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Article

Climate Change Perceptions and Associated Characteristics in Canadian Prairie Agricultural Producers

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Abstract: Climate change (CC) poses a threat to agricultural sustainability, which is important in the Canadian Prairies, as agriculture is a major occupation and driver of the economy. Agriculture involves both the creation and mitigation of emissions related to CC. To implement adaptation and mitigation practices, producers should accept CC as fact. This study is based in Saskatchewan, Canada, where CC denial is prevalent in public comments. To assess the validity of this anecdotal impression, this study provided a snapshot of Saskatchewan agricultural producers' perceptions and observations of CC and assessed whether views on CC are associated with characteristics of political orientation and affiliation, mental flexibility, systems thinking, time orientation, climate knowledge, climate observations, and demographic variables. A survey was developed with the following four sections: (1) individual characteristics; (2) observed changes in climate-related variables; (3) knowledge and perceptions about CC; and (4) demographic variables. The survey included multiple-choice questions and items scored on a Likert scale. The survey was completed by 330 Saskatchewan agricultural producers (i.e., farmers and ranchers). The results indicated more CC denial in Saskatchewan producers than in other Canadian samples. Individual and socioeconomic characteristics of lower levels of formal education, identifying as male, conservative political affiliation and ideation, low trust in science, and low mental flexibility were associated with less acceptance and concern of CC. It is therefore necessary to consider socioeconomic and individual characteristics of producers in measures aiming to increase the acceptance of the reality of CC. Future intervention research should target male producers with lower levels of formal education, low trust in science, low mental flexibility, and right-leaning political ideation for the improvement of CC perceptions and examine different teaching methods (e.g., lectures, workshops, webinars) and dissemination methods (e.g., online versus in-person sessions) to see how various techniques may influence learning, as well as the way the information is used by particular groups.

Keywords: climate change; denial; Six Americas; Saskatchewan; Canadian Prairies; agriculture

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1. Introduction

Climate change (CC) poses a threat to global crop yields and agricultural sustainability [1,2]. Agricultural sustainability is important in Saskatchewan, as agriculture is a major occupation and driver of the economy [3]. Saskatchewan is the largest crop-producing province in Canada, with approximately 47% of Canada's cropland [3]. In Saskatchewan, there were 34,523 farms run by 45,350 operators in 2016, with most farms having a total area of at least 3520 acres [4]. Farm operators are predominantly (i.e., 75%) males aged 55 and over [4]. Many adaptive practices exist throughout Saskatchewan, such as zero-till, cover cropping, feed stockpiling, increasing farm size, employing beneficial management practices, earlier seeding dates, mixed farming, and changes in crop varieties (e.g., [5]). Nonetheless, producers' overall ability to adapt will be tested by the cumulative impacts of CC [6]. Barriers to adaptation may include inadequate financial resources and supports, an

insufficient awareness of available options, a lack of preparation, and political resistance (e.g., [7]).

The agro-climate of Saskatchewan is characterized by a large temperature range and variable precipitation, which are and will be directly affected by CC that amplifies natural variability [6,8]. Since the mid-twentieth century, there have been notable changes in the climate of Saskatchewan. In Southwestern Saskatchewan, a warming of winter and spring maximum and minimum temperatures, decreased snowfall, and earlier spring runoff were observed [9]. Recent climate trends across Saskatchewan include increases in the number of days, with extreme high temperature in the winter and spring, and decreases in cold spell frequencies and extreme low temperatures [10–12]. The Prairies (i.e., Alberta, Saskatchewan, and Manitoba) have the strongest warming trends across Southern Canada, especially in winter [6]. Such changes are likely to continue in the future, with projected impacts of CC in Saskatchewan including shifting and variable precipitation patterns, more frequent and intense droughts, longer growing seasons, increasing temperature, and increased evapotranspiration [13–15]. Soil moisture deficits and more frequent and intense droughts across the Prairies during summer are likely to result from increases in evapotranspiration, despite increasing precipitation [16,17].

Agriculture is vulnerable to a variable climate, resulting in year-to-year variation in crop and livestock production [18]. Crop and pasture productivity, livestock production and reproductive rates, and nutrient cycling are impacted by variability in temperature and precipitation [19]. Indirect effects of CC on agriculture include socio-economic factors, such as effects on global food security [6]. Some indirect effects of climate change on agricultural vulnerability in Saskatchewan include financial uncertainty [20], the lack of institutional support [21], and increased conflict over water resources between agricultural producers and other industries (i.e., oil, gas, and mining [22]). Changes in evapotranspiration and the timing of temperature-related events such as spring runoff will have adverse effects on late summer water supplies and result in decreased summer soil moisture. Increases in intense droughts will negatively affect agriculture, leading to financial losses such as the over $2.97 billion reduction in agricultural production recorded across the Prairies during the drought of 2001–2002 [23]. In 2021, only 12% of cropland in Saskatchewan had topsoil with adequate moisture [24]. A change in the timing of precipitation events negatively impacts agriculture; for instance, heavy snow and rain during harvest in 2019 resulted in approximately 12% of canola in Saskatchewan, and 2.7 million acres of canola across Canada, being left unharvested [25]. Increased exposure to high temperatures (i.e., above 30 °C) and more variable precipitation can negatively affect crop yields of corn, soybeans, canola, and wheat [26–28]. Rising temperatures are also favourable for pests, diseases, and weeds [19]. Prairie agriculture could also benefit from a longer warmer growing season, although taking advantage of a favourable climate would require considerable adaptation [29].

