimicrobial, antioxidant, anti-inflammatory, appetite-increasing, immunomodulatory, and gastro-protective hypoglycemic, hypolipidemic, hepatoprotective, anti-fertility and hypotensive activities	Johannah *et al*., 2018, Alagawany *et al.,* 2021. Mousa *et al.,* 2008
3.	*Azadirachta indica*	Neem	anti- inflammatory, anti –ulcer, antipyretic, anti –malarial, antibacterial, antifungal and antiviral	Mukherjee., 1996 and Bharathi *et al.,* 2020
4.	*Aloe vera*	Aloe	anti-inflammatory, antiviral, antibacterial, antifungal, anti-radioactive and immuno-stimulant	Mehrabi *et al.,* 2020
5	*Glycyrrhiza glabra Linn.*	Mulethi	Growth promoter	Kumar *et al.,* 2007
6.	*Allium sativum*	Garlic	Growth promoter, Antimicrobial, Antiviral, Antioxidant, and Antiparasitic	Valenzuela-Gutiérrez, R. *et al.,* 2021
7.	*Citerus sinesis*	orange	Antimicrobial and antifungal	Acar, *et al.,* 2015

S. No.	Scientific name	Common name	Useful part	Reference
1.	*Zingiber officinalis*	Ginger	Rhizome	Mascolo *et al*., 1989 and Ajeel *et al*., 2013
2.	*Curcuma longa*	Haldi	Rhizome	Chainani-Wu 2003, Koca *et al*., 2020
3.	*Azadirachta indica*	Neem	Leaves	Onivosa *et al.,* 2017, Saravanan. *et al*., 2011
4.	*Aloe vera*	Aloe	Leaves	Mehrabi *et al.,* 2020
5.	*Glycyrrhiza glabra Linn.*	Mulethi	Roots	Kumar *et al.,* 2007
6.	*Allium sativum*	Garlic	Bulb	Valenzuela-Gutiérrez, R. *et al.,* 2021
7.	*Citrus sinensis*	orange	peel	Acar, *et al.,* 2015

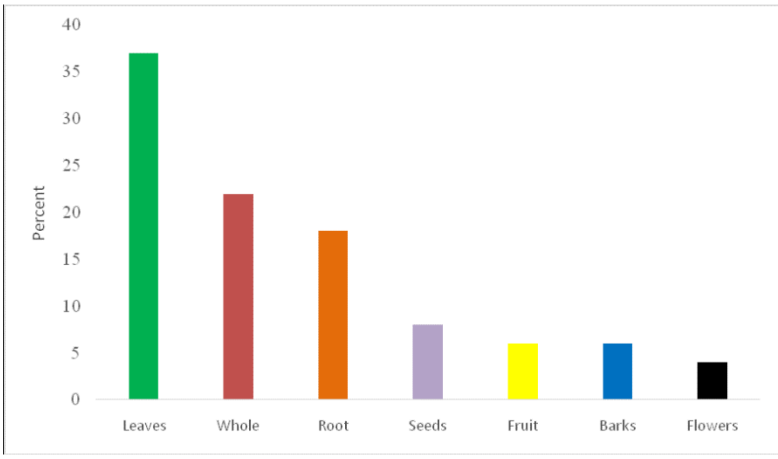


Figure source: Anjusha *et al.,* (2019)., Int.J.Curr.Microbiol.App.Sci 8(9): 2371-2376

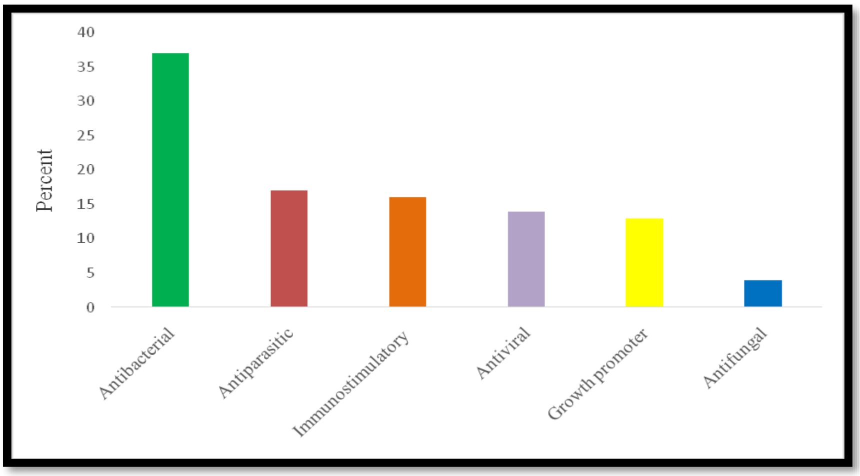
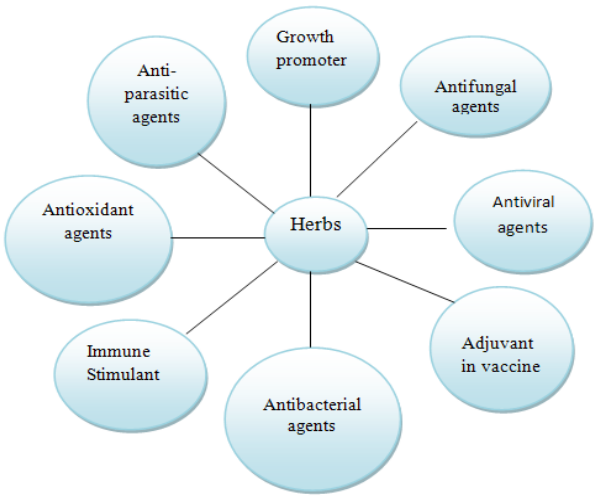


