



Overview of Azolla and Its Importance

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Abstract- The Azollaceae family includes the freshwater fern known as Azolla, which is endemic to Asia, Africa, and America. Azolla is a small, free-floating fern that goes by several names, including duckweed fern, mosquito fern, fairy moss, and water fern. It is easy to cultivate and highly productive. It is therefore farmed both large and small-scale around the world. It's high in protein and nearly full of all the minerals you need. It can be grown in a variety of ways using various techniques and approaches. Due to the presence of *Anabaena azollae*, it has a variety of uses, including fixing atmospheric nitrogen. It can be used to some crops as manure and as a bio fertilizer. By adding minerals to the soil and enhancing its characteristics, it can enrich the soil. The significance of azolla in a variety of fields as well as its dispersion over the globe, primarily in India, have been discussed in this article.

Keywords- Importance of Azolla, Methods, Distribution, Nutrients Value, Present Status of Azolla.

1. INTRODUCTION:

The Azollacea family includes freshwater ferns like azolla. It may be cultivated in any open tank and is simple to grow [1]. Some Azolla species are indigenous to parts of the United States, Central and South America, and Western North America. In addition, they have a strong following in Southern Africa, Australia, New Zealand, Hawaii, Asia, the UK, Ireland, and other European nations. It reproduces both vegetatively by splitting into separate plants and sexually by producing large female and microscopic spores. [4]. Lakes, bogs, streams, and other bodies of water are where they naturally exist. Some have naturally or via human activity spread to various parts of the world. Around the world, azolla often grows in freshwater in tropical, subtropical, and warm climates [3].

Cyanobacterium *Anabaena Azolae*, which is symbiotic, is found inside the leaf cavities. The Macrophyte of Azolla is known as Frond, and it can grow to a length of 15 cm or more in species like *A. Nilotica* and *A. Pinnata*, respectively [5]. It has a primary rhizome that splits off into secondary rhizomes, all of which bear little, alternately placed leaves. The nodes on the ventral surfaces of the rhizomes have a large number of unbranched, adventitious roots hanging down into the water. In shallow water, the roots may touch the earth and get nutrients from it. The roots also absorb minerals straight from the water. The leaf has two lobes: an airborne, chlorophyll-containing dorsal lobe and a buoyant, colourless, cup-shaped ventral lobe that is partially submerged [2].

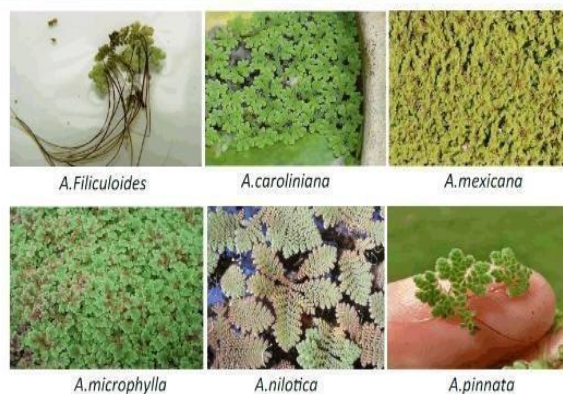


Fig.1. Different species of Azolla

In addition to being a good source of protein, azolla also has a lot of important minerals like iron, calcium, magnesium, potassium, phosphorus, and manganese. Due to its higher protein and amino acid content than soybean, it is also utilized as feed [1]. It is fat-free and contains no fat, 40–60% protein by dry weight, 10-15% minerals, and 7–10% amino acids. It's a great feed for cows, buffalo, goats, sheep, chickens, and other animals. In the absence of competition for light, azolla ferns grown singly on an open water surface demonstrate high relative growth rates (RGRs). Biomass doubling times of less than 2 days or RGRs that are significantly higher than those typically observed in land plants have been reported [7][8]. As a result of its rapid rise in biomass, it is often referred to as the "super plant" [9].

