

Hydroponic fodder production technology

for sustainable animal feed production

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In April 2023, India surpassed China to become the world's most populous country. This population growth contributes to challenges such as the depletion and degradation of natural resources like soil and water due to urbanization and industrialization. However, India has the largest livestock population globally, leads in milk production, ranks third in egg production, and eighth in meat production. These animal products are crucial for food security and income support of the country. The vast animal population also compete with growing human population for space and other resources. This highlights a complex dynamics where increased animal population strains and as well as supports country's agro-based food systems. It is quite challenging to provide balanced nutrition to such a vast animal base, especially in the background of scarce natural resources (soil and water), without which, human being will not get right kind of food for their survival and growth. Hydroponic is a method to produce sprout cereal plants without soil which can also be used as food and fodder crop. In case of livestock, it offers resource efficient and sustainable fodder to uphold the livestock productivity. The highly nutritious nature of hydroponic fodder and its minimal input requirement make it a befitting option for animal nutrition in future climate change challenges.

Keywords: Animal nutrition, Fodder crisis, Hydroponic fodder, Resource efficient

Sustainable animal production system offers a solution, balancing the current needs with future food security. This approach emphasizes a harmony between social, economic, and environmental factors. By focusing on practices that ensure both profitability and environmental protection, sustainable animal husbandry addresses the need of today while safeguarding resources for the future generations. It integrates efficient production methods with environmental stewardship, ensuring that livestock farming remains viable and beneficial in the long term, promoting both current and future food security. Befitting example of sustainable animal husbandry practices include converting cow dung into compressed natural gas (CNG) and connecting the same with

hydroponic fodder production with the support of solar based renewable energy, which will be a path towards sustainable goal where responsible production and consumption will be a way towards balanced ecosystem. For sustainable animal production system, both input (animal breed, feed and its management) and output (animal products and by-products) are equally crucial.

Sustainability in animal feeding

Success of a dairy farm mostly depends on production efficiency of dairy animals, which is largely influenced by feeding practices. Steady supply of quality feed and fodder enhance the productivity of dairy animals. Feed and fodder provide critical nutrients for the health, production and welfare of dairy animals. They account for about 70% of total cost of milk

production in a dairy farm i.e. animal feed are directly or indirectly affected by the climatic change and natural calamities. Uncanny climate and growing need of population are widening the demand-supply gap of feed and fodder. In India, animals are generally fed with poor quality dry fodder (due to their marginal proposition), which have low palatability and less nutritional content. This leads to suboptimal performance of the animals. Concentrate feed is palatable and nutritious but poor farmers cannot afford concentrate feeding due to its higher cost. Relying solely on grain for animal feed reduces farmer profits and contributes to environmental pollution, as high-protein feeds produce methane gas during digestion. To ensure a balanced diet, animal nutritionists recommend a blend of two-thirds

fodder (green and dry) and one-third concentrate as ideal animal feed. Again, out of the two-thirds fodder, one-third should be green fodder. This combination will address all aspect of animal diet i.e. bulkiness, balanced nutrition, palatability and economics. Green fodder is essential for animal health, providing water, protein, nutrients, vitamins, minerals, and antioxidants that strengthen animals and help them fight against disease. However, only 4% of arable land in India is currently used for fodder production, and this is expected to decrease over time as land is a limiting factor in production. Additionally, green fodder production is reliant on rainwater and suffers from shortages in both summer and rainy seasons. In 2022, India had 35% less green fodder than required, a deficit projected to worsen by 2050. Shortage of fodder adversely affects productivity of animals which results in cost escalation and price of the products. Therefore, it is imperative to find ways to provide animal feed with minimal land and water use avoiding environmental pollution.

Hydroponic fodder for sustainable animal feed production

Hydroponic fodder presents a promising solution for sustainable animal feed production, offering a way to meet future demands and support animal health while addressing environmental challenges. This technology allows for the efficient cultivation of animal feed using less land and water, offering an eco-friendly alternative that supports sustainable practices in animal husbandry. By integrating hydroponics, farms can reduce costs and adverse environment impacts by maintaining productivity. Maize, ragi, bajra, cowpea, horse gram, sun hemp, jowar and foxtail millet seeds are found to be suitable to grow by hydroponic method. The choice of an appropriate fodder crop can be based on the seasonal suitability for the area and the availability of affordable seeds.

