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AZOLLA: CHEAP AND FEED SUPPLEMENT TO LIVESTOCK

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Azolla is a free-floating aquatic pteridophyte found worldwide in tropic and temperate fresh water ecosystems. It belongs to the family of salvinaceae. It appears as a green mat over water surface. Azolla fern hosts a symbiotic relationship with blue green algae (BGA) *Anabaena azollae*, an extracellular endosymbiont which is responsible for the fixation and assimilation of atmospheric nitrogen. Both the partners are photo-synthetically competent but the fern provides photosynthates to the BGA while the cyanobiont meets the N₂ requirement of the association. This association is outstanding because of its high productivity coupled with high rate of nitrogen fixation, equivalent to around 25 kg/ha, generally, it multiplies asexually through splitting methods, but sexual reproduction through spore formation has also been observed. Azolla *Microphylla* and *A. pinnata* are most commonly grown species and other species of Azolla are *Filiculoides*, *Caroliniana*, *Rubra* and *Maxicana*.

It is commonly seen floating on water surface of flooded rice fields, small pond and other water reservoirs. Azolla can serve as an excellent N₂ bio-fertilizer for paddy crop as it forms an ideal environment for its growth. One or more species of Azolla are found naturally in almost every geographical area where lowland rice is grown. It is quick multiplication and doubles its biomass in 5-10 days, depending on climatic conditions, and yield can reach 8.5-10.5 tones fresh matter/ha in Asian paddy fields (Table.1).in a study 37.8 t fresh weight/ha (2.78 t DM/ha) has been reported from *Azolla pinnata* in India. Besides N₂ biofertilizer, Azolla has other multiple uses like biological herbicide, animal feed and as water purifier. Azolla farming, in general, is inexpensive due to high productivity and it can be multiplied in natural water bodies for production of biomass.



Nutritional value of Azolla

Azolla is very rich in proteins, essential amino acids, vitamins viz; vitamin A, vitamin B12, and minerals including calcium, phosphorous, potassium, ferrous, copper, magnesium. On a dry weight basis, Azolla contains 25-35% protein, 10-15% mineral, and combination of amino acids, bio-active substances and biopolymers 7-10%. Azolla is poor in carbohydrate, fatty acids.

Azolla is succulent of poor in fiber content (crude fiber 9.07 - 22.25%). On an average the ether extract value for various species varies between 1.60 - 5.05 % while total ash was in the range of 10.15-36.10% and NFE values varied between 30.08 - 52.46%. The variations in the nutrient composition of *Azolla* meal is due to differences in the response of *Azolla* strains to environmental conditions such as temperature, light intensity and soil nutrients which consequently affect their growth morphology and chemical composition. The cell wall composition of *Azolla* is highly variable depending upon the species and the season of cultivation of Azolla. Cellulose and hemicelluloses content range between 6.8 to 36.7% and 10.09 to 17.8 respectively.

Amino acid composition: The *Azolla microphylla* strain is a good source of amino acids and its composition is on given in table.

Table 1. Amino acid composition of Azolla meal

Amino acids	DM%	g /100g protein
Lysine	0.98	4.58
Methionine	0.34	1.59
Cystine	0.18	0.84
Threonine	0.87	4.07
Tryptophan	0.39	1.82
Arginine	1.15	5.37
Isoleucine	0.93	4.35
Leucine	1.65	7.71
Phenylalanine	1.01	4.72
Tyrosine	0.68	3.18
Glycine	1.00	4.60
Serine	0.90	4.21
Valine	1.18	5.51

Materials Pond Size and Construction

To grow azolla in 6X4 pond following silpauline sheets of 150 GSM or any other polythene sheet, sieved fertile soil, vermicompost, poultry manure, cow dung, powdered rock phosphate, culture of azolla and micronutrients.

Growing conditions:

Azolla Unit require regular upkeep and monitoring of the pond. The site should be under partial shade to reduce the evaporation of water and also, for better growth of Azolla. Water is the basic requirement for the growth and multiplication of Azolla and is extremely sensitive to lack of water Azolla absorbs the nutrients from water. water source should be nearby for regular water level maintenance. The species vary in their requirement of ideal temperature.

In general, azolla multiplies rapidly at the daily mean temperature of 15 °C to 30°C. Azolla is sensitive to desiccation. Above 30 °C to 33°C or below 10°C, the growth is highly retarded. It prefers open/diffused light for photosynthesis and grows well in partial shade. in sunlight is needed for its normal growth and protation from during winter low temperature (<10 °C) is needed. Maintenance of adequate water level essential. The optimum relative humidity is 85 to 90 per cent.

