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Hydroponics Fodder Production: An Alternative Technology for Sustainable Dairying*

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Livestock contributes about 12% of the total agricultural household income in rural India and plays a critical role in the lives of particularly small and marginal farmers and landless persons. Green fodder is one of the most important inputs in dairy as it provides required nutrients/ minerals for milk production and helps maintain the health of the dairy animals. Control of feed cost in dairy animals impacts the profit and results in successful dairy farming. Generally, it is observed that the feed cost is about 70 to 75% of the total milk cost where in green fodder constitutes 13 to 35% of the total input feed. Good dairy practices recommend that milch cattle be fed green fodder ad-lib. The National Dairy Development Board recommends that a cow yielding 8 to 10 litres of milk per day be fed 25 to 30 kg of green fodder, 4 to 5 kg of dry fodder and 4.0 to 4.5 kg of concentrate per day during lactation.

However, the availability of green fodder is declining day by day. The resultant lack of green fodder compels the farmer to feed the cattle inferior dry fodder, straw, ordinary grass, or set cattle free for open grazing, which adversely affects the milk production.

Reasons for scarcity of green fodder

1. Rapid urbanization has caused shrinkage of land available for grazing.
2. The land holdings are shrinking due to fragmentation and the farmer is not able to set aside land for cultivation of green fodder.
3. The farmer prefers to use the available land to cultivate cash and food crops.
4. There is a scarcity of water for irrigation, especially in the summer months and the farmer prefers to grow cash crops with the available water, which would earn him more income.
5. Most farms lack fencing and free grazing cattle and wild animals enter the fields and feed on the succulent fodder.
6. There is an acute shortage of farm labour to undertake the cultivation of green fodder, cutting the same, chaffing it and feeding the same to the cattle.
7. In coastal areas/ forest areas adequate land may not be available to undertake cultivation of green fodder.
8. In several parts of the country, the climate is not conducive for fodder cultivation.
9. In areas where the dairy industry is flourishing, there may be a shortage of green fodder due to heavy demand.

Options

The dairy business today is facing many challenges, predominant amongst which is the shortage of green fodder. The acute shortage of green fodder has caused dairy farmers to look for alternative options and explore sustainable methods of obtaining quality green fodder. One such technology is hydroponics. Using hydroponics the farmer is able to ensure quality production of green fodder. While hydroponics technology can be implemented in greenhouses/ poly-houses, many innovations have been brought about which enable cultivation of green fodder through hydroponics technology under ordinary farm conditions.

What is hydroponics?

The word hydroponics has been derived from the Greek word, “Hydros” meaning ‘water’ and “Ponic” meaning ‘working’. Hydroponics is the scientific way of growing plants/ crops in water without any soil, generally in controlled conditions/ environment. In this method, water is generally enriched with or incorporated with a well-balanced formula of the nutrients that are essential for plant growth.

However, green fodder can be produced with the use of fresh water only and use of nutrient rich solution is not necessary. There is no added advantage as measured in terms of increase in nutritional value or quantity of the fodder produced as a result of using nutrient solution as compared to using ordinary water.

When hydroponics is used for cultivation of green fodder, seed, water and sunlight are the only inputs that are required as the green fodder is fed to the animals after about 7-10 days of plant growth, which is achieved using the energy reserves of the seed itself. Barley, oats, maize, wheat, cowpeas, etc., are commonly cultivated using hydroponics to produce high quality nutritious green fodder for dairy animals. Sorghum is generally not preferred as hydrocyanic acid toxin production is a serious problem associated with sorghum forage and could be lethal to animals if ingested in higher quantities, especially when fed when the crop is less than 45 days of growth.

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Benefits and advantages of cultivation of green fodder using hydroponics

