

Original Research Article

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Development of Solar Operated Hydroponic Fodder Production System

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ABSTRACT

Keywords

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The study was conducted with view of establishment technology of production and to reduce the scarcity of fodder to the livestock. A solar operated hydroponic system was designed in the area 150 ft² with bamboo sticks and shade net at the Technology Park, CTAE, Udaipur. Unit consist of 4 shelves with bamboo stand having production capacity of 30kg per day. Plastic trays were used for fodder production, automatic irrigation system controlled with Arduino and solar panel with battery buckup used for power supply. The 10th day fodder was harvested and laboratory test were carried out to study the content of crude protein, crude fibre, Ether extract and total ash. Three Maize seed rates were selected for the chemical analysis i.e. 600g, 750g, 900g per tray. Test shows that highest crude protein and ether extract was observed in 900g/tray hydroponic fodder 14.81 %, 3.01 % respectively.

Introduction

In India, livestock plays an important role for the nutritional security, particularly of the small and marginal farmers. As per the 20th livestock census 2019, total cattle population in the country is 192.49 million (Anonymous 2019). Total cattle population is increased by 0.8 % over previous livestock census 2012. In Rajasthan it was 13.3 million cattle population during 2012 now 13.9 million cattle population. There is change of 4.41 %

in these five years (RLDB 20th livestock census 2019).The increase in the livestock population along with the intensive rearing system has resulted in the increase demands for feeds and fodder in the country. The feed scarcity has been the main limiting factor in improving the livestock productivity. The land allocation for cultivation of green fodder is limited to only 5% of the gross cropped area; but by 2020, India would require a total 526, 855 and 56 million tons of dry matter, green fodder and concentrates respectively

(Ramteke *et al.*, 2019). To overcome from this situation and decreasing of water use in agriculture and to increase the green fodder production by using less amount of water some methods and technologies were needed that can contribute to improved water use efficiency and productivity. The conventional method for fodder production needs more land to produce and it dependent on the seasonal or weather conditions with long time period of growing, more use of water so a requisite need of a technique which can reduce the land need and water use, with less days of production. Through which the only available land will use by human for the food and income and also the feeding requirement of the livestock will maintain and the productivity survival life will also increase. There are several techniques are design to overcome this situation.

A novel method called 'Hydroponics' which means growing plants without soil by using nutrient water at desired temperature and humidity (Jemimah *et al.*, 2015). The word hydroponics comes from two Greek words 'hydro' and 'ponics' which means water and working respectively (Reddy *et al.*, 2012).

Solar energy can be more important to India's plan not only to integrate new capacity but also to maximize energy security and address environmental concerns, and lead valuable market for renewable energy (Sharma *et al.*, 2012). Solar operated hydroponic fodder production system requires less maintenance, irrigation is fully on automation. The major cause of electricity supply in many villages continuous electricity supply is not provided; in hydroponic system irrigation is done periodically to maintain humidity and temperature. If electricity not supplied properly green fodder gets dry and affected by fungus (Kamat *et al.*, 2018). The fungus is dangerous for the cattle health. Though solar is used only day time, the battery had backup capacity of 13 days, hence solar operated

hydroponic fodder production system developed and performed at CTAE, Udaipur.

Materials and Methods

The experimental was carried out at the Technology Park, CTAE campus, MPUAT Udaipur. The study area, Udaipur is situated on longitude 73⁰ 42' and latitude of 24⁰ 35' and at an elevation of 582.17 meters above mean sea level. The farm area is characterized by sub humid climate with an average annual rainfall is 641 mm, mostly received during monsoon season (June to September). The maximum temperature goes as high as 46°C during summer and minimum as low as 5°C during winter months.

Shade net house

A shade net house was constructed with the locally available bamboo. The dimensions of shade net house are 15 feet length x 10 width x 10 feet height in the middle and 8feet height in the corners. The dimension of door is 6feet x 3 feet. Door is also made of bamboo sticks. After the construction of frame structure of bamboo house, it is covered with green colour shade net of 60-80% UV treated so which could resist the much sunrays which directly fall on the green fodder.

Bamboo framed hydroponic stand

A bamboo framed hydroponic stand was made of bamboo sticks. Average diameter of bamboo sticks were 7.5 cm. Dimensions of stand was of length 8.6 feet x width 4.9 feet and height of 7 feet. This stand has four compartments in it to place the hydroponic trays. The gap between first three compartments was of 2.3feet each from the bottom. This structure was fixed into the ground. The isometric view of hydroponic stand and shade net house shown in Fig. 1 and 2. The life span of this bamboo hydroponic stand around 5-6 years. In each stand of this

structure had space that can hold around 12 hydroponic trays. All sticks were tied with a steel wire and fixed by using nails. The Shade net house and bamboo framed hydroponic stand with hydroponic trays shown in Fig. 3.