In our country, poor, landless farmers, more specifically women

often manage livestock. For these farmers, hydroponic fodder offers a space-efficient and low-cost solution, as it requires no soil and minimal water. Producing 1 kg of elephant grass needs 60-80 litres of water, whereas 1 kg of hydroponic fodder requires only 3 litres, saving 95% of water compared to traditional methods. With hydroponic technology, 1000 kg of green fodder can be produced daily on just 480 square feet of land, compared to 10-20 acres that is needed for the same amount using conventional methods. Landless and women farmers in developing countries like India mostly lack land in their name. Not only land, they also have poor control over other natural resource like water. So hydroponic fodder farming can be an ideal option for these resource poor farmers.

Hydroponics is a method of growing plants using only water and nutrients, bypassing the need for soil. This technique offers a quicker growth cycle compared to conventional methods; while traditional fodder cultivation takes 45-60 days, hydroponic fodder is ready to feed animals in just 7-8 days. The nutrient content of hydroponic fodder is significantly higher than that of conventional forage, making it suitable for cows (organic dairy), goats, grass fed piggery, chickens (cage free poultry) and other animals. In just four

days, hydroponic fodder is ready for consumption for poultry, and in seven days, it can be fed to other animals as well.

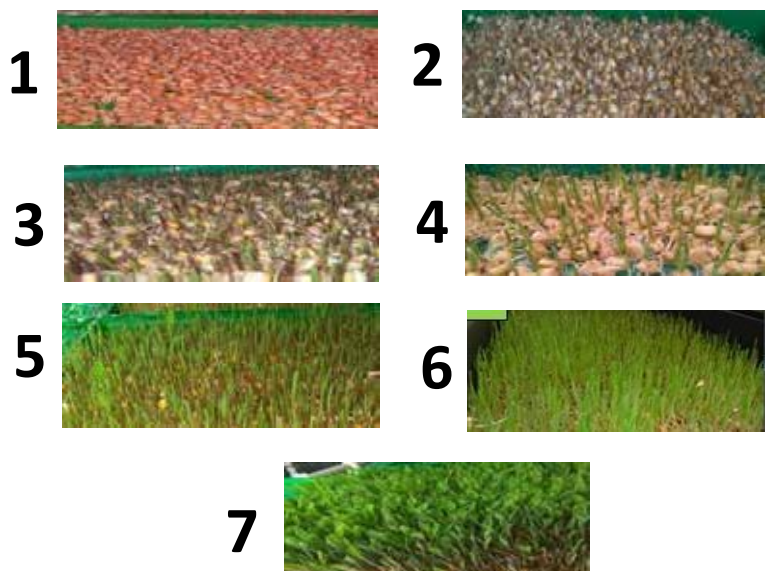
Hydroponic fodder cultivation is a versatile cropping pattern and can be done in any season—whether it is rainy or dry—making it a highly adaptable against climatic challenges. Farmers can produce nutritious fodder in their own yards with just 1-2 hours of effort per day. This method is entirely organic, as it does not require pesticides or fertilizers, and both seeds and roots are consumed by the animals, leaving no waste. The controlled production of hydroponic fodder checks weeds, insects, dust, insecticides, pesticides, germicides and carcinogens in it.

Hydroponic fodder production

To set up a hydroponic system, one can use a bamboo or iron frame to hold flat trays with slight inclines to ensure proper water drainage. These trays, which have small holes to prevent water accumulation, can grow various crops like maize, ragi, bajra, cowpea, horse gram, sun hemp, jowar and foxtail millet. Within seven days, the grass reaches a height of 20-30 cm, ready to feed livestock. For successful hydroponic cultivation, ensure high-quality seeds¹, avoid direct sunlight, maintain proper wind movement, and ensure good water drainage to prevent fungal growth.