Figure Source: Maiappan., et al, 2020. Natural Herbs as an Alternative Treatment against Fish Diseases. Biotic Research Today 2(10): 1023

The use of functional supplements, such as plants, can also improve growth and feed assimilation, contributing to a better optimization of aquaculture resources The use of functional supplements, such as plants, can also improve growth and feed assimilation, contributing to a better optimization of aquaculture Int.J.Curr.Microbiol.App.Sci (2019) 8(9): 2371-2376.



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SEED PRODUCTION IN BENGAL GRAM / CHICKPEA / GRAM (*Cicer arietinum* L.)

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Chickpea (*Cicer arietinum* L.) is considered as one of the most important and valuable legume. The word *'Cicer'* is derived from a Greek word 'Kiros' which refers to well- known Roman family 'Cicero'. The word*'arietinum'* is derived from Latin word *'aries*' which means 'ram' (male sheep) because of ram's head shape of *Kabuli* chickpea. Chickpea, an annual legume belongs to family *Leguminaceae*(*Fabaceae*), subfamily Faboideae. Chickpea is commonly known as Gram, Bengal gram, Garbanzo bean or Egyptian pea. Chickpea's center of origin is South-Western Asia. Chickpea is consumed as whole seed, dal, fried, boiled and salted. Sprouted chickpea is usually eaten as vegetable or added to salads. Chickpea plants are also used as fodder. Leaves of chickpea plant are used as vegetable. Sometimes, whole seeds are milled for animal feed. Glandular secretion from leaves, stem and pods of Chickpea includes malic acid (90-96%) and oxalic acid (4-10%). About 4-4.5 kg of these acids can be obtained from per hectare of chickpea crop. This sour tasting acid can be used as medicine or used as vinegar. Milling into dal, puffing into snack foods, grinding into flour are the primary processes to which chickpea is subjected to. Chickpea is used for preparation of various sweets and spicy dishes using either spilt grains or flour. Exudation of leaves called 'Amb' possess medicinal value for cholera, constipation, diarrhea, bronchitis, blood purification. To cure scurvy disease, germinated seeds are recommended.

Notified varieties : Digvijay, Vishal, Vikas, Vishwas, PKV Kabuli 4, Pusa 1103, Pusa 1105

Land requirement : Land should be free of volunteer plants. The previous crop should not be the same variety or other varieties of the same crop.

Field inspection : A minimum of two inspection shall be made from the time the crop approaches flowering until it is ready for harvesting.

Isolation distance : A minimum isolation distance of 10 m for foundation seed and 5 m for certified seed should be maintained.

Field preparation : Chickpea plants are highly sensitive to poor aeration in the soil. Seedling emergence and plant growth are hindered if field is compact. The field should have loose tilth and good.

Seed and sowing

- Sowing time : Chickpea is grown in rabi (postrainy season) following a kharif (rainy season) crop or kharif fallow. The sowing is done in the month of October or November. Late sowing (December-January) should be avoided as the late-sown crop may experience moisture stress and high temperatures at the critical stage of pod-filling, leading to reduced yield and seed quality.

- Isolation distance : Isolation of a seed crop is done by maintaining a distance from other nearby fields of the same crop and other contaminating crops. Chickpea being a self-fertilized crop has a very low out-crossing percentage (0-1%). In India, an isolation distance of 10 m for foundation seed and 5 m for certified seed is required.
- Suitable soil type : Chickpea can be successfully grown in a variety of soil types including coarse-textured sandy to fine-textured deep black soils (vertisols). However, the best suited soils are deep loams or silty clay loams with a pH ranging from 6.0 to 8.0. Saline soil and fields with a high water table are not suitable for chickpea.
- Sowing : Sowing is usually done on conserved soil moisture. A pre-sowing irrigation may be needed, if the available soil moisture is not adequate for germination. Kabuli chickpea should never be irrigated immediately after sowing, particularly in deep black soils. This is because the kabuli chickpea seeds have thin seed coat and deteriorate faster as compared to desi type and are also more susceptible to seed rot and seedling damping off.
- Sowing depth : Seed should be sown deeply enough to make contact with moist soil. A depth of 5-8 cm seems to be ideal for the emergence of chickpea.
- Spacing : Line sowing is a must in the crop grown for seed production as it facilitates interculture operations, rouging and field inspection. Row-to-row spacing of 30 cm and plant-to-plant spacing of 10 cm are generally used, which give a plant population of about 33 plants per m^2 (330,000 plants ha^{-1}). Wider row spacing (45-60 cm) can be used in large seeded kabuli chickpea and irrigated crops (both desi and kabuli types), which are expected to have greater plant width. Broad bed and furrow system or ridge and furrow system are very useful for irrigation, drainage and interculture operations.
- Seed rate : It differs from variety to variety, depending on seed size. For initial seed multiplication of a new variety, the multiplication rate (yield per plant) is more important than yield per unit area.