In a cyclic relationship, climate affects agriculture, and agricultural practices affect CC. As indicated in the sixth assessment report of the Intergovernmental Panel on Climate Change [8], agriculture is an important sector for both the creation and mitigation of emissions related to CC, with agriculture accounting for 10% of Canadian greenhouse gas emissions [30]. Despite over 97% of professional climate scientists affirming the reality of anthropogenic CC, belief in the reality of CC among agricultural producers is varied [31–34]. In the Prairie Provinces, only an estimated 70% of the population accepts that the climate is changing, compared to the national average of 86% [33,35]. To implement adaptation and mitigation practices, agricultural producers (i.e., farmers and ranchers) should accept CC and understand its effects on agricultural sustainability [36]. Acceptance of the reality of CC impacts environmental behaviours, such that more acceptance and concern of CC is associated with more actions contributing to adaptation and mitigation [37,38]. Greater perceived personal risk from CC is also associated with greater adaptation and mitigation behaviours, including farm practices promoting soil health [39,40]. Studies suggest that experiencing local warming [41] and extreme weather events [42] influences

the perceived threat of CC and predicts CC mitigation if the weather events are attributed to CC. Producers have been shown to emphasize personal experience, contextualizing their views of CC in relation to experienced climate observations [43]. However, in Saskatchewan, the experienced observations often strengthened individual views of natural variability rather than CC [43]. This may be due in part to Saskatchewan having one of the most variable climates in the world [44].

Perceptions of CC consist of more than just whether or not an individual accepts that the climate is changing. Research conducted by Maibach et al. [45] identified six unique categories for CC perceptions. These categories, referred to as Global Warming's Six Americas, fall along a continuum from alarmed, with the highest belief in CC, most concern, and most motivation, to dismissive, with the lowest belief, concern, and motivation. Previous research shows that various sociodemographic and personal characteristics are associated with perceptions of CC [46,47]. In order to address CC denial and improve adaptation and mitigation practices, it is necessary to know the characteristics associated with differing CC perceptions.

In the general population, the denial of CC is linked to sociodemographic characteristics such as race, sex, age, education, and political views [46,48]. For instance, male and Caucasian identification are associated with less acceptance of the reality of CC [48]. In a British sample, individuals over the age of 55 were significantly more likely to deny the reality of CC [49]. A higher level of formal education is associated with stronger belief in CC, with a recent study in Alberta finding that placing value on learning, research, and innovation is the strongest predictor of using adaptive and mitigative practices [46,50]. In an American sample, individuals who identified with conservative political parties rejected CC more than those who identified with other parties [48]. Political ideology (i.e., the extent to which individuals report being right or left wing, along a continuous scale) is significantly related to CC view in the same direction as political affiliation, but to a lesser extent [46].

Personal characteristics such as trust in scientific information and systems thinking (i.e., a holistic view that involves the understanding that parts of a system will act differently when isolated from the rest of the system [51]) are associated with greater acceptance of the reality of CC [46]. Future time orientation is associated with an increased individual perception of potential environmental risk and has been shown to amplify the positive correlation between risk perception and a liberalism ideology [52]. In addition, constructs of openness to experience (i.e., level of open-mindedness as a personality trait) and ego resiliency (i.e., the ability to adapt to stress-inducing factors) are negatively related to denial [53,54].

The denial of CC and associated characteristics in agricultural producers is a topic of recent interest in the United States and around the world [55–58]. Previous research focused on agricultural producers in Africa and Asia show associations between CC perceptions and characteristics of sex, age, education, and culture [47]. In the United States, female producers demonstrated more accurate climate knowledge than males [55]. By contrast, males in African countries had a greater perception of CC [47]. Karki et al. [47] reviewed CC perceptions in agricultural producers around the world, finding that, in many cases, older farmers were more likely to accept the reality of CC; however, studies from Chile, the USA, and Nigeria reported a negative relation of age with climate change awareness and perception. In all the continents of Africa, Asia, North America, and South America, formal education is the most significant factor in determining CC perception [47]. Political views were determined to be a primary driver of CC perceptions in a sample of Montana producers [57]. Partisan affiliation and political ideology are shown to have strong impacts on CC knowledge and perceptions in the United States, with Republican and conservative participants viewing CC as a low national priority, as less important and less harmful [55–57].

However, producers' views of CC in Canada have received little attention in the literature. Despite the relationship between climate and agriculture, and the prominent

denial of CC in Saskatchewan, associations between sociodemographic (i.e., political and demographic) and individual characteristics of agricultural producers in Saskatchewan and CC perceptions has not been studied in detail. To our knowledge, this study is the first to examine Saskatchewan agricultural producers' CC beliefs according to the Global Warming's Six Americas categorization [45]. While a substantially larger presence of CC denial in rural Saskatchewan is documented [33], the characteristics that contribute to denial in this population are largely unknown. The purpose of this study is to develop a snapshot of agricultural producers' CC perceptions and gain an understanding of characteristics associated with CC perceptions. Such information will enable a more efficient intervention, such as which audiences to target when providing information to increase the acceptance of the reality of CC, and inform the framing of climate information to increase the acceptance of CC adaptation and mitigation practices. This study addresses the following research question: What is the pattern of perceptions among Saskatchewan agricultural producers, and what individual and sociodemographic characteristics are associated with CC denial?

