

Azolla:

An excellent green fodder

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Due to the shortage of green fodder and their high price in animal feeding, breeders are looking for easily accessible and affordable alternatives. In this context, Azolla which grows quickly in freshwater lakes, rivers, marshes, and ditches in temperate and tropical areas with cheap production cost can play a vital role. The nitrogen-fixing blue-green algae Anabaena azollae has a symbiotic connection with Azolla, which enhances the protein concentration of Azolla, making it one of the best alternative feed sources for protein. Furthermore, as compared to Hybrid Napier and Lucerne, biomass yield is about 3–10 times higher. It is also a good source of several minerals and vitamins. Thus, Azolla can be used to enhance the livestock productivity and profitability.

Keywords: Azolla, Green fodder, Livestock

INDIA ranks first in milk production but has lower milk productivity compared to other developing and developed countries. Lack of quality feed and fodder fed to milch animals in India reduces milk production. Quality feeds increase milk production and productivity. India is focusing on conservation agriculture, which has resulted in a further decrease in fodder production. Due to the lack of fodder, commercial feed is used to compensate increasing meat and milk production costs. Furthermore, commercial feed contains urea and other artificial milk boosters, which negatively impact milk quality and livestock health. There should be an easy-to-grow feed alternative.

Azolla (*Azolla pinnata*) is a floating fern specially found in paddy fields. The nitrogen-fixing blue-green algae *Anabaena azollae* has a symbiotic connection with Azolla, which enhances the protein concentration of Azolla, making it one of the best alternative feed sources for protein. It fixes 25 kg/ha of nitrogen. It can be used as green manure in paddy fields before or after transplanting. It is also proven as a good source of several minerals and vitamins.

Azolla can be grown in small areas like cattle yards, wastelands, and uncultivated lands to yield high biomass of quality feed for dairy animals. It is used as an alternative and sustainable feed for livestock, goat farming, chicks in poultry, etc. If grown commercially for the above purposes, it will be a cost-effective feed, biofertilizer that can reduce fertilizer consumption, especially in paddy cultivation.

Cultivation

Production of Azolla needs several requirements such as area for Azolla nursery, availability of sunlight etc. Higher production of Azolla can be obtained in the cemented structures covered with plastic receiving optimum sunlight and shade (especially in high temperature areas). These can be constructed in backyard of house, corners of cattle sheds and in open space where enough sunlight is available. Azolla as green manure can also be used in paddy fields with 10% of the land kept for Azolla production. Azolla production for livestock especially for milch animals can be done in the cattle shed at any corner where sufficient

sunlight is present. It can be grown in a small tank like structure made of bricks and cement.

The depth of the structure should be 20 cm, length can be made according to the requirement. On an average, the size of the structure for maintaining one milch animal is 2.5 m length, 1.5 m width and depth is 20 cm. For the recommended size of structure i.e. 2.5 m length, 1.5 m width and 20 cm depth, 15 kg of well sieved soil preferably black soil, 2–3 kg of farm yard manure is added to the structure and water level is always kept at a depth of 10 cm. Soil and farm yard manure mixture should cover a depth of 10 cm. Soil is applied to hold and provide nutrients to Azolla and farm yard manure is applied as it is a good source of carbon. Nutrient mixture is applied which contains phosphorus, potassium, magnesium and other nutrients. This mixture of nutrients and especially micronutrient application is not only useful for Azolla but is also useful for the dairy cattle that feed on it. Before a day of inoculation 2–3 g of carbofuron is added and mixed well. The material is allowed to settle down and is checked for

Table 1. Comparison of biomass and protein content of Azolla with different forage crops

Forage crop	Annual biomass production (MT)	Dry matter content (MT)	Protein content (MT)
Hybrid Napier	250	50	4
Kolakattai Grass	40	8	0.8
Lucerne	80	16	3.2
Cowpea	35	7	1.4
Subabul	80	16	3.2
Sorghum	40	3.2	0.6
Jowar	35	3	0.6
Azolla	730	56	20

Source: Pillai *et al.* (2002)

Table 2. Quality parameters of *Azolla microphylla*

Parameter	Mean concentration (%)	Mineral	Mean concentration
Organic matter	80.53 ± 0.59	Na	15.25 ± 1.21 mg/g
Crude protein	24.06 ± 0.35	K	20.13 ± 1.44 mg/g
Crude fibre	13.44 ± 1.20	P	4.87 ± 0.58 mg/g
Ether extract	3.27 ± 0.18	Ca	9.73 ± 0.26 mg/g
Ash	19.47 ± 0.59	Fe	1.00 ± 0.25 mg/g
Nitrogen free extract	37.71 ± 1.83	Cl	10.7 mg/g
Neutral detergent fibre	45.52 ± 1.93	Cu	28.05 ± 2.89 µg/g
Acid detergent fibre	30.16 ± 1.12	Mn	771 µg/g
Acid detergent lignin	8.96 ± 0.56	Co	4.6 µg/g

Source: Buckingham *et al.* (1978) and Chatterjee *et al.* (2013)

foam formation on the surface of water. Foam (if any) is removed and the water is left undisturbed overnight. If cultivation is done in an area with high temperature then the structure should be covered with shade net. After this, 200 g of Azolla is inoculated on the water. In summer, care is taken that minimum water level of 10 cm and shade is provided using green cloth or coconut leaves to reduce excess loss of water and to reduce excess sunlight. After 10–15 days, the water gets fully covered by Azolla. It is extracted using a net, leaving small amount in the water as inoculant for further production.