1. **Nutritional benefits:** The green fodder from hydroponics is highly nutritious and of better quality as compared to Conventionally Grown Fodder (CGF). In comparison to conventional green fodders, Hydroponics Green Fodder (HGF) contains more crude protein (13.6% v/s 10.7%) and less crude fibre (14.1% v/s 25.9 %).
2. **More appetizing:** The green fodder is more succulent and tasty and animals relish it. The intake of HGF by dairy animals is more as compared to CGF and this results in dairy animals being in better health and resultantly yielding more milk.
3. **Water savings:** The HGF system requires only 2-3 litres of water to produce one kilogram of green fodder as compared to 55 to 75 litres of water required for the traditional CGF. Apart from this, there is no wastage of water as the available water is also recycled.
4. **Wider temperature range:** HGF system allows fodder to be grown within a wider temperature range of 15-330C and relative humidity (RH) range of 70-80% without any fungal growth. The technology is environmental friendly.
5. **Land requirement minimal:** Hydroponic technology takes the pressure off the land as it requires only 10 m X 5 m to grow 600-650 kg of fodder per day whereas to produce the same quantity, one hectare of land would be required under CGF system. This quantity of fodder is sufficient to rear 20-25 milch cattle. This eliminates the dependency on land, and even landless persons can undertake dairying as an occupation using HGF technology.
6. **Easily scalable:** The hydroponics system can easily be scaled down (or up) to cater to the needs of farmers owning just two head of cattle!.
7. **Less labour requirement:** The CGF system requires labourers to undertake land preparation, sowing, irrigation, cutting, transporting fodder from field to cattle shed, cutting the chaff and finally feeding the cattle, whereas under the HGF system, just one labourer can complete the entire process in 2-3 hours per day!.
8. **Less time to grow green fodder:** The HGF is fed to cattle when the plants are at just 7-8 days from seed germination when they are about 20 to 30 centimetre in height.
9. **Higher bio-mass conversion rate:** In HGF, the biomass conversion ratio is as high as 6-7 times that of the CGF grown for 65 to 80 days.
10. **Round the year production:** HGF can be produced all around the year as it is grown under semi-protected conditions.
11. **Minimal losses:** There is no wastage under HGF system, as the entire succulent tender plant (at 7-8 days), comprising of roots, leaves, grain and stem is fed to the animals whereas the CGF consists of only leaves and stem.
12. **Organic/ natural green fodder:** The HGF is completely organic as except water, no other inputs like pesticides that could contaminate the fodder are used in the production. This also results in the milk being of higher quality.
13. **Faster growth and higher yield:** The hydroponic systems can produce the green fodder at a faster rate and result in high yield of fodder as compared to the conventional system of cultivation.

How is it done?

The HGF cultivation systems can be hi-tech and fully automated or can be simple low cost, effective structures developed locally by farmers by taking advantage of the basic principle of the seed germinating and growing for about 7 to 8 days using only water till they are about 20 cm in height.

An automated hydroponic system has chambers in which foggers are installed. These foggers spray a fine mist of water on to the trays to keep the seeds moist and maintain the RH between 70 and 80%.

However, for the average farmer low cost effective sustainable solutions are needed. Both scientists and ordinary farmers have modified the way hydroponics is used to grow fodder. The most commonly used system is described in the following paragraphs.

A specially constructed frame made of GI pipes or angle bars is erected to hold plastic trays measuring 18″ X 32.5″ X 2″, in which 1 to 1.25 kg of seed can be placed to produce about 3.5 to 5.5 kg of green fodder. The dimensions of the trays is determined so that they can be easily managed by anyone and other standard sizes such as 53″ x 53″ x 7″, 29″ x 53″ x 7″, 41″ x 41″ x 7″, etc., that are available in the market can also be used.

1. To reduce the cost further, the frame can be erected using bamboo and instead of trays, bamboo baskets can be used.
2. The entire arrangement is covered with shade net cloth.
3. An arrangement to pump water to be pumped from a reservoir at the bottom to pipes in which holes have been punched in at the top of the frame is designed. The water dribbles in to the tray and drains out in to the reservoir for the process to be repeated.
4. The untreated maize seed is soaked for about 4 hours.
5. About 1 to 1.25 kg of soaked maize seed is spread out on to each tray.
6. At the end of 7-8 days the seeds have germinated and have formed plants measuring about 20 cm in height. The tray resembles a mat with the roots intermingled and seeds intact.
7. About 3.5 kg and 5.5 kg HGF is produced from each kg of yellow maize (CT-818) and white maize (GM-4), respectively. Generally, the production cost of HGF from white maize is lower (Rs.4) than that from yellow maize (Rs.5) per kg.
8. The cost of a wooden shade net HGF production unit capable of producing 30 kg fodder/ day is about Rs.6,000 while that producing about 350 kg/ day is

about Rs.50,000 while that of a GI pipe/ angle bar/ MI steel shade net unit with a daily fodder production potential of 150 kg is about Rs. 25,000 increasing progressively to Rs.1,50,000 for a unit producing 750 kg.

