

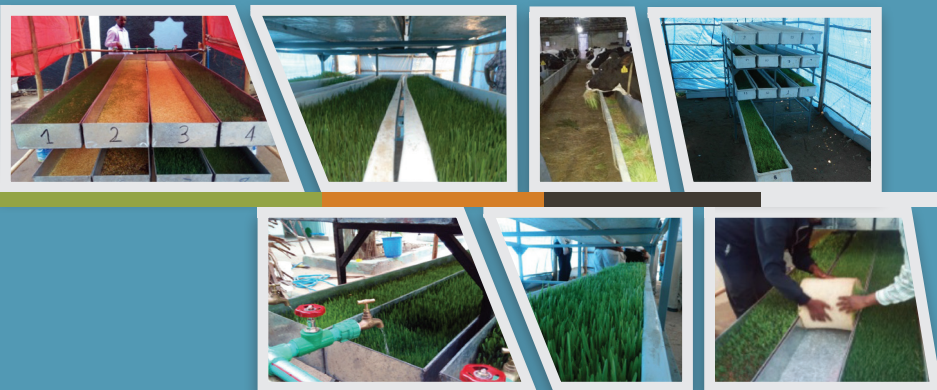


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The U.S. Government's Global Hunger & Food Security Initiative

# Hydroponic Fodder Production


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***Photos: Mercy Corps Ethiopia 2015 and 2016***

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## Hydroponic Fodder Production

PRIME (Pastoralist Areas Resilience Improvement through Market Expansion) is a five-year project led by Mercy Corps Ethiopia in partnership with international and local organizations. Funded by the United States Agency for International Development (USAID), PRIME focuses on selected districts of Ethiopia's Afar, Oromiya and Somali regions.

PRIME stands for Pastoralist Areas Resilience Improvement through Market Expansion. Funded by USAID, the project is a five-year long initiative designed to improve the lives of pastoralist communities in Ethiopia's dry lands.

PRIME reduces hunger and poverty within these communities via transformative, innovative, and scalable market-driven approaches. By amplifying prospects for long-term development, Ethiopia's pastoralist communities and systems become more resilient and food secure.

### **PRIME focuses on:**

- Improving livestock and livestock products marketing systems
- Enhancing resilience and ability to adapt to climate change
- Increasing and diversifying household assets through livelihood diversification and long-term market opportunities
- Improving the nutritional status of children and mothers

PRIME improves the lives of chronically food insecure and vulnerable populations with innovative approaches to economic development. PRIME addresses existing livelihood and market concerns, as well as the underlying systemic reasons that leave populations vulnerable in the first place. Skilled in actualizing pro-poor market development in Ethiopia, PRIME's partners are uniquely positioned to catalyze change.

*For more information please visit: [www.mercycorps.org](http://www.mercycorps.org) [www.prime-ethiopia.org](http://www.prime-ethiopia.org)*

## Hydroponic Fodder Production in Practice

Numerous hydroponic fodder production applied research attempts and business ventures have been and are being conducted currently in the world. A myriad of approaches and technical solutions with diversified scale, sophistication were developed, tested and put in routine production. The diversification of approaches towards hydroponic fodder production is dictated by the climate, local costs and availability of infrastructure. Technologies vary from ones that are extremely small scale for producing sprouted grain for backyard livestock operations (rabbits or chicken) to sophisticated, large, automated commercial systems with controlled environment.

There is general consensus that there is no significant gain in fodder dry matter increase through sprouting grain and producing hydroponic fodder when compared to the starting dry matter of the grain used. Grain usually contains around 85-87% dry matter and hydroponic fodder usually contains 80-85% water. Research results show large diversity in dry matter gain or loss, ranging from 10% loss to 15% gain over 8-10 sprouting cycle. The nutritional quality gains however are constantly noted. This especially in crude and digestible protein, the gains of which range from 2-4%. The same is valid in various extent for some vitamins and micro nutrients.

The cost benefit analysis of converting grain into sprouted hydroponic fodder from the aspect of cost per unit of dry matter produced, productivity of livestock fed have been also conducted in various socio economic, livestock production and climate circumstances.

The results are again across the board. Majority of the comparative research in developed agricultural and livestock systems show that hydroponic fodder production is less competitive than classical fodder production on per 1 kg dry matter basis produced.

