Future agricultural suitability models as tools for climate change adaptation in British Columbia

INSIGHTS FROM A STAKEHOLDER FOCUS GROUP

Authors

Vali Vakhshoori

Postdoctoral Researcher, School of Environment and Sustainability, Royal Roads University

Robert Newell

Canada Research Chair in Climate Change, Biodiversity and Sustainability, School of Environment and Sustainability, Royal Roads University

Alesandros Glaros

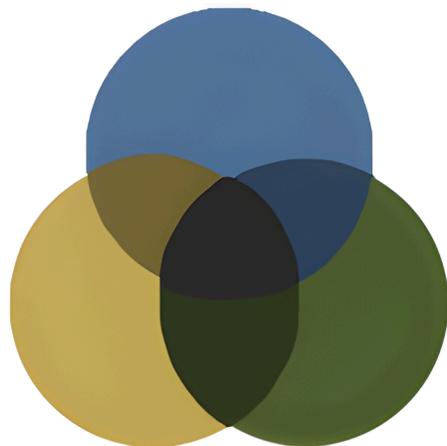Postdoctoral Fellow, School of Environment and Sustainability, Royal Roads University

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We respectfully acknowledge that this project took place on the unceded homelands of the Lekwungen-speaking Peoples, the Songhees and Esquimalt Nations, on which Royal Roads University is situated. We are grateful to live, work, and learn in this territory, recognizing that the land itself is a teacher, and we thank the traditional caretakers for their enduring relationship with this place.

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1. Executive Summary

This report presents findings from a series of stakeholder focus groups that examined a model of future agricultural land suitability in British Columbia under different climate change scenarios. The model projected changes in crop suitability across the province using climate, land classification, and property value data, and its purpose is to inform long-term agricultural planning and climate change adaptation. The focus groups were designed to evaluate the model's value as a tool for agricultural planning and decision-making. The focus group discussions explored the model's potential applications and limitations, the governance considerations for applying the model to planning and practice, and the future research needs for enhancing the model's value as a tool for supporting climate change adaptation in the agricultural sector.

Participants in the focus groups included agricultural producers, planners, researchers, consultants, and representatives from local and provincial government. Their lived and professional experiences spanned urban, peri-urban, and rural contexts in various places across British Columbia. The focus group sessions involved participants exploring the model outcomes using the Agrilyze map-based data platform, followed by breakout and plenary discussions on the model outcomes and their usefulness as a tool for agricultural planning and decision-making.

The focus group data consisted of discussion transcripts, which were analyzed using thematic coding methods. Findings from the analysis include:

- Climate-driven agricultural suitability models are valuable strategic tools for long-term planning, scenario exploration, and early identification of emerging agricultural opportunities.

- The model's predicted agricultural suitability provides only a conditional (rather than deterministic) understanding of agricultural opportunities, as these opportunities also require alignment between local soil and water conditions, available agri-food infrastructure, market access, and institutional support.

- Local variability in factors such as microclimates, soil chemistry, hydrology, and farm-scale conditions limits the usefulness of province-wide models as decision-support tools, and their use should be complemented with on-the-ground knowledge in agricultural planning and decision-making.

- Climate-driven agricultural suitability models are valuable tools for regional planning, agricultural feasibility assessments, research coordination, and storytelling, especially when used to communicate place-based futures rather than precise predictions.

- Agricultural suitability models that indicate where suitability will improve due to climate change can support opportunity-oriented narratives around climate change adaptation, innovation, and diversification in ways that counter the dominant "doom and gloom" climate narratives.

- Agricultural suitability models can be misused to justify converting otherwise protected agricultural land to urban development in areas where agricultural suitability is projected to decline.

- Long-term climate change adaptation requires coordinated governance and planning systems, alongside technical tools, to align land use, infrastructure, markets, and social policies.

The study indicates that climate-informed agricultural suitability models are most effective when used as exploratory tools in planning and governance processes and when complemented by other data and tools. When used alongside local expertise and coordinated cross-sectoral planning, such models can support proactive, long-term climate change adaptation strategies and policies that advance sustainable and resilient agri-food systems.

2. Introduction

Climate change is reshaping agricultural systems, landscapes, and geographies (Perez et al., 2015; Drolet, 2011). Warmer temperatures and longer frost-free periods are expanding the potential range for some crops, while water scarcity, heat stress, and seasonal unpredictability threaten productivity in current agriculturally active regions. Such changing conditions affect where and how crops can be grown in the future; thus, it is important to develop and implement plans, policies, and strategies for helping the agri-food sector adapt accordingly.

In the Canadian province of British Columbia, the agricultural landscape is diverse and ranges from fertile valleys in the south coast and interior regions to cooler, resource-rich regions in the north (Roussin et al., 2015). Most of the farmland in the province is safeguarded within the Agricultural Land Reserve (ALR); however, the protection of the ALR does not guarantee long-term agricultural viability in the face of climate change. The suitability of places across the province for cultivating different crops may shift as climate patterns change and influence what can be grown and where. Shifts in temperature, precipitation patterns, and growing season are altering agricultural conditions across British Columbia (Government of British Columbia, 2024), creating both new opportunities and risks for farmers. Anticipating these shifts is essential for sustainable land-use planning, supporting regional food systems, and ensuring that agricultural policies are responsive to future environmental realities.

Understanding the spatial patterns and magnitudes of potential changes in climate and agricultural productivity requires robust, science-based assessments of land and crop suitability. Climate projections from global and regional models enable researchers and policymakers to explore how agricultural potential may evolve under different greenhouse gas emissions scenarios. Models that integrate these climate projections with land and soil data can be used to identify areas that may become more or less suitable for different economically and dietarily important crops. In turn, such models can support decision-making by informing adaptation strategies and long-term planning.

Vakhshoori et al. (2025) developed a series of spatially explicit crop suitability models to evaluate how climate change may reshape agricultural potential across British Columbia. These models were made accessible through Agrilyze, an interactive mapping platform developed by i-Open Technologies, and the model outcomes and data are available from the project webpage: www.triaslab.ca/agrigenomics#model. The purpose of making the model and data publicly available is to provide a tool to inform decision-making by farmers, planners, and policymakers with respect to adapting agriculture to a changing climate.