Precautions and tip for hydroponic fodder cultivation

1. While growing HGF, one must be careful not to use seed that has been treated with pesticides and fungicides.
2. The water used for sprouting of grains should be clean and free from chemical agents and water in the tank should be replaced every 3 days as it can be a major source of microbial contamination.
3. In order to avoid fungal growth, proper phyto-sanitation has to be maintained. The trays have to be washed and cleaned after every cycle. If necessary, fungicides need to be used but should best be avoided as any residue may adversely affect health of animals.
4. White maize/ corn seed has been found to have a better germination rate as compared to yellow maize.
5. The seeds should be free of impurities to avoid clogging of the pipes/ foggers and also produce quality fodder.
6. The racks of the hydroponic system should be kept in a partially diffused light shed so as to prevent yellowing of the leaves.

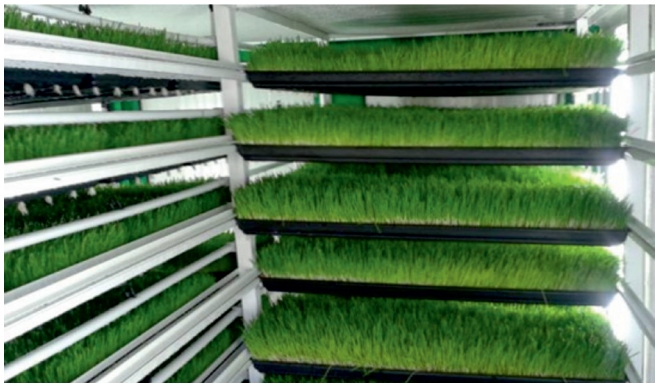
Comparison Table of Green Fodder Cultivation Using Hydroponics and Conventional Land based Cultivation

Sr. No	Parameter	Conventional Land Based Fodder Cultivation	Hydroponics Systems
1	Area required	One ha land to produce 600 kg per day	50 sq mt to produce 600 kg per day
2	Fodder production in days	65-70 days	7 days
3	Water requirement	Very high at 30 litres per kg of green fodder	Minimal at just 1.5 to 3 litre per kg of green fodder
4	Soil fertility	Essential	Not required
5	Fertilizer application	Required	Not required
6	Fodder yield	Dependent on environment, cultivation practices, etc	Controlled conditions
7	Labour requirement	Intensive for sowing, harvesting, chaffing, etc	Minimal
8	Fencing and farm protection	Essential	Not required – can be undertaken in small shed or even under shade net
9	Green fodder utilization	Significant Wastage	Complete- almost no wastage

Some success stories

Zhanzhane is a small sleepy village in Phaltan block of Satara district. It is chronically drought affected as it is on the leeward side of the Sahyadri mountain range. Since income from agriculture is not assured, most farmers have migrated to nearby Pune or are struggling to make ends meet.

Shri Suresh Baban Bhosale, completed Class XII and started helping his father in farming and taking care of their two milch buffaloes. However, since the income from farming and dairying was inadequate to meet the needs of the family, Shri Suresh migrated to Pune to work for a private company. However, he was unhappy staying in a small tenement in Pune. He missed the open spaces of his village. On a trip back home, he attended a meeting organized by Govind Dairy, Phaltan, near Pune. The dairy officials explained how dairying could give assured income all year round if undertaken properly. This motivated him to come back to the village to try his hand at dairying once again. The availability of green fodder was a major impediment in undertaking dairying. The extension workers of Govind Dairy guided him to set up a low cost hydroponics unit. Technically, a hydroponics unit needs a GI pipe frame, shade net, timers, sprinklers or humidifiers/ mistifiers, etc. However, as Suresh did not have the resources to spend Rs.40,000 odd for this, he innovated and using only bamboos and locally available babool logs, erected a frame large enough to accommodate 46 trays of 3X2 feet. As against the requirement of 22-25 sq m of green shade net cloth, he could manage to buy only about 15 sq m and used jute sacking to cover the rest of the frame. Since he did not have an automated sprinkler or mistifiers, he made do with a manual spray pump generally used to spray pesticides to water the fodder. Each of his trays produces 15-16 kg of greenfodder in about 7-8 days, and he feeds each of his buffaloes about 10-12 kg per day.



