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FACTORS THAT INDUCE THE RECOVERY OF DEGRADED PASTURES BY FARMERS OF THE RIO DAS CONTAS HYDROGRAPHIC BASIN

Fatores que induzem a recuperação de pastas degradadas por agricultores da bacia hidrográfica do Rio das Contas

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ABSTRACT

The intensification of agricultural production in the future must necessarily happen on a sustainable basis. Thus, the present study aimed to analyze the role of education and climate perception for the pro-environmental behavior of farmers with a focus on the recovery of degraded pastures. The willingness to adopt agricultural techniques that mitigate greenhouse gas (GHG) emissions was considered as a factor of pro-environmental behavior. For the analysis, a case study was carried out with farmers whose properties are located in the river basin of Rio das Contas, Bahia. Methodologically, the work was divided into three main stages: data collection; exploratory analysis of responses regarding the willingness to adopt sustainable production techniques, a proxy used to represent pro-environmental behavior; and the analysis of a probability model (Probit). The main factors responsible for this perception of climate change identified in the study were access to formal education and technical assistance. The research showed that these two variables can promote the recovery of degraded areas, as they are able to assist in decision making in the face of climate change scenarios. It was concluded that technical assistance and schooling make farmers more willing to undertake more sustainable agricultural techniques.

Keywords: Pro-environmental behavior, Agriculture, Sustainability.

RESUMO

A intensificação da produção agrícola no futuro deve ocorrer necessariamente em bases sustentáveis. Assim, o presente estudo teve como objetivo analisar o papel da educação e percepção do clima para o comportamento pró-ambiental de agricultores com foco na recuperação de pastagens degradadas. A disposição em adotar técnicas agrícolas que mitiguem as emissões de gases de efeito estufa (GEE) foi considerada como fator de comportamento pró-ambiental. Para a análise, foi realizado um estudo de caso com agricultores cujas propriedades estão localizadas na bacia hidrográfica do Rio das Contas, Bahia. Metodologicamente, o trabalho foi dividido em três etapas principais: coleta de dados; análise exploratória das respostas sobre a disposição em adotar técnicas de produção sustentável, uma proxy utilizada para representar o comportamento pró-ambiental; e a análise de um modelo de probabilidade (Probit). Os principais fatores responsáveis por essa percepção das mudanças climáticas identificadas no estudo foram o acesso à educação formal e à assistência técnica. A pesquisa mostrou que essas duas variáveis podem promover a recuperação de áreas degradadas, pois são capazes de auxiliar na tomada de decisão diante de cenários de mudanças climáticas. Concluiu-se que a assistência técnica e a escolaridade tornam os agricultores mais dispostos a empreender técnicas agrícolas mais sustentáveis.

Palavras-chave: Comportamento pró-ambiental, Agricultura, Sustentabilidade.

1. INTRODUÇÃO

The increase in the world population to approximately 10 billion people by 2050, added to the expectation of improving economic conditions in several countries, will considerably increase the demand for food around the world, especially in Asia, Latin America and Africa (KASTNER *et al*.,

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2012). Brazil will play a central role in this process, both positively and negatively. On the one hand, Brazilian agricultural production is one of the most important for the world's food supply. However, the national agricultural sector accounts for more than a third of Brazilian emissions of greenhouse gases (GHG), which are largely responsible for global climate change (SUELA *et al*., 2020a). According to a report by the Observatório do Clima (2014), by 2025 Brazil will meet the domestic demand for food and will still generate surpluses to be exported. However, at the same time, GHG emissions will increase as the global demand for food grows.