For models such as the one developed by Vakhshoori et al. (2025) to be meaningful and actionable, their outcomes must be presented and communicated in ways that are accessible to people who make decisions on the ground, such as farmers, planners, and local governments. Effective translation of scientific results into clear, usable insights is needed to apply models to practice and to use such models for supporting decision-making (Newell et al., 2021; Rose et al., 2018). The research presented in this report uses focus group methods to engage agri-food stakeholders in British Columbia in an assessment of the future agricultural suitability model developed by Vakhshoori et al. (2025) in terms of its strengths, weaknesses, and potential applications to agricultural planning, policy, and practice.

3. The Model

This report focuses on the application of the future agricultural suitability model, and it presents the outcomes of the focus group testing of the model. Details on the development and outcomes of the agricultural suitability modelling work can be found in Vakhshoori et al. (2025), and this report does not discuss this work in depth. However, to provide context for the findings from the focus group study, this section summarizes the model development and the main trends in the model outcomes.

The model was developed to assess the future suitability of agricultural land for field-grown crops in British Columbia under different climate change scenarios (Figure 1). The model analyzed crops that are economically and dietarily important in the province, specifically: cabbage, cauliflower, lettuce, strawberry, kale, broccoli, and celery. The modelling work used a spatial approach and established baseline sustainability for the crops using data on historical crop planting and production, local and regional climate conditions, land capability classifications, and economic indicators (e.g., regional averages for property values). Machine learning models were developed to evaluate land suitability across the province from the current year to the end of the 21st century under different climate change scenarios. The climate change scenarios were based on the Intergovernmental Panel on Climate Change's (IPCC) Shared Socioeconomic Pathways (SSP) framework, and the modelling work used data from climate projections for the SSP2, SSP3, and SSP5 scenarios.

Figure 1. Machine learning workflow projecting land suitability (2022–2100). The models utilize geospatial and inventory inputs to forecast agricultural potential under SSP2, SSP3, and SSP5 climate pathways.
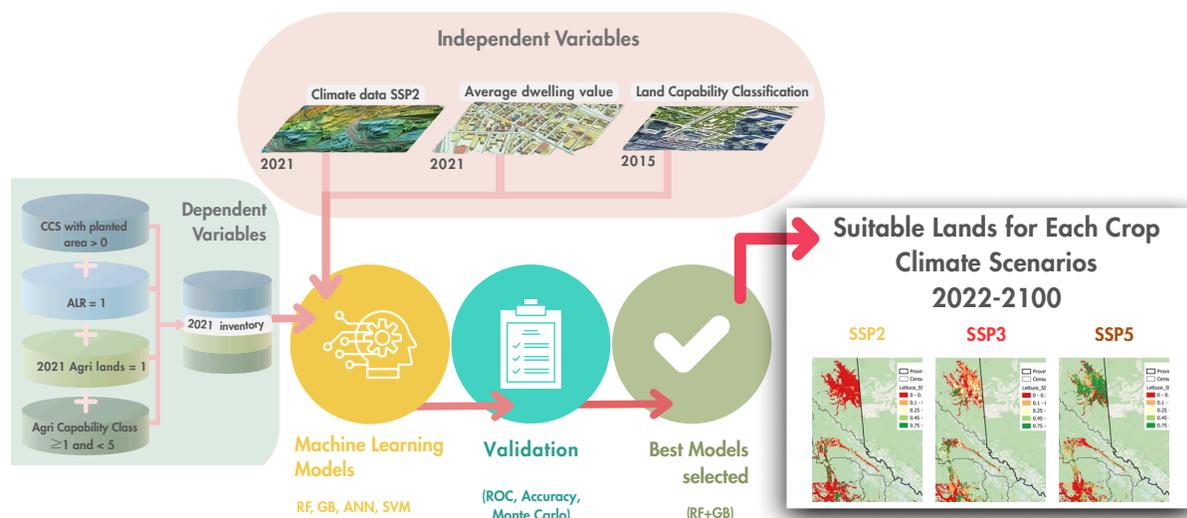
The results of the agricultural suitability modelling revealed spatial shifts in future suitability, with the patterns of these shifts varying by crop. Northward expansions in production ranges were observed for cabbage, cauliflower, and lettuce due to predicted warmer conditions, particularly in higher-emissions scenarios (i.e., SSP3 and SSP5). The model produced more nuanced results for the suitability of strawberry, kale, and broccoli, projecting an expansion in the production range under moderate-to-high warming scenarios (i.e., SSP2 and SSP3) but losses in total suitable crop production area in the latter half of the 21st century under the highest warming scenarios (i.e., SSP5). Unlike the other modelled crops, celery is projected to experience a consistent decline in suitable agricultural land across all scenarios; however, this finding may be due to data limitations on current cultivation in the province, which affect the model's reliability.

The suitability projections represent modelled climatic potential and do not account for socio-economic, regulatory, infrastructure, or market constraints that influence realized agricultural production. As with all climate-driven spatial models, results are subject to uncertainty associated with climate scenarios, input data quality, and spatial resolution. Accordingly, the focus groups involved assessing the strengths and weaknesses of the model outputs and their decision-support applications within these methodological constraints.

4. Methods

Two online focus groups were conducted on October 15 and 16, 2025, to collect stakeholder feedback on the strengths, weaknesses, and potential applications of the agricultural suitability models and maps developed by Vakhshoori et al. (2025). Each session lasted approximately two hours and was held on Zoom. In total, 19 participants took part. These participants were based in various places across British Columbia and represented a variety of sectors, including provincial and local government, academic and research institutions, agricultural and environmental consults,

agri-technology and innovation organizations, and the agri-food sector. The sectoral and geographical diversity among participants enabled research that captured perspectives from subject-matter experts and potential end users, including those involved in agricultural research, land-use planning, and policy development.

