



***Azolla* (Aquatic Fern) as Bio Fertilizer (Eco- Friendly Agriculture)**

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Aquatic fern *Azolla* spp. is of interest as a bio fertiliser for wetland rice. It is common and widely practiced in other countries, such as China, Vietnam, and the Philippines, but has yet to be adopted in Korea; in a major way. This removes nitrogen up to 3-5 kg N every day, as it produces nitrogen based blue green algae, *Anabaena Azollae*. *Azolla's* capacity to build a light-proven mat that suppresses certain weeds has been used in rice production for centuries. Used as a bioaccumulator for phytoremediation. *Azolla* meal may also be used as an unusual feed option with promise as a feedstuff for livestock.

Introduction

Azolla is a branched free floating aquatic fern, available mainly on moist soils, ditches, marshy ponds and rice fields, and is widely distributed in the tropical regions of India, Thailand, Korea, Philippines, Brazil and West Africa. Nitrogen stored in *Azolla* is made accessible to the rice crop as the fern is decomposed. Algae inhabits each of the cells located at the bottom of the *Azolla* and replaces the ambient nitrogen. We establish a symbiotic partnership with cyanobacterium / BGA *Anabaena Azollae*, which fixes atmospheric nitrogen and allows the plant access to the critical nutrient. It relies on the photosynthetic fern that provides the energy to remove the nitrogen. In addition to nitrogen, the decomposed *Azolla* also supplies K, P, Zn and Fe to the crop. It also manages marine plants that would otherwise interfere with the nitrogen harvest. *Azolla* is a very productive plant. It doubles the biomass in 3-10 days, depending on the circumstances, and yields in Asian rice fields can hit up to 8 to 10 tons of fresh matter per hectare..

The other species of *Azolla*: *Filiculoides*, *A. Mexicana*, *A. Caroliniana*, *Azolla microphylla*, *Azolla nilotica*, *Azolla pinnata*

Classification (taxonomy)

- **Class:** Pteridophyta
- **Order:** Salviniales
- **Family:** *Azollaceae* (Salvinaceae)
- **Genus:** *Azolla*
- **Sub genus:** Eu- *Azolla*

Until the mid-1980s, *Azolla* was used as a natural manure for spring rice in northern Vietnam. *Azolla* has been used as a green manure for wetland rice in northern Vietnam and central and southern China for centuries owing to its symbiotic nitrogen fixation and thus high nitrogen content. By the early 1980s, the usage of South Cotabato extended to the Philippines.

Nevertheless, since the late 1980s, the socio-economic condition in these countries has shifted drastically with the implementation of a free economy structure. Growth and the dissolution of the farmers' association that supported inoculum for rice cultivation are factors that explain the rapid decrease in the usage of *Azolla*.



Parthasarathy *et al.* (2002) reported that 5 % replacement broiler ration with dried *Azolla* was quite profitable and safe for broiler production. *Azolla* is relatively sensitive to salt, cultivation in saline environment for a period of two consecutive years decreased salt content from 0.35-0.15 and desalinate rate (71.4%) was 1.8 times faster than through water leaching and 2.1 times faster than *Sesbania* and also reduced the electrical conductivity, pH of acidic soil and increased calcium content of soil (Anjuli *et al.*, 2004). Arora *et al.* (2006) found that tolerance and phyto-accumulation of chromium by three *Azolla* species and also results found by Cohen-Shoel *et al.* 2002 shows biofiltration of toxic elements by *Azolla* biomass. *Azolla* exhibits a remarkable ability to concentrate metals Cu, Cd, Cr, Ni, Pb and nutrients directly from pollutants or sewage water. Rai *et al.* (2012) conducted an experiment and reported that layer birds fed with fresh *Azolla* had a higher body weight at 8 weeks or higher egg production at 40 and 72 days than control. Murthy *et al.* (2013) fed 2 kg fresh *Azolla* per day to the milking cows replacing 50% of concentrate for 3 months and reported that *Azolla* maintained good dairy performance while decreasing feed+labour costs by 16.5% and milk production costs by 18.5%.