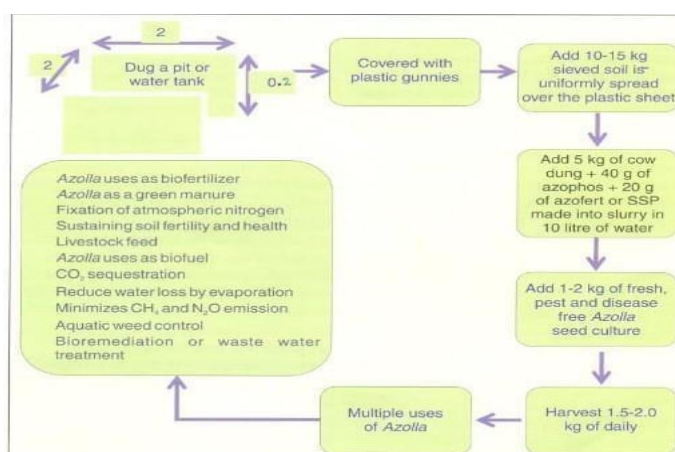


Fig.2. Overview of Azolla

2. CULTIVATION OF AZOLLA

As previously mentioned, Azolla can be grown artificially or spontaneously. The following procedures are used in order to promote better growth under artificial settings. Convenient Method: Create a 6.0 x 1.0 x 0.2 mt small pit, cover it with a layer of plastic bag to shield the intruding root system, and then cover that with a silpauline sheet (120 G) of thickness. [10]. Pay more attention to the area that requires shade than to the part that gets a lot of sunlight. Fill this pit with 80–90 kg of dirt and cover it with silpauline sheets to ensure that the setup is not damaged in any way. Subsequently, the pit should be filled with 10 cm of water and mixed with 10-15 kg of cow dung. Every two to three days, mix the two kg of Azolla pinnate that was placed in the water bath [10]. Clear out all the debris to maintain the pH level, which needs to be neutral. Due of its capacity for rapid multiplication within 3–4 days. The Azolla will be ready for harvest once the tank is completely covered.



Fig.3. Azolla growth in paddy



Fig.4. Azolla growth in rectangular pit

3. SOME SPECIFICATIONS FOR CULTURING AZOLLA

3.1 Requirement for climate: - Azolla can be grown or found in ditches, ponds, and wetlands in warm temperate and tropical regions. Azolla likes to be in the shade and requires between 30 and 50 percent of the light it needs for growth for photosynthesis. Since the production of this crop (azolla) depends on water, one should take care to ensure an adequate supply. For Azolla to develop effectively, it is always recommended that the pond have at least 5 inches of water. 20°C to 35°C is the ideal temperature range for azolla growth. Azolla's capacity to reproduce will be severely hampered by temperatures higher than 36°C. For better output and quality, azolla requires water with a pH of 5.0 to 7.0 and a relative humidity of 80 to 90% [11].

3.2 Pond position: - The location of the pond is important for growing azolla. Make sure you have a location where you can check in frequently. Because this requires a good supply of water, pick a location near a good water source. Because azolla prefers partial shade, one should either select or create partial shadow to fill in the area where partial shade is anticipated. This slight partial shadow helps azolla grow more successfully and prevents water from evaporating. Make sure there are no sharp or prickly objects on the pond bottom that could harm or penetrate the sheet that is placed there [11].

3.3 Constructing a pond for the growth of azolla: - Depending on how much Azolla is expected to be utilized for animal feed, different farmers have different pond sizes. Smallholders with a 6 by 4 foot space can grow azolla. This might produce an extra kg of feed each day. The pond has to be cleaned and levelled thoroughly. Bricks or perhaps a raised embankment formed of the earth you dug out could be used to construct the side walls of the pond. Put a substantial piece of plastic sheet in the pond's bottom and anchor it with bricks from the side walls on all four sides. A net should also be placed over the pond to prevent leaves and other debris from falling into it [11].

3.4 Azolla is growing (producing): - Equilibrate combine fresh, fertile soil, water, and cow manure in the pond. To cover the 6-by-4-foot pond, 1 kg of fresh Azolla culture is required. Consistently apply this culture to the pond. Make sure the water depth in the pond is at least 5 to 6 inches. You may encourage Azolla to develop quickly by using the rainwater that falls during the monsoon season. Pond water with a high salt level can have a negative impact on azolla growth, therefore this is another important factor in azolla production. If you are cultivating Azolla, it is best to analyze the water for alkalinity and acidic qualities [11].

3.5 Pond maintenance in azolla cultivation: - Apply 1 kg of cow manure and 100–120 grams of superphosphate to the pond once every two weeks to maintain the Azolla cultivation. Ensure that any weeds that develop in the pond are frequently removed. The pond should be cleaned up once every 6 to 8 months, and Azolla cultivation should be restarted with new soil and culture [11].

3.6 Harvesting: - Azolla is often ready for harvest in 2 to 3 weeks after the culture is put on hold in the pond. Azolla can be harvested every day once it reaches full maturity. Utilize plastic

sieves to gather the biomass from the pond's surface. An average of 1 kg of fresh azolla can be produced daily in a pond that is 4 feet by 6 feet in size.

4. TYPES OF CULTIVATION

As shown below, there are primarily two forms of cultivation:

4.1 Conventional Agriculture: - Azolla is normally grown using conventional techniques in ponds or other small bodies of water that are flooded with water. The first step in traditional cultivation is choosing an appropriate place, where we pick a site with lots of sunlight and a consistent water supply. Azolla enjoys water that is motionless or moves slowly. It is not advisable to choose a body of water with trash, aquatic plants, or weeds. Water should be between 10 and 15 cm deep. Then a small amount of azolla was added to the body of water. Under ideal circumstances, the plant will grow quickly. Check and maintain the water body on a regular basis, and remove any overgrowth to avoid congestion, which can result in stagnation. When it has entirely covered the water's surface, or when it has reached the harvesting stage, which typically takes 7–10 days. It can be gathered manually or using basic nets.