1. Procuring healthy seeds with <12% moisture content
2. Seed washing for removal of dirt and dead seeds
3. Seed soaking for 20-24 hours
4. Seed germination for 30 hours in warm place
5. Transfer the sprouted seeds to clean tray and spread for even distribution
6. Water should be sprinkled at an interval of 2-3 hours for 10-15 seconds
7. On 7th day rack is ready for harvest and feed the livestock
8. One tray of 1kg maize seed produces 6 kg of fodder

Step wise procedures of maize fodder production through hydroponic system



Stages of Hydroponic fodder (Seven days procedure)

Advantages of hydroponic fodder

Hydroponic fodder enhances digestion, boosts milk production and quality, increases egg yield, and improves fertility and immunity in animals. It also saves labour, energy and time. It does not involve technical work. Only 2-3 hours of daily work can reap nutritious green fodder for all kind of livestock. Farmer can do the work without difficulty.

The cost of producing hydroponic maize fodder in India is approximately ₹5 per kilogram, which is higher compared to traditional maize fodder at ₹3 per kilogram. However, despite the higher production cost, hydroponic maize fodder offers significant

Table 1. Economic feasibility of hydroponic fodder system in India for maize

Cost incurred	Hydroponic fodder (without labour- 6 sq.ft area/month)
Cost of seed (maize)	120 kg @ ₹30/kg= ₹3,600
Cost of labour	----
Cleaner for cleaning of equipments	200
Total cost	3,800
Return	
Quantity yield	5 kg @ 1 kg seed =600kg
Cost of fodder	8/kg=600*8= ₹4,800

Economic feasibility of hydroponic fodder system shows that it is an economically feasible model as BCR is more than 1 (1.26) = 4800/3800=1.26.



Advantages of growing hydroponic fodder

¹ Seed is the major cost that shares 90% of cost of production. Quality seed determines overall fodder quality and its production.

advantages. Its high nutritional value, due to its short growth duration, and the fact that both the roots and shoots are consumable by animals, can lead to less overall feed costs for farms. As hydroponic fodder is highly succulent, it is highly palatable for farm animals. It is completely free from toxins. For a woman livestock farmer, this technology gives direct as well as indirect benefit by addressing income and profit of farm along with nutritional security by improving animal productivity. This technology addresses multiple issues of women farmers like drudgery involved in conventional fodder farming, poor control and access to land and social constraints like poor mobility. It can be done within home premises.

Challenges

Hydroponic fodder technology needs controlled environment i.e. the standard levels include temperature (19 to 22°C), humidity (average 60%), light intensity (2000 lux), length (12-16 h) and aeration for 3 minutes at every 2-6 h interval should be maintained. Under varied agro-climatic zones of India, sometimes the system does not yield desired output. Contamination with fungi is a major problem in this system. Feeding contaminated fodder may reduce the yield of the animals or may even make the animal sick. Moulds' spores are common in most seeds, and the damp environments of fodder growing rooms are suitable for promoting their growth. Fodder growing rooms require specific temperature and humidity. Small and marginal farmers can develop controlled environment by using low cost inputs like electric bulbs, shed nets and altering the frequency and time of sprinkling. Seed treatment can also reduce the mould growth. Availability of quality seed is only 15-20% of the fodder requirements in India. Therefore quality seed production as well as its availability in the vicinity of hydroponic fodder growing area is the primary requisite to overcome the challenges prevailing in hydroponic fodder production.

SUMMARY

India is one of most natural disaster-prone country that affect livestock, their feed, quality milk and meat from them that ultimately affect human food consumption. However, in many areas, lands remain waterlogged and in some drought prevail for months. This land limitations impact adversely quality fodder production. Conventional fodder farming faces significant challenges due to the growing human population and the

impacts of climate change, which could soon lead to a fodder crisis. Therefore, alternative methods of production are essential to meet the nutritional needs of animals and ensure a stable food supply. Hydroponic fodder is a sustainable solution to meet fodder crisis for future climate and environmental challenges. But to harness maximum benefit, the working of hydroponic system needs to be modified for various agro-climatic conditions in India. Performance of plants

growing in this system as well as the performance of livestock consuming this fodder needs to be evaluated. Thus, quality feed and fodder not only safeguard the animal's body requirements but also fulfils the proteinaceous food requirement by the growing human population, which is a step towards one health approach and sustenance in the changing climatic situations.

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