(Green Fodder Cultivation Using Hydroponics)

Using all his ingenuity and innovativeness, Shri Suresh is producing about 250 kg of green fodder and is rearing 10 buffaloes, which yield 130 litres of milk daily, earning him over Rs. 4160 per day and after expenses, he is left with almost Rs.2500 daily!

(Shri Suresh using a hand sprayer to water the green fodder in his hydroponics unit)

There are numerous such farmers and institutions that have adopted the basic concept of hydroponics and have innovated to reduce the cost of errection while maintaining the output and quality standards of the green fodder.

Not only individuals but institutions too have realized the need to promote cultivation of green fodder using hydroponics. The Warana Shakari Dudh Utpadak Sangh, a unit of the Warana Group, and a major supplier of milk and milk products in Maharashtra was facing a shortage in procuring milk from farmers due to reduced output, as there was a drought in 2013-14. To find a permanent solution to the fodder supply issue it approached NABARD seeking assistance. In May 2015, NABARD sanctioned a project under its Umbrella Project on Natural Resource Management Programme with a total financial outlay of Rs.594.56 lakh and term loan of Rs.465.92 lakh to help provide hydroponic units to 5000 dairy farmers. A small grant component was also included to enable the Sangh for generating awareness, conduct meetings, publicity and other related interventions. This has helped dairy farmers to grow green fodder using just 100 litres of water per day in just about 100 sq ft of space and the increased milk production has helped the Warana Dairy ensure milk supplies.

Farmers need to be encouraged to adopt the hydroponics systems of cultivating green fodder to ensure a steady supply of green fodder all through the year for the dairy animals.

Economics of the unit

Hydroponic System for Production of Green Fodder for 2 Head of Cattle					
					(Area required 10 ft X 10 ft)
A . CAPITAL COST					Amount in Rs
Sl No	Name of component	Unit	Quantity	Rate	Amt (Rs)
	PVC Stand				
1	PVC Pipe size 1"	feet	30	460	13800
2	PVC Four Way 1"	nos	60	45	2700
3	PVC Tee 1"	nos	120	40	4800
4	PVC Elbow 1"	nos	12	9	108
5	PVC Band Plug 1"	nos	17	35	595
6	Fogger (80 foggers)	Unit	1	500	500
7	Filter	Unit	1	1000	1000
8	Plastic trays	nos	120	80	9600
9	Motor 0.50 HP	Unit	1	3000	3000
10	Timer	Unit	1	1500	1500
11	Plumbing material	Lump sum	1	500	500
12	Water tank 1000 litre	Unit	1	2000	2000
13	Shade net (90%)	Sq mt	40	25	1000
14	Labour charges for asembly	Lump sum	1	500	500
	Total capital cost				**41603**

B. RECURRING COST					Amount in Rs
Sl No	Name of component	Quan-tity	Unit	Rate	Amt (Rs)
1	Maize seed (2 kg per day@ Rs15 per kg for 365 days)	1277.5	Kg	14	17885
2	Electricity		Lumpsum		750
3	Labour @ Rs.50 per hr per day for 365 days			18250	
	Sub Total				**36885**
	Grand Total (A+B)				**78488**

		Amount in Rs
Capital Cost		41603
Recurring Cost Every Year		36885
Add Minor Repairs to unit		500
Recurring Cost from Year II onwards	37385	

C. Income Stream Calculations for Green Fodder					
i	Price of green fodder (at market rates)	7300	Rs.per kg	6	43800
ix	Total income from 2nd year onwards		Amunt in Rs		
	Particulars	Details	Unit	Rate	Amount
	Production of green fodder	7300	kg	8.5	62050
	Year II onwards	7300	Kg	8.5	62050

D. Cost-Benefit Stream					
Sl No	Pariculars	Yr I	Yr II	Yr III	Yr IV
1	Capital cost	41603	0	0	0
2	Recurring cost	36885	37385	37385	37385
	Total cost	78488	37385	37385	37385
3	Income	62050	62050	62050	62050
4	Net Income		24665	24665	24665

N.B The hydroponics unit will be captive unit meant for supply of green fodder to the farmer's cattle only and not for sale in market. Milk production increases by about 10 to 20% (150 to 165 litres per lactation) when fed green fodder as compared to straws and dry fodder, expenditure on concentrates also comes down and the health of the cow also improves resulting in saving on veterinary care. These benefits have not been monetized in the above economics.

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