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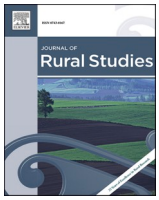

"Why would a farmer pay more money to use something that's not gonna give them anything back": Identifying gaps and opportunities to promote regenerative agriculture in Alberta, Canada☆

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A B S T R A C T

Context: Regenerative agriculture (RA) is increasing in popularity despite a lack of consensus on an agreed definition, creating challenges promoting the approach and developing policies to support its adoption.
Objective: This paper highlights findings from a RA study in Alberta, Canada conducted to understand the opportunities for RA and to inform effective policy design and implementation.
Methods: Data were gathered from 14 participants through in-depth semi-structured interviews who represented various stakeholder groups with diverse knowledge and experience related to RA in Alberta. Data from these interviews were coded and thematically analyzed to generate our findings.
Results and conclusions: The findings reveal that defining RA requires a context-specific approach that considers regional conditions and individual farmer needs. Key barriers to the implementation of RA practices include Alberta's climate, short growing season and a lack of producer knowledge. Insufficient inclusion of diverse perspectives in agricultural policymaking, disincentives for early adopters of RA and the lack of incentives for farmer participation in policy discussions are identified as policy gaps requiring adjustments.
Significance: The findings highlight the need for tailored policies that accommodate the diverse needs of farmers while promoting the principles of RA. This study provides valuable insights into how farmers perceive government policies related to RA, offering policy recommendations to help develop more effective strategies to overcome barriers and promote the expansion of RA in Alberta.

1. Introduction

Regenerative Agriculture (RA) has been described as an approach to farming that prioritizes healthy soil and offers potential for addressing the challenges associated with conventional agriculture (Rhodes, 2017). It has been advocated as a method to combat effects of climate change (Kastner, 2016). However, due to the lack of a singular, widely accepted definition, the way RA is understood and practiced varies across practitioners (Khangura et al., 2023; Newton et al., 2020). This lack of a clear definition makes it difficult to promote RA as a credible farming practice (Mambo and Lhermie, 2024; Newton et al., 2020). Although policies have enabled shifts towards sustainability in agricultural practices (Gish, 2022), the absence of effective agricultural policies remains a barrier to enabling the widespread transition to RA.

The lack of a clear definition can create several challenges (Newton et al., 2020). Due to the difficulty in comparing the benefits and drawbacks of RA, research in RA becomes complicated due to the challenges in measuring and evaluating RA's impact (Jayasinghe et al., 2023; Khangura et al., 2023). A comprehensive definition is essential in enabling policymakers to develop supportive frameworks to help measure progress made towards sustainable initiatives (Schreefel et al., 2020). Beacham et al. (2023) illustrates the implications of offering incentives for rewarding farmers' good farming practices in RA without a clear definition as it leads to misconceptions as to its impacts due to "*overly loose terms*" (p. 6), it ends up being conflated to approaches such as agroecology. These challenges highlight the need to establish a comprehensive understanding and/or definition of RA, which would facilitate more effective research, implementation, and policy development.

Despite a lack of consensus on its definition there is notable growing interest in this field within North America, as it is referenced by governments, producer organizations, farmers and agri-food corporations as an agricultural approach that can foster both positive ecological outcomes and food production (Leu, 2020; Tittonell et al., 2022; Wilson

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et al., 2022). Despite growing interest in this approach, its role in policy remains unclear in terms of whether government entities view this as a viable agricultural practice. Policy programs supporting the growth of RA have been present in Canada at both federal and provincial level. However these policy programs do not explicitly refer to RA by name (except British Columbia and Living labs) (British Columbia Ministry of Agriculture and Food, 2024). These programs reference practices that are common to RA and other forms of agriculture which include conservation agriculture, sustainable agriculture, agroecology, and organic agriculture.

Interest in the RA approach continues to grow among various stakeholders within the sector, with much attention being spent on understanding RA, its differences from other agricultural approaches, and its potential benefits. Given the importance of policy in enabling transitions within the agricultural sector (Al-Kaisi and Lal, 2020; Tittonell et al., 2022), our study gathers insights from practitioners and stakeholders related to RA operating in Alberta, Canada about the role of policy in fostering a transition to RA. Alberta has an opportunity to enhance its agricultural policies and programs by recognizing the benefits of RA methods, which are already in use, and could be integrated into existing regulatory frameworks. This integration could help Alberta's agriculture industry proactively adapt to and mitigate challenges like soil erosion and the impacts of extreme climate events, such as drought, which have negative economic consequences on agricultural productivity (Gilbert and McLeman, 2010; Larney et al., 1995).

1.1. Purpose of the study

In this study, we elicit producers' perspectives on a definition of RA within Alberta to understand opportunities and identify gaps in government policy promoting RA in Alberta. The findings will inform an understanding of the extent of RA utilization in Alberta and pinpoint areas that require additional support to facilitate the development of evidence-based agricultural policies (El Benni et al., 2023). Government support and other policy mechanisms play an important role in supporting the adoption of sustainable agriculture practices (Barbosa, 2024; Piñeiro et al., 2020) and an identification of the opportunities and gaps in government policy promoting RA in Alberta will, in turn, help inform the adoption of sustainable agricultural policies. To identify opportunities and gaps, we ask the following questions in our study.

- How is RA understood and defined by stakeholders in the sector within Alberta?
- What specific RA practices are being implemented and utilized by producers in Alberta?
- What are the challenges and barriers to implementing and expanding RA practices in Alberta?
- What are areas where policy adjustments are needed to foster adoption of RA in Alberta?

The remainder of this introduction section provides a literature review on topics that include the distinction of RA from other farming approaches and the current policy landscape RA is situated in within the Alberta context. An overview of the methodological approach follows that includes a description of the participants, sampling approach, and the analysis methods. This is followed by the results and discussion sections, highlighting the major findings of the study and situating them within the context of the academic literature and policy context of Alberta. The conclusion summarizes the insights from the study and includes a discussion on the evidence collected and solutions provided along with a discussion on how new policies or changes to existing policies may be brought about.

