

## Azolla: A Promising Booster Towards Agricultural Productivity

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### **Introduction:**

Mosquito or duckweed fern popularly known Azolla, is a free-floating branched aquatic fern. It grows rapidly on the surface water in mostly fresh water and can be also found on moist soils, marshy pond land and is widely distributed in tropical region of India. During the green revolution in India, high yielding rice varieties increased agricultural output, but small stature plants resulted in a lower straw-to-grain ratio. Therefore, less straws are available for cattle feed which causes a serious threat to cattle growing farmers. In this context, Azolla behaves as livestock feeding substances and simultaneously as a biofertilizer in wet land paddy cultivation. Azolla fixes atmospheric nitrogen with the symbiotic association of host plant, blue green algae (*Anabaena azolle*) and possesses a high nutrition value. As it requires less investment and can be used for low cost alternative technique for higher production in rice crop, promotes farmers to cultivate Azolla for achieving sustainable results in terms of livestock feed and biofertilizer source.

The aquatic fern known as azolla (*Azolla* sp. ), characterised by its short, branched, floating stem and its roots that penetrates into the water, is a member of the Salvinaceae family. The leaves of azolla plant are arranged in alternate manner and each has a green, thick, aerial dorsal lobe (containing chlorophyll) and a slightly thin and larger floating ventral lobe (which is colorless). Hence the azolla plant appears reddish brown in colour due to presence of anthocyanin pigment. Small size species *Azolla pinnata* ranges from 1-2.5 cm and *Azolla nilotica* grows upto 15 cm in plant size. As it floats on surface of water singly or in mat type form, it looks like triangular or polygonal in shape. *Azolla nilotica* produce dark green to reddish carpet appearance where other species have red anthocyanin pigment. The

symbiotic relationship between the nitrogen-fixing blue-green alga (cyanobacterium) *Anabaena azollae* and azolla plant is the most interesting aspect of azolla cultivation. The fern creates a protected cavity inside each leaf which stores atmospheric fixed nitrogen and maybe other growth-promoting chemicals. (Lumpkin et al., 1982).

### Chemical composition

Nutritional value	On dry matter basis
Crude protein	24.61%
Crude fibre	15.0 %
Lignin	11.4 %
Ash	15.9 %
Starch	4.1 %
Phosphorous	6.1 mg/kg
Potassium	17.4 mg/kg
Sodium	9.0 mg/kg
calcium	11.0 mg/kg
Iron	3.90 mg/kg
Magnesium	5.0 mg/kg

### Beneficial effect of Azolla

#### 1. Livestock Feeding

Azolla has a high protein, amino acid, vitamin (A, B12, Beta Carotene), and mineral content, making it a good nutritious feed for animals. It also has a low lignin content. It has been discovered that feeding of Azolla to poultry birds enhances broiler chicken weight and boosts egg production in layers chickens. Azolla may be fed to sheep, goats, pigs, rabbits, and fish. Some instances are milch animals had a 10-15 percent rise in milk production, meat by weight 8-10 percent increase for goat, and egg laying capability of poultry was increase 10-15 percent. *Azolla pinnata* is being suggested as a viable unconventional protein supplement for cattle during the lean phase of the year in rain fed locations based on the current research and observations. As climate change threatens livestock production due to its effect on the quantity and quality of feed crops, fodder, and forage, this technology has promise climate change adaptive capability and is beneficial in climate change adaptation of farmers in these regions (Kumar and Chander, 2017).

## 2. Bioremediation

*A. pinnata* and *Lamna minor* were discovered to remove the heavy metals iron and copper from contaminated water (Jain et al., 1989). *Azolla* shows a great potentiality to directly concentrate metals such as copper, Cd, Cr, Ni, Pb, and nutrients from pollution or sewage water.

## 3. Biofertilizer

It decomposes rapidly in soil, allowing for maximum nutritional availability to rice plants. Hence it can be used as a good source of biofertilizer as well as green manure. It helps to increase the rice yield by 20-30%.



## 4. Weed control

With its thick covering, *Azolla* acts as an organic mulching in rice fields, preventing the growth of weeds. It also helps keep soil wet for longer by reducing the rate of evaporation. It was shown that an *Azolla* cover significantly decreased the amount of weeds, particularly the dominant weed *Monochoria vaginalis*.

