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Perception of grain farmers in the Brazilian Cerrado region regarding the adoption or non-adoption of bioinputs

Percepção de produtores de grãos da região do Cerrado Brasileiro quanto à adoção ou não-adoção de bioinsumos

Percepción de los productores de granos de la región del Cerrado brasileño sobre la adopción o no-adopción de bioinsumos

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ABSTRACT
Background: The adoption and expansion of the use of bioinputs on farms appears to be one of the paths to achieving more ecological cultivation and production, based on the three pillars of sustainability: environment, social and economy. Therefore, understanding the motivations and barriers that lead farmers to adopt (or not) and expand (or not) the use of bioinputs are essential.
Purpose: The objectives of this study are to determine a) the profile of grain farmers in the Brazilian Cerrado that contributes to the adoption or non-adoption of bioinputs on their farms; b) which sources the grain farmers uses to learn about bioinputs technology; and c) which barriers or limitations prevent the adoption or increase in the use of bioinputs by grain farmers in the Brazilian Cerrado.
Method: This study collected data from 122 farmers who answered closed questions on a 5-point Likert scale related to the famer's profile, limitations and motivations regarding the topic of bioinputs. The collected data were analyzed using descriptive statistics, graphs and binomial logistic regression (Logit), Mann-Whitney test and chi-square test.
Results: According to the data presented, there is evidence that non-family farmers may be the most suitable audience for the adoption and expansion of bioinputs; in addition, farmers who chose to adopt the use of bioinputs on their properties were informed and kept updated through events, training courses, lectures, teaching and research institutions and regenerative agricultural organizations; on the other hand, there is a lack of understanding of how the adoption and continued use of these products should be carried out.
Conclusions: The main conclusions show that non-family farmers are the main consumers of bioinputs under the conditions studied and that efficient rural technical assistance can promote the adoption and increased use of bioinputs.
Keywords: regenerative agriculture; grain farmers; bioeconomy; motivations; bioinputs.

RESUMO
Contextualização: A adoção e a expansão do uso dos bioinsumos nas propriedades rurais parece ser um dos caminhos para a obtenção de uma produção mais ecológica, baseada nos três pilares da sustentabilidade: ambiente, sociedade e economia. Deste modo, compreender as motivações e as barreiras que levam o produtor rural a adotar (ou não) e a expandir (ou não) o uso dos bioinsumos é fundamental.
Objetivo: Os objetivos deste estudo visam determinar: o perfil dos produtores rurais de grãos do Cerrado Brasileiro que contribui para a adoção ou não-adoção dos bioinsumos em suas propriedades; quais as fontes que o produtor rural utiliza para conhecer a tecnologia de bioinsumos; e quais as barreiras ou as limitações que impedem a adoção ou aumento do uso dos bioinsumos pelos produtores de grãos do Cerrado Brasileiro.
Método: Este estudo coletou dados de 122 agricultores que responderam perguntas fechadas na escala Likert relacionadas ao perfil do produtor, limitações e motivações em relação ao tema. Os dados coletados foram analisados por meio de estatística descritiva, gráficos e regressão logística binomial (Logit), teste de Mann-Whitney e teste qui-quadrado.
Resultados: De acordo com os dados apresentados, há evidências de que agricultores não-familiares é público mais adequado para a adoção e expansão de bioinsumos; além disso, os produtores que optaram por adotar o uso de bioinsumos em suas propriedades foram informados e mantidos atualizados por meio de eventos, cursos, palestras, instituições de ensino e pesquisa e organizações agrícolas regenerativas; por outro lado, há uma falta de compreensão de como a adoção e o uso contínuo desses produtos devem ser realizados.

Conclusões: As principais conclusões foram que o agricultor não-familiar é o principal consumidor de bioinsumos nas condições estudadas e que a assistência técnica rural eficiente pode promover a adoção e o aumento do uso dos bioinsumos.
Palavras-chave: agricultura regenerativa; produtores rurais de grãos; bioeconomia; motivações; bioinsumos.

RESUMEN
Contextualización: La adopción y ampliación del uso de bioinsumos en las propiedades parece ser una de las formas de obtener cultivos y producciones más ecológicas, basados en los tres pilares de la sostenibilidad: el medio ambiente, la sociedad y la economía. Por lo tanto, es fundamental comprender las motivaciones y barreras que llevan a los productores a adoptar (o no) y ampliar (o no) el uso de bioinsumos.
Objetivo: Los objetivos pretenden determinar: perfil de los productores de granos en el Cerrado brasileño que contribuye para la adopción o no adopción de bioinsumos en sus propiedades; qué fuentes utilizan los productores para aprender sobre tecnología de bioinsumos; y qué barreras o limitaciones impiden la adopción o mayor uso de bioinsumos por parte de los productores de granos en el Cerrado brasileño.
Método: Este estudio recolectó datos de 122 agricultores que respondieron preguntas s en una escala Likert relacionadas con el perfil del productor, limitaciones y motivaciones en relación al tema. Los datos recolectados fueron analizados mediante estadística descriptiva, gráficos y regresión logística binomial (Logit), prueba de Mann-Whitney y prueba de chi-cuadrado.
Resultados: Existe evidencia de que los agricultores no-familiares pueden ser el público más adecuado para la adopción y expansión de los bioinsumos; además, se informó y mantuvo actualizado a los productores rurales que optaron por adoptar el uso de bioinsumos en sus propiedades a través de eventos, cursos, charlas, instituciones educativas y de investigación y organizaciones de agricultura regenerativa; por otro lado, existe una falta de comprensión de cómo se debe llevar a cabo la adopción y el uso continuo de estos productos.
Conclusiones: Las principales conclusiones muestran que el agricultor no-familiar es el principal consumidor de bioinsumos en las condiciones estudiadas y que una asistencia técnica eficiente puede promover la adopción y mayor uso de bioinsumos.
Palabras clave: agricultura regenerativa; productores rurales de granos; bioeconomía; motivaciones; bioinsumos.

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1 INTRODUCTION

The search for more sustainable agriculture and resilient to environmental challenges has motivated the governments of developed and developing countries, as well as companies belonging to the food production chain, to invest in new technologies and management techniques that protect the environment. (Hardoim, Martins & Martins, 2023). In this context, regenerative agriculture is a production model that aims to improve soil quality, promote biodiversity, capture carbon, preserve the water cycle, promote animal and human welfare, and promote profitable agricultural production (Mpanga et al., 2021; Day & Cramer, 2022).

Among the technological tools for regenerative agricultural production is bioinputs, defined by the Brazilian government through the National Bioinputs Program (Decree No. 10.375 of 2020 and amended by Decree No 11.940 of 2024) as "process or technology of plant, animal or microbial origin, intended for use in the production, storage and processing of agricultural products, aquatic production systems or planted forests, which positively affects growth, development and the response mechanism of animals, plants, microorganisms and derived substances and that interact with the products and the physical-chemical and biological processes" (Brazil, 2020, 2024).

