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Growing seed

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ROLE OF INDIGENOUS TECHNICAL KNOWLEDGE (ITK) IN AQUACULTURE

Article Id: AL202198

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The Indigenous technological (ITK) in aquaculture predominantly related to farm inputs has been developed by the farmers themselves, based on their experiences. Farmer's innovation is based on their indigenous knowledge. The indigenous knowledge is the accumulated knowledge, skills, and technology of the local farmer derived from the interaction of the ecosystem. The knowledge has been inherited from generation to generation. This radically changes the use of fertilizers and devised some unique right-hand thumb rule for disease diagnosis and treatment without the costly antibiotics and chemotherapeutic agents, which is mostly useful for middle fish farmers.

1. Garlic and Fenugreek- As a fish attractant

Some farmers are used garlic and fenugreek seed for easier harvesting and fish attractant. For that 1kg of semi-dried garlic mixture with 250g of roasted and grind fenugreek seed. After mixing, both compounds applied in a pond. After one hour, a group of fish gets attracted to it because of aroma release through this compound, and fisher catches the fish easily. This mixture is enough to a water body for the one hectare area. This combination is also used as bait or attractant for angling.

2. Application of cattle urine

Some fish farmers in India collected cow urine and sprinkled on the surface of the fish pond to get control of algal bloom, but this method has been a band in other countries.

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3. Broadcasting ash in fish pond

In this system, first of all, burns the paddy straw or hay and after that complete burning gets ash, this ash is broadcasting in the fish pond, Farmers believe that it prophylactic measures to keep out the fish disease.

4. Asafoetida (Hing) are used for attracting Magur and Singhi

Most of the fish farmers in India culture Magur and singhi because there is a lot of demand in the fish market, but there is a lot of difficulty in harvesting it because it burrows inside the mud. For eliminating this problem twigs, leaf or branch of tree are placed in the pond before harvesting. Then the hing is tied in a cloth and is kept in around the leaf or twigs so that the fish becomes attract After 5 to 10 minutes put the net around the twigs and harvest the fish.

5. Control of Argulus by gunny bag and bamboo pole

Some farmers are old gunny bag is kept in bottom of pond, So that the larvae sticks to the bag and the farmer dry and killed eggs of Argulus deposited over them, and some of the farmers used bamboo pole for buried in the pond in several places, the fish rubs own body with this pole and the argulus is leaves the body surface of fishes.

6. Using Turmeric in fish ponds as an antibacterial agent

Turmeric having antibacterial and anticancer properties *curcumin* is the active compound in turmeric which has been shown to have a wide range of therapeutic value, fish farmers broadcast the paste over the water to treat the *Aeromonas hydrophilla* infection. Sometimes also used in an external insecticidal and antifungal agent.

7. Uses of Mahua

Mahua (*Madhuca longifolia*) belongs to family *Sapotaceae*, which is known for its sweet flowers which possess a lot of ethnic values among the tribal people for the development of various fermented and non-fermented food products. In the fisheries sector, it is used for control the weed and predatory fishes, the dose is @250 ppm, because of *saponin*and *mourin*active compound present in Mahua and it is Hematotoxin (toxins that destroy red blood cells, disrupt blood clotting), which breakage the RBC and causes the death of fishes.

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8. Use of pieces of banana trunk

In villager fish farmers, pieces of the banana trunk place afloat to maintain the alkalinity and to serve as a food supplement, banana trunk having pores containing oxygen which ultimately helps to increase the level of oxygen. Before the rotten of banana trunks its remove from the pond.

9. Use of pieces of rachis of jackfruit

Tadpole infestation is a serious problem, primarily due to competition between tadpoles and fish for food and also caused harvest problems and impaired post-harvest sorting and grading. For control this problem Jackfruit is used. Jackfruit rachis is a stick in nature because it's containing gummy shell, farmers utilize the rachis of jackfruit in the pond for relief from tadpole, the tadpole is attached with the rachis, and later tadpole is removed from the water.

10. The ripe palm fruit for crab reduction

Some areas of fish farmers are used ripe palm fruit for the reduction of crab from a pond. The smell of the ripe fruit attracts the crab and they aggregate on the fruit to eat and farmers remove them easily by hand or by scooping. In some cases empty earthen pots are also used for removal of crab from shrimp farm because this crab is competition to shrimp for feeding, empty pots are placed at the bottom of the shrimp pond at a different place where feed is usually placed. After 4-5 days the pots are removed from the pond which gets filled with crabs.

11. Usage of Haritaki and khayer

Many medicinal plants such as *Acacia catechu* and *Terminalia chebula*are used for the hatching of fish eggs because early hatching of spawn dies due to immature condition, for solving the problem local farmers adopt a solution of 2kg Haritaki and 250gkhayer for 100 litter of eggs.

Procedure: - mixing the above material in 2 lit of water and keep for one night and heat the mature for one hour later filtering the mixture through fine cloth and mixture is applied to the eggs in hatchery, after 6-8 hrs of fertilization this fertilized eggs kept in the mixture for 5

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minutes, due to the application of this mixture the outer membrane of the fertilized eggs become hard which increase the hatching time.

12. Use of paddy straw

As we know turbidity is common problem during rainy session. For control, the turbidity of pond farmers is used paddy straw, when the hay rots the farmers periodically remove them from the pond the method especially controlling clay particles is found to be effective.

13. Akashi fruit for fish tranquilizer

For harvest the fish from pond tranquilized or anethetized is the best method. The indigenous communities of Jharkhand use the fruit of Akash plant as a fish tranquilizer. This fruit is semi grained and mixed with water @1 kg per 100 liters and sprinkled over the water surface. After half an hour fish start to float on the water surface and they are collected by netting or hand picking.

14. Control pH of water

Someplaces such as Mathurapur and south 24 Parganas use the branches of tamarind and moringa trees for reducing the water pH. The dose is 3-5 pieces of 30-35 cm and keeps it for 3-4 days when they yellowish color of water turnoff then they remove those branches.

15. One should not venture into the sea for fishing when 'Mother Sea' is in her menstrual period

During May-Jun month in southwest coast large area of the sea looks like red blood in color and also very bad odor emanating from that area. In this time fishermen do not go for fishing. Traditional fisherman believes that time Mother Sea *(kadalamma)* is in her menstrual period. The good science behind this theory is during the May-June period seawater temperature is high on the west coast of India. In the first few months increase the nutrient content in the sea due to terrestrial drainage. Due to this both factors increase the temperature and nutrient algal bloom produced specially *Gymnodiniumperidinium*. This bloom is called red tide and also called harmful algal blooms (HABs), and they produce a toxin that makes fish and shellfish dangerous to eat. The rapid growth of algae leads to oxygen depletion which in turn leads to mass mortality of marine organisms leading to off odor.

