

## LÍNGUA INGLESA

### BIOMÉDICAS

**TEXTO-BASE:** FOGUESATTO, C. R., MACHADO, J. A. D. What shapes farmers' perception of climate change? A case study of southern Brazil. **Environment, Development and Sustainability**, n. 17, v. 23(2), 2021, p. 1525-1538.

#### QUESTÃO 01

Assinale a alternativa **CORRETA** que justifica o estudo sobre a percepção de agricultores acerca da mudança climática.

- a) Segundo os autores, o entendimento da percepção de agricultores sobre a mudança climática é um pontapé inicial para a adoção de estratégias de mitigação dos efeitos negativos de eventos climáticos extremos.
- b) Segundo os autores, o estudo das secas como eventos climáticos extremos podem auxiliar na percepção do seu impacto, considerando o aumento das perdas econômicas e da insegurança alimentar.
- c) Segundo os autores, com o uso de modelos econométricos relatados na literatura, verifica-se que há inúmeras variáveis que podem influenciar a percepção dos agricultores acerca da mudança climática.
- d) Segundo os autores, ainda que exista vasta literatura acerca do estudo da percepção dos agricultores em relação à mudança climática, estudos empíricos no Brasil são relativamente escassos.

## QUESTÃO 02

Analise as proposições a seguir e assinale a alternativa **CORRETA**.

I – O estudo relatado no artigo concentra-se na análise dos fatores que influenciam a percepção da mudança climática por agricultores brasileiros.

II – O estudo relatado no artigo é um dos muitos já realizados considerando-se a população de agricultores brasileiros investigada.

III – O estudo relatado no artigo utilizou um questionário para levantamento de dados enquanto a análise dos dados foi feita com tratamento estatístico.

IV – O estudo relatado no artigo pode fomentar programas e políticas voltadas para a adoção de estratégias de mitigação/adaptação dos efeitos da mudança climática.

- a) Somente as alternativas II, III e IV estão corretas.
- b) Somente as alternativas I, III e IV estão corretas.
- c) Somente as alternativas I, II e IV estão corretas.
- d) Somente as alternativas I, II e III estão corretas.

## QUESTÃO 03

Em relação aos procedimentos de coleta e de análise de dados, analise as proposições a seguir e assinale a alternativa **CORRETA**.

I – O estudo englobou agricultores de todas as partes do estado do Rio Grande do Sul.

II – O estudo englobou agricultores do estado do Rio Grande do Sul de regiões afetadas especialmente pelas secas.

III – O instrumento de coleta de dados foi refinado após pilotagem e um total de 172 questionários foram validados, após a coleta de dados.

IV – Os dados coletados receberam tratamento estatístico por meio de um software apenas.

- a) Somente as alternativas II e IV estão corretas.
- b) Somente as alternativas I e II estão corretas.
- c) Somente as alternativas II e III estão corretas.
- d) Somente as alternativas I e III estão corretas.

#### QUESTÃO 04

Tomando por base os resultados do estudo, assinale a alternativa **INCORRETA**:

- a) Os resultados da análise estatística por meio do modelo de regressão revelaram que o tamanho da família não é um fator que se relaciona com a percepção da mudança climática.
- b) Os resultados da análise estatística por meio do modelo de regressão revelaram que a apatia ambiental não é um fator que se relaciona com a percepção da mudança climática.
- c) Os resultados da análise estatística por meio do modelo de regressão revelaram que o tamanho da propriedade rural é um fator que se relaciona com a percepção da mudança climática.
- d) Os resultados da análise estatística por meio do modelo de regressão revelaram que a idade do agricultor é um fator que se relaciona com a percepção da mudança climática.

#### QUESTÃO 05

Defina o que os autores chamam de “eventos do século” e forneça três exemplos de suas manifestações no Brasil. Em seguida, discorra sobre os impactos de alguns desses eventos no país, citando as regiões afetadas, suas causas e consequências.

#### QUESTÃO 06

Liste (quantas e quais), defina (ao que se referem) e classifique (por tipo) pelo menos 4 das variáveis explanatórias do estudo (socioeconômicas e psicológicas), excetuando-se aquelas cuja medição foi realizada em Escala Likert.

#### QUESTÃO 07

Cite e explique, pelo menos, uma limitação do estudo apontada pelos autores.



# What shapes farmers' perception of climate change? A case study of southern Brazil

Cristian Rogério Foguesatto<sup>1</sup> · João Armando Dessimon Machado<sup>1</sup>

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## Abstract

Climate change poses several challenges worldwide, including the increase in severity and frequency of extreme weather events, such as droughts. As a result, there are projected environmental, economic and social impacts in several sectors, including agriculture. However, the extent of climatic impacts depends on farmers' awareness and their capacity for adaptation in response to changes in the climate. This study analyzes the factors that influence farmers' perception of climate change. Data were collected from a farm-household survey in the Rio Grande do Sul state, Brazil. Using a logistic regression model, we identified that farm size, support of extension workers, number of conservation practices adopted, and ecocentrism value influenced positively the perception. Moreover, we found that farm size relied on government actions, subsidies, and anthropocentric value was affected negatively. These findings showed that socioeconomic and psychological factors shape farmers' perception of climate change. Extension workers and policymakers should increase farmers' awareness on climate change improving the communication on the nature importance for the ecosystem as a whole (ecocentrism) and/or explaining the importance of nature for human welfare (anthropocentrism).

**Keywords** Agriculture · Anthropocentrism · Drought · Ecocentrism · Extreme weather events · Psychology

## 1 Introduction

Climate change refers to long-term changes in the statistical distribution of weather conditions, persisting for an extended period, such as decades or longer (Intergovernmental Panel on Climate Change—IPCC 2012). Globally, climate change is a topical subject and there is evidence this phenomenon is taking place (Bonnot et al. 2018). Because of these changes, it is projected that extreme weather events (e.g., waves of heat, waves of cold, droughts, storms, hurricanes, floods) increase in frequency and severity along the next coming decades (IPCC 2012). Compared with other economic sectors, agricultural

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✉ Cristian Rogério Foguesatto  
[cristian\\_rogeriof@hotmail.com](mailto:cristian_rogeriof@hotmail.com)

<sup>1</sup> Centro de Estudos e Pesquisas em Agronegócios, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

production activities are one of the most vulnerable facing climate change (IPCC 2012) because the agricultural systems are directly influenced by climatic conditions (Deressa et al. 2009). Droughts, for instance, can increase the risks of economic losses (Gross and Cassol 2015) and food insecurity around the world (Twongyirwe et al. 2019).