Each focus group began with a presentation on the project's objectives and the model framework, namely, how climate change projections and spatial datasets were used to assess crop suitability across British Columbia. The presentation was followed by a demonstration of the crop suitability model outcomes, as displayed through the Agrilyze platform. The participants were shown how to use the platform to explore maps, layers, and projected changes in agricultural suitability across British Columbia under different climate change scenarios.

Following the demonstration, participants engaged in two activities to simulate thinking about how the model might inform agricultural planning, policy, and practice. In the first activity, participants focused on regions that they were familiar with and used the Agrilyze platform to identify expected changes in agricultural suitability for selected crops (Figure 2). This exercise helped assess how effectively the model and data platform communicated future trends and whether users gained meaningful insights relevant to their areas of expertise and interest.

Figure 2. Agrilyze platform interface illustrating the predictive modelling framework and corresponding crop suitability projections (2022–2100) across SSP2, SSP3, and SSP5 climate scenarios.
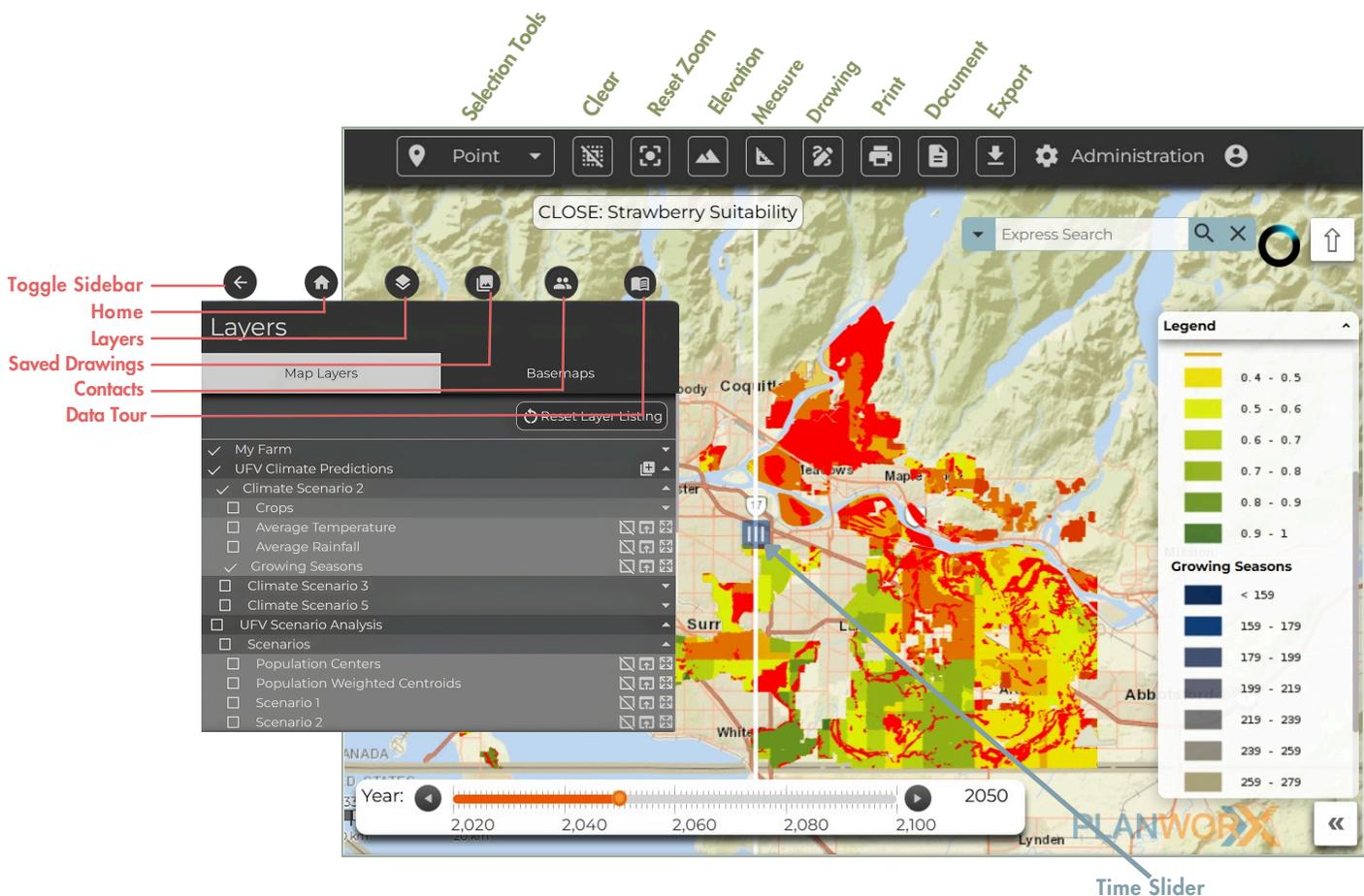
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In the second activity, participants were organized into two breakout groups to discuss the implications of the opportunities and threats associated with climate-driven changes in agricultural suitability, as shown by the model. One group focused on the areas where agricultural opportunities may increase, and they discussed the types of support, infrastructure, and policy measures needed to enable new production activities in these areas. The other group focused on areas expected to lose agricultural suitability, and they discussed the potential role of agri-technologies, such as vertical farming, digital agriculture, and agri-genomics, in supporting continued food production. Both discussions focused on ways to build resilience, enhance innovation, and support climate change adaptation in the agricultural sector.

After the breakout sessions, all participants reconvened for a plenary discussion, where they shared thoughts and reflections on the utility of the model, areas for improving the communication of model outcomes, interface design, and the model's decision-support value. The workshops generated qualitative data in the form of discussion transcripts, and analysis of these data provided insights into both the perceived decision-support value of the model and the user experience of interacting with the model and data.

