W 1288-B

SMALL-SPACE INDOOR FOOD PRODUCTION

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Growing your own fruits and vegetables is possible even if you don't have access to soil or the outdoor space for raised beds or containers. Whether you live in a home, townhouse, or an apartment, there are options for you to grow your own food crops indoors. This publication will concentrate on herbs and vegetables that can be grown in small-scale indoor systems. It will cover location, lighting, growing systems, and crops you can grow with basic management. This is the second in a three-part Extension publication series that will provide all the information you need to get started in small-space food production.

A. Small-space outdoor food production (site, light, containers, media, and management)

B. Small-space indoor food production (site, supplemental, lighting, growing systems, and management)

C. Small-space crops and cultivars (vegetable, herb, and small fruit crops and cultivars)

Potted herbs on a sunny windowsill. Light levels may be adequate during some times of year, but supplemental lighting is likely needed in winter seasons.

SITE AND LIGHTING FOR INDOOR SMALL-SPACE FOOD GROWING

Growing food indoors requires attention to light, air movement, and practical considerations such as proximity to heat/air conditioning vents, and the risk of leaking water.

Ensuring the plants will have adequate light is the first important task. There are two broad categories of indoor sites in regards to light. First are locations with some natural light where production will be enhanced with some supplementation. Second are locations where all light needs to be provided. Lighting for these sites is often called sole source.

Sunrooms, windowsills, or areas near a large window that receive several hours of sunlight per day would provide at least part of the natural light needed. Keep in mind there is a difference in the length of day as well as the angle of the sun during the fall through spring months that will reduce indoor light levels. Herbs and leafy vegetable crops require at least 4-6 hours of direct sunlight per day. Ideal light levels for these indoor food crops will be higher than light needs for most houseplants and light needs for fruiting crops are even higher. The reduced light during the winter can limit the growth or prevent vegetables or herbs from reaching maturity to harvest, whereas a foliage houseplant with low light would just grow slowly. There may be indoor locations that might support leafy or herb crops during some parts of the year.

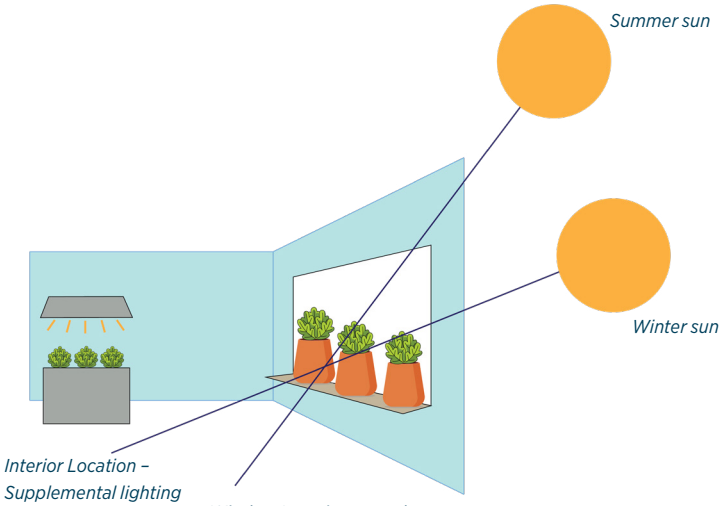

Figure 1. *The location in the room as well as the time of year impact how much light indoor plants receive. Some crops may be able to grow with summer light through the window, but most indoor crops will need supplemental lighting to thrive and produce well in both the summer and the winter.*

Single bulb supplemental lighting fixture with reflector. This is an LED bulb that can fit into fixtures commonly used for fluorescent lights.

However, supplemental lighting is very likely to be needed to enable good growth and production of leafy crops in the darker months, and good fruiting crop production would likely need supplemental light all year long.

Knowing how much supplemental lighting is needed for good crop growth is one of the biggest challenges in indoor food production. Two key pieces of information are needed. First, the light needs of the crop (A), and second, the light available in the site (B). The difference between these two values is how much light will need to be added (C = A - B). Once you know how much light needs to be added, then calculations of lighting type, size, duration, and distance can be developed. For indoor sites near windows, both winter and summer calculations will be needed. In many ways, growing leafy crops and herbs in indoor sites without any natural light may be simpler because the lighting can be more consistent.

Table 1 below provides general guidelines for sole source lighting of common food crops (value A). Small handheld meters measuring footcandles are relatively inexpensive and commonly used for measuring lighting for photography. Light measures more specific to plant growth will be more accurate but more expensive. Refer to *Both and Torres* listed in the References section for additional information about measuring light and converting between different light measures.

