DEVELOPMENT OF A COST EFFECTIVE, ENERGY SUSTAINABLE HYDROPONIC FODDER PRODUCTION DEVICE (Jan 2012).

Project Report by-

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We thank all those whom we could not name, who have helped us directly or indirectly. Your help was vital for the success of this project.

The Objective:

- design a low technology rural device that can be the cheapest hydroponic fodder production system in the world.

- Reduce the operating costs by using natural sunlight for photosynthesis

- Raise higher operating temperature range of these devices to at least 30 degrees and

- Eliminate air conditioning.

- Utilize organic fungicides and growth promoters.

What is Hydroponics?

In natural conditions, soil acts as a mineral nutrient reservoir but the soil itself is not essential to plant growth. When the mineral nutrients in the soil are dissolved in water, plant roots are able to absorb them. When the required mineral nutrients are introduced into a plant's water supply artificially, soil is no longer required for the plant to thrive. Almost any terrestrial plant can grow like this. This method of growing plants using mineral nutrient solutions, in water, without soil is known as hydroponics.

It is possible by Hydroponic techniques to achieve better than normal farm production, immune to natural weather variations, as well as organic and more nutritive, in just about 5%of the space & 5% of the irrigation water. NASA is reported to be working on this subject to meet fresh green food needs in space.

Some of the reasons why hydroponics is being adapted around the world for food production are the following:

- No soil is needed
- The water stays in the system and can be reused; thus, lower water costs.
- Stable and high Organic production.
- Immune to weather
- Pests and diseases are easier to get rid of than in soil because of the container's mobility
- Energy and labor saving
- It is easier to harvest

- No pesticide damage

Today, hydroponics is an established branch of agronomy. Progress has been rapid, and results obtained in various countries have proved it to be thoroughly practical and to have very definite advantages over conventional methods of horticulture.

There are two chief merits of the soil-less cultivation of plants. First, hydroponics may potentially produce much higher crop yields. Also, hydroponics can be used in places where in-ground agriculture or gardening is not possible.

INDIA AND HYDROPONIC FODDER

Indian agriculture scientists have been familiar with Hydroponics Fodder growing for more than 30 years. Govt. of India had in late 1980s imported half a dozen 'Fometa' Hydroponics Fodder devices for Indian research establishments of ICAR. It is also reported that 50 more Fometa device kits were imported and assembled in India.

Each Fometa occupied 30sq. mts. of space and was designed to produce, on a daily basis, 1000 kg of highly nutritious clean green fodder of more than 85% digestibility. These devices failed to be useful to India, because they needed air-conditioning to maintain a temperature of 22+/- 2 C. They used large numbers of fluorescent tubes for photosynthesis. With irregular electricity supplies, fodder could not be produced on a regular basis.

Capital cost of these machines was so large, and electricity operating expenses made the operational cost of these devices uneconomical to produce fodder. The attempt to use hydroponics for growing fodder in India was discarded as a bad dream; unsuitable and unaffordable in India.

NEED OF GREEN FODDER FOR COWS

Green fodder is the natural diet of cattle. Green fodder is the most viable method to not only enhance milk production, but to also bring about a qualitative change in the milk produced by enhancing the content of unsaturated fat,, Omega 3 fatty acids , vitamins, minerals and carotenoids.

