

A COST-BENEFIT ANALYSIS OF CLIMATE-SMART IRRIGATION FOR PRINCE EDWARD ISLAND POTATO

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BACKGROUND

- Prince Edward Island contributes 20.4% of Canada's total potato production
- In 2024, the potato industry had an economic impact of Can \$1.35 B on the island
- In a humid environment such as PEI, potato production is largely rainfed.
- Seasonal droughts can have a devastating impact on yields and are expected to increase with climate change.
 - Drought in 2020 caused a 12.8% decrease in average provincial yield from 2019.
 - Currently occur once or twice a decade.
- Climate-smart supplemental irrigation (SI) applies the exact amount of water a crop needs.
 - Though system investment and operation can be costly
- Large-scale, long-term studies to determine the cost-benefit of SI are difficult to conduct.
- Process based crop models can simulate yields and other variables over many years and situations that would be difficult to test in-field.

OBJECTIVES

- Investigate the potential total yield gain from applying climate-smart supplemental irrigation
- Determine the payback period for four irrigation systems

METHODS

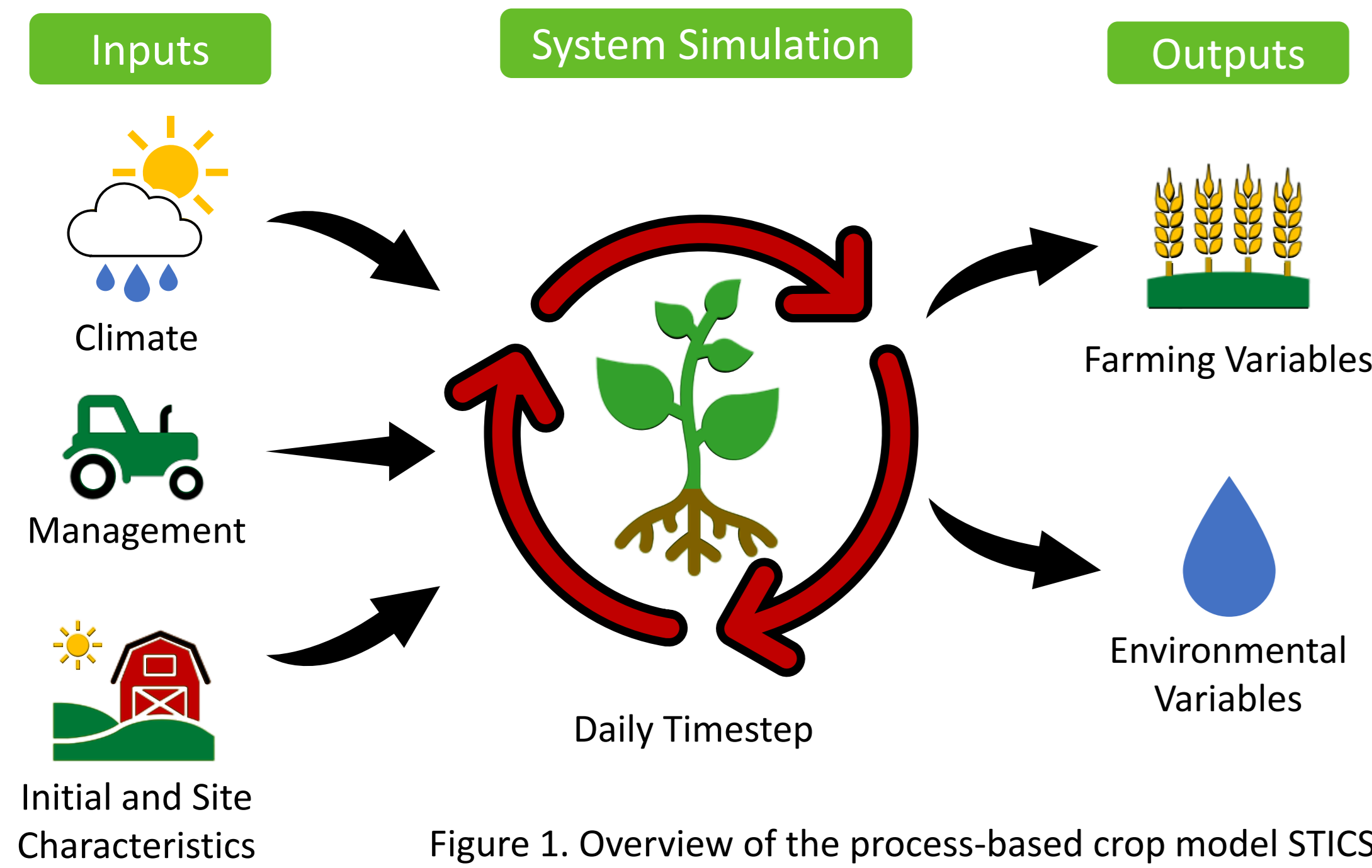


Figure 1. Overview of the process-based crop model STICS

Russet Burbank yields were simulated using the STICS crop model (figure 1) for twelve scenarios (figure 2) from 2001 – 2024 approximating the lifespan of an irrigation system. Simulations were completed with water stress effects and again without water stress effects to represent the application of SI, where the yield gain is the difference between the results of these simulations. The payback period was then calculated for four irrigation types (table 1).

Table 1. Coverages and costs for four irrigation systems. Values are from 2018 and adjusted for inflation for 2024. Operation costs are based on an application of 152mm and were adjusted for the exact water requirements.

	Pivot I	Pivot II	Hose Reel and Sprinkler	Hose Reel and Boom Cart
Field Coverage	38.5 ha.	2 x 20 ha.	2 x 20 ha.	2 x 20 ha.
Water Supply	Dedicated	Shared	Separate	Separate
Capital Cost (Can\$)	301 186	25 300	412 040	422 480
Operation Costs (Can\$ / ha)	331	71	710	269