Many types of lighting may be used indoors. Traditional greenhouse lighting fixtures, such as metal halide or high-pressure sodium may be used, but they are expensive, bulky and add quite a bit of heat. These elements make them a challenge indoors. So, the focus here will be on fluorescent and light emitting diodes (LED) because the fixtures are smaller, lighter, and easier to add to an indoor growing site.

Sole source lighting for small containers of herbs on a kitchen table. This type of system allows for consistent growth and the use of standard containers and greenhouse growing mix.

Kitchen-scale hydroponic system with supplemental lighting for herbs.

The best lights to use for supplementation will be fluorescent or LED lights that have a thin profile to allow as much light in as possible for crops growing on a table, windowsill, or other horizontal surface. Some indoor hydroponic systems also will enable these types of supplemental lights to be installed vertically to provide even lighting to plants in a tower or other vertical growing system (Figure 2).

Table 1. Examples of lighting needs for sole source indoor locations for common vegetables and herbs

Crop*	Footcandles of light needed if provided for 16 hours per day**	Footcandles of light needed if provided for 20 hours**
Baby leafy crops/ transplants	1,000	750
Bibb (small head) lettuce	1,400	1,100
Basil	1,400	1,100
Strawberries	2,000	1,650
Compact tomatoes	2,400	1,900

*Crop need estimates from *Both and Torres* articles cited below.

** Footcandle is a value of light measurement common in photography that is tailored to the human eye and not plant needs. However, footcandle meters can be inexpensive to purchase. So, while less scientific, this measurement is more easily accessible to home growers. (calculations using Apogee source).

In addition to light, keep in mind a few other important site factors for indoor food production. Be sure that the location is not too close or receiving direct air flow from a heat/air conditioning vent. Plastic shields on vents can be used if needed to redirect air flow. Also consider locations where the potential for water leakage isn't too much of a concern. Trays can be used under small containers and drip pans similar to those used under washing machines could be used for small scale hydroponic systems to reduce water leak risks.

INDOOR GROWING SYSTEMS

Containers. Producing food indoors can occur in a range of growing systems. One of the simplest places to begin would be containers for herbs or leafy green crops. Small to medium sized containers could be used to grow a range of herbs and leafy vegetable crops on a windowsill, a table, or other flat surfaces. Refer to UT Extension Publication W 1288-A Small-Space Outdoor Food Production for a broader discussion of selecting containers and growing mixes for small-scale food crops in containers. Indoor containers can be a great way to take advantage of light available indoors through the seasons as they can be moved to intercept light.

Small Nutrient Film Technique (NFT) hydroponic system in an indoor growing area with supplemental lighting.

Another advantage of using containers indoors is that the environment is more consistent than a porch or patio, so care can be more consistent. Supplemental or sole source lighting can be installed over containers containing herbs, leafy vegetables or even compact fruiting vegetables like compact tomatoes or strawberries.

Commercially manufactured hydroponic/aeroponic systems. There are many options for indoor food production using commercially designed and manufactured hydroponic systems. A more detailed overview of hydroponic growing systems can be found in UT Extension publication W844-A which covers indoor and small greenhouse systems. In the home or office, these systems can range from modern and fun tabletop systems with integrated lighting (Image 4) to scaled down versions of systems used in hydroponic greenhouses (Image 5) where plant roots sit in or are bathed in hydroponic nutrient solution. Larger systems, such as towers are often termed aeroponic because water is pumped upward to passively drip down over roots (Figure 2). Some of the advantages of these systems are their aesthetics and functionality. However, the downside can be an increased cost.

DIY hydroponic systems. If cost is an issue, or do-it-yourself is preferred, there are many hydroponic growing systems that can be designed and constructed. These range from simple mason jar systems that can grow single plants to small deep-water systems that contain a reservoir of nutrient solution that plant roots can access. Small systems can be constructed using plastic containers that can be quite cost effective.

A small DIY hydroponic system that enables small tomato plants to be secured by holes in the lid and their roots to access the nutrient solution in the plastic container.

MANAGING FOOD CROPS IN INDOOR GROWING SYSTEMS

If herbs or vegetables are grown in containers, watering should be done when the upper portion of the growing mix is dry but not the entire container. Adapt watering to the crop because some herbs may prefer to be grown drier while leafy greens would prefer a consistent moisture supply for rapid growth. As a rule, watering should be done until water drains out of the bottom of the container, so having a pan or tray under the containers will be important. Bottom watering can also be used, but don't let the bottom of the container sit in water continually as that will waterlog the lower media. Frequency of watering will depend upon the location, season, crop, and plant size. The best way to monitor moisture content in the substrate is manually. Simply use your hand or finger to determine how moist the substrate is and how deep that moisture can be found.

