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Azolla: Empowers Women Rural Farmers

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Abstract

Azolla is commonly known as mosquito fern, duckweed fern, fairy moss, and water fern, is a small free floating aquatic fern native to Asia, Africa, and the America. It grows in swamps, ditches, and even in lakes and rivers where the water is not turbulent. The name Azolla is derived from the two Greek words, *Azo* (to dry) and *Ollyo* (to kill) thus reflecting that the fern is killed by drought. Azolla-*Anabaena* is a symbiotic complex in which the *entophytic* blue-green algae *Anabaena zollae* lives within the leaf cavities of the water fern Azolla. It is important to keep Azolla at the rapid multiplication growth phase with the minimum doubling time. Periodic application of cow-dung slurry, super phosphate and other micro and macro nutrients except nitrogen prevents plants from reaching sporulation stage. Biomass should be removed every day or on alternate days to avoid overcrowding. PH level should be tested periodically and maintained regularly.

Introduction

Azolla is a floating fern and belongs to the family of *Azollaceae.* The fern Azolla, hosts a symbiotic blue green algae *anabaena* Azolla, which is responsible for the fixation and assimilation of atmospheric nitrogen. Azolla, in turn, provides the carbon source and favorable environment. In Azolla, the *endosymbiont* is even carried through the sexual reproductive phase, perhaps the only one of this kind in the plant kingdom. It is this unique symbiotic relationship, which makes Azolla, a wonder.

Figure 1: Azolla Cultivation

Beneficial Usages

Azolla as Nutritional Supplement

Azolla is used as food supplement for variety of animals like cattle, goat, pigs, rabbits, chickens, ducks and fish. An experiment conducted and reported that Azolla can

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Figure 2: Preparation of Azolla Bed

be utilized as fodder for cattle and pigs. It was also found that broilers feed with Azolla resulted in growth and body weight values similar to those resulting from the use of maize-soya bean meal and found that digested Azolla slurry remaining after biogas production is suitable as fish pond fertilizer.

An experiment was conducted with 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 and labor costs by 16.5% and milk production costs by 18.5%. In case of 'Black Bengal' goat, replacement of the concentrate up to 20% with sun-dried Azolla resulted better growth with no adverse effect on its health.

Azolla is quite profitable and safe for broiler production. An experiment with feeding broiler chicken with maize and soybean meal 10% replaced by dried Azolla *pinnata* and reported that feed cost significantly decreased without affecting the meat production resulting higher net return. An experiment was conducted 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.

Figure 3: Azolla as a Fodder

Azolla as Biofertilizer

Azolla is cultivated in the paddy field either as mono crop or as intercrop and incorporated into the mud/ soil for increasing humus and nutrient content of the soil. This practice of Azolla cultivation is widely popular in the countries of south-east Asia like India, China, Philippines, and Indonesia etc. The use of Azolla increased rice yields by 112% over unfertilized controls when applied as a mono crop during the fallow season, by 23% when applied as an intercrop with rice, and by 216% when applied both as a mono crop and an intercrop. When Azolla used as a bio-fertilizer in paddy field it produces around 300 tons of green bio-hectare per year under normal subtropical climate which is comparable to 800 kg (1800 kg of urea) of nitrogen.

Azolla has quick decomposition rate in soil and thus it speeds up the efficient availability of its nitrogen to rice plant. The quick multiplication rate and rapid decomposing capacity of Azolla has become paramount important factor to use as green manure cum bio-fertilizer in rice field.

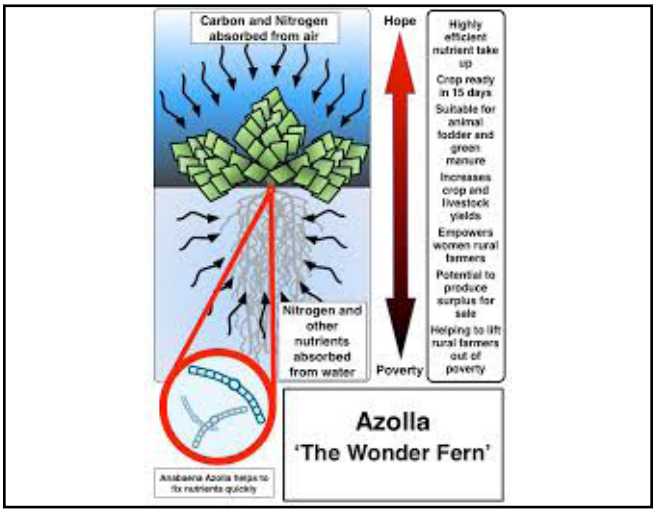

Figure 4: Azolla seeds-Wonder Fern

Azolla as Mosquito Repellent

Azolla can also be used in the control of mosquitoes, for a thick Azolla mat on the water surface can prevent breeding and adult emergence. In a survey of pools, ponds, wells, rice fields and drains found that breeding by *Anopheles spp*. was almost completely suppressed in water bodies that were completely covered with Azolla.

Azolla in Production of Bio-Gas

Anaerobic fermentation of Azolla (or a mixture of Azolla and rice straw) results in the production of methane gas which can be utilized as fuel and remaining effluent can be used as a fertilizer because it contains all the nutrients originally incorporated in plant tissues except for a small percentage of nitrogen .An experiment was conducted with the mixture of cow dung and Azolla residues found that best ratio was 1:0.4, which gave gas production 1.4 in Biogas.

Azolla in Reclamation of Saline Soils

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 level of acidic soil and increased calcium content of soil.