4.2 Modern production: - Utilizing bioreactors or other specially made containers to promote development, modern Azolla production techniques are more efficient and controlled. Among these techniques are bioreactors, closed systems that offer regulated conditions for azolla development. They can be set up indoors or in controlled surroundings, making it possible to cultivate plants all year long. To maximize growth, nutrient-rich water is circulated, and artificial illumination can be used. Then azolla can be grown in the floating trays or containers. These may be positioned in bigger water areas like ponds or tanks. They support keeping the environment under control while allowing Azolla to develop normally. Providing a balanced fertilizer solution can improve azolla growth and nitrogen- fixing capacity. Management is essential in modern farming. For larger-scale yield, modern agriculture can mechanize harvesting. Azolla can be picked, dried, and processed for use as a soil conditioner or animal feed.

Both conventional and contemporary techniques for growing azolla have benefits and drawbacks. Traditional methods are straightforward and inexpensive, but they might not promote the best possible growth. Modern techniques can be more resource-intensive yet allow more control over growth characteristics. The cultivation technique used will depend on the volume of output, the resources at hand, and the precise objectives of using Azolla in farming or other applications.

5. DIFFERENT METHODS OF CULTIVATION

Azolla is grown using a variety of techniques both in India and other countries. Some of the approaches that are used are given below since adopting various methods will be useful for various regions and their availability.

A. Natural ponds or water bodies

In this method, Azolla is grown in existing ponds or water bodies. Azolla grows naturally when conditions are suitable. It is important to maintain the right water quality and temperature for optimal growth.

B. Artificial ponds or tanks

This technique entails building ponds or tanks specifically for the growing of azolla. To stop seepage, the ponds might be lined with a waterproof substance. This approach gives you better control over the nutrient and water quality levels.

C. Floating trays or rafts

Azolla can be cultivated on the surface of the water in floating trays or rafts. These trays may be constructed from Styrofoam, bamboo, or plastic. This technique is appropriate for smaller-scale farming.

D. Rice fields

Making use of the flooded conditions, azolla can be planted next to rice fields. Asia is where this technique is most prevalent. The azolla acts as a supplement feed for livestock and contributes nitrogen to the rice crop.

E. Azolla beds on land

In areas with limited water bodies, Azolla can be cultivated in shallow beds on land. These beds are kept moist, and Azolla grows in moist soil.

F. Vertical Azolla cultivation

This technique involves growing azolla vertically on mesh screens or ropes so that it can dangle in the water. By doing this, the surface area for growth is maximized.

G. Growing in a greenhouse

Using a greenhouse to control environmental factors like temperature, light, and humidity can promote more rapid growth and higher yields.

6. DISTRIBUTION OF AZOLLA

Azolla generally grows and thrives in freshwater environments including ponds, lakes, slow-moving rivers, and marshes. It favors places where the water is motionless or moving slowly, and it can create thick mats on the water's surface. Temperature, sunlight, nutrient availability, and water pH are all known to have an impact on azolla growth [3]. Azolla is widely distributed around the world, spanning several continents.

Asia: - It is one of the continents where Azolla may be found. Azolla is a native of Asia, and it is particularly widespread in nations like Vietnam, China, India, and Japan. It has been utilized as a natural fertilizer in these areas' traditional agriculture.

Africa: - Azolla can be found in a number of African nations, especially in areas with suitable water habitats. It has also been used in African agriculture for its capacity to fix nitrogen.

North America: - The United States and Canada are just two of the countries where Azolla species can be found. It is regarded as an invasive species in some areas of the united areas because of its tendency to cover water bodies, block sunlight, and harm native species.

South America: - Additionally, Azolla is sold in several nations like Brazil and Argentina.

Azolla has been cultivated and utilized outside of its natural range for agricultural purposes in many different regions of the world. In rice fields, where its capacity to fix nitrogen helps improve soil fertility and decreases the need for synthetic fertilizers, it is frequently grown as a green manure or cover crop. Azolla can also be used in fish farming as a nutrient-rich rice supplement and as animal feed.

7. USES OF AZOLLA

There are various uses of Azolla widely seen throughout the world. Some of them are discussed below.

7.1 Azolla as atmospheric nitrogen fixation: - Azolla can be used to fix nitrogen from the atmosphere in the soil as NH₄⁺. When applied to crops, particularly rice crops, in flood-prone areas, it releases 40%–60% of its energy within 20 days, and 55–90% of its energy is released after application. By applying 10–12 t/ha of azolla manure, soil nitrogen is increased by 50–60 kg/ha [17]. It is strongly advised for rice crops since it minimizes the nitrogen fertilizer.