Seed size (100-seed weight)	Seed rate
Small (less than 20 g)	50-60 kg ha^{-1}
Medium (20-30 g)	60-90 kg ha^{-1}
Large (30-40 g)	90-120 kg ha^{-1}
Extra-large (more than 40 g)	120-150 kg ha^{-1}

Fertilizer application : Fertilizer requirements depend on the nutrient status of the field, and thus, vary from field to field. Therefore, the doses of fertilizers should be determined based on the results of soil test. The generally recommended doses for chickpea include 20-30 kg nitrogen (N) and 40-60 kg phosphorus (P) ha^{-1}. If soils are low in potassium (K), an application of 17 to 25 kg K ha^{-1} is recommended. There will be no response to application of K in soils with high levels of available K. Total quantities of N, P and K should be given as a basal dose.

Irrigation : Chickpea is generally grown as a rainfed crop, but two irrigations, one each at branching and pod filling stages, are recommended for higher yield. Higher number of irrigations may lead to excessive vegetative growth in heavy soils.

Weed management : Pre-emergence herbicides, such as Fluchloralin @ 1 kg a.i. ha^{-1} or Pendimethalin @ 1.0 to 1.5 kg ai. ha^{-1} were found effective in controlling early flush of weeds. Mechanical and/or manual weeding can be done where wide row spacing is used.

Plant protection : Chickpea being a rich source of protein, is prone to damage by insect-pests and diseases. In general, root diseases (fusarium wilt, collar rot and dry root rot) are more prevalent in central and peninsular India, whereas foliar diseases (ascochyta blight, botrytis gray mold) are important in northern, north-western and eastern India. Among the insect pests, pod borer (*Helicoverpa armigera*) is the most severe yield reducer throughout India in the field, while bruchids (*Callosobruchus chinesis*) cause severe damage in storage.

Threshing : Thresh the pods either with bamboo stick or pulse thresher.

Drying : Dry the seeds to 8-9% moisture content.

Seed grading : Grade the seeds using wire mesh sieve for large seeded varieties. Do not select the discoloured and broken seeds for seed.

Seed treatment : Treat the seeds with carbendazim @ 2 kg ha^{-1} of seed. Treat the seed with neem oil/ groundnut oil/ leaf powder of tobacco/ neem. Expose the seeds thrice with 50% CO_2 at 8% moisture content at 15 days interval.

Storage : Store the seeds in gunny bags for short term shortage with moisture content of 8-9%. Store the seeds in polylined gunny bags for medium term storage with seed moisture content of 8-9 moisture %. Store the seeds in 700 gauge polythene bag for long term storage with seed moisture content of less than 8%.

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SKILLED HUMAN RESOURCE: NEED OF FARM MECHANIZATION

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The agriculture sector in India has witnessed a considerable decline in the use of human power in agriculture related activities. The trend has paved a way for a range of agricultural tools. A large number of these are driven by fossil fuel operated vehicles such as tractors, diesel engines. This has resulted in a shift from the traditional agriculture to a more mechanized agriculture. Employment Guarantee Act and huge demand from the construction sector in cities. Labour is available at a higher cost per hectare and this would increase the demand for mechanization. It has been observed that the percentage of agricultural workers to total workers in India has been gradually declining and it is expected to further decline to 25.7% by 2050 leading to severe farm labour shortage. Only about 40% to 45% of agriculture in India is mechanized. The penetration is lower with the small and marginal farmers who own land less than 5 hectares. Thus, there is a lot of potential for increasing the penetration of farm mechanization and therefore growing the need of mechanization and skilled human power required for that.

Farm mechanization requires skilled and well-trained personnel to use various energy sources and improved farm tools and equipment to increase productivity, cropping intensity, precision and speed of harvest. Efficiency of various agricultural inputs and reduce losses at various stages of agricultural production. The combination of skilled humans and agricultural mechanization is a requirement of contemporary agriculture to increase productivity and overall production at the lowest possible cost.

