INTRODUCTION

Potentially high-value crops such as fruits, vegetables, tobacco, sod and nursery stock must be of top quality to win acceptance in the marketplace. Attaining quality requires timely management decisions – especially regarding crop production inputs.

Water, in the form of precipitation or irrigation, is one of the most critical crop inputs. Water must be supplied in sufficient quantity, of desired quality, when the crop needs it. But natural rainfall can be unpredictable. By controlling your crop's water supply, you are controlling an essential production variable. The importance of irrigation may increase in the coming years as a result of increased climate variability and fluctuation.

Beyond good soil management, irrigation is the best strategy available to meet your crop's water requirements when natural rainfall is inadequate. This book will help you plan and implement best management practices to fulfill water needs profitably, safely and in an environmentally responsible way.

Irrigation does not suit every operation. Its benefits must outweigh its costs. Consider the criteria on the next page before purchasing, modifying or simply assessing your irrigation system requirements.

Potatoes, whether for the table or processing, need irrigation to obtain high quality and yields.

A successful celery crop depends on irrigation.

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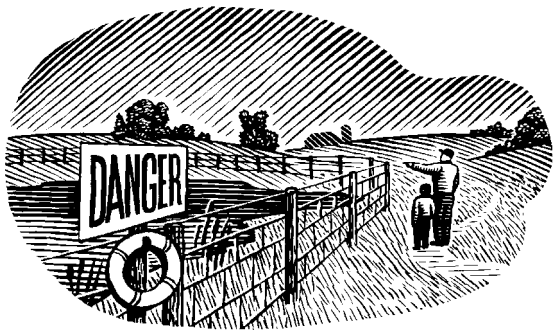
IF YOU'RE CONSIDERING AN IRRIGATION SYSTEM

GENERAL CRITERIA	DETAILS
WATER QUALITY	• irrigation water should be free of contamination from pesticides (herbicides), heavy metals, organic solids, salts, nematode and other parasitic organisms • water should be of desirable temperature and pH
WATER QUANTITY	• sufficient volumes must be available on demand within reasonable distance • design should accommodate peak crop needs (for frost protection, design should be able to accommodate several consecutive nights' use) • strategy should be in place to recharge limited volumes of water
REGULATIONS & LEGAL CONSIDERATIONS	• these must be complied with before drawing water to irrigate • *Ontario Water Resources Act* requires a Permit To Take Water from a surface or ground water source, or a combination of both, if the amount exceeds 50,000 litres (10,000 Imp gal) per day
CAPITAL	• capital investment and operating costs can vary dramatically depending on system type, power sources, usage pattern, crop, field location and maintenance
LABOUR & MANAGEMENT	• irrigation systems demand differing degrees of input
ENVIRONMENTAL IMPACT	• irrigating should not jeopardize the water cycle of a fragile ecosystem, nor interfere with quantity or quality of flowing water for downstream users
SAFETY	• an irrigation pond poses a potential hazard, especially in areas where there is easy access • fencing should be provided, with Warning signs posted in high risk situations • certain irrigation systems may carry an inherently high risk while in use, because of high operating pressure or potentially dangerous electrical energy

Each system demands differing degrees of labour input.

With these considerations in mind, let's look at the reasons for choosing irrigation.



Where possible, irrigation ponds should be fenced and signed.

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BENEFITS OF IRRIGATION

ESTABLISHMENT

- recently transplanted or seeded crops require water for root establishment /germination, especially tree fruits and nuts, berry crops, grapes, nursery stock and field vegetables

GROWTH AND VIGOUR

- plants require water for all phases of growth, including cell division, cell elongation, photosynthesis and transpiration during the growing season – it is the process of transpiration that provides a cooling effect to the crop as it grows

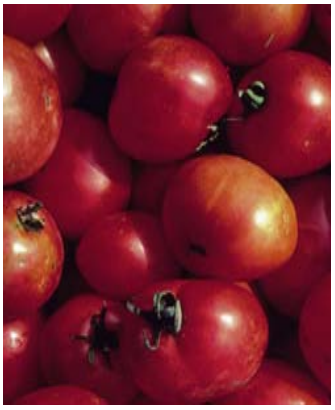
FLOWER-SETTING AND FRUIT DEVELOPMENT

- adequate water supply enhances fruit and flower bud formation (feathering in young trees), flowering, fruit set and fruit sizing

QUALITY

- the flavour, appearance and post-harvest attributes of certain fruits and vegetables can be improved with water-efficient irrigation in situations where rainfall or available soil water is limited. In some situations, some fruit and vegetable crops may not respond positively to irrigation water in terms of flavour or sugar development. (This may be cultivar- and soil type-specific.)