Thus, it is essential that the country continues to intensify agricultural production, however, it must take place on a sustainable basis, that is, contributing to the mitigation of greenhouse gas (GHG) emissions. This process is known as sustainable agricultural intensification (SAI). According to Rockström (2017), the ISA aims to ensure the production of more food and, at the same time, make the "ecological footprint" of the sector smaller and smaller, thus becoming more sustainable. Since 2010, Brazil has been encouraging ISA through the ABC Plan (Sectoral Plan for Mitigation and Adaptation to Climate Change for the Consolidation of a Low-Carbon Economy in Agriculture). The ABC Plan finances activities such as agroforestry systems, no-tillage, recovery of degraded pastures and biological nitrogen fixation, reduction of pesticide use, among others (WANDER *et al.*, 2016).

According to Meyer (2015), the pro-environmental behavior of farmers may be directly related to their educational level, Hyland (2016) says that the perception of climate change can help in pro-environmental decision making, in this way, it can be to relate the possibility of achieving the objectives proposed by the SAI directly with the hypotheses of the aforementioned authors, which will be tested in this research. Aklin *et al.* (2013) reports that education is positively correlated with environmentally sustainable attitudes in different contexts. At the same time, climate perception, which is linked to the way in which individuals' access and understand climate change, plays a crucial role in their willingness to change production practices (PERSSON *et al*., 2015).

Faced with these issues, it is of fundamental importance to understand how Brazilian farmers are behaving in the face of the process of sustainable intensification of their activities. Therefore, the objective of this work was to analyze the role played by formal and informal education and climate perception in pro-environmental behavior, taking as main point, the choice of farmers to carry out the recovery of their degraded pastures in the region of the hydrographic basin of Rio das Contas, Bahia.

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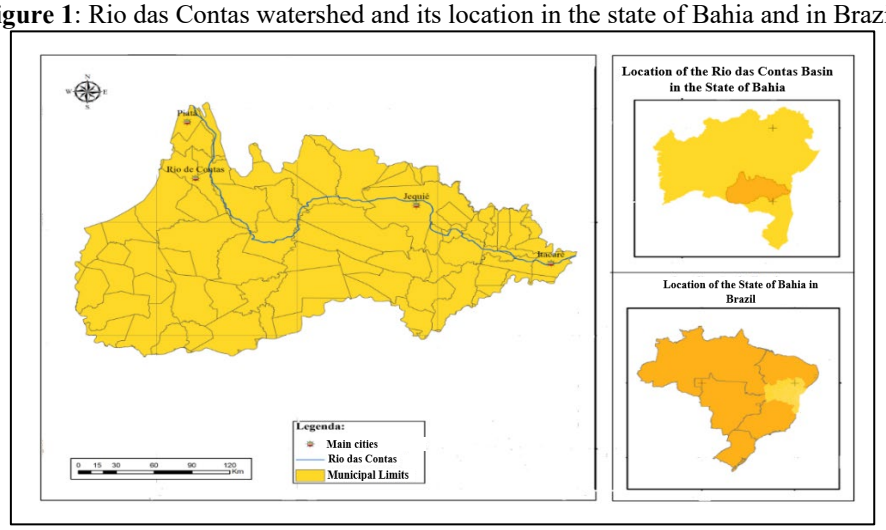
We chose to carry out the study at a regional level, since the results of studies that study the occurrence of climate change for the country as a whole do not demonstrate essential characteristics of certain locations, which also suffer from the impacts generated by these changes. Such local analyzes are fundamental for understanding the decision to adopt mitigation strategies. As Brazil is a country of continental dimensions and with different edaphoclimatic and socioeconomic conditions, knowledge of these issues at the local level can be a preponderant factor for the evaluation and readjustment of national public policies.

Therefore, a case study was carried out with farmers whose properties are located in the Rio das Contas watershed, in Bahia (geographical coordinates 12º55' and 15º10' South latitude and 39º00' and 42º35' West longitude) (Figure 1).

Figure 1: Rio das Contas watershed and its location in the state of Bahia and in Brazil.



Source: Matos (2016).