All discussions were recorded with participant consent. The audio recordings were transcribed using Trint transcription software, and the data were subsequently analyzed in NVivo (v. 15). A qualitative thematic analysis approach was employed, which combined deductive and inductive coding techniques. A deductive coding framework was developed to investigate the model's applications and usefulness as a decision-support tool. The framework was based on the recommendations presented by Vakhshoori et al. (2025) for how agricultural planners, policymakers, and practitioners could use the model. Specifically, the framework focused on two major themes related to: (1) ways of supporting farmers and developing communities in areas of emerging agricultural suitability, and (2) encouraging the adoption of agri-technologies by farmers and developing agri-technology capacity in communities in areas of declining agricultural suitability.

Following the deductive coding, inductive coding was done to capture emergent subthemes, participant perspectives, and contextual nuances not captured by the deductive coding framework. The combination of deductive and inductive coding used in the analytical approach provided a nuanced understanding of how participants perceived the practical value, applications, and limitations of climate-driven agricultural sustainability models as decision-support tools for agricultural planning and adaptation in British Columbia.

5. Results

5.1 Emerging Suitable Areas

The subthemes that were identified in the deductive theme of emerging areas of agricultural suitability include: (1) planning, policy, and crop variety adaptation, (2) water, irrigation and infrastructure constraints, (3) decision risk and timing, and (4) economic, infrastructure, and regional feasibility.

Participants discussed valuable opportunities for crop diversification, expanded growing seasons, and the adoption of new crops in emerging agriculturally suitable areas. Participants also noted that leveraging these opportunities depends on access to water and fertile soil, accurate model interpretation, and clear timelines for anticipated climatic and environmental changes to help farmers engage in adaptation planning with confidence.

5.1.1 Planning, policy, and crop variety adaptation

They noted that climate-driven opportunities for future crop production are only feasible if they are supported by funding, policy, and programs. Several participants argued that existing replanting and diversification programs should be more explicitly aligned with future climate conditions, particularly for perennial crops, which have longer investment horizons and slower potential returns. The climate-based agricultural suitability maps were viewed as a useful evidence base to guide decisions and to potentially justify innovation in crop selection.

"Now, we can actually predict how the land is going to change and say, hey, this is an opportunity to continue to grow and develop." (FG2, P5)

"There's already funding out there for people to replant grapes, replant apple crops, forage reseeding...there could be a criterion on selecting those varieties that are more likely to be suitable for a changing climate, as opposed to just funding a change. You're showing that there's climate change coming, and so those supports should be related to making sure you're selecting varieties that are suitable for the future." (FG1, P8)

"If they're going to support replanting certain crops, the support shouldn't just be for replanting your common varieties...not just having someone replace their current apple trees with the same varieties. They should be something that's going to be good for the future due to climate change." (FG1, P8)

Participants also noted that the model can help reduce uncertainty about crop diversification. Such an application of the tool is particularly useful when attempting to encourage farmers to experiment with new crops or varieties in regions that are anticipated (as shown by the model) to experience broad-scale improvement in suitability. As noted by a participant, using the model in this way reduces risks for farmers interested in working with new/different crops, and it may encourage them to invest time in seeking support for crop diversification (see Figure 3).

"I look at this and think this is a really useful tool for somebody who wanted to diversify their farm and try something new...if you see a bigger area that's changing from red to yellow or red to green, it helps reduce the risk of trying something new and helps justify applying for funding." (FG1, P5)

Figure 3. Northward expansion of lettuce suitability (2100). SSP projections map a clear northward shift. Visualizing this red-to-green transition serves as a practical tool for decision-making in managing future crop transitions.
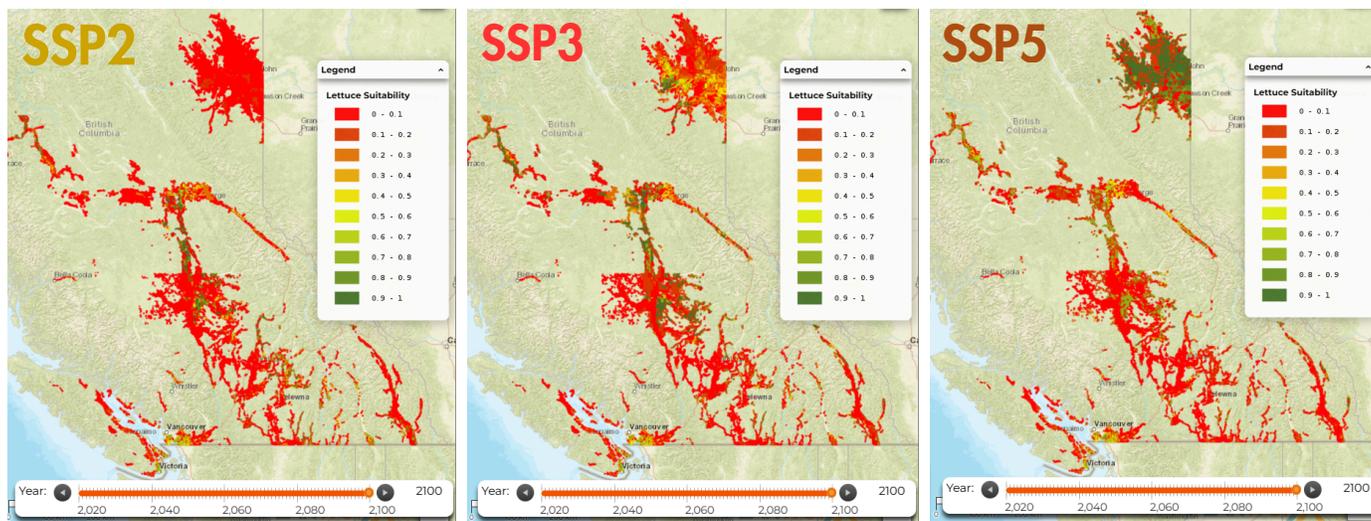
The focus group discussions frequently emphasized the importance of long-term planning and policy alignment to support transitions to emerging suitable areas. Climate suitability information was noted to be valuable for guiding strategic investment, infrastructure development, and funding decisions over multi-decade timelines. Rather than responding reactively to climate change impacts, it was argued that early planning could reduce costs, improve coordination, and enable deliberate transitions in agricultural systems and infrastructure.