1.2. The Murky distinction of RA

The definitional fluidity of RA presents both opportunities and challenges. On the one hand, RA's broad appeal enables diverse actors to rally around a shared vision of agricultural sustainability (Gosnell et al., 2019). On the other, it creates space for confusion, co-optation, and critique. Giller et al. (2021) argue that RA is increasingly used as a catch-all term for a variety of practices which include no-till farming and holistic grazing, many of which are neither new nor uniquely regenerative. For instance, large agribusinesses have incorporated RA language into sustainability marketing campaigns without clearly altering conventional production methods (Wilson et al., 2025).

The popularity of RA mirrors earlier waves of environmentally motivated agricultural reform. Since at least the 1970s, agricultural approaches such as organic farming, biodynamic, permaculture, and agroecology have been promoted as more sustainable alternatives to industrial farming (Mambo and Lhermie, 2024; Pretty, 2007). These paradigms emerged in response to the global question of how humanity can feed itself without exhausting the ecological systems upon which agriculture depends (Foley et al., 2011; Garnett et al., 2013). RA continues this trend by offering an ethos of reciprocity with nature which seeks to align food production with the regeneration of soil, biodiversity, and water systems, rather than merely reducing harm (Rhodes, 2017; Schreefel et al., 2022).

This regenerative ethos is often framed as a paradigm shift (Gosnell, 2022; Gosnell et al., 2019), contrasting with industrial models based on extraction and control. Yet scholars remain divided on RA's viability at scale. Rhodes (2017) argues that no agricultural system to date has succeeded in nourishing large populations without eroding the very resources it depends on. While preliminary studies suggest that practices like cover cropping, composting, and rotational grazing can enhance soil health and ecosystem services (Giller et al., 2021; LaCanne and Lundgren, 2018), more longitudinal and geographically diverse research is needed to evaluate RA's efficacy across social, economic, and ecological contexts (Newton et al., 2020).

Despite these knowledge gaps, RA is being actively promoted by governments, NGOs, corporations, and producers (Gordon et al., 2022). This surge of interest may stem less from empirical validation than from RA's aspirational and ethical appeal. However, widespread adoption without clear standards risks superficial implementation or "greenwashing," especially when corporations invoke RA to signal sustainability without systemic change (Gordon et al., 2022; Newton et al., 2020; Tittonell et al., 2022).

A further complication lies in the distinction between regenerative and sustainable agriculture. These terms are often used interchangeably, yet they reflect different conceptual frameworks. Sustainable agriculture generally emphasizes maintaining agricultural productivity while minimizing harm, ensuring intergenerational equity and long-term food security (Pretty, 2007; Tilman et al., 2002). It often centers on stabilizing existing systems through incremental improvements like reduced chemical input, soil conservation, and energy efficiency (Kassam et al., 2009). RA, by contrast, aspires to go beyond sustainability by actively improving ecological conditions. Proponents emphasize the restoration of soil organic matter, enhanced biodiversity, carbon sequestration, and improved hydrological cycles (LaCanne and Lundgren, 2018; Rhodes, 2017; Schreefel et al., 2022). This distinction may appear subtle but reflects different paradigms: one focused on minimization of impact, the other on ecological regeneration and resilience. As such, sustainable agriculture and RA exist on a continuum (at least conceptually) where what is regenerative is sustainable, but what is sustainable is not necessarily regenerative.

Importantly, many practices now labeled as regenerative such as no-till agriculture, composting, polycultures, and rotational grazing have deep roots in agroecology, organic farming, and Indigenous and traditional knowledge systems (Sands et al., 2023). As Tittonell et al.'s (Tittonell et al., 2022) paper refers to RA as "*agroecology without politics*," (p1), it's a rebranding that may strip away the socio-political commitments of movements it draws from. Thus, the rise of RA also raises concerns about the epistemic authority through which farming

knowledge is validated, particularly when Indigenous practices are repackaged through Western scientific frameworks without acknowledgement of their origins (Sands et al., 2023).

1.3. Extent of RA in Canada

RA is gaining increasing recognition in Canada as a viable strategy for improving soil health, preserving biodiversity, and fostering more resilient food systems. This growing interest is largely a response to the long-term challenges posed by industrial farming practices, which have historically emphasized short-term productivity often at the expense of ecological integrity (Obregón et al., 2023a,b). As concerns about soil degradation, water scarcity, and climate change intensify, regenerative approaches are being viewed not only as corrective but also as proactive measures to future-proof Canadian agriculture against environmental shocks and economic uncertainty (Cannon, 2022).

Rather than entirely replacing conventional farming, RA is emerging as a complementary set of practices within the broader agricultural landscape. Many Canadian farmers continue to employ traditional methods while simultaneously experimenting with regenerative techniques such as cover cropping, reduced tillage, intercropping, and diverse crop rotations (Obregón et al., 2023a,b). The degree of adoption varies widely by region. In provinces where local environmental conditions support these practices, or where government programs provide targeted incentives, integration has been more noticeable. These blended approaches reflect a pragmatic transition strategy that aligns ecological goals with existing farm operations.

Despite increasing momentum, the expansion of RA in Canada is constrained by several persistent challenges. A major barrier lies in the ambiguity of the term itself, without a universally accepted definition, RA is subject to multiple interpretations, which can dilute its coherence as a movement (Newton et al., 2020; Obregón et al., 2023a). Financial hurdles, including the high upfront costs of transitioning to new systems and the potential for reduced yields during the early years, further deter widespread adoption (Gammage et al., 2023; "Regenerative Agriculture, " n.d.). In addition, technical knowledge gaps and the limited availability of regionally tailored support services complicate implementation. Structural issues like fragmented land tenure, where a significant number of farmers lease rather than own their land, make it difficult to justify the long-term investments required to realize the full benefits of regenerative practices (Obregón et al., 2023a,b).