The basin is part of the East Atlantic hydrographic region (BRAZIL, 2013). It is characterized by having small to medium-sized cities, low level of industrialization and economic activity focused mainly on agriculture and livestock, which makes it potentially more vulnerable to the adverse effects of climate change. The Rio das Contas watershed is a typical example of this region (PAULA *et al*., 2010). Therefore, its choice to carry out the research is due to the fact that the understanding of these issues was very little explored regionally. Furthermore, as it comprises a great diversity of biomes (Cerrado, Caatinga and Atlantic Forest) and is basically dependent on agriculture, this basin provides valuable scientific and natural capital (MATOS, 2016; SUELA *et al*., 2020b).

Finally, it is possible to affirm that the impacts caused by climate change tend to be extremely severe in the Northeast region, where the basin is located. In the Northeast, the highest temperature

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increases and great interannual variability of precipitation are expected during the rainy season (December-February) (SUELA *et al.,* 2021; MACHADO-FILHO, 2016). The expected climate changes for the Northeast could negatively affect the agricultural aptitude of the region. Agricultural losses, in turn, exacerbate problems already faced by poorer farmers, such as rural-urban migration, fragmentation of properties, low access to formal education, etc. (MACHADO-FILHO, 2016).

2. OBJECTIVE

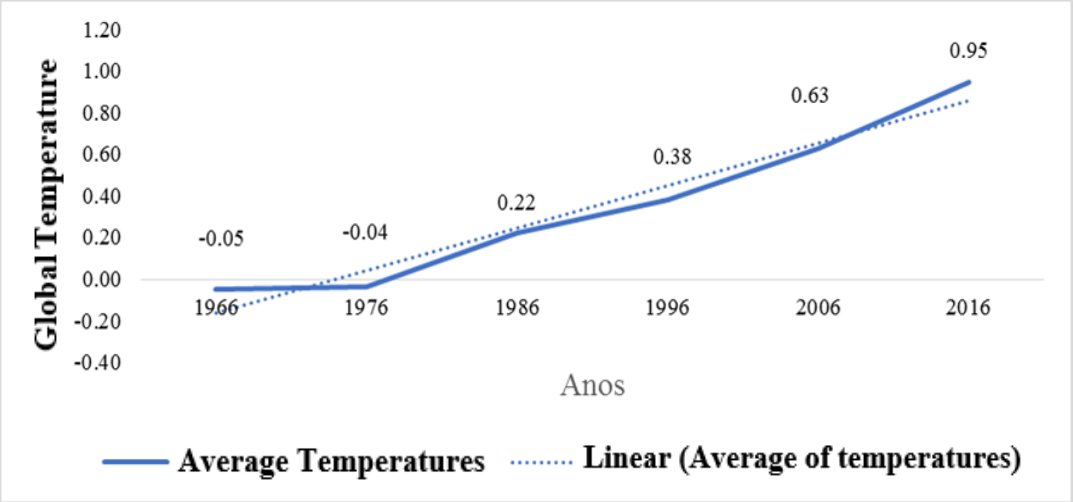
The main objective of this research was to analyze the relationship between education (formal and informal) and climate perception impacting directly on the pro-environmental behavior of producers, with a focus on carrying out the recovery of degraded pastures by farmers in the river basin of Rio das Contas, Bahia.

3. CLIMATE CHANGE AND AGRICULTURAL ACTIVITIES: CONCEPTUALIZATION

According to the Intergovernmental Panel on Climate Change (IPCC, 2017), climate change refers to a change in the state of the climate that can be identified (through statistical tests, for example) by changes in the mean and, or, in the variation. of its properties and that persist over a long period of time. Climate change can occur either through natural internal processes or external forces, such as modulations of solar cycles, volcanic eruptions, and persistent anthropogenic changes in atmospheric composition or land use. Emissions of so-called greenhouse gases - GHGs (methane, nitrous oxide and carbon dioxide) are the main causes of the phenomenon of climate change (IPCC, 2017). In anthropogenic terms, it can be said that both agricultural and industrial production have a high potential for generating GHGs.

