

Application of Hydroponics Technology in Agriculture and Livestock Sector for Sustainable Food Production

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Abstract: *Hydroponics is science of growing plants without the use of soil. The word hydroponics has been derived from the Greek word where 'Hydro' means water and 'Ponic' means working, i.e. working with water. The hydroponics technology can be applied in several agriculture and horticulture crops. Ayurvet has applied hydroponics technology in growing green fodder, raising paddy nursery and growing wheatgrass for human health. The inception took place with an idea to provide a viable solution of green fodder to dairy farmers as land man ratio is shrinking constantly. Farmers are not able to spare land for green fodder as it is occupied for crops for human nutrition. Moreover, water is precious resource which needs to be conserved through innovative technologies.*

Keywords: *Hydroponics. Green fodder, Hydroponics Paddy nursery*

I. Ayurvet Pro Green Hydroponics Technology

In India, Hydroponics technology is gaining momentum; however all the developed countries have already adopted this technology. Ayurvet Research Foundation (ARF) is pioneer in developing Hydroponics technology in India. **Ministry of Agriculture, India** had given the **commercial test report to Ayurvet's Hydroponics machine** which is the first machine to get the same. Ayurvet has also got **Patent (293138)** for the process and design of the machine. We have made certain innovations since 2009 in the design and process of production to make it economically viable.

II. Ayurvet ProGreen Hydroponics Technology for Green Fodder

Food security and food safety go hand in hand. The safety of grain, fruits, vegetable, milk, egg, meat is very critical in the human diet. Balanced feed is key for quality milk production. Green fodder is an important component of animal diet. Needless to say that feeding of quality green fodder and forages not only result in higher milk production, but improvement in the quality of milk in terms of **CLA, Omega 3 and vitamin**



contents. The green fodder availability is limited due to land constraint. Total land allocated for fodder production has remained constant at 4-5 per cent of 140 million ha of cultivable land over several decades. It is, therefore, imperative to look for alternative methods of fodder production especially green fodder. Green fodder production through hydroponic technique is one of the efficient and economic methods which is gaining importance. Production of Green fodder through **AyurvetProGreen Hydroponics machine** is an efficient method which produces year round **green fodder from 100 kg/day – 2000kg/ day.**

Various studies conducted suggest that Hydroponic green fodder is highly palatable, digestible and nutritious having higher amount of protein and micronutrients as compared to the conventionally grown fodders.



1.1 Balanced Animal Nutrition: Key to healthy Milk

Indian Scenario

India has 56.7 percent of world's buffaloes, 12.5 percent of cattle and 20.4 percent of small ruminant population. While we are the largest milk producer in the world, our average production of milk per animal is much lower than the world average. One of the reasons for this is that the genetic potential of our indigenous germplasm has not been fully exploited due to poor nutrition, breeding and health management. The fact that deficiency of feed and fodder alone account for nearly 50 percent loss in livestock production and that 60-70 percent of expenditure on milk or meat production is on feeding, it deserves attention.

Balanced Animal Nutrition: Key to Healthy Animal

The area under permanent pastures and grazing lands has been declining over the years and this trend is likely to continue in the future too. Presently, the land availability for fodder production and pastures is a meagre 4- 5 per cent of the cultivated area. Due to overgrazing and other factors, the productivity of the pastures has been declining. The area under fodder crops has almost remained static for the last 3- 4 decades [1]

Despite India being largest producer of milk in the world, we are not able to provide balanced animal nutrition to animal. Balanced nutrition is key to healthy animal which will produce healthy milk or meat.



1.2 Gaps in Demand and Supply

Livestock sector faces profitability issues because of inadequate supply of feed and fodder. As per the estimates, it has been predicted that demand and supply of fodder (from 1995 to 2025) would fall short from about 60- 65% for green and around 20- 25% for dry fodder (Table 1). Presently, deficiency of feed and fodder combined is about 50%, accounting for about half of the total loss in livestock production.