In practice, the term bioinputs is used as a synonym for biofertilizers, biopesticides and inoculants, among other biologically based products, which were initially used in organic or agroecological agriculture, but currently play an increasing role in conventional agriculture. An alternative or a complement to fertilizers and phytosanitary products can reduce production costs (Vidal et al., 2020).

However, the perception of the adoption and use of biological products in the production system is still permeated by barriers and limitations by many farmers. Identifying the factors that determine such limitations, as well as the motivations for the use of this technology is essential for expanding practices in the agricultural environment. Therefore, the present study is guided by three important questions:

a) "What is the profile of grain farmers in the Brazilian Cerrado that contributes to the adoption or non-adoption of bioinputs on the farms?"
b) "Which source(s) of origin and update are determinant for the grain farmers to know the bioinputs technology that impacts the decision-making of the use of technology in the field?
c) "What are the barriers or limitations that prevent the adoption or increase in the use of bioinputs by grain farmers in the Brazilian Cerrado?"

The Brazilian Cerrado was chosen as the study site for this work because there has been movement on the part of grain farmers in this region to adopt the use of bioinputs on their farms, aimed at the production of large grain crops, especially soybeans.

2 THEORETICAL FRAMEWORK

2.1 Motivations for adopting the use of technology in regenerative agriculture

The motivations that lead farmers to adopt the use of technologies on their farms are not yet well established. However, researchers such as Ryan & Gross (1943), Kivlin & Fliegel (1967), Adesina & Zinnah (1993), Negatu & Parikh (1999), Rogers (2003), Prager & Posthumus (2010) and Ruzzante, Labarta & Bilton (2021) presented studies that show that the theory of agricultural technology adoption is multidisciplinary and combines elements of three main fields, called paradigms, which highlight the role of different factors in the rates and patterns of adoption of new technologies. Among the factors, three different paradigms can be highlighted: a) the diffusion of innovation, in which information is considered a critical parameter that controls the diffusion of an innovation through society; b) the economic restrictions, in which farmers aim to maximize utility, using unequally the resources destined for the adoption of technology; and c) the perception of the adopter, which allows for a level of subjectivity by stating that it is the perceived need to innovate and the perceived attributes of innovations that determine adoption behavior on the basis of cultural, contextual and individual factors.

In this context, Ruzzante, Labarta and Bilton (2021), using empirical studies on adoption theories, reported that the education of farmers, the size of the household and the property, access to credit, access to rural extension services and membership in organizations and cooperatives are positively correlated with the adoption of agricultural technologies. In addition, O'Donoghue, Minasny & McBratney (2022) emphasize that regenerative technologies have substantial support from the consumer market, the business sectors of the food chain and the farmers themselves. These stakeholders hope that regenerative agriculture can be confirmed as a system of agricultural production that increases the product quality and ensures the availability of resources to agriculture , such as soil, water, biota, renewable energy and human effort. Another relevant factor that encourages the adoption and expansion of regenerative agriculture technologies is social learning, through the exchange of knowledge and the sharing of the effects of technologies (Soto et al., 2021).

Finally, moving away from conventional agricultural models, which are dependent on chemical inputs, the adoption of sustainable food production systems, based on ecological practices and landscape management, is a change of no return (Lemke et al., 2024). Thus, scientific innovations aimed at this new model are fundamental in this new scenario.

Among these innovations, the adoption of bioinputs has emerged as a sustainable alternative for the ecosystem (Getahun, 2020, Ejjem et al., 2023). The bioinputs market in Brazil is on the rise, driven both by technological advances and by the regulation of sustainable agricultural practices (Valente, 2024). According to CropLife Brazil (CLB), in the 2021–22 crop year, soybean was the crop with the highest participation of bioinputs, representing 42% of the total used in Brazil, followed by cotton, sugarcane and corn. In addition, the value of the Brazilian bioinputs market increased by approximately 154% in 2021–22 compared with that in the previous crop year (Valente, 2024). Therefore, the consumer market for bioinputs is growing, and thus, it is important to understand the motivations that lead farmers to adopt or expand the use of bioinputs.

2.2 Limitations/barriers to the adoption of technologies in regenerative agriculture

The adoption or expansion of bioinputs on farms, although promising, faces challenges inherent to this type of decision-making by farmers. Social, financial, situational, technological and operational constraints seem to be the main barriers and limitations for the bioinputs market. According to Lima (2023), the low technical and knowledge level of farmers, in addition to the shortage of specialized technical assistance and the technique of the use of biological products, are the main obstacles encountered by farmers. Another important concern is possible biological insecurity, considering that, given the possibility of production by the farmers himself, within the property (on farm production) of biological products. This production on farm can result in risks to plantations, the environment, and human health, through the selection of pathogens, requiring a regulation. This possible risk is minimized during industrial production, which involves more regulations and inspections.

In addition, there is a lack of notable examples in the business field, and farmer's adopt the technology to act inductively, using examples from other countries and limiting the expansion of the use of bioinputs (Marques, 2022). According to Lemke et al. (2024), regulatory problems, lack of technical knowledge, cost and effectiveness of bioinputs are limitations for the biological products market. For these authors, interest in regenerative practices is related mainly to the expected profitability potential rather than the environmental benefits (Lemke et al., 2024).

Importantly, barriers and limitations are not mutually exclusive. According to Hurley et al. (2023), the main barriers to the adoption of techniques in regenerative agricultural systems are financial viability, lack of knowledge about the benefits of this practice, lack of models, lack of supporting policies and legislation, lack of experience in environmental programs, infrastructure requirements, and lack of technical assistance, among others. These barriers usually occur concomitantly, discouraging farmers from knowing, adopting and expanding the use of regenerative tools, such as bioinputs.

Thus, it is possible to observe the diversity of barriers and limitations to the adoption or expansion of the bioinputs market, and a multifactorial approach to better understand the desires and needs of these consumer-producers is necessary.

2.3 Means of disseminating information and knowledge

According to Silva et al. (2020), rural communication favors the circulation of information, both within the rural environment with farmers and agents of the agricultural environment, and in other sectors of the food production chain, , such as agribusinesses . In this context, Brazil began the process of disseminating information on new technologies through the publication of newsletters, lectures and radio programs. Additionally, when observing the relationship between a farmer and the technical-scientific information received, it is necessary to get closer to the farmer to encourage him to take part in the learning and dissemination of new technologies (Silva et al., 2020).

Therefore, as the farmer is the main decision maker within the property and, in most cases, is the one who interacts with the community, with the suppliers of inputs, among other professionals related to the agricultural sector, it is necessary for all those involved to communicate with each other effective communication to transmit information in a clear and reliable way, establishing interactions between organizations and producers (Januário, 2023).

Thus, given that agricultural production involves several risks and uncertainties, it is necessary for farmers to have adequate access to information for effective decision-making, including the adoption of new technologies and/or the expansion of the use of these technologies (Mtega, 2021). In this way, agricultural information is generated by various stakeholders, such as, for example, the farmers themselves, through experience acquired in the medium and long term, or through agricultural research, which must be presented through easy-to-use communication channels. access, in addition to the use of appropriate and simplified language (Munyua & Stilwell, 2013, Isaya et al., 2018, Mtenga, 2021).