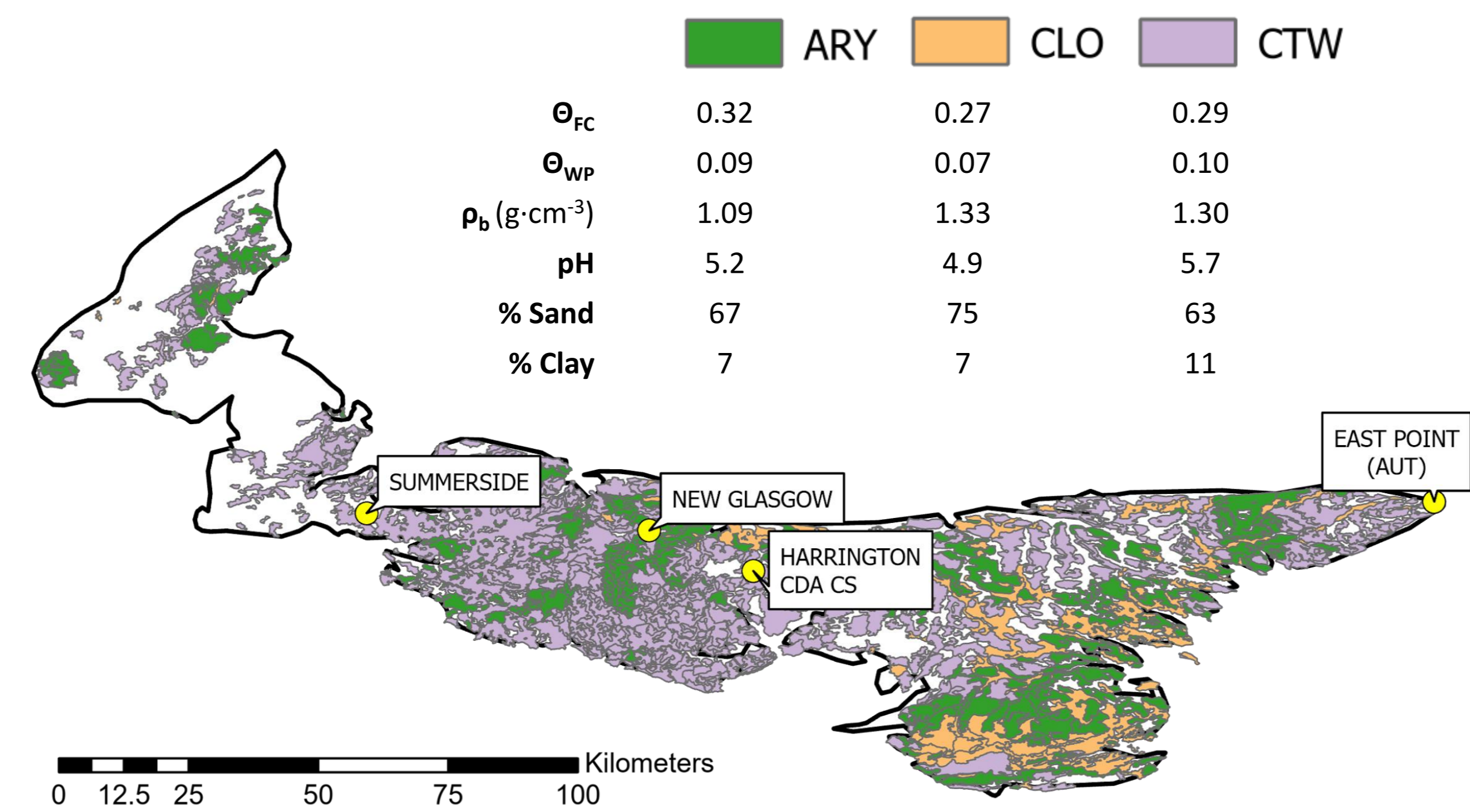


Figure 2. Four weather stations and three major soil types chosen for the study. Each of the three soils are an acidic, fine sandy loam.