2. Materials and Methods

In order to answer the research question, an anonymous online survey was constructed. The survey consisted of questions on CC perception, CC understanding, mental flexibility, systems thinking, trust in science, political views, and demographic information. Questions were included to assess climate knowledge and observations. As no existing instrument assessed all the topics of interest, a tailored questionnaire was devised using selected questions from a variety of existing instruments. The survey was developed with four sections: (1) individual characteristics; (2) observed changes in climate-related variables; (3) knowledge and perceptions about CC; and (4) demographic variables.

Mental flexibility was assessed with four questions taken from various scales, including one question from the Big-Five Inventory (BFI [59]), one question from the Adult State Hope Scale [60], and two questions from the Ego Resiliency Scale (ER89 [61]). The four selected questions were rated on a 5-point Likert scale, with the question from the BFI scored from 1 (*Definitely false*) to 5 (*Definitely true*) and the others asking participants to rate how much a statement applied to them from 1 (*Does not apply at all*) to 5 (*Applies very strongly*). Systems thinking was assessed using three self-report questions from the Systems Thinking Scale (STS [62]). The selected questions presented statements (e.g., I think of the problem at hand as a series of connected issues) that were rated on a 5-point Likert scale ranging from 1 (*Never*) to 5 (*Most of the time*). Time orientation was assessed through three questions from the Consideration of Future Consequences Scale (CFC [63]). The CFC is a self-report questionnaire, and the selected questions involved statements (e.g., since my day-to-day work has specific outcomes, it is more important to me than behaviour that has distant outcomes) that were scored on a 5-point Likert scale ranging from 1 (*Extremely uncharacteristic*) to 5 (*Extremely characteristic*).

Climate knowledge was assessed using six questions. Two questions required participants to rate their knowledge of the processes that result in CC and the impacts of CC on a scale from 1 (*Not at all knowledgeable*) to 4 (*Very knowledgeable*). Four questions involved statements (e.g., in recent decades, the most obvious climate change in Saskatchewan has been:) that were scored based on accuracy, with the correct response (e.g., higher temperatures in winter) scored as one and all incorrect responses scored as zero. Ten questions were used to assess observations of climate experienced over the course of participants' farming careers. The first question assessed whether or not participants noticed a change in the length or timing of the seasons over the time they had been farming. Nine questions asked participants to rate changes in the average yearly quantity of various climate proxies (e.g., rainfall in summer) on a 5-point Likert scale from 1 (*Decreased a lot*) to 5 (*Increased a lot*). CC perceptions were assessed using the Six Americas Super Short Survey, Yay! (SASSY! [64]). The SASSY! is a four-item self-report questionnaire that measures opinions about CC, developed from the original 36-item Six Americas screener [45]. The SASSY! categorizes CC perceptions into six distinct categories: dismissive, doubtful, disengaged,

cautious, concerned, and alarmed. The questionnaire includes two items rated on a 5-point Likert scale ranging from 1 (*Not at all*) to 5 (*A great deal*), one item rated on a 5-point Likert scale from 1 (*Not at all important*) to 5 (*Extremely important*), and one item scored on a 4-point Likert scale from 1 (*Not at all worried*) to 4 (*Very worried*). The SASSY! demonstrated good test–retest reliability and convergent validity [45] and high internal consistency ($\alpha = 0.814$) in the sample evaluated.

Political orientation was assessed using four aspects of political preference: overall, on social issues, on economic issues, and on environmental issues. Each aspect was rated on a scale from 1 (*Far left*) to 5 (*Far right*). Political affiliation was assessed by asking participants to indicate the political party they most associated with.

Ethical approval was obtained through the University of Regina Research Ethics Board. Participants were recruited via email from the Saskatchewan Conservation and Development Association (SCDA) contact list in association with the Water Security Agency ($n = 45$) to complete an anonymous online survey that was open from 28 October 2020 to 15 December 2021. Participants were also recruited via Insightrix's SaskWatch online panel ($n = 300$) in December 2021. Eligible participants recruited via email did not receive compensation, while participants recruited via Insightrix received $2.50 for participation in the survey in the form of SaskWatch points, which may be donated or redeemed. The surveys were designed to have the same appearance across platforms. Inclusion criteria required that participants were agricultural producers in Saskatchewan and over the age of 18 years old.

3. Results

Analyses were performed using SPSS version 27. Of the 345 participants who accessed the online survey, 330 were included in the analysis. Duplicate responses ($n = 5$) and participants who did not complete the end of the CC questions ($n = 10$) were removed. Of the 15 removed responses, 14 had been recruited via email from the SCDA contact list, and one duplicate response was removed from data collected via Insightrix. The participant's second response to the assessment was removed from the data analysis. Participant demographics are shown in Table 1.

Table 1. Sociodemographic characteristics of participants.

