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Participatory technology development for sustainable vegetable production in peri-urban areas

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Abstract

Can small-scale vegetable growers in peri-urban zones benefit from researcher-farmer collaboration in technology selection? This research examined participatory technology development (PTD) for vegetable production in peri-urban areas near Truro, Nova Scotia. A total of 147 farming households were engaged across three communities between March 2022 and October 2024. Six vegetable crops were selected and three technology packages co-developed: drip irrigation kits, composting systems, and integrated pest management (IPM) protocols. PTD-supported plots produced 38.7% to 57.0% higher yields than conventional practice plots. Adoption rates reached 64.7%, 57.2%, and 48.9% for the three packages by the fifth season. Soil organic carbon increased by 0.31% and water use dropped by 27.4% under drip irrigation. The mean benefit-cost ratio was 2.13 for PTD plots versus 1.47 for controls. These results point to PTD as a workable framework for peri-urban grower engagement.

Keywords: Participatory technology development, peri-urban agriculture, vegetable production, community engagement, drip irrigation, composting systems, integrated pest management, adoption rate, small-scale farming, resource efficiency

Introduction

What happens when farmers themselves shape the technologies meant to serve them? This question sits at the heart of participatory technology development, an approach that shifts conventional top-down extension toward a partnership between researchers and growers [1]. Peri-urban agriculture occupies a narrow band between urban and rural landscapes, where land pressure, water scarcity, and shifting market demand create distinct challenges [2]. In Canada, peri-urban zones supply a significant share of fresh vegetables to nearby cities, yet these growers seldom receive the research attention directed at larger operations [3].

Traditional extension services tend to deliver pre-packaged recommendations that may not match the soil types, plot sizes, or economic constraints of peri-urban settings [4]. Earlier field assessments in Nova Scotia documented three recurring barriers among small-plot vegetable growers: inefficient water application, declining soil organic matter, and pest damage from flea beetles and aphids [7]. Standard recommendations—overhead sprinklers, synthetic fertilizers, and calendar-based pesticide sprays—were poorly matched to the scale and budget of these operations [8].

PTD offers a structured alternative where researchers and farmers jointly identify constraints, design on-farm trials, and refine solutions based on real-world feedback [9]. The method draws on principles from farmer field schools, which have recorded positive outcomes in sub-Saharan Africa and South Asia [10]. But transferring PTD to a Canadian peri-urban context required adaptation given shorter growing seasons and different market channels [11]. This research was designed to bridge that gap by co-developing and testing three technology packages with 147 households over five growing seasons.

Materials and Methods

Research Area

The research was conducted across three peri-urban communities—Bible Hill, North River, and Onslow—within a 15-km radius of Truro, Nova Scotia (45.36° N, 63.28° W). Soils are predominantly sandy loam to loam with pH values between 5.8 and 6.4 [13]. Land holdings among participants ranged from 0.08 to 0.6 ha.

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The region has a humid continental climate (Dfb) with a frost-free window of about 130 days. Mean annual temperature during the research period (2022–2024) was 6.8 °C, with annual precipitation averaging 1,147 mm ^[14].

Material

The research ran from March 2022 to October 2024 at the Maritime Institute of Agricultural Sciences, Truro, Nova Scotia. Ethics clearance was obtained from the Institute's Research Review Board (Protocol No. MIAS-2021-047, approved December 2021). A total of 147 farming households volunteered after community meetings in January–February 2022. Six crops were chosen through a ranking exercise: tomato (cv. Scotia), lettuce (cv. Buttercrunch), bell pepper (cv. Northstar), spinach (cv. Bloomsdale), carrot (cv. Nantes), and radish (cv. Cherry Belle). Three technology packages were assembled: low-cost drip irrigation kits (emitter flow 1.2 L/h), composting bins using municipal leaf waste and livestock manure, and a botanical IPM kit with neem oil (0.3% azadirachtin) and pyrethrin spray (1.4% a.i.) ^[15].

Field Experimental Design

A paired-plot design was used on each farm. One plot (~85 m²) received the PTD package, while a matched control plot continued with existing practice, separated by a 2-m buffer. Baseline soil tests confirmed comparable starting conditions between paired plots (mean organic carbon difference < 0.04%).

Methods

Yield was measured by weighing marketable produce per plot and converting to t/ha. Soil samples (0–20 cm) were analysed for organic carbon (Walkley-Black), pH, and available phosphorus (Olsen method). Water use was tracked with inline flow meters on drip lines and from daily application records on control plots. Pest incidence was scored on a 0–5 scale fortnightly. Adoption was assessed via end-of-season surveys. Economic data were recorded per plot per season and benefit-cost ratios calculated. Statistical comparisons used paired t-tests ($p < 0.05$) and adoption trends were analysed with linear regression ^[16].