There are several manifestations of climate change on the planet, among them the increase in the number of occurrences of hurricanes, tsunamis, accentuated melting of the polar ice caps (which raise the level of the seas), the increase in rainfall, resulting in floods, and periods of droughts, which are getting more and more prolonged and negatively affecting life on earth (SUELA *et al*., 2020a). However, the main manifestation of climate change that has been documented with a high degree of certainty today is global warming. This statement can be exemplified by Figure 2, which shows the rise in temperatures in the last five decades.

Figure 2: Growth of world temperatures.



Source: NASA Goddard Institute for Space Studies (2016).

The data provided by the IPCC (2017) allow classifying the main sectors responsible for global GHG emissions. The main emitter is the Electricity and Energy Production sector, with a share of 35% of emissions, followed by the Agriculture, Forestry and Other Land Uses sector, with 24%, Industry, with around 21%, the transport with 14%, and the Construction sector with 6%.

The Brazilian configuration in relation to the sectors with the highest GHG emission rates presents a significant difference when compared to the global characteristics. Based on information provided by the Climate Observatory (2015), the activities with the highest GHG emissions, in descending order, are: Land Use Changes, with 35% (mainly due to deforestation), the Energy sector, with 29 %, Agriculture, with 27%, and, finally, the Industry and Disposal of Polluting Waste sectors, with 6% and 3%, respectively.

With the information presented above, it is possible to observe that the agricultural sector, both from a global perspective and from a Brazilian perspective, stands out in relation to GHG emissions, making it an important agent when it comes to possibilities of mitigating the effects caused by these pollutants. A large part of the environmental impacts arising from agriculture and livestock originate from the abusive use of water, mainly in plantations and agro-industries, in the intensive use of agrochemicals and in the use of unsustainable production practices, which damage the soil, often permanently from management of ruminants, which are the biggest emitters of methane.

As population growth will increasingly demand food production, the great challenge for world agriculture will arise: to produce enough food, fiber and energy to meet this growing demand. For

this to occur without intensifying the existing pollution, it will be necessary to implement, in the traditional ways of production, the adequate and intelligent use of land and animal management, so that the environment itself is no longer degraded.

Gurgel and Laurenzana (2016) report that low-carbon agriculture (ABC Program) is the mitigating practice capable of reducing GHGs emitted into the atmosphere. This program, launched by the Brazilian government in 2010, proposes the reduction of harmful gases released into the environment, through agricultural activities that use highly effective agricultural and technological techniques, which leads to a decrease in the intensity of toxic substances released into the environment. The ABC Program can be considered a form of climate-conscious agriculture. According to Food and Agriculture Organization of the United Nations (FAO) (2013), activities such as the recovery of degraded areas, integration-crop-livestock-forest and planted forests, which are actions encouraged by the ABC Plan, increase productivity in a sustainable way, in addition to reducing GHGs.

4. METHODOLOGY

This article sought to examine Meyer's (2015) theoretical procedure. According to the author, people's environmentally positive behavior increases as their educational level increases. The idea contained is that education can make individuals aware of the external effects of their behavior and, thus, more concerned with social well-being and environmental conservation. Meyer's (2015) formulation was expanded in this study to consider not only formal education, but also the knowledge acquired during work in agricultural activities. For this, it was considered that the farmer could increase his knowledge through access to technical assistance, by participating in class associations or cooperatives and also by working with agricultural activities (experience).

At the same time, the hypothesis of Hyland *et al.* (2016) was considered, according to the author, the perception of farmers determines their assessment of climate change and, therefore, their willingness to implement mitigation measures. In the present work, to analyze the perception, two pieces of information were considered, based on the literature that informs that farmers will be more willing to protect the environment the higher their awareness of some environmental problem and the threats that can cause them harm. (HYLAND *et al*., 2016):

i. Knowledge about climate change and the adverse effects of this phenomenon on farmers' activities.

ii. Observation of climate change by farmers (droughts, summers, heat waves, etc.).