Variable	Participants ($n = 330$)	
	n	**%**
Age		
≤26 years	14	4.2
27–40 years	65	19.7
41–67 years	187	56.7
≥68 years	52	15.8
Prefer not to say	12	3.6
Sex		
Male	192	58.2
Female	122	37
Prefer not to say	16	4.8
Education		
Less than grade 12	14	4.2
High school	71	21.5
Partial university	54	16.4
College diploma	81	24.5
University degree	94	28.5
Prefer not to say	16	4.8

Table 1. *Cont.*

Variable	Participants (n = 330)	
	n	%
Ethnicity/Race		
White/Caucasian	268	81.2
Asian	6	1.8
African Canadian	6	1.8
Aboriginal/Metis	18	5.5
Other	3	0.9
Prefer not to say	29	8.8
Political Party		
Conservative	160	48.5
Liberal	35	10.6
NDP	28	8.5
Other	36	10.9
Prefer not to say	71	21.5

3.1. Data Preparation

An exploratory factor analysis (EFA) was conducted to assess if the items selected from various questionnaires did in fact measure mental flexibility, systems thinking, and time orientation. Variables of interest were computed using mean scores and then used in further analysis. A principal axis factor analysis was conducted with oblique (Promax) rotation for the ten selected items used in the survey. Two items from the CFC [63] were reverse scored: "I only act to satisfy immediate concerns, figuring that I will take care of future problems that may occur later" and "Since my day-to-day work has specific outcomes, it is more important to me than behaviour that has distant outcomes". The item "I prefer work that is routine" from the BFI [59] was also reverse scored.

The Kaiser–Meyer–Olkin measure verified the sampling adequacy for analysis, KMO = 0.672. Bartlett's Test of Sphericity was significant ($p < 0.001$), verifying that the correlation matrix was appropriate for EFA [65]. Three factors prior to rotation had eigenvalues over Kaiser's criteria of one, which together explained 37% of the variance after rotation. The examination of the scree plot supported the three-factor solution. Table 2 shows the factor loadings > 0.25 after rotation and their respective reliabilities. Although not all the items for each factor were selected from the same scale, a theme arose across items within each factor, and the emergent factors were used for further analysis. The first factor represents mental flexibility, the second factor represents concrete/present focus, and the third factor represents systems thinking (see Table 2). The factor for mental flexibility included the item "I consider how things might be in the future and try to influence those things with my day-to-day behaviour" from the CFC, which demonstrates mental flexibility via changing behaviour to influence future events and was therefore included in the factor for mental flexibility. The factor for systems included the item "There are lots of ways around any problem that I am facing now", indicating systems thinking as being able to determine that cause and effect is necessary to identify various solutions. The final factor included the BFI item "I prefer work that is routine" to form a factor for concrete, present focus. The three items in this factor were reverse scored, such that lower scores indicated a more concrete, present focus.

Average scores were computed for each EFA factor, political orientation, and climate knowledge (see Table 3). Likert-scale questions for climate observations were recoded, such that greater observed change in either direction was scored higher (i.e., decreased/increased a lot = 3, decreased/increased slightly = 2, and no change = 1). The mean score of the recoded variables and observation question regarding a change in the timing and length of seasons was calculated to obtain a climate observation rating. Climate perception was calculated as the mean score of the four SASSY! questions. SASSY! category membership was determined based on responses to the four SASSY! questions in the survey. A scoring

matrix was created using the "SASSY Group Scoring Tool" [64] to manually determine the SASSY! category for each participant.

Table 2. Results from a factor analysis of the questionnaire.

Construct/Items	*M*	*SD*	Loading	α
Factor 1: Mental Flexibility				0.585
I enjoy dealing with new and unusual situations	3.16	0.924	0.741	
I like to take different paths to familiar places.	3.28	0.979	0.645	
I consider how things might be in the future and try to influence those things with my day-to-day behaviour.	3.83	0.802	0.293	
Factor 2: Concrete/Present Focus				0.524
I only act to satisfy immediate concerns, figuring that I will take care of future problems that may occur later. (R)	3.28	1.118	0.727	
Since my day-to-day work has specific outcomes, it is more important to me than behaviour that has distant outcomes. (R)	2.82	1.008	0.592	
I prefer work that is routine. (R)	3.11	0.979	0.292	
Factor 3: Systems Thinking				0.618
I think of the problem at hand as a series of connected issues.	3.65	0.759	0.805	
I think recurring patterns are more important than one specific event.	3.74	0.838	0.630	
I think I understand how a chain of events occur.	3.98	0.764	0.577	
There are lots of ways around any problem that I am facing now	4.07	1.287	0.290	

Note. N = 330. The extraction method was principal axis factoring with an oblique (promax with Kaiser normalization) rotation. Only factor loadings above 0.25 are shown. Reverse-scored items are denoted with (R).

Table 3. Means and standard deviations of scores on baseline measures.

Variable	*M*	*SD*
1. SASSY! CC categories	3.69	1.604
2. Climate knowledge	1.26	0.283
3. Climate observations	1.84	0.442
4. Political views	3.33	0.908
5. Trust in climate science	2.57	0.902
6. CC perceptions	2.92	1.037
7. Mental flexibility	3.43	0.669
8. Concrete/Present focus	3.07	0.742
9. Systems thinking	3.86	0.640

3.2. Snapshot of Producers' CC Views

The proportion of participants in each SASSY! category was reported. To compare the results of this study with previous samples, a Chi-square test of Independence was conducted to examine the relationship between SASSY! categories and sample location. Another Chi-square test of Independence was conducted to examine the relationship between the SASSY! categories and four demographic variables (i.e., sex, age, education, and political affiliation) in the Saskatchewan sample. Significance was evaluated by calculating a Chi-square statistic (χ^2) and obtaining a *p*-value from a χ^2 distribution. An alpha of 0.05 was used when assessing statistical significance. Adjusted residuals greater than 3 were used to determine when a cell deviated significantly from independence [66]. Pearson correlation coefficients were computed to assess the relationship between ordinal demographic variables (i.e., age and education) and climate observations, climate knowledge, mental flexibility, concrete/present focus, and systems thinking.