Therefore, understanding farmers regarding the choices of appropriate communication channels is important for improving access to the dissemination and update knowledge of innovations and new technologies, such as bioinputs.

3 METHODOLOGY

The first stage of the research was based on semi structured and qualitative interviews, with the objective of allowing respondents to express their thoughts on the proposed theme, adoption or non-adoption of the use of bioinputs, as presented by Cerveira et al. (2024). In this stage, six grain farmers in the Rio Verde region, state of Goiás, reported their

experiences, motivations and limitations regarding the adoption, or non-adoption, of bioinputs on their properties. The six farmers interviewed were selected due to the knowledge of the concepts about regenerative agriculture. In addition, the selected farmers were at different levels of adoption of regenerative technology, including non-adoption. Thus, the interviews were recorded with the permission of the interviewees and then transcribed for subsequent qualitative analysis of the texts. The recordings totaled 5 hours and 19 minutes of audio and 76 transcribed pages (Cerveira et al., 2024).

Based on the analysis of the qualitative data obtained in these interviews, a structured questionnaire was prepared for the present study, consisting of a set of closed questions on a 5-level Likert scale with the following options: unimportant; not unimportant; neither important nor unimportant; important; and very important. The details of the questionnaire, as well as its results, are presented in the next section.

The applied questionnaires contained questions related to the socioeconomic profile of farmers, such as age, sex, location, property area, production area, main production, family farming practices, in addition to knowledge about bioinputs, motivations and barrier limitations for the adoption of the technology.

First, the questionnaire was shared online among the main groups of grain grain farmers in the Brazilian Cerrado region. Owing to the low level of engagement of producers in answering the questionnaire, printed questionnaires were subsequently distributed to rural properties, thus increasing the degree of participation of farmers. In total, 122 questionnaires were answered and validated. The online distribution of questionnaires was carried out among groups of rural grain farmers, associated with Cooperatives and Rural Associations. As for the in-person distribution of questionnaires, this was carried out voluntarily by farm technicians, during routine technical visits to the properties, thus allowing 6 states to participate in the data collection.

In the first step, the analysis of the data obtained consisted of descriptive statistics, several graphs and a binomial logistic regression (Logit). Binomial logistic regression is a statistical analysis used to classify records based on the values of the input fields and categorical target field. For this purpose, the logit model calculates the values of the coefficients after providing an experimental dataset with known values of the dependent and independent variables. This statistical method is used to determine which producer characteristic(s) affect the adoption or non-adoption of bioinputs (Hair et al., 2009). With this same logic, the method also answers which factor(s) significantly affect(s) the motivation or limitation of the use of this technology.

In the second stage, the data obtained from these questionnaires were compared between the groups, i.e., between those who adopted the technology and those who did not, via the Mann–Whitney U test and the chi-square test. The Mann–Whitney test is used for the comparison of two unpaired groups, checking whether they belong to the same population, whereas the chi–square test is a statistical test used to determine whether there is a statistically significant difference between the expected frequency and the observed frequency of categorical data, which leads to the assumption of an association between two qualitative variables. These tools were used to determine whether the source of origin and update the knowledge of bioinputs technology contributed to its adoption (Hair et al., 2009). For both stages, Jamovi® software was used (The Jamovi, 2022) and Stata® (Statacorp, 2023) as instruments for statistical measurements.

4 ANALYSIS AND DISCUSSION OF RESULTS

4.1 Descriptive profile of the grain farmers who participated in the study

Based on the responses obtained through the questionnaires administered to grain farmers, it was possible to establish a profile of the study participants, as shown in Table 1.

Table 1
Profile of the grain farmers who participated in the study

Descriptive Statistics	N	Omitted	Mean	Median	Minimum	Maximum	Shapiro–Wilk W	Shapiro–Wilk p
Age	122	0	47	47	18	82	0.984	0.161
Property area (ha)	121	1	1,812.55	130.00	11.00	30,000.00	0.462	< .001
Production area (ha)	121	1	1,506.42	115.00	3.00	22,000.00	0.478	< .001
Gender (1 Male; 0 Female)	122	0	91%					
Agr. Fam. (1 No Fam.; 0 Fam.)	122	0	62%					
Product Main (1 Soybean; 0 others)	122	0	91%					
Know bioinputs (1 Yes; 0 No)	122	0	73%					
Applies bioinputs (1 Yes; 0 No)	89	33	60%					

Source: Research data

Table 1 shows that the age group of the grain farmers who participated in the study ranged from 18-82 years, with a mean of 47 years. The size of the farms ranged from 11—30,000 hectares. In view of this wide area, the median, which is approximately 130 hectares, is considered the best indicator for representing the most common farm area. In the productive area, it follows the same logic, with a size of 115 hectares being more representative (median). According to the categorical

indicators, the main crop of agricultural production is soybean, with 91% of farmers admitting this chain as the main crop. The most representative gender of the respondents was male, with 91% of the respondents and 61.5% being self-declared family farmers. This self-declaration of the producer was validated in Brazilian legislation, which correlates one of the legal aspects, that is, the size of the property, to adjust this categorization. the relationship with the size of the property according to the law to be considered a family farmer. Finally, of the 122 respondents, 73% (or 89 grain farmers), declared that they knew the bioinputs technology and 33 did not know. Among the knowledgeable grain farmers, 60% (or 53 farmers) declared that they make use of this technology on their properties. Figure 1 represents such a distribution.

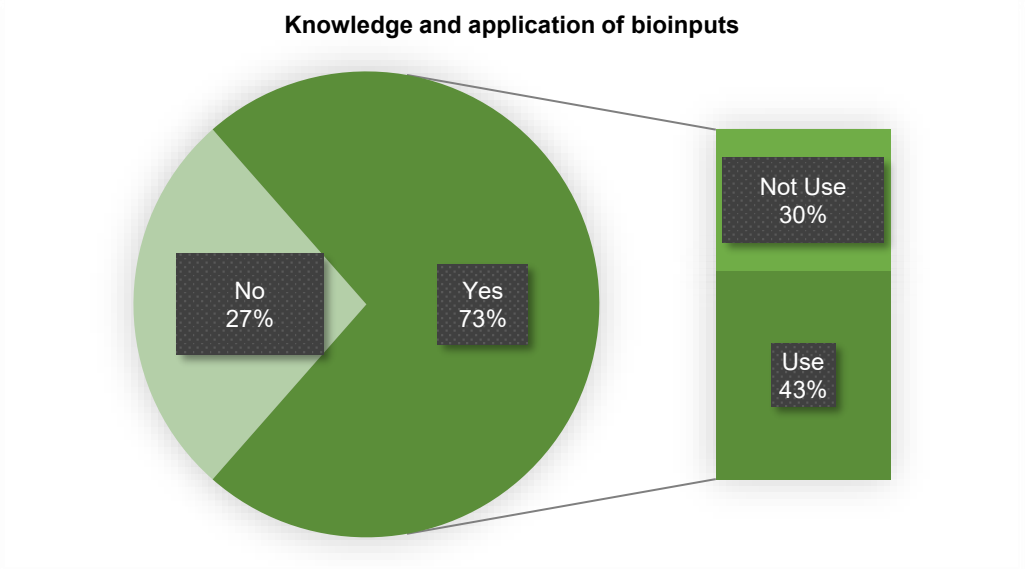

Figure 1. Percentage of grain farmers who know (or do not know) the bioinputs and who apply (or do not apply) the bioinputs in their properties.
Source: Research data.

