

# Hydroponic Lettuce

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## Introduction

Lettuce (*Lactuca sativa*) is one of the most commonly grown hydroponic vegetables. Hydroponics is a method of growing plants without soil. Plants may be grown in a nutrient solution only (liquid culture) or they may be supported by an inert medium (aggregate culture). In both systems all of the plants' nutritional needs are supplied through the irrigation water.

Hydroponics is a highly exacting and demanding system that requires a greater amount of production knowledge, experience, technical skill, and financial investment than many other greenhouse systems. A grower must be committed to meeting the daily demands of production to be successful.

While there are a number of different hydroponic systems that have been commercially successful for lettuce production, this profile will focus on the nutrient film technique and the floating raft method. Prospective growers should obtain as much information as they can about hydroponic production before entering into this type of enterprise.

## Marketing

Higher production costs require growers to identify consistent markets willing to pay a premium price. Such market niches may take some time to develop to



NUTRIENT FILM TECHNIQUE

maximize returns. Growers with superior crops and off-season or year-round availability will have a marketing edge. Potential hydroponic growers should talk to local grocers or specialty food retailers interested in locally grown crops. Restaurant chefs and caterers are other potential markets. Wholesalers, such as produce brokers selling to restaurants, may also be potential markets for hydroponically grown lettuce and greens. Several growers in Kentucky have found schools to be a growing market for hydroponically grown lettuce. In fact, because hydroponic lettuce can be grown year-round in Kentucky, schools may represent a market opportunity for Kentucky farmers.



## Market Outlook

The quantity and variety of leafy greens and herbs demanded by Americans has increased as

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consumers desire more health and diversity in their diets. Greens and herbs may be grown and marketed on a variety of scales for different markets, from farmers markets to large-scale commercial wholesale accounts. Whole-sale production of greens is dominated by western production regions. While Kentucky producers could investigate smaller-scale wholesale production, likely opportunities for hydroponic greens will come from direct marketing to consumers. Proper handling practices and other food safety considerations are crucial components for successful marketing of greens and herbs.

## **Production Considerations**

### *Facility requirements and location*

Hydroponics production requires greenhouses with the ability to provide adequate heat in winter months and either shading or chilling for water in the summer months. Well or county water is almost always used for hydroponic lettuce production as surface water may put crops at risk for diseases. Overly chlorinated city water can cause problems in lettuce production.

The facility should include a germination area for seedling production. This may be a section of the greenhouse or an environmentally controlled room with benches and artificial lighting (cool white fluorescent or high pressure sodium lamps).

### *Cultivar and plant selection*

The most common types of lettuce grown hydroponically are looseleaf, butterhead, and romaine (cos). Leafy greens, sometimes used to complement a lettuce selection, include bok choy, spinach, and Swiss chard. Whenever possible, select varieties that have been specifically developed for greenhouse production. Because of the capital-intensive nature of hydroponics, growers should only grow those crops with a high economic value and the qualities in demand for the intended market.

### *Germination*

Plants are propagated by placing seeds into a

germination medium. Seeds can be placed into a soilless mix (such as peat and perlite) in seeding or plug trays. An inert medium (such as rockwool or oasis cubes) can also be used to produce transplants. Germinating seeds are watered with overhead mist irrigation or sub-irrigated using an ebb and flow bench. In the latter system, the irrigation water plus fertilizer is periodically pumped on to the ebb and flow bench and then drained away after a specified period.

Along with irrigation and high humidity, providing a light source and temperature control helps promote the rapid production of strong, healthy transplants. Excessive temperatures often encountered in summer can reduce germination of some lettuce varieties. Seedlings are usually allowed to grow for 2 to 3 weeks prior to transplanting.

### *Production systems*

A discussion of hydroponic production systems is complicated by the number of different techniques that can be used and whether they are open or closed; continuous flow (active) or static (passive); liquid or aggregate. Production of plants in artificial soil or soilless mixes commonly used in greenhouse or nursery production, including the tobacco float system, is technically not hydroponics since the potting medium provides some nutrition.

Hydroponic lettuce is commonly produced using either the nutrient film technique (NFT) or the floating raft method, both as closed systems. A closed system is one in which the surplus nutrient solution is recovered after use and then recycled through the system. This requires monitoring and adjusting the solution so that depleted nutrients can be replenished and the solution sterilized prior to circulating through the system again. In contrast, the nutrient solution in an open system is not recovered and recycled.

## **NUTRIENT FILM TECHNIQUE (NFT)**

Plants are placed through holes along a plastic pipe (e.g. PVC pipe), tube, or closed trough

(gutter) so that only the roots extend inside. A shallow stream of nutrient solution constantly flows over the bare roots within the pipes. The pipes are placed on a slight decline, generally at bench-height. The nutrient solution is introduced to the head of the pipes where it flows by gravity to the lower end, is collected, and recirculated.



FLOATING RAFT SYSTEM

### **FLOATING RAFT SYSTEM**

Seedlings are inserted into holes in a platform or raft that is generally made of Styrofoam. Rafts may be small enough to support an individual plant or large enough for multiple plants. Roots from the plants grow into the nutrient solution as the raft floats directly on top of it. Air is pumped into the solution to provide the necessary oxygen for healthy root development.

