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FEATURES

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# Four Technologies Driving Efficiency in Lettuce Production

*Janeen Wright*

The role of efficiency has shifted in recent years for greenhouse lettuce operations. As cost pressures have become more pronounced and the market more competitive, reducing operating expenses has moved to the forefront of operational priorities.

In practical terms, this involves reducing cost per head and using labor, space and energy more effectively. It also means adopting systems that support predictable production outcomes by reducing variability and minimizing waste wherever possible.

ETFE glazing has extremely high light transmission and is highly durable in harsh environmental conditions. Photo credit: Boal Systems

As operations scale, even small inefficiencies can have a significant impact when multiplied across thousands of plants. A slight inconsistency in climate, spacing or handling can quickly translate into lost yield or increased costs.

Growers are placing greater emphasis on systems that deliver repeatable, reliable results across every production cycle for this reason. While no single solution is the magic pill for success, several key innovations clearly stand out as foundational to high-performing greenhouse lettuce operations.

**Mobile Gutter Systems (MGS) maximize production space**

One of the most visible changes in modern lettuce greenhouses is the adoption of automated mobile gutter systems (MGS) to increase yield per acre and reduce production costs.

These closed-loop setups use specialized gutters to autonomously transport plants through various cultivation stages.

At the new Salad Days greenhouse in Mississippi, mobile gutter systems increase growing capacity without expanding the footprint. Photo credit: Jeff Warschauer/FGM USA

Initially, gutters are kept tightly spaced during early development when plants are small. Spacing then widens as plants mature and require more room to grow.

MGS maximize production space per square foot by increasing early-stage plant density. This eliminates unused gaps during early growth stages, allowing growers to produce more plants within the same footprint.

By facilitating the automation of plant movement, MGS reduce how many times humans must handle the plants. This lowers labor costs and reduces the risk of damage, inconsistency, or contamination caused by frequent human contact.

The production consistency that MGS provide is hard to beat, with even spacing and predictable movement that ensures each plant experiences similar growing conditions. This leads to better crop uniformity and more reliable harvest timing.

It also supports scalability. As operations expand, maintaining uniformity across larger growing areas becomes more challenging. MGS provide standardized spacing and plant movement that can be easily replicated. This level of control is especially valuable for growers supplying retail and foodservice markets, where consistency in size, quality and timing is critical.

**Glazing advancements support a more stable growing environment**

Light is one of the most important inputs for lettuce production, driving both photosynthesis (plants' ability to convert light into energy) and photomorphogenesis (plants' ability to use light signals to control growth and development, such as leaf shape, stem length and color).

Advances in greenhouse coverings have focused on improving energy efficiency, light diffusion and durability to help growers make the most of this free resource. Modern glazing systems are designed to enhance light transmission and diffusion to spread light more evenly across the crop canopy. This prevents uneven plant growth and leads to a more uniform crop.

As the greenhouse lettuce market has grown more competitive, reducing operating costs has become a top priority for growers.

They also help improve temperature control, reducing the need for excessive heating or cooling and contributing to a more stable growing environment and enhanced energy efficiency.

Some key innovations in materials over the years include, but are not limited to:

- **Multi-wall polycarbonate**: Multiple layers improve insulation while maintaining strong light transmission.
- **Light-diffusing materials:** Coatings or additives that help spread light more evenly.

- **Heat-reducing coatings:** Reflect excess solar radiation to prevent overheating.
- **Photo-selective covers:** Materials infused with additives or pigments that alter the light spectrum (i.e., Red to Far-Red ratio) to support healthier plant growth.
- **Biodegradable films:** Offer more sustainable alternatives to reduce reliance on traditional petroleum-based plastics.

Emerging technologies are also pushing the boundaries of greenhouse design. Wavelength-selective glazing is under development and can convert less useful light into photosynthetically active radiation (PAR). Researchers are also testing photovoltaic systems that can generate electricity without significantly reducing the light available to crops.

ETFE roofing systems are one example of how material innovation can also improve durability and reduce risk. Unlike traditional glass, which can shatter when it breaks and rain down on crops, ETFE is highly impact-resistant and does not break into sharp fragments. It is easier to maintain and particularly well-suited for regions prone to extreme weather events or for operations that rely on in-house maintenance.

**Advanced climate conditioning reduces energy costs**

Maintaining tight environmental control helps ensure crops reach their full potential, while also reducing the likelihood of disease or stress-related issues that can disrupt production.

New technologies such as absorption chillers, heat pumps and high-efficiency fans make it easier than ever before to find a climate solution that addresses specific crop needs or adapts to various growing locations.

An example of such a solution centers on the climate corridor concept, which allows growers to draw air from the interior or exterior of the greenhouse using air handlers and crossflow heat exchangers. This gives growers the flexibility to choose the optimal conditioning source (interior air, exterior air or a blend of both) to meet their needs, thereby reducing energy consumption.

**Absorption cooling turns waste heat into an energy efficiency advantage**

Growers often use their natural gas boilers for $CO_2$ supplementation in the spring or summer by redirecting a portion of the flue gas into the greenhouse for distribution. Due to reduced heat demand in the summertime, absorption chillers can make use of the waste heat generated by the boilers to turn the hot water into cold water.

Excess cold water not used for current cooling demand can be stored in a water-buffer tank for later use. While the OPEX (operating expenses) savings gleaned from absorption cooling depend on your location and its utility rates, it can offer benefits when:

- The climate is too hot and humid for traditional evaporative cooling
- The proposed cooling system has a dehumidification and active cooling phase
- The chiller plant doesn’t operate during peak hours (4 hours per day)

Including absorption chilling in a chiller plant eliminates the need to install a $CO_2$ system or incur costs for liquid $CO_2$ supplementation.

Water-cooled chillers prove significantly more efficient than air-cooled chillers. Growers benefit from lower

operating costs and greater efficiency, not to mention energy savings.

**Efficiency will define the future of greenhouse lettuce production**

In today's growing environment, success is increasingly defined not by how much technology is used, but by how effectively it performs.

The innovations outlined here are helping growers improve efficiency, increase consistency and better control production costs. As these systems continue to evolve, their role in supporting reliable, scalable greenhouse lettuce operations will only become more important. **IG**

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*Janeen Wright is Senior Communications Specialist for Prospiant, a greenhouse manufacturing, design and build company serving growers in the U.S. and Canada. She holds a Bachelor's degree in horticulture and is a former editor for* Greenhouse Grower *magazine. To learn more about greenhouse solutions for produce growing, visit Prospiant.com.*