According to Figure 2, the states participating in the study were Minas Gerais (54 producers), Goiás (44), Mato Grosso (17), Mato Grosso do Sul (5), Pará and São Paulo, with 1 participant each.

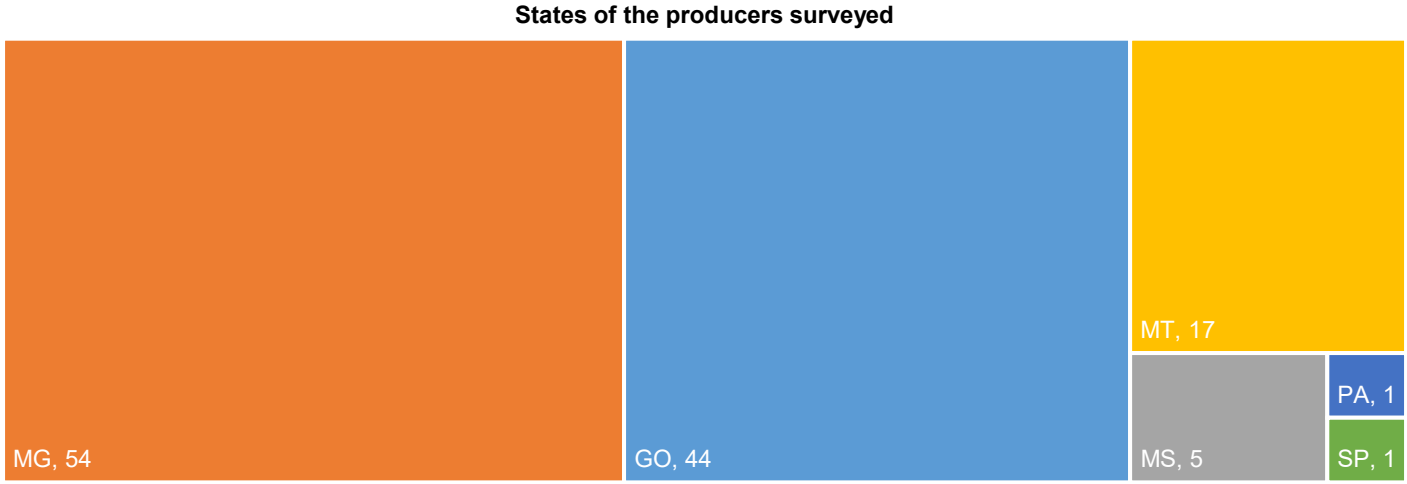

Figure 2. States of the grain farmers who participated in the study.
Source: research data.

The farmers declared that they were knowledgeable about bioinputs technology and were presented with a list of statements to verify how much such statements were adherent to their perceptions of the technology. They are as follows: i) I am interested in bioinputs technology (Interest_bio); ii) I am willing to grow crops via bioinputs (Willingness_bio); iii) I am motivated to use bioinputs (Motivation_bio); iv) I am able to grow crops via bioinputs (Able_bio); v) I am asked to cultivate them via bioinputs (Requested_bio); vi) I feel pressured to grow crops via bioinputs (Pressed_bio); vii) I believe that I can cultivate prioritizing the use of bioinputs (Prioritize_bio); and viii) I believe that I can grow crops by reducing the use of agrochemicals (Decrease_agroche). Figure 3 represents the results obtained from the average of the responses for each

of the statements, considering two subsegments within the segment of knowledgeable producers: a) the subsegment of those who adopt the technology (blue) and b) the sub-segment of farmers who do not adopt the technology (orange).

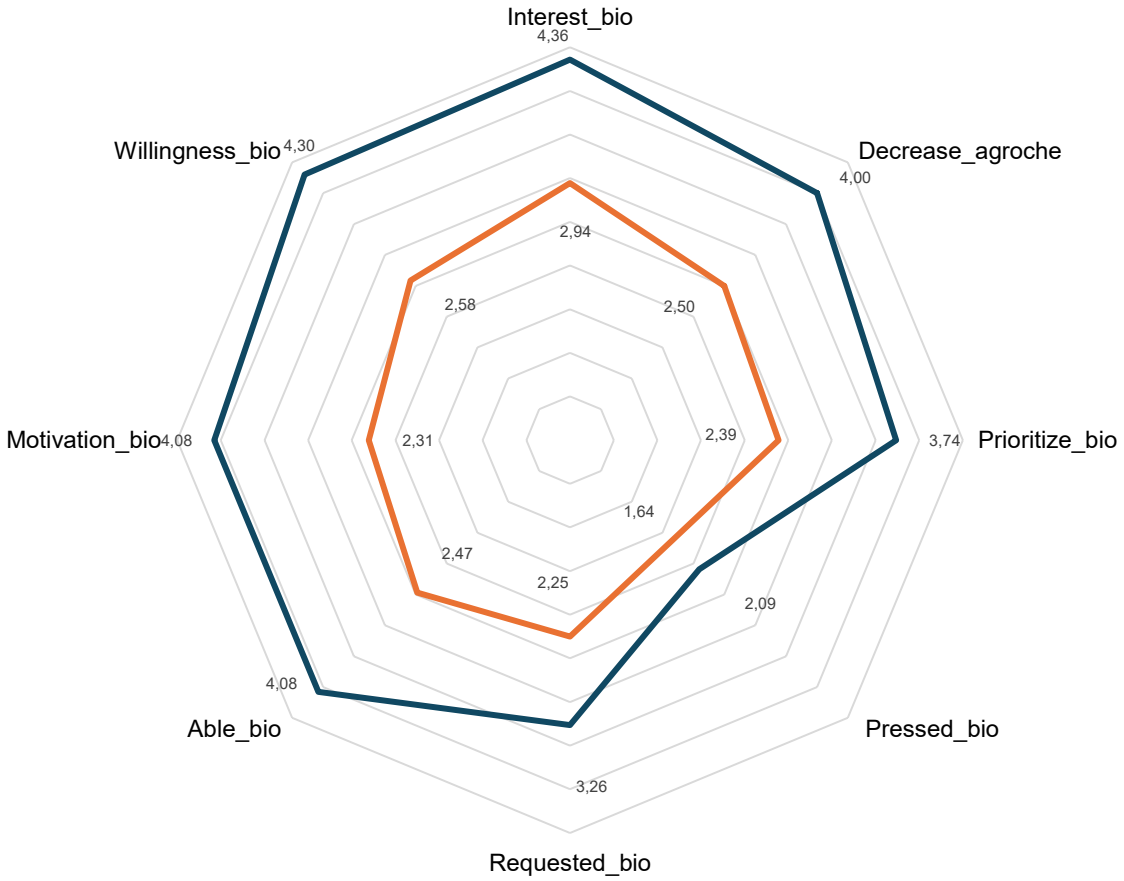

Figure 3. A scale of importance (0-5) of the factors studied among farmers who know and apply bioinputs (in blue) and those who know and do not apply bioinputs (in orange).
Source: Research data.