Of the 330 participants, 148 (45%) were in the three lowest SASSY! categories (i.e., dismissive, doubtful, and disengaged). There were 60 participants in the cautious category, 71 in the concerned category, and 51 in the alarmed category (see Figure 1). A Chi-square

test of Independence was conducted to examine the relationship between the SASSY! categories and sample location (i.e., rural Saskatchewan; Calgary and Edmonton [67], Canada [68]). There was a statistically significant association between SASSY! categories and sample location, χ^2 (15, N = 1483) = 193.316, $p < 0.001$. The association was small to moderate [69], with Cramer's V = 0.208. In comparison to the other locations, participants in Saskatchewan were less likely to fall into the cautious and concerned categories and more likely to fall into the doubtful and disengaged categories. The proportion of participants categorized in the lowest category (dismissive) and highest category (alarmed) in rural Saskatchewan and the other sample locations did not significantly differ.

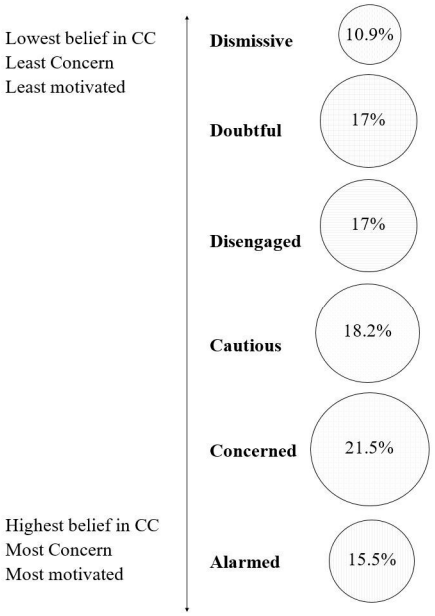

Figure 1. Proportion of participants in the Six Americas (CC) categories. *(Note:* Proportion is represented by area. CC = Climate Change).

For the Saskatchewan sample, a Chi-square test of Independence was conducted to examine the relationship between the SASSY! categories and four demographic variables (i.e., sex, age, education, and political affiliation). The relationship between SASSY! categories and race was not analyzed, as a majority of the sample identified as Caucasian; therefore, expected cell frequencies were well below five. The association between SASSY! categories and sex was statistically significant χ^2 (5, N = 314) = 21.271, $p < 0.001$. The association was moderately strong [69], with Cramer's V = 0.260. Females were more likely than males to fall into the alarmed SASSY! category and less likely than males to fall under the dismissive SASSY! category. There was not a statistically significant relationship between SASSY! categories and age χ^2 (15, N = 318) = 12.905, $p = 0.610$. The relationship between SASSY! categories and education was statistically significant χ^2 (20, N = 314) = 34.256, $p < 0.024$. The association was small [69], with Cramer's V = 0.165. Individuals with a university degree were more likely to fall under the alarmed SASSY! category. There was also a statistically significant relationship between SASSY! categories and political affiliation χ^2 (10, N = 223) = 34.571, $p < 0.001$. The association was moderately strong [69], with Cramer's V = 0.278. Participants with a conservative political affiliation were less likely to fall into the alarmed category and more likely to fall into the dismissive SASSY! category than those with non-conservative political affiliation.

Pearson correlation coefficients were computed to assess the relationship between demographic variables (e.g., age) and climate observations, climate knowledge, mental flexibility, concrete/present focus, and systems thinking. An alpha level of 0.05 (two-tailed) was used to assess significance (see Table 4). There were statistically significant positive correlations of education with climate knowledge, r(220) = 0.208, $p < 0.001$, concrete/present

focus, r(220) = 0.169, $p < 0.05$, and systems thinking, r(220) = 0.134, $p < 0.05$. A higher level of formal education was associated with more accurate climate knowledge scores, greater concrete/present focus scores, and higher systems thinking scores. Age was significantly positively correlated with climate knowledge, r(222) = 0.136, $p < 0.05$, with higher age associated with more accurate climate knowledge scores.

Table 4. Correlations with demographic variables.

	n	1	2	3	4	5	6	7
1. Age	222	--						
2. Education	220	−0.001	--					
3. Climate observations	223	0.074	−0.004	--				
4. Climate knowledge	223	0.136 *	0.208 **	0.187 **	--			
5. Mental flexibility	223	0.004	0.016	0.092	0.127	--		
6. Concrete/present focus	223	0.121	0.169 *	−0.095	0.236 **	−0.065	--	
7. Systems thinking	223	0.091	0.134 *	0.085	0.242 **	0.331 **	0.117	--

** Correlation is significant at the 0.01 level (two-tailed). * Correlation is significant at the 0.05 level (two-tailed).

3.3. Are Characteristics Associated with CC Perceptions?

Pearson correlation coefficients were computed to assess the relationship between SASSY! categories, climate knowledge, climate observations, political orientations, trust in climate science, CC perceptions, individual characteristics of mental flexibility, systems thinking, and concrete, present focus from the EFA. An alpha level of 0.05 (two-tailed) was used to assess significance (see Table 5).

Table 5. Correlations for study variables.

