GREENHOUSE PRODUCTION

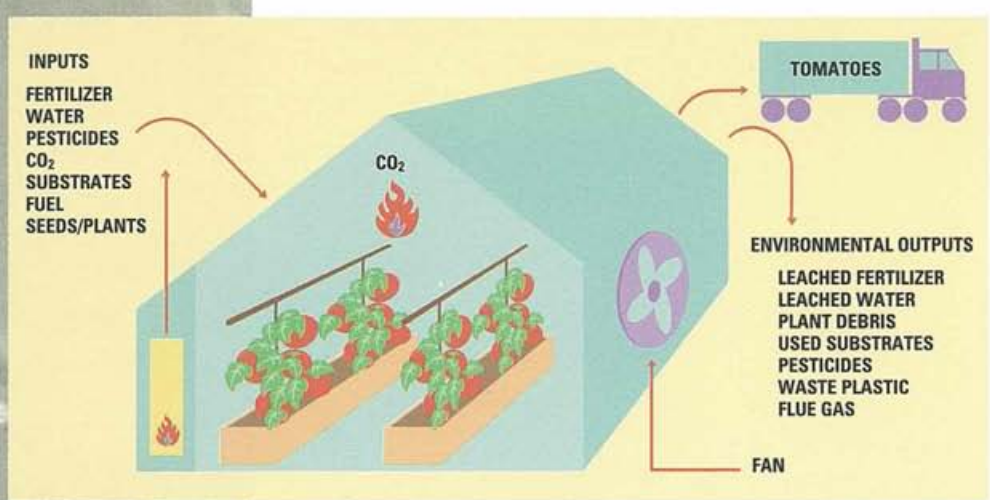
Greenhouses provide an enclosed growing environment that can be controlled, year round. This allows intensive culture with annual yields many times higher than field production. However, greenhouses also create a large amount of waste products that may have an environmental impact.

The Greenhouse Environmental Audit

Wastes from a greenhouse will vary with different crops, growing technologies and greenhouse structures. Using tomatoes grown in non-recirculating rockwool as an example, the table (below) shows the estimated output from a one-hectare, plastic greenhouse.

ESTIMATED OUTPUT PER HECTARE – TOMATOES IN ROCKWOOL

Tomatoes (40 kg/m²/yr)	400 tonnes/yr
Leached fertilizer salts	7.5 tonnes/yr
Leached irrigation water	4,000 m³/yr
Used rockwool (every 1.5 yrs)	114 m³/ha
Plant debris	40-60 tonnes/yr
Plastic greenhouse covering (every 3 yrs)	4 tonnes/ha



Sample greenhouse environmental audit-tomatoes in rockwool.

Major Environmental Concerns

- ▸Management of water and fertilizer run-off.
- ▸Waste management.
- ▸Reduction of pesticide use.

WATER AND FERTILIZER MANAGEMENT

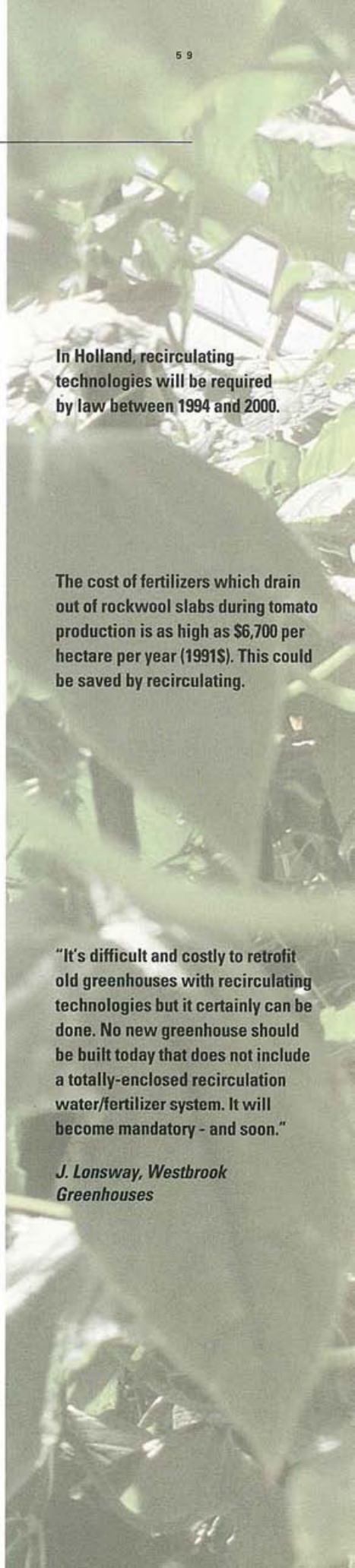
There is potential for groundwater contamination from greenhouse fertilizers, pesticides, wash-down waters, and roof shading/cleaning. We are not certain of the environmental impact of these discharges but we can reduce the amount of water and fertilizer lost to the subsoil. This involves technology to collect, adjust, and re-use fertilized irrigation waters.

