SUPPLEMENTAL IRRIGATION IN RAINFED POTATO:

LONG-TERM COSTS, BENEFITS, AND INSIGHTS FROM PRINCE EDWARD ISLAND, CANADA

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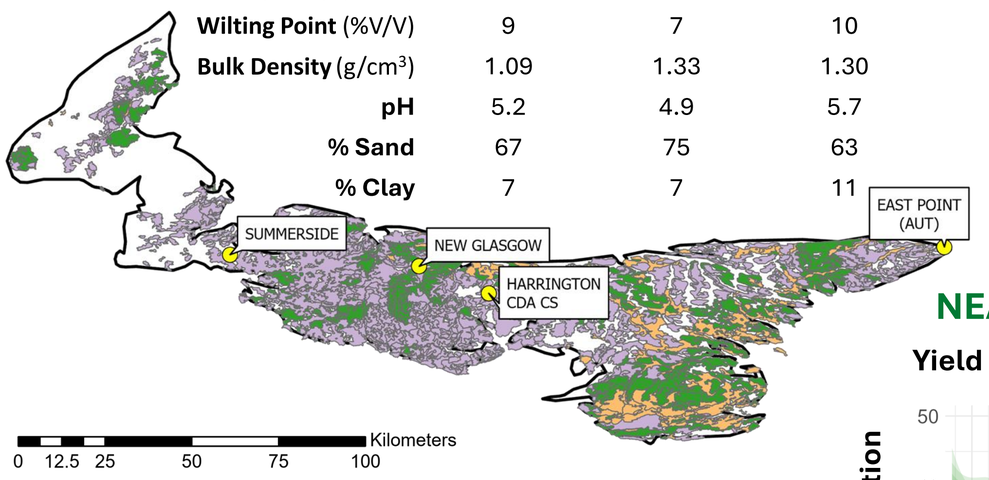
BACKGROUND

- Canada's smallest province, producing ~20% of nation's potato crop.
- Historically rainfed.
- Increasing drought frequency due to climate change.
- Often during most sensitive period July-August (tuber growth and bulking).
- Supplemental irrigation may be needed in the future.
- What is the payback period for investing in a system?
- What effect does the inclusion of environmental costs due to N_2O emissions and NO_3 leaching have on payback periods ?

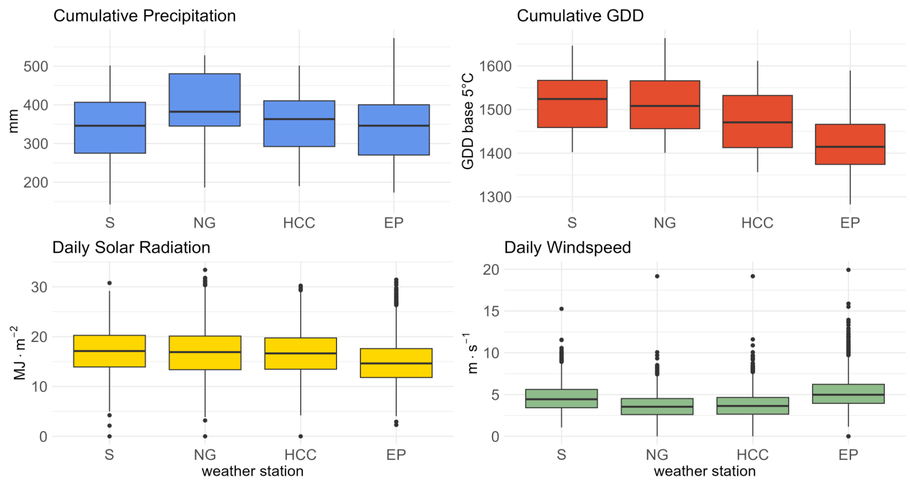
METHODS

- Historical (2020 – 2024, 4 weather stations) and near-future (2027 – 2047, 1 weather station)
- Drought in 2001 and 2020 (July-August precipitation ~75% decrease from historical average)