Power transmission system

Solar panel 80W was installed on the top of the shade net house and it was connected with solar charge controller. From solar charge controller both positive and negative terminal of the 40Ah battery was connected to it to recharge from the solar panel and supplies the electricity to the pump, solenoid valves, relay switch and Arduino module (Aruna *et al.*, 2018). Positive terminal wire of the Motor pump was connected with load port of the solar charge controller and other negative terminal wire connected with relay switch. Solenoid valves connection were alike motor pump connection. All the negative terminals of the control system made common. Arduino module was connected with the controller through USB cable and it connects with the relay switch regulate the functioning of solenoid valves and pump according to the programme which was fed in the chip of the module. Programme was done according to the requirement of the water level of the hydroponic system. The flow diagram of solar operated hydroponic system shown in Fig. 4.

Selection of seed rate

Three Maize seed rates were selected to calculate the plant height, root length and chemical analysis. The seed rates were 600 g, 750 g, 900 g per tray (Islam *et al.*, 2016).

Chemical analysis

Chemical analysis was done to the hydroponic maize fodder on 10th day to find out the Moisture content, Crude protein, Crude fiber, Ether extract and total ash according AOAC standards (AOAC, 1980

and Bakshi *et al.*, 2017). After the Analysis date were recorded and compared between the treatments to find the best treatment according to the chemical analysis. The procedure for the estimation of these parameters as follows:

Moisture content

The moisture of fresh and dry fodder was determined by the process of hot air oven method

$$MC = \frac{W2 - W1}{W3}$$

Where,

MC=Moisture content

W1=Initial weight of sample (g)

W2= Final weight of sample (g) and

W3= Weight of dried sample in grams

Crude protein

The crude protein in hydroponic maize fodder was determined by using micro Kjeldhal method

$$\text{Protein \%} = \frac{T.V \times 0.014 \times 100(\text{ml}) \times 0.01 \times 100 \times 6.25}{\text{weight of sample(g)} \times \text{Aliquot used in distillation(ml)}}$$

Where, T. V= titre value

Crude fiber

The crude fiber of hydroponic maize fodder was determined by the sequential acid and alkali hydrolysis method using Fibra-plus apparatus

$$\text{Crude fiber(\%)} = \frac{W1 - W2}{W} \times 100$$

Where,

W1= weight of the sample before ashing (g)

W2= weight of the sample after ashing (g)

Ether extract and total ash

Ether extract was done using Soxhlet apparatus and principle involved was that when a known weight of feed was ignited to ash. The weight of ash thus obtained was expressed in terms of percentage.

Results and Discussion

The performance evaluation of power transmission system was conducted. The Arduino module controlled the on and off of the motor and solenoid valves. The time interval was given for 4 hours. By using foggers, the irrigation water supply for the

fodder was good. Solenoid valves were installed in each compartment because motor pump which we selected could not able to build much pressure for the fogging, so solenoid valves operated the supply of water to each compartment separately.

Chemical analysis was done on 10th day for the three seed rates 600g/tray, 750 g/tray and 900g/ tray. The highest crude protein, crude fiber, ether extract, and total ash was observed in the seed rate 900g/tray. The highest weight was also observed in 900 g/tray seed rate which was 5.15 kg. Chemical analysis of hydroponic green fodder at different sed rate shown in Table 1.

Table.1 Chemical analysis of hydroponic green fodder at different sed rate

Particulars	Seed rate (kg/tray)		
	600	750	900
Plant height	19.32	23.37	25.65
Root length	10.72	17.38	20.15
Total Weight per tray	3.51	4.38	5.15
Dry matter (%)	12.93	13.78	14.01
Crude protein (%)	13.06	14.75	14.81
Ether Extract (%)	2.90	3.01	3.30
Crude fiber (%)	12.90	12.50	13.85
Total ash (%)	2.20	2.56	2.90

Fig.1 Isometric view of Hydroponic stand

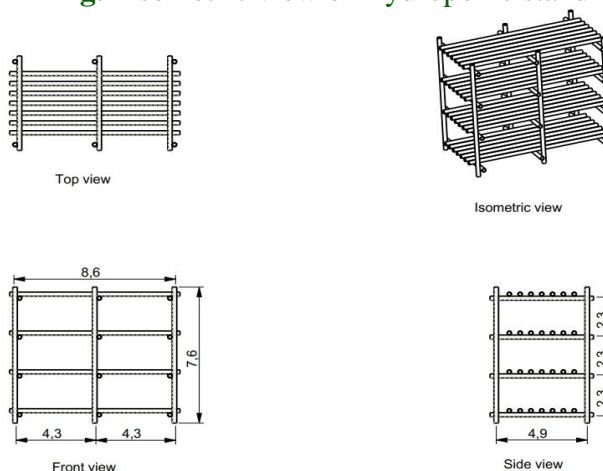


Table.2 Specifications of solar operated hydroponic green fodder production system

