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## A Study on the Potential of *Azolla pinnata* as Livestock Feed Supplement for Climate Change Adaptation and Mitigation

Gulshan Kumar<sup>1</sup> and Hem Chander<sup>2\*</sup>

<sup>1 & 2</sup> Department of Biosciences, Career Point University, Hamirpur (H.P.), INDIA

\* Correspondance: E-mail: [hemchander78@gmail.com](mailto:hemchander78@gmail.com)

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**ABSTRACT:** *Azolla pinnata* is an aquatic fern. It is a good source of high quality protein. It also contains almost all essential amino acids, vitamins, Beta-carotene, minerals and appreciable quantities of bio-polymers. It contains 21-23% crude protein. Investigations were undertaken to explore nutritive potential of *Azolla pinnata* as balanced feed for livestock. An on farm trial was conducted on cattle, goat and chicks at three locations of Hamirpur district namely Lag-Manwin (Bhoranj), Annu (Hamirpur) and Mann (Nadaun). *Azolla* units were established for cultivation of *Azolla* at each location. The cultivated *Azolla* was then fed to select cattle, goat and chicks as protein supplement for two months regularly. There was an appreciable increase in milk production (10-15%), meat by weight (8-10%) and egg laying capacity (10-15%) in milch animals, goats and chicks respectively. On the basis of the present investigations and observations, *Azolla pinnata* is being recommended as potential unconventional protein supplement for livestock during lean period of the year in rain fed areas. This technology has promising climate change adaptive capacity and is helpful in climate change adaptation of famers in these areas as climate change is a threat to livestock production because of the impact on quantity and quality of feed crops, fodder and forage.

**Keywords:** *Azolla pinnata*; Feed Supplement; Climate Change; Livestock; Mitigation.

**INTRODUCTION:** *Azolla pinnata* is an aquatic free floating fern belonging to the family Azollaceae. It grows in association with blue-green algae- *Anabaena azolle* which has utility as a nitrogen fixer. Nutritive value of *Azolla* is well documented and promotes it as a good source of protein as it contains around 21-23% crude protein. It is also found to contain essential minerals like Iron, Calcium, Magnesium, Potassium etc. and appreciable quantities of Vitamins A and Vitamin B-12.<sup>1</sup> It is considered to be the most promising because of the ease of cultivation, minimal water for propagation, high productivity and good nutritive value.<sup>2,3</sup> It was used as feed to juvenile black tiger shrimp, goats and buffalo calves.<sup>4,5,6</sup> Whereas *Azolla filiculoides* was also used in diets for sows and as partial replacement of protein source for growing-fattening pigs.<sup>7,8,9</sup> *Azolla pinnata* was also tried as a protein supplements for Rabbits.<sup>10-14</sup> It is also a potential source of nitrogen and is a potential feed ingredient for livestock, goatry and backyard poultry.<sup>15</sup> There is an acute shortage of feed and fodder for dairy animals due to climate change and other factors. The shortage of green fodder has been estimated to be 30-35% in lean period in rain fed districts Bilaspur, Hamirpur and Una of Himachal Pradesh. During present investigations *Azolla pinnata* has been observed as an alternative to green fodder and as supplementary protein diet due to its high palatability and enhanced yield under rain fed condition in lean period.

**MATERIALS AND METHODS:** On farm trial was conducted at three locations viz. Village Lag-Manwin in Bhoranj Block, Village Annu in Hamirpur Block and Mann village in Nadaun Block of Hamirpur (H.P.) At all the three locations, three pits of uniform dimensions (3 X 1 X 0.2 m) were dug preferably under the partial shade of a tree, after covering silpauline sheet (150 GSM) without any holes and spread out over the pits such that sheets were no longer and broader than the pits, 20-25 kg sieved fertile soil was uniformly spread over the silpauline sheet in each pit, while 12-14 kg Vermi-compost was also added to it. About 18-20 gms Single Super Phosphate (SSP) in 120-150 liters water is poured onto the sheet. Water was poured to make the water level reach about 9 cm. A few hours later, about 500 gms to 1 kg of fresh and pure *Azolla pinnata* cultures were inoculated in the pit (Figure 1). *Azolla pinnata* rapidly grows, multiplies and fills the pit within 15-17 days (Figure 2). *Azolla pinnata* production in one unit during one year is approximately equal to 260 kg.

About 1.5-2.0 kg/m<sup>2</sup>/week of *Azolla* can be harvested. To assess the palatability of *Azolla* in cows and chicks, fully grown *Azolla* was harvested daily and it was first washed with clean water and then directly fed to the milch animals and poultry (Figure 3 and Figure 4). It was also fed by mixing with double quantity by weight of dry wheat straw to milch animals.

The information so generated was analysed statistically using ANOVA and Tukey-Kramer Multiple Comparison test.



Figure 1: Preparation of Silpauline *Azolla* Pit.



Figure 2: Production of *Azolla pinnata* for harvesting.



Figure 3: Feeding of fresh *Azolla pinnata* to milch animal.



Figure 4: Feeding of fresh *Azolla pinnata* to backyard poultry.