As farmers realize the decision-making process to adopt practices that can mitigate the negative effects of extreme weather events, understanding their perception regarding climate change is pivotal (Foguesatto et al. 2020). The comprehension of farmers' perception of changes in climate is the first step to developing strategies of mitigation and adaptation. A representative survey of nearly 5000 farmers in the USA revealed that the perceived risks of the weather and climate were important for the developing adaptation measures (Mase et al. 2017). Given this backdrop, Tesfahunegn et al. (2016) suggest that the farmers' perception of climate change must be documented.

Using econometric models, the literature has shown there are various variables (e.g., age, farmer income and farm size) that influence farmers' perceptions regarding climate change. Therefore, individual characteristics play an important role in perception. In Chile, the study of Roco et al. (2015) concluded that age, income, tenure, weather information from the internet and from mass media influenced farmers' perception. Similarly, in Ethiopia, Tesfahunegn et al. (2016) found that some biophysical and institutional variables positively influence farmers' perception of climate change. These studies provide valuable insights, focused mainly on the influence of socioeconomic factors on perception.

The growing impact of extreme weather events caused by climate change on agricultural systems has generated a rich literature on farmers' behavior in the last few years. In Brazil, however, empirical studies for understanding farmers' perception on climatic issues are rather scarce. The few efforts on this subject are mainly based on the descriptive analysis (see, Pires et al. 2014) and qualitative techniques (see, da Silva and França 2018). Therefore, Brazilian literature does not satisfactorily address the relation of farmers' personal characteristics and their perception of climate change.

The objective of this paper is to analyze the factors that influence farmers' perception of climate change. To the best of our knowledge, this is one of the first attempts to quantify farmers' perceptions in Brazil and in South America. To try filling this gap, we conducted a farm-level survey in the Rio Grande do Sul (RS) state, Brazil, analyzing the data through logistic regression technique. In addition, to explore farmers' socioeconomic characteristics, we include in the regression model, farmers' psychological factors, as explicative variables as an attempt to better understand their perception. To meet this point, we used constructs with roots in environmental psychology, including the environmental values proposed by Thompson and Barton (1994). The findings of this paper contribute with the current literature, providing Brazilian empirical evidence on this topic, as well as providing useful insights for developing programs and the designing of policies to promote and facilitate the adoption and diffusion of strategies of mitigation/adaptation the effects of climate change.

## 2 Effects of climate change in Brazil

In the last few years, Brazil has witnessed climate extreme weather events, including heat waves, floods and droughts. Heat waves, for instance, have affected the whole of Brazilian regions, and in the winter of 2015, the temperature reached 3–4 °C above normal (Nobre

et al. 2018). Some of these extreme events are characterized as “events of the century.” We refer as example of these facts the floods in 2009, 2013, 2014 and 2017 in Amazon; droughts since 2012 in the semiarid region of Northwest; droughts in the Southwest, which caused the worst water crisis in São Paulo metropolitan region since 1960 (Nobre et al. 2018).

In the extreme south of Brazil, particularly in the Rio Grande do Sul state, extreme weather events have been negatively affected the grain production (such as maize and soybean) in the last few summer seasons (Nedel et al. 2010; Fochezatto and Grando 2011; Gross and Cassol 2015). Soybean is one of the most important crops for the Brazilian economy (Artuzo et al. 2018) and historically, RS is one of the largest producers of this commodity. In the 2017/18 harvest, this state produced about 17 million tons of soybean, with a productivity of 3013 kg/ha (Companhia Nacional do Abastecimento—CONAB 2018). Despite rain-fed and irrigation agriculture have been practiced in this region, the rain-fed system is widely predominant (Radin and Matzenauer 2016). Given this, the recent droughts, such as occurred in 2004/05 and 2011/12, caused huge economic losses. Because of the severe dry season, in 2004/05, RS total soybean production was only about 2800 million tons (CONAB 2018).

### 3 Methodology

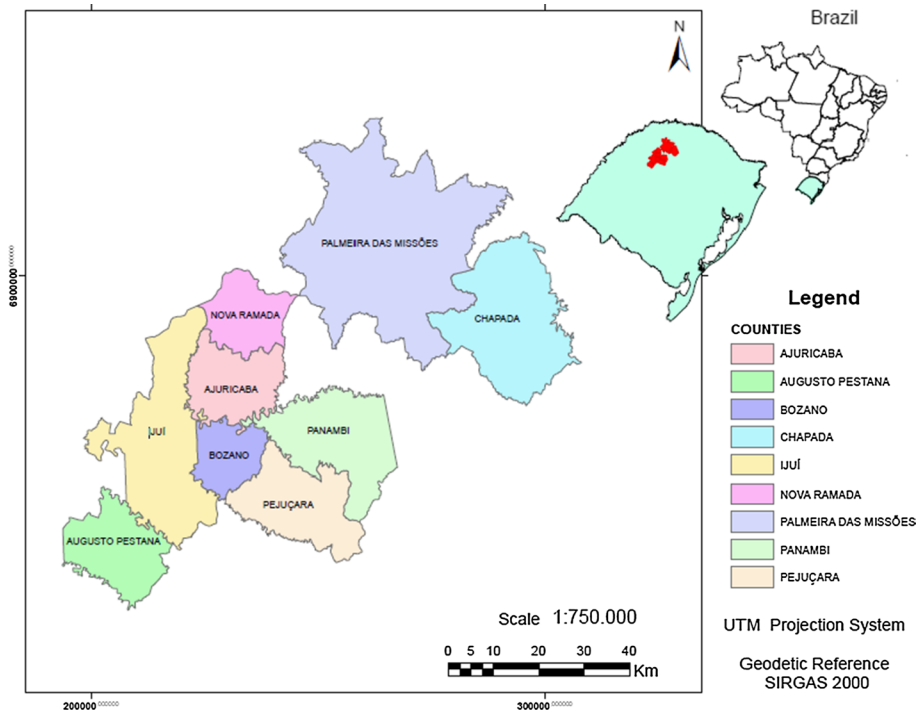
#### 3.1 Study area and data collection

Based on the assumption that people's perception is related to socioeconomic and psychological factors, this study was conducted in nine counties of the northwest region of Rio Grande do Sul, Brazil (Fig. 1). This region was selected because it had been identified as vulnerable to climate change, mainly due to severe droughts (Instituto Nacional de Meteorologia—INMET 2018). In addition, the counties assessed are important producers of agricultural commodities, including soybean.