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16. Presence of sardine shoals

Oil sardine having to jump in nature according to the traditional fisherman, the splashing of water on sea surface indicates the presence of shoal of sardine. This knowledge is used for encircling the shoal of oil sardine by traditional fishermen.

For the identification of bottom, sardine shoal fisherman looks series of little air bubbles release due to while sardine feeding on the muddy bottom, the oil sardine shoal range from 2-25 meter in length.

17. Presence of flock of sea birds is an indication of fish shoals

When large fish shoal sees in the water surface near the shore, fish-eating birds like *Kadal kakka* (Seagull) fly in the large number over the water for catching the fish.

18. Coconut spikes as fish aggregating device

Especially in fishermen from Kerala use a specific type of fishing method locally called *kolachal fishing* for cuttlefish. A fisherman is set the kolachal in a large number in the selected area of the sea. After 4-5 days aggregating there. Here *kolachal*use as an artificial fish aggregating device (FAD). These FDA provide breeding and hiding places for cuttlefish. Kolachal also serves as an artificial substrate on which periphyton grows in large number; periphyton is an excellent food for cuttlefish hence kolachal serves as a feeding place for them.

19. Tannin for preservation of fishing nets

For the making of fishing net, traditional farmers use natural fiber like cotton, sisal, hemp, manila, and coir. Traditionally tannin is used for the preservation of fishing nets. For the preparation of tannin, the bark is cut in small pieces, crush well and boiled with water in metal vessels till a concentration solution is obtained. The remaining part is squeezed, the liquid is collected and filtered. The net is immersed in the solution for a day or two and dried. To prevent the leaching of tannins fixed by dipping in 1% solution of copper sulfate and ammonia.

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20. Fishing of snake heads (*Channa* spp.) with petromax and sickle

In the northernmost part of the state of Kerala, fishing of snakehead by using petromax and sickle. This method used during the monsoon months in paddy fields, associated canals and ditches. In this method, 3-4 persons are required. One person holds the petromax and moved forward. Another member who follows the light bearer bag made of palm leave and carried a hand net with him. Another person carries a sharp sickle. Due to fish attracted to the light, it gets stupefied by the intense light of the petromax. Fisherman catches the fish by using the hand net or the bag.

21. Singhi (*Heteropneustes fossilis*) for treating anemia in pregnant women and children

The coastal people of Kerala 'Singhi' are used as excellent food for pregnant and children get rid of anemia. The Asian stinging catfish or fossil cat, *Heteropneustes fossilis*, is a species of air sac catfish found in India, Bangladesh, Pakistan, Nepal, Sri Lanka, Thailand, and Myanmar. It is locally known as *kadu, theyili, moyya or kari*in different parts of Kerala. Singhi fish containing iron, which is used for the synthesis of hemoglobin for treating the anemia disease.

22. Transport and acclimatization of fish

The state of Assam in the district of Karbi-Anglong fish seed vendors transported seed in aluminum hundies. They add 50 ml of local rice beer for every 10 liters of water in these hundies. The vender says that the survival of fry is better, rice beer is added into hundies during transport because rice beer may act as some sort of anesthetic agent during transport.

23. Control of Epizootic ulcerative disease syndrome (EUS)

Some traditional farmers are applying branch of Neem plant into fish pond for helpto control ulcer on the body of fishes.

24. Low budget fish Gunabajalam prove effective for crops

In the farmers of TamilNadu at Kanyakumari district, they use fish gunabajalam of fish hormone produced by Mrs. Thangam with help of some farmers. They use this hormone for growing their rose, chili and paddy crops.

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Preparation of fish Gunabajalam: - take 1 kg of fish waste and jaggery and mix well with 10 liters of water in a plastic drum. Stir the mixture in the clockwise and anticlockwise direction for 3 to 4 days and keep the drum in shade. After 15 days filter the solution (1liter of fish hormone in 100 liters of water for one acre) and spray over the crops. Spraying time is early morning or evening because most of the insects attack the crops during this time.

25. In Chhattisgarh, Bastar tribes use traditional fishing techniques

Bisar: Bisar is made from bamboo splits like a normal mate and weaves with nylon threads across the bamboo splits. Bisar is attached with *Sodiya* they help to collect the fish in flowering water. The uppermost part is open and the lower part is less open when to take out fishes from sodiya. For trapping the small and medium size of the fish used.

Pelna: It is a triangular shape made of bamboo weave with a nylon net and tied with a triangular frame. One arm had for holding the pelna upright. Under deep water, they move forward keeping pelna upright from the bottom of pond or rivers.

Dhuta: Dhuta used for storage of fish it's made up from bamboo splits weaving it as bottle shaped container. The capacity of dhuta is 2-5 kg and 1-3 kg dry fishes and fresh fishes respectively.

Conclusion

ITK is such knowledge that is presumably eco-friendly; economic and highly credible with a practical point of view, without any side effect. There is also a possibility for combining the indigenous technical knowledge and knowledge of management based on modern science to create effective hybrid management systems. It is imperative to analyze such technologies so that the scientific principle behind them could be properly understood. Once this is done, it will be easier to further refine and upgrade them by blending them with modern scientific knowledge.

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STINGLESS BEEKEEPING FOR SUSTAINABLE AGRICULTURE: AN AREA TO PONDER

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In tropics and subtropics, stingless bees are the principal pollinators of a diverse ecosystem. The foraging activity of these bees is influenced by biotic and abiotic factors all throughout the year. The raw stingless honey possesses distinct types of phenolic and flavonoid compounds of variable biological and clinical importance. Due to minute size they gather lower quantity but quality of honey. It can be effectively used for greenhouse pollination because of their limited foraging distance and foraging activity, at the peak time of 10.00 am to 12.00 noon. Natural wild colonies can be reared in artificial small hives for easy honey collection. Unlike, other bee families there are no such pest and disease associated except some predators or parasitoids. Due to their docile nature, they are the good components of apitourism. More scientific research needs to be carried out for the promotion of these bee flora and to prove a greater employment generation in rural sectors.