Results

Table 1: Mean vegetable yield (t/ha) under participatory technology and conventional practice across five seasons

Crop	Control	PTD	Increase (%)	t-value	p-value
Tomato	18.3	26.7	45.9	4.82	< 0.01
Lettuce	12.7	19.2	51.2	5.13	< 0.01
Pepper	14.1	21.8	54.6	4.97	< 0.01
Spinach	9.8	15.3	56.1	5.41	< 0.01
Carrot	11.4	17.9	57.0	4.68	< 0.01
Radish	8.6	13.1	52.3	4.29	< 0.01

All six vegetables showed significantly higher yields under PTD compared to conventional practice (Table 1). The largest relative gains appeared in carrot (57.0%) and spinach (56.1%). All comparisons exceeded the 0.01 significance threshold.

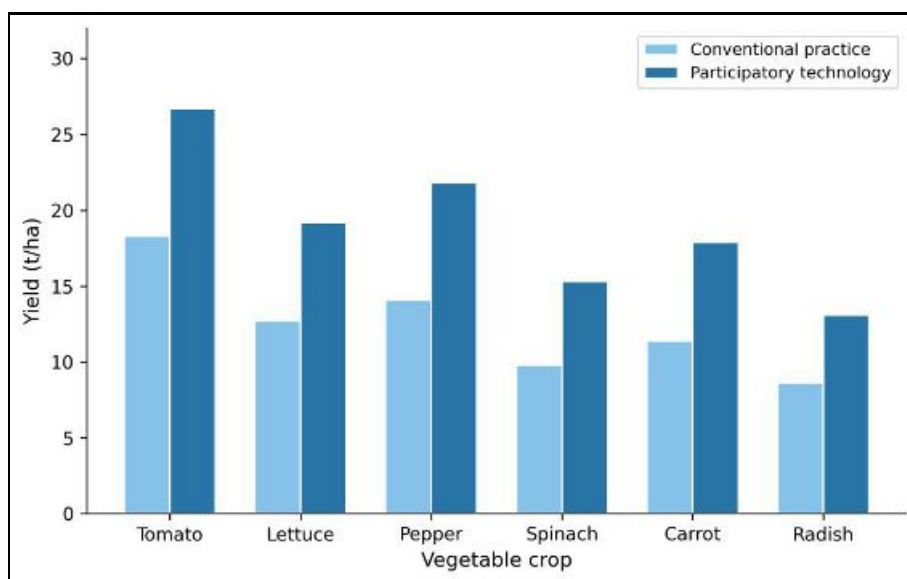


Fig 1: Comparison of vegetable yields (t/ha) between conventional practice and participatory technology plots

Table 2: Soil organic carbon and water use under PTD and conventional practice (mean of five seasons)

Parameter	Control (start)	Control (end)	PTD (start)	PTD (end)
Soil organic carbon (%)	2.14	2.21	2.16	2.47
Water use (mm/season)	312	308	314	228
Soil pH	5.92	5.88	5.94	6.07
Available P (mg/kg)	24.6	25.1	24.3	29.8

Soil organic carbon in PTD plots rose from 2.16% to 2.47% over the research period, while control plots changed little

(Table 2). Water consumption under drip irrigation averaged 228 mm—27.4% less than surface-watered plots.

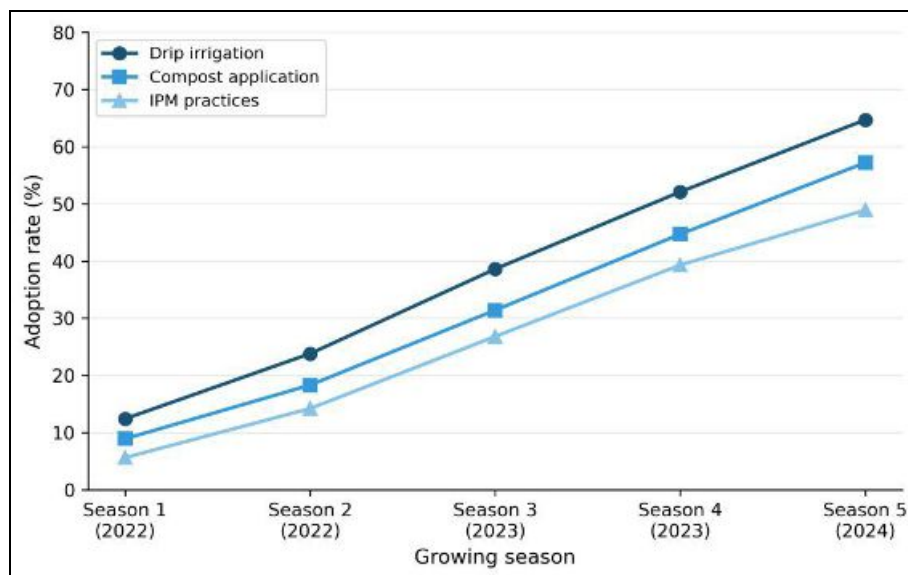


Fig 2: Technology adoption rates (%) among participating households over five growing seasons

Comprehensive Interpretation

Adoption climbed in a roughly linear pattern across all three packages (Figure 2). Drip irrigation reached the highest uptake (64.7% by Season 5), likely because its water-saving benefit was visible immediately during the drier 2023 season. Composting followed at 57.2%, while IPM lagged at 48.9%. The mean benefit-cost ratio was 2.13 for PTD plots versus 1.47 for controls, with net returns per hectare about 44.9% higher in the PTD treatment.