"You know, if we have the knowledge that we…may be more viable in forty years, fifty years to move things from where they currently are, then it's kind of important to have those structures in place, that long-term visioning." (FG2, P5)

"If there are these longer-term systems for longer-term planning in place, then that actually makes it more economically viable to build the infrastructure to create the technologies that are needed in a more structured, effective and efficient way." (FG2, P5)

5.1.2 Water, irrigation and infrastructure constraints

Participants noted that infrastructure constraints will prevent the cultivation of new crops, regardless of climate-driven suitability. Participants noted that climate projections alone are insufficient for identifying new agricultural opportunities without also considering irrigation infrastructure, water storage, and licensing regimes.

"I find it hard to think about the opportunities when we're not talking about irrigation… access to irrigation is a huge factor for what can be grown and what the opportunities are." (FG1, P1)

"There are regions of the province that are basically already fully allocated...so it's almost like sure, it's suitable to grow lettuce, but there's no water, and lettuce needs to be grown under irrigation. So it's actually not suitable anymore. Climate-wise, yes, but there are other resources that are required." (FG1, P5)

Participants emphasized that without long-term planning for irrigation infrastructure, the actual agricultural suitability of areas identified through the model as presenting new opportunities is highly uncertain. As agricultural suitability expands into new areas, developing water storage and irrigation infrastructure is a critical step toward supporting reliable production and enhancing the long-term viability of agriculture in these regions.

"If rainfall decreases in those areas and there's no irrigation available, then those areas are no longer suitable...we definitely need to start identifying where we need water and building that infrastructure with a long game in mind." (FG2, P6)

"Even if there's maybe less precipitation in the summer, there might be a lot in the off seasons... and you can have water storage, which then can be used for irrigation." (FG1, P1)

Market access and downstream infrastructure were also identified as important for enabling a local agricultural industry in emerging suitable areas. Participants noted that investments in processing, packing, freezing, and transportation infrastructure will be essential to fully realize the agricultural opportunities offered by a changing climate. Considerations of distance to markets and shipping costs are important planning factors that can shape where and how new agricultural activities develop, particularly in larger-scale agri-food systems.

"We may be able to grow a lot of strawberries and lettuce up in the Peace [region], but is there a market for it? Like, how far do you have to ship that product, then, to get to market? And you also have to think about the processing facilities that would have to come with it if there's a large volume of new product being produced in an area." (FG1, P1)

"Not all crops can go right from the field to the store. What areas of the province now have the infrastructure to manage those crops, to freeze them, to pack them, to grade them, versus what areas of the province will need that infrastructure in the next fifty years?" (PG1, P4)

5.1.3 Decision risk and timing

The temporal dimensions of climate change (i.e., when changes occur) shape and affect farmers' willingness to change their practices. Focus group participants questioned whether the shifts projected by the model would occur within a timeframe that justifies investment, particularly given that farmers often plan over generational time horizons.

In this discussion, the urgency of adaptation was closely tied to the need to clarify the pace and timing of change when communicating the model outcomes to end users (i.e., farmers; see Figure 4).

> *"Are we talking most of the change is going to happen in the next twenty years, or is it thirty years out? Like, [as] a farmer, you're worried about your lifetime and maybe your kid. Are these changes happening really quickly, or is it over the next hundred years?" (FG1, P8)*

Figure 4. Screenshot of the model outcomes showing near-term shifts in SSP2 strawberry suitability (2022 vs. 2029). (a) In 2022, some areas exhibit moderate suitability (scores 0.3–0.6), and (b) in 2029 (only seven years later), the same areas exhibit high suitability (scores 0.8–1.0).
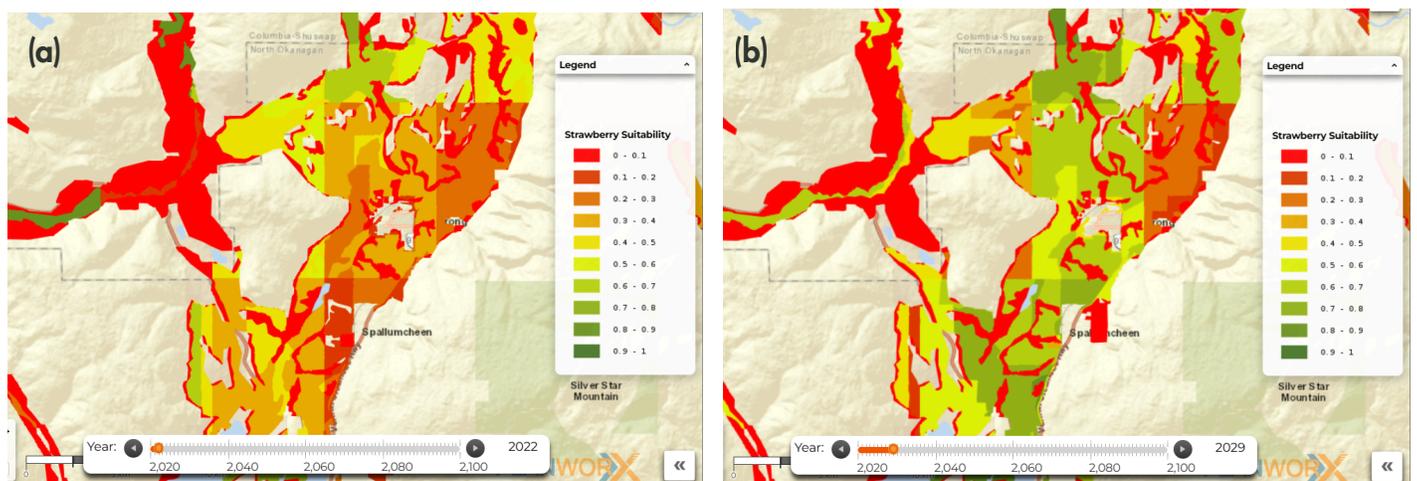
To reduce risks related to using the model to make decisions, participants discussed the importance of pairing long-term projections with localized data and digital agriculture tools. Such data could include information from local weather stations. These types of data would be useful for translating regional trends and patterns in climate change and agricultural suitability into actionable, farm-level insights.