The empirical data used were generated from a farm-level survey applied to farmers' soybean producers who declared themselves as the main decision maker of the farm. A preliminary questionnaire was designed using past research pieces and assisted by nine experts in economic behavior and farm management. To test the adequacy of the questionnaire, a pretest was made with 15 farmers. Based on the feedback obtained during the pretesting, some adjustments were made on the flow of the questions. Following these procedures, we contacted key informants (extension workers, managers of the union of rural workers, schools and agricultural cooperatives) seeking to build a list of potential respondents. With this list in hand, a team of five questionnaire applicators (undergraduate students with agricultural experience and who were trained for this job) then got in touch with the farmers and they collected the data face to face. At the end of each application, a snowball sample technique was used, i.e., respondents were asked to indicate to other farmers to participate in the survey. The data collection was carried out from December 2017 to March 2018, and 172 questionnaires were validated.

#### 3.2 Data analysis

Empirical data were coded and analyzed using the Statistical Package for Social Scientists (SPSS v. 21) and R Programming Language (R Core Team 2019). The data from the



**Fig. 1** Map of the area under study

survey were analyzed by means of descriptive statistics and logistic regression model. The information of the central tendency of key variables and household socioeconomic characteristics, and other descriptive statistics, was useful for providing an initial overview of the farmers' sample. A logistic regression was used to identify the factors that influence the perception of climate change.

Logistic models have been used in agricultural economics and environmental psychology on a wide range of topics, including adoption of water conservations practices (Jara-Rojas et al. 2012), adoption of smart farming (Pivoto et al. 2019) and farmers' climate change perception (Apata et al. 2009; Tesfahunegn et al. 2016). This model was chosen over other models due to its advantage in mathematical simplicity to give meaningful results (Tesfahunegn et al. 2016). The logistic model considers the relationship between a dichotomous dependent variable and a set of explicative variables, whether binary, continuous, count variables or measured by scales. In this study, the logistic estimation is given by:

$$\ln \left[ \frac{P}{1-P} \right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots \beta_k X_k, \quad (1)$$

The quantity  $P/(1-P)$  is called the odds (likelihoods) ratio, where  $P$  represents the probability for farmers' being perceived climate change, and  $1-P$  refers to the probability of not being perceived changes in climate. More specifically, a farmer is considered to have a perception of changes in climate if (1) he/she declared the existence of climate changes; (2) he/she perceives the increase in occurrence of droughts over time.  $\beta_0$  is the intercept,  $\beta_1 + \beta_2 + \cdots \beta_k$  are regression coefficients of the explanatory variables of  $x_1, x_2, \dots x_k$ . If the

value of odds ratio is less than 1, the likelihood of the effect of the independent variable on the dependent variable is decreased (negative relationship), odds ratio value greater than 1 indicates positive relationship and odds ratio value of one indicates no relationship. The regression logistic follows the premises of (1) linear relationship between the vector of explanatory variables and the dependent variable, (2) expected value of residuals equal to zero, (3) absence of heteroscedasticity; and (4) absence of multicollinearity (Fávero et al. 2009).

The explanatory variables refer to a set of socioeconomic (e.g., age, farm size, family size, support of extension workers) and psychological variables (Table 1). Socioeconomic variables were obtained by a review in the existing literature on climate change perception and adaptation among farmers worldwide, including Apata et al. (2009), Ishaya and Abaje (2008), Mertz et al. (2009) and Fosu-Mensah et al. (2012).

Psychological factors were analyzed by latent variables using the three environmental values proposed by Thompson and Barton (1994). These values are ecocentrism (a view that promotes the environmental preservation because the nature is intrinsically valuable), anthropocentrism (nature is important due to its benefits for human welfare), and environmental apathy (a perspective by which nature is not valued at all). For ecocentrism, anthropocentrism and environmental apathy, we measured twelve, eleven and nine questions, respectively, using the same backdrop presented in the paper of Thompson and Barton (1994). All items were assessed using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) and were averaged to compute their subscale scores. Cronbach's Alpha was used to assess the reliability of these variables. The questionnaire also had open questions where farmers could describe their perception of climate change (see "Appendix 1").

## 4 Results

### 4.1 Farmers' descriptive statistics

Of 172 farmers surveyed, 124 (72.09%) perceive climate change. This means that most farmers were aware of climate change. However, in studies carried out in Africa and Asia regions, this level of awareness was higher than 80% (Fosu-Mensah et al. 2012; Alam et al. 2017). According to a respondent "In the summer season of 2011/12, occurred the biggest drought that I remember" (farmer number 142). This perception is in line with the rainfall records (Fig. 2). In the season of 2011/12, the rainfall amount was the lower (245 mm) while the historical average was 613 mm.

Some farmers also highlighted their perception about the temperature, as follows, "In nowadays, the days seems hotter" (farmer number 12). Compared with the mean annual temperature records, this perception is convergent. As shown in Fig. 3, in the last 25 years there is a tendency to increase in temperature. On the other hand, a farmer that does not believe in climate change said, "People are less accustomed to working under the sun, so they think it's warmer [...] it was always hot in the summer" (farmer 9).

The most respondents were male (88.6%), and almost 80% live in rural areas, with an average distance of 15.54 km of their mainlands. Regarding the contact with extension workers, about 90% of farmers receive some type of support. Other descriptive statistics are presented in Table 2.