Factors as labor cost, initial investments in controlled environment facilities and energy costs associated with maintaining the environment control are the ones that substantially increase the costs of this production in colder climates and in developed countries. However, in less developed regions and in regions that do not require investments in temperature and humidity control, where labor costs are lower, land and technologies for conventional fodder production are inexistent, transportation costs are high and seasonal variations of fodder prices are extreme, the cost structure is often shifted in favor of hydroponic fodder production.

Majority of research points towards the conclusion that hydroponic fodder production, taking all factors into account is best suited for producing supplement fodder for feeding extensively reared poultry, dairy cows and high value breeding animals.

There seems to be no straight forward and universal answer to the question: Why going through the trouble of producing and feeding the animals with sprouted grain instead feeding the grain directly as is?

This manual and the technologies and production methods proposed in it were selected and suggested in an effort to research the viability of supplement fodder production for various livestock species on the scale appropriate for small scale farmers engaged in both subsistence and small scale commercial livestock production in agro-pastoral and peri-urban farming situations in warm and dry climate.

The presented design is flexible and can be subject to innovative approaches in size, materials used, automation etc. Further reading resources available on the internet are suggested on page 13 of this manual.

# Hydroponic Fodder Production Rationale

Globally, hydroponic fodder production has become increasingly popular as it may be more competitive than classical agricultural production in certain contexts. While commonly viewed as high-tech or even prohibitively expensive technology it can be in fact established by producing the equipment using locally available materials and manufacturing capacities and can be competitive way of producing fodder. Some of the possible advantages of hydroponic fodder production are:

**Rational utilization of water.** When it comes to irrigation water utilization, hydroponic production is by far more efficient than any other form of agriculture devoted to fodder production. This is especially important in areas suffering from chronic water shortages or in areas where irrigation infrastructure does not exist;

**Secure production.** Open field production of fodder crops is often avoided due to security reasons. Fodder crops ready to be harvested are often victim of theft by other farmers grazing their animals on them or are simply stolen. Hydroponic production can be securely conducted in the backyard of a farmer's house. In addition, the hydroponic fodder production is conducted in a semi controlled environment making the crop safe from failure due to weather elements;

**No need for ownership or leasing of land.** In many instances small scale farmers do not poses or cannot access land that is productive enough for feasible fodder production using classical agricultural technologies. In areas dominated by pastoral livestock production, land is usually public and land rights are not clear enough to assure the farmer clear possession or right of use. Hydroponic fodder production eliminates the need for secure ownership of land for production;

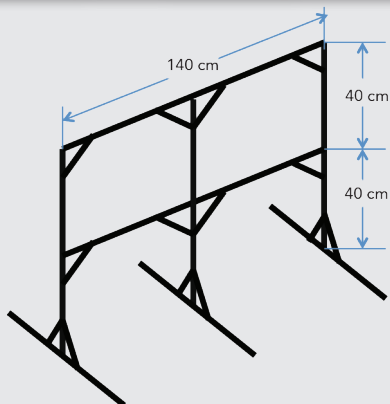
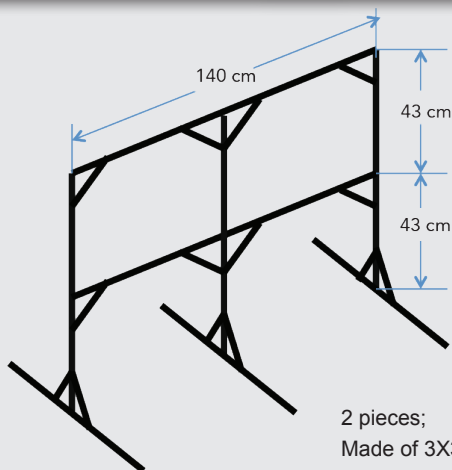
**Low fixed assets investment.** Classical agricultural production requires substantial investment in agricultural machinery, equipment and infrastructure including: machinery and equipment for land preparation, crop production, harvesting, post harvest handling and transportation, infrastructure for transportation, storage of the produce and irrigation. Hydroponic production requires substantially less investment in fixed assets and their maintenance. The equipment and the facilities needed can be manufactured locally from local materials and require minimal maintenance when compared to the machinery, equipment and facilities needed for classical fodder production;

**Low operational cost.** While classical fodder production requires constant operational expenditures (mechanization maintenance, fuel, lubricants, fertilizers, crop protection products), hydroponic fodder production utilizes only seed and water as production inputs;