Based on these results, shown in Figure 3, we hypothesize that agreement with the statements regarding the perception factors of bioinputs may have different effects among the segments that use and do not use the technology in question. This may of course be influenced by some of the characteristics of the socioeconomic profile, which will be analyzed in the next part of this article.

4.2 Effects of the perceptions and profiles of grain farmers that affect the adoption or non-adoption of bioinputs

Tables 3 and 4 present three binomial logistic regression analysis models in which the effect of the perception variables (based on the statements about the perception of bioinputs technology answered by the grain farmers) and the profile of the respondents in relation to the variable of technology adoption are presented. In the first model, the isolated effect of perceptions is considered, in the second model, the age variable is added, whereas in the third model, whether the farmers declares himself to be a family farmer is added. Neither the gender profile nor the type of production could be considered because both violate the mini-mum assumption for the number of respondents for each category (Hair et al., 2009). The production area and farm area cannot be used in the analysis because they have multicollinearity, i.e., they have a direct correlation with the family farmers, since such characteristics tie the size of the farm to be categorized as such (between other aspects) according to the law (Law No. 11.326, of July 24, 2006). This fact greatly reduces the measures of fit of the model.

Table 3
Measures of Model Fit

				Global Model Test		
Model	**Deviation**	**AIC**	**R^2_{adj}**	**χ^2**	**Df**	**p**
1	67.3	85.3	0.439	52.8	8	< .001
2	64.5	84.5	0.463	55.6	9	< .001
3	41	63	0.659	79.1	10	< .001

Source: Survey data

Table 4
Binomial regression analysis (LOGIT) of the factors that contribute to the adoption (or lack thereof) of bioinputs by grain farmers in the Brazilian Cerrado region

Predictor	Estimates	Standard error	Z	P	Odds Ratio
MODEL 01					
Intercept	6.173	1.546	3.994	< .001	479,516
Decrease_agroche	-0.581	0.463	-1.255	0.209	0.559
Prioritize_bio	0.052	0.405	0.129	0.898	1.054
Pressed_bio	-0.039	0.407	-0.097	0.923	0.961
Requested_bio	-0.034	0.368	-0.094	0.925	0.966
Able_bio	-0.358	0.425	-0.842	0.400	0.699
Motivation_bio	-0.474	0.427	-1.111	0.267	0.622
Willingness_bio	-0.594	0.501	-1.186	0.236	0.552
Interest_bio	0.010	0.625	0.016	0.988	1.010
MODEL 02					
Intercept	9.041	2.586	3.497	< .001	8,442,132
Decrease_agroche	-0.521	0.466	-1.117	0.264	0.594
Prioritize_bio	0.049	0.418	0.117	0.907	1.050
Pressed_bio	-0.097	0.411	-0.236	0.814	0.908
Requested_bio	-0.113	0.356	-0.317	0.751	0.893
Able_bio	-0.329	0.423	-0.776	0.438	0.720
Motivation_bio	-0.526	0.434	-1.211	0.226	0.591
Willingness_bio	-0.625	0.505	-1.238	0.216	0.535
Interest_bio	-0.007	0.633	-0.010	0.992	0.994
Age	-0.055	0.034	-1.629	0.103	0.947
MODEL 03					
Intercept	6.265	3.406	1.839	0.066	525,662
Decrease_agroche	-1.015	0.619	-1.641	0.101	0.362
Prioritize_bio	0.434	0.529	0.820	0.412	1.543
Pressed_bio	0.075	0.555	0.135	0.893	1.078
Requested_bio	-0.487	0.470	-1.036	0.300	0.614
Able_bio	0.073	0.523	0.140	0.889	1.076
Motivation_bio	-0.384	0.670	-0.574	0.566	0.681
Willingness_bio	-0.609	0.724	-0.841	0.400	0.544
Interest_bio	-0.068	0.809	-0.084	0.933	0.934
Age	-0.060	0.044	-1.362	0.173	0.942
Fam_Agr: Yes – No	4.084	1.105	3.696	< .001	59.387

Source: Survey data.
Note: the results represent the odds ratio of applying bioinputs.

Table 3 presents the fit measures of Model 1, with only the technology perception factor variables; Model 2, with the inclusion of age; and Model 3, with the inclusion of the self-declaration of family farmers. In all three models, the significance of the global model is observed; however, it is only in Model 3 that there is a significant factor that influences the adoption of bioinputs: not being a family farmer. Table 4 shows the three models and highlights the family farmer factor, which has a significance level of 1%, with an odds ratio of 59.387.

Thus, the fact the grain farmers know the bioinputs technology could be considered a first stimulus for its use. However, this fact, demonstrated with perception factors, makes it clear that there are no differences between the groups that use and do not use such technology. Age, by sequence, also had no influence on the adoption of technology by producers. Finally, whether being a family farmer or not has a significant effect on the adoption of bioinputs in the field: the analyses show that not being a family farmer increases the odds ratio of these farmers using bioinputs by 59 times. That is, nonfamily farmers who are knowledgeable about bio-input technology are expected to have a 98% chance of adopting bioinputs and a 2% chance of not adopting bioinputs. Owing to the high accuracy, specificity and sensitivity of the model, it is possible to predict this profile of grain farmers with high accuracy in the adoption of bioinputs.

After the binomial logistic regression analysis of the data presented, it was possible to observe in the model represented in Table 4 that the only factor that significantly influences the adoption or non-adoption of bioinputs by grain farmers in the Brazilian Cerrado is self-declared family farmers. Thus, it is possible to observe that age and perceptions regarding the technology of bioinputs do not have a significant influence at the 1% level on the decision to adopt (or not use) bioinputs.

To visualize these results , Figure 4 shows an estimate of the marginal influence of the characteristic "Family Farmer" (Fam_Agr), in which the average of the other factors estimated in Model 2 is considered and only the fact that being a family farmer or not varies and how this affects the distribution of probabilities of adoption of this new technology (the use of bioinputs).