**RESULTS AND DISCUSSION:** After consumption of *Azolla pinnata*, there was an appreciable increase of 10-15% in milk production (Table 1), 8-10 % increase in meat by weight (Table 2) and 10-15% increase in egg laying capacity (Table 3), in milch animals, goats and chicks respectively. Regarding palatability, at all the three locations it was observed that upon daily harvesting 1.2 kg - 1.5 kg of *Azolla pinnata* was consumed by cattle per day that ultimately increased yield 200-250 ml per day in comparison to farmer practices of feeding only dry fodder in lean periods especially March-June in summer season and September-December in winter season. The nutrient constitution of *Azolla pinnata* is found to be almost similar to that of commercial livestock feed, except that the protein content is high (Table 4). On the basis of the present investigations, *Azolla pinnata* is being recommended as potential unconventional protein supplement for livestock during lean period of the year in rain fed areas of Himachal Pradesh. This technology is also helpful in climate change adaptation as climate change is a threat to livestock production because of the impact on quality of feed crop and forage, water availability, animal and milk production, livestock diseases, animal reproduction, and biodiversity.<sup>16</sup> About 35-40 % cattle owners has already adopted this technology of *Azolla pinnata* cultivation after extension and training. This technology has enhanced income of farmers through increase in milk production (200-250 ml per cattle per day) in three villages of District Hamirpur.

Table 1: Milk yield after consumption of *Azolla pinnata* by Cattle.

Location	Continuous Feeding of fresh <i>Azolla pinnata</i> as supplement (kg) per cattle per day	Increase in Milk yield (Liter) in two months
Lag-Manwin	1.2-1.5	13.50
Annu	1.2-1.5	12.00
Mann	1.2-1.5	15.00

Table 2: Meat by weight yield after consumption of *Azolla pinnata* by 6 months goat.

Location	Continuous Feeding of fresh <i>Azolla pinnata</i> as supplement (gms) per goat per day	Increase in meat by weight yield (Kg) in two months
Lag-Manwin	200-225	2.0
Annu	200-210	2.1
Mann	200-250	2.2

**Table 3: Egg laying capacity after consumption of *Azolla pinnata* by backyard poultry.**

Location	Continuous Feeding of fresh <i>Azolla pinnata</i> as supplement (gms) per chick per day	Increase in Egg laying capacity (no. of eggs) in two months
Lag-Manwin	30-40	3-5
Annu	35-40	5-7
Mann	40-45	4-6

**Table 4: Nutritional composition of *Azolla pinnata* as a livestock feed.**

Crude protein (%)	21-23
Crude fiber (%)	10-13
Total Ash (%)	24-27
Essential Minerals (%)	45-55

Environmental factors that affect Efficiency of *Azolla pinnata* cultivation are:

- Water is very essential for growth and survival. Since it is free floating fern, 7-11cm deep water is required.
- The pH is the most important element for its multiplication. The optimum pH of 5.0-7.2 is good for growth. It grows well in slightly acidic to slightly alkaline soils.
- The high temperature inhibits the growth and nitrogen fixation. Temperature below 5°C and above 35°C has adverse effect.
- The salinity of water adversely affects its efficiency.
- Photosynthesis is the prime requirement for its survival. The long photoperiods and optimum temperature supports the growth and increases its nitrogen-fixation potential.
- Except nitrogen, all micro and macro elements are essential for its normal growth.
- Use of nitrogenous fertilizers adversely affects its growth. However, use of low concentration of ammonium and nitrate promote the growth of *Azolla pinnata*.

Recommendations for *Azolla* unit establishment are:

- A place of direct sunlight should be avoided and a partial shady place should be chosen.
- *Azolla pinnata* biomass should be regularly removed daily to avoid overcrowding.
- *Azolla pinnata* should be protected from pests like pyralis and snails.
- About 10-15 kg bed soil should be replaced with equal quantity of fresh soil, once in a month, to

avoid nitrogen build up and prevent micro nutrient deficiency.

- Chlorised tapwater should be avoided and one third water also needs to be replaced with fresh water, once in fortnight to prevent nitrogen build up in the bed.
- A new and fresh *Azolla pinnata* unit has to be prepared and inoculated with pure culture of *Azolla pinnata*, when contaminated by pests and diseases.
- Use Jute or plastic mulch to cover upper surface of *Azolla pinnata* unit to avoid chilling effect of frost during winter season.

**CONCLUSION:** Present investigation was conducted on cattle, goat and chicks at three locations of Hamirpur district namely Lag-Manwin (Bhoranj), Annu (Hamirpur) and Mann (Nadaun). *Azolla* units were established for cultivation of *Azolla* and then it was fed to select cattle, goat and chicks as protein supplement for two months regularly. There was an appreciable increase in milk production (10-15%), meat by weight (8-10%) and egg laying capacity (10-15%), in milch animals, goats and chicks respectively. On the basis of the present investigations, *Azolla pinnata* is being recommended as potential unconventional protein supplement for livestock during lean period of the year in rain fed areas of Himachal Pradesh.

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