**Low labor requirements.** While classical fodder production requires either qualified labor to operate machinery or high level of human labor with appropriate stamina, hydroponic production requires modest labor. All work in a hydroponic production can be performed by unskilled labor, elderly or even partially disabled individuals;

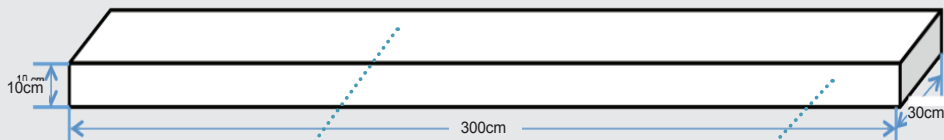
**On-demand production.** While in classical agriculture the natural vegetation cycles of the crops (annual and perennial) are long and production lasts several months, in hydroponic fodder production the production cycle is as short as 7-9 days. This makes the planning of the production very efficient since the farmer can react to the supplement fodder needs swiftly.

## Hydroponic Racks



2 pieces;  
Made of 3X3 cm welded square iron profiles;  
Painted with rust proofing paint

## Hydroponic trays

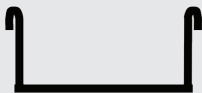


### Detail

- Tray rims need to be folded to increase structural strength.
- Trays need to be water proof

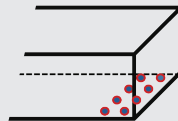
### Detail

- Bottom of the tray needs to be perforated with 2mm holes to provide for water drainage on one side of the tray. See detail below



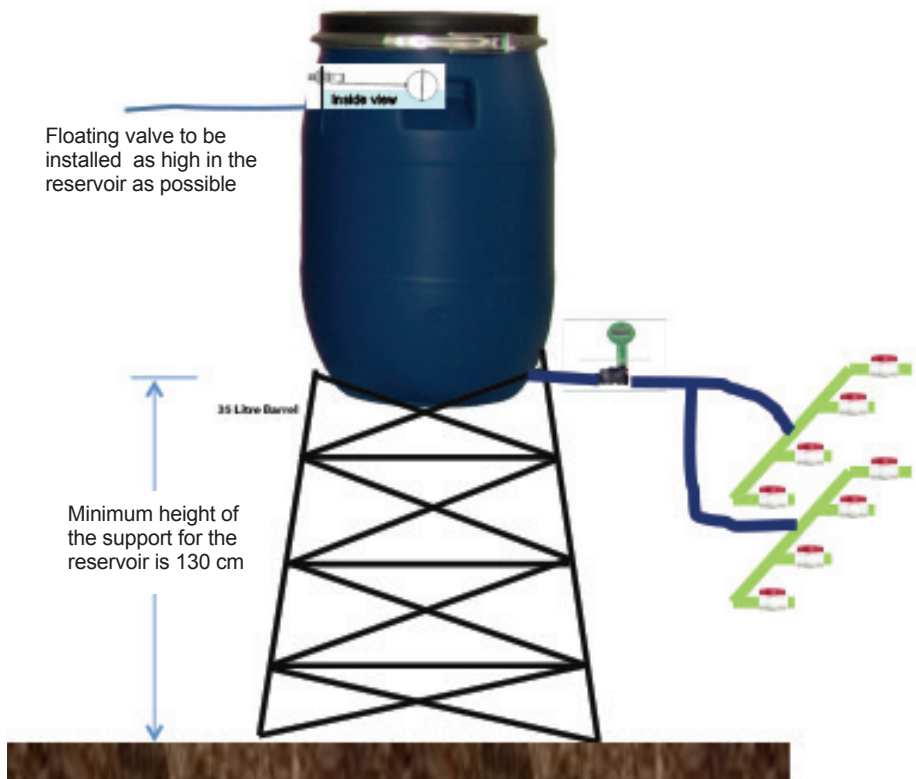
### Detail

- Folded tray rims for increased strength



- 8 pieces;
- Made of 1.5-2 mm galvanized iron sheet or 2 mm aluminum sheet or fiberglass. Wood lined with plastic for waterproofing can also be used.