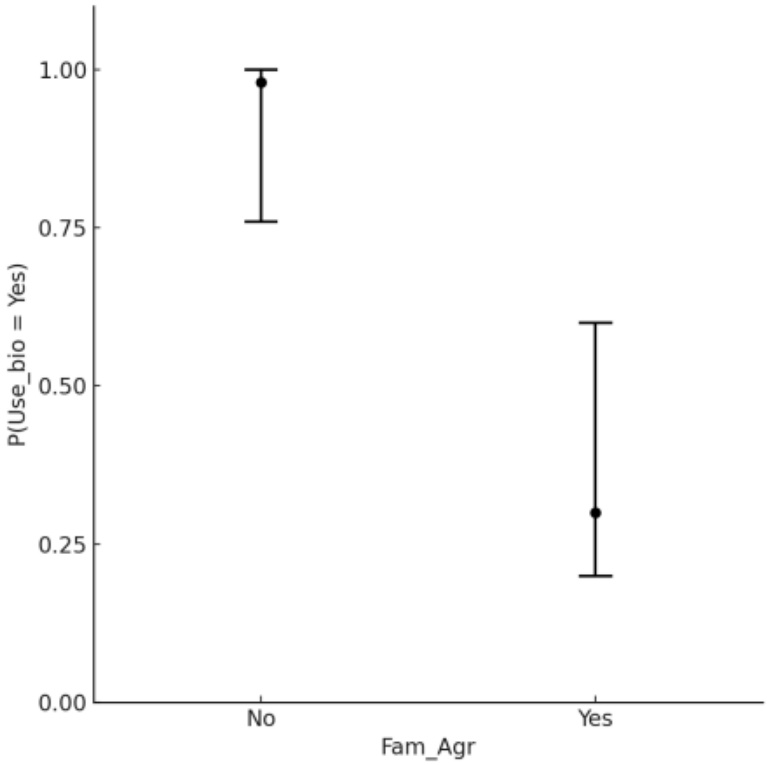

Figure 4. Marginal effect on the probability of distribution of whether the farmer is a family family farmer.
Source: Research data.

Figure 4 shows that the distribution of nonfamily farmers is much greater and greater (because the minimum value observed was above 75%) than the distribution of family farmers and that the average probability (the point on this straight line) of the nonfamily farmer is also much greater and much closer to the maximum value obtained (100% probability). Once we have seen the main characteristics for this use of technology, now, in the next part of the article, we will see the main barriers and/or limitations for this adoption and/or for the increase of this use.

4.3 Perceptions of grain farmers regarding the barriers/limitations that prevent the adoption of or increase the use of bioinputs

To analyze the limitations of the adoption and increase in the use of bioinputs on farms, farmers were asked to rate the importance of the following statements: i) lack of knowledge on the subject limits the use of bioinputs (Lack_of_knowledge); ii) the lack of access to extension projects on the use of bioinputs makes their application difficult (Lack_TARE_use_bio); iii) the lack of access to extension projects on the management of bioinputs hinders their use (Lack_TARE_management_bio); iv) the lack of knowledge about the production of bioinputs on their farm limits their use (Lack_known_bio_product); v) the lack of specific tax incentives for the application of bioinputs limits their use (Absence_tax_incentive_bio); vi) the lack of certification of bioinputs hinders their adoption (Lack_bio_certification); vii) the specificity of the bioinputs limits their use (High_specificity_bio); viii) the specificity of management limits their use (High_specificity_management_bio); ix) the absence of cooperatives to help produce bioinputs limits their use (No_coop_prod_bio); x) insufficient technical assistance hinders the adoption of bioinputs (Lack_TARE_bio); xi) poor quality technical assistance hinders adoption of the use of bioinputs (TARE_without_quality_bio); xii) lack of dissemination of bioinputs limits their use (Lack_disclosure_bio); and xiii) lack of awareness of bioinputs limits their use (Lack_conscience_bio).

The classification was carried out using a 5-level Likert scale, with the following options: 1) not important; 2) not very important; 3) neither important nor unimportant; 4) important; 5) very important, as shown in Figure 5.

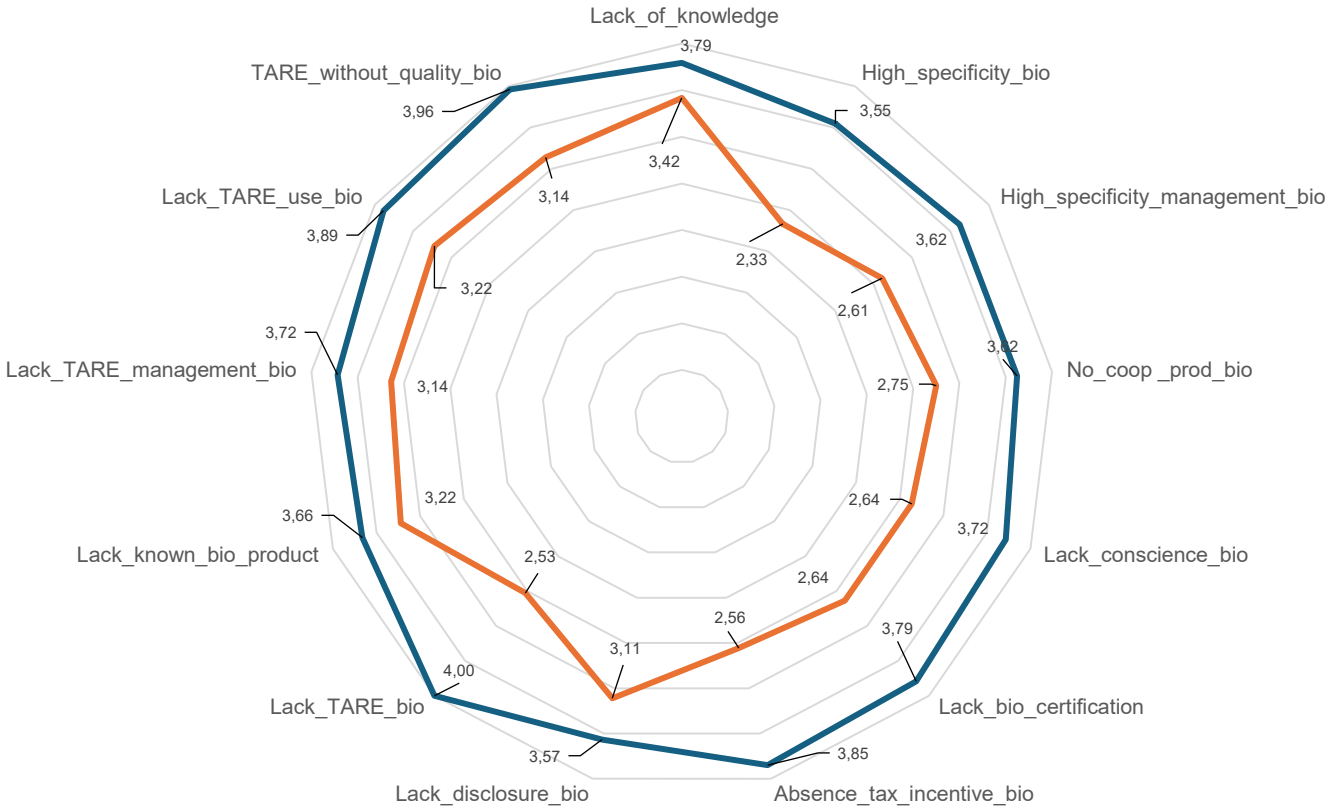

Figure 5. Scale of importance (0-5) of limitations rated by grain farmers regarding the adoption or increased use of bioinputs on their farms.
Source: Research data.
Note: The blue curve represents the limitations indicated by grain farmers who adopt the use of bioinputs, and the orange curve represents the limitations indicated by grain farmers who do not adopt the use of bioinputs.

