March 2002 volume 4 no.1

LEISA INDIA

Including Selections from International Edition

Managing Livestock Sustainably

AZOLLA – A sustainable feed substitute for livestock

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The demand for milk and meat has been increasing and animal husbandry, as a profitable occupation, is expanding. However, there is a substantial decline in fodder production, owing to the decreasing area under forest and grasslands. The fodder availability from various crops has also decreased largely due to the introduction of high yielding dwarf varieties.

The shortage of fodder is, therefore, being compensated with commercial feed, resulting in increased cost of production of meat and milk. Moreover, as commercial feed is mixed with urea and other artificial milk boosters, it has a deleterious effect on the quality of milk produced and the longevity of the livestock, which in turn leads to degenerative diseases like cancer and coronary ailments in human beings.

Search for an alternative took us to a wonderful plant, "Azolla", which holds the promise as a sustainable feed substitute for livestock.

Importance of Azolla

Azolla is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B12, Beta Carotene), growth promoter intermediaries and minerals like calcium, phosphorous, potassium, ferrous, copper, magnesium etc. Azolla, on a dry weight basis, is constituted of 25-35% protein content, 10-15% mineral content and 7-10%, a combination of amino acids, bio-active substances and bio-polymers. Carbohydrate and oil content in Azolla is very low. Thus the bio-composition of Azolla, makes it one of the most economic and efficient feed substitutes for livestock. Moreover, Azolla can be easily digested by livestock, owing to its high protein and low lignin content.

Trials were carried out by Natural Resources Development Project (NARDEP), Vivekananda Kendra, with Azolla as a feed substitute in Tamil Nadu and Kerala. Trials on dairy animals showed an overall increase of milk yield by 15–20% when 1.5–2 Kg of Azolla was combined with regular feed. 15–20% of commercial feed, especially oil cake, can be replaced with the same quantity of Azolla on dry weight basis, without affecting milk production. It was also found that Azolla feeding improves the quality of milk and the health and longevity of livestock.

Feeding Azolla to poultry birds improves the weight of broiler chicken and increases the egg production of layers. Azolla can also be fed to sheep, goat, pig and rabbit as feed substitute. In China, cultivation of Azolla along with paddy and fish is said to have increased the rice production by 20% and fish production by 30%. Trials conducted on Azolla as fish feed substitute are also encouraging.

What is Azolla?

Azolla is a floating fern and belongs to the family of Azollaceae. The fern Azolla, hosts a symbiotic blue green algae *anabaena azollae*, which is responsible for the fixation and assimilation of atmospheric nitrogen. Azolla, in turn, provides the carbon source and favorable environment for the growth and development of the BGA symbiont. In Azolla, the endo-symbiont, the BGA 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 wonderful plant.