Minimize leaching - water and fertilizer applied in excess of plant needs can be collected and held by:

- ▸Concrete floor "catch basin".
- ▸Sub-irrigation systems - e.g. flooded floors, ebb and flow benches, trough benches.
- ▸Drainage collection - e.g. plastic sheet or troughs for rockwool slabs, Lecadan® pots, bagged substrates.
- ▸Growing system containment - e.g. nutrient film technique (NFT) plastic troughs, deep flow systems, floating raft systems.

Adjustment and recirculation - once collected, the solution is recirculated immediately or held for later recirculation. In both cases, the solution may have to be re-conditioned in various ways for re-use. Recirculation is resource efficient, reduces water and fertilizer costs, and is more environmentally friendly.

Solution disposal - sometimes, some or all of the nutrient solution must be disposed of. This may be due to salt imbalances, end of a crop cycle, disease infection, or contamination. As this is a nutrient-enriched solution, there is the potential for pollution if released. Preferred disposal is to sewage systems, holding/settling ponds or as irrigation water to adjacent field crops. Least preferred is discharge into tile drains or surface water.



In Holland, recirculating technologies will be required by law between 1994 and 2000.

The cost of fertilizers which drain out of rockwool slabs during tomato production is as high as $6,700 per hectare per year (1991$). This could be saved by recirculating.

"It's difficult and costly to retrofit old greenhouses with recirculating technologies but it certainly can be done. No new greenhouse should be built today that does not include a totally-enclosed recirculation water/fertilizer system. It will become mandatory - and soon."

J. Lonsway, Westbrook Greenhouses

Plant debris is a large part of the waste produced by greenhouses. Composting or spreading the crop material on adjacent crop land are two good options for disposal.

Almost half of Ontario's greenhouse area is plastic. When these greenhouses are re-covered, 620 tonnes of plastic results as waste.

Half of Ontario's greenhouse vegetable production uses rockwool. Every time rockwool slabs are replaced, 83 transport truckloads of used rockwool must be disposed of.

WASTE DISPOSAL

Greenhouses produce large amounts of waste. Wherever possible, reduce, reuse and recycle. Three items that produce a lot of waste are: plant debris, soilless growing substrates and plastics.

Plant debris - to prevent diseases, all plant debris should be removed from greenhouses as soon as possible. The best management practice is to compost the material, although certain items, such as crop support strings or plant tags, will need to be managed separately. In certain cases, debris can be fed to livestock or applied to adjacent crop land as green manure.

Soilless growing substrates - substrates are either organic or inorganic. In vegetable production, they are typically thrown out after one to three years. In flower crops, the stock plants are replaced after 3-6 months because of disease concerns or because they are breaking down.

- ►Peat from peat bag culture (tomatoes, cucumbers) can be amended and composted and used by landscape firms. Peat is organic, environmentally friendly and eagerly taken by people for landscaping/gardening purposes.
- ►Inorganic substrates (e.g. rockwool) do not decompose and must be dumped in landfill sites. Recycling of rockwool is not yet available in North America. Some growers are shredding rockwool and spreading it on agricultural land.
- ►Inorganic expanded clay such as Lecadan® does not break down and, with sterilization, can be re-used. Use is still developmental.
- ►Commercial technologies that do not use growing substrates are available (NFT, Deep Flow Systems). These technologies may become important in the future.