Figure 5 shows evidence that the lack of technical assistance and rural extension (TARE) is a significant aspect limiting the adoption or limiting the increase in the use of bioinputs by grain farmers in the Cerrado, which was confirmed in Table 5.

Table 5
Binomial regression analysis of the factors that limit the adoption or increase in the use of bioinputs by grain farmers

Predictor	Estimates	Standard error	Z	p	Odds Ratio
Intercept	-3.192	1.509	-2.116	0.034	0.0411
Lack of bio knowledge	-0.2476	0.44	-0.563	0.574	0.7807
Lack_TARE_use_bio	-0.5114	0.677	-0.755	0.450	0.5996
Lack_TARE_management_bio	0.7849	0.649	1.21	0.226	2.1921
Lack_known_bio_product	-0.3962	0.34	-1.165	0.244	0.6729
Absence_tax_incentive_bio	0.0565	0.322	0.175	0.861	1.0581
Lack_bio_certification	0.0707	0.335	0.211	0.833	1.0732
High_specificity_bio	0.4198	0.515	0.814	0.415	1.5216
High_specificity_management_bio	-0.079	0.471	-0.168	0.867	0.924
No_coop _prod_bio	-0.4698	0.436	-1.078	0.281	0.6251
Lack_TARE_bio	1.3518	0.489	2.763	0.006	3.8644
TARE_without_quality_bio	0.2604	0.37	0.704	0.481	1.2974
Lack_conscience_bio	1.7202	0.664	2.592	0.197	5.5854
Lack_disclosure_bio	-1.7311	0.697	-2.485	0.130	0.1771

Source: Survey data.
Note: the results represent the odds ratio of applying bioinputs.

According to Table 5, grain farmers who do not have access to a satisfactory TARE have a 3.8-fold greater odds ratio of not adopting or, if they do, not increasing the use of bioinputs on their property. That is, a producer with a lack of TARE is 3.8 times more likely to not adopt bioinputs than to adopt them. It is clearly a limiting element in the use and expansion of technology.

4.4 Means of communication/dissemination that enable grain farmers to learn about and keep up to date with bioinputs technology

To analyze the means of communication/dissemination that allowed the grain farmers to update their knowledge about the bioinputs technology, the study participants were asked the following options regarding the source of knowledge

about the technology and the source of updating and monitoring of changes in the technique: i) events/training/Lectures (Events); ii) input/consultancy companies (Companies); iii) research and education institution (University); iv) technical assistance and rural extension (TARE); v) digital communication (websites, webinars, podcasts, videos) (digital_media); vi) printed information (books, magazines, leaflets) (Print_material); vii) relatives (relatives); viii) other farmers or Professionals in the field (Professionals); ix) training/Demonstration (Demonstration); x) government agency (Gov); xi) nongovernmental organizations (NGOs); and xii) agricultural regenerative organizations (NGO_regenerative), as shown in Figure 6:

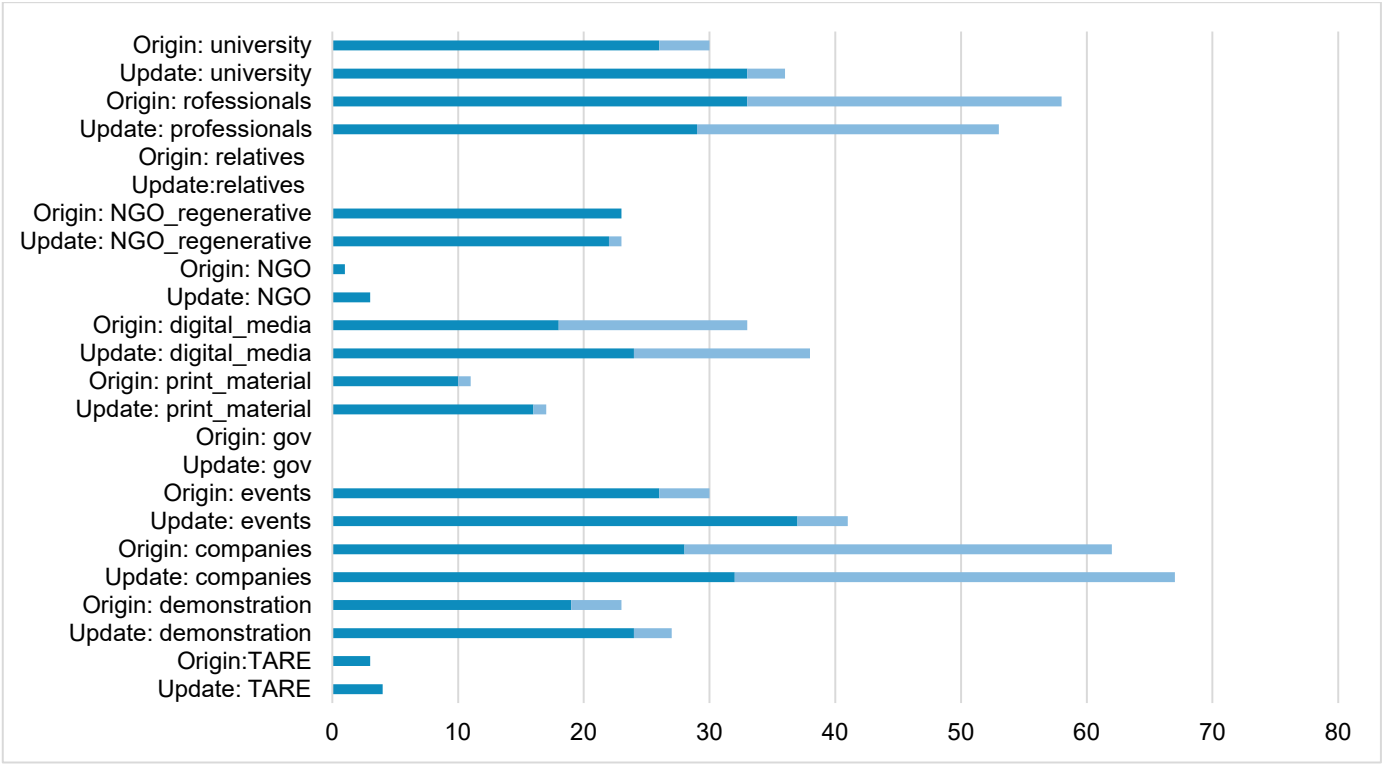

Figure 6. Number of respondents who indicated the means of communication/dissemination used by grain farmers as a source of access to knowledge about bioinputs (origin) and technology updates (update), considering those who adopted (dark color) and those who did not adopt (light color) technology.
Source: Research data.

Analyzing Figure 6, it is not possible to observe explicit differences regarding sources of information (either to learn or to update) between the means of communication and dissemination used by grain farmers. The only observation is that there was no mention of sources of information originating from the government (governmental) or from relatives. For this reason, it is necessary to perform a statistical analysis to verify whether there is a difference between the means of knowledge cited by producers and whether they adopt the technology. Table 6 presents the statistical analysis of the data, showing the significance (or not) of the differences observed, except for the government source and relatives (not indicated by the grain farmers).