Thinking of bees strikes delicious honey and painful sting in our mind. But there are some traditional bee species which are devoid of a functional sting. They bite with mandibles, but the biting intensity is just like that of an ant. From centuries they are prevailing in various tropics and subtropics making horizontal combs inside tree branches, wooden dead logs, cracks in walls of houses, etc. The nest comprises brood cells, honey, and pollen cells. Brood and food chamber are made up of wax and propolis called as 'involucrum' gathered from various plants. Queen mates with only one male. There can be two or more queens laying eggs in the same nest. Production of new queens is regular, often they are killed and never endorsed to produce eggs. By mass-provisioning, they provide food to the broods. Flavonoid-rich honey fetches good market price because of its medicinal values. In Karnataka, Kerala, and North East some tribes are practicing traditionally.

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Role of Stingless Bee

Pollination: Due to the polylectic nature, they play an ecological role by pollinating wild and cultivated plants through foraging.

Research: From the Cretaceous period stinglessbee species co-evolved along with the local vegetation.Also, the greater abundance in tropical forests and vivid diversity fetches fair research attention.

Aesthetic Value: Aesthetics is another area of the economic importance of stingless bees that involve the making of artifacts such as jewellery and souvenirs to bring happiness and relief to people.

Apitourism: As these eco-friendly bee species are stingless and not ferocious,therefore it provides a great opportunity for tourism. A natural forest environment with nests and different designs of beehives will attract people who would want to try out some of the bee products.

Nutritional and Medicinal Honey and Other Hive Products: Honey is mainly made up of glucose and fructose. It also contains minerals, vitamins, other nutrients, and is also popular for its exceptional medicinal (antioxidant and antibiotic) properties. They are the great gatherers of pollen and producer of beeswax, which is extensively used in cosmetic industries. The propolis are having antibiotic properties that are effective in healing wounds and infections in the body.

Foraging Activity and Crop Choiceof Stingless Bee

Till date, there are more than 500 species that have been reported from various parts of the globe. Out of that 130 species are identified as potential pollinators of varied crop species. Stingless bees are the generalist flower visitors of broader range plant species viz. field crops, fruit and vegetable crops, weeds, medicinal-aromatic and ornamental plants throughout the twelve months. They prefer mainly small flowers, dense inflorescence, flowers with long corolla tubes that are wide enough for the bees to enter and white or yellow-coloured flowers. It is effectively used for greenhouse pollination because of their limited foraging distance and foraging activity at the peak time of 10.00 am to 12.00 noon.

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Nesting Habitats and Rearing of Stingless Bee

Diversity in nesting habitats from varied climatic and geographic conditions are seen in these minute creatures. In South India, they are found prevalently in different ecological zones involving tropical evergreen, semi-evergreen, grassl and, moist deciduous, dry deciduous, shrublands, freshwater wetland, subtropical secondary scrub, grassy slopes and

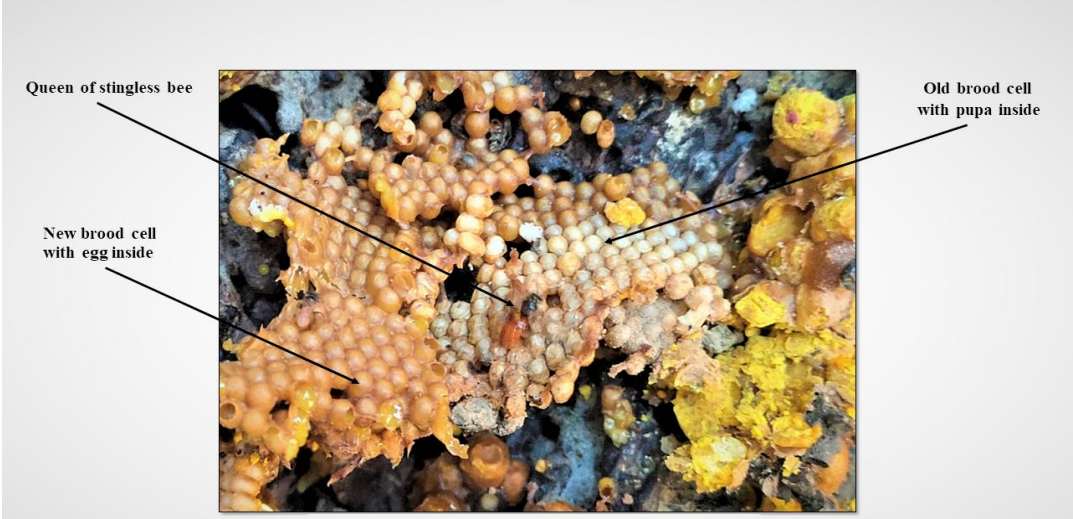

Fig.1: Stingless bee queen with broods.

thorny scrub type of forest vegetation. Stingless bee constructs their nests in old tree trunks or human dwelling places like cracks and crevasses of constructed walls, hollow iron pools, or bamboos. They can be reared in artificial wooden hives, bamboo hives, or PVC boxes of varied sizes.

Fig.2: Stingless bee colony with honey pots.

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Fig. 3 : Stingless bee colony with brood and bee bread.

Pests Association

There is no such important disease associated with this bee species. However, they do suffer from predation, parasitism like flies, ants, spiders, mites, wasps, birds, lizards, toads, and, of course, humans, which are common pests of social bees worldwide.

Syrphid fly: One of the most serious pests with bright orange-yellow and black markings and is frequently observed hovering near nests during summer. They are widely available in all regions where stingless bee colonies are present.

Phorid fly: Phorid fly are mostly associated with Australian stingless bee species. It hovers outside and hunts singly. Once a bee is out for foraging the wasp swoops from back in an unpredictable way and takes up to its nest.

Dry fruit mite: Dry fruit mites are the serious concern on *T. iridipennis* colonies in India. The infestation initiates from the pollen store and subsequently spreads over the brood cells. Later it declines the worker strength of the colony by carrying away all food store and young ones.

Advantages of Practicing Stingless Bee Colony

- As like, other honey bees they are environment and human-friendly domesticated bees. They are safe to keep near to a farmhouse and handled by people who are allergic to other traditional bees.

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- Swarming is absent in stingless bees because the mature physogastric queen is unable to fly. However, they make a new colony with the newly emerged queen if the nest is full. So, there is no chance of completely losing the entire colony.
- Due to the small-sized body, their foraging range is also much narrower compared to the commercial one. Hence, they could be utilized effectively in homestead gardening or polyhouses.
- The small size of this kind gives access to forage in varieties of flowers, whose opening is too narrow to permit other bees. Thus, making a peaceful coexistence with other commercial bees.
- There are no such pests and diseases associated with them, unlike the commercial bee species. However, they have some natural enemies with less economic importance.