Structure of *Azolla*

The shape of the Indian species is typically triangular, about 1.5 to 3.0 cm in length, 1 to 2 cm in width. Roots emanating from growing branches were still suspended in water. The dorsal lobe, which stays open to sunlight, has a special cavity housing its symbiotic host, the blue green algae (BGA) and the anabaena azole. The fern is capable of fixing ambient nitrogen in the soil in the form of NH_4^+ and is usable as soluble nitrogen for the wetland rice crop, the main cereal crop in India (Size-1-5 cm). The *Azolla* giant is 15 cm long and is found in Central Africa.



A. Microphylla



A. Pinnata

On dry weight basis *Azolla* contains the following chemical composition:

Advantages of *Azolla*

1. This develops quickly in the wild and can even thrive under managed conditions.
2. It can easily be generated in large quantities needed as green manure in both seasons – *Kharif* and *Rabi*.
3. It can fix atmospheric CO_2 and nitrogen to form carbohydrates and ammonia and, after decomposition, add available nitrogen for crop uptake and organic carbon content to the soil.
4. Oxygen produced due to oxygen photosynthesis allows the root system of the crop and other soil microorganisms to breathe.
5. This solubilizes Zn, Fe and Mn and renders them usable for rice.



6. Azolla suppresses tender weeds like Chara and Nitella in the paddy area.
7. Azolla releases plant growth regulators and vitamins that promote the development of the rice plant.
8. Azolla can, to a certain degree, be a replacement for chemical nitrogen fertilizers (20 kg / ha) and improve crop yield and quality.
9. This improves the productivity of the usage of chemical fertilizers.
10. It decreases the evaporation levels of the irrigated rice field.

Economic content of *Azolla*

Nitrogen	: 5.0%
Phosphorus	: 0.5%
Potassium	: 2.0-4.5%
Calcium	: 0.1-1.0%
Magnesium	: 0.65%
Manganese	: 0.16%
Iron	: 0.26%
Crude fat	: 3.0-3.3%
Sugar	: 3.4-3.5%
Chlorophyll	: 0.34-0.55%
Ash	: 10%

Limitations

1. Liquid is pre-requisite for its multiplication. And it's not ideal for upland crops.
2. A substantial amount of inoculum is needed, which is difficult to transplant during rainy days.
3. Temperature of more than 35 ° C is not acceptable.
4. Extreme low temperatures are also not appropriate.
5. The shortage of equipment required to use Azolla as a sterile inoculum.
6. Indisponibility of varieties appropriate for higher temperatures with low P use.
7. The initial costs of production are large.
8. The supply of nutrients to plants is not immediate.
9. The demand for Azolla is not that common.
10. Ignorance of citizens regarding the value of Azolla.

Precaution to be adopted

1. Maintenance of pure culture free of contaminants is important for successful yield.
2. Azolla can be collected on a daily basis to prevent overcrowding.
3. Temperature is a key factor for successful production. It's estimated to be around 35 degrees Celsius. Throughout cold areas, the forage plot is to be filled with a plastic sheet in order to may the effects of cold weather.
4. Priority should be provided to areas with clear and sufficient sunshine. The shadow of a position produces fewer.
5. The pH of the material will be between 5.5 and 7.

Suitable nutrients such as cow dung slurry, micronutrients should be applied when and when necessary.



Growth of azolla

Growing of the Azolla is generally two types that are

1. Azolla Insitu 2. Azolla exsitu (In Insitu process Azolla is grown with a standing crop in the region, but in exsitu it is grown in the environment by a appropriate volume of water. There is also another form. 3. Azolla in polythene)

The field is ploughed in low land; g/sq. m. LED and tiny packages with a diameter of 50 cm render small ponds with a depth of 3×2×1 m. Only 10-15 cm of standing water is allowed in the ponds.