To test these hypotheses, the methodology used was divided into three main steps. The first was to collect primary data from farmers in the watershed using a semi-structured questionnaire. The questionnaire contained questions about the socioeconomic conditions of the producers, about their willingness to adopt more sustainable agricultural techniques and about their degree of knowledge/perception about climate change and extreme events. Following the methodology proposed by Hartter (2009), farmers were selected by simple random sampling, with 95% statistical confidence in a universe of 145,467 properties, resulting in 289 chosen rural properties.

The second stage corresponded to the exploratory analysis of the farmers' responses regarding their willingness to adopt sustainable production techniques, a proxy used to represent pro-environmental behavior. For this, the chi-square test (χ^2) was used. This is a non-parametric test that evaluates the dependence between two variables. In the case of this study, the null hypothesis tested was that pro-environmental behavior is independent of farmers' educational level (formal or informal) or climate perception.

In the last part, the determinants that lead the farmer to carry out the recovery of their pastures were analyzed, taking into account several reasons that may influence their decision. For this analysis, the probability model (Probit) will be used:

$$P_i = P(Y_i = 1 \mid X) = F(X_i\beta)$$

where P_i is the probability that the farmer is willing to recover his degraded areas ($Y_i = 1$); X represents the vector of explanatory variables; and $F(.)$ is the cumulative standard normal distribution function.

The explanatory variables used to test the study hypotheses can be divided into three groups:

Group 1: Formal education

i. Education: indicates the farmer's level of education (illiterate = 0; know how to read and write = 1; incomplete primary education = 2; complete primary education = 3; incomplete secondary

education = 4; complete secondary education = 5; incomplete higher education = 6; complete higher education = 7).

Group 2: Informal knowledge

ii. Experience: indicates the length of time the farmer has worked with agricultural activities (up to 5 years = 0; from 6 to 15 years = 1; from 16 to 30 years = 2; Over 30 years = 3);

iii. Technical assistance: dummy that takes the value 1 when the farmer had access to technical assistance in the previous year; and

iv. Association: dummy that takes the value 1 when the farmer participates in class associations (rural union, for example) or cooperatives.

Group 3: Climate Perception

v. Climate Changing: Indicates whether the farmer has observed/perceived any extreme climate change (Don't know answer = 0; No, not at all = 1; No, maybe not = 2; Yes, maybe = 3; Yes, definitely = 4).

vi. Climate perception: indicates the degree of knowledge about climate change and its impacts on agriculture (does not know = 0; knows little = 1; knows, but incompletely = 2; knows comprehensively = 3).

Other control variables[2]*:*

vii. Gender: dummy that takes the value 1 when the farmer is male;

viii. Credit: dummy that takes the value 1 when the farmer had access to agricultural credit to make investments in the property in the previous year;

ix. Ownership: dummy that takes the value 1 when the farmer owns his establishment.

5. RESULTS

In order to have a better understanding of the results of this study, it is essential to know the general characteristics of the sample used. Considering the socioeconomic conditions of the farmers

[2] Each variable in this category, as well as its specification, was based on the literature on the topic. Their non-inclusion could lead to bias due to the omission of a relevant variable, as they are important for the farmer's decision making.

interviewed, it was observed that about 60% have, at most, completed elementary school, and of these, 22% are illiterate; 21% have completed high school, but only 7% have completed higher education. A significant portion of producers is male (83%) and has, on average, 51 years of age and 31 years of work in agricultural activities. Most of the farmers considered do not have access to technical assistance or credit (70% and 73%, respectively). About 65% participate in some rural class association/union. Approximately 55% of farmers depend exclusively on income generated on the property.