Conclusion and Future Prospects

It is fascinating to rear these wild bees in traditional domestic ways. On artificial rearing each colony produces 600-700 gm of honey per year, fetching a good market value of around Rs. 3000 to 5000 per kg. In Ayurveda, meliponid honey possesses a great demand due to its exceptional medicinal (antioxidant and antibiotic) properties. Recent adverse actions such as Deforestation or habitat degradation, Intensive applications of Agrochemicals, Lack of knowledge, Destructive harvesting, Climatic changes, etc. are forcing these eco-friendly bees under threat. With new scientific approaches, higher production can be achieved, which would prove to be an alternative employment generation for unemployed youths. Further research on the medicinal property of stingless honey, propolis, and other bee products will help to find a solution for many ailments.

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BLAST OF WHEAT- AN OVERVIEW

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Wheat is grown all over the world, under a variety of climatic settings ranging from subtropical to temperate. However, extensive wheat production has always attracted a variety of restrictions, resulting in the establishment of biotic and abiotic limits. Among them, blast is one of the most deadly wheat diseases. The fungus *Magnoporthe oryzae* pathotype Triticum causes wheat blast (WB), commonly known as 'Bruson' (Portuguese meaning 'burnt'). Brazil, Bolivia, Paraguay, Argentina, and Uruguay are the only nations in South America where wheat blast is restricted (Kohli *et al.*, 2011). However, it was discovered in Bangladesh in April of 2016. (Callaway*et al.*, 2016; Malaker *et al.*, 2016). It has already been discovered in 15% of Bangladesh's wheat-growing region. Wheat blast absolute from Bangladesh was determined to be comparable to that of Brazil based on molecular features (Malaker *et al.*, 2016).

Symptoms

Wheat blast attacks all portions of the plant that are above ground.Head/spike infection is the most noticeable symptom (Fig 1). It's easy to mix up with *Fusarium* head blight. There has also been rachis blackening, lower nodes, grain shrivelling, and low-test weight (Malaker *et al.*, 2016). The pathogen is known to generate pyricularin, a non-host specific toxin (Agrios*et al.*, 2005). Depending on the timing of infection, symptoms on the head might range from elliptic lesions with bleached centres to spike bleaching, sterility, and empty grains. Depending on the stage of the plant, lesions on leaves vary in shape and size. Lesions become less common as plants age. Infection on seedlings can be extremely harmful in high-temperature, high-humidity environments and can even result in plant death (Igarashi*et al.*, 1990).

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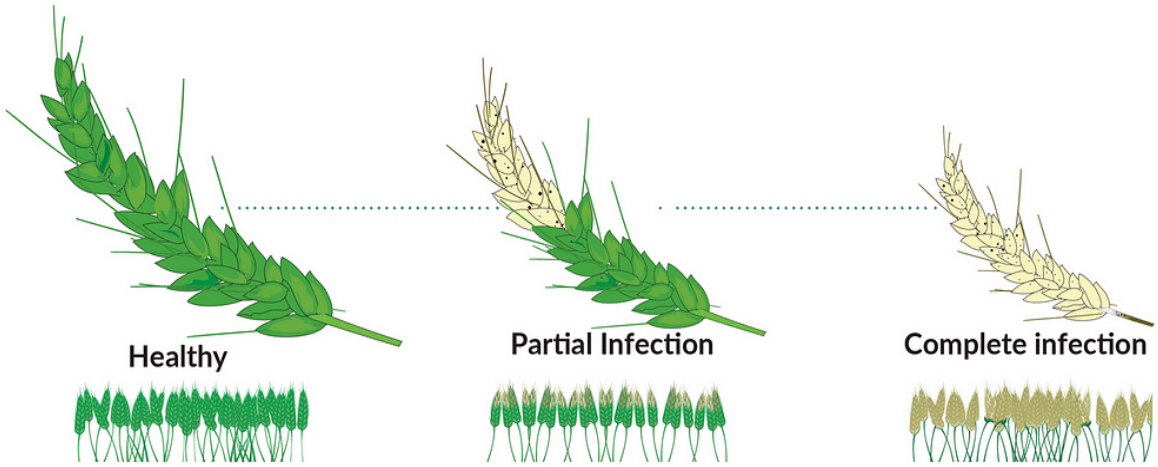

Fig 1: Wheat blast infecting the spike (Source: cimmyt.org)

Indian scenario

India is on track to become a wheat exporter by 2050, with a production target of 140 million tonnes. In South Asia, a large 7 million hectares of wheat acreage has been identified to be very sensitive to WB, with the majority of it in India but also in Bangladesh and Pakistan (Mottaleb *et al.*, 2018). Weather-based recasting has revealed the country's northeastern plain zone (NEPZ) and centre zone are extremely vulnerable, and if WB outbreaks occur in the major northwestern plain zone (NWPZ) during a hot and humid year, the results might be disastrous. However, the Government of India (GoI) has taken an unprecedented proactive approach to the issue of WB by establishing awareness, surveillance, and monitoring modules in the affected/vulnerable India–Bangladesh border areas. The 'wheat holiday,' which prohibits wheat growing in West Bengal's Murshidabad and Nadia districts, as well as a 'no wheat zone' within 5 kilometres of Bangladesh's border, are widely praised measures to prevent WB from entering the nation. The impact and success of the wheat holiday are still unknown. The wheat holiday in West Bengal, which produces 1.24 percent of the country's total wheat, should have little impact on the country's total wheat production, which has already topped 100 million tonnes. The 'wheat trap nurseries' have also been planted in the border regions to prevent disease migration in all seasons(Bishnoi*et al.*, 2021). Under the auspices of ICAR-Indian Institute of Wheat and Barley Research, Karnal, the All India Co-ordinated Wheat and Barley Improvement Project, which has a network of centres and co-operators all throughout India, is particularly watchful and equipped to deal with the problem (Saharan *et al.*, 2016).

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Management

Avoidance- Sowing wheat seed from blast-affected regions is not recommended. When there is a lot of rain, it's important to keep an eye out for the blast. Sprinkler watering systems can predispose wheat to blast; hence they should be avoided (Saharan *et al.*, 2016).