Demographic shifts in Canada's farming population also shape the trajectory of RA. Younger farmers, who are generally more attuned to environmental concerns and long-term sustainability, are often more willing to adopt regenerative practices (Obregón et al., 2023a,b). Their openness to innovation and holistic land management contrasts with the traditional methods favored by many older farmers. Meanwhile, the aging agricultural workforce and the declining rates of intergenerational farm transfers introduce additional pressures that may either accelerate or impede the spread of regenerative methods (Chen and Jia, 2022). These demographic dynamics underscore the importance of targeted outreach and education to support a new generation of land stewards.

Public and private actors alike are increasingly engaging in efforts to facilitate the shift toward RA. Governmental programs, such as cost-sharing initiatives and climate-resilience funding, are beginning to lower the financial risks of adoption (Alberta Government, 2024; Government of Canada, 2023). At the same time, private sector engagement from food companies aligning their supply chains with sustainability goals to financial institutions offering green investment instruments is helping to mainstream regenerative approaches ("McCain Regen Fries | Regenerative Agriculture," n.d.). Community-based programs and producer-led networks are also playing a critical role in knowledge exchange and mutual support. Nevertheless, these mechanisms remain in a formative stage, and broader systemic change will require more cohesive and scalable policy frameworks.

RA currently represents a promising but still emergent facet of Canada's agricultural sector. Its capacity to deliver triple-bottom-line benefits which include economic viability, environmental restoration, and social well-being is increasingly acknowledged among stakeholders (Obregón et al., 2023a,b). However, the overall pace of change is moderated by persistent structural barriers, such as unclear definitions, financial risks, and entrenched production models. Successful integration of regenerative practices will depend on the development of inclusive, context-sensitive policies and the alignment of regenerative goals with farm business strategies. As policy debates, grassroots initiatives, and market innovations continue to evolve, so too will the extent and impact of RA in shaping the future of Canadian farming.

1.4. Current policy

In Canada, recent initiatives and funding streams have been introduced to support RA. These include the Sustainable Canadian Agricultural Partnership (SCAP) (Government of Canada, 2023), and the inclusion of RA practices in the Canada-B.C. Knowledge and Technology Transfer Program (KTTP), (British Columbia Ministry of Agriculture and Food, 2024). Additionally, in 2021, B.C. launched the Regenerative Agriculture and Agritech Network to "drive transformation and modernization in the agriculture sector" (British Columbia, 2021, para. 11) and promote the adoption of RA practices among farmers. More recently in Alberta, in July 2024, PrairiesCan announced funding of $250,000 for creating a Regenerative Agricultural Lab for the Stettler Adult Learning Centre to promote the adoption of RA among agri-producers (Government of Canada, 2024). This government funding specific to RA demonstrates the federal government's commitment to transforming agricultural practices towards sustainability as part of the Framework to Build a Green Prairie Economy (Government of Canada, 2023).

Alberta's dedication to advancing sustainability within its agricultural sector is evident through its agreements with the federal government, including the 5-year SCAP program launched in 2023, which includes The Resilient Agricultural Landscape Program (RALP) (Alberta Government, 2024). RALP provides funding to help agri-producers "to conserve and enhance the environmental resiliency of their agricultural landscapes" (Alberta Government, 2024, para. 1). RALP evaluates funding eligibility based on improvements in carbon sequestration, livestock impacts, and enhancements to water and biodiversity, promoting sustainable practices within Alberta (Alberta Government, 2024).

The Government of Alberta's Soil Conservation Act is a piece of legislation that aligns with one of the core foci of RA which is 'care for the soil.' According to the Agricultural Lands Law and Policy in Alberta (Powell, 2019), the Soil Conservation Act serves as Alberta's predominant legislation for the conservation of agricultural soil (Alberta Government, 2022a). In section 3 of The Act, it is mandated that all agricultural landholders are required "to prevent soil loss or deterioration of soil from taking place" on their land (Alberta Government, 2022a). The Act establishes Agricultural Service Boards (ASBs), who act as local advisory bodies that collaborate with municipal councils and the Minister to develop agricultural policies tailored to municipalities, as per section 2 of the Agricultural Service Board Act (Alberta Government, 2022b).

2. Methodological approach

This study employs a qualitative approach using in-depth semi-structured interviews to examine perspectives of farmers and other agricultural stakeholders experienced in RA on a definition of RA within the context of Alberta. Interview data were thematically analyzed using NVivo to identify the experiences, attitudes, and perceptions of the participants. While qualitative approaches provide rich, detailed insights (Braun and Clarke, 2006; Rutledge and Hogg, 2020) they also carry the potential for subject bias, which can significantly impact the

validity of the results (Galdas, 2017). Given the qualitative nature of this study, participant bias was a primary concern, as participants could have misunderstood questions or provided answers that are socially desirable. To mitigate this, the questionnaire was designed with open-ended responses, allowing participants to freely express their thoughts without being limited by predefined options. Follow-up questions were crafted to further explore and clarify participants' answers while intentionally avoiding leading questions that could influence their responses. This approach to research is supported by other recent scholars including Frankel-Goldwater et al. (2024) and Chapman et al. (2019).

2.1. Interview recruitment

Participants were recruited using convenience and snowball sampling methods, targeting individuals in Alberta with relevant experience and expertise in RA. Initial participants were identified from predetermined lists of members belonging to producer groups such as Rural Routes to Climate Solutions. Additional participants were identified through a Google search, which helped identify individuals and organizations with publicly available information indicating their expertise and involvement in RA within Alberta. Recruitment strategies included sharing recruitment letters via email and creating posts on LinkedIn to identify potential participants through professional networks.