Applying controlled release fertilizers or soluble fertilizers once or twice a month can provide the needed nutrients for container herbs and vegetables. Be sure to follow the directions provided with the product and select fruiting/bloom formulas or leafy/grow formulas depending on the crop. You will also want to visually monitor crops through time to ensure that leaf color, growth rate, and plant habit do not indicate an excess or deficiency of key nutrients.

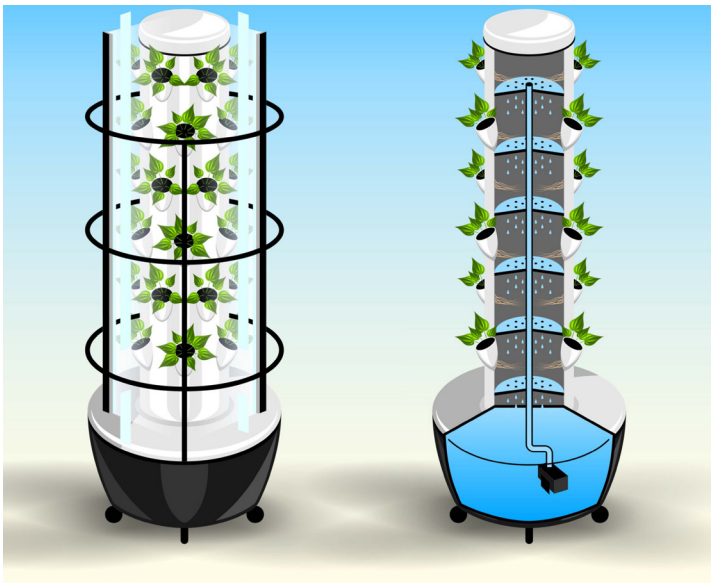

Figure 2. *An aeroponic growing tower system. The image on the right shows the design of the system and delivery of the nutrient solution while the image on the left shows a tower with an accompanying rack to support supplemental lighting.*

Watering and fertilizing will be done together for indoor hydroponic growing systems. Often at this small scale, purchasing a pre-mixed liquid or easily soluble fertilizer will be the simplest method. It is crucial to use fertilizers designed for hydroponic growing because the ratios of nutrients will differ versus those used in soil or growing mixes. Also, hydroponic fertilizers will be formulated to dissolve completely in water. See W-844B and W 844C for more detailed discussions of managing leafy and vine crops in small hydroponic systems.

A small windowsill container of microgreens is a simple way to begin indoor food production.

SELECTING CROPS FOR INDOOR SITES AND SYSTEMS

Once you have assessed the light levels for your indoor location and narrowed down potential growing systems, it will be easier to select crops and cultivars. Make sure that your crop, site, and growing system are a good fit. This will prevent poor plant growth, challenging management, or other frustrations down the line. Starting with cost effective and simple containers may be a great way to begin before moving on to more expensive and complex growing systems. Keep in mind that leafy crops and herbs are simpler and faster to grow than fruiting crops and require lower levels of lighting. Microgreens (see more details in UT Extension publication W346-J) or baby greens would be some of the quickest crops to grow with the lowest light requirements. With some experience in leafy greens, new crops or more complex systems could be added to the indoor growing area.

ONLINE RESOURCES

UT Extension Publication W 1288-A Small-Space Outdoor Food Production: **tiny.utk.edu/W1288A**

UT Extension Publication W 1288-C Crops and Cultivars for Small-Space Food Production: **tiny.utk.edu/W1288C**

An Introduction to Indoor Hydroponic Systems with Amy Dunlap video: **https://youtu.be/s5YLJJh-3kM**

ADDITIONAL INFORMATION AND REFERENCES CITED:

For an overview of small-scale hydrosystems – UT Extension Small Space Food **https://www.youtube.com/watch?v=s5YLJJh-3kM**

Apogee Instruments. Conversion – PPFD to Foot-candles.
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Both AJ, Mattson N, and Lopez R. 2018. Utilizing supplemental and sole-source lighting in urban-crop production environments. Produce Grower **https://www.producegrower.com/article/utilizing-supplemental-and-sole-source-lighting-in-urban-crop-production-environments/**

Trinklein, DH. 2016. Lighting indoor houseplants. Missouri Extension **https://extension.missouri.edu/publications/g6515**

Torres A, and Lopez RG. 2010. Commercial greenhouse production: Measuring daily light integral. **https://www.extension.purdue.edu/extmedia/ho/ho-238-w.pdf**

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