Plastics - plastic film from poly greenhouses, plastic ground covers and substrate bags are major sources of waste. The technology exists to recycle plastic film but is not available in Canada. Options are landfill sites or stock piling for future recycling. Where possible, use glass instead of plastic when building new greenhouses. Other plastics, such as pots and trays, are generally made from re-ground materials and can be recycled. However, plastic recycling companies want the plastic to be dry and clean. This can be difficult to achieve.

PESTICIDE REDUCTION

►Know what pests you have in the greenhouse. Monitor them with careful crop inspection and by using aids such as yellow sticky traps for flying insects.

Physical Controls

►Screen over vent openings (be aware of reduced ventilation).

►Place large quantities of yellow or blue sticky tape or cards, depending on the insect, above the crop.

►Control pest-carrying weeds next to the greenhouse.

►Prevent infested plants from coming into the greenhouse.

►Attract insects to ultraviolet light traps.

►Consider new technologies, such as a "bug vacuum".

Sanitation is an important part of pest management. Take advantage of breaks in cropping to thoroughly clean the greenhouse.

Cultural Controls

Sanitation - remove plant debris. Sanitize people, tools and machines. Clean walks and surfaces. If you have had major disease problems and have a break between crops, consider complete sterilization of the greenhouse at that time. Soil or re-used substrates should be steam-pasteurized or fumigated.

Prevention - avoid introducing infested plants.

Environmental Manipulation - manage temperature and ventilation to prevent condensation on plant surfaces. Control nutrient solution temperatures and root zone aeration to prevent certain root-borne diseases.

Timing of Planting - if your cropping schedule permits, allow sufficient time between crop removal and replanting to reduce chances of pest carryover. This is usually a minimum of one week; the longer, the better.

Plant Health and Vigour - minimize plant stress (through adequate spacing, good nutrition, etc). A fast growing healthy plant is less susceptible to pests.

Seed Treatments - hot water, chemical and fungicide seed treatments can prevent a number of diseases. Treatments can be done by either the seed supplier or the grower.

Cross Contamination - minimize or eliminate other plants, including weeds, from the growing area. They can be a serious source of pests and diseases that otherwise would not be present.

- ►Use resistant varieties where possible to avoid diseases.
- ►All major greenhouse insect pests have biological control agents commercially available. In vegetable crops, biological control is a viable option. In ornamentals, biological control will become increasingly important as experience is gained. At this time, however, it is generally not appropriate on a large scale.
- ►When chemical control is required, use chemicals that will control the pest without affecting its natural enemies. Consult your Pest Management Advisor for chemicals compatible with biological control agents. Spot spraying might be useful. Certain pesticides are less toxic and more environmentally-friendly than others (for example, insecticidal soaps and microbial agents). Certain application equipment may be more efficient, resulting in less run-off and pesticide use. Foggers and ultra-low volume (ULV) applicators, for example, use less than traditional high-volume sprayers. There are concerns, however, that ULV applicators deposit pesticides on surfaces other than just the plants such as greenhouse walls. This may result in contaminated run-off when water condenses on the surfaces.

Whitefly is a major greenhouse pest. Fortunately an effective biological control agent is available.

BIOLOGICAL CONTROL AGENTS FOR GREENHOUSE INSECTS

PEST	BIOLOGICAL CONTROL AGENT
WHITEFLY	Encarsia formosa
SPIDER MITE	Phytoseiulus persimilis
WESTERN FLOWER THRIPS	Amblyseius cucumeris Orius insidiosus
APHIDS	Aphidius matricariae Aphidoletes aphidimyza
FUNGUS GNAT	Hypoaspis miles Steinernema carpocapse
LEAFMINER	Dacnusa sibirica Diglyphus isaea

Growth Regulators

Growth regulators are used for height control of several greenhouse floral species. Pesticide concerns also apply to growth regulators. A new method of height control called "DIF" manages plant height by controlling the difference between day and night temperatures (i.e. cooler day temperatures). Most floral species respond to DIF. The number and rates of growth regulator application can be reduced when DIF is used. However, DIF will only work during the cold months of the year. Plant quality is superior when a combination of growth retardants and DIF is used.

Most floral species such as these lilies respond to the use of DIF.