Following the initial identification phase, purposive and snowball sampling methods were employed to recruit additional participants. From these lists, we shortlisted a subset of stakeholders with knowledge and experience in RA for in-depth interviews. All participants were provided with information about the research study and gave their verbal and written consent before participating in the interview as per the University of Calgary's Conjoint Faculties Research Ethics Board from which this study got approval.

2.2. Participants

A total of 14 participants, all residing in Alberta, were recruited for this study. Each participant possessed some level of knowledge and experience with RA, either through personal or professional involvement. Participants represented various occupations and agricultural operations within the RA sector ahs shown in Table 1.

Table 1
Thematic domains, thematic categories and corresponding themes.

Thematic domains	Thematic categories	Themes
Understanding of RA	Personal definition	● Best practices for preserving and enhancing soil and land health ● Context-specific
Utilization of RA practices	Current implementation of RA practices	● Cover crop diversity, ground cover ● Integrating livestock, grazing practices ● Limiting chemical use
	Obstacles to implementing	● Extreme climate ● Insufficient knowledge
Barriers to the expansion of RA	Perceptions of government policies	● Disincentives for early adopters ● political and economic barriers
	Barriers to participating in policy discussions and policy development for RA	● Power imbalance and distrust in external authorities
	Experience securing financial assistance	● Ineffective government funding programs
Opportunities for policy design and implementation	Areas for policy adjustment	● Avoid harsh and/or broad mandates ● Balance rewards and penalties ● Education and tailored support

Participant	Agricultural Operation	Additional roles
P1		Government
P2	Rancher	
P3	Rancher	Business owner
P4		Agriculture Consultant
P5		Producer Organization
P6	Rancher	
P7	Livestock mowing operator & Rancher	Educator
P8	Rancher	Agriculture Consultant
P9	Rancher	
P10	Berry Farmer	
P11		Business owner
P12	Grain farmer	Government
P13	Grain Farmer	
P14	Vegetable producer	

Multiple participants wore multiple hats such as being an educator and running a ranch. Participants represented 11 different counties across the province and were largely concentrated in central Alberta (see Fig. 1). Of the 14 participants, one was Indigenous, 3 were Caucasian women and the rest of the participants were Caucasian men. The median farm size of the participants was 2200 acres. The largest farm was 50,000 acres and the smallest farm was 60 acres.

A sample size of 12 interviews is typically sufficient for conducting a thematic analysis (Braun and Clarke, 2006). While the threshold for thematic analysis was met, the sample size is small relative to farming operations across Alberta. Nonetheless, the diversity of operations and geographical regions within the participant pool enables us to gather important insights. Our sample size relative to the agricultural operations in the province match sample representations found in Frankel-Goldwater et al.'s. (2024) study.

Fig. 1. Geographic locations of participants by county.

2.3. Data collection

Semi-structured interviews were conducted using an interview guide that included a set of open-ended questions across four thematic domains. These open-ended questions allowed participants to freely respond and share detailed insights through story telling. Probing questions enabled participants to elaborate further and provide deeper insights into their experiences and perspectives.

Questions in the interview guide were organized into four thematic domains: 1) understanding of RA; 2) utilization of RA practices; 3) barriers to the expansion of RA; and 4) opportunities for policy design and implementation. Each thematic domain represents a specific area of focus, while questions within each thematic category were designed to explore specific aspects related to the broader domain. This structure ensured that the interviews comprehensively covered all relevant topics, allowing for detailed and organized data collection.

The majority of the interviews were conducted virtually using the Microsoft Teams communication platform and lasted approximately 60 min each. Due to technical difficulties, 2 interviews were conducted over the phone. Given Alberta's expansive geography, conducting interviews via Microsoft Teams was a practical approach, allowing participants to engage from their own locations without the need to travel. All interviews were conducted in English. Data collection took place over a three-month period from April to August 2024.

2.4. Data analysis

To ensure accuracy, audio recordings were automatically transcribed into text using Microsoft Teams. Transcripts were reviewed and compared to the audio recordings to ensure fidelity. All identifiable information was removed from the transcripts to protect participants' anonymity. Data analysis was conducted using NVivo 14 software. Thematic analysis, as developed by Braun and Clarke (2006), was employed.

Four thematic domains pertaining to the research questions were created in NVivo prior to analysis to systematically categorize and analyze the data, facilitating a comprehensive view of the main focus of the research. A mixed approach of inductive and deductive thematic analysis was undertaken in four phases.

1. **Phase One – Deductive approach:** Four predefined codes acting as thematic domains were created, with predefined thematic categories corresponding to the thematic domains resulting in a total of 7 thematic categories. This structured approach allowed for the initial categorization of the data, facilitating the organization of the data required for phase 2.
2. **Phase Two – Inductive approach:** The data was reviewed to gain familiarity and a comprehensive understanding. Initial codes were created for each of the thematic categories by identifying significant and insightful concepts within the data. These data were extracted and tagged with a word or phrase representing the general meaning of the data and annotated to pursue further understanding. As many initial codes as time allowed were created, focusing on data relevant to the research questions.
3. **Phase Three – Second review:** The data was reviewed a second time to identify any missing data that was not coded in phase two and to ensure all data was appropriately coded. This phase ensured accuracy in the coding process.
4. **Phase Four – Theme identification and refinement:** Overarching themes were identified by organizing, combining, and refining the initial codes. Themes were reviewed to ensure they accurately reflected the assigned data. Sub-themes were created when necessary to enable a deeper analysis of particular aspects, capture the complexity of the data, and organize it more logically for coherent overall analysis. Certain themes were combined or discarded to ensure that findings meaningfully addressed the research questions. We focused on the most common and relevant themes that directly addressed the research questions and objectives of the study. Considerations for identifying key themes include the frequency of the theme appearing across the data set, as indicated by the number of references coded for each theme and the richness of data that provided in-depth experiences, perspectives and understanding.