The optimum pH is for azolla 5 to 7. High acidic or alkaline pH adversely of effect growth of this fern. Though all elements are essential, phosphorus is most limiting element for its growth. About 20 ppm of phosphorus in the water is optimum. In advance conditions viz. nutrient deficiency, bright light Azolla hot summer or cold winter, it also turns red or brownish red.

It can successfully be grown round the year in southern states like Karnataka, Kerala, Goa, Tamil Nadu and Maharashtra and during monsoon and summer months in states of Punjab, Haryana, Delhi, U.P., Bihar, M.P., Rajasthan, Gujarat, and Chhattisgarh. In hilly states where winter is pronounced, azolla can be grown only in monsoon and summer months.

Table 2. Biomass and doubling time Different *Azolla* species growth in poly house (at 30°C to 32°C)

Azolla spp.	Biomass (g) (fresh wt.)/g	Doubling time (days)
<i>A. filiculoides</i>	4-5	6-7
<i>A. microphylla</i>	5-6	5-6
<i>A. pinnata</i>	2-3	10-12
<i>A. rubra</i>	4-5	6-7
<i>A. mexicana</i>	4-5	6-7
<i>A. caroliniana</i>	5-6	6-7
<i>A. rubra</i>	5-7	7-8

Pond size and construction: The size of pond depends on factors like number of animals, quantity of supplemental feed required and availability of resources. For small holders, an area of 6x4 feet for *Azolla* cultivation can produce about one kg of supplemental feed per day. Selected area should be cleaned and leveled. A water body of 2x1.5x0.4 m is dug and leveled to maintain uniform water. It is lined with a silpauline sheet/ any other polythene sheet. Silpauline is resistant to the ultra violet radiation in sunlight. Width of the bed is maintained at 1.5 m to enable the cultural operation from both sides. The side walls of the pond can be of either bricks or raised embankment with the excavated soil.

Cultivation Technology

The methodology for economically cultivating *Azolla* by the livestock farmers is described here under:

- After spreading the durable plastic sheet in the pond, all the sides have to be secured properly by placing bricks over the side walls.
- About 10 – 15 kg of sieved fertile soil is uniformly spread over one sqm about 10 cm deep over the silpauline sheet. Slurry made of 5 kg of pre-decomposed (2 days) old cow dung and 30 g of super phosphate mixed in 10 liters of water, is poured onto the sheet. More water is poured on to raise the water level to about 20-25 cm.
- About 0.5 – 1 kg of fresh and pure culture of *azolla* is inoculated in the water of the pit. it multiply rapidly and make a green covers net over the pit within 10 – 15 days. From then on, 500 – 600 g of *azolla* can be harvested daily. Biomass should be removed at regular interval of 4-5 days to avoid overcrowding and un interrupted growth.

- A mixture of 20 g of super phosphate and 1 kg cow dung should be added every 5 days to maintain rapid multiplication of the *azolla*.
- About magnesium, iron, copper, sulphur nutrient of mix in made by mixing 10 kg rock phosphate, 1.5 kg magnesium salt and 500 g of murate of potash add 40g of it monthly intervals to enhance the mineral content of *azolla*. This not only takes care of the micronutrient requirement of *azolla* but also the cattle when it is fed with the *azolla*.

Precautions

- For rapid multiplication periodic application of cow-dung slurry, super phosphate and other macro and micronutrients should be done.
- The temperature should be maintained below 28°C. If the temperature rises, the light intensity should be reduced by providing shade.
- The pH should be tested periodically and maintained between 5.5 and 7.5.
- About 5 kg of bed soil should be replaced with fresh soil, once in 30 days, to avoid nitrogen build up and prevent micro-nutrient deficiency.
- At every 10 days interval, 25 to 30 percent of the water needs to be replaced with fresh water.
- At every six months the bed should be cleaned, the water and soil replaced and new *Azolla* inoculated.
- In case of pest and diseases infestation a fresh bed has to be prepared and inoculated with pure culture of *Azolla*.
- The *Azolla* should be washed in fresh water before use, to remove the smell of cow dung and other smell.

