



Cornell University  
Cooperative Extension  
Rockland County

10 Patriot Hills Drive  
Stony Point, NY 10980  
Phone: (845) 429 - 7085  
Fax: (845) 429 - 8667  
www.rocklandcce.org

# Green Roofs

## Benefits and Functions of a Green Roof

Interest in “green roof” or “eco-roof” planting has increased as people continue to search for ways to minimize our impact on the environment. Green roofs trap airborne pollutants and help to manage stormwater by catching and storing water for possible re-use, filtering out sediment and pollutants, and slowing runoff. These roofs create alternative habitats for some plants and animals that are displaced when land is cleared for building.

In addition to the environmental benefits above, green roofs have long-term economic advantages, though initial costs and maintenance are higher than those of conventional roofing. A typical green roof may cost at least two and one half times more than a conventional roof, but is expected to last twice or possibly three times as long, therefore construction costs can be recovered over time. The vegetation on the roof insulates the building below, conserving energy and reducing the costs of heating and air conditioning. In some European cities, where roofs have been widely planted for decades, the combined area of many vegetated roofs has moderated the “heat island effect” warming of the urban climate.

Plantings in visible areas of a green roof may be designed to add beauty to spaces that are often unsightly. Many plants suitable for a green roof are colorful ornamentals that may help to reduce stress and increase the well-being of building occupants. Green roofs also help to filter out unwanted noise. Where space is limited, an accessible green roof adds to the usable area of a building; land cleared for recreational amenities may be reduced.

## Engineering Considerations

It is easier to design a new building to accommodate the specifications of planted roofs, though retrofitting an existing structure is possible. Before either is attempted, **a structural engineer must assess the load-bearing capacity of the building** to certify that the structure will be able to handle the weight of the roofing materials, plus rain, snow, equipment, human activity, and other applicable loads. Wind resistance must also be taken into consideration. Each roof must be customized to local conditions. The engineer will make recommendations for structural adjustments if necessary.

A successful green roof requires the collaboration of many professionals; the engineer, architect, builder, and plant grower must work in concert with each other and local officials responsible for building codes. Due to cost considerations and the complexity of design and installation, most green roofs in the United States are installed on commercial or municipal buildings and condominiums or large residential apartment complexes. Increased availability of lower cost, modular systems may eventually make installations on smaller residential structures feasible. Sheds and other small, temporary structures with less complicated engineering concerns than larger buildings have potential as green roof sites for enthusiastic gardeners.

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## **Extensive vs. Intensive**

Extensive green roofs rely on a thin, mostly inorganic substrate as a medium for plant growth. The growing medium is usually only a few inches deep and supports limited types of very tough (though potentially ornamental) plants. The relatively light weight materials (as compared to an intensive green roof, below) allow the use of plantings in a variety of situations. Flat roofs are the most appropriate sites for roof greening, but a gently sloped structure may be designed to accommodate greenery.

Intensively planted green roofs are classic “roof gardens”, similar to a conventional ground level gardens, except for the elevation. The soil medium that supports the plants is often more than a foot deep, but is generally not less than six inches in depth. The cost of construction, weight of the materials, plus regular maintenance of the plants limits the application of these gardens to large apartment complexes, commercial and municipal sites.

## **Waterproofing**

It is imperative that the surface of the roof be **completely watertight**. Various types of polymer or rubber, applied as a membrane over the roof decking are employed. Since even a small leak may result in premature aging of the roof and costly repairs, the membrane must be protected by material that prevents damage from plant roots, maintenance or other activity.

## **Roof Components and Construction**

Planted roofs are built in layers. Besides the waterproof membrane and protection layer, there must be a drainage layer for water overflow, a filter (or separation) layer to prevent silting and clogging of the drainage layer and loss of planting medium. The planting matrix and plants form the top layers of the roof. The planting medium of an extensive roof contains very little organic matter. This reduces silting and shrinkage, but requires plant material that can tolerate very low fertility. Most green roofs include an insulation layer above the waterproof membrane or below the roof deck.

A wide range of materials are used in green roof construction, from natural stone, expanded shale or clay to highly engineered, synthesized plastic modular units. Roofing components made from recycled materials are available. The precise components used will depend on individual building specifications.

Irrigation is necessary for plant establishment in most situations. Some green roof plants will require additional irrigation in drought conditions, especially those at the top of a pitched roof.

## **Planting the Roof**

### **Plant Selection:**

The plants on a green roof must be able to withstand exposure to strong winds, sunlight, extremes of heat and cold, alternating periods of wet and dry soil, and drought. Succulent plants, especially some sedum species; grasses and certain bulbs have proven hardy. Plants that evolved in alpine environments have great potential. Many species that are used widely in Europe are likely to be suitable in our climate, but must be tested in local conditions. Plants native to New York and the Northeast U.S. would be appropriate if they can survive the difficult conditions of the rooftop.

### **Plant Establishment:**

Spring planting is preferable. This takes advantage of cool temperatures and generally abundant rainfall conducive to rapid establishment, though additional irrigation may be necessary during dry spells. Well-rooted plants from plugs or small containers are the best bet for cost effective establishment of growth that covers the roof and holds the substrate together. Full establishment may take 12 to 18 months.

Seed is not recommended in most cases, because it may wash out in a heavy rain and the time necessary for establishment may be lengthy. Cuttings of plants that are quick-rooting may be used on roofs that are very stable and have adequate irrigation, as long as they have time to root in before extreme hot or cold weather. Established mats of vegetation are produced by some growers, especially for large projects; these may be bulky and difficult to work with, must be ordered in advance and are expensive.

## Maintenance

During establishment, special attention should be given to irrigation and weeding. Though drought tolerant, most plants will benefit from supplemental irrigation until they are established. Weeds will be minimal on an extensive green roof that is dry and contains little organic matter; those that do establish, especially woody plants, have the potential to damage the waterproof membrane. Other weeds, especially annuals, may out-compete the desired vegetation at some point during the season, then die back, leaving gaps in the cover. Inspect and remove weeds at regular intervals during establishment. Once the plants are established, weeding may not be needed more than once or twice during a season. At these times, the drainage system should also be inspected, and any problems remedied.

Since one goal of a green roof installation is to lower the environmental impact of building, fertilizer applications should be kept to a minimum. Many succulents and other tough plants will grow adequately without fertilizer inputs, especially once they are established; nutrient cycling from decaying plant parts should be sufficient. If fertilizer is necessary to enhance growth, only slow-release materials should be used. This will minimize the impact of nutrient-rich runoff from the roof.

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Prepared by: Amy Albam, Horticulture Lab Technician.

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