3. Results

3.1. Thematic domains, thematic categories and corresponding themes

Four thematic domains and seven thematic categories were used to identify main themes that emerged from the analysis (see Table 1). Corresponding sub-themes under main themes provide more specific aspects of the findings.

3.1.1. Participant's understanding of RA

Participants primarily defined RA as a set of best practices aimed at enhancing or preserving land and soil health. They frequently cited the six soil health principles, sometimes referred to as 6-3-4TM, as a widely recognized and utilized framework for best practices in RA (Williams, 2022). They referenced various aspects of the framework, including its usefulness in acting as a guide for improving land and soil through "six principles of soil health" (para. 3), "three rules of adaptive stewardship" (para. 4), and "four ecosystem processes" (para. 5), ultimately helping to work with the power of nature (Williams, 2022). This focus on practices/principles was supported by participant P12 who stated that a focus on the practices/principles was a suitable approach to defining RA as the processes are verified in their ability to achieve the desired outcomes. A perspective offered by other participants who subscribed to the 6 soil health principles put the focus more on RA being about the outcome rather than the process. Participant P2 provides their understanding and definition of RA, saying,

> "Most people when they hear regenerative, what they mean is trying to employ as many of the five or six soil health principles as possible. And I think it's an insight that I would hold true regenerative agriculture for my own personal definition. It uses and employs those principles, but regenerative is the outcome that we're looking for. It's not the method, indeed."

Many participants expressed that RA has many parallels to organic certification in terms of best practices but noted that RA is less of a "black and white system" (P10). They described RA as a more inclusive approach that is flexible in improving soil structure, rather than being stringent about what you can or cannot use, as is the case with organic certification.

3.1.2. Context-specific

Although participants described best practices as the guiding framework for RA, they frequently emphasized that RA methods are highly contextual and must be adapted to local needs and conditions. Participants note that not all RA practices will be used the same way on every farm. Participant P10 mentions, "*This is more of a use of principles, products and stuff like that and everyone's a little bit different to get to their end game.*"

Participants highlighted that factors such as the farmer's personality, culture, geographic location, and social context influence the diverse ways RA is practiced and the achievement of desired outcomes. They frequently noted that RA requires context-specific methods that align with the unique needs and values of each farmer. They expressed that the needs and effective strategies for farming in one region might differ significantly from another due to varying environmental conditions and available resources. Some participants mentioned their mixed feelings about trying to define RA due to its contextual nature, concerned that when we "*simplify it down to actions*" (P11), there is potential to erode the true essence of the practice.

3.2. Utilization of RA practices

3.2.1. Cover crop diversity and ground cover

The most common RA practice participants noted was cover cropping, aimed at protecting soil from the sun and wind. As one participant said, "*we know that when we leave cover on the soil, it helps*" (P6). They shared the benefits of implementing diverse practices and sowing diverse plant species, specifically highlighting multispecies and perennial cover cropping as beneficial for livestock feed due to its ease of harvesting and regrowth. For ground cover, variations of fescues and clover were noted for preventing soil loss in dry, windy conditions and keeping soil cooler. Other participants reported that legume ground cover was beneficial for horse feed and rejuvenating pastures. Participants also identified polyculture as a key practice within RA, noting that it maximizes photosynthesis and benefits pollination, particularly when combined with limited synthetic fertilizers.

3.2.2. Integrating livestock and grazing practices

Participants with livestock also employ diverse grazing practices such as bale grazing, rotational grazing, and targeted grazing. They cite these methods as strategic ways to mimic natural ecological processes for improving land and controlling land vegetation. As participant P7 shares, "*I think it's really about working with your land, and so using the animals as tools to improve your land while still balancing their performance and health.*"

Like the benefits of grazing cover crops, participants noted that integrating livestock has reduced or replaced the need for chemical fertilizers and herbicides, promoting animal health and well-being. Participants noted the various types of livestock they integrate, including horses, cattle, bison, elk and deer, with the intention to improve soil health, promote plant growth and maintain ecosystem balance. Participants indicated they intentionally use livestock and grazing practices to mimic the positive effects on the land that hoofed animals had before conventional agriculture became dominant.

3.2.3. Limiting chemical use

Participants frequently mentioned reducing chemical use as a key RA practice. Participants expressed the reasons for eliminating chemicals as beneficial to environmental health and human health, as participant P8 shared, "*synthetic fertilizer, herbicide, insecticide, pesticide, any of those words that end in 'cide', is the same as homicide and suicide.*" While not all participants are able to eliminate chemicals entirely, there is a strong consensus that reliance on chemicals contradicts healthy soil principles and goes against the beliefs and values integral to practicing RA. In addition to growing polycultures and integrating livestock, participants strive to limit chemical use by employing strategies such as using a rotary harrow during the spring to reduce preburn herbicide use and conducting soil testing to avoid over-fertilization.

3.3. Obstacles to implementing RA practices

3.3.1. Extreme climate

Participants identified drought and season length as significant obstacles to implementing RA practices, particularly cover cropping. Participant P4 noted, "*Something like cover crops, they take too much water, and they can't even get them established when it doesn't rain and under irrigation.*" They further highlight that the financial risk associated with uncertain yields due to extreme climate and short growing season discourages farmers from adopting cover cropping. Participant P4 shared,

> "*It's very hard to find payback and a lot of times, especially in our dry weather, it can, it can hurt you because if you use up all your moisture and then you're gonna try to plant a crop and there's no moisture there or your nutrients are tied up, then it's gonna cost you more. So, it's just too risky right now.*"

Another moisture related concern was expressed by participant P2 who noted that drought conditions have left little stubble/ground cover at the end of the growing season which was quickly consumed by the soil microbes in their biologically active soils. Once this surface ground cover had been consumed, it left the soil exposed to wind erosion.