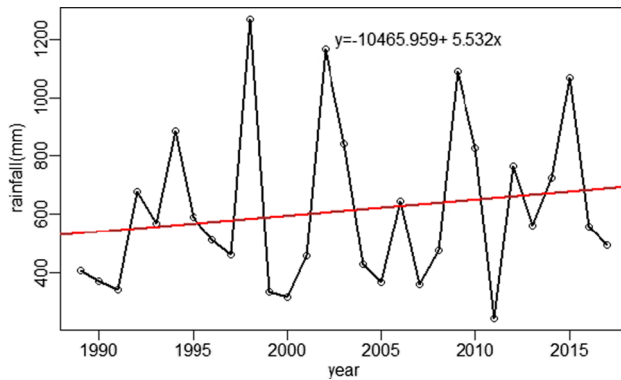
**Table 1** Measurement of explanatory variables and their expected signal of influence

| Explanatory variables  | Type of variable <sup>a</sup> | Definition                                                                                                                        | Expected signal | Source <sup>b</sup>        |
|------------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------|
| Age                    | <i>C</i>                      | Age of farmer (years)                                                                                                             | –               | Roco et al. (2015)         |
| Farm size              | <i>C</i>                      | Farm size in hectares                                                                                                             | +               | Tesfahunegn et al. (2016)  |
| Extension work         | <i>D</i>                      | 1 if the farmer received technical assistance; 0 if otherwise                                                                     | +               | Tesfahunegn et al. (2016)  |
| Conservation practices | <i>O</i>                      | Number of conservation practices adopted in farm                                                                                  | +               | Foguesatto et al. (2019)   |
| Subsidies              | <i>D</i>                      | 1 if the farmer received economic subsidies in the last few years; 0 if otherwise                                                 | +               | Alauddin and Sarker (2014) |
| Family size            | <i>C</i>                      | Number of family members                                                                                                          | +               | Tesfahunegn et al. (2016)  |
| Rely on government     | <i>D</i>                      | 1 if the respondent relies on governmental support; 0 if otherwise                                                                | +               | Buys et al. (2012)         |
| Ecocentrism            | <i>L</i>                      | All environmental values variables were measured through Likert scale (1–5), from 1 = completely disagree to 5 = completely agree | +               | Foguesatto et al. (2019)   |
| Anthropocentrism       | <i>L</i>                      |                                                                                                                                   | +               | Foguesatto et al. (2019)   |
| Environmental apathy   | <i>L</i>                      |                                                                                                                                   | –               | Heath and Gifford (2006)   |

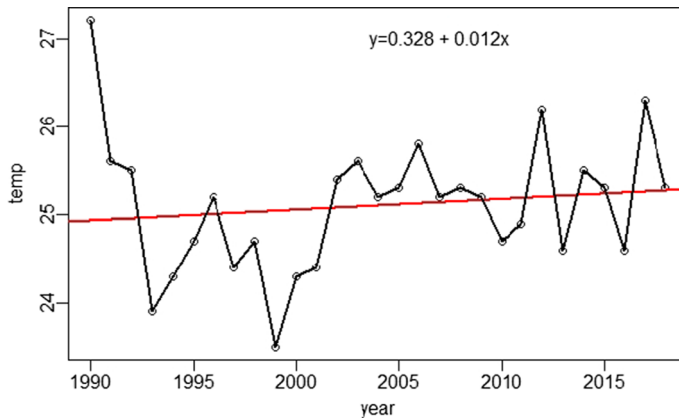
There is no multicollinearity among the explanatory variables. Actually, the highest coefficient was 0.440, found between “ecocentrism” and “anthropocentrism” (“Appendix 2”)

<sup>a</sup>*C* continuous variable, *D* dummy variable (binary variable), *O* count variable, *L* Likert variable (strongly disagree–strongly agree, 1–5)

<sup>b</sup>Source of expected signal hypothesis. They are based on empirical findings and theoretical assumptions on people’s behavior regarding climate change



**Fig. 2** Rainfall variation in the summer season between 1989 and 2017. This station is in Cruz Alta, a county of the northwest region of Rio Grande do Sul that borders with Pejuçara. Summer season refers from November to February. The season of 1989, 1990, 1991 and 2001 have some omit values. *Source:* INMET (2018)



**Fig. 3** Average of annual temperature between 1990 and 2018. This station is in Cruz Alta, a county of the northwest region of Rio Grande do Sul that borders with Pejuçara. *Source:* INMET (2018)

**Table 2** Descriptive statistics of the sample

|                              | Mean  | Min. | Max  | SD     | Cronbach's alpha |
|------------------------------|-------|------|------|--------|------------------|
| Age                          | 44.78 | 18   | 86   | 12.79  | –                |
| Farm experience <sup>a</sup> | 30.54 | 4    | 68   | 13.50  | –                |
| Family size                  | 4.04  | 1    | 9    | 1.19   | –                |
| Farm size                    | 85.15 | 2    | 3000 | 262.20 | –                |
| Conservation practices       | 3.35  | 1    | 7    | 1.41   | –                |
| Ecocentrism                  | 3.62  | –    | –    | 0.66   | 0.808            |
| Anthropocentrism             | 3.22  | –    | –    | 0.68   | 0.720            |
| Environmental apathy         | 2.64  | –    | –    | 0.91   | 0.850            |

<sup>a</sup>Farm experience presented multicollinearity with farmers' age, and then, this variable was not included in the regression analysis

The conservation agriculture (CA) refers to seven practices that can contribute simultaneously for an increase in food production and economic gains, and for decreasing the environmental impacts. The diffusion of no-tillage in Brazil starts in the early 1990s (Freitas and Landers 2014) and the adoption rate of this practice is extremely high in the north-west of RS due to the land's characteristics. In our sample, all farmers use this practice. The other CA practices are green fertilizer (62.7%), crop rotation<sup>1</sup> (44.1%), crop-livestock integration (39.8%), terrace (20.36%), lines of permanent vegetation (10.38%), and cover plants between the lines (1.16%). The numbers in parentheses refer to the percentage of adoption. In addition, in all farms, soybean is the main crop produced in the summer season and about 65% of respondents grow wheat in the winter.

The environmental values were measured using a Likert scale. Ecocentrism was the higher average, followed by anthropocentrism. The average of environmental apathy was lower than three. The Cronbach's Alpha showed that all environmental values presented an adequate coefficient ( $\alpha > 0.6$ ).

