

# Resource use efficiency in protected cultivation: towards the greenhouse with zero emissions

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## Abstract

Protected cultivations are expanding all over the world, particularly in otherwise marginal agricultural land. However, protected cultivation involves the intensive use of resources such as soil, water, fertilizers, pesticides and energy. As a consequence, such intensive production systems are perceived by many as artificial and highly pollutant processes. Protected cultivation, and more particularly greenhouse production, has to be—and to be seen—more respectful of the environment. The greenhouse of the future will have nearly zero environmental impact. This goal can be achieved by developing a sustainable greenhouse system that: does not need any fossil energy and minimizes carbon footprint of equipment; with no waste of water nor emission of fertilizers and full recycling of the substrate; with minimal need of plant protective chemicals, yet with high productivity and resource use efficiency. An environmental and economical study of the current situation is a tool to identify the most critical elements of the production process, in various climatic and market conditions, so that suitable technologies may be developed to address the locally relevant bottlenecks. The greenhouse of the future can fulfil the need for safe use of resources (energy, water, pesticides) through modification of greenhouse design and management. Coatings and additives can be used to improve the performance of greenhouse covers in terms of light transmission vs. thermal insulation. More efficient greenhouse ventilation is expected to have a positive effect on the cutback of inputs as well. The greenhouse can benefit from the reduction of waste through better management of irrigation and climate. Moreover, an increase in crop productivity can be achieved through early warning of biotic/abiotic stress produced by pest or disease infection, or suboptimal environment. This article will discuss the current expectations and limitations on resource use efficiency in protected cultivation.