Table 6
Comparison between groups via the Mann–Whitney U test for the analysis of the means of communication/dissemination used by farmers that enabled knowledge about the technology of bioinputs.

Source of Knowledge	Origin		Update	
	Statistics	p value	Statistics	p value
Events/Training/Lectures	557	< .001	394	< .001
Input Companies	592	< .001	603	< .001
Research and Education Institution (Universities)	592	< .001	440	< .001
Rural Extension	900	0.153	882	0.096
Digital Media (websites. webinars. podcasts. videos)	881	0.466	893	0.555
Printed information (books. magazines. pamphlets)	801	0.025	693	0.001
Other Farmers/Professionals in the field	718	0.491	602	0.264
Training/Demonstration	936	0.009	900	< .001
Non-Governmental Agency	557	0.423	394	0.153
Regenerative Agricultural Organizations	592	< .001	603	< .001

Source: Research data

According to Table 6, it is possible to observe a significant difference at the 1% level between the sources presented:

- Events/Training/Lectures (Events);

- Input/Consultancy Companies (Companies);
- Research and Education Institution (University);
- Printed information (books, magazines, pamphlets) (Print_material);
- Training/Demonstration (Demonstration);
- Regenerative Agricultural Organizations (NGO_regenerative).

This difference demonstrates that such information sources, both for initial knowledge of the technology and for the maintenance of this knowledge, have a significant influence on the adoption of bioinputs technology. However, it is valid to consider that such an influence can be positive or negative. For this reason, another statistical tool, the chi-square test, was used. It evaluated the association between each of these knowledge sources with respect to whether to adopt the technology. Thus, identifying the sources of information for grain farmers regarding bioinputs technology is only part of this study. After that, we seek to understand how rural producers are affected by them in choosing the most appropriate channels of communication of information, and this information is presented below.

Table 7 presents the chi-square test analysis of the data obtained regarding the main sources of knowledge communication used by grain farmers who adopt or do not adopt bioinputs, either for knowledge of the technology or for improvement and technology updates.

Table 7
Chi-square test on the association between grain farmers who use (yes) or do not use (no) bioinputs regarding sources of knowledge and technical updating.

Use_bio		Events		
		No	Yes	Total
No	obs freq	32	4	36
	exp freq	23.9	12.1	36
	chi-square	2.8	5.4	8.2
Yes	obs freq	29	27	56
	exp freq	37.1	18.9	56
	chi-square	1.8	3.5	5.3
Total	obs freq	61	31	92
	exp freq	61	31	92
	chi-square	4.5	9	13.5

Pearson chi-square = 13.5023 Pr = 0.000

Use_bio		Companies		
		No	Yes	Total
No	obs freq	2	34	36
	exp freq	11.7	24.3	36
	chi-square	8.1	3.9	12
Yes	obs freq	28	28	56
	exp freq	18.3	37.7	56
	chi-square	5.2	2.5	7.7
Total	obs freq	30	62	92
	exp freq	30	62	92
	chi-square	13.3	6.4	19.7

Pearson chi-square = 19.6970 Pr = 0.000

Use_bio		University		
		No	Yes	Total
No	obs freq	32	4	36
	exp freq	23.9	12.1	36
	chi-square	2.8	5.4	8.2
Yes	obs freq	29	27	56
	exp freq	37.1	18.9	56
	chi-square	1.8	3.5	5.3
Total	obs freq	61	31	92
	exp freq	61	31	92
	chi-square	4.6	8.9	13.5

Pearson chi-square = 13.5023 Pr = 0.000

Use_bio		Print_Material		
		No	Yes	Total
No	obs freq	35	1	36
	exp freq	31.7	4.3	36
	chi-square	0.3	2.5	2.8
Yes	obs freq	46	10	56
	exp freq	49.3	6.7	56
	chi-square	0.2	1.6	1.8
Total	obs freq	81	11	92
	exp freq	81	11	92
	chi-square	0.6	4.1	4.7

Pearson chi-square = 4.7333 Pr = 0.030

Use_bio		Demonstration		
		No	Yes	Total
No	obs freq	32	4	36
	exp freq	27	9	36
	chi-square	0.9	2.8	3.7
Yes	obs freq	37	19	56
	exp freq	42	14	56
	chi-square	0.6	1.8	2.4
Total	obs freq	69	23	92
	exp freq	69	23	92
	chi-square	1.5	4.6	6.1

Pearson chi-square = 6.0847 Pr = 0.014

Use_bio		NGO regenerative		
		No	Yes	Total
No	obs freq	35	1	36
	exp freq	25.8	10.2	36
	chi-square	3.3	8.3	11.6
Yes	obs freq	31	25	56
	exp freq	40.2	15.8	56
	chi-square	2.1	5.3	7.4
Total	obs freq	66	26	92
	exp freq	66	26	92
	chi-square	5.4	13.6	19

Pearson chi-square = 18.9437 Pr = 0.000

Source: Research data

Table 7 clearly shows that some sources of knowledge, whether as a new practice or to maintain knowledge, have positive effects, while others have negative effects. All test results were significant at the 5% level, thus indicating a strong association between technology adoption and the source of knowledge. When the expected number of respondents is greater and the actual result is smaller, it is expected that the item has a negative association, i.e., a greater number is expected than was observed. The reverse is also true. According to the results, the following conclusions can be shown:

- Events/Training/Lectures (Events) have a positive influence on grain farmers. The farmers who discover the technology and/or update themselves through events have a positive influence on its adoption.
- Input/Consultancy Companies (Companies) have a negative influence, either as an initial source of knowledge or update. The source of input companies negatively reverberates in the adoption of the practice.
- Research and education institutions (University) have positive effects on technology adoption.
- Printed information (books, magazines, leaflets) (Print_material) has a positive effect on technology adoption.
- Training/Demonstration (Demonstration) has a positive effect on technology adoption.
- Agricultural Regenerative Organizations (NGO_regenerative) have a positive effect on technology adoption.

5 CONCLUSIONS

According to the data presented, the main conclusions of this study are as follows: a) there is evidence that nonfamily farmers may be the most appropriate audience for the adoption and expansion of bioinputs, and b) there is a need for investment in qualified technical assistance to assist farmers in decision making and in the continued use of biological products.

It is noteworthy that grain farmers are increasingly informed about the importance of using biologically sourced products; however, there remains a lack of understanding regarding how the adoption and continued use of these products should be carried out. This finding challenges the traditional modernization theory, which often assumes that technology dissemination alone naturally leads to adoption. The adoption of bioinputs depends not only on knowledge availability but also on technical guidance and practical support. Therefore, it is essential that technical assistance and consultancy services are properly trained to adequately meet farmers' demands. Raising farmers' awareness of their role in establishing more balanced agriculture is essential for successful learning about the use of biological products, which require specific viability conditions as well as the use of appropriate equipment for their conservation and field application.

The results also indicate that there is specificity in the choice of information sources about bioinputs that influence the behavior of farmers regarding