## 4.2 Model results

The findings obtained by the regression model are presented in Table 3. Farmers' age, family size, and environmental apathy did not influence the perception of the farmers surveyed. On the other hand, seven factors were significant. Farm size had a significant negative effect ( $p > 0.1$ ). This means that an increase in land size significantly reduced the likelihood of farmer perceive climate change. The extension workers had a significant positive effect

**Table 3** Coefficient estimates of the binary logistic model

| Explanatory variables | $\beta$ | S.E.  | Sig.     | Exp ( $\beta$ ) |
|-----------------------|---------|-------|----------|-----------------|
| Age                   | 0.009   | 0.017 | 0.595    | 1.009           |
| Farm size             | -0.005  | 0.003 | 0.070*   | 0.995           |
| Extension work        | 1.448   | 0.879 | 0.099*   | 4.254           |
| Number of CA          | 0.322   | 0.166 | 0.053*   | 1.380           |
| Rely in government    | -1.516  | 0.537 | 0.005*** | 0.220           |
| Subsides              | -0.388  | 0.200 | 0.053*   | 0.678           |
| Family size           | 0.398   | 0.447 | 0.373    | 1.489           |
| Ecocentrism           | 0.885   | 0.384 | 0.021**  | 2.423           |
| Anthropocentrism      | 1.119   | 0.417 | 0.007*** | 3.061           |
| Environmental apathy  | -0.362  | 0.268 | 0.276    | 0.696           |
| Constant              | -4.555  | 2.332 | 0.051    | 0.011           |
| -2 Log likelihood     | 138,805 |       |          |                 |
| Cox and Snell $R^2$   | 0.323   |       |          |                 |
| Nagelkerke $R^2$      | 0.435   |       |          |                 |

Significant levels at: 10%\*, 5%\*\* and 1%\*\*\*

<sup>1</sup> We considered adoption of crop rotation if the farmer cultivates in summer harvest at least 25% of land size with maize, according to the recommendation of Brazilian Agricultural Research Corporation (Empresa Brasileira de Pesquisa Agropecuária—EMBRAPA 2011).

( $p > 0.1$ ). Therefore, the support of extension workers influenced the farmers' perception. The number of CA practices also had a significant positive influence ( $p > 0.1$ ). This result suggests that farmers who adopt more CA practices are more likely to perceive climate change. Relying on the government had a significant negative influence ( $p > 0.01$ ). Thus, farmers that rely on governmental action had a lower likelihood of perceiving climate change. Farmers, who have received economic subsidies in the last few years, also had a lower likelihood to perceive it ( $p > 0.1$ ). Regarding psychological factors, ecocentrism and anthropocentrism had a positive effect on farmers' perception of climate change, with a significance level of ( $p > 0.5$ ) and ( $p > 0.01$ ), respectively.

## 5 Discussion and concluding remarks

In this paper, we analyzed the farmers' perceptions of climate change. The results of empirical data showed that there are socioeconomic and psychological factors that influence this perception. These results corroborated with the current discussion on this subject.

It was expected that farmers' ages had a negative influence on their perception of climate change. Younger farmers probably had more contact on issues related to climate change during their school education. Events that occurred in the 1990s, including the Rio Summit and the Kyoto Protocol, giving a boost regarding the negative impacts caused by climate change (de Matteis 2019), which in turn, led to including courses and disciplines of environmental management in schools and universities. However, as mentioned earlier, age was not significant. Family size and environmental apathy also have no significance in the model. This sense of apathy is often attributed to a lack of comprehension over the benefits of nature. People who are characterized as environmentally apathetic have no pro-environmental behavior (Foguesatto et al. 2019).

The significant negative effect of farm size implies that farmers with larger lands were less likely to perceive climate change. In contrast, the study of Apata et al. (2009) that analyzed farmers' perception and adaptation on climate change, the farm size was a significant positive factor. This finding also is divergent of our hypothesis. A plausible explication for this empirical result is that larger farmers have farms with a higher technological level, which can affect their perception. For instance, perhaps farmers with irrigation systems do not recognize climate change. However, this paper does not analyze this situation.

The support provided by extension workers can serve as a proxy of several types of information. Therefore, not surprisingly, contact with extension services had a significant positive effect on the farmers' perception of climate change. In line with this finding, Prokopy et al. (2015) related that extension educators are better informed on the changes occurred in climate over the last few years. They play a critical role to help farmers to prepare for this, despite the increasing role of private consultants in providing information (Prokopy et al. 2015).

The influence signal of subsidies was opposite to the expected. As subsidies also play a role in implementing climate change adaptation strategies (Alauddin and Sarker 2014), it was expected this influenced the perception of climate change positively. A plausible

explication for our findings is that farmers may be using subsidies for other reasons not directly related to the adoption of measurements, such as the renegotiation of agricultural debts.

The perception of climate change is a key factor for developing adequate adaptation strategies (Deressa et al. 2009; Below et al. 2012). Therefore, based on economic (e.g., anthropocentric behavior) or environmental (e.g., ecocentric behavior) motivations (or both), we expected a positive effect of CA adoption on farmers' perception of climate change, and this hypothesis was confirmed. Ecocentric value had a significant positive effect on farmers' perception of climate change, and anthropocentric value too. A pivotal implication of the ecocentric and anthropocentric values is that they can influence farmers' behavior on climate change for different reasons (Morgan et al. 2015). Ecocentric farmers' had environmental concerns and the anthropocentrics are concerned with self-interest. Despite some authors arguing that anthropocentrism is the root of ecological crisis, because is a *home economics* view, i.e., the nature is important mainly for human welfare (Minteer and Manning 2005; Kopnina et al. 2018), our findings showed that self-interest contributes to climate change perception and might to adopt measures of adaptation or mitigation. Therefore, although appearing to be a paradox, anthropocentric behavior is not necessarily *bad* for nature (Foguesatto et al. 2019). For this reason, anthropocentrism should be considered a pro-environmental behavior. For extensive details on anthropocentrism, see Hayward (1997) and Kopnina et al. (2018).

Although the set of socioeconomic and psychological variables in the regression model of this study explained a substantial amount of variance in farmers' perception on climate change, some cautions should be exercised regarding generalizing these findings. For several reasons, including long distances around the farms, a random sampling technique was not used. Therefore, the results cannot be generalized for all northwest region of RS. In addition, a set of other items should be analyzed by the questionnaire.

However, an extensive questionnaire may be of limited utility for farmers who wish to quickly answer the study.

Despite these limitations, the results of this first attempt to understand farmers' perception of climate change in Brazil by using econometric models can be useful to inform policymakers. For instance, the proportion of farmers that do not recognize climate change underscores the need for redesigning local climate change communication strategies (Hitayezu et al. 2017). In this regard, extension works have a pivotal role, because daily they are in direct contact with the farmers. They should try improved farmers' awareness of climate change showing the nature importance for the ecosystem as a whole (ecocentrism) and/or highlighting the importance of nature for human welfare (anthropocentrism). Independently of reason, it is pivotal that farmers seek adaptation strategies to manage the impacts of climate change.