> *"At a workshop I was at earlier this year, they were talking about more localized weather stations that were accessible to farmers. I feel like that, in conjunction with this, could be really helpful tools." (FG1, P9)*

5.1.4 Economic, infrastructure, and regional feasibility

Participants frequently noted that climatic suitability does not automatically translate into economic viability for growing a particular crop in a specific region. Decisions about what to grow require consideration of production costs and processes, expected yields, soil capability, market access, and climatic conditions. Participants observed that many crops are currently imported not only because of climate-related limitations but also because domestic production has not been financially viable.

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"We're importing those crops for a reason…we can't grow them at certain points in the year, but also it's not financially reasonable to be growing them here. But, with technology and varieties, maybe we can shorten that period where we're importing and grow a higher percentage of our own." (FG1, P8)

Participants also identified land-use pressure and urban encroachment as forces that may reshape where agriculture occurs and who holds larger parcels of land.

"There are already large shifts happening, I think, with changes in how range tenures are…we're seeing a lot of family ranches where not a lot of the kids want to ranch. So it's possible that there's either going to be an influx of newcomers who like the lifestyle but don't have the experience, or you're going to lose some of that." (FG2, P7)

Participants emphasized the need for regional information on production costs and expected yields to help farmers understand the level of risk and the economic opportunity (or lack thereof) associated with growing different crops.

"People often have to triangulate to figure out what kind of yields they could get…it might be kind of like one place or another. Even knowing, yes, you can grow it, but the yields will be low, would be really helpful information." (FG1, P5)

Participants repeatedly identified infrastructure and logistic issues as severe challenges for communities, despite future opportunities. Participants commented that transportation, energy, storage, and processing systems often remain constraints on a thriving local agricultural industry. Long-distance trucking was highlighted as a barrier to agri-food systems, particularly in northern regions where extreme cold events can rapidly erode agricultural revenue due to high energy costs.

5.2 Vulnerable and Declining Areas

The subthemes that emerged related to the deductive theme of agriculturally declining areas include: (1) heat and water stress, and declining suitability, (2) economic, infrastructure, and logistics barriers, (3) shifting seasons and adaptive cropping, (4) agri-tech, genomics, and low-energy adaptation, and (5) long-term planning and adaptation. Participants who live in climate-vulnerable areas described adaptation as a balancing act between immediate survival under worsening summer conditions and longer-term experimentation with seasonal shifts, low-energy technologies, and breeding strategies. Participants noted that equitable and just climate adaptation can be challenging to implement within economic and institutional systems that do not always support those most exposed to climate risk.

5.2.1 Heat, water stress, and declining suitability

As noted by the participants, farmers in areas projected to be vulnerable and to experience declines in productivity due to climate change (as per the agricultural suitability model) will face heat and water stress as immediate and compounding pressures.

Heat and water stresses influence what crops can be grown in particular areas, as well as when (and at what cost) these crops are grown. In several regions of British Columbia, model projections indicate that climate change is not a distant risk and is already affecting people. Some participants discussed the model outcomes as confirming lived experience associated with repeated extreme heat events, prolonged summer drought, and declining summer suitability for many crops. Additionally, participants noted that climate change impacts, such as reduced precipitation, are compounded by current infrastructure issues, including limited access to irrigation.

"If rainfall decreases…and there's no irrigation available, then those areas are no longer suitable." *(FG2, P6)*

Participants indicated that the model instilled a sense of pessimism about local agricultural futures in some of the regions in British Columbia. Participants from the Alberni Valley described how the model portrays their region as effectively unsuitable for agriculture across the scenarios, which can lead to a sense of hopelessness about the local agriculture industry. Others echoed this sentiment about other regions, noting the anticipated intensifying dryness, longer hot periods, and the increasing difficulty of sustaining crops through the summer without continuous irrigation.

"When I clicked on literally every crop in every scenario, it's just like it's not suitable now, it's not gonna be suitable in the future. Just kind of give up now…we're already hot…pushing forty degrees multiple days a year already. And, it's only gonna get hotter and drier throughout the valley." *(FG1, P6)*

"It really dries out, and you get the hot, longer, hotter, drier falls…unless you're able to just keep pumping water onto things and growing under shade cloth…it's just like I'm at the point…where I'm looking at taking August off. Like, it just is almost pointless." *(FG1, P2)*

5.2.2 Economic, infrastructure, and logistics barriers

Participants discussed the economic pressures that shape farmer decisions in areas with declining agricultural suitability. In these discussions, climate vulnerability was closely tied to land values and investment dynamics, as well as to questions of who can afford to adapt to climate change, relocate farm operations, or exit the agricultural industry altogether. Participants noted that declining agricultural suitability, when compounded by broader systemic economic pressures, can accelerate the need to make difficult decisions, such as selling farmland or shifting out of production altogether.

"We have properties worth millions, but they make peanuts off it…now they've gotten to the stage where, in my opinion, they're ready to sell, they're ready to transfer the farming to someone else, but there's no one else. And the kids have gone on and become lawyers and doctors because they didn't want their kids to do farming because it's not very good in terms of the situation." *(FG2, P2)*

"It's not so much the suitability for farming, but the viability of farming…land values are completely out of control as far as farming is concerned…there's just no end of issues that are kicking out farming from being anything that anybody can get into easily." (FG2, P1)

Participants noted that economic pressures are unevenly distributed between large, well-capitalized operations and smaller producers who lack the financial buffer to absorb repeated climate shocks. In addition, participants described how investors can use climate projections to anticipate shifts in land value, which can potentially undermine agricultural livelihoods and communities. The models presented in this work, as well as similar models in other contexts, could be used to guide land investment and acquisition.