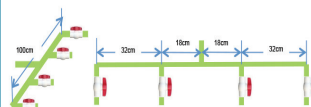
## Water Reservoir and Reservoir Support



- One piece;
- Metal or plastic barrel with minimum 200 liters volume;
- If water is available under pressure, float valve can be mounted on inlet;
- Support for the barrel can be done from wooden poles, metal poles, concrete, etc.
- If water is reliably and constantly available under pressure the entire reservoir is not needed



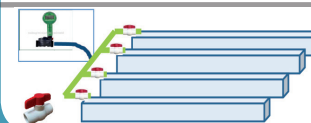
- Floating valve to be installed on the water reservoir if there is access to water mains under pressure. This is a simple floating valve used for toilet basin reservoirs.
- If there is no access to water mains under pressure, the hydroponic reservoir is to be filled manually making this valve not needed.



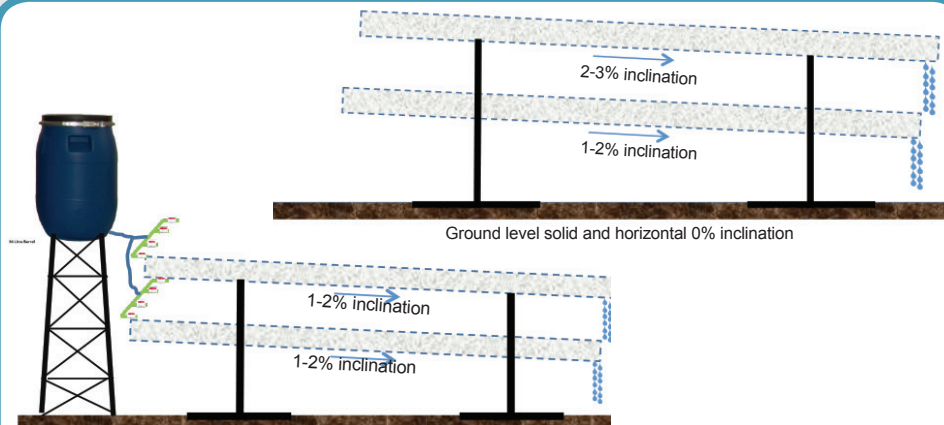
- Water distribution system can be produced using regular plastic pipes used in house plumbing.
- Each of the four outlets needs to be fitted with a simple valve for regulating the flow in each hydroponic tray.



- Battery operated solenoid valve with a timer can be purchased from suppliers of small irrigation systems. They usually cost 25-60 USD depending on sophistication and producer.
- These valves are programmable over a seven day cycle, they are battery operated and ideal for establishing a regular and precise watering regime.



- The assembly of the watering system needs to be done in accordance with the size of your system and it is individual for each installation.



#### Correct Installation

- The installation needs to be conducted on leveled ground. It is best if the ground is solid (concrete) so that the hydroponic is not off-balanced over time;
- The correct inclination of each of the racks in the hydroponic needs to be assured using a level;
- The water reservoir (if used ) needs to be in close proximity to the hydroponic installation for ease of operation.





Installation of the irrigation system, which distributes the desired amount of water to each tray.



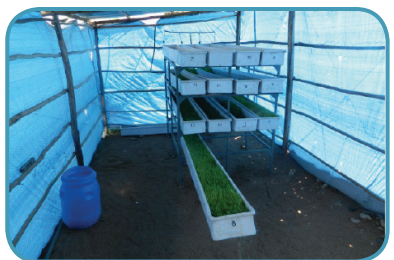
The adjustment of the water flow needs to be done manually and using trials. It is important to reduce unnecessary water run off. Adjusting the proper inclination of the trays is also important to secure steady flow and soaking of the seeds/ roots of the fodder. Fast flow of the water in the tray before the root systems develop will result in the seed be washed towards the lower end of the tray.



Occasional control of the appropriate flow of water is needed due to potential variation of water pressure which influences the water flow.



Battery operated solenoid valve can be programed, making sure that irrigation will continue regularly without the presence of an operator. These solenoid valves, usually used for lawn irrigation are inexpensive and reliable. Programing depends of individual needs and can be established by trials. It is best to have more frequent irrigation over short periods of time.