## Appendix 1: Questionnaire

### 1. General characteristics (socioeconomic factors)

- 1.1 – Age:  
 1.2 – Farm size (ha):  
 1.3 – Number of family members:  
 1.3 – Do you receive information or technical assistance from extension agents: ( ) yes ( ) no  
 1.4 – Did you received financial support in the last few years? ( ) yes ( ) no  
 1.5 – Do you rely on government? ( ) yes ( ) no

### 1.6 - Sustainable agricultural practices adopted (check the ones you use in your farm):

|                                                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Green fertilizer</b> - (practice of adding leguminous plants to soil with the intention of nutritionally enriching it with nitrogen) ( )                                                         |
| <b>No tillage</b> – (way to grow crops each year without disturbing the soil through tillage or plowing, that is, soil plowing only on the seeding line) ( )                                        |
| <b>Crop rotation</b> (soybean-maize) - (alternating different species of summer crops annually) ( )                                                                                                 |
| <b>Terrace</b> (planting technique designed to contain erosion caused by water runoff) ( )                                                                                                          |
| <b>Forestry and reforestation</b> (if you have permanent preservation areas) ( )                                                                                                                    |
| <b>Cordons of permanent vegetation</b> (plants cultivated in rows arranged in contour lines, aiming to control erosion in declivity areas) ( )                                                      |
| <b>Agricultural and livestock integration</b> (exploitation of agricultural and livestock activities, in an integrated way, in rotation or succession, in the same area and at different times) ( ) |

### 2. Perception of climate change

- 2.1 – Do you believe in the occurrence of climate change? ( ) yes ( ) no  
 2.2 – Do you perceive the increase in occurrence of droughts over time? ( ) yes ( ) no  
 2.3 – Comparing with the last few years, there are changes in temperature?  
 2.4 – Comparing with the last few years, there are changes in rainfall amount?

**3 (ecocentrism), 4 (anthropocentrism), 5 (environmental apathy) – Environmental values:** please, mark according your opinion as follow (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

|                                                                                                                                  |   |   |   |   |   |
|----------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|
| <b>3.1</b> – One of the worst things about overpopulation is that many natural areas are getting destroyed for development       | 1 | 2 | 3 | 4 | 5 |
| <b>3.2</b> – I can enjoy spending time in natural settings just for the sake of being out in nature                              | 1 | 2 | 3 | 4 | 5 |
| <b>3.3</b> – Sometimes it makes me sad to see forests cleared for agriculture                                                    | 1 | 2 | 3 | 4 | 5 |
| <b>3.4</b> – I prefer wildlife reserves to zoos                                                                                  | 1 | 2 | 3 | 4 | 5 |
| <b>3.5</b> – I need time in nature to be happy                                                                                   | 1 | 2 | 3 | 4 | 5 |
| <b>3.6</b> – Sometimes when I am unhappy I find comfort in nature                                                                | 1 | 2 | 3 | 4 | 5 |
| <b>3.7</b> – It makes me sad to see natural environments destroyed                                                               | 1 | 2 | 3 | 4 | 5 |
| <b>3.8</b> – Nature is valuable for its own sake                                                                                 | 1 | 2 | 3 | 4 | 5 |
| <b>3.9</b> – One of the most important reasons to conserve is to preserve wild areas                                             | 1 | 2 | 3 | 4 | 5 |
| <b>3.10</b> – Being out in nature is a great stress reducer for me                                                               | 1 | 2 | 3 | 4 | 5 |
| <b>3.11</b> – Sometimes animals seem almost human to me                                                                          | 1 | 2 | 3 | 4 | 5 |
| <b>3.12</b> – Humans are as much a part of the ecosystem as other animals                                                        | 1 | 2 | 3 | 4 | 5 |
| <b>4.1</b> – The worst thing about losing the rain forest is that it will restrict the development of new medicines              | 1 | 2 | 3 | 4 | 5 |
| <b>4.2</b> – The best thing about camping is that it is a cheap vacation                                                         | 1 | 2 | 3 | 4 | 5 |
| <b>4.3</b> – It bothers me that humans are running out of their supply of oil                                                    | 1 | 2 | 3 | 4 | 5 |
| <b>4.4</b> – Science and technology will eventually solve our problems with pollution, overpopulation, and diminishing resources | 1 | 2 | 3 | 4 | 5 |
| <b>4.5</b> – The thing that concerns me most about deforestation is there will not be enough lumber for future generations       | 1 | 2 | 3 | 4 | 5 |
| <b>4.6</b> – One of the most important reasons to keep lakes and rivers clean is so people have a place to enjoy water sports    | 1 | 2 | 3 | 4 | 5 |
| <b>4.7</b> – One of the best things about recycling is that it saves money                                                       | 1 | 2 | 3 | 4 | 5 |
| <b>4.8</b> – Nature is important because of what it can contribute to the pleasure and welfare of humans                         | 1 | 2 | 3 | 4 | 5 |
| <b>4.9</b> – We need to preserve resources to maintain a high quality of life                                                    | 1 | 2 | 3 | 4 | 5 |
| <b>4.10</b> – One of the most important reasons to conserve is to ensure a continued high standard of living                     | 1 | 2 | 3 | 4 | 5 |
| <b>4.11</b> – Continued land development is a good idea if a high quality of life can be preserved                               | 1 | 2 | 3 | 4 | 5 |
| <b>5.1</b> – Environmental threats such as deforestation and ozone depletion have been exaggerated                               | 1 | 2 | 3 | 4 | 5 |
| <b>5.2</b> – It seems to me that most conservationists are pessimistic and somewhat paranoid                                     | 1 | 2 | 3 | 4 | 5 |
| <b>5.3</b> – I do not think the problem of depletion of natural resources is as bad as many people make it out to be             | 1 | 2 | 3 | 4 | 5 |
| <b>5.4</b> – I find it hard to get too concerned about environmental issues                                                      | 1 | 2 | 3 | 4 | 5 |
| <b>5.5</b> – I do not feel that humans depend on nature to survive                                                               | 1 | 2 | 3 | 4 | 5 |
| <b>5.6</b> – Most environmental problems will solve themselves given enough time                                                 | 1 | 2 | 3 | 4 | 5 |
| <b>5.7</b> – I don't care about environmental problems                                                                           | 1 | 2 | 3 | 4 | 5 |
| <b>5.8</b> – I'm opposed to programs to preserve wilderness, reduce pollution and conserve resources                             | 1 | 2 | 3 | 4 | 5 |
| <b>5.9</b> – Too much emphasis has been placed on conservation                                                                   | 1 | 2 | 3 | 4 | 5 |