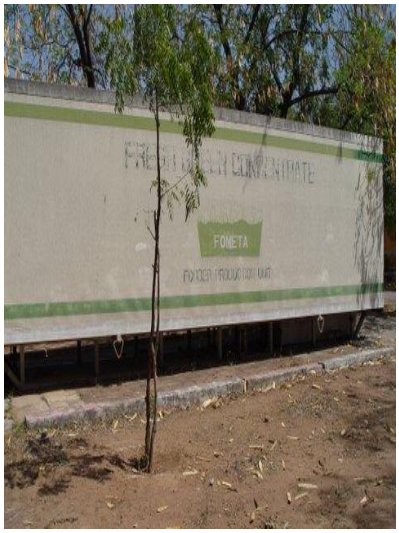
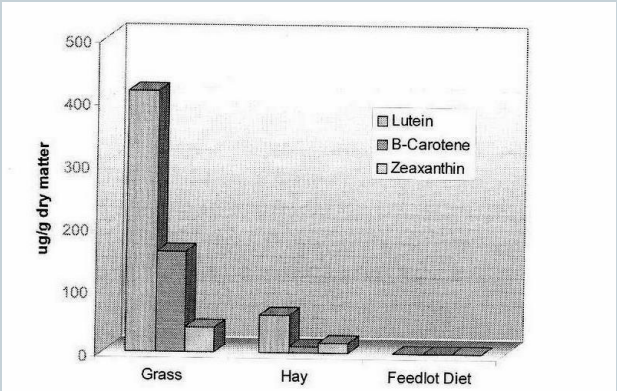


Fig #1 **Fig #2** **F.ig # 3**

Fig# 1: Imported Fometa Device, Fig# 2: Interior details of Fometa Device, Fig# 3: Functioning Fomet**a** Device

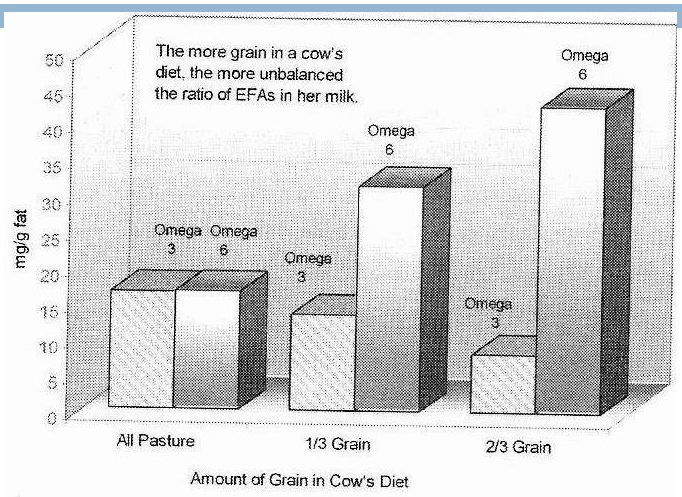
Hydroponics fodder growing is the state-of-the-art technological intervention to supplement the available normal green fodder resources required by the dairy cattle. But, after the unfortunate Fometa experience, Indian scientists and planners have not given any attention to this subject. With increased pressure on farm lands to produce increasing needs of food grains, providing green fodder by hydroponics fodder growing is a necessity for the Indian dairy industry.

Greens only provide Carotenoids Hydroponics /Pastures is the answer



Grass has more carotenoids than hay or a typical feedlot diet
J Animal Science (2003). 81:360-367.

Only Green Forage enhances CLA



J Dairy Science (1999). 10:2146-56.

Modern researches have confirmed that grass fed cow's milk is very rich in EFAs (Essential Fatty Acids). Omega 3 is the most important constituent of grass fed cow's milk, particularly for brain and eyes. Some clinical studies indicate that a 1:1 ingested ratio of *Omega* 6- to *Omega* 3- (especially linoleic vs alpha-linolenic) fatty acids is important to maintaining cardiovascular health.

Typical Western diets provide ratios of between 10:1 and 30:1 (i.e., dramatically higher levels of *n*−6 than *n*-3). The ratios of *n*−6 to *n*−3 fatty acids in common vegetable oils are: canola 2:1,soybean 7:1, olive 1:33, sunflower (no *n*−3), flax 1:3, cottonseed (almost no *n*−3), peanut (no *n*−3), grapeseed oil (almost no *n*−3) and corn oil 46:1 ratio of *n*−6 to *n*−3.