Host resistance- Blast host resistance is unknown; however, Brazilian wheat cultivars BR18, IPR85, and CD113 have shown a modest level of resistance. CIMMYT line Milan derivative accessions have also been demonstrated to have a high level of resistance (Kohli *et al.*, 2011). There is a scarcity of data on the discovery of quantitative trait loci (QTL) and related markers connected to them. Having anti-blast properties, Pongsu Seribu 2, a moderately blast-resistant rice variety, was recently mapped using QTLs connected to resistance genes. It was discovered and cloned a QTL connected to blast resistance (Fatah *et al.*,2014).

Chemical application- There hasn't been any systematic and compelling study on the chemical control of wheat blast. However, suppressing seed inoculum using tricyclazole 75WP @2g/kg or carbendazim 50WP 1g/kg seed is well known in rice blast. Initial infections can be managed using need-based sprays of carbendazim 50WP @1g/L or tricyclazole 75WP 0.6g/L or Propiconazole 25EC/carpropamid 30SC 1ml/L or Isoprothiolane 40EC 2g/L during spike initiation or blooming, depending on the condition. Spray at flowering has been effective in controlling(Saharan *et al.*, 2016).

Conclusion

If total eradication is unattainable, the path forward for WB is to devise measures for limiting the illness to Bangladesh in Asia and the hotspot regions of Latin America. The inoculum load in Bangladesh must be reduced to reduce the susceptibility of the Indian wheat industry. Non-wheat seasons, non-poaceous crops in the offseason, disease-free resistant variety seeds, agronomic practices that favour disease non-development, development and implementation of integrated disease management practices, and continuous monitoring of disease movement and quarantine are all ways to achieve this. Early warning systems based on climate analogues must be developed, and the economic and quarantine importance of the blast pathogen must be fully understood, in addition to attracting investment in the rapid development of high-yielding, WB resistant wheat varieties using cutting-edge technologies such as speed breeding, genomic selection, and gene editing (Bishnoi*et al.*, 2021).

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INTEGRATED PARTHENIUM MANAGEMENT

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In India, *Parthenium hysterophorus L*. (Asteraceae), a noxious weed, commonly known as carrot weed, white top, or congress grass. It is a herbaceous, erect, and annual plant. The origin of parthenium is considered to be from Mexico, the USA, Trinidad to and Argentina. The general notion of belief is that when the USA exported grain to Indian under its US PL 480 (also known as "Food for Peace") scheme, which was basically a food assistance program; the seeds of parthenium also came with it and established itself as a naturalized weed within no time.

Presently it has been spread about 35 million hectares of land in India. Ever since weeds became a global threat, including in India, efforts have been made to control weeds using various methods such as mechanical, competitive (allelopathy), chemical, and biological control methods. Weeds, however, have resisted all efforts to control it for one reason or another. Biological control, deliberately exploiting natural enemies, insects, bioherbicides, nematodes, snails, and competing plants to control harmful weeds, thrives more effectively and co-friendly than conventional weed control methods.

Habitat and dispersal of Parthenium

Parthenium thrives in desert areas, grasslands, fields, forests, floodplains, agricultural areas, urban areas, overgrazing, industrial areas, playgrounds, roads, railways, and residential areas. Drought and reduced veld coverage that followed created favourable conditions for parthenium weeds to settle. Although parthenium weeds can grow in many soil types, they are particularly dominant in alkaline, hard clay soils. The leaf of parthenium looks like a carrot leaf that can reach a height of 1 to 1.5 meters. It has branches. The stems and leaves have hairs on the surface. The flowers are white. It is spread mainly by seeds. Weeds can produce up to 154,000 / m2 seeds, and a single plant can produce about 15000 - 25,000 seeds. Seeds are very light in weight and are easily carried or transported by air, water, or various human activities. Seeds do not require dormancy and can germinate whenever moisture is present. Seeds germinate with the commencement of rains; flowering begins a month later

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and continues for another three months. In northwestern India, parthenium germinates mainly during the months of February-March, experiencing high post-rainfall growth in June-July and producing seed in September-October. It usually completes its life cycle between 180-240 days. Due to the bitter cold, its growth is slow and stagnant from November to January. Parthenium has the ability to regenerate from the cut or broken parts. Its allelopathic effects associated with the absence of natural enemies such as pests and diseases are two key factors contributing to its rapid spread in India.

Harmful Effect

In general, parthenium is a toxic, harmful, problematic, allergic, and aggressive weed that poses a severe threat to humans and livestock. This weed has been considered a major source of dermatitis, asthma, nasal-dermal and nasal-bronchial infections in India and Australia. In addition to the side effects, it also causes a few other problems, such as the closure of familiar roads and reduces the value of parks, gardens, and residential areas. Furthermore, it dramatically reduces crop production without losing biodiversity.

Fig 1: Parthenium

Integrated Management of Parthenium

Since weeds became a threat to India and other countries, efforts have been made to control weeds in multiple ways. But so far, no single method has been proven satisfactorily as each method has one or more limitations such as the possibility of temporary relief, high environmental safety costs, etc. Therefore, there is an urgent need to adopt an integrated approach to parthenium control methods together and if applicable.

Physical Method

Physical control involves hand weeding, time-consuming and unpleasant workmanship, exacerbated by the health risks involved in particle weed control. Proper removal of parthenium before flowering and seed set is the most effective method. Weeding after seeding will increase the area of invasion. Burning, another method used to control

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weeds, is not a helpful particle control strategy. However, research shows that the burning of some targets (e.g., weed control with wood) will not cause the growth of parthenium as long as the veld is allowed to thrive before the stock is formed. This too seemed insufficient for two reasons; it requires a large amount of fuel and burns destroy all the other critical economic crops that grow in its area.

Chemical control

Chemical control is an effective way to control the parthenium in areas where its natural enemies are absent. The use of herbicides, such as chlorimuron ethyl, glyphosate, atrazine, amethyst, bromoxynil, and metsulfuron, is known to be very effective in controlling weeds. The most effective treatment for parthenium growth was glyphosate and metribuzin, with higher mortality 4 weeks after treatment (WAT) in both rosette and bolted phases than 2, 4-D, triasulfuron + terbutryn, bromoxynil + MCPA, and atrazine + s-metolachlor. Pendimethalin was a slow-acting treatment in both stages of development. Overall, the efficacy of herbicides was more promising for rosette parthenium plants than for binding plants. In no crop areas, uncultivated areas, and along railways and sidewalks, spraying `of standard salt solution (Sodium chloride) at concentrations of 15-20% has been observed. Found to be effective.