## 5. Mosquito control

*Azolla* inhibits breeding of mosquito, known as mosquito fern. A dense mat of *Azolla* floating on the water's surface may prevent mosquito hatching and adult development.

## 6. Azolla in Production of Biogas

Methane gas is produced during anaerobic fermentation of *Azolla* (or a mixture of *Azolla* and rice straw), which can be used as fuel, and the remaining effluent can be used as a fertiliser because it contains all the nutrients originally incorporated in plant tissues, with the



exception of a small percentage of nitrogen lost as ammonia. Gas production was increased by a factor of 1.4 when cow dung and Azolla residues were mixed in a ration of 1:0.4.

### **7. Azolla and Bioenergy**

When Azolla Anabaena is grown in a nitrogen-free atmosphere and a water medium containing nitrate in the symbionts, the organism produces hydrogen from water instead of fixing nitrogen [Peters 1975]. This results in a clean, high-energy fuel that does not contribute to air pollution. Immobilizing fern-isolated Anabaena-Azollae cells or placing them in a microaerobic environment, partial vacuum, argon-enriched atmosphere, or carbon dioxide-enriched atmosphere have all been shown to improve the rate at which these organisms produce hydrogen.

### **8. Medicinal use of Azolla**

Azolla is used to prepare cough medication in Tanzania (Raja et al., 2012)

### **9. Azolla as a human food**

In India and other parts of the East, azolla is commonly used as a cattle feed, but its potential as a human diet is less well recognised. Research on possible space station, space flight, and Moon/Mars habitation diets has helped to spur this shift. Protein-wise, azolla is quite similar to soybeans. Minerals account for 10–15% of the dry weight, and essential amino acids for 7–10%. Vitamins and carotenoids make up the remaining 2-5%. 20-30% of Azolla's dry weight contains protein; this is rather high for a vegetable. When it comes to proteins, Azolla contributes a higher portion.

### **10. Azolla as a Component of Space Diet**

Azolla was recently recommended as part of the space diet during living on Mars after studies by Katayama et al., 2008 in partnership with the Space Agriculture Task Force discovered that it met human nutritional needs.

#### **Cultivation of azolla:**

Growing of Azolla is done basically by two types:

- In-situ Azolla (cultivated with standing crop on the field)
- Ex-situ Azolla (grown in outside and incorporate in main field )

Thirdly, Azolla can be cultured in polythene bags using a different technique.

### Azolla Cultivation Procedure

**1. Selection of pond location** – A area near to the house can be prefer for continuous monitoring of the pond. Site under partial shade can be considered more to reduce the evaporation loss and effective photosynthesis of azolla. Regular water supply should be maintained. Floor of pond should be free from stones or any root debris to avoid water leakage and puncture of sheet.

**2. Pond size and construction** – The number of species being grown, the amount of supplemental feed and the availability of resources are all factors that influence ideal pond size. – Azolla may be cultivated on 6 X 4 feet of ground and provide around one kilogramme of Supplementary feed each day. A suitable area must be cleaned and levelled. The lateral walls of the pond may be formed with bricks or an embankment made with excavated earth from the pond. After spreading the long-lasting plastic sheet (silpauline, a polythene tarpaulin) in the pond, bricks must be laid over the side walls to firmly secure the edges of pond. – After inoculating the culture, a net should be put over the pond to provide shade and prevent leaves and other debris from falling in. The shade net must be hung over the walls of the pond and supported by thin wooden poles or bamboo sticks. The plastic sheet and net over the pond area may be held in place by placing bricks or stones as weights around the boundaries.

**3. Production of Azolla** -The pond has to be filled with a uniformed layer of fertile sieved soil combined with cow dung and water. A pond of 6 feet by 4 feet will need around 1 kilogramme of fresh Azolla culture, which should be spread out evenly throughout the water body. In addition to dung, biogas slurry may be utilised, and the depth of the water should be four to six inches. During the monsoon season, collecting rainwater from rooftops to use for growing Azolla will assure good and rapid development. However, Growth will suffer if the overall salt content of the water utilised for agriculture is too high.