Sl.No.	Parameters	specifications
1	Shade net house	
	(a) Area	150 ft ²
	(b) Length x breadth x height (ft)	15 x10 x 10
	(c) Shade net	70 % UV protected
2	Bamboo framed hydroponic stand	
	(a) Area	42.14 ft ²
	(b)number of compartments and size	4 and 8.6 ft x 4.9 ft x 7 ft
3	Solar panel	80 W maximum power
4	Battery	40 Ah capacity Lead acid solar battery
5	Solar Charge Controller	Maximum panel voltage 25V
6	Arduino module	1, 5V
7	Relay switch	1, 5V
8	Motor pump	140 Psi, 7-9 L/ min 12V DC motor
9	Water tank	200 Liters capacity
10	Hydroponic trays	48
11	Foggers	32 foggers
12	Laterals	4
13	Solenoid valves	4 and 12V capacity

Fig.2 Isometric view of Shade net house

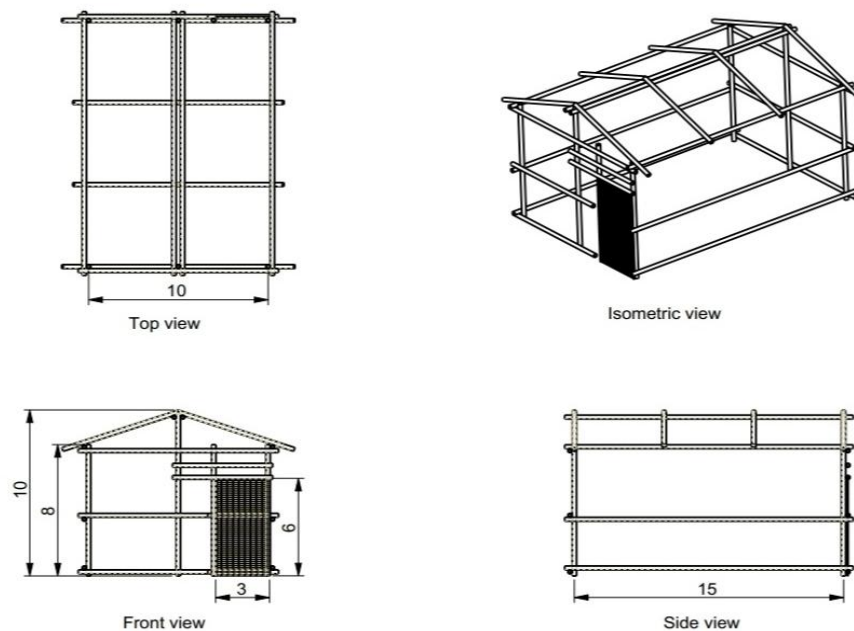
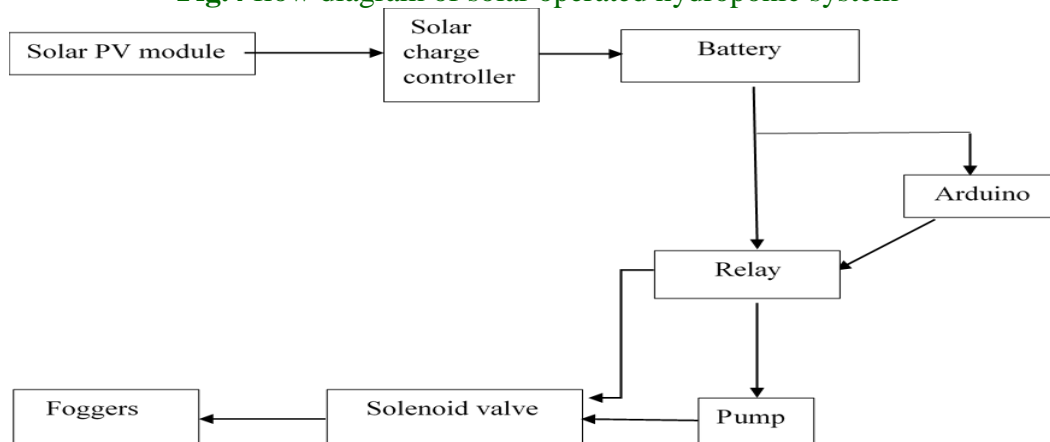


Fig.3 Shade net house and bamboo framed hydroponic stand with hydroponic trays



Fig.4 flow diagram of solar operated hydroponic system



In conclusion, solar operated hydroponic system specially designed for green fodder. small and marginal farmers easily adopt this because whole structure was designed by locally available bamboo sticks. Arduino which was used for the automation controlled whole irrigation system of hydroponics. The specifications of solar operated hydroponic green fodder production system shown in Table 2.

The highest crude protein, dry matter, ether extract, crude fiber, total ash and weight per tray was observed in 900g seed rate per tray as 14.81%, 14.01%, 3.30%, 13.85%, 2.90 and 5.15 kg/tray. This was the best combination for the given tray size.

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