Allelopathic Control

Parthenium can be controlled by planting *Cassia sericea, C. tora, C. auriculata, Croton bonplandianum, Amaranthus spinosus, Tephrosia purpurea, Hyptissuaveolens, Sida spinosa, and Mirabilis jalapa*. In India, crop rotation using Marigold (Tagetes spp.) During the rainy season, instead of the common crop, it effectively reduces parthenium invasion in cultivated areas. Both root and shoot extracts of three allelopathic grasses, namely *Dicanthiumannulatum, Cenchrus pennisetiformis*, and *Sorghum halepense*, reduce germination and suppress plant growth at the beginning of the rare P weed. hysterophorus. Watery leafy plants of *Azadirachta indica*, *Aegle marmelos*, and *Eucalyptus tereticornis* completely inhibit the germination of parthenium seeds.

Biological Control

Biological control is a natural and effective way to reduce or minimize pests and the effects of pests by using natural enemies. Biological control of parthenium involves using

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various biocontrol agents such as microbial pathogens, insects, and botanicals. In various biocontrol control techniques, plant pathogens can be effective, safe, and beneficial to the environment. There are two basic strategies for using weed control biology: the introduction of exotic pathogens, called "old-fashioned way," and "propagation method" or "bioherbicidal," in which pathogens already exist (native or introduced) and population. They increase in size. Of the various insects, the leaf-feeding beetle (*Zygogrammabicolorata*) and the stem galling moth (*Epiblemastrenuana*), both imported from Mexico, have revealed excellent prospective to control this weed. Both adults and larvae of *Z. bicolorata* feed on leaves. The fully-grown larvae enter the soil and pupate. One adult per plant is effective in skeletonizing leaves within 4–8 weeks, but little success has been achieved as the weed has very high generative potential; moreover, the insect is not species-specific and is found to attack sunflower in India. The most promising fungus to treat parthenium is *Puccinia abrupta var. partheniicola* (Jackson) Parmelee, *Puccinia xanthii* var. *Parthenia-hysterophorae* (formerly known as *P. melampodii Diet*. and How.) (Uredinales), *Entylomacompositarum* De Bary (Ustilaginales), and *Plasmoparahalstedii* (Farlow) Berl. and *De Toni* (Peronosporales). In this case, *Puccinia abrupta var. partheniicola* and *Puccinia xanthii var. parthenii hysterophorae* originated in Mexico and has been fully explored and released in Australia; they are the most potent biocontrol fungal bacteria of this weed in Australia

Conclusion

The *P.hysterophorus* grows in a wide range of areas and causes changes in surface plants and underground nutrients. As a result, it can compete with native and exotic flavor plants important for livestock. In addition, changes in vegetation and soil structure can lead to the final transformation of some trophic levels and alter the function of the ecosystem. Therefore, proper ways to manage *P. hysterophorus* are needed to avoid potential threats to biodiversity and economic losses. Biological controls using allelopathy, insects, and fungal bacteria are a practical and environmentally friendly alternative to other time-consuming, expensive, toxic, physical, and chemical methods. Nine insects and two rust species have been released in Australia to test this weed. Of these, two insects are *Z. bicolorata* and *E. stenuana* and two rusty fungi, *Puccinia abrupta* var. *partheniicola* and *Puccinia xanthii* var. *parthenii hysterophorae*, has shown strength and is used to control this weed. However, weeds have not been fully explored and are still causing trouble in Australia and India, and

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much remains to be done by scientists, farmers, and governments to work together to control these weeds.

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SOLID-STATE FERMENTATION IN ANIMAL NUTRITION

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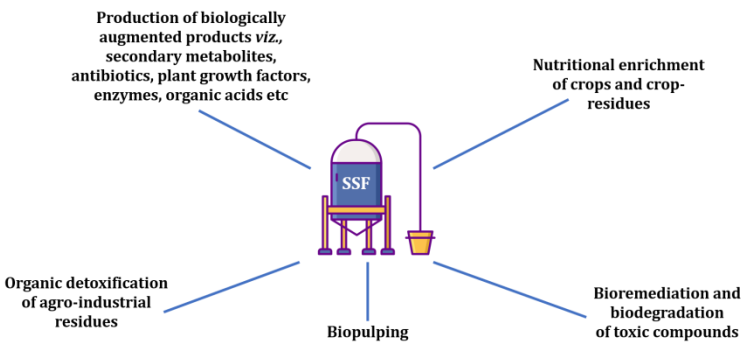
Solid-state fermentation (SSF) is a fermentation process occurring in a solid matrix in the presence of a little or negligible amount of free water, provided that the substrate must have sufficient moisture to support the growth and metabolism of microbes. It can be delineated as a process of the growth of micro-organisms on a solid substrate without a free-flowing aqueous phase.The solid matrix under consideration might be a reservoir of nutrients or merely a support infused with nutrients allowing microorganisms to grow.It is a fermentation method used by industries like the pharmaceuticals, food, textile etc., to produce biologically active secondary metabolites from microbes; and is emerging as a potential alternative to submerged/liquid fermentation(Nigam and Pandey, 2009).The advantage of SSF is accountable to the fact that it brings the microorganisms under cultivation in close proximity of the substrate and hence maximal substrate concentration is achieved. It mimics natural microbiological processes of fermentation like composting and ensiling. SSF provides a favourable habitat to microbes, replicating their natural environment they grow in, hence is highly preferred to grow and produce useful value added products in biotechnological industries. Processes where SSF finds application are:



Research in the field of SSF dates back to 1960–1970, when production of protein enriched cattle feed by SSF was done utilizing agro-industrial residues, thus offering a perfect solution for the development of nutritionally enriched roughages for livestock, and simultaneously reduction of air pollution. Recently, it is gaining more popularity in the solid waste management, biomass energy conservation and biotechnology industries (Pandey, 2007).

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Rice straw, sugarcane bagasse, wheat straw, rice hulls, and corn cobs are among the agricultural wastes utilised as SSF substrate (Gonzalez et al., 1993).

Steps in Solid State Fermentation

SSF is normally multistep processes involving the following steps:

i. The process is initiated with the pre-treatment of substrate raw material by mechanical, chemical or biochemical processing to increase the surface area and increase nutrient availability.

ii. Deposition of a solid culture substrate, such as rice or wheat bran, on flatbeds after seeding it with microbes for fermentation

iii. The substrate is then left in a room with temperature-control system for some days.

iv. Hydrolysis of primarily polymeric substrates, e.g., polysaccharides and proteins.

v. Utilization (fermentation) of hydrolysis products.

vi. Separation and purification of end products.