Year	supply (m.t.)		demand (m.t.)		Deficit of demand (%)	
	Green	Dry	Green	Dry	Green	Dry
1995	379.3	421	947	526	59.95	19.95
2000	384.5	428	988	549	61.10	21.93
2005	389.9	443	1,025	569	61.96	22.08
2010	395.2	451	1,061	589	62.76	23.46
2015	400.6	466	1,097	609	63.50	23.56
2020	405.9	473	1,134	630	64.21	24.81
2025	411.3	488	1,170	650	64.87	24.92

Table 1: Estimates of demand and supply of fodder resources in India (m.t.) [2,3]

1.3 Green Fodder: Important Component of Animal Nutrition

We are not able to provide adequate and nutritious feed to our livestock and the shortage of feed and fodder continues. Needless to say that feeding of quality green fodder and forages not only result in higher milk production but also the quality of milk in terms of **CLA, Omega 3 and vitamin contents**.

Despite extensive efforts being made by the central and state agencies, fodder shortage continues to be a major constraint in dairy industry. This shortage is in green as well as dry fodder both. It is, therefore, necessary to look for alternative methods of fodder production from ensiling to hydroponics [4]

1.4 Hydroponic Green Fodder: An Alternative, Safe and Sustainable Solution

Acute shortage of land and increasing value being attached to water for cultivation of food crops has led to hydroponics fodder production technology. In the conventional system, seed starts germinating when it gets favorable conditions, like water/moisture, air, temperature and light. A seed utilizes maximum energy from the nutrients stored in it for developing radical (roots). However, very less amount of energy is utilized for the growth of the plumule (shoot). Therefore, in hydroponics technique, favorable conditions are provided to the seed so that the nutrients stored in the seed are directly utilized for development and growth of the plumule.

1.5. Hydroponic Fodder: Sustainable and Environment Friendly

Advantage of hydroponic feed/fodder Hydroponics technique has proven useful and efficient for producing quality fodder/feed for livestock. The technique is advantageous because it controls the climatic conditions as well as plant nutrition. Hence, it is possible to get increased production, stable harvests of high quality fresh green fodder year round. The hydroponic fodder/feed is produced under completely controlled conditions and is thus free from undesirable materials such as **weeds, insects, dust, insecticides, pesticides, germicides and carcinogens**. Hydroponics culture is probably the most intensive method of crop production in today's agricultural industry. With the possibility of adjusting air and root temperature, light, water, plant nutrition and adverse climate, hydroponics is highly productive. It conserves water and land and is environmentally sustainable. The Hydroponic Fodder production technology has several advantages, such as producing **highly**



nutritious fodder rich in vital nutrients, minerals, proteins, amino acids and having better **palatability and digestibility; saving of water, soil, time and labour.**

Ayurvet's Pro Green hydroponics machine uses natural sunlight for crop production which enters the system through full view glass windows. These window glasses also enable inspection and monitoring of inner chamber. Hydroponics is water saving technology. The Machines are available in different capacity from 100 kg/ day green fodder/ biomass to 2000 kg per day/ biomass . We have our installations at more than 100 sites in India and abroad.

Types of fodder that can be produced:

- Maize
- Barley
- Oats
- Wheat



Hydroponic Green Fodder

Figure 3- Hydroponics Green Fodder [6]

Various studies conducted suggest that Hydroponic green fodder to be highly palatable, digestible and nutritious having higher amount of protein as compared to the conventionally grown fodders.