"A lot of the investors I work with are looking at…where do we buy in the future, so that we're buying land that will correspond with the climate changes…I can really see this information being very helpful for them to look at not only various climate options, but also various timeline options, and what crops will grow in different parts of the province where the land is cheap now, compared to, say, the Fraser Valley." (FG1, P4)

Participants also noted that the current food systems infrastructure is designed to serve global supply chains and multinational actors, rather than local or regional production networks. Consequently, communities have little capacity and few viable pathways to store, process, and distribute food locally. Participants stressed that long-term economic resilience in the local/domestic agricultural industry requires coordinated investment in local infrastructure, diversified production systems, and agri-tech integration that supports regional self-reliance rather than global dependence. From a planning and policy perspective, these comments imply a need to realign land-use, infrastructure, and agri-tech strategies to support economically-viable, locally-embedded food systems.

"We ship in tons and tons of food products from California…they grow stuff that they shouldn't grow in areas that are not viable…they industrialized it. We don't have the infrastructure to do it because it's set up to support the global supply chain for multinationals. It isn't set up to support local…how you store, how you manufacture, how you process, how you get it." (FG2, P2)

"We've got to get busy investing in infrastructure at the local level…connecting food manufacturing…making sure when we grow stuff, it is diversified and local." (FG2, P2)

5.2.3 Shifting seasons and adaptive cropping

Participants discussed summer conditions as becoming less favourable for agriculture. Instead, there are increasing opportunities for agriculture in the shoulder seasons and winter production, particularly in regions with fewer frost days. With this in mind, participants discussed climate vulnerability and suitability as being related to a seasonal reconfiguration of agriculture. Some participants shared their experiences with actively experimenting with overwintering crops, earlier spring planting, and extending fall harvests.

"Yes, it's gonna get hotter and drier in the summer…but the flip side of that is more moisture in the winter, fewer days with snow in the ground…the potential for the off seasons of like fall, winter, spring go up." (FG1, P6)

"I have been experimenting with overwintering salad green crops…so that's really where my opportunity is…we can see the climate shifting so that it might be become more suitable to grow certain things on the shoulder seasons." (FG1, P2)

Participants highlighted how longer growing seasons can support higher-value crops later into the year, with implications for both profitability and food security. Additionally, adaptive cropping was described as a way to spread labour and harvest pressure over time, which can contribute to the economic viability of small-scale farming. However, participants also cautioned that such adaptations require careful alignment with frost risk, growing degree days, and local microclimates. It was noted that these small-scale details are not well captured in regional-scale models, such as the model explored in this focus group study.

"Our tomatoes are still going strong literally days ago…with climate change, I imagine that, like I said, our number of frosted days is just gonna get lower and our growing season's gonna become theoretically longer…if you've got high value crops…that can grow into the fall. (FG1, P6)

"If you can stretch that crop so that you've got some coming off in September, some coming off in October, it makes it more doable for a small farmer who's only got themselves to do the job so that they theoretically could extend their crop season." (FG1, P6)

"The one thing that's not changing is day length. So, you know, even if we're getting warmer, we're not changing the rotation of the planet to get longer days in the winter…we've been looking into doing night interruption lighting to see if that might work too." (FG1, P2)

5.2.4 Agri-tech, genomics, and low-energy adaptation

The focus group on agricultural adaptation in climate-vulnerable areas involved discussion on the trade-offs between practical, low-energy technologies and fully automated, controlled-environment systems. Some participants expressed skepticism about energy-intensive vertical farming, while also noting opportunities to apply agri-tech, genomics, and other innovations in open-field or protected outdoor settings. Techniques such as tunnels, shade cloth, soil management, and night interruption lighting were described (albeit skill-intensive) as effective ways to cope with heat and water stress.

"My interest area has always been how can we do this outside in the soil, low energy as possible…not so much the indoor vertical farming side of things." (FG1, P2)

"It's not necessarily [that] the tech is really on the high end, but your skill level needs to be on the high end…you got to know when…to take the frost cloth off…and put the shade cloth on." (FG1, P2)

"We just ran the lights about two hours after sunset…to kind of get them a shorter night…it seemed to work." (FG1, P3)

Agri-genomics and cultivar breeding were discussed as long-term solutions to climate adaptation in the agricultural section. Participants noted that such strategies can be implemented to address otherwise insurmountable constraints, such as day length and temperature tolerance. These strategies may be particularly effective for extending production northward and/or into shoulder seasons.

"Is there room for agri-genomics to do breeding…where you could be pushing these crops further north… but you're limited by the day length? Can they then be manipulated genetically so that they require less day length in order to produce a crop?" (FG1, P6)

"I think the agri-genomics component can really support this trying to like grow in more variable conditions and grow in yeah, I really extend the season out." (FG1, P2)

Participants cautioned that technology alone is insufficient to achieve sustainable, climate-resilient agriculture without equitable implementation and support. In particular, concerns were raised that agri-tech funding often favours large corporations, leaving small farmers to bear the risks related to experimenting with new crops and agricultural practices.

"To me is not so much the tech itself, but the implementation of the tech and certainly helping farmers have some consistency and reliability in using new tech, giving them support for using new tech…they know they don't really know, depending on what it is, how it's going to be applied and how it may affect their crops. And, they may be left with nothing in the end. And, so we're certainly, you know, hearing that that's a gap, that you know, they're just expected to try something out, and you know, wait an entire growing season to see if it's been effective or not. And, they're not really given any help." (FG2, P1)

"What I see is grants and contributions to support ag tech go to the multinationals…I think what we need to do is focus on ag tech inventions and support to reshape our local food supply chain. That's where we need to put the dollars…make sure you think about the small farmer ."(FG2, P2)

Participants highlighted that the main strength of agri-tech and soilless or vertical farming lies in the proximity to consumers and infrastructure. Such farms can be established in urban centres where transportation distances can be minimized and year-round production becomes economically viable.