Regarding knowledge about climate change and its impacts on agricultural activities, 15.2% said they were unaware of the topic, 63.7% that they know little, 17.7% that they know it incompletely and 3.4% that they know it in an incomplete way. embracing. Thus, it is possible to affirm that a considerable portion of the farmers in the region still need more and better information on the subject. This result can be explained by the fact that climate change is a highly complex phenomenon, which can have multiple causes and different physical characteristics, with consequences that imply a wide scale of risks (SHI *et al*., 2016).

The largest share of farmers (74%) said they were willing to change their ways of managing the land so that their activities cause less negative impact on the environment, demonstrating concern about the phenomenon. The activity that farmers are most willing to adopt is to reduce the use of pesticides (54% of those who are prone to pro-environmental behavior would “certainly” adopt this practice). The other practices mentioned, in order of importance, were: no-tillage (36%), recovery of degraded pastures (32%), reforestation (19%), agroforestry systems or crop-livestock-forest integration (18%) and waste treatment animals (11%).

All the techniques mentioned by the farmers are part of the strategies proposed by the Brazilian government in order to reduce GHG emissions in the agricultural sector. Since, none of the interviewed farmers reported having had access to credit provided by the ABC Plan. In this way, public investment for the technical training of producers and facilitating their access to credit could increase the reach of the ABC Plan in the Rio das Contas basin, increasing the environmental sustainability of agriculture in the region. For this to become a reality, policymakers should take into account that farmers' preferences and willingness to pay for technologies differ significantly in terms of potential benefits and costs, and even in relation to their expectations of financial support from the government (KHATRI-CHHETRIA *et al.,* 2017). On this last point, it is important to point out that a

significant part of the agriculture practiced in the region is family-owned, with poorly capitalized farmers and, therefore, with low investment capacity.

Table 1: Association between level of education and willingness to adopt GHG mitigation techniques by farmers in the Rio das Contas watershed.

Level of schooling	Willingness to adopt sustainable production techniques (%)	
	No	Yes
Illiterate	46,15	53,85
Know how to read and write	33,33	66,67
Incomplete elementary school	27,27	72,73
Complete primary education	16,67	83,33
Incomplete high school	10,53	89,47
Complete high school	25,00	75,00
Incomplete higher education	8,33	91,67
Complete higher education	10,53	89,47
Total	25,95	74,05

Test statistic: $\chi 2 = 17.30$, P-value = 0.016.
Source: Search results (2022).

The chi-square tests performed (Tables 1, 2, 3, 4, 6 and 7) indicated that the willingness to change agricultural practices towards more sustainable activities is directly related to the level of schooling (Table 1), with informal knowledge (represented by access to technical assistance, participation in class association and experience, Tables 2, 3 and 4, respectively), with the observation/perception of some abnormal weather condition (Table 5) and with the choice of recovery of degraded pastures (Table 6).

Table 2: Association between farmer experience (measured in years of work in agricultural activity) and willingness to adopt GHG mitigation techniques by farmers in the Rio das Contas watershed.

Farmer experience	Willingness to adopt sustainable production techniques (%)	
	No	Yes
Up to 5 years	38,5	61,5
From 6 to 15 years	13,3	86,7
From 16 to 30 years old	29,7	70,3
Over 30 years	25,7	74,3
Total	26,0	74,0

Test statistic: $\chi 2 = 6.43$, P-value = 0.094.
Source: Search results (2022).

Table 3: Association between access to technical assistance and willingness to adopt GHG mitigation techniques by farmers in the Rio das Contas watershed.

Access to technical assistance	Willingness to adopt sustainable production techniques (%)	
	No	Yes
Did not have access	31,7	68,3
Had access	12,6	87,4
Total	26,0	74,0

Test statistic: $\chi 2 = 11.47$, P-value = 0.001.
Source: Search results (2022).

Table 4: Association between participation in class associations and willingness to adopt GHG mitigation techniques by farmers in the Rio das Contas watershed.

Participation in class associations	Willingness to adopt sustainable production techniques (%)	
	No	Yes
Does not participate	34,0	66,0
Participate	21,5	78,5
Total	26,0	74,0

Test statistic: $\chi 2 = 5.37$, P-value = 0.021.
Source: Search results (2022).