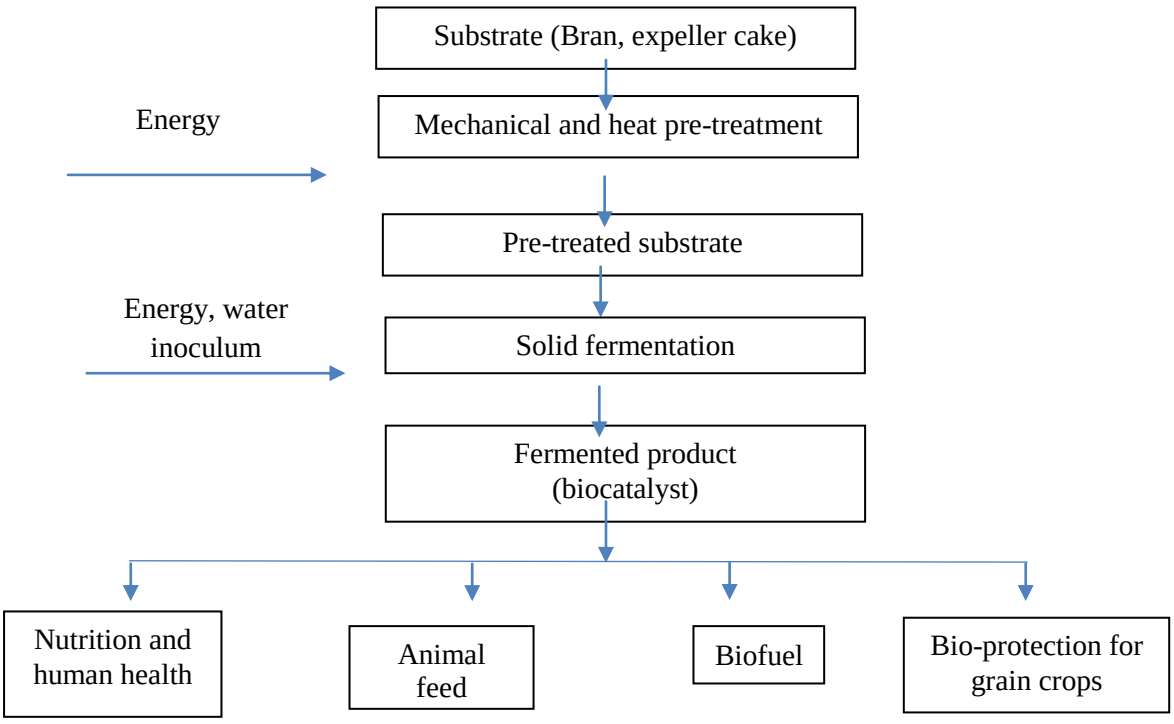

Fig.1: Solid-state fermentation process for production biomolecules and value-added products (Srivastava *et al.*, 2019)

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Applications of SSF

Solid-state fermentation has emerged as a potential methodology for the production of microbial products such as feed, fuel, industrial chemicals, and pharmaceutical products.

It is widely employed to manufacture several enzymes, organic acids, which are subjected to extraction and purification, employed to produce different products.

It can also be used in bioremediation and bio-leaching.

Application of SSF in production of certain active secondary metabolites are listed below.

Product	**Use**	**Source**	**Substrate**
Pharmaceuticals			
Zearalenone	Growth promoter	*Fusariummoniliforme*	Corn
Bacterial endotoxin	Insecticide	*Bacillus thuringensis*	Coconut waste
Penicillin	Antibiotic	*Penicilliumchrysogenum*	Sugarcane bagasse
Cephalosporin	Antibiotic	*Cephalosporiumarmonium*	Barley
Oxytetracycline	Antibiotic	*S. rimosus*	Corn cob
Cyclosporin A	Immuno suppressive drug	*Tolypocladiuminflautum*	Wheat bran
Enzymes			
Lipase	*Aspergillus niger, Candida rugosa, Penicilliumrestrictum*	Gingelly oil cake, coconut cake, babassu oil cake,	
Cellulases	*Bacillus subtilis, Aspergillus sp*	Banana fruit stalk wastes, soyabean meal,	
Pectinases	*Talaromycesflavus, Aspergillus niger*	Citrus wastes, soy bran and wheat bran, apple pectin.	
Polymers			
Succinoglycan	Agrobacterium tumefaciens, Rhizobium hedysaris	Spent malt grain or ivory nutshaving or grated carrots, impregnated spent malt grains	
Xanthan gum	Xanthomonascampestris	Spent malt grains, citrus peels, apple pomace, or grape pomace, Impregnated spent malt grains.	

Conditions for SSF

The technical and economic success of SSF is determined by a number of factors, some of which are listed below:

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i) The choice of substrate: It determines the fermentation by-products and biomolecules.

Material used for substate: For production of enzymes like amylase, starch-based substrates are used as material for SSF, while for the production of cellulase enzymes cellulosic or lignocellulosic substrates are used.The morphology and chemical composition of the substrate play crucial roles for enzyme production. (Soccol et al.,2017). Based on the type of substrate under consideration, SSF can be of two types: SSF with non-reactive (inert) materials acting as mere support and;

Noninert materials, such as biomass which act as support, and serve as carbon and nutrient sources to promote microbial growth (Carbou et al., 2018)

***Particle size of substrate*:** Substrates with finer particle sizes provide a fixed geometry and a greater surface area: volume ratio, show better enzyme production than substrates with larger particle sizes. But if the particle is too small, it causes agglomeration and interferes with microbial respiration, decreasing the microbial growth (Oriol et al., 1988).

***Moisture*:** Substrate moisture influences the SSF process significantly. Low substrate moisture is unfavourable for microbes, resulting in their poor growth, while high moisture content serves as an obstacle to oxygen penetration and hence slow down the process. Since the substrate is the fundamental parameter for microbial growth,kineticsdepend on it (Thomas *et al.,* 2013).

ii) The choice of microorganisms:

The choice of the microbes is apparently based on the selection of the substrate and desired product.Fungi and yeast are the most preferred microbes for SSF, as they thrive on solid medium and are able penetrate it with their hyphae and rhizoids, and their water activity is suited for SSF.Bacterial contamination can be avoided in fungal SSF by increasing the substrate: moisture ratio.The microbiological components of SSF can occur as single pure cultures, mixed identifiable cultures or totally mixed indigenous microorganisms. In bacterial species, Bacillus and Clostridium are the potential bacteria, while *Aspergillus, Trichoderma, and Mucor* are well-known fungal species for the SSF process (Sangsurasak et al.,1996). Additionally, filamentous fungi are best suited to produce industrially important enzymes by solid state fermentation.