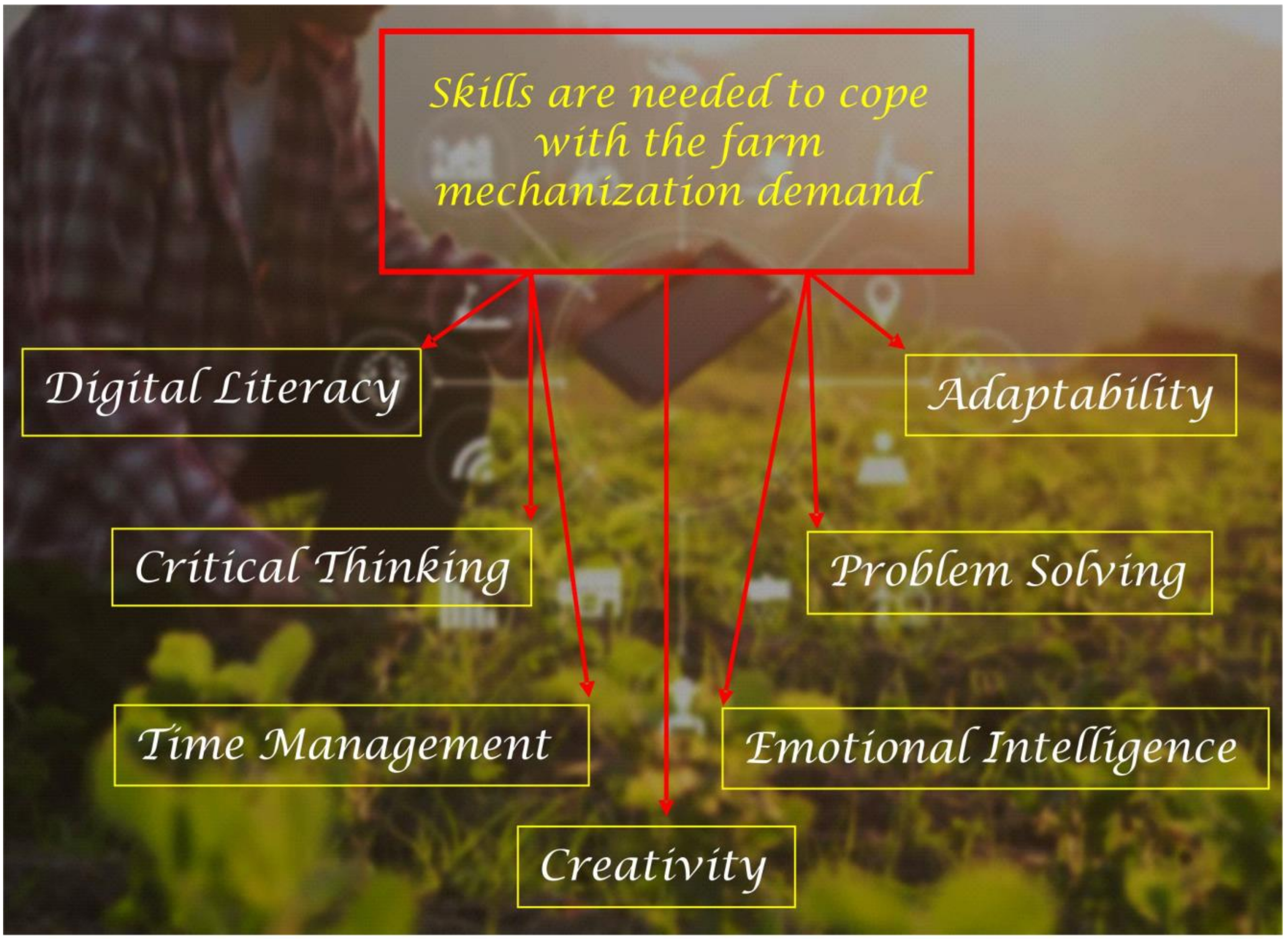
Skilled Human Resource

In agriculture, tasks are usually executed manually because it is impossible to automate every aspect of farm work. This results in labour being the most important operating expense for a plantation or large farm management. Hence, precise labour tracking is an indispensable factor for agriculture.

Skilled human resource or manpower refers to the person who is trained, well-educated, experienced, devoted to their field and is capable of doing any specific work in a balanced way and efficiently.

Management of farm machinery and human resources can have a great impact on the productivity and profitability of agriculture business. They are extremely helpful to farmers, right from planning and scheduling operations perfectly to tracking and controlling processes across the entire plantation. Technical education and skill development are two essential capabilities that required to secure India's long-term growth in mechanized world. It is important to create competent skilled human resources to fulfil the potential of agriculture sectors for mechanization. Agricultural workers with advanced skills are needed to meet the demand of the industry. The agricultural sector is made up of many components. Consequently, a profession in this field can be divided into a variety of job types, ranging from technology to management, as well as physical work.

Technical education and skills development are two critical capabilities that need to be cultivated to ensure India's long-term growth in today's global environment. It is important to create competent human resources to preserve, diversify and take advantage of the potential of agricultural value chains. Agricultural universities must make the development of agricultural human resources a continuous process.