RESULTS

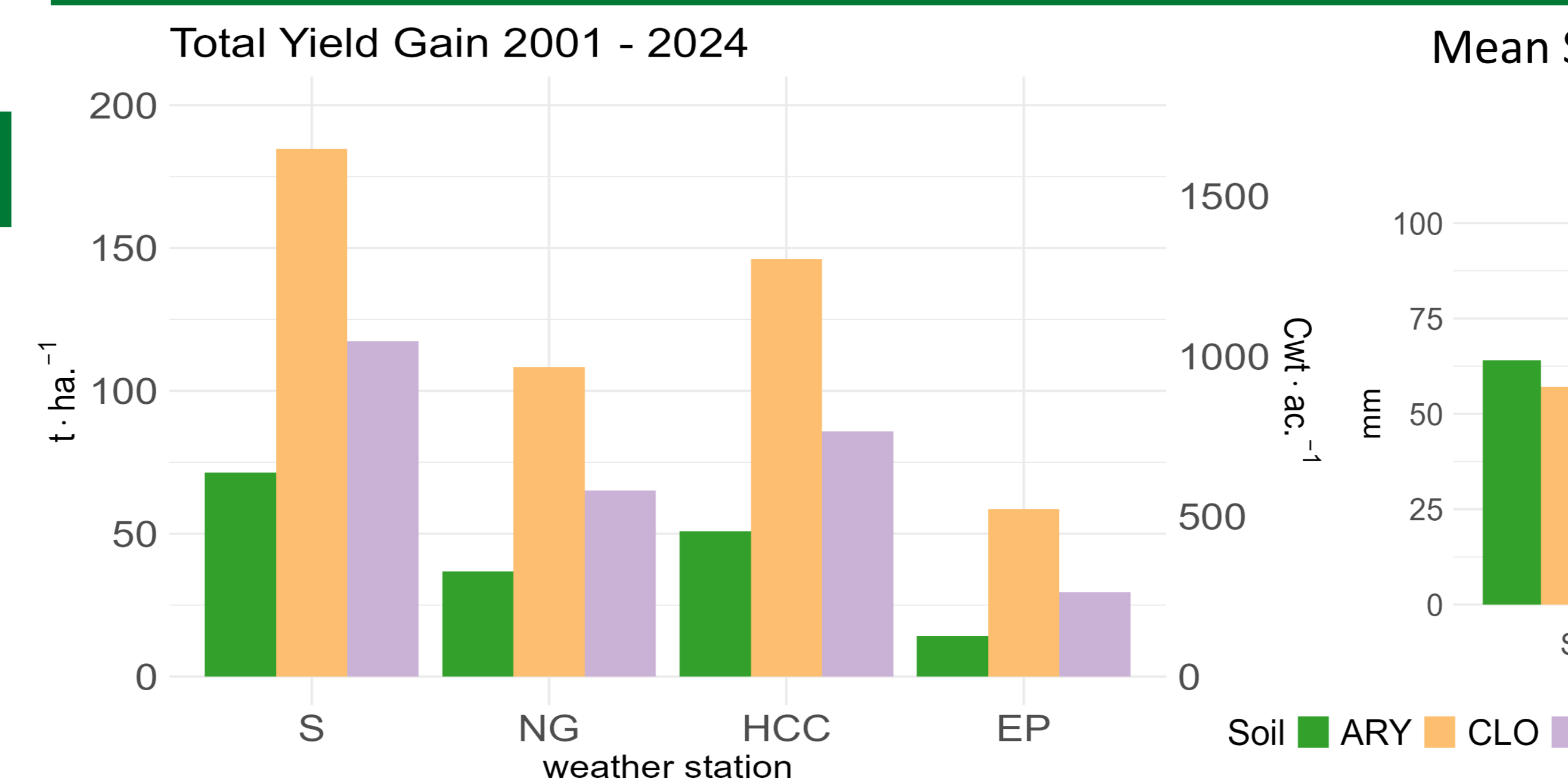


Figure 4. Total simulated yield gain accumulated over the study period (2001-2024). Yield gain is the difference between yearly yield simulated with and without water stress effects.

