meeting the environmental challenge of growing food crops

MORE PREDICTABLE PRODUCTION LEVELS AND HARVEST DATES ARE DRIVING GROWERS TO ADOPT CONTROLLED ENVIRONMENT AGRICULTURE.

by david kwack

Photos courtesy of Mike Dixon, University of Guelph

Even though most greenhouse vegetable growers are producing fewer types of crops than ornamental plant growers, trying to control the environment of these food crops can be a much bigger challenge.

"The environmental control challenges for vegetables are much tougher because the produce is going to be consumed," said University of Guelph professor Mike Dixon, who is director of the Controlled Environment Systems Research Facility in Guelph, Ontario, Canada. "The fact that they are destined to be a food commodity requires more attention to things like pest control.

"For vegetable production, since the margins are typically small for food crops, growers are trying to tightly control inputs as much as they can without compromising the quality and productivity of the commodity. This is a significant challenge and requires a great amount of detail to environmental control than for typical ornamental crops. Ornamental commodities, since they are not eaten, are not subject to the same kinds of stringent controls, especially with pesticide residues. But it's more than that. The food safety regulations for food crop inputs and production outputs (e.g. nutrient runoff) are much tighter than they are for ornamental commodities. That means that environment control is a key factor in maintaining production standards and quality standards in a competitive market."

meeting market expectations

Dixon said part of the issue with trying to maintain the proper environment for vegetable production is consumer expectations for "perfect" fruits and vegetables.

"Consumers have been conditioned by generations of what today are considered environmentally unacceptable cultural management practices, using chemicals and pest management protocols, that occasionally leave residues," he said. "Consumers don't want peppers with spots on them. Consumers don't want roses with blemishes on the flower petals. In the minds of consumers, they expect virtual perfection and don't appreciate that the means to achieve this are not necessarily environmentally correct today.

"There is a transition between the old ways of doing things and the new ways of doing things. In terms of controlled environment agriculture, growers are transitioning to production practices that don't compromise quality and productivity and yet meet environmental standards as well. That can be a tough balance."

Dixon said that growing food crops in the northern latitudes year-round requires some type of controlled environment production.

"In Canada, six months out of the year food crops can't be produced unless they're grown in a controlled environment," he said. "This requires that the growing has to be done in a nearly subtropical environment in which many disease pathogens and insects thrive. These pests gravitate toward these ideal controlled environment conditions. It's the growers' challenge to maintain some kind of balance and still meet the quality and production requirements of the market."

minimizing costs maximizing production

Dixon said the degree of sophistication that is achievable with today's technology should really be taken advantage of by growers especially in regards to minimizing labor.

"Labor is the top line in the cost of production in a controlled environment commodity," he said. "Automation, including computer controlled environments and automated irrigation can mitigate the labor bill. Energy is a close second in regards to major costs."

Dixon said the winter environment in the northern areas of the United States and in Canada is a major challenge for controlled environment growers.

"Winter production in these areas requires a

bringing space technology back to earth

One of the major elements of Mike Dixon's research program at the University of Guelph's Controlled Environment Systems Research Facility is the development of technologies for food production (i.e. life support) in the context of long term human space exploration missions. Dixon said the technologies being transferred from his program to the greenhouse sector are those that were developed for these missions.

"These technologies are being adapted to terrestrial agri-food sector applications in as economical a way as possible," Dixon said. "Some of the technologies being developed include LED systems, environment control protocols, recycling systems, environment sensors and imaging systems for diagnostics. Terrestrial agriculture is benefiting greatly from research activities taking on the challenge of growing food on the Moon and Mars."

Mike Dixon, director of the Controlled Environment Systems Research Facility at the University of Guelph in Guelph, Ontario.

higher level of technical sophistication than is needed for operations located further south," he said. "The farther south an operation is located the issue then becomes heat extremes. In the middle latitudes, which include a large portion of the United States, environment control challenges are not as extreme as they are in Canada, Mexico and South America.

"In more moderate climates, growers tend to be slower in adopting more sophisticated technology because the cost benefit is harder to justify. Labor costs will be the major factor that will drive the conversion to automation for a lot of middle latitude growers. Up until recently they haven't

been required. What has changed is that the capital cost requirements for a lot of technology enhancements or retrofits in older greenhouses have become very attractive. For example, the cost of LED lighting is not only energy conservative, but it can also enhance productivity with the appropriate technology and application information."

more predictable profitable production

Dixon said since the margins on food crops are relatively small compared to many ornamental crops, growers need to have relatively large greenhouse operations in order to be profitable.

"We're talking on the order of 50-200 acres of controlled environment greenhouses," he said. "To consider manually managing that scope of a greenhouse production system is prohibitive. It's not realistic, growers couldn't do it. It's absolutely required that that they engage some form of automation, controlling especially irrigation, lighting and conventional environment control including opening vents, etc. The largest controlled environment food production area in North America is in the Leamington area in southwest Ontario. This area is typified by very large, highly sophisticated controlled environment agriculture systems for the production of tomatoes, peppers and cucumbers."

Dixon said automating irrigation to reduce labor costs and automating basic temperature and humidity control in the greenhouse will significantly enhance the production system.

"It comes down to the cost benefits analysis," he said. "Each grower has to look at it on the basis of their own specific case. It depends on the commodity. It depends on the local market and the margins growers can obtain with a more homogenous quality that they realize with automation. Automation offers more predictable production levels and predictable harvest dates. These are the kinds of issues that drive the adaptation to controlled environment computer automation and even robotic systems.

"Adding more sophistication gives more reliability in some cases as well as predictability in terms of production and quality. And that can only enhance a grower's attractiveness to the market."

Dixon said automating irrigation to reduce labor costs and automating basic temperature and humidity control in the greenhouse has been shown to significantly enhance the production system of a grower's greenhouse.

"That's really the goal," he said. "Look at the capital cost requirement to obtain that level of technical sophistication and amortize over a reasonable three- to five-year period. Then look realistically at the labor savings, energy savings and the environmental impact savings including waste and runoff that would be realized by doing it. If it makes economic sense then there's the answer.

"Sometimes it's difficult to line up all of the things that need to be considered in a cost-benefit analysis. Depending on the size of an operation, if it's a small-scale operation, it may not make economic sense to incorporate this automation because the cost-benefit is probably going to take 10 years to realize. But as the scale of the operation goes up, generally the justification for automating the system and reducing labor costs is greater."

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