Benefits of skilled human resource in farm mechanization :

- More efficient use of land and other natural resources, labour and capital in agriculture.
- Conservation of soil and other natural resources essential for agriculture.
- Increasing efficiency, production and yields in agriculture and improving the quality and preparation of agricultural products and their proper processing on the farm in order to facilitate their marketing and, in particular, to raise the nutritional level.
- Improved income, standard of living, job opportunities, working conditions and prospects for the development of agriculture as a contribution to redressing the imbalance between agriculture and other occupations in these aspects.

- Promotion of mechanization, where appropriate, and safety in agricultural work, and lightening of the tasks in agriculture, in particular for women and children.
- Achieving an adequate balance of employment between agriculture and other branches of economic activity.
- Provide appropriate career guidance to rural youth.
- Encourage an adequate number of young people to enter various fields of agriculture, where appropriate.
- Overcome the problems of seasonal unemployment and underemployment in agriculture.
- Bridging the gap between technical developments that affect agricultural production and their use in practice.
- Improvement of rural life in general and promotion of greater satisfaction in agricultural work.

Duties of skilled human resource in farm mechanization

1) Selection of Machinery

Agricultural equipment and machinery must be selected in a way that is compatible with all the agricultural needs of a farmer. Choosing the right farm machinery brings multiple benefits to farmers that also allow them to protect themselves from operating expenses, generate more profit and grow more crops with less effort.

2) Farm Power Management

Agricultural machinery can help farmers increase their productivity and production, while allowing them to carry out agricultural operations in a timely manner. Cropping intensity is improved and farmland becomes more financially viable by producing a second crop or multiple crops in the same area. Various integrated farming system possible from mechanization.

3) Maintenance of Machine and Repairing

To minimize costly breakdowns, thorough maintenance and precise repairs are necessary to keep farm equipment running smoothly and reduce the cost of mechanization.

4) Innovative Technology Adoption

The adoption of technologies is influenced by the development, diffusion and application of existing and innovative biological, chemical and mechanical techniques at the farm level, all of which are included in agricultural and other inputs; it is also influenced by education, training, advice and information, which form the knowledge base of farmers, but are still necessary.

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SUSTAINABLE FARMING-STATUS IN INDIAN AGRICULTURE

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As the saying goes "From great soil comes great food", farming practices considering health of the soil is more important in today's agriculture. The Green Revolution of the 1960s transformed India from self-sufficiency to surplus enough to export farm produce by adopting unsustainable farming methods; however, this transition unleashed the slew of problems affecting biodiversity and human health, particularly malnutrition. In this regard, sustainable farming practises that consider the health of society, the environment, and the economy altogether help to subdue this effect. The emphasis on the sustainable indigenous farming practises of many other underrepresented but successful Indian farmers has become a necessity in order to raise awareness and encourage bigger farm groups to pursue sustainable farming, which can contribute to the evergreen revolution movement.

Introduction

Although India was liberated from the British regime in 1947, it was still plagued by the after effects of the Bengal Famine, which compelled Indian traditional agriculture to adopt modern developments in order to meet food security. The utilization of high-yielding varieties of Rice and Wheat, intensive irrigation, use of pesticides and fertilizers produced millions of extra tonnes of grain leading to the Green revolution in 1960's. It made India self-sufficient to surplus enough to export. Nonetheless, the shift unleashed many problems affecting biodiversity, chemical overuse, loss of soil fertility, cereal centric, and taking a major toll on human health especially malnutrition. Such unfathomable condition necessitates the transition from green to evergreen movement, as rightly coined by Dr. M. S. Swaminathan as "evergreen revolution". This features the pathway of increasing the food security of the nation with judicious integration of natural resources for sustainable farm production. NITI Aayog has laid a 3-year road map (2017-20) for the same. Along with these national level initiations, we also need to grandstand the commitment of some legends, those who have been following the path of sustainable green movements. Like Subhash Palekar's "natural farming", Vathur Narayana Reddy's "organic agriculture", and a few other examples of sustainable farming who ought to be the models for the Indian evergreen revolution and food security. In this article, we emphasize the sustainable indigenous farming system which can serve a road map for evergreen revolution.

Subhash Palekar Natural Farming (SPNF)

Farming practices that are considering soil health are necessary for future food security. Subhash Palekar, an agricultural graduate, joined his father's farming and began to implement his ideas in the field. SPNF technique promotes the use of natural resources such as farm manure as well as other natural products such as Jeevamrut, which is widely utilised in natural farming, protects the soil microbiome and the soils overall health and fertility instead of chemical pesticides.

Organic farming and farmers in India

Organic farming in India is about 2.78 M ha as of March 2020; according to the Union Ministry of Agriculture and Farmers' Welfare, constituting two per cent of the 140.1 M ha net sown area in the country. The National portal of India provides detailed information on various organic farming centres and states, including National Centre of Organic Farming (NCOF) and Sikkim Organic Mission, as well as organic farming in Mizoram, Tamil Nadu, Rajasthan, Maharashtra, and Uttarkhand's organic orthodox tea. Further information on initiatives taken by the Ministry of Food Processing Industries for the development of organic farming is also available. Information on crop rotation, crop residue, organic manure, bulky organic manure, bio-fertilisers, and types of bio-fertilisers, bio-pesticides and vermicompost are also provided in national portal of India.
The Organic Farming Association of India (OFAI) was founded by India's organic farming community to promote organic farming as a means of achieving sustainable agriculture and to assist farmers in successfully transitioning to organic farming methods. The association's president will always be an organic farmer, but it actively campaigns against the introduction of genetically modified (GM) organisms and seeds into Indian agriculture, which may not be a wise decision in our opinion because GM crops can be part of organic and sustainable farming, with the main advantage of chemical-free crop protection and crop production.