## Housing

- The hydroponic installation needs to be housed in a simple facility that will allow for a semi controlled environment for better fodder growth. The following are the basic environmental requirements for best fodder growth:
  - Ideal temperature for growth is 19-22°C;
  - The trays should never be exposed to direct sunlight, strong wind and heavy rain;
- The housing can be made of inexpensive locally available materials;
- Inexpensive and durable plastic sheeting can be applied to further prevent exposure to wind, direct sunlight and rain. It will also slightly increase the humidity inside the hydroponic facility which is desirable in low humidity environment;
- The facility floor must be solid (compacted earth, concrete, cobblestone or similar). The floor needs to allow for easy drainage of excess water coming from either the hydroponic installation or the water used for washing the trays, soaking the seeds, etc.;
- The floor needs to be kept free of any unnecessary equipment, garbage, vessels and other objects that may serve as a hiding place for rodents and harbor other contaminants such as mold;
- The approach and entrance to the facility needs to be wide enough for ease of operation in bringing inputs in and fodder out and fitted with a light door;

## General Startup

The following are the factors to consider when starting production of fodder using hydroponic technology:

- What animals (and how many) will eat the fodder?
- Where will you set the fodder system and what are the environmental conditions of that location?
- Is water and electricity available for the fodder system?
- Is the space large enough to allow easy harvest of the fodder and maintenance of the system?
- Will you be able to clean and maintain the system as required in the location where the fodder system will be placed?
- What type of seed or grain will you grow?
- Have you found a supplier for your seed/grain?
- How will you store the seed to prevent loss to rodents and pests?
- Do you have access to products and information to help prevent mold and fungus growth should these occur?

## Mold Growth and Mold Growth Prevention

Mold growth is the largest problem in hydroponic fodder production. Controlling mold growth is important if you want to produce healthy and safe fodder. Here's one way to help keep your system mold-free and produce healthy fodder:

1. Purchase bulk bleach (5%) and dilute to 1 - 1.5% concentration. Commercial bleach (varikina) usually comes at 4.5-5.0% concentration. Diluting 1 liter of 4.5-5% concentrated bleach with 4-5 liters clean water will give you the concentration needed for sanitizing the seed. Follow the safety instructions on the original bleach package when handling it. Be sure to check the original concentration of the bleach purchased in order to correctly calculate the dilution ratio. It is best to try to purchase bleach in bulk quantities since 0-8-1 liter bottles come with increased packaging cost.
2. Use the 1-1.5% bleach solution to soak the seed for disinfection, to rinse the trays after each batch of fodder produced, and to occasionally spray the fodder if you notice mold growth;
3. Hydrogen peroxide with concentration 1-2% can also be used for the same purpose and in the same way as bleach.

## Seed to be Used

For hydroponic fodder production it is best to use barley, wheat or sorghum. The seeds of these plants sprout relatively fast and faster than other possible plants such as maize or legumes. Fast sprouting and growth a very important in this intensive 7-9 days production cycle technology.

## General Growing Tips

**Water Quality:** Clean water is a very important factor. Muddy water will cause your hydroponic system to be contaminated and possibly the silt will clog the distribution pipes. If needed mount a filter that will prevent impurities and soil getting into the system. The water needs to be nearly of drinking quality. The water temperature should be from 15°C (minimum) to 25° C (maximum) and the pH Level should be between 6.2 and 6.4.

**Climate Control:** The hydroponic installation should not be exposed to direct sunlight, wind and rain. Appropriate lighting for the photosynthetic process to be conducted should be assured. Best air humidity for growth of fodder is 40% to 80% (60% optimum) and the ideal temperature is between 19°C and 22°C.

**Quality of the Seed or Grain:** Although it may cost slightly more, good quality, clean grain or seed will save time since you will not need to spend time to wash it and you will avoid any health problems the animals fed with the fodder may have from seed full of foreign objects and impurities. The seed has to have good germination. Do not use seed treated with chemicals. Try to buy seed when it is cheapest on the market which is usually after harvest. The seed should be dry enough to prevent molding and should be protected from rodents.

### Procedure

1. Soak the seed to be used for 12 - 24 hours in a 1 - 1.5% bleach solution on the day before seeding it in the trays. For one tray presented in this design with a surface of 0.9 m<sup>2</sup> you will need 4.5 to 5.5 kg of seed. Seed quality, germination rate and growing conditions will affect the amount of seed required. Adjust quantity as needed. Seed is best soaked if it is placed in a sack made of old mosquito net and submerged into a bucket containing the bleach solution over night. That will allow for easy drainage after soaking.
2. The seed that has soaked for 12 - 24 hours is spread in the tray with a maximum height of 1cm. You can allow 2 - 3 cm between the seedbed and the ends of the channel to allow room for expansion as the seeds and swell from the water and sprout into a mat.
3. After seeding the tray, return it into position on the hydroponic rack so its irrigation can start.
4. Trials show that one tray can produce 25 - 30 kg of fodder in 8 days cycle.