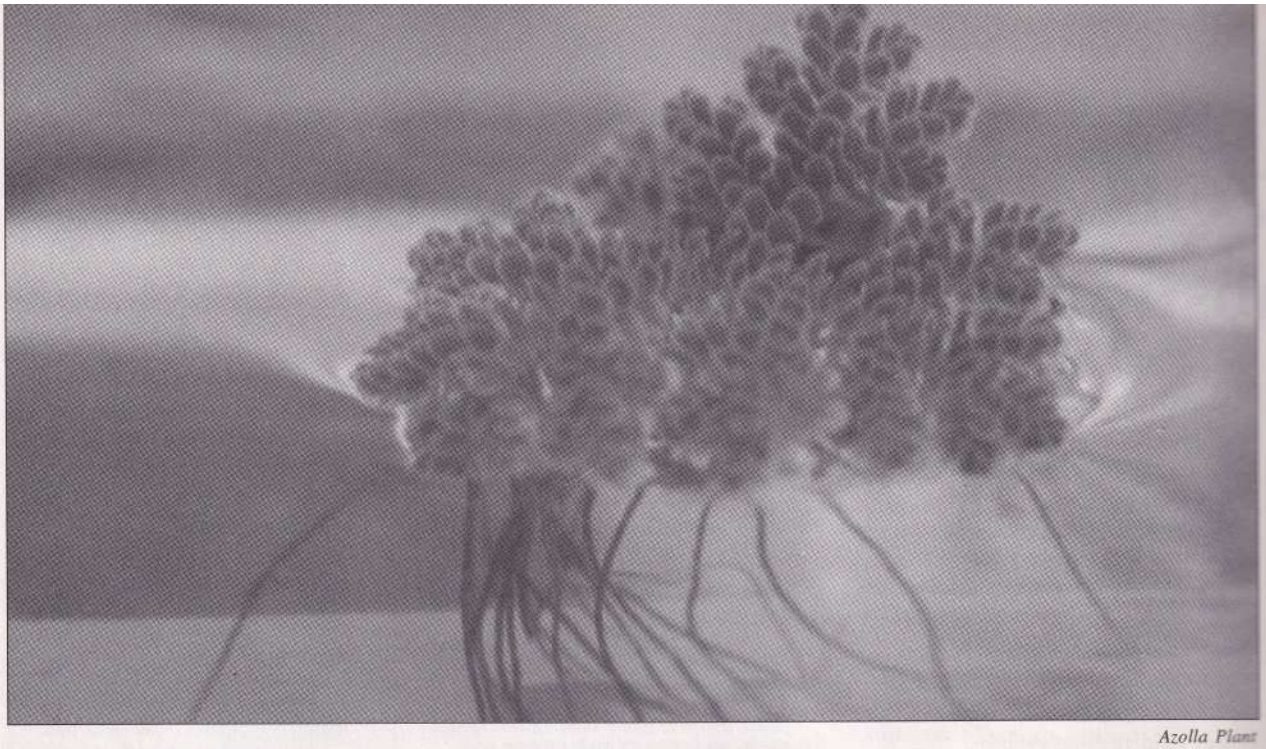
NARDEP method of Azolla production

Natural Resources Development Project (NARDEP) has been working on Azolla for the last 3 - 4 years, finding its potential as a feed substitute and exploring cost effective methods for the mass multiplication of Azolla in farmers' homesteads.

In NARDEP method, an artificial water body is made, preferably under the shade of a tree, with the help of a silpauline sheet. A pit of the size of 2M X 2M X 0.2M is dug as a first step. This pit is covered with plastic gunnies to prevent the roots of the nearby trees piercing the silpauline sheet, which is spread over the plastic gunnies. About 10 – 15 kgs of sieved fertile soil is uniformly spread over the silpauline sheet. Slurry made of 2-kg cow dung and 30 gms of Super Phosphate in 10 litres water, is poured onto the sheet. More water is poured to make the water level reach about 10 cm. About 500 gms to 1kg of fresh and pure culture of Azolla is inoculated in the pit. Azolla will rapidly grow and fill the pit within 10-15 days and about 500 gms – 600 gms of Azolla can be harvested daily thereafter. A mixture of 20 gms of Super Phosphate and about 1 kg of cow dung should be added once in 5 days. This is done to keep the Azolla in rapid multiplication phase and to maintain the daily yield of 500 gm./pit. Micronutrient mix containing magnesium, iron, copper, sulphur etc., can also be added at weekly intervals to enhance the mineral content of Azolla. In this method the cost of production of Azolla is less than 65 ps./kg (See Table III)

Cultural Practices for Optimum Bio-mass

1. It is important to keep Azolla at the rapid multiplication growth phase with the minimum doubling time.
2. Periodic application of cow-dung slurry, super phosphate and other macro and micronutrients except nitrogen, prevents plants from reaching sporulation stage.
3. The temperature should be retained below 25°C. In case the temperature goes up, the light intensity should be maintained below 40 klux by providing shade.
4. Biomass should be removed every day or on alternate days to avoid over crowding
5. PH should be tested periodically and should be maintained between 5.5 and 7.



Azolla Plant

Azolla plant can be easily manipulated (special manipulation technique has been developed to enhance a particular mineral or amino acid content in Azolla) to synthesize more quantities of desired secondary metabolities. These include, amino acids, vitamins, anthocyanines and even mineral compounds derived through proper manipulation with nutrients and environmental factors. Adding the respective salts in the medium can increase the much needed iron, copper and calcium content of Azolla biomass.

Though there is no large-scale incidence of pests and diseases in Silpauline based production system, the pest and disease problems have been noticed during intensive cultivation. The pest attack can be controlled by the application of Furodan @ 10 gram / sq.meter. Similarly, treating Azolla with Bavestine 2% solution can control most of the fungal diseases (Editor's Note: However, ecofriendly alternatives could be explored). In case of severe pest attack, the entire bed should be cleaned and a fresh bed may be laid out in a different location. Biomass collected from field applied with pesticide should not be used as a feed for livestock. It is better to have a fresh inoculation after every pesticide / fungicide application.

Table I. Comparision of Biomass and protein content of Azolla with different species

Yield of Azolla 730 MT / Hectare @ of 200 gm./sq.m/day

Sl. No.	Item	Annual Production of Biomass MT	Dry Matter Content MT	Protein Content MT
1.	Hybrid Napier	250	50	4
2.	Kolakattai Grass	40	8	0.8
3.	Lucerne	80	16	3.2
4.	Cowpea	35	7	1.4
5.	Subabul	80	16	3.2
6.	Sorghum	40	3.2	0.6
7.	Jowar	35	3	0.6
8.	Azolla	730	56	20

Precautions

1. A shady place, preferably under a tree, with sufficient sunlight should be chosen for the Azolla production unit. A place of direct sunlight should be avoided.
2. All corners of the pit should be of the same level so that the water level can be maintained uniformly.
3. Azolla biomass @ 300 gms – 350 gms /sq.meter should be removed daily to avoid over crowding and for keeping the fern at rapid multiplication phase.
4. Suitable nutrients should be supplied, as and when, nutrient deficiency is noticed.
5. Plant protection measures against pests and diseases should be taken as and when required.
6. About 5 kg bed soil should be replaced with fresh soil , once in 30 days, to avoid nitrogen build up and prevent micro-nutrient deficiency.
7. 25 to 30% water also needs to be replaced with fresh water, once in 10 days, to prevent nitrogen build up in the bed.
8. Replacement of water and soil should be followed by fresh inoculation of Azolla, at least once in six months.
9. A fresh bed has to be prepared and inoculated with pure culture of Azolla, when contaminated by pest and diseases.