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iii) Physio-chemical characteristics:

Volume of inoculum volume, viability, and vegetative cells' ability are the first physiochemical parameters that determine the growth of mycelium and microbes and their interactions with the substrate in medium.

Moisture: The moisture level is another important parameter. A moisture level in range of 60-70% is generally suited for both fungi and bacteria under the SSF condition. The requirements for water by microorganisms is expressed as the water activity (A_w) of the microorganisms and not the amount of water present in the solid substrate (Desgranges et al., 1991). Bacteria mainly grow at higher a_w values, while filamentous fungi and some yeasts can grow at lower a_w value (0.6-0.7)

The optimum pH for action of fungal metabolic activity is 4-5. pH: It is a significant parameter which makes the SSF process efficient. However, the accumulation of organic acids as fermentation by-products causes a decline in pH, it can be maintained by other salts present in the medium.

Temperature:In general, SSF is carried outat optimum levels by mesophilic microorganisms. Particularly, fungi can survive in the wide range of temperature of 20°C-55°C. The maximum product output is obtained as microbes function best at their optimum temperature (Penaloza et al., 1991).

Nutrient requirements: The fulfilment of nutritional demands of the microorganism during the SSF is a strong determinant of the output. Macro- and microelements are a pre-requisite and improve the metabolic activities of microorganisms during the fermentation (Krishna et al., 2001). A Carbon/Nitrogen ratio of 16 is best suited for the composition of the substrate and is used for fermentation processes (Krishna et al., 2005).

SSF Treatment of Crop Residues for Ruminant Feeding

Crop residues are commonly known as "lignocellulosics" because they have high content of cellulose and are associated with the biopolymer lignin. Even with the assistance of hydrolytic enzymes, the rumen microbiota (bacteria, protozoa, and fungus) are not capable of efficiently cleaving these bonds. White rot fungi (WRF) can break the ligno-cellulose

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complexes in such crop residues, releasing free cellulose and thus increasing their feeding value for ruminants. Compared to untreated roughages, biologically treated roughages exhibit greater digestibility for most nutrients (both cell walls and cell solubles) and a greater crude protein content and more fermentable carbohydrates.

Furthermore, recent findings have shown that feedstuffs exposed to solid state fermentation (SSF) using fungi result in lower methanogenesis as a result of enhanced digestion and nutrient absorption, and a decrease in structural carbohydrates. Kamra and Zadrazil (1988) elucidated that when the product is meant for ruminant feeding, the bioconversion procedure should increase lignocellulose digestibility. The biological upgradation of crop residues into animal feed should be characterised by considerable lignin degradation and nutrient liberation from the matrix and the accumulation of digestible components (Zadrazil et al., 1999) as enhancing the nutritional status of the finished product using microbial protein. Silva et al. (2002) reduced substrate fibre and CP levels treated with *Pleurotuspulmonaris*. However, all fungi do not improve the digestibility of straw. Jalc et al. (1994) reported that during bioconversion of wheat straw with *Polyporus ciliates*, digestibility was improved whereas with *Lentinustigrinus*, it was reduced.

A major proportion of animal trials on the application of fungal-treated agro wastes elucidated favourable nutrient utilisation response, nitrogen (N) balance and gain in body weight (Walli et al., 1988; Mahesh 2012; Shrivastava et al., 2012) although it is not consistent with all types of fungi. It is an established fact that good quality forage NDF in lactating cow diet is needed to maintain rumen functioning and optimum milk yield (Robinson and McQueen, 1992), so fungal treatment of fibrous feed improves digestible NDF and hence improves milk yield. Ward and Perry (1982) reported an improved digestibility of DM and NFE of corn cobs treated with *Trichodermaviride* in lambs. Fazaeli et al. (2004) observed that inclusion of fungal treated straw upto 30% of the total mixed ration in lactating Holstein cows improved the digestibility and an increase in fat corrected milk yield by 13% and average body weight gain. Ruminants release more CH_4 on fibrous diets. Mahesh (2012) observed a linear reduction in CH_4 (%) from fungal treated wheat straws which contained lesser fibre fractions (NDF and ADF) than untreated straw. Abo-Donia et al. (2005) and Omer et al. (2012) reported a substantial improvement in ruminal pH and the NH3-N concentration of the rumen liquor in biologically treated groundnut hulls and sugarcane bagasse, and *Trichodermaressi* treated corn stalks (Omer et al., 2012).

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Differences between Solid State Fermentation (SSF) and Submerged Liquid Fermentation (SLF)

Solid State Fermentation (SSF)	***Submerged Liquid Fermentation (SLF)***
Preferred organisms need less water for growth. Eg: filamentous fungi.	Water content is much higher than the media concentration
The inert support (natural or artificial), containing all components for growth are in the form of solution.	The essential processed ingredients are expensive.
Less probability of contamination as there is lesser availability of water	Higher water activity is the major cause of contamination in SLF.
Small size bioreactors can be used.	Large-scale bioreactors are required as the volume of the media is more
Less consumption of energy is needed for aeration and gas transfer.	Power consumption is more due to high air pressure
The limiting factor for growth is diffusion of nutri	Vigorous mixing makes diffusion easy
Downstream processing is easier, cheaper and less time consuming.	The aqueous form makes downstream process difficult and expensive
Liquid waste is not produced	High quantity of liquid waste is produced

(Manpreet *et al.*, 2005)

Limitations of SSF

- Microorganisms that can only withstand low moisture levels can be employed.
- Precise monitoring of SSF conditions (e.g., O_2 and CO_2 levels, moisture content) is not possible.
- As a result of the sluggish growth of the organisms, product creation is limited.
- Heat generation causes issues, and controlling the growing environment is quite challenging.

Conclusions

SSF is a potential clean technology for producing microbial metabolites from solid substrates like agro-industrial waste. SSF is a cost-effective green technology for the production of high-efficiency metabolites. Many value-added compounds are produced using SSF at the industrial level. To make the process more efficient, this technology must be improved in the areas of mass transfer, aeration, agitation, and maximal substrate conversion into products. This field has enormous potential, with the ability to expand to a bigger scale

in additional sectors in the near future to generate more industrially relevant metabolites and produce cost effective animal feed.

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