*Seed soaking bucket lined with net*

## Feeding livestock with hydroponic fodder

1. Hydroponic fodder should be used as feed supplement. The following are the recommended amounts of fodder that can be fed daily to a single animal depending of body weight using the rule that an animal can eat up to 1 - 1.5% of it's weight of hydroponic fodder daily:

Cattle	live weight 300 - 400 kg,	approximately 3 - 5 kg/day
Shoats	live weight 25 - 35 kg,	approximately 0.3 - 0.5 kg/day
Chicken	live weight 1 - 1.5 kg,	approximately 0.15 - 0.2 kg/day
2. Animals should not be fed this fodder in the morning. They should be given this supplement fodder ration after they return from the pasture in the evening. Animals need to get used to the fodder gradually over a 4-5 day period it's gradual increase in the daily ration.



Proper sterilization of the seed is important to prevent mold growth which is the single largest problem in hydroponic fodder production. While there are several agents and procedures to properly sterilize the seed, using commonly available 1-1.5% bleach solution to soak the seed 12-24 hours before seeding is by far the easiest and economical method.



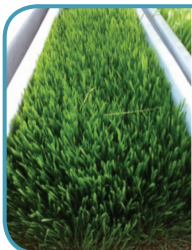
Spreading the seed in the tray using a plastic or wooden spreader with 14 cm height, which is 1 cm less then the depth of the tray. Using this device will help to evenly spread the seed across the bottom of the tray.



Four day old crop.



Orderly seeded tray. Until all trays are put in function, control the water flow frequently to assure that there is enough moisture in the trays to support growth and there is no excess flow of water that will wash the seeds towards the lower part of the tray. After all trays are put in function the monitoring of the water flow will be minimal.



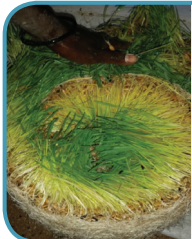
Seven to eight day old crop ready for harvest and utilization. The fodder has dark green color. The seed contains all the nutrients needed for 9-10 day growth in presence of only water and sunlight for photosynthesis. Therefore, it is not necessary to use any artificial fertilizers. If the fodder in the tray becomes pale green in color, it means that the nutrients needed for growth start becoming deficient. Harvest the tray and replant it with fresh batch of seed.



Harvesting the crop on the eight day. The fodder mat is rolled and cut using a sharp knife in manageable size cuts, commonly called "biscuits".



For appropriate sterilization of the seed make sure that the bleach that usually comes as 4.5% is properly diluted to 1-1.5% concentration before adding the seed. The seed has to be well stirred in it.



The entire fodder biscuit is edible, roots and all. It represents a good source of digestible protein and other nutrients and can be fed to all domestic animal species after a period of gradual adaptation. Fodder produced in this way usually exerts lack of calcium if fed to dairy cows, dairy goats and egg producing chicken. This calcium deficit should be supplemented with calcium rich mineral supplement or calcium rich feeds.

## FURTHER READING AND VIEWING

There is abundance of literature and video materials on Hydroponic fodder production on the internet. Use your internet browser by keying in "hydroponic fodder" to find many and diversified resources. Some are listed below.

<http://www.sheepandgoat.com/#!/hydrofodder/cgre>

<http://hydroponicskenya.com/products/fodder-systems/>

<http://lives-ethiopia.org/2014/04/29/hydroponic-fodder/comment-page-1/>

<http://www.foddersystems.com/why-fodder.html>

<http://www.grandeurafrica.com/how-to-maintain-cool-temperatures-in-your-hydroponic-fodder-structure/>

<http://oldsite.cropking.com/fodderking>

<http://www.agricultureinformation.com/postings/growing-fodder-hydroponically/>

<https://www.youtube.com/watch?v=2BYvgIJ2Fo>

<https://www.youtube.com/watch?v=vTFzil70E00>

<https://www.youtube.com/watch?v=aE4PtZW5hwA>

<https://www.youtube.com/watch?v=iDQtIjPQni8>

<https://www.youtube.com/watch?v=KE7iSqQ9HIE>

<https://www.youtube.com/watch?v=6xz7abcsGPs>

[https://www.youtube.com/watch?v=vYGFli\\_IXhl](https://www.youtube.com/watch?v=vYGFli_IXhl)



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