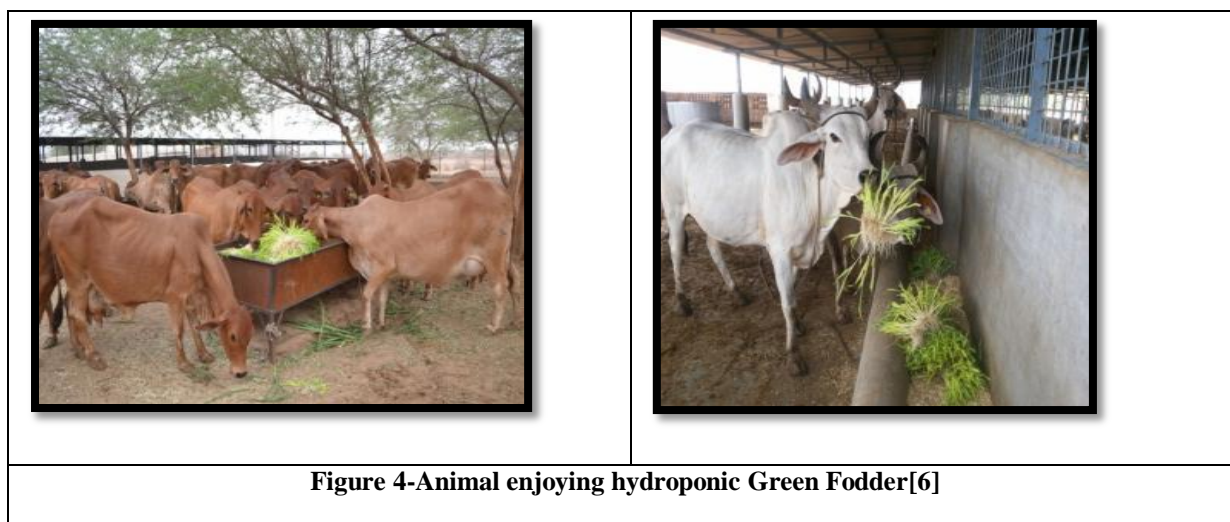


Figure 4-Animal enjoying hydroponic Green Fodder[6]

Nutrient	Conventional Fodder	Hydroponics Fodder
Crude Protein%	12.00	26.00 *
Crude Fibre%	16.25	6.89
Ash%	6.55	3.92
Ether Extract	4.50	3.95

Table 2 : Comparison of Nutrient Content of Hydroponics And Conventional Barley Green Fodder(% DM basis)[6]



The CP values are high in hydroponics fodder because the nutrient solution is provided directly to the root zone under controlled condition, enabling better uptake of the nutrient.

We have authenticated this result after conducting various research trials. [5]

III. Application of Ayurved Pro Green Hydroponics Technology in Agriculture

Along with green fodder, nurseries of different agricultural crops can be grown in our hydroponic system within a span of 8-10 days. These nurseries can then be transplanted into agricultural fields for getting better yields. The main advantage of this system is that compared to conventional method of growing crops we can save seed, cost and time

1.1. Ayurved Pro Green Hydroponics Technology in raising Paddy Nursery

Rice (commonly known as dhan in South Asia) accounts for a significant contribution to the total food grain production in India. It is grown in about 25% of the total cultivable area in India and is the staple crop for more than 60% of India's population

In spite of being the second-largest rice producer after China, Indian rice farmers face a plethora of problems. Landholdings and land for rice cultivation is diminishing, irrigation water is becoming scarce, labor is becoming unavailable as young people prefer to look for jobs outside the agriculture sector, excessive use of fertilizers and pesticides, emission of large amounts of greenhouse gases such as methane, climate change and unpredictable weather patterns, decreasing soil fertility due to unfavorable and topographical conditions, productivity loss, poor yields, poor and water management.