## Appendix 2: Correlation matrix of explanatory variables

| Variables            | Age    | Farm size | Extension work | Number of CA | Rely on government | Subsidies | Family size | Ecocentrism | Anthropocentrism | Environmental apathy |
|----------------------|--------|-----------|----------------|--------------|--------------------|-----------|-------------|-------------|------------------|----------------------|
| Age                  | 1      |           |                |              |                    |           |             |             |                  |                      |
| Farm size            | -.048  | 1         |                |              |                    |           |             |             |                  |                      |
| Extension work       | .170*  | -.012     | 1              |              |                    |           |             |             |                  |                      |
| Number of CA         | .020   | -.090     | -.046          | 1            |                    |           |             |             |                  |                      |
| Rely in government   | -.179* | .143      | -.120          | .010         | 1                  |           |             |             |                  |                      |
| Subsidies            | -.045  | -.059     | .020           | -.164*       | .246**             | 1         |             |             |                  |                      |
| Family size          | -.179* | .045      | .102           | -.039        | .018               | .074      | 1           |             |                  |                      |
| Ecocentrism          | .146   | -.066     | .125           | -.053        | .012               | -.047     | .023        | 1           |                  |                      |
| Anthropocentrism     | .028   | .073      | .008           | -.020        | -.087              | -.142     | -.041       | .440**      | 1                |                      |
| Environmental apathy | .094   | -.003     | .030           | .033         | -.068              | -.148     | -.101       | -.067       | .284**           | 1                    |

\*Correlation is significant at the 0.05 level

\*\*Correlation is significant at the 0.01 level

## LÍNGUA INGLESA

### BIOMÉDICAS

**TEXTO-BASE:** FOGUESATTO, C. R., MACHADO, J. A. D. What shapes farmers' perception of climate change? A case study of southern Brazil. **Environment, Development and Sustainability**, n. 17, v. 23(2), 2021, p. 1525-1538.

#### QUESTÃO 1:

Enunciado: Assinale a alternativa **CORRETA** que justifica o estudo sobre a percepção de agricultores acerca da mudança climática:

Gabarito:

Segundo os autores, o entendimento da percepção de agricultores sobre a mudança climática é um pontapé inicial para a adoção de estratégias de mitigação dos efeitos negativos de eventos climáticos extremos.

Distratores:

- 1) Segundo os autores, o estudo das secas, como eventos climáticos extremos, podem auxiliar na percepção do seu impacto, considerando o aumento das perdas econômicas e da insegurança alimentar.
- 2) Segundo os autores, com o uso de modelos econométricos relatados na literatura, verifica-se que há inúmeras variáveis que podem influenciar a percepção dos agricultores acerca da mudança climática.
- 3) Segundo os autores, ainda que exista vasta literatura acerca do estudo da percepção dos agricultores em relação à mudança climática, estudos empíricos no Brasil são relativamente escassos.

Justificativa: A alternativa está incorreta pois os autores, no segundo parágrafo da introdução, argumentam que o entendimento da percepção de agricultores sobre a mudança climática torna-se o primeiro passo para o desenvolvimento de estratégias de mitigação dos efeitos negativos de eventos climáticos extremos e de adaptação, conforme mostra o trecho: “As farmers realize the decision-making process to adopt practices that can mitigate the negative effects of extreme weather events, understanding their perception regarding climate change is pivotal (Foguesatto et al. 2020). The comprehension of farmers’ perception of changes in climate is the first step to developing strategies of mitigation and adaptation. A representative survey of nearly 5000 farmers in the USA revealed that the perceived risks of the weather and climate were important for the developing adaptation measures (Mase et al. 2017). Given this backdrop, Tesfahunegn et al. (2016) suggest that the farmers’ perception of climate change must be documented”.

## QUESTÃO 2:

Enunciado: Analise as proposições a seguir e assinale a alternativa **CORRETA**:

I – O estudo relatado no artigo concentra-se na análise dos fatores que influenciam a percepção da mudança climática por agricultores brasileiros.

II – O estudo relatado no artigo é um dos muitos já realizados considerando a população de agricultores brasileiros investigada.

III – O estudo relatado no artigo utilizou um questionário para levantamento de dados enquanto a análise dos dados foi feita com tratamento estatístico.

IV – O estudo relatado no artigo pode fomentar programas e políticas voltadas para a adoção de estratégias de mitigação/adaptação dos efeitos da mudança climática.

Gabarito:

Somente as alternativas I, III e IV estão corretas.

Distratores:

1) Somente as alternativas II, III e IV estão corretas.

2) Somente as alternativas I, II e IV estão corretas.

3) Somente as alternativas I, II e III estão corretas.

Justificativa: A resposta correta pode ser depreendida a partir do último parágrafo da introdução. Nele os autores tratam do objetivo geral do estudo (análise dos fatores que influenciam a percepção da mudança climática por agricultores brasileiros). a população investigada (agricultores brasileiros do estado do Rio Grande do Sul sendo o estudo um dos primeiros a incluir tal população), o instrumento de coleta de dados utilizado (questionário para levantamento das percepções dos participantes) e o método de análise de dados (técnica de regressão logística) e os impactos dos resultados obtidos com o estudo (contribuir com a literatura e fornecer subsídios para desenvolver programas e políticas voltadas para a adoção de estratégias de mitigação/adaptação dos efeitos da mudança climática). Portanto, estão corretas as alternativas I, III e IV e está incorreta a alternativa II.

### QUESTÃO 3:

Enunciado: Em relação aos procedimentos de coleta e de análise de dados, analise as proposição a seguir e assinale a alternativa **CORRETA**:

- I – O estudo englobou agricultores de todas as partes do estado do Rio Grande do Sul.
- II – O estudo englobou agricultores do estado do Rio Grande do Sul de regiões afetadas especialmente pelas secas.
- III – O instrumento de coleta de dados foi refinado após pilotagem e um total de 172 questionários foram validados, após a coleta de dados.
- IV – Os dados coletados receberam tratamento estatístico por meio de um software apenas.

Gabarito:

Somente as alternativas II e III estão corretas.