When a cow is raised on pastures, her milk has an ideal one to one ratio of these two EFAs discussed above. Studies suggest that if your diet contains roughly equal amounts of these two fats, you will have a lower risk of cancer, cardiovascular disease, autoimmune disorders, allergies, obesity, diabetes, dementia and various other mental disorders.

WHY HYDROPONIC FODDER?

In India, the demand for green fodder is increasing on the account of diversified use of agricultural residues. Adequate attention is not being given to production of fodder crops due to increasing pressure on land for production of food grains, oil seeds and pulses.

In order to meet this increasing demand for green fodder, the next best alternative is Hydroponics Fodder to supplement the meager pasture resources. Some of the benefits of hydroponic fodder production being

- *Land preservation*
- *Water conservation*
- *Faster growth and maturity*
- *Contamination free*
- *Minimal use of Fungicide and Pesticide*
- *Less labor and maintenance costs*
- *Control over growing environment*
- *Time saving*
- *Continual produce*
- *Weed free*
- *Highly palatable & Nutritious fodder*

Present Facilities

The Bamboo Apparatus, Plant material and Nutrient solution

We have conducted the experiment in a small room of about 3m X 3m X 3m in dimension. Two sides of the room have walls, while the other two sides (North-South) have double glazed glass windows, permitting the sunlight, and filtering out the heat. The optimum temperature required for hydroponic crops is around 22 degrees C and the maximum temperature that the crop can tolerate is usually around 30-32 degree C. Since during winter season the temperature in northern India is well within the acceptable limits, thus facilitating successful hydroponics production...

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Fig # 4 Fig# 5 Fig# 6

Fig #4, Facilities under construction (2009), (Sh. Subodh Kumar, KN Agarwal and KK Sharma foreground), Fig #5, Present (2010) Hydroponic structure, Fig #6, Internal bamboo shelf system (2011)

Present Operations

We used the seeds of barley and wheat, barley is considered the seed of choice for production of hydroponic fodder.. Seeds of this crop are inexpensive and freely available in the Indian market. We also used wheat seeds with interesting results. The seeds of these two crops (around 1 kg each) were placed in small plastic trays (approx. 100 grams mass each), which were arranged in a shelf system made of bamboos. The choice of bamboo instead of aluminum or steel was to make this economically viable and adaptable by any Indian farmers.

Our twin goals were to make this fodder completely in an organic manner, and to suit the local Indian conditions for development of a cost effective hydroponics Fodder device. Hence, we decided to use a fungicide & nutrient solution commonly known as Beejamrit. Compost Tea is being extensively studied and used in USA for similar purposes.

Fig # 7 Fig # 8 Fig # 9

Figure #7, Seeds under germination, Fig # 8, Fodder under growth Fig # 9, Fodder for harvesting

Fig # 10, harvested hydroponics fodder

OBSERVATIONS

It took around 24 hrs for the seeds to germinate. The mass of the crops increased to 6 kg from 1kg in around 10 days. Another interesting observation during this period was that though the mass of barley crop was greater than that of wheat, the roots of the wheat were much denser. However, the upper part of the wheat was lighter as compared to that of barley.

The increase in masses of the two crops was almost parabolic. The seeds grew to about 8 inches in height in 10 days. In this experiment no efforts were made to alter the indoor air quality and humidity . However, such controls in the past 2010 experiments are known to

produce similar growth in 6 to 7 days time. Thus it is also concluded that environment control has a role in growth of hydroponic fodder.

The temperature for most part of the day was around 25-26 degree C, while the humidity was around 50 %. The pH of the nutrient solution was in the range of 7-8.

CONCLUSION

Our aim was to setup a model hydroponic apparatus which could be easily built by any Indian farmer in order to meet the fodder needs of his cattle.

Producing green fodders under controlled conditions is economical and suitable for adoption by this country. There exists a great need for scientists and engineers across the globe to take up research in this challenging and interesting field for application in hydroponics. The challenge here is to produce a system viable and adaptable throughout the year in a cost effective and energy sustainable manner.