Variable	*n*	1	2	3	4	5	6	7	8	9	10
1. SASSY! category	330	--									
2. Climate knowledge	329	0.338 **	--								
3. Climate observations	330	0.548 **	0.192 **	--							
4. Political views	328	−0.313 **	−0.082	−0.173 **	--						
5. Political party	223	−0.360 **	−0.124	−0.299 **	0.483 **	--					
6. Trust in climate science	329	0.664 **	0.320 **	0.427 **	−0.265 **	−0.381 **	--				
7. CC perceptions	330	0.937 **	0.329 **	0.569 **	−0.321 **	−0.388 **	0.685 **	--			
8. Mental Flexibility	330	0.093	0.202 **	0.103	−0.001	−0.036	0.030	0.115 *	--		
9. Concrete/present focus	330	0.010	0.190 **	−0.100	−0.022	−0.015	0.025	−0.018	0.005	--	
10. Systems Thinking	330	0.035	0.280 **	0.133 *	0.005	−0.038	0.066	0.046	0.307 **	0.146 **	--

** Correlation is significant at the 0.01 level (two2-tailed). * Correlation is significant at the 0.05 level (two2-tailed).

Political orientation scores showed a negative correlation with most assessed variables. There was a statistically significant negative correlation between political orientation and the SASSY! categories, r(328) = −0.313, $p < 0.001$, and trust in climate science, r(328) = −0.381, $p < 0.001$. This indicates that left-leaning political views are associated with SASSY! category membership toward the alarmed end of the spectrum and with higher trust in climate science. Political orientation was also significantly negatively correlated with CC perception, r(328) = −0.388, $p < 0.001$; the more left-leaning the political views were, the more CC was reported as being of greater importance and concern. Experienced climate observations were also negatively correlated with political orientation, r(328) = −0.173, $p < 0.05$. The level of climate knowledge and the three EFA factors were not significantly associated with political orientation scores. Political affiliation was significantly negatively correlated with the same variables as political orientation but to a greater extent.

CC perceptions showed a statistically significant positive correlation with all the assessed variables, aside from political orientation, concrete/present focus, and systems thinking. Since the SASSY! category was derived from variables used to calculate CC perception, the correlation was high, r(330) = 0.937, $p < 0.001$. There was also a significant positive correlation of CC perception with both climate knowledge, r(329) = 0.329, $p < 0.001$ and climate observations, r(330) = 0.569, $p < 0.001$. Participants who reported a greater

perceived importance of and concern for CC also showed greater climate knowledge scores and reported observing more CC in their environment. In addition, there was a significant positive correlation between CC perceptions and mental flexibility, r(330) = 0.115, $p < 0.05$. Higher CC perceptions are associated with greater mental flexibility. Those who rated CC as more important also rated their trust in climate science more highly, r(329) = 0.685, $p < 0.001$. Trust in science ratings also showed a statistically significant positive correlation with all the other assessed variables, with the exception of political orientation and the three EFA factors. Trust in climate science was significantly positively correlated with climate knowledge, r(329) = 0.320, $p < 0.001$ and climate observations, r(329) = 0.427, $p < 0.001$; as trust in climate science ratings increased, so did climate knowledge scores and the ratings of experienced CC observations. Trust in climate science ratings was significantly positively correlated with the SASSY! category, r(329) = 0.664, $p < 0.001$. As ratings of trust in climate science increased, SASSY! categories were likely to be closer to alarmed.

The three EFA factors were significantly positively correlated with climate knowledge. There was a strong positive correlation of climate knowledge with mental flexibility, r(329) = 0.202, $p < 0.001$, concrete/present focus, r(329) = 0.190, $p < 0.001$, and systems thinking, r(329) = 0.280, $p < 0.001$. Individuals who rated higher in climate knowledge also scored higher in mental flexibility, scored lower in concrete/present focus, and scored higher in systems thinking. Systems thinking was also significantly positively correlated with climate observations, r(330) = 0.133, $p < 0.05$, with greater systems thinking scores associated with more reported observed changes.

4. Discussion

Agricultural producers have a unique relationship with CC, as their livelihood relies on the climate while also requiring the production emissions that contribute to CC. Acceptance and understanding of the reality of CC play a role in the willingness to practice CC adaptation and mitigation [36]. Previous research on a small sample size of the general population suggests that there is less acceptance of anthropogenic CC in Saskatchewan than in other regions in Canada [35]. Knowing the current views of CC held by agricultural producers in Saskatchewan is important, as it provides evidence about what kinds of information might be most effective in framing communication to encourage CC adaptation and mitigation across Saskatchewan for a target audience of agricultural producers.

This is the first study to examine the categorization of Saskatchewan agricultural producers using the SASSY!, providing a snapshot of current CC views in this population. Denial of CC is prevalent in public comments in Saskatchewan, and previous research has estimated that a lower percentage of people in the prairies accept the reality of anthropogenic CC, especially in rural areas [33]. The research results partially support this notion, with a greater percentage of Saskatchewan producers categorized into the lower three SASSY! categories, compared to a Canadian sample [68] and samples from Calgary and Edmonton [67]. However, the proportion of Saskatchewan producers in the lowest category (dismissive) and highest category (alarmed) did not significantly differ from the other sample locations. While there is less acceptance of the reality and severity of CC among Saskatchewan producers than in the other populations, the proportion of individuals who completely reject the idea that CC is real, and actively oppose efforts to reduce greenhouse gas emissions, is similar across samples. Descriptions of the Six Americas categories [45] suggest that fewer Saskatchewan producers, compared to the other samples, are likely to act to reduce greenhouse gas emissions due to a lack of understanding of CC and/or the perception of CC impacts as insignificant. As such, providing accurate and relevant CC information to Saskatchewan producers in a way that improves their understanding is an essential component of encouraging behaviours that reduce greenhouse gas emissions and encourage adaptation to lower the risks from a changing climate.