Table 5: Association between the perception of climate condition and the willingness to adopt GHG mitigation techniques by farmers in the Rio das Contas watershed.

Observation/perception of weather condition	Willingness to adopt sustainable production techniques (%)	
	Não	Sim
Don't know how to answer	100,0	0
No, not at all	50,0	50,0
No, maybe not	25,0	75,0
Yes maybe	33,3	66,7
Yes definitely	23,7	76,3
Total	25.95	74.05

Test statistic: $\chi 2 = 9.19$, P-value = 0.057.
Source: Search results (2022).

Table 6: Association between the producer's choice to carry out the recovery of degraded pastures and his willingness to adopt GHG mitigation techniques in the region of the Rio das Contas watershed.

Recovery of degraded pastures	Willingness to adopt sustainable production techniques (%)	
	No	Yes
No recovery	53.19	46.81
Recovery	8.23	91.77
Total	26	74

Test statistic: $\chi 2 = 106.31$, P-value = 0.00.
Source: Search results (2022).

The results in Tables 1 to 6 represent an initial view of the evidence of validity of the hypotheses by Meyer (2015) and Hyland *et al.* (2016). In other words, it is possible to state that, based on the preliminary exploratory analysis of the data, the adoption of agricultural techniques that mitigate or enable the reduction of GHG emissions is a process that involves pioneer farmers, producer associations or individuals concerned with future impacts. of climate change.

After the exploratory analysis provided by the different specifications of the Chi-square test, Table 7 presents the results of the Probit model. The estimated model correctly classified 62.28% of the observations, demonstrating a good fit. The *Wald Chi2* statistic was significant at 1%, which leads to the rejection of the null hypothesis that all regression coefficients are simultaneously equal to zero, thus allowing the application of the analysis. However, only the variables referring to the level of education of the farmers, access to technical assistance, knowledge about climate change, their experience and the possible occurrence of adaptation by the producers were statistically significant at the conventional levels of statistical significance.

Table 7: Determinants of pro-environmental behavior focusing on the recovery of degraded pastures by farmers in the Rio das Contas watershed.

Variables	Coefficient	Standard error	Marginal Effect	Standard error
Education	0,0713*	0,0425	0,029*	0,0174
Experience	0,0137***	0,0048	0,0056***	0,002
Adaptation	0,3034*	0,1681	0,1209*	0,067
Technical assistance	0,4707***	0,1749	0,1835***	0,067
Association	-0,2441	0,1729	-0,097	0,069
Climate perception	0,1864*	0,0970	0,0755*	0,0399
Sexo	-0,2273	0,2101	-0,09	0,08
Credit	0,2339	0,1826	0,093	0,073
Property	0,0728	0,05197	0,029	0,217
Constant	-0,4929	0,4333	–	–

Notes: (***), (**) and (*) indicate significant at 1%, 5% and 10%, respectively; Wald stat chi2 = 26.94 (Prob > chi2 = 0.0014); Pseudo R2 = 0.067; R^2 Count = 0.623.

Source: Search results (2022).

In agreement with Meyer's hypothesis (2015), the level of education and technical assistance proved to be important drivers of the pro-environmental behavior of farmers in the sense of choosing

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the application of the recovery of degraded pastures. According to Below *et al.* (2012), both variables have a direct effect on the reduction of risks associated with extreme weather events, as they allow greater knowledge of mechanisms and processes that reduce vulnerability to these events. In addition, they allow the farmer or agent involved to know and adopt strategies that mitigate GHGs and, thus, reduce risk.