All crops require an adequate moisture supply for growth and development. Vegetative growth and early development are accelerated by irrigating and protecting this hazelnut or filbert planting.



Most high-value crops require properly timed and adequate moisture supplies. Irrigating fresh-market tomatoes enhances size, volume and texture of produce in a dry year.

Reliable and healthy transplant stock is what the landscape industry requires. Irrigation can help.

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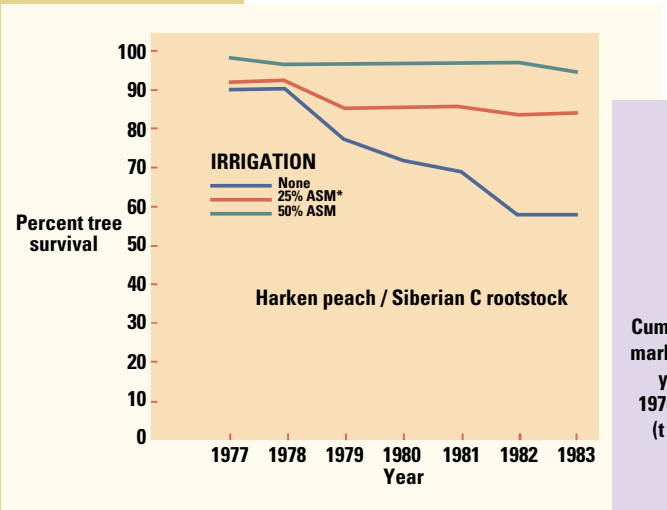
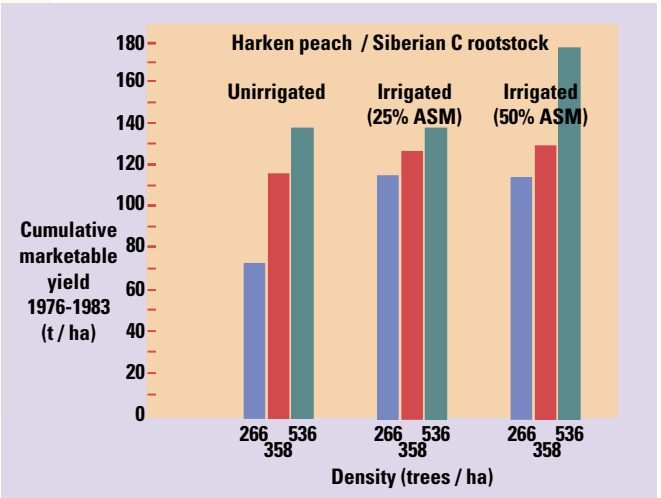


*ASM = Available Soil Moisture



Irrigation helps a young peach orchard become established. Young trees need ample water for root development, shoot growth and fruit bud initiation. Overall, marketable yield is increased.

SPECIAL APPLICATIONS

- ▸ evaporative cooling to ensure quality fruit and continued crop development under conditions of excessive heat, e.g., strawberry, nursery stock
- ▸ frost protection of high-value crops, e.g., vegetables and tobacco, fruit, asparagus and berries
- ▸ wind erosion protection of soil and crops in extreme conditions, e.g., vegetables and tobacco
- ▸ seedbed activation of direct-seeded vegetable crops, e.g., rutabaga, carrot
- ▸ chemigation and fertigation: crop protection materials and necessary nutrient treatments can be applied at a lower cost to the producer. Fertilizer treatments can be applied with precision, e.g., tree fruits, nursery stock, berry crops, vegetables.

Fertigation involves supplying water and nutrients at the same time. Compared to untreated checks, yield increases of up to 20% have been measured with the fertigation of high-value crops such as green peppers.

Irrigation can help you avoid losses of high-value crops. For example, frost damage on strawberries can be prevented with sprinkler irrigation during the bloom period. The blossom shown here is not freezing. As irrigation water is applied, it turns to clear ice, releasing a small amount of heat that prevents the blossom from freezing.