Soil Type	ARY	CLO	CTW
Field Capacity (%V/V)	32	27	29
Wilting Point (%V/V)	9	7	10
Bulk Density (g/cm^3)	1.09	1.33	1.30
pH	5.2	4.9	5.7
% Sand	67	75	63
% Clay	7	7	11



GROWING SEASON CLIMATE MEANS (2001 – 2024)



S – Summerside NG – New Glasgow HCC – Harrington CDA CS EP – East Point

CLIMATE PROJECTIONS

- Six global climate models:
  - CanESM5
  - GFDL-ESM4
  - IPSL-CM6A
  - MPI-ESM1-2
  - MRI-ESM2
  - UKESM1
- Three SSPs:
  - SSP1-2.6
  - SSP3-7.0
  - SSP5-8.5

IRRIGATION SYSTEMS

- Average lifespan of irrigation system: 20 Years
- 90% irrigation efficiency

	Pivot I[A]	Pivot II[A]	Hose Reel and Sprinkler[B]	Hose Reel and Boom Cart[C]
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$)	301 186	25 300	412 040	422 480
Operation Costs[a] (Can$ / ha)	331	71	710	269

[a] Based on average application of 152mm. Data obtained from Jiang et al. (2024) and adjusted for inflation.

ENVIRONMENTAL AND SOCIETAL COSTS

	Loss to	Effect on	Mid. Cost Scenario (Can$/kg N)
N_2O	Air	GHGs	22.20
	Air	Increased UV	4.44
NO_3	Surface water	Eutrophication	26.64
	Groundwater	Drinking water	2.22

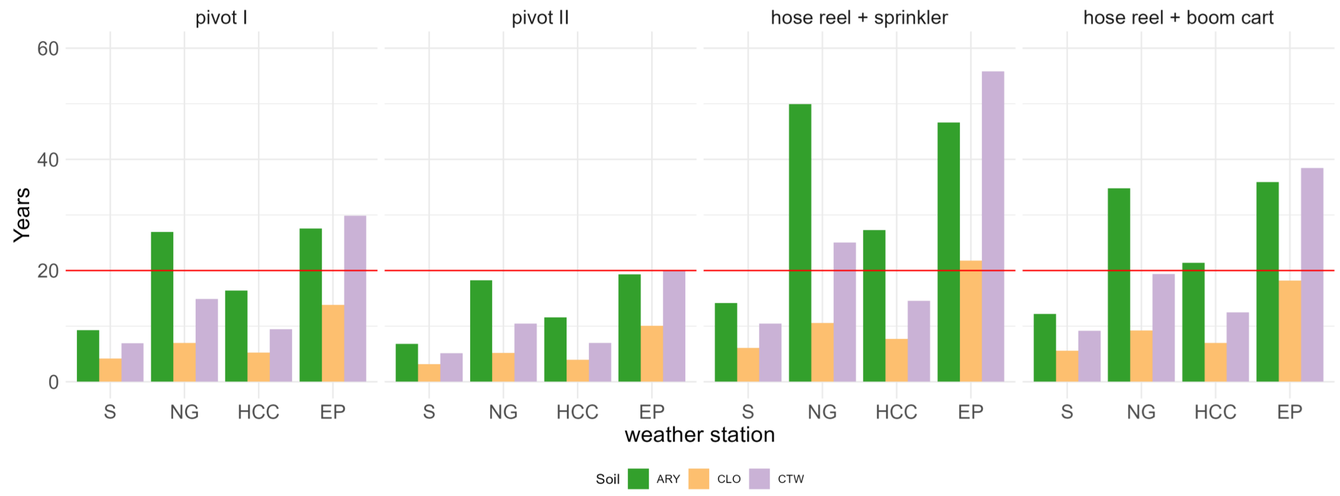
Data obtained from Van Grinsven et al. (2013), converted to Can$ and adjusted for inflation.