Sustainable farming can be supported at the individual level in two ways: either by taking inspiration or recognising and rewarding the outstanding contribution made to the organic industry by farmers, stakeholders, state governments, and business entities. One such initiative by the Jaivik India Awards, in 2019 honoured six of India's Best Organic Farmers including Lanuakum Imchen, Manoj Kumar, Kailash Ram Netam, Sachin Tanaji Yavale, Hanumanth Halaki (Organic Farmers' Group) and Maathota Tribal Farming and Marketing Producer Company Limited (Organic Farmers' Group for their achievements. This kind of initiatives needs be scaled up to promote and encourage sustainable Agriculture in India. We must also be inspired by excellent organic farmers like Fukoka of Karnataka, L Narayana Reddy, is a farmer from Varthur in Bengaluru. He became interested in organic farming after a traveller from California handed him a copy of Fukuoka's 'One Straw Revolution,' a book that outlined organic agricultural techniques. He stopped using chemicals including pesticides and decided to dedicatedly practice organic and natural farming, a transition that was completed in 1979. He has also written few books on organic farming practices in Kannada language including the book called 'Saavayava krushi chetana'. All of these success stories of organic farmers should drive a sustainable green movement without compromising the productivity and quality of the crop produce.

Conclusion

We can strengthen soils that support robust crops while protecting water sources, reducing greenhouse gas emissions, and creating fields more resilient to extreme weather by adopting sustainable farming practices. Further adopting artificial intelligence and machine learning, in addition to GM crops help to increase agricultural output in sustainable agriculture. The high scope of the sustainable farming in a whole and organic farming in particular is also being seen because a lot of people are reshaping their health in their lifestyle. As a result there is a huge possibility for the farmers to get a great response for organic products from the consumers. It's a win-win situation for both farmers and the environment.

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VALUE ADDITION AND NUTRITIONAL VALUE OF JACKFRUIT

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Introduction

Jackfruit (*Artocarpus heterophyllus* Lam), It is an unusual Indian fruit grown mostly in West Bengal, Bihar, Assam, and the Western Ghats. Among tropical fruits, Jackfruit is an essential underused fruit that is frequently referred to as the poor man's fruit due to its low cost and availability in vast quantities during the season. Because the fruits may be collected from wild or locally accessible trees, they help impoverished people's livelihoods. Furthermore, when planted in agroforestry and home garden systems, it has the potential to improve local revenue. The mature fruit of jackfruit is divided into three parts: the bulb (30-32 percent), the seeds (18 percent), and the peel (5-55 percent).The fruit, both immature and ripe, is the principal commercial product of jackfruit. The sweet and fragrant arils of ripe jackfruit are mostly eaten as a dessert (bulb). The young or the fruits is not mature is also consumed as a vegetable, and it contains a lot of vitamins and minerals. During the season, seed is a rich source of starch and a delicacy. The mature fruits' jackfruit seeds are also fried, boiled, or roasted for direct consumption.

Nutrional Value

The fruit contains a lot of beta-carotene, potassium, and a tiny bit of ascorbic acid. It also contains vitamins B complexes including thiamin, riboflavin, and niacin, as well as minerals like calcium and potassium. It is claimed that the seeds are more nutrient-dense than the bulb because they contain larger concentrations of protein, fat, potassium, glucose, phosphorus, and calcium. The tree's timber is also highly valued for its strength and is desired for construction and furniture. In order to create disposable plates, the dried leaves are stitched together (Devi et al., 2014).

Every year, West Bengal produces a lot of jackfruit. Because it is perishable and there is a seasonal oversupply, a sizeable portion of it gets wasted. Post-harvest losses in jackfruit are approximately 30-35 percent during the peak season .With over 100 products that can be created from the immature stage to the fully grown condition, jack fruit has a tremendous value-added potential.

The significance of the fruit, seed, and rind is unknown to both growers and consumers. Therefore, value addition is crucial for both utilising the excess fruits that are available during the season and enhancing lifestyle.