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PROTECTING WATER RESOURCES

Irrigation depends on reliable supplies of fresh, clean water from surface and/or ground water sources. You must be aware of potential impacts that your irrigation system has on the quantity and quality of ground and surface water.

SUMMARY OF ENVIRONMENTAL CONCERNS

CONCERN		ASK YOURSELF
QUALITY		• **is quality of irrigation water not used by the crop and returned to the hydrologic (water) cycle good enough for downstream users, and for reuse?** • **will water from deep ground water sources, which can contain impurities, have harmful surface water impacts?** • **is source water of reliable quality for intended use?**
QUANTITY	Sources	• **are you putting aquatic systems at risk?** ◦ large rivers and lakes within reach (< 2 km) can supply large amounts of water, while small watercourses and wetlands have limited supplies ◦ construction of dams, ponds and stream pumps to facilitate water-taking can disturb watercourses, and ultimately disrupt the aquatic ecosystem ◦ in some situations, a minimum suction screen size will prevent destruction of small fish ◦ ground water supplies may not be sustainable ◦ cumulative effect of several water-taking projects on a single ground or surface water source should be evaluated ◦ excessive taking from ground water may result in contaminants travelling from upper ground water to deeper aquifers ◦ stands of deeply rooted woody perennials such as apple orchards or natural woodlots can suffer from drastic changes in water table depth ◦ large ground water-takings can lower levels in wetlands, small streams, and in nearby wells
	Measuring Quantity	• **are you measuring and recording water quantity used according to conditions of your Permit To Take Water?** ◦ water used must be accurately recorded
	Equipment	• **are you maintaining and using equipment properly?** ◦ pressure gauges become unreliable if used for purposes other than irrigation, e.g., spreading liquid manure • **are you using the best available technology to conserve water?**
	Timing	• **can you time water-taking to ensure adequate flow remains?** ◦ time water applications for desired crop response ◦ take no more than 10% of flow from surface water sources, e.g., rivers, creeks, streams ◦ take surplus water only when impact on aquatic ecosystems and hydrology is minimal

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A large river like this one can be a suitable source of water. Wetlands and smaller watercourses are not as well suited to irrigation.

Taking large amounts of water from ground water can lower levels in wetlands, small streams and nearby wells.

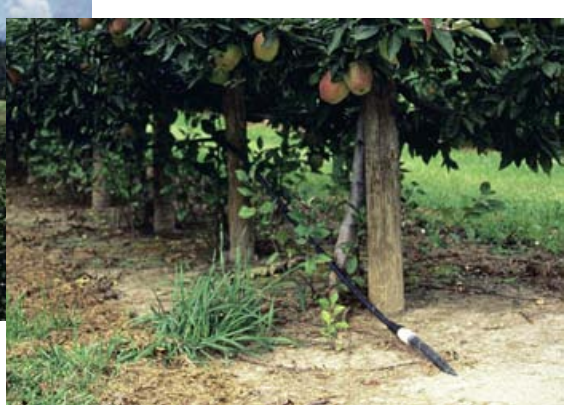
DESIGN, MATERIALS AND MANAGEMENT

The main components of an irrigation system are design, materials and ongoing management.

Design must take into account your crop's needs and response along with the environmental concerns listed in the previous chart. Materials include power source, pumps, conduit pipes, emission points and monitoring devices. Ongoing management includes monitoring, record-keeping, scheduling and application.

Irrigation technology is improving, responding to growers' demands for more efficient systems. Newer systems meet crop needs with more efficient distribution of water. Gentler application methods help maintain soil structure, and also help to avoid surface compaction problems.

Irrigation can help growers service niche markets with more predictable volumes of high-quality produce.



Trickle irrigation systems can deliver water to where the crop needs it, efficiently and economically, as shown here with high-density apples on M9 rootstock.

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INDUSTRY STANDARDS FOR MEASUREMENT

Throughout this book, there's a mix of metric and Imperial measurements. Although convention calls for metric, irrigation presents a special case.

Most of the technology used – pumps, gauges, pipes and nozzles – is developed in the United States. Most measurements are in Imperial units, with the exception of flow rates (US gallons per minute – US gpm).

In this book, in many cases Imperial units will be presented first, followed by metric in brackets, e.g., 4-inch (100-mm) pipe. For water volumes and flow rates, we'll use acre inches and US gpm, with no metric conversions – to conform with industry standards.

For help with a variety of conversion factors, please see the inside front cover of this book.