SIMULATIONS

- STICS crop model v. 10.3.0
- Automatic irrigation applied July-August, max 30mm when stress <1 (0 = stress, 1 = no stress).

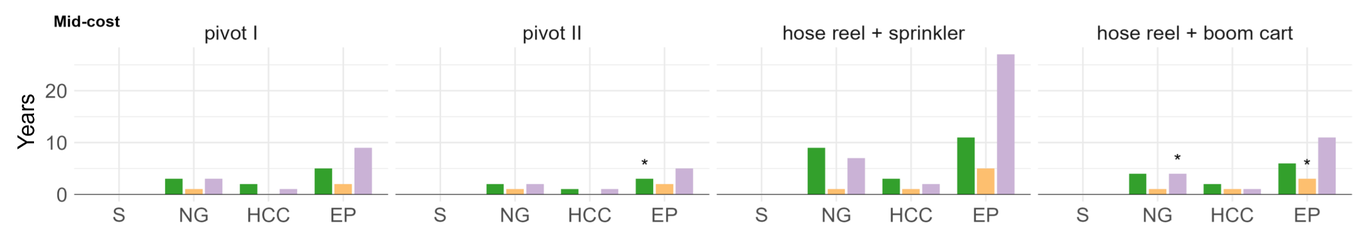
COST-BENEFIT ANALYSIS

HISTORICAL PAYBACK PERIODS (2001-2024)



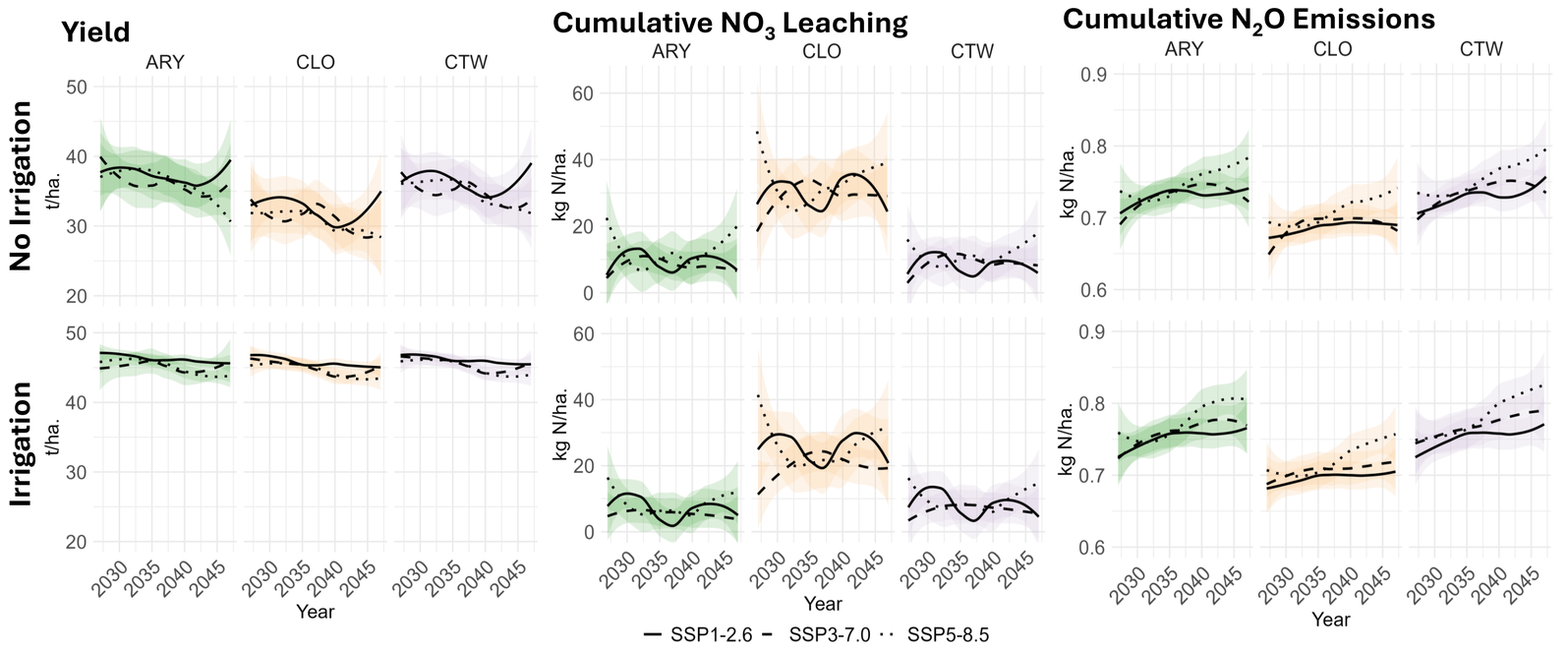
Payback period for each soil type and irrigation type at each weather station area. Payback calculated assuming a worst-case marketable yield of 70% total yield. The redline indicates the system lifespan threshold.