Value added products unripe jackfruit

Chips-Jackfruit chips are made from unripe jackfruit. Slices of various sizes are cut and blanched in 94°C to 95^{o}C boiling water for 5 minutes. The slices are then dried for 1 hour at 60°C and 6 hours at 75°C. Finally, the slices are cooked in edible oil at 170°C. When the slices have turned a light yellow colour, they are taken from the pan and combined with salt before being packaged (Bhuyan et al., 2013). **Pickle**- Pickle is made from unripe jackfruits. Small pieces are created from bulbs and seeds and packed with oil, salt, and spices to create value-added goods. **Brined product**- Mature green jackfruits are cleaned, skinned, and sliced into little pieces. They are then stored in a solution containing 8% salt, 1.25 percent acetic acid, 0.1 percent KMS, and 91.65% water. The components are then placed into an airtight plastic container and stored in a cold, dry location. **Ready-to-cook (RTC) jackfruit** - The jackfruit has been cleaned, skinned, and sliced into bite-sized pieces. These chunks may be kept and packed for ready-to-cook jackfruit products with minimum preparation. **Preserved jackfruit** - Unripe mature bulbs can be blanched and dehydrated for use all year.

Value Added Product from Half-Ripe Jackfruit Candy

For the purpose of manufacturing candy, half-ripe jackfruit with medium-firm flesh is picked and rinsed. Then, it is divided into pieces of 1.0 cm by 0.5 cm by 0.5 cm, and blanched for 4 minutes in 95°C boiling water. After 2 hours of soaking in 2% calcium lactate and 0.1 percent KMS, the components are drained. The pieces are immersed in sugar solutions of 25, 35, 45, 50, 60, and 70 °Brix at intervals of 12 to 13 hours. Before being dried in a cabinet dryer at 70°C until the moisture level reaches 10%, the slices are drained and rinsed with clean water to remove any syrup that may still be present. In a polypropylene pouch, the product is stored at ambient temperature (28–32°C).

Value Added Products from Ripe Jackfruit: **Jackfruit Rind Jelly**

The recovery of jackfruit bulbs or edible part (pulp) ranges between 20% and 25%. After cutting the fruit into various pieces, the bulbs are carefully removed. Because the fruit contains sticky latex, a small amount of vegetable oil is applied to the hands before removing the seeds from the bulbs. **Jam**-It is made with additives from the pulp of ripe fruits. To extract juice, fully ripe jackfruit bulbs are mashed and cooked for 5-7 minutes. Then 700 g sugar and 10 g pectin are added to 1 kilogramme jackfruit pulp and boiled until the TSS reaches 64° Brix before adding 0.25 percent citric acid. End point is determined through flake test and the jam is poured while hot in sterilized bottle and stored at room temperature. **Jackfruit leathers**- Fully mature jackfruit is washed and picked after the seeds are removed. These bulbs are boiled for 5-7 minutes while being combined with 10-15% sugar to extract the juice. KMS At 0.1g/kg is then added, and the mixture is simmered for an additional 3 to 5 minutes. The mixture is dispersed in a stainless steel tray after being distributed in a steam jacketed pan. A cabinet dryer is used to dry the tray for 20 hours at 60 °C, or until the moisture content is 20%. It is then preserved after cooling and cut into the required size pieces. **Nectar** -The bulbs are put through a pulping machine where 10% hot water is combined to create pulp. Using this pulp, nectar is produced. Canning: Ripe bulbs can be kept for up to a year in sugar syrup or as sweetened pulp, while unripe bulbs are canned with a small amount of citric acid. Jackfruit pulp has strong flavor, it is be used to flavour ice cream, custard, beverages, bread products, ready-to-serve (RTS) drinks, chutney, toffee, and other value-added commodities. **Ready to eat (RTE) products**- Jackfruit bulbs that are ripe can also be preserved as a convenient, ready-to-eat food item with minimal preparation. This product must be kept and delivered in a refrigerator because it has a finite shelf life.

Seeds of Jackfruit: In the same way as vegetables are used in culinary preparation, jackfruit seeds can be processed into seed powder. Seeds are used in vegetable cooking and seeds are often roasted and eaten like nuts.

Conclusion

Jackfruit is known as minor fruit crop or underutilized fruit crop but there are lots of utility of jackfruit plant from immature to mature. But due to lack of knowledge of farmers it is tilled now known as rear fruit plant. More research should be necessary for more production of this crop and also to make it commercialize.

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PLASTIC LOW TUNNELS: STRATEGIES FOR OFF-SEASON CULTIVATION OF CUCURBETACEOUS VEGETABLES

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Abstract
For off-season production of cucurbits including summer squash, bottle gourds, bitter gourds, muskmelon, watermelon, round melons and long melons in peri-urban areas of India's northern plains, plastic low tunnels are ideally suited and highly profitable. In comparison to open field gardening, some cucurbits, like cucumber, can have a significantly higher yield. The cost of building the protected structure, its operating expenses, and the market for premium outputs, all have a direct impact on the economics of protected farming. Therefore, plastic low tunnels are ideal since they can typically be built at a low cost, and their ongoing maintenance costs are also quite low. The best technique to boost the productivity and quality of vegetables, especially cucurbits, is to grow them beneath covered structures like low tunnels. In order to improve plant growth by warming the air surrounding the plants in the open field during the winter, row covers or low tunnels are flexible, translucent coverings that are erected over the rows or individual beds of transplanted vegetables.