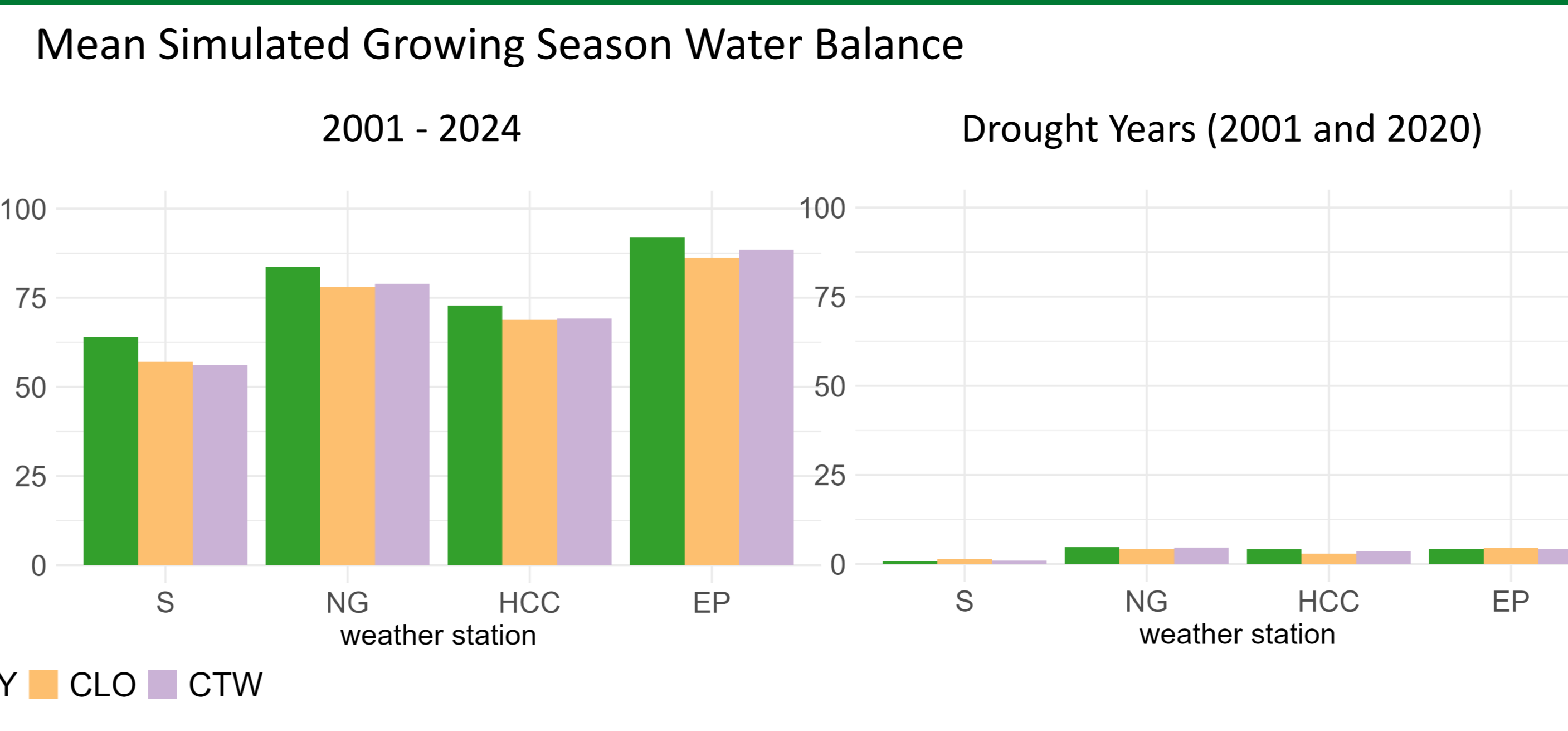


Figure 5. Mean simulated water balance over the 2001-2024 growing seasons (June – September, left) and two major drought years (2001 and 2020).

PAYBACK PERIOD – YEARS

Table 2. Payback period (number of years to break even on the initial investment cost) for each soil x weather station simulated scenarios. One field or part of a field was assumed to be under potato cultivation each year (i.e. each year had the possibility for supplemental irrigation application). High and low market yield estimate 90% and 70% of the total yield are marketable, respectively. The market rate used for the calculation was Can\$ 400.92, adjusted for inflation from the 2023 rate of Can\$ 390.44 (AAFC, 2024).

		A. Pivot I								B. Pivot II							
		S		NG		HCC		EP		S		NG		HCC		EP	
Market Yield		High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
ARY		10**	13*	24	32	14*	18*	43	59	8**	10**	18*	24	11**	14*	31	40
CLO		4**	6**	9**	12*	6**	8**	10**	13*	3**	4**	7**	10**	5*	6**	8**	10*
CTW		7**	8**	13*	17*	9**	12*	21*	27	5**	7**	10**	13*	7*	9**	16*	20*
		C. Hose Reel and Sprinkler								D. Hose Reel and Boom Cart							
		S		NG		HCC		EP		S		NG		HCC		EP	
Market Yield		High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
ARY		14*	19*	34	46	20*	26	70	104	14*	18*	32	42	19*	24	57	76
CLO		6**	8**	13*	17*	8**	10**	14*	19*	6**	7**	13*	16*	8**	10**	14*	18*
CTW		9**	12*	18*	24	13*	17*	30	42	9**	11**	17*	23*	12*	16*	27	36