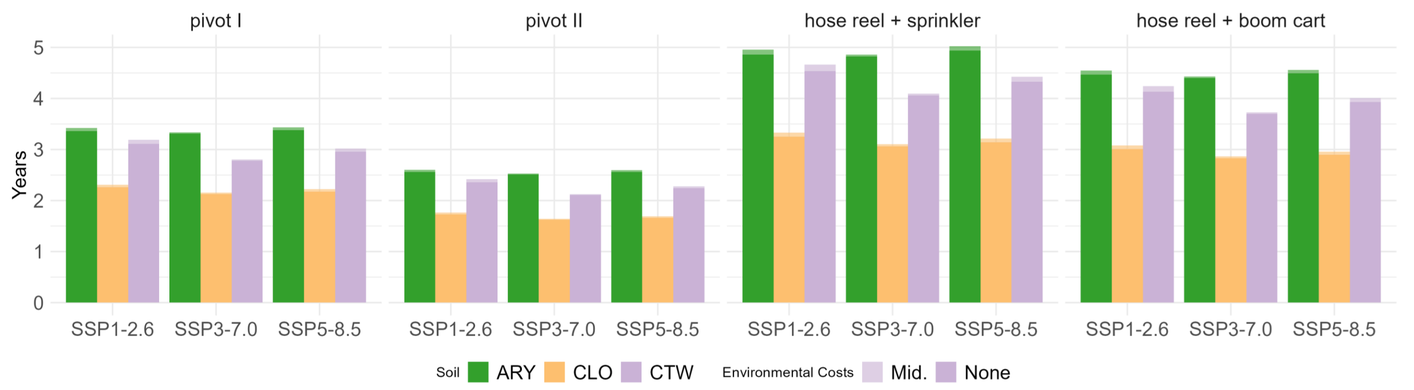
Increase in Payback Period due to Environmental Impacts



Number of years added on to the pay back period when including environmental costs due to N_2O emissions and NO_3 leaching in a mid.-cost scenario
* Indicates a payback period no longer within the 20-year threshold that was previously under the threshold

NEAR FUTURE PROJECTIONS AND PAYBACK PERIODS (2027-2047)





Payback period for each soil type and irrigation station for 2027-2047 projections. Payback calculated assuming a worst-case marketable yield of 70% total yield. The environmental costs show the increase in payback period years when including a mid-cost scenario.

CONCLUSIONS

- From 2001-2024 the payback period varied greatly by soil type, weather station and irrigation system.
- Soil types with higher water holding capacity (ARY) and cooler areas (EP) saw less benefit than lower capacity soil and other station areas.
- Including the cost of increased emissions and leaching had some impact, bringing three scenarios over the payback period threshold of 20 years.
- In the near future (2027-2047), the payback period across all scenarios was < 5 years.
- Near future environmental costs had minimal impact. Irrigation may have reduced leaching by keeping soil moist and reducing preferential flow.

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