Green Azolla @ 50-200 g + P₂O₅ by SSP @ 20 kg / ha along with furadan 1g / kg Azolla is combined and released into the pond retaining a water level of 10-15 cm for further growth and multiplication of Azolla. Azolla multiplies quickly and, in only two weeks, creates a green layer like a blanket on the water surface of the pool.

This green Azolla is collected in the bamboo basket and moved to the transplanted rice field for further multiplication as a dual rice crop for nitrogen fixation in the rice crop. Harvested green Azolla may be transformed to compost by pounding in pits for a month, which is then used as FYM for other crops grown in the upland. During the season, Green Azolla is harvested 15-20 days early, however during the winter Azolla develops gradually due to moisture stress and low winter temperatures, and Azolla can be harvested 25 to 30 days apart during the winter.



Growing Azolla in field

How to apply Azolla in rice field

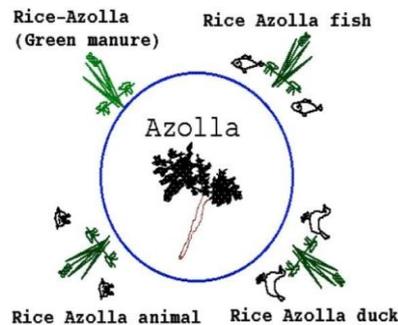
The Azolla bio fertilizer can be applied in 3 ways in rice field.

Method 1: Fresh Azolla biomass is inoculated in the rice field 2-3 weeks before transplanting.

Method 2: Azolla can be grown in separate plot and can be applied to main field just before transplanting.



New Horizon of Azolla use



New Horizon of Azolla use

Method 3: *Azolla* can be inoculated after transplanting rice and grown as dual culture of rice and incorporated subsequently. In dual culture *Azolla* is grown in the rice field with the standing crop. When thick mat is formed water is drained out and *Azolla* is incorporated in soil. Again in fresh inoculation is done @ 0.5 t/ha. In this phase *Azolla* is grown in 8 weeks. It is again incorporated in soil. It is suitable for medium to long duration.

Favorable conditions for higher efficiency of *Azolla*:

- **Water:** 10-15 cm fresh current water is necessary in multiplication pond.
- **Temperature:** the day or night temperatures ranging between 32°C and 20°C have found to be most favourable. The optimum temperature for luxurious growth of *Azolla* is 25 to 30°Celsius and can be raised successfully in the mid Hills.
- **Light:** *Azolla* prefers to grow well under particle shade. As dual cropping *Azolla* gets particle shade from rice plant and therefore as dual cropping with rice is most successful.
- **Soil pH:** *Azolla* grows well in slightly acidic soil having 5.2 to 5.8 pH.
- **Nutrition:** Being an N fixing fern *Azolla* does not require nitrogenous fertilizer for its growth. However application of N @ kg/ha is useful as a starting dose in new multiplication area. Phosphorus 20@ kg/ha is desirable for good bio-mass production.

Azolla produce around 8-10 tonnes of green mass which is equal to 25-30 kg N₂ which is again to 55-66 kg of urea.

Summary

The history of the usage of *Azolla* in agriculture and animal husbandry is not quite long. In reality, people began to learn about the various benefits of this plant in the 1990s. Given its countless advantages, there has not been much interest among Indian farmers who do not favour the usage of *Azolla* plant farming. Local people, like fishermen, have very little awareness of the advantages of this aquatic species. Throughout the future, these algae will do well in the area of agriculture and animal husbandry by amplifying raw materials and goods.

Azolla has been of interest to botanists and agriculturist for years because of its symbiotic relationship with a nitrogen fixing, blue green algae, and anabaena. It provides an excellent source of organic Matter and nitrogen for crops. As *Azolla* grows, it forms a floating, light proof mat of living



plants that suppresses weed growth. In addition, *Azolla* can be fed to a variety of farm animals, it is an effective water purifier, it help to reduce ammonia volatilization from fertilizers.

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