Uses/potential benefits

Net worth of ₹7.90 can be saved from feed cost per kg weight gain in goat when concentrate mixture is replaced with Azolla. Incorporating dried Azolla to the feed (15% of the concentrate mixture) proved more economic than feed without Azolla incorporation (100% concentrate). Its bio-composition makes it an efficient and economic substitute for

livestock. Comparison of biomass and protein content of Azolla with different forage crops revealed that it has 3–10 times higher biomass compared to Hybrid Napier and Jowar (Table 1). It has high digestibility, crude protein and low lignin content, and therefore, can be fed to sheep, goat, pig and rabbit as feed substitute. As shown in Table 2, it contains appreciable amount of quality traits i.e. organic matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract etc. Different concentration of many minerals, viz. Na, K, P, Ca, Fe, Cl, Cu, Mn and Co were reported by earlier researchers (Table 2).

A study was carried out in Kerala to assess the status of certain macro and micro minerals in dairy animals, by analyzing feed and fodder samples. In comparison to various feeds and fodders such as Paddy straw, Napier grass etc Azolla that was grown as subsidiary green fodder in stagnant water was found to be a good source of several minerals. It can serve as a prospective green

feed complement for the dairy cattle for the enhancement in productive performance especially where/when green fodder availability is scanty. About 15% of the milk production increased when 1.5–2 kg of fresh Azolla was mixed with regular feed of the lactating cow. A trial evaluated *Azolla microphylla* by supplementing in crossbred cattle at Eastern Research Station of NDRI, Kalyani. The animals in control group were fed conventional ration of paddy straw, green fodder and concentrate mixture as per recommendation of NRC 2001. In the treatment group, 2 kg of fresh Azolla was supplemented over conventional ration. The results revealed that milk yield increased by 11.2% on supplementing Azolla.

Continuous feeding of fresh *Azolla pinnata* as supplement enhanced milk yield (12–15%), meat by weight yield (2.0–2.2%) and egg laying capacity (3–7%) (Table 3).

Precaution for cultivation

- Azolla producing unit should be placed in a shaded location, ideally beneath a tree, with enough sunshine. A location that receives direct sunlight should be avoided.
- To keep the water level consistent, all four sides of the pit should be at the same level.
- To minimize overpopulation and to maintain the fern in the fast growth phase, remove 300–350 g/m² of Azolla biomass daily.
- When a nutritional shortage is discovered, appropriate nutrients should be provided.
- When necessary, plant protection measures against pests and diseases should be adopted.
- To minimize nitrogen build-up and micronutrient deficiencies, around 5 kg of bed soil should be replenished every 30 days with new soil.
- To avoid nitrogen accumulation in the bed, 25–30% of the water must be replenished with freshwater every 10 days.
- Water and soil replacement should be followed with Azolla inoculation at least once every six



Azolla cultivation in constructed structures

Table 3. Improvement in livestock/poultry productivity after continuous feeding of fresh *Azolla pinnata* as supplement

Location	Milk yield		Meat by weight yield		Egg laying capacity	
	Supplement (kg) per cattle per day	Increase in milk yield (litre) in two months	Supplement (g) per goat per day	Increase in meat by weight yield (kg) in two months	Supplement (g) per chick per day	Increase in egg laying capacity (no. of eggs) in two months
Lag Manwin	1.2–1.5	13.50	200–225	2.0	30–40	3–5
Annu	1.2–1.5	12.00	200–210	2.1	35–40	5–7
Mann	1.2–1.5	15.00	200–250	2.2	40–45	4–6

Source: Kumar and Chander (2017)

- months.
- When contaminated by pests and diseases, a new bed must be constructed and inoculated with a culture of Azolla. It should be ensured that pure culture is used to avoid the contamination.
- The pH of the mixture (water, soil and FYM) should be maintained in the range of 5.5–7.5.
- Timely harvesting should be done to avoid crowding in the tank.

Harvesting and preparation for livestock feed

Plastic tray with 1 cm² mesh holes may be used to drain the water from the floating Azolla plants. Washing aids in the separation of little plants that drain from the tray. The plants, as well as the water in the bucket,

may be returned to the original bed. Fresh Azolla should be combined in 1:1 ratio with commercial feed for use as animal feed. Livestock may be given Azolla without extra concentrate after a week of feeding Azolla mixed with concentrate. It may also be given to both egg layers and broilers in poultry.

Economic benefits

The expense of pond preparation is negligible (sheet plus labour cost). The increased milk yield and decreased use of concentrates for animal feeding might result in a net benefit of more than ₹4000 per year to a farmer.

SUMMARY

Azolla can be utilized as an

alternative source of green fodder by small and marginal holder dairy farmers. It can be grown and utilized in all types of agro-climatic situations. If good care of Azolla pond is taken, one can harvest quality feed every day reducing cost of feed and fertilizers. Hence, Azolla cultivation allows farmers to save money on livestock feed supplements. Dairy producers, particularly those with limited area for fodder production can reap benefits of Azolla cultivation.

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Avoid wasting food

While millions of people go hungry, vast quantities of food are lost every day, either spoiled during production or transport or thrown into the waste bins of households, retailers or restaurants. Squandering food is also a waste of the precious resources used to produce it. Up to 10% of global greenhouse gas emissions are associated with food that is not consumed. Food waste is filling up the world's landfills, where it decomposes and generates methane, a greenhouse gas that is more harmful than CO₂. In developing countries, there is a need for improved storage and infrastructure to avoid food loss, as well as access to technologies that can match agri-food supply and demand.