As in other global studies, demographic variables of education, sex, and political affiliation were associated with SASSY! category membership. The results of this study were consistent with research showing that CC denial is negatively correlated with level of

formal education [46,48,70]. Because higher levels of formal education were associated with greater climate knowledge scores, providing climate information to individuals with less formal education may reduce rates of denial—if the information is deemed trustworthy. The results of this study were also consistent with research showing that CC denial is associated with the demographic characteristics of sex (greater for males [46]). Contrary to previous research, the results of this study did not show an association between age and SASSY! categories. Previous research shows mixed results, with a review of agricultural producers around the world finding that, in many cases, older farmers were more likely to accept the reality of CC; however, studies from Chile, the USA, and Nigeria reported a negative relation of age with climate change awareness and perception [47]. Previous research with other samples has indicated that individuals over the age of 55 were significantly more likely to deny the reality of CC [49]. It is possible that an association between age and SASSY! categories was not found in this study due to a limited age range; the majority (56.7%) of the sample was in the 41–67-year age range. The older age of Saskatchewan producers may contribute to the lower acceptance of the reality of CC, given the negative correlation between CC views and age in samples with more age variability.

Understanding characteristics associated with CC perceptions is important for targeting information to individuals who have characteristics associated with less acceptance of the reality of CC. This study explored how individual characteristics such as sociodemographic and personal factors may interact with political affiliation and be associated with CC perception. The results of this study were consistent with US research showing that CC denial is associated with political affiliation (greater for individuals belonging to conservative political parties [48]). Conservative political views, low trust in science, and low mental flexibility were associated with lower CC perception scores. Therefore, males belonging to conservative political parties (e.g., Saskatchewan Party, Conservative Party of Canada) may be the most relevant targets of efforts to increase the acceptance of the reality of CC. Such efforts should consider the identity of conservative males and frame communications about CC around values that are important to this group (e.g., economic and community stability reasons for CC mitigation strategies) to align with system justification motives. Research suggests that individuals who hold conservative political views put more value on maintaining firm loyalty to group opinions than openness to change with evidence or experience; therefore, low mental flexibility may be a foundational value for individuals with conservative political views and reflect a choice rather than an ability [71]. This suggests that new methods would be best presented to this group as means to accomplish existing goals and concerns, rather than as adaptations. These results were consistent with previous research, which found that right-leaning political views were associated with lower trust in climate science, and lower CC perception was significantly associated with low trust in climate science [46]. Therefore, when providing information with a goal of improving CC perceptions, strategies should take an approach that builds an audience's trust. Agricultural outreach to increase CC perceptions and reduce barriers to the adoption of adaptation and mitigation strategies should therefore use an approach that provides relevant information in a way that protects group identity. Efforts to increase trust in science may include framing descriptions of climate science methods in terms of familiar practices (e.g., many farmers are skilled in equipment repair, and thus know how to use "the scientific method" to figure out what is wrong with a vehicle).

CC perception, political ideology and affiliation, and trust in scientific information may be linked by system justification motives. In Saskatchewan, there is a contrast between the right-leaning Provincial governing party (i.e., the Saskatchewan Party) and left-leaning Federal governing party (i.e., the Liberal Party). Producers may avoid CC information because it is a threat to their political or economic systems if, for instance, they are not able to afford the currently available, environmentally sustainable practices or the practices are promoted by a competing political party [72,73]. Evidence regarding CC indicates that our current economic and political systems are not sustainable and will be detrimental to our long-term well-being; therefore, accepting the reality of CC is a threat to those

systems [74]. This leads those who base their individual and group identity on these systems to ignore or downplay issues such as CC [75]. This may be particularly true for producers, as the profession is high risk due to various factors that are out of their control (e.g., weather, international markets, and distribution problems). Defending one's system may also influence the perceived importance of information based on its source. Many of the outcomes and solutions associated with CC align with liberal views regarding the appropriate balance between public good and individual rights, such as relatively positive views of governing tools such as taxes and government regulation [76]. Therefore, when information about CC is presented by someone who is affiliated with a liberal perspective (e.g., the federal government), it is viewed by conservatives as serving the opposition and not keeping their groups' best interests in mind. Trust is defined as the belief that another person or group will take one's own interests into consideration when making decisions (e.g., [77]); therefore, sources of information from opposing political groups are, by definition, from an untrustworthy source. This decreased trust in the source of the information can influence trust in climate science itself, contributing to denial. Therefore, it is important to present information in a way that takes an individual's system into account and increases trust in climate science in order to increase acceptance of the reality of CC. Motivational interviewing, a technique involving interest in the other's well-being, expressing empathy and understanding, and meeting resistance in a calm manner, which allows the individual to present their views, may also increase trust by generating meaningful conversation [78]. With motivational interviewing, a science advocate not only becomes a more trustworthy source of information but also gains understanding of the goals, concerns, and negative affective responses of the denier.