"So, perhaps something that might come out of…this workshop or the research that you're doing might be pointing towards the fact that the real strength of agri-tech and vertical farming and soilless growing is to put it right in the middle of the urban centers themselves so that your trucking goes down to basically zero…you can sell fresh fruit year round to urban dwellers that will never see a farm because they live in a tiny apartment, but they want access to fresh foods." (FG1, P6)

Participants discussed integrating agri-tech with existing infrastructure, particularly where waste heat, wastewater, and energy systems could offset operational costs. Such integration would support the viability of high-tech farms in low-density and rural regions. In this way, agri-tech was framed not as a standalone agricultural solution for declining rural communities, but as part of hybrid, localized systems that align technology with settlement patterns, institutional anchors, and energy contexts.

"One of the things that we were looking at was potentially, especially in the north, was pairing this type of technology with…large structures that might have a lot of waste heat, such as hospitals…I think in those scenarios in town centers and things, it might be more viable." (FG1, P2)

5.2.5 Long-term Planning and Adaptation

Long-term planning was noted to be essential for managing the decline, transition, and relocation of agricultural activities in ways that avoid crisis-driven responses. Without coordinated, forward-looking systems, communities are left reacting to emergencies rather than proactively shaping adaptation pathways. Participants acknowledged the possibility that farms, infrastructure, and even entire agricultural regions may need to move from less to more agriculturally suitable area; however, they also explained that such transitions are only feasible with advance planning and institutional support.

"If we have the knowledge that we…may be more viable in forty years, fifty years to move things from where they currently are, then it's kind of important to have those structures in place, that long-term visioning…knowledge of the future was always great for planning." (FG2, P5)

Urban expansion and land-use changes were identified as additional pressures that shape where agriculture can realistically be established and persist over the long term. Participants highlighted how development-driven changes to hydrology and soil conditions can gradually erode agricultural capacity. Accordingly, the integration of land-use and climate adaptation planning is needed to ensure that productive agricultural land is not progressively degraded or displaced without clear alternatives for food production being established.

"Urban development, particularly if it's upstream or if there's higher elevation and agricultural land is below it, is highly [impactful]…changes in hydrology essentially turn the land into something that's unusable from an agriculture perspective. And ,the more you expand urban development into agricultural areas, it creates more opportunity for degradation for the agricultural area that's next to those urban areas." (FG2, P1)

Participants noted that climate change adaptation is not only about responding to climate impacts but also about enhancing ecosystem services, improving land management practices, and strengthening restoration efforts to help agricultural regions remain viable over time. Rather than treating environmental and agricultural decline as inevitable, several participants indicated that such decline is not inevitable with strategic, targeted investment and policy alignment in protecting agricultural health and buffering against long-term stressors.

"All the focus on ecosystem services is to help agricultural areas be able to adapt to some of these climate change issues and challenges… whether riparian areas have been restored, whether hedgerows have been installed, does that help reduce temperature? Presumably, we're doing all that kind of stuff so we can protect the health of agricultural areas as well (FG2, P1)."

6. Key Findings and Conclusions

This study demonstrates that climate-informed crop suitability modelling can play a valuable role in supporting agricultural planning, adaptation, and decision-making in British Columbia. However, for these tools to be useful, their outcomes must be interpreted within broader social, economic, and governance contexts. Focus group participants emphasized that crop suitability based on a narrow set of climate and land variables is insufficient to guide agricultural planning and decision-making. Instead, model outcomes should be considered alongside other important factors such as soil quality, water availability, local and regional agri-food infrastructure, market access, policy, and producers' local knowledge.

An important finding from this research is that climate change is reshaping agricultural landscapes and opportunities for farming in uneven and place-specific ways. Participants noted that the model's outcomes are useful for identifying where emerging opportunities may arise, particularly in northern and interior regions of British Columbia, where longer growing seasons may enable the cultivation of new crops in the coming decades. Participants also cautioned that harnessing these opportunities is contingent on various factors. Supportive policies, implemented over longer time horizons, are required to de-risk innovations in crop selection and technology application both in areas experiencing declines in suitable agricultural land and in areas anticipated to see new opportunities for crop production. Accordingly, participants noted that climate change adaptation in the agricultural sector is not just a technical problem of crop-climate matching but also a process of navigating systemic challenges that require coordinated investment and planning.

Participants also highlighted the importance of local and hyper-local variability. Participants explained that microclimates, soil conditions, hydrology, and farm-level management practices can vary substantially within areas, and that these differences and variability are not sufficiently captured by a model designed primarily for regional-scale use. Such comments position the model as a tool for gaining initial insights into geographical shifts and changes in agricultural potential, rather than as a prescriptive, site-specific decision-making tool. Accordingly, the model outputs are most effectively used when combined with producer knowledge, local assessments, and complementary data sources.

The focus group participants shared ideas about the model's practical applications. Participants noted that the model has value as a tool for community agricultural planning, regional feasibility assessments, knowledge mobilization, and storytelling about future land-use pathways. Importantly, the ability to visualize risks and opportunities was seen as a powerful application of the model for moving beyond climate "doom and gloom" narratives toward proactive adaptation pathways.

However, participants also raised concerns about the model's potential misuse, particularly its use to justify converting agricultural land to urban development in areas projected to have declining agricultural suitability.

Participant comments pointed to several improvements to strengthen the model's practical relevance. These include expanding the range of crops analyzed, integrating land-use change and ecosystem service considerations, and improving the resolution and localization of input data to better capture microclimatic variability. Participants also emphasized the importance of clarifying temporal horizons and economic feasibility information to support more confident decision-making. The discussions about how to improve the model indicated that it should not be considered a finished product, and instead, it can serve as an evolving tool for collaborative efforts among researchers, planners, producers, and policymakers.

The key contribution of this research is that it demonstrates how climate-driven agricultural suitability models can inform long-term agricultural transition when applied in long-term planning processes alongside other complementary data and tools. Outcomes from the focus group discussions indicate that successful climate change adaptation in the agricultural sector depends on early action, coordinated systems, and governance structures capable of managing shifts in agri-food (and related) systems. When applied appropriately, the model can generate insights into where agriculture may be possible in the future, and it can provide a shared evidence base for shaping resilient, equitable, and forward-looking food systems in British Columbia.

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