Distratores:

- 1) Somente as alternativas II e IV estão corretas.
- 2) Somente as alternativas I e II estão corretas.
- 3) Somente as alternativas I e III estão corretas.

Justificativa: Somente as alternativas II e III estão corretas e as alternativa I e IV estão incorretas. Os autores, na seção de Metodologia, nas subseções 3.1, em ambos os parágrafos, e 3.2, no primeiro parágrafo, explicam que o estudo englobou agricultores de nove “condados”

ou regiões do estado do Rio Grande do Sul. Segundo os autores, os participantes dessas regiões foram incluídos na pesquisa pois essas regiões são vulneráveis à mudança climática e foram afetadas especialmente pelas secas severas que lá ocorreram. Ainda, os autores explicam que o questionário utilizado como instrumento de coleta de dados foi refinado após pilotagem e, ao final, um total de 172 questionários foram validados, após a coleta de dados ter sido feita. Por fim, os autores também explicam que os dados coletados receberam tratamento estatístico por meio de dois softwares diferentes (SPSS e R).

#### QUESTÃO 4:

Enunciado: Tomando por base os resultados do estudo, assinale a alternativa **INCORRETA**:

Gabarito: Os resultados da análise estatística por meio do modelo de regressão revelaram que a idade do agricultor é um fator que se relaciona com a percepção da mudança climática.

Justificativa: Os resultados do modelo relatados no primeiro parágrafo da seção 4.2 apontam que a idade do agricultor, o tamanho da família e a apatia ambiental não se mostraram fatores que influenciam a percepção da mudança climática. Portanto, a alternativa é correta pois contém uma afirmação falsa.

Distratores:

1) Os resultados da análise estatística por meio do modelo de regressão revelaram que o tamanho da família não é um fator que se relaciona com a percepção da mudança climática.

Justificativa: Os resultados do modelo relatados no primeiro parágrafo da seção 4.2 apontam que a idade do agricultor, o tamanho da família e a apatia ambiental não se mostraram fatores que influenciam a percepção da mudança climática. Portanto, a alternativa é incorreta pois contém uma afirmação verdadeira.

2) Os resultados da análise estatística por meio do modelo de regressão revelaram que a apatia ambiental não é um fator que se relaciona com a percepção da mudança climática.

Justificativa: Os resultados do modelo relatados no primeiro parágrafo da seção 4.2 apontam que a idade do agricultor, o tamanho da família e a apatia ambiental não se mostraram fatores

que influenciam a percepção da mudança climática. Portanto, a alternativa é incorreta pois contém uma afirmação verdadeira.

3) Os resultados da análise estatística por meio do modelo de regressão revelaram que o tamanho da propriedade rural é um fator que se relaciona com a percepção da mudança climática.

Justificativa: Os resultados do modelo relatados no primeiro parágrafo da seção 4.2 apontam que o tamanho da propriedade rural (além de outras seis variáveis) se mostrou como um fator que influencia a percepção da mudança climática. Portanto, a alternativa é incorreta pois contém uma afirmação verdadeira.

### **QUESTÃO 5:**

Enunciado: Defina o que os autores chamam de “eventos do século” e forneça três exemplos de suas manifestações no Brasil. Em seguida, discorra sobre os impactos de alguns desses eventos no país, citando as regiões afetadas, suas causas e consequências.

Resposta esperada: O/a candidato/a deve demonstrar a capacidade de localizar informações específicas no texto bem como a de sintetizar ideias principais a partir dos dois parágrafos da seção 2 intitulada “Efeitos da mudança climática no Brasil”. Segundo os autores, “eventos do século” incluem as ondas de calor, enchentes e secas que têm ocorrido no Brasil. As ondas de calor, por exemplo, têm afetado inúmeras regiões do país, com elevação de temperatura no inverno de 3-4° C acima do normal. As enchentes ocorridas em 2009, 2013, 2014 e 2017 na Amazônia também são exemplos citados. Ainda, as secas desde 2012 na região semiárida do Nordeste e as secas no sudoeste, que casaram a pior crise hídrica da região metropolitana de São Paulo desde 1960.

### **QUESTÃO 6:**

Enunciado: Liste (quantas e quais), defina (ao que se referem) e classifique (por tipo) pelo menos 4 das variáveis explanatórias do estudo (socioeconômicas e psicológicas), excetuando-se aquelas cuja medição foi realizada em Escala Likert.

Resposta esperada: O/a candidato/a deve demonstrar a capacidade de localizar informações específicas no texto e demonstrar a compreensão, a partir da Tabela 1, de pelo menos 4 (seis)

das 6 (seis) variáveis explanatórias do estudo. Segundo os autores, foram utilizadas 10 medidas relativas às variáveis explanatórias, sendo 3 (três) baseadas em Escala Likert. As demais incluem:

- 1 – idade: idade do agricultor (em anos); variável contínua;
- 2 – tamanho da propriedade: tamanho da propriedade em hectares; variável contínua;
- 3 – trabalho da extensão rural: se o agricultor recebeu ou não suporte técnico; variável fictícia/artificial/binária/nominal;
- 4 – práticas de conservação: número de práticas de conservação adotadas na propriedade; variável de contagem;
- 5 – subsídios: se o agricultor recebeu subsídios econômicos ou não nos últimos anos; variável fictícia/artificial/binária/nominal;
- 6 – tamanho da família: número de membros da família; variável contínua.

#### **QUESTÃO 7:**

Enunciado: Cite e explique, pelo menos, uma limitação do estudo apontada pelos autores.

Resposta esperada: O/a candidato/a deve demonstrar a capacidade de localizar informações específicos do texto e de compreender ideias principais apresentadas na conclusão do estudo, mais especificamente nos três últimos parágrafos do texto. Segundo os autores, ainda que o conjunto de variáveis socioeconômicas e psicológicas utilizadas no modelo de regressão do estudo tenham sido capazes de explicar em boa parte a percepção dos agricultores sobre a mudança climática, uma técnica de aleatorização da amostra não foi empregada em virtude das longas distâncias das propriedades. Logo, os resultados não são generalizáveis para toda a região noroeste do estado do Rio Grande do Sul. Ainda, os autores reconhecem também a necessidade de inclusão de outros itens no questionário, mas ponderam que um questionário muito extenso pode se mostrar inadequado para este tipo de pesquisa envolvendo agricultores.