7.2 Use of Azolla as green manure: - Before the rice is transplanted, it can be used as a monocrop by being added as a basal manure. It can be moved to another location and applied to upland crops there.

S. no.	Constituents	Dry matter(%)
1.	Crude protein	24-30
2.	Crude fat	3.3-3.6
3.	Nitrogen	4-5
4.	Phosphorous	0.5-0.9
5.	Calcium	0.4-1.0
6.	Potassium	2-4.5
7.	Magnesium	0.5-0.65
8.	Manganese	0.11-0.16
9.	Iron	0.06 - 0.26
10.	Soluble sugars	3.5
11.	Crude fibre	9.1
12.	Starch	6.54

Table.1. Nutrition content in Azolla

Both a mono-crop and an intercrop can be grown with it. A few modifications to the management of the primary crop are necessary when using azolla as a green manure crop. In order to provide nitrogen for the spring rice crop, monoculture Azolla is grown in China and Vietnam in the winter and spring. The early summer rice crop also receives nitrogen production using the same method, albeit less frequently. Due to the high temperatures and frequent pest infestations in the summer, the azolla pinnata is harmed. In areas where there isn't enough time for azolla monoculture, Azolla is intercropped with rice [18].

7.3 Azolla as a livestock feed: - Azolla is utilized as animal feed because it includes 26% crude protein, 16% crude fiber, 3.47% ether extract, 16 ash, and other beneficial components [16]. Fish, cattle, and other animals may all eat it. Chickens to promote their growth. While it raises the weight of the boiler hens and egg production in poultry, it boosts the milk yield by 15% in cattle. It can be used for pig pens as well as sheep, goats, and other animals. Azolla can be used as livestock feed because it assists the animal- rearing business most [16].



Fig. 5. Azolla as a animal feed

7.4 Azolla as a biofuel: - Azolla can produce bioenergy which includes biodiesel, bio or syngas, biohydrogen, etc. Azolla takes the CO₂ from the atmosphere and converts it into carbon-rich

lipids using photosynthesis which can be used as biofuel. This reduces the use of fossil fuels thereby reducing environmental problems. It enhances microbial activity by producing energies like H₂, lipids for biodiesel, jet fuel hydrocarbons, etc. for ethanol production [16].

7.5 Azolla in Bioremediation: - It is seen that the *A. pinnate* and *lamna minor* have the ability to remove the iron and copper from the polluted water [19]. In case the pollutants are present in the low concentration which can be prevented by using Azolla just by passing it through the water bodies. Azolla biomass can act as a biofiltration of It is astonishing to witness how it concentrates nutrients and metals like Cu, Cd, Cr, Ni, and Pb directly from polluted or sewage water [20].

7.6 Azolla as weed controller: - It has been noted that Azolla can be utilized in some locations to eradicate weeds from rice fields. As this Azolla forms a thick layer which will suppress the growth of the weed by making them to deprive of sunlight as a result, the farmers' expenses for weed control will be reduced, which will help them by boosting their income thanks to Azolla's advantages. It is also apparent that the rice crop, which has already surpassed the Azolla mat and will continue to develop, will not be harmed by this [21].

Azolla has numerous other applications in a variety of industries, including medicine, food for different species, repellents, human food in some regions of the world, larvicide, and many more. It is because there are so many nutrients in it. The azolla contains some of the nourishment stated above.

8. CONCLUSION

Azolla is a beautiful fern that goes overlooked by farmers across the world. As a main crop, it can enhance the former with a remarkable profit if proper methods are followed. As we have mentioned it has a wide range of uses in various disciplines which can benefit farmers in many ways. A bigger amount of yield can be attained by using contemporary technology and the right methods. In order to acquire the most output, we've outlined a few cultivation techniques and requirements. When accepted, they may be advantageous for the numerous utilities mentioned above. Azolla had spread in most of the continents with different uses and for different purposes. Most of the utilities of azolla are not in practice and even the implements or the tools for harvesting are not available which is the minimum disadvantage for large-scale production. In this review, it has been absorbed that the Azolla can also be a beneficial crop if the right steps are adopted.

9. ACKNOWLEDGEMENT

I acknowledge the research efforts made in numerous ways to improve the Azolla. In spite of this, I would want to thank everyone who has contributed to the expansion of Azolla by doing study on its numerous components. In order to increase yield, we need also help farmers discover easy answers to some of their problems. The crop is widely distributed in many parts of the world thanks to the research article. As a result, I want to express my gratitude to scientists and researchers for their efforts to address the shortcomings of the Azolla.

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