> Alberta's short growing season and harsh winters also pose a challenge for cover cropping. Participant P5 noted, "*mostly because it's rather difficult to get a cover crop established or it's definitely more difficult to get a cover crop established here before winter sets in.*" These conditions sometimes necessitate increased use of chemical inputs to grow more feed, which contradicts the principles of RA. Participant P6 describes the challenges with drought combined with limiting chemical inputs, stating, "*We have been experiencing a drought, and the reduction of cultivation and the attempted reduction of synthetic herbicides has created some challenges. Germination hasn't been great because of the drought, so we have weeds.*"

As participants seek to better integrate cover crops into their operation, they face increasing challenges, with some years being more difficult than others. They highlight that rising drought incidence affects everyone, regardless of their RA practices. Exclusive crop producers encounter specific difficulties with cover crops, as they often need to wait until after their main crop harvest to seed cover crops, leaving limited time in the season to benefit from them.

3.3.2. Insufficient knowledge

Insufficient knowledge and lack of understanding of best practices was identified by participants, especially when first starting with RA, as a significant barrier. Some mentioned that they have overestimated the speed of biological systems for improving soil health or underestimated inputs needed for sustainable ecosystems.

Moreover, despite the availability of research regarding benefits of RA practices, participants noted that they struggle to access and understand these studies due to cost barriers and the complexity of translating academic findings into practical applications on their farm. Participant P10 states,

> "There's a lot of amazing research papers out there, but trying to understand them and then apply them to my farms, that's a whole full time job. A lot of the work that academia does is hard to find because I don't have $40 to $80 per research study. So that's a barrier to entry I think for academia to the average farmer."

Participants also frequently mention the gap in academia in supporting sufficient research to demonstrate the effects of RA. They refer to a lack of interest in funding RA research from both industry and government, alongside limited academic institutions offering diplomas, courses or formalized training for RA. Additionally, they point out the difficulties in applying conventional research methods to RA due to its long-term nature, whereas traditional research often focuses on short-term, isolated variables, making it challenging to capture the full benefits and effectiveness of RA practices using standard research methodologies.

Participants reported insufficient knowledge regarding crop production. Unlike ranching operations where participants could rely on information and mentors through forage associations, crop producers reported largely relying on books, and even "*YouTube University*" (P8). Even the educators affiliated with agricultural colleges noted largely getting their information from books and online resources rather than validated knowledge through their institutions.

3.4. Barriers to the expansion of RA: perceptions of government policies in facilitating or impeding the expansion of RA

3.4.1. Disincentives for early adopters

Participants noted that government programs intended to support farmers adopting RA practices often exclude early adopters, who do not

receive the same incentives as those just starting, creating frustration for those already implementing RA practices. Participant P3 cited challenges with the On-Farm Climate Action Fund (OCAF), a program offered by Government of Canada which supports the adoption of "nitrogen management, cover cropping and rotational grazing practices" (Government of Canada, 2021, para. 3), noting that early adopters are not eligible for the program's incentives. Participant P9 shares their frustration, stating,

> "*The most recent frustrating one is trying to deal with the government programs for implementing regenerative practices that are paying people to transition. But they're like, oh, you're already doing it. Well, you can't qualify for stuff. So, that's been kind of frustrating."*

Additionally, farmers who want to adopt RA practices often lack financial support and knowledge, placing the burden on experienced farmers who mentor others while managing their own farms and not receiving any incentives to support early adopters. As participant P11 noted, "*they end up running their farm and then also providing free mentorship services for a wide variety of other farmers.*" This lack of support is perceived by participants as hindering the sustainability of RA practices, given the wealth of contextual knowledge some farmers hold but are not financially supported for sharing.

3.4.2. Political and economic barriers

Participants frequently mentioned their concerns with the carbon tax as a barrier for the expansion of RA due to the increased financial burden on farmers' input costs, which discourages them from adopting RA practices. They added that agriculture is politicized in Canada and polarized ideologies make it difficult to make progress on the widespread adoption of RA. As participant P1 said,

> "Sometimes you get an understanding of responsibility, and all these ideologies come in and they've got these really uber extreme, conservative attitude saying, 'well, we don't need to do that.' I wish people just put those extreme ideologies aside, try to understand what our common goal is, to have a healthy planet so we can sustain our people."

Participants believe that RA is not promoted by government, as participant P8 noted, because they are not "*motivated or rewarded or compensated for moving regenerative agriculture*," indicating political risk. They also shared that government agricultural programs are largely ineffective, burdensome, and more designed for political gain than meaningful support. Some participants expressed that these program designs lead to frustration and discouragement, providing insufficient support and making it unappealing for anyone to continue or start RA. As Participant P3 noted,

> "The programs are all universally designed to get votes by appealing to small producers and providing peanuts. But then they are also designed to wear out and work with people that are already exhausted trying to do so many different things on their own little parcel of property, that it's just God, why would anybody wanna do this?"

Another participant observed that some farmers let political ideologies overshadow their personal values, leading to decisions and practices that are more aligned with political agendas than with sustainable principles, creating a barrier to the expansion of RA. This is due to the conservative climate that dominates Alberta politics, especially in rural areas where interest in economic returns often supersede interest on conservation or the environment.

3.4.3. Power imbalance and distrust in external authorities

Participants believe it is important for farmers to be involved in policy discussions, but they frequently perceive a power imbalance and distrust in external authorities as barriers to their participation. They feel that industrial influences are more powerful than they are, leading them to view the system as inherently unfair or "*set to screw us*" (P3), ultimately discouraging them from participating. Participants highlighted challenges with policy decisions often made without fully understanding or representing their interests, creating a sense of disconnect. Participant P6 noted,

> *"An important thing is recognizing what's happening out here on the ground and the challenge with that is our voices are small now there are fewer and fewer of us, whether we be regenerative or not. So, there's fewer and fewer of us, we have fewer and fewer rural MLAs'* (Members of the Legislative Assembly) *to* support *us and to help us."*

Participants believe policy discussions should create an opportunity to increase local participation and amplify diverse perspectives in developing agricultural policy. As participant P3 noted, "*It's important the right ones with the right concepts and ideas based on real ecological principles and processes and real economic realities and true finance comprehension of what it takes to make a system work.*"

Some participants noted other barriers to their participation, such as self-perceived inadequate skills preventing them from contributing the way they'd like or not encountering opportunities to participate. Participant P2 noted that they do not get involved in policy discussions because they expect their organizations to do so on their behalf.