Using Azolla as livestock feed

Azolla should be harvested with a plastic tray having holes of 1 sq.cm mesh size to drain the water. The tray along with Azolla should be kept in a bucket, half filled with water. Azolla should be washed to get rid of the cow dung smell. Washing also helps in separating the small plantlets which drain out of the

tray. The plantlets along with water in the bucket can be poured back in to the original bed. Fresh Azolla thus collected should be mixed with commercial feed in 1:1 ratio to feed livestock. For poultry, Azolla as such can be fed, both for layers and broilers. However, it is advisable to mix Azolla in regular feed in 1:1 ratio at the beginning, for one week. After a fortnight of feeding on Azolla mixed with regular feed, livestock may be directly fed with Azolla, without the addition of regular feed material.

Nutrient content and its impact on growth

The nutrient constitution of Azolla is found to be almost similar to that of commercial poultry feed, except that the protein content is high and calcium content is slightly low. Feeding trials carried out on poultry with different combinations of commercial feed and Azolla, showed that 20–25% of commercial feed could be replaced by supplementing it with fresh Azolla in diet. Birds with 75% of the regular feed and 12.5% in the form of Azolla, weighed almost equal to the birds with 100% regular feed (Table II). The birds receiving normal feed with 5% extra, in the form of Azolla, grew faster than the birds with 100% feed alone. 10–12% increase in the total body weight was also observed. The trials on broiler chicken showed a substantial increase in their body weight. The number of eggs laid per bird and quality of eggs (the yellow yolk portion of egg being more prominent and yellowish) was also better than those of the control birds.

There was a substantial improvement in the quantity, as well as, quality of milk produced, when dairy cattle were fed with Azolla combined with commercial feed along with an improvement in the health of the cattle. The increase in the milk yield was to the tune of 10–15%, which went up to 20%, during summer months from February to May. It is found that the increase in the quantity of the milk produced on the base of nutrient was higher than the quantity of Azolla fed. Hence, it is assumed that more than the carbohydrate, protein content and other components, like carotinoids, bio-polymers, probiotics etc., may be contributing to the over all increase in the production of milk.

Table II. Result of Feeding Trials Conducted For Poultry

Sl. No.	Age of birds in Weight	100% Feed	50% Feed + 16% Azolla	75% Feed + 12.5 % Azolla	100% Feed + 5 % Azolla
1.	7	155	120	120	149
2.	8	193	151	149	188
3.	9	234	179	181	245
4.	10	278	201	252	335
5.	11	320	231	312	398
6.	12	373	264	416	480
7.	13	433	309	454	544
8.	14	494	344	518	614

Table III. Economics of Azolla production

S.No.	Particulars	Amount (Rs.)
1.	Cost of 120 gauge Silpauline 2.8M X 1.8M (Production in 1 sq.meter / day is 300 grams) Cost of 4 units Silpauline is Rs. 80 X 5	400.00
2.	Labour Charges For Bed Preparation	100.00
3.	*Cow-dung 1 X 4 = 4 Kg Rs. 2 X 73	146.00
4.	Superphosphate 25 X 4 = 200g X 73 = 1400 gms	7.50
5.	Magnesium Sulphate 1 kg	4.00
6.	Micro-nutrients 73 X 5 = 365 grams	15.00
7.	Cost of inoculation material 200 X 8 = 1,600 gms	5.00
	TOTAL COST OF PRODUCTION (Rs)	**677.50**
	Total Production 350 days in 4 units (4 kg/day for 350 days for one year) Kgs/annum	1050
	Unit Cost of Production (Rs/kg) (Rs. 677/1050)	**0.65/kg**

(Note: * Application of cow-dung and Super phosphate once in 5 days,.i.e., 73 times in a year)

Conclusion

Azolla can be used as an ideal feed substitute for cattle, fish, pig and poultry, apart from its utility as a bio-fertilizer for wetland paddy. It is popular and cultivated widely in other countries like China, Vietnam, and 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.

Dairy farmers of South Kerala and Kanyakumari district have taken up the low cost production technology developed by NARDEP as part of the project funded by Department of Bio-technology (Government of India). It is hoped that in the coming days, 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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Acknowledgement :

We acknowledge with thanks the financial assistance received from department of Bio-technology (Government of India) for carrying out the research on the propagation of BGA and Azolla in NARDEP, Vivekananda Kendra, Kanyakumari.

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