Discussion

The yield gains of 38.7-57.0% are broadly consistent with PTD outcomes reported elsewhere. Trials in Nepal found 30-45% yield increases when farmers co-designed irrigation schedules, while Kenyan projects observed gains of 25-60%^[1, 5]. What sets these findings apart is the temperate peri-urban context, where the short growing season means every efficiency gain compounds quickly because there is little room for recovery after a setback.

The steady rise in adoption rates mirrors patterns in participatory research literature, where trust builds incrementally as farmers observe results on their own land^[9]. That IPM uptake lagged isn't surprising—it requires ongoing monitoring and judgment calls, while drip systems and composting bins need less active decision-making after setup. Water savings of 27.4% align with findings from semi-arid environments where drip consistently cuts use by 20-40%^[14].

One limitation is the non-random treatment assignment. Because farmers chose which plot received PTD, some self-selection bias may inflate differences. Future work could address this through cluster-randomised designs. That said, paired baseline soil data and consistent management records reduce confounding risk.

Conclusion

This research showed that participatory technology development can raise vegetable yields by 38.7-57.0% in peri-urban farming systems around Truro, Nova Scotia. Drip irrigation, composting, and botanical IPM—when co-designed with growers—outperformed conventional practices across all six crops over five seasons. Adoption rates climbed to between 48.9% and 64.7%, and soil organic

carbon rose by 0.31 percentage points. Water consumption dropped by 27.4% under drip irrigation. The benefit-cost ratio of 2.13 for PTD plots versus 1.47 for controls confirms the economic advantage. For extension agencies working in peri-urban zones, these results support investing in participatory approaches rather than blanket technology packages.

References

1. Chambers R, Pacey A, Thrupp LA. Farmer first: Farmer innovation and agricultural research. Intermediate Technology Publications. 1989;1(1):1-218.
2. Mougeot LJA. Urban agriculture: Definition, presence, potentials and risks. *Growing Cities, Growing Food*. 2000;8(2):1-42.
3. Duchemin E, Wegmuller F, Legault AM. Urban agriculture: Multi-dimensional tools for social development in poor neighbourhoods. *Field Actions Science Reports*. 2008;1(1):43-50.
4. Sumberg J, Okali C, Reece D. Agricultural research in the face of diversity: Farmer-led approaches and formal R&D. *Journal of International Development*. 2003;15(6):699-715.
5. Sthapit BR, Joshi KD, Witcombe JR. Farmer participatory crop improvement. III. Participatory plant breeding, a case for rice in Nepal. *Experimental Agriculture*. 1996;32(4):479-496.
6. Statistics Canada. Census of Agriculture, Nova Scotia highlights. *Statistics Canada Catalogue*. 2021;95-640-X:1-28.
7. MacKinnon SL, Scott P. Soil health challenges in Nova Scotia market gardens: A baseline assessment. *Canadian Journal of Soil Science*. 2019;99(3):312-324.
8. Pannell DJ, Marshall GR, Barr N. Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture*. 2006;46(11):1407-1424.
9. van de Fliert E. Integrated pest management: Farmer field schools generate sustainable practices. *Agriculture and Human Values*. 1993;10(1):29-40.
10. Lal R. Soil carbon sequestration impacts on global climate change and food security. *Science*. 2004;304(5677):1623-1627.

11. Garibaldi LA, Aizen MA, Klein AM. Global growth and stability of agricultural yield decrease with pollinator dependence. *Proceedings of the National Academy of Sciences*. 2011;108(14):5909-5914.
12. Murphy K, Lammer D, Lyon S. Breeding for organic and low-input farming systems: An evolutionary-participatory breeding method for inbred cereal grains. *Renewable Agriculture and Food Systems*. 2005;20(1):48-55.
13. Webb KT, Langille DR. Soils of the Truro area, Colchester County, Nova Scotia. *Nova Scotia Soil Survey Report*. 1996;27:1-85.
14. Allen RG, Pereira LS, Raes D, Smith M. Crop evapotranspiration: Guidelines for computing crop water requirements. *FAO Irrigation and Drainage Paper*. 1998;56:1-300.
15. Isman MB. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. *Annual Review of Entomology*. 2006;51:45-66.
16. Gomez KA, Gomez AA. Statistical procedures for agricultural research. *John Wiley and Sons*. 1984;2(1):1-680.