Alternatively, a view expressed by P12 who is employed by the Alberta Government noted that the policy making process is an open one and they are always seeking more involvement from producers in the development of policy. However, producers are often unable to participate through the process due to time constraints. P12 notes that policy development is a long and arduous process that most producers don't have the capacity and resources to see it all the way through.

3.4.4. Ineffective government funding programs

Participants frequently noted that there is insufficient government funding to help people transition to RA. Some participants mentioned that funding programs are not effectively designed to support ecological systems, stating that capping the amount of funds available per producer disincentivizes those operating at a large scale and that programs are "*not designed to create massive change*" (P3). Participant P6 noted that some individuals who were encouraged to adopt RA practices under the impression they would receive grant money found themselves financially strained when the funding ran out and they had to bear the full cost themselves.

There is also concern that current research and funding focus too narrowly on methane emissions rather than considering the full carbon cycle. Participant P7 expressed frustration with this limited focus, arguing that a holistic approach that measures both emissions and carbon sequestration would provide a more accurate assessment of the ecological benefits of RA. Another participant noted that securing research funding often requires including a carbon related goal; if a research proposal cannot integrate this, it is unlikely to receive funding. Many participants noted they are resistant to programs that only measure one aspect or have a limited focus, feeling that this overlooks the broader benefits of their sustainable practices. They prefer metrics that reflect the full environmental impact, such as carbon sequestration through plant growth and soil health.

Additionally, P7 spoke about greenhouse gas emissions targets as a barrier to funding. They reference that the 30 % reduction target in fertilizer greenhouse gas emissions caused confusion, as it was initially interpreted as requiring a 30 % reduction in fertilizer use, which was considered unfeasible. It was later clarified to focus on emissions reduction rather than fertilizer use, but the benefits of using inhibitors to reduce emissions without impacting yield were not well understood or accepted by farmers. As participant P4 noted, "*Why would a farmer pay more money to use something that's not gonna give them anything back?*" Participants reiterated that they are unlikely to invest in technologies or products that reduce emissions if they do not also improve yield or offer other direct advantages, citing the financial risk of doing so.

3.5. Opportunities for policy design and implementation: areas for policy adjustment

3.5.1. Avoid harsh and/or broad mandates

Participants believe there is an opportunity to create policies that are better targeted and focused, with tailored approaches to "*find the best solutions for the farm*" (P4). They see an opportunity to foster understanding and support for creating a favourable environment for the adoption of RA without resorting to harsh mandates or overregulation. Participants noted that overly strict policies are likely to be ignored, and a more flexible, supportive approach is needed. Participants mentioned that mandates must come with incentives and adequate support. For example, providing subsidies for zero-till equipment or covering upfront costs for seeds can help early adopters transition to RA without taking on financial risk, allowing them to experiment with what works rather than forcing a one-size-fits-all mandate.

Additionally, participants shared that farmers are more likely to adopt RA practices if they can see tangible benefits, implying a preference for policies that demonstrate the advantages of RA rather than enforcing changes without clear evidence of success. Participants suggested that acceptance for mandates might first be built through campaigns focusing on specific benefits of regenerative practices, highlighting success stories and providing education on the long-term advantages for both the environment and agricultural sustainability.

3.5.2. Balance rewards and penalties

Overall, participants noted their preference for policies that incentivize good practices rather than using penalties to enforce behaviour. As participant P3 shared, "*We need to focus on changing a path to success for the people that are gonna steward those lands, but we need to do it by stopping the punishment and the disincentives.*" However, participants argued that there needs to be a balanced approach using both penalties and rewards to encourage sustainable practices. Some participants noted that farmers who purchase vast quantities of land as financial investments often neglect soil health. As a result, policies were implemented to enforce responsible land stewardship, including penalties such as revoking farming privileges for non-compliance. Conversely, good farming practices were rewarded with more access to farmland.

Participant P11 reported contradictions in attitudes where farmers want financial support for good practices but resist regulatory measures that enforce them. For example, while some farmers prefer to be paid for preserving wetlands, they resist outright regulations that would prohibit draining them. They suggested implementing a levy system where farmers who engage in harmful practices, such as excessive nitrogen use, pay a fee. This money could then be used to support farmers who are adopting sustainable practices, such as funding a mentorship program that financially incentivizes early adopters.

Participants provide other examples of rewards, such as tax breaks for maintaining healthy landscapes, watersheds and sustainable practices, as a way to incentivize good environmental stewardship. They believe that these incentives help motivate and encourage farmers to adopt and maintain sustainable farming practices. Furthermore, participants emphasize the importance of creating a supportive policy environment that recognizes and rewards the efforts of farmers who are proactive in their stewardship of the land. This approach, combining both rewards and penalties, aims to advance the widespread adoption of RA that benefits both the environment and the farming community.

3.5.3. Education and tailored support

Participants frequently discussed opportunities for policies to focus on tailored environmental education and outreach for farmers. They emphasized that education is one of the most important factors for advancing RA, both for public awareness to garner support and for farmers themselves. They noted that farmers who lack education might unintentionally engage in harmful practices. Conversely, farmers cannot be rewarded for good behavior if they are unaware of how to implement effective practices on their farms.