**4. Maintenance of the pond** Azolla will grow better if one kilogramme of cow dung and 100 grammes of super phosphate are applied once every two weeks. Remove any trash or aquatic weeds found in the pond on a regular basis. Every six months of interval, the pond must be evacuated and the culture must be replaced with fresh Azolla culture

**5. Azolla harvesting and feeding of livestock:** Azolla development in the pond will take two to three weeks, depending on the initial amount of culture supplied, nutrition and environmental conditions. After full development, it may be collected everyday. Biomass may be harvested from the surface of the pond using plastic sieves.



A 6 X 4 foot area may generate around 850 to 900 grammes of fresh Azolla (yield per day in a season). • Azolla may be given to cattle both fresh and dried form. It may be provided either directly or in combination with concentrates. To eliminate the odour of cowdung, azolla must be properly rinsed with fresh water.

**6. Yield:** About 8-10 metric tonnes of azolla's green mass are converted into 25-30 kilogrammes of nitrogen gas, which in turn yields 55-66 kilogrammes of urea.

**7. Economics of Cultivation:** The expenditure of preparing a 6 × 4 feet pond is less than Rs.500 (including sheet and labour cost). An additional fish production and decreased use of feeding concentrates for cultured fish species might result in a net profit of over Rs. 4500 per year for a farmer.

#### **Requirements for azolla growth**

- 1. Water:** Fresh, moving water at a height of 10-15 cm is required in the reproduction pond maintaining a water level of 4 inches is critical factor for growth and optimized production of azolla.
- 2. Temperature:** Duranal temp between 32°C- 20°C considered to be optimal for for azolla growth and multiplication. This plant normally prefers to thrive in partial shade.
- 3. Relative Humidity:** 85 to 90 percent relative humidity is the optimal range.



**4. Soil pH:** Azolla thrives in slightly acidic soil with a pH of 5.2 to 5.8.

**5. Nutrition:** As an N-fixing fern, Azolla does not require nitrogen-containing fertiliser for growth. Phosphorous concentrations of 20 kg/ha are desirable for bio-mass production.

#### **Important tips for growing azolla**

1. Azolla multiplies quickly; keep the biomass at between 300 and 350 grammes per square meter by picking it daily to prevent overpopulation.
2. To increase the Azolla's mineral content, apply a combination of Super Phosphate and cow dung once every five days, as well as weekly applications of a mixture comprising magnesium, iron, copper, sulphur, etc.
3. Every 10 days, replace 25-30% of the pond's water with new water to avoid nitrogen accumulation.
4. Every six months, completely change out the water and dirt, and then plant some new Azolla seeds.
5. For easy harvesting, maintain the water level at least 10 centimetres above the Azolla roots.
6. Once the Azolla has been harvested, it is washed carefully to eliminate any remaining dirt or odour of cow dung before being fed to the animals.

#### **Conclusion**

As we are approaching to meet the increasing demand of food consumption without compromising the soil health and environmental integrity, azolla can be an effective solution in this regard by adopting it as a source of biofertilizer in rice based intensive cropping system in Indian scenario. With suppression of weed, azolla helps to enhance the nutrient availability by maintaining suitable pH and fixing C and N in soil. It can also be used as unconventional feed for livestock due to rich in protein (high amount of amino acid- lysine methionine, arginine and carotene) minerals, vitamins. The cost of rearing animal is reduced as it can be used to replace concentrate and other conventional feed. In young animals azolla inclusion in diet promotes feed intake, body weight gain and improves the overall health as azolla contains growth promoters. It increases fat content of milk and yield in lactating animal, feed conversion efficiency in broiler, enriched protein content in layers. Therefore we can conclude that the azolla can be grown commercially if labour scarcity is not a problem.

to increase the yield of rice crop and enhance a balanced nutritional diet for livestock in agri based industry sector.

### Reference

- Adhikari, K., Bhandari, S., & Acharya, S. (2020). An overview of azolla in rice production: a review. *Reviews in Food and Agriculture*. 2(1): 04-08.
- Raja, W., Rathaur, P., John, S. A., & Ramteke, P. W. (2012). Azolla: An aquatic pteridophyte with great potential. *Int. J. Res. Biol. Sci.* 2(2):68-72.
- Roy, D. C., Pakhira, M. C., & Roy, M. (2016). Estimation of amino acids, minerals and other chemical compositions of Azolla. *Advances in Life Sciences*. 5(7):2692-2696.