This was the first study to look specifically at the relationship between CC measures (i.e., CC perception and SASSY! category) and characteristics of mental flexibility, systems thinking, and time orientation, with results showing that, for agricultural producers, none of the three characteristics were significantly associated with the SASSY! categories, and only mental flexibility was significantly associated with CC perception. Mental flexibility, systems thinking, and concrete/present focus had not previously been directly considered in the context of the CC measures used in this study; however, previous research found that systems thinkers tend to accept the scientific consensus, recognize risks, and support policy interventions to address CC [51], and future time orientation is associated with increased individual perception of potential environmental risks [52]. It is possible that systems thinking and time orientation are associated with environmental risk perception rather than CC denial. Previous research has shown that concepts related to mental flexibility (e.g., openness to experience, ego resiliency) are associated with denial [53,54]. In this study mental flexibility was significantly associated with CC perception but not the SASSY! categories. One major difference between CC perception and the SASSY! categories is whether a response of "I do not know" was the midpoint of the scale (CC perception) or indicative of denial (SASSY! category); therefore, knowledge of CC may have an influential role in this association. While there were no significant associations for the SASSY! categories and the three factors, all three were significantly associated with climate knowledge, with higher climate knowledge scores associated with high mental flexibility, high systems thinking, and low concrete/present focus. Climate knowledge ratings were significantly associated with higher SASSY! categories and greater CC perception. The three assessed factors may not be directly related to CC denial, but, rather, climate knowledge may mediate the correlations between CC denial and these factors.

Limitations and Future Directions

Although the results from this study are consistent with previous research and anecdotes that suggest less acceptance of the reality of CC in Saskatchewan and determined characteristics associated with CC perceptions in this sample, there are limitations that should be considered. One limitation of this study is that participants were not representative of the general population of Saskatchewan producers. Compared to the population

of Saskatchewan producers, more participants in this sample were female, younger, and responsible for larger farms. Interestingly, despite previous research indicating that being female [48,70] and younger [46,49] was associated with greater belief in CC, the sample in this study showed less acceptance of CC than Canadian [68] and urban Alberta [67] samples. This may indicate that, although the same associations are observed, the entire population of Saskatchewan producers is skewed downward in the acceptance of the reality of CC.

Another limitation is the history effect. This study was conducted during a period of province-, nation-, and world-wide unrest. Since CC is a large-scale and polarizing issue, the state of affairs could have had an influence on study results. Specifically, the COVID-19 pandemic began near the beginning and persisted throughout the duration of this study. In Saskatchewan, the pandemic had a polarizing effect, with most Saskatchewan residents believing that society became more divided over the course of the pandemic [79]. Opposition to COVID-19 mandates provided a platform for the far-right "freedom convoy," with many Saskatchewan residents donating to the cause [80]. With regard to the climate, 2021 was also a year of severe drought. Trevor Hadwen, an agroclimate specialist for Agriculture Canada, reported that 99% of Saskatchewan's farmland had "abnormally dry" conditions as of April 30, 2021 [81]. The dry conditions persisted throughout the year, with only 12% of cropland in Saskatchewan having topsoil with adequate moisture by October 2021 [24]. In response to the present survey, many participants indicated that they were forced to alter their farming practices over the year in response to the drought. These events may have influenced responses to several of the survey questions. Polarization in society may have led group membership (e.g., conservative political affiliation) to become more influential in decision-making and the perception of current events. This could affect factors such as the importance of group loyalty, how to determine what is trustworthy, when to update incorrect views, etc. [71]. Conversely, the drought may have also influenced responses by highlighting the potential for negative consequences to producers without CC adaptation and mitigation. Whether these historical factors affected the results or not can only be determined by comparing these findings with similar research conducted in other conditions.

5. Conclusions

This study is the first to provide a snapshot of Saskatchewan agricultural producer's CC perceptions, finding that CC views varied greatly across the sample. While many producers in Saskatchewan show some belief in CC, concern about the effects of CC, and motivation to act on the issue, nearly half of the participants were in the three lowest SASSY! categories (i.e., dismissive, doubtful, and disengaged). Many Saskatchewan producers did not accept the reality of CC, which is an important factor in encouraging behaviour toward the adaptation to, and mitigation of, CC. The proportion of Saskatchewan producers categorized in the lowest (dismissive) and highest (alarmed) categories did not significantly differ from Canadian and urban Prairie samples. However, there was less acceptance of the reality of CC in Saskatchewan producers who were less likely to fall into the cautious and concerned categories and more likely to fall into the doubtful and disengaged categories. As agriculture both contributes to and is directly affected by CC, and Saskatchewan producers were less accepting of the reality of CC than other Canadian samples, producers in this region may be a target for Federal outreach to increase CC adaptation and mitigation.

This study adds to an existing base of literature demonstrating that demographic and personal characteristics are associated with lower CC perceptions, and it is the first to do so among Saskatchewan agricultural producers. CC perceptions in Saskatchewan producers were significantly associated with characteristics of sex, education, and political views, parallel to associations found in existing literature from elsewhere in the world. Findings of this study suggest that females, individuals with a university degree, and participants with non-conservative political affiliation were more likely to be in the alarmed SASSY! category, while males and participants with conservative political affiliation were

more likely to fall into the dismissive SASSY!. While previous research has found mixed results for association between CC perceptions and age, this study found no significant association with CC perceptions but identified a positive correlation between age and climate knowledge. This study was the first to assess mental flexibility directly in relation to CC perception, finding that greater mental flexibility was associated with higher CC perceptions. Outreach aiming to increase acceptance of the reality of CC should target male producers with lower levels of formal education, low mental flexibility, and right-leaning political views. As acceptance and understanding of the reality of CC are important to the adoption of CC adaptation and mitigation strategies into agricultural operations, it is necessary to understand producers' CC perceptions and associated characteristics when creating strategies to reduce barriers for the acceptance of sustainable practices.

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