Participants believe the best approach is to encourage farmers to be educated on the benefits of transitioning to RA and to be incentivized to do so. "*There isn't enough policy in place that's using the carrot approach to encourage people to educate people as to why they wouldn't want to transition*" (P8). Participants provided examples to enhance education, such as post-secondary education offering diplomas or courses, working with consultants, allowing farmers to access practical research, or enabling farmers to observe and learn from the anecdotal evidence of what other farmers are doing.

Participants believed that government agents or extension services that help educate and support farmers should be re-implemented, citing a program Alberta used to have but canceled. As participant P4 shared,

> "There needs to be the people out there that are resources for it from the government like what we used to have. It was the current government and in their last mandate. They just eliminated almost all the extension out there. When you don't have any kind of third party resources, then it's a challenge. So yeah, we need to kind of build up again. Unfortunately a lot of things got cut."

Participants are in favour of policies that support research to produce evidence-based information relevant to their local context and emphasized the importance of communication between researchers and farmers.

4. Discussion

4.1. How RA is understood

Participants view RA as a flexible set of best practices rooted in soil health and environmental sustainability, with effectiveness depending on regional adaptation. This aligns with Buckton et al. (2023), Schreefel et al. (2022), and Giller et al. (2021), who emphasize the importance of tailoring RA to local conditions. Participants also debated whether RA should be defined by its practices or outcomes, an issue reflected in the literature (Mambo and Lhermie, 2024), with concern that a practice-only focus risks cooptation if outcomes aren't verified.

The variability of contextual conditions and weather challenges participants report, highlights the importance of tailoring strategies to fit the local context in the form of "*adaptable strategies*" (Grigorieva et al., 2023, p.2). Given Alberta's large and diverse geographical landscape which includes at least 6 eco-regions, (Natural Regions Committee, 2006), it may be more practical to develop a flexible framework of best practices that reflect local conditions and needs of farms (Lemke et al., 2024). An illustration of this could be that rather than mandating the complete elimination of chemical inputs, which might be difficult for some farmers in Alberta, an adaptive framework could encourage a reduction in their use instead. This approach would allow farmers to use chemical inputs under specific situations at their discretion. Such flexibility acknowledges the diverse agricultural contexts and needs of farmers in Alberta, making RA more achievable.

4.2. Extreme weather and insufficient knowledge

Frequent droughts in Alberta pose major challenges to RA practices like cover cropping, making adoption financially risky due to uncertain yields (Powell, 2019; Sulaiman and Misnan, 2022). Financial incentives are essential for adoption without burdening farmers, especially small-scale ones (Dessart et al., 2019; Dipu et al., 2022; Kenny and Castilla-Rho, 2022). Knowledge gaps also hinder adoption. Since academic research isn't always accessible, knowledge-sharing networks and mentorship (Hou, 2020; Laforge, 2017) offer practical alternatives. Group participation fosters commitment (Gosnell et al., 2019), while succession planning remains a challenge for early adopters (Obregón et al., 2023a,b). Extension services and communities of practice have proven effective for transferring localized knowledge (Danso-Abbeam,

2022; Piñeiro et al., 2020), supporting the need for stronger extension programs in Alberta.

4.3. Limited participation in policy discussions

Participants emphasized the need for more inclusive, locally grounded policy discussions. Barriers such as bureaucratic complexity and low institutional trust hinder farmer participation (Sander et al., 2024; Whitton and Carmichael, 2024). Participatory modelling (Jordan et al., 2018) offers a promising approach for integrating farmer knowledge. Concerns about corporate influence and co-optation were raised, with some farmers wary of aligning with RA for this reason. Providing incentives for participation, could increase engagement and encourage knowledge sharing among Alberta's farmers.

4.4. Need for tailored policies and enhanced education

Participants highlighted two policy priorities: context-sensitive policymaking and improved farmer education. Top-down policies risk ineffectiveness, while bottom-up approaches incorporating farmer input can ensure better adoption (Huber et al., 2024; Kenny and Castilla-Rho, 2022; Sulaiman and Misnan, 2022). This participatory, incentive-based model aligns with "*farmer-led regenerative design*" (Lunn-Rockliffe et al., 2020 p.20). Enhanced education was another major theme. Participants stressed the value of peer learning, continuous education, and advisory services (Hou, 2020; Rizzo et al., 2024). "*Knowledge brokers*" could also support knowledge exchange and adoption of sustainable practices (Rust et al., 2022 p.41).

5. Conclusion

Defining RA in Alberta requires collaboration among policymakers, farmers, and agricultural stakeholders, considering diverse farmer needs across the province. Research indicates that an adaptive strategy approach is suitable for Alberta's varied eco-regions, weather, and operational realities (Buckton et al., 2023; Huber et al., 2024; Kenny and Castilla-Rho, 2022; Schreefel et al., 2022). Policymakers can integrate RA principles into existing regulations, like Alberta's Soil Conservation Act, by emphasizing incentives and supports, avoiding the need for new legislation. Policies should help farmers implement RA practices through tailored support and educational outreach on soil conservation. Including diverse perspectives and fostering local participation in policy discussions are crucial for effective RA policies. Incentives for farmers to share their knowledge and perspectives are also vital.

Producers are skeptical of the policymaking process, perceiving it as favoring corporate entities and difficult to participate in. To enhance farmer participation, policy makers can offer honorariums or stipends for their expertise and time, and organize regular roundtable workshops with diverse agri-producers, land stewards, farmers, and ranchers practicing RA. This wound ensure that policies reflect their needs and promote inclusive policy development. Interest in RA spans all levels of agriculture, making policy crucial in shaping RA, its adoption, its ecological impacts, and agricultural resilience. Policies should support both early adopters and new operators, maintaining focus on RA's goals. Transparent reporting of outcomes and impacts can build trust and foster ongoing collaboration with the regenerative and sustainable farming community.

CRediT authorship contribution statement

Tatenda Mambo: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Francine Nelson:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Juhi Huda:** Writing – review & editing. **Guillaume Lhermie:** Writing – review & editing, Supervision, Resources, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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