Insects: Insect damage is one of the major problems in the tropics. Lepidoptera, Pyralidae larva are most harmful insect pests to *azolla*. At higher temperature around 30°C, the damage is severe, because *azolla* growth slows down while insect growth is active. In extreme cases, *azolla* mat in the field is eliminated within a few days by Pyralidae. The application of imidacloprid @5ml/1000 l water provides effective control of the insects

Utilization of Azolla in Livestock Feed

Though India stands first in the world in terms of milk production and bovine population, average production still needs to be improved. This may be due to low plane of nutrition due to insufficient availability of quality fodder/feed. It is also called as *Green gold mine* due to its high nutritive value and



Super plant due to its fast growth. Azolla was found to be a very nutritive and cheap organic feed substitute for dairy cattle, poultry, pig, fish etc. In recent years, azolla has become prominent, because of its ability to concentrate minerals on heavily polluted water particularly arising from sewage treatment facilities. Coupled with its potential as a feed resource for livestock. For two cows, two units (beds length 2.5 m each with an area of around 8 sq m) utilization. to introduce Azolla, the fresh azolla should be mixed with commercial feed in 1:1 ratio to feed livestock. Field trial showed an overall increase of milk yield of approximately 15% when 1.5 - 2 kg of fresh azolla per day was supplemented with commercial feeds. Azolla feeding improves quality of milk, meat and improved in growth & development. Azolla can be fed to sheep, goat, pig as feed substitute and dried azolla meal can be incorporated up to 20 % of the concentrate mixture of kids without any adverse effect. Livestock can easily digest Azolla due to high protein content and low lignin content. Azolla feeding also improves the weight of broiler chicken and increasing the egg production in case of layer.

Advantages of Azolla Cultivation

1. It easily grows under controlled condition with very good yields.
2. It can easily be produced in large quantity in both the seasons – *Kharif* and *Rabi*.
3. It as fixes atmospheric CO₂ and nitrogen to form carbohydrates and ammonia respectively and after decomposition to help maintained C:N ratio in soil and increase the fertility of soil.
4. The oxygen released due to oxygenic photosynthesis, helps the respiration of root system of the crops as well as other soil microorganisms.
5. It solubilizes Zn, Fe and Mn and makes them available to the rice.

6. Azolla suppresses tender weeds such as Chara and Nitella in a paddy field.
7. Azolla releases plant growth regulators and vitamins which enhance the growth of the rice plant.
8. Azolla can be a substitute for chemical nitrogenous fertilizers to a limited extent (25 kg/ha) and it increases the crop yield and quality.
9. Improve seedlings or transplanted plant establishment and survival.
10. It reduces the rate of evaporation in irrigated paddy field improve drought tolerance by water less frequently.

Harvesting and Feedings of Azolla

Depending on the initial quantity of culture added, environmental conditions and nutrition, Azolla's growth in the pond is complete in about two to three weeks time. It can be harvested daily after the full growth. Plastic sieves (1 cm²) can be used to harvest the biomass from the pond's surface. About 800 to 900 grams of fresh Azolla (mean yield per day in a season) can be produced from an area of 6 X 4 feet. Azolla can be fed to the livestock either in fresh or dried form. It can be given directly or mixed with concentrates to cattle, poultry, sheep, goat, pigs and rabbits. feeding of Azolla @ 800 grams (fresh weight) on an average per day, improved the monthly milk yield by at least 10 liters per cow. It takes a few days for the animals to get used to the taste of Azolla. After a fortnight of feeding on *Azolla* mixed with concentrate, livestock may be fed with soul *Azolla* or mixed with straw. So, it is better to feed it along with the concentrates in the initial stages. A farmer can realize a net profit of over Rs. 4000 per annum from the additional milk yield and reduced usage of concentrates' feeding for livestock. For poultry, *Azolla* can be fed to egg layers as well as broilers.

Conclusion

Azolla is also called as *Green gold mine* due to its high nutritive value and *Super plant* due to its fast growth. It was found to be a very nutritive and cheap organic feed substitute for dairy cattle, poultry, pig, fish etc. It has been well established that azolla can be grown for meeting organic cattle feed supplement in addition to use as Dual Culture in rice farming and bio-manure for crops, vegetables and plants for environmental conservation and economic returns.

Beyond its agricultural utility, Azolla contributes significantly to climate change mitigation. It rapidly sequesters carbon and helps lower methane emissions in rice cultivation systems. In addition, its capacity for bioremediation makes it useful in treating polluted water bodies. Emerging industrial applications-such as its potential use in biofuel and bioplastic production-further underscore its economic importance. However, large-scale utilization is hindered by limitations including short shelf life, high moisture content, and ecological risks associated with its invasive nature.

In essence, Azolla represents a cost-effective, eco-friendly solution with broad benefits across food security, climate mitigation, and environmental management. To fully harness its potential as a cornerstone of climate-smart agriculture, future efforts must focus on improving preservation techniques, establishing standardized practices, ensuring ecological safeguards, and advancing genetic and precision cultivation strategies.

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