Under such circumstances, in the near future, it will become very challenging to produce high-quality paddy. Taking this into consideration, farmers need to adopt new technologies to cope with these challenges. Farmers need technologies that can reduce their cost of cultivation, reduce drudgery, improve their returns and are sustainable

1.2. Success starts at Nursery

The importance of establishing a proper paddy nursery in traditional rice cultivation cannot be overstated. The performance and yield of a rice crop are strongly affected by its early stages. Using unhealthy seedlings can reduce yield by at least 10%. Transplanting the seedlings at an appropriate time is also very crucial in getting optimum yield. In South Asia, rice seeds are commonly grown in nurseries on flat seedbeds before being transplanted into the puddled field. Traditionally, Indian farmers use the wet-bed nursery mainly in areas where water is sufficient. Pre-germinated seeds are broadcasted on a soil that is thoroughly puddled and leveled. The addition of organic manure and a small amount of inorganic fertilizer as basal dressing increases the easiness of uprooting of seedlings and seedling vigor.



Figure-5- Hydroponic Paddy Nursery Figure-6 Mechanical Transplanting of hydroponic Paddy[6]



Indian farmers encounter several problems in establishing proper paddy nursery, transplanting survival, diseases, etc. Additionally, the traditional mat-type nursery requires cumbersome, labor-heavy land preparation. It also needs agrochemical input and regular watering. They also observed more incidences of contamination, yellowing of leaves, and tip burning because of the open field nursery preparation. Hydroponics may be one solution to the many problems currently affecting paddy growers in India such as adverse climate and diminishing land and water.

The hydroponics technique is also advantageous relative to conventional agriculture. Because the crops are grown under a controlled environment, the nursery is free from weeds and shielded from insects. As such, there is no need to use expensive and toxic pesticides or herbicides. The temperature, light, water, and nutrition can be fully adjusted to optimum conditions making the hydroponics paddy nursery highly productive even with limited water and land area. Seedlings grown using hydroponics paddy nursery establishes well in the field and can be useful particularly during delayed monsoon rains.

1.3. The Hydroponics Paddy (rice) Nursery Protocol

The Ayurvet Pro Green Hydroponics Paddy Nursery grows rice seedlings under a fully controlled environment and multilayer shelves. A special nutrient solution is provided at regular intervals to meet the requirements of the seedlings and encourage strong root .Hydroponics seven-day paddy growing cycle. development. It only takes seven days for the rice seedlings to reach 15 centimeters at 30-33 C and 75-80% humidity. The humidity and temperature play a crucial role in the growth of the paddy nursery and these can be adjusted to suit the crop requirement. The other advantages of hydroponics paddy nursery over conventional nursery cultivation include: Hydroponics-grown seedlings recover fast, produce tillers vigorously, mature uniformly, and have higher yield gain Crops mature earlier leading to early harvesting and better returns Uses 95% less water Suitable for late delayed monsoon conditions Land for nursery can be used for other purposes Mechanical transplanting ensures uniform spacing and plant density. Mechanized transplantation cover 3 to 4 acres per day with less manpower

The organization has been working on the technology for the past 11 years .Since 2009, Ayurvet Research Foundation have conducted experiments and field trials in 50 villages of Sonipat, Panipat in Haryana and western Uttar Pradesh with around 2,500 paddy farmers. Regular training and demonstration sessions were organized for the farmers for making them aware of the technology. To date, a total of 81 hectares have been transplanted with rice seedlings grown using the hydroponics paddy nursery.

1.4. Hydroponic Paddy Nursery & its Mechanical Transplantation: Supported by NABARD

The National Bank for Agriculture and Rural Development (NABARD) Chandigarh Regional Office has approved the work done by the research foundation. In 2016, NABARD funded a three-year project on the development of hydroponically grown paddy nursery and mechanized transplantation in 210 acres in Sonipat District in Haryana. Under the project, paddy seedlings were grown in trays using a hydroponics system in seven days. The seedlings were transplanted on farmers' fields on the 8 day using mechanical transplanter.

By promoting the wider use of hydroponics paddy nursery, the government can help Indian rice farmers save significant amounts of water, land, labor, time, and other resources. Organizing free training for farmers in different parts of the country will make them aware of the technology and its benefits which empowers them. It will also give them insights into developing new sources of income.