Furthermore, the results in Table 7 indicate that the farmer's experience as well as the situation of the need to adapt to the consequences of climate change are drivers of the willingness to adopt more sustainable production techniques and, in the case studied, the recovery of deteriorated pastures. According to Suela *et al.* (2020a) and Matos (2016), farmers' understanding of environmental issues is an important characteristic for their adaptation processes and investment in mitigation activities, because when they become aware that changes in the environment are occurring, it makes if possible to prepare for future climatic adversities. According to Matos (2016), climate perception has the potential to influence intentions, which can result in behaviors that are more favorable to resource conservation or higher levels of acceptance of policies aimed at containing climate change. Thus, the hypothesis of Hyland *et al*. (2016).

To conclude the analysis in question, it is important to emphasize that the most important variable for the willingness to adopt more sustainable production techniques was technical assistance (as indicated by the value and statistical significance of the estimated marginal effect – Table 7). The initial exploratory analysis (Tables 1 to 6) already indicated that 68.3% of farmers who did not have access to technical assistance services would be willing to change their form of production in search of sustainability; in turn, among farmers who had access to technical assistance, this value is approximately 19 percentage points higher (87.4%). This result can be explained by the fact that in the technical assistance/rural extension services, over time, the contact between farmer-technician/extensionist becomes friendly, creating the confidence that the producer needs to finally accept the suggestions of the farmer. specialist.

Thus, knowing that public institutions for technical assistance and rural extension (ATER) are usually the link between farmers and public policies, especially in the case of family farming, it is important to emphasize that Bahia has undergone an important process of replacing its ATER The Bahian government extinguished the Bahia Agricultural Development Company (EBDA) and created the Bahia Superintendence of Technical Assistance and Rural Extension (BAHIATER) in order to improve and expand ATER services in the state. In light of this, perhaps the time is ripe for public

policy makers in the state to enhance the participation of farmers in the scope of their ATER services, in the implementation of existing policies and in the creation of new policies or programs. This becomes even more important when considering that Bahia has the largest semi-arid area in Brazil, which makes the state one of the most vulnerable to climate change in the country.

6. CONCLUSION

To verify the relationship between education (formal and informal) and climate perception, taking into account the pro-environmental behavior towards the recovery of degraded pastures by farmers in the river basin of Rio das Contas/BA, was the proposed objective for this research. Through the analysis carried out, important results were obtained for the region, which may help in some mitigating measures for the environment that are already necessary. From the results, some conclusions were drawn on the subject.

The two main hypotheses that guided the research were confirmed. The first uses the ideas proposed by Meyer (2015) where the main concept is presented that the producer could increase his knowledge by having access to technical assistance. The second hypothesis, which used the study by Hyland *et al.* (2016) to be formulated, it was assumed that farmers' perceptions determine their assessments of climate change and, therefore, their willingness to implement mitigating measures.

According to the results obtained, it can be said that the adoption of sustainable agricultural techniques is strongly related to the availability of technical assistance, as this form of knowledge transfer has the ability to make the farmer more aware of sustainable production methods, pioneer producers, that is, those people with pro-environmental initiatives and producer associations, a place with the power to disseminate knowledge about the proposed subject.

Another important factor that was also validated by the survey was the level of education. The results indicated that the higher the individual's level of education, the greater their propensity to protect the environment. In other words, formal education proved to be an important driver for the pro-environmental behavior of farmers. Furthermore, knowledge about climate change and its effects on agriculture and the observation of some type of extreme event that can be attributed to climate change are indicators of willingness to use sustainable production techniques.

Finally, as a public policy suggestion, it is suggested to value the farmers' empirical knowledge in the process of seeking investments in more sustainable production techniques to contribute to the fight against climate change, such as the actions contained in the sectoral plan to adaptation to climate change and low carbon emissions in agriculture with a view to sustainable development (ABC+ Plan). In this way, it is assumed that this valorization makes it possible for the alteration and/or adaptation of production techniques to be built jointly between farmers and institutions that work with agriculture. In this context, it is relevant that public policies for rural development, especially those related to climate change, can be operationalized, adequate or built in a participatory way, which would probably cause greater validation of them by farmers.

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