#### *Nutrient solutions*

There are numerous nutrient solution recipes available for hydroponic systems. Nutrients can be purchased as a ready-to-mix product or growers can prepare their own solutions based on a standard or modified formula. In most systems two nutrient tanks are required: one to supply the calcium nitrate and the other for the remaining nutrients. These two solutions mix as they are injected into the irrigation line. Hydroponic nutrient solutions lack the buffering capacity of soil, so the solution pH can change during production. The pH, along with oxygen levels, soluble salts, and temperature, need to be closely monitored.

#### *Pest management*

Sanitation is the key to maintaining a disease-free

system. The most devastating disease problems occur in hydroponics when a water mold (e.g. *Pythium* or *Phytophthora*) or other water-borne pathogen is introduced into the system. Water molds have motile spores that can quickly spread to all the plants within a recirculating system. Since there are no fungicides registered for controlling these pathogens on greenhouse lettuce, this type of disease outbreak can result in complete loss of the crop. The solution tanks will have to be drained and all equipment must be cleaned with a bleach solution or other disinfectant before planting subsequent crops. If the infection originated in the germination area, those benches and systems will also have to be thoroughly disinfested. Other diseases that can occur on greenhouse lettuce include *Botrytis* gray mold, powdery mildew, and downy mildew.

Greenhouse pests of particular concern are aphids, thrips, whiteflies, and mites. Taking steps to prevent insects and mites from entering the greenhouse is the first step to controlling infestations. The use of insect screening on the sidewalls (if sidewall ventilation is used) and other entry points can help in this regard.

Plants should be inspected daily for signs of disease, insects, and mites. There are very few pesticides labeled for greenhouse production of these crops so preventative management and early detection of pest and disease problems will be crucial.

Nutrient solutions provide an ideal location for algal growth. Since algae thrive in wet, well-lit sites, shading solution tanks can inhibit their growth.

#### *Harvest and storage*

Hydroponic lettuce is generally harvested with the roots attached. Excessively long roots may be trimmed or wrapped around the lower stem prior to packing. Leaving the roots intact provides a longer post-harvest storage life; plants can stay fresh for 2 to 4 weeks under the proper storage conditions (near freezing temperatures and high

humidity). Because there is no soil involved, the plants remain clean and do not require washing. Plants can be packaged individually or in bulk, depending on the market demand.

#### *Labor requirements*

Labor needs per 3,000-square-foot greenhouse are approximately 140 hours for production and 1,500 hours for harvesting/packing/marketing.

### **Economic Considerations**

Greenhouse production requires a significant start-up cost, as well as demanding labor and management. Initial investments include greenhouse construction, production system costs and equipment. The cost of a production-ready greenhouse, excluding land costs, can run approximately \$10 per square foot. A well-run hydroponics operation can have gross returns of \$10 to \$25 per square foot of production space for the season, depending on crop quality and market.

Initial investments include greenhouse construction and equipment purchases as well as purchase of seed and other inputs. Higher marketing and packaging costs may be expected for producing hydroponic herbs and greens for premium markets.

Hydroponic lettuce production budgets from The Ohio State University were modified in 2012 to reflect Kentucky production scenarios. Breakeven costs for a 3,000-square-foot greenhouse with 8 turns (harvests) per year and 5,900 marketable heads per turn were estimated at \$0.71 per head for variable costs and \$0.18 per head for fixed costs. This equals a breakeven price above all costs, including operator labor time, of about \$0.90 per head.

Hydroponics production can vary considerably by operation and market. Because of variations in greenhouse size and construction materials, as well as packaging and marketing used, producers should develop budgets specific to their situation.

### **Selected Resources**

- Selected Resources and References for Commercial Greenhouse Operators (University of Kentucky, 2013) <http://www.uky.edu/Ag/CCD/introsheets/GHresources.pdf>
- Aquaponics – Integration of Hydroponics with Aquaculture (ATTRA, 2010) <https://attra.ncat.org/attra-pub/summaries/summary.php?pub=56>
- Controlled Environment Agriculture (Cornell University) <http://www.cornellcea.com/>
- Floating Hydroponics Greenhouse (Cornell University) [http://aesop.rutgers.edu/~horteng/floating\\_hydroponics.htm](http://aesop.rutgers.edu/~horteng/floating_hydroponics.htm)
- Hydroponic Crop Program (Ohio State University) <http://u.osu.edu/greenhouse/hydroponic-crop-program-introduction/>
- Hydroponic Systems (Kansas State University, 1997) <http://www.ksre.ksu.edu/bookstore/pubs/mf1169.pdf>
- Hydroponics (Oklahoma State University) <http://osufacts.okstate.edu/docushare/dsweb/Get/Document-6839/HLA-6442web.pdf>
- Hydroponic Vegetable Production (Texas A & M, 2005) <http://aggie-horticulture.tamu.edu/greenhouse/hydroponics/index.html>
- Market Analysis of Hydroponic Lettuce in the Nashville Region (University of Tennessee, 2002) <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.501.4939&rep=rep1&type=pdf>
- Virtual Grower 3.0 (USDA-ARS) <http://www.ars.usda.gov/Research/docs.htm?docid=22087>

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*Reviewed by Tim Coolong, Extension Specialist (Issued 2012)*  
*Photos by Tim Coolong, University of Kentucky (NFT, pg. 1) and*  
*Sheila Foran, University of Connecticut (floating raft system, pg. 3)*

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