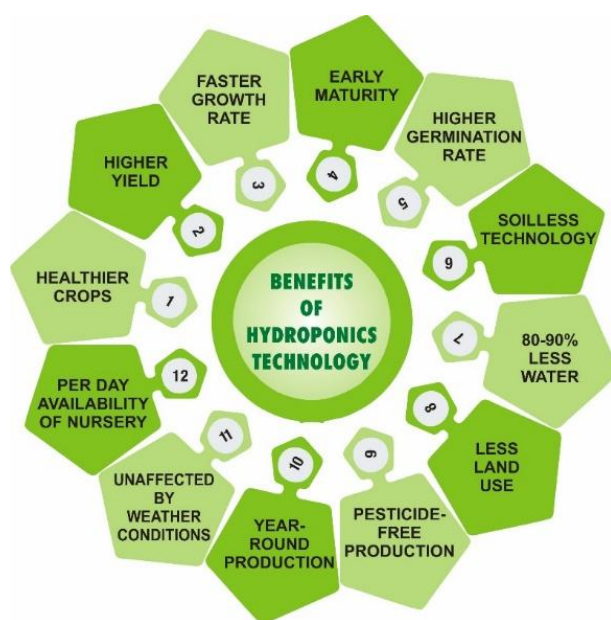


Figure 7- Hydroponic Technology for Wheat Grass [6]

Fertilizers, agrochemicals and pesticides, when used in higher quantities than needed, become contaminants to food, feed and environment. This has prompted international organizations to establish standards for the safe production of fresh crops that can be safely consumed. To provide a wholesome nutrition for a healthy and rejuvenating body, green food could be very useful in providing nutrients like vitamins, minerals, proteins, enzymes and antioxidants which are researched for numerous health benefits. Wheat grass is a nutritional powerhouse, rich in chlorophyll, antioxidant vitamins, minerals and other nutrients that support optimal health contains significant amount of iron, phosphorus, magnesium, manganese, copper & zinc. In house hydroponically grown wheat grass, without any use of fertilizer or pesticide, taken up for juice preparation under hygienic conditions was analyzed for microbiological safety and various nutritional parameters.

Wheatgrass consumption can boost the immune system and is helpful in improving the conditions of patients suffering from various lifestyle diseases like heart ailment, indigestion, cancer, diabetes, obesity, etc

1.5. Hydroponics Technology for Horticulture

Recently Ayurvet Pro Green hydroponics technology is applied in producing horticulture crops

Ahydroponic system containing Nutrient Film Technique(NFT) was installed at Galgotia University, Greater Noida, which is used for production of vegetable nursery, leafy vegetables and demonstration of hydroponics technology to the students

Nursery of tomato, chillies, brinjal were raised . In another intervention, NFT system raises medicinal plants like kalmegh and Ashwagandha. The benefit of the technology is uniform production with no chemical fertilizers and pests.

The Hydroponics is also catering to emerging microgreens sector. Due to Covid 19 people are more conscious about healthy diet. The hydroponic system can develop microgreens in 10-20 days (vary with crop).Microgreens contains four times more nutrients by weight than their fully grown counterparts. Microgreens are developed when sprouts are allowed grow for a longer time . Microgreens of green gram & gram are developed in just 10 days.





Figure -8 Hydroponically raised Horticulture crops [6]

IV. Conclusion

Green fodder is the key for better production, animal health, and milk quality. Ayurvet Pro Green hydroponics technology was evolved for green fodder production and its availability round the year.

Hydroponics system also eliminates additional pressure on water and land resources. The process of growing green fodder hydroponically allows the control of climatic conditions for optimum growth with guaranteed output per day. In current scenario this could be a viable alternative for feeding animals.

Government agencies and likeminded organization should come forward and rope in technologies through which we can minimize the use of pesticides or raise chemical- free Fodder, nursery, horticulture crops to ensure safe food production.

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