Azolla in Bioremediation

It was found that Azolla *pinnata* and *Lamna* minor removed the heavy metals iron and copper from polluted water. The pollutants at low concentration could be treated by passing it through ponds and can be reused for agriculture purpose. Recently studies found that tolerance and phyto-accumulation of chromium by three Azolla species and also results shown as 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.

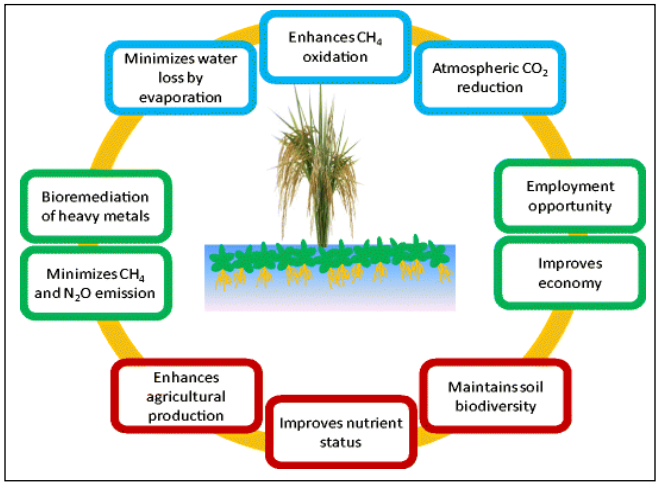

Figure 5: Benefits of Azolla

***Azolla and Bioenergy*:**

A non-polluting, high energy fuel when Azolla *Anabaena* is grown in a nitrogen- free atmosphere and or a water medium containing nitrate in the symbionts, instead of fixing nitrogen evolve hydrogen, using water as the source shows that rate of hydrogen production can be increased by exposure to a micro aerobic environment, a partial vacuum or argon-enriched or carbon-dioxide enriched atmosphere or by immobilization of cells of *Anabaena*-Azolla isolated from the fern.

Azolla as a Human Food

Azolla is widely used as a livestock feed in India and the Far East, but its potential as a food for people is less well known. This is now changing and some of the impetus has come from studies into diets that could be used for space stations, space travel, and habitation on the Moon and Mars. Azolla's protein content is close to that of soybean. It is a rich source of minerals (10-15 % of dry weight), essential amino acids (7-10 % of dry weight), vitamins and carotenoids. 20-30 % of Azolla's dry weight is protein, which is a lot for a vegetable. The quality of the protein in Azolla is good.

Figure 6: Azolla as human Food

Numerous Features

Mosquito Control

Azolla can be used to control mosquitoes because a thick Azolla mat on the water surface helps to prevent breeding and adult emergence. In a survey of pools, ponds, wells, rice fields, and drains, breeding by *Anopheles* was almost completely suppressed in water bodies that were covered with Azolla.

Laboratory experiments shows that immature mosquito populations of *Anopheles subpictus*, *Culex pseudovishnui* and *C. tritaeniorhynchus* were reduced by a 90% cover of Azolla *microphylla*, and that Azolla *pinnata* greatly reduced the oviposition and adult emergence of *Culex quinque fasciatus* and Anopheles *culicifacies*.

Figure 7: Mosquito Fern

Weed Control

Azolla can be used to control weeds. Azolla cover significantly reduced the total amount of weeds, particularly the predominant weed *Monochoria*

vaginalis. The Azolla cover reduced light intensity by about 90%, reducing photosynthesis in the floodwater and thus reducing oxygen concentration of the water by more than 50%.

Besides reducing light intensity, an Azolla cover alters light quality, the green leaves having a filter effect that increases the relative amount of infrared rays which reduces the germination of light-sensitive seeds.

Removal of Heavy Metal Pollutants from Water

Azolla can be used to purify water polluted by metals. Azolla *pinnata* and *Lemna* minor (duckweed) removed the heavy metals iron and copper from polluted water when the metals are present at low concentrations. They concluded that effluent containing metal pollutants in low concentrations could be treated by passing it through ponds containing one or both of these water plants.

Scientist found that a mixed culture of *Lemna* and Azolla in the ratio of 2:1 was able to purify highly polluted effluent from factories sufficiently for it to be used for agricultural purposes. Azolla's potential to purify water has potential applications for both industrial and mining operations, as well as space exploration.

Purification of Waste Water

Azolla has the ability to grow well in partially treated domestic wastewater and in effluents from wastewater stabilization ponds despite the high ammonium content of the medium. These results confirm Azolla's use as a biofilter for the removal of both phosphorus and nitrogen. Furthermore, Azolla is able to do when nitrogen becomes a limiting growth factor, which is sometimes the case with urban waste water treated by conventional processes. This illustrates the advantages of using Azolla instead of other small macrophytes *(Lemnaceae)* which are also used to upgrade waste water quality.

As pointed the Azolla biomass resulting from the purification process can also be used as a biofertilizer, which decreases the cost of phosphorus removal in waste water with particular benefits to small communities.

Figure 8: Azolla in waste water treatment

Conclusion

Azolla can be used as an ideal feed substitute for cattle, fish, pig and poultry, apart from its utility as a biofertilizer for wetland paddy. It is popular and cultivated widely in other countries like China, Vietnam, Philippines, etc., and is yet to be taken up in India, in a big way. The production technology has to be standardized to the diverse and different agro-climatic zones of the country, to enable its wider spread. Azolla technology will be taken up in a big way by the dairy farmers, especially, by those who experience land scarce conditions for fodder production.

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