Keyword : Cucurbits, Off-Season**,** Plastic Low Tunnels, Protected structure

Introduction

For the purpose of gaining an early market advantage, vegetable growers frequently attempt to advance the growing season for particular vegetables. Crops like muskmelon, round melon, long melon, cucumber, bitter gourd, etc., are profitable in the market if they are produced early by a month or in the summer. Our country has a long-standing tradition of growing some cucurbits in the off-season on river beds, but there is only a very small amount of land available for this activity. Early crop planting can extend the growing season, especially for some cucurbits that can be cultivated in low-cost protective structures like plastic low tunnels or row covers from January to mid-February. In the USA, Israel, and certain European nations, it is common practice to employ plastic low tunnels (row covers) and plastic mulching for off-season muskmelon, watermelon, and summer squash production in order to sell the products for a premium price.

Materials required for construction

Pipes made of High Density Polyethylene (HDPC) and Polyvinyl Chloride (PVC) that are one inch in diameter and two meters long. Transparent Low Density Polyethylene (LDPE) films with a 2 meters width and a thickness of 25 to 50 microns as well as 50 cm in size.

Nursery Raising

Depending on the crop, seedlings of the desired cucurbits are raised in the nursery greenhouse in the months of December or January in plastic pro-trays with 1.5 inch cell size in soil-less media. When the night temperature in northern India is quite low, between the middle of January and the first week of February, seedlings that are 30-32 days old and have reached the four leaf stage are transplanted in an open field under row covers or plastic low tunnels.

Preparation of Beds, Fixing of Hoops, Transplanting and Covering of plastic

The seedlings are transplanted using a drip watering system in a single row at a planting distance of 50 cm on each bed. Before transferring seedlings to beds, the distance between the rows is kept at 1.5 to 1.6 meters, and flexible galvanized iron hoops are manually fastened at 1.5 to 2.0 meters apart. Depending on the crop and the time of planting, the width of the two ends of the hoops is kept 45–60 cm above the surface of the beds. In order to conserve the most sunlight, tunnels are typically constructed from north to south. Following the morning transplantation of the appropriate cucurbitaceous crops, the plastic is typically covered in the late afternoon. After transplanting, 3–4 cm-sized vents are typically formed on the eastern side of the tunnels, just below the top, at a distance of 2.5–3.0 m. Later, as the temperature rises, the size of the vents can be increased by shortening the distance between two vents. Finally, depending on the crop, its growth, and the nighttime temperature at that time, the plastic is fully removed from the plants in February or March.

Pollination

Most cucurbits require pollination, which is typically carried out by honeybees (*Apis melifera* L.) because they are monoeceous in sex form. Flowering bees may readily work in tunnels through the vents formed in the plastic when there is competition. One beehive with 30.000 workers is sufficient for pollinating crops like muskmelon, summer squash, etc. For the best bee activity, the beehive box is always positioned on the north-western edge of the field.

Fertization and Plant Potection

In the first month, from January till February, drip irrigation can be used to apply fertilizer at a rate of 4.0 m^3 per 1000 m^2 every 6-7 days. N: P: K (5:3:6) fertilizer solution is sprayed at 80–100 ppm per cubic meters of water. In the second month, 4.0 m^3 of water can be administered over the course of 4 days with a fertilizer solution containing 120-150 ppm/m^3 of water until the crop starts to flower. After that, the fertilizer is reduced to 20 to 30 parts per million (ppm) until the fruits are the size of lemons, at which point it is again increased to 120 to 150 ppm per cubic metre of water. To improve the quality of the fruit in muskmelon, the fertilizer solution quantity is once more decreased to 50–60 ppm prior to the ripening of the fruit. However, in other cucurbits, the amount of fertization always increases, going from 50 ppm to 300 ppm during the height of fruiting. If necessary, a systematic insecticide can be sprayed into the crop using drip irrigation to control insects in the early stages of growth when the crop is protected by plastic tunnels and foliar spraying is not an option.

Harvesting

The fruits will be ready for harvesting during the third week of April if the muskmelon crop was transplanted during the first week of February. The first week of April, which is typically 45 days earlier than the normal season production, is when the fruits from the mid-January transplanted crop can be harvested. Similar to this, other cucurbitaceous crops in northern regions of the nation can also be advanced by 40–60 days.

Conclusion

Low tunnels are ideal for growing vegetables in mountainous states like Himachal Pradesh, Jammu & Kashmir, Uttarakhand, and the North Eastern states, as well as in cold desert regions, peri-urban areas of the northern plains, and other areas. In hilly areas, indigenous technical databases must be created to make the adoption of protected farming sustainable. The greenhouse needs to be designed in a way that is both affordable and appropriate for its surroundings. It is necessary to develop the package of methods, including fertigation, for various agro-climatic conditions. To reduce environmental pollution, the use of biodegradable plastics or polymers should be encouraged. The current technique will undoubtedly benefit greatly from further development in order to realize the full potential of low-cost polytunnels for vegetable production in the hilly regions.

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