* payback period < length of study period (24 years), **payback period < half of study period (12 years).

DISCUSSION AND CONCLUSION

- Clear differences in yield gain between:
 - CLO soil – lowest plant readily available water.
 - ARY soil – highest plant readily available water.
 - East Point (EP) – lowest mean growing season GDD, lowest mean daily solar radiation, highest daily windspeed.
 - Contributes to better cooling, less water stress in plant.
- SI was considered beneficial if the payback period was less than 24 years – the assumed lifespan of the irrigation system.
- Beneficial in 87% of all high market yield scenarios.
- Beneficial in 77% of all low market yield scenarios.
- Beneficial for all soil types and irrigation types at Summerside (S) and Harrington (HCC) in high market yield scenario.
- Generally not as beneficial:
 - East Point Area – cooler climate with higher growing season water surplus.
 - ARY soil or similar soil types with high water holding capacity
- Mostly Beneficial:
 - CTW soil type – most common on island.
 - 75% of low market yield scenario payback periods < system lifespan.
- Highly Beneficial:
 - CLO or similar soil types with low water holding capacity.
 - Beneficial for CLO soil across all stations and irrigation types
 - Payback period as short as 3 years.
- Future Work: Simulations with CMIP climate projections.

Climate-smart supplemental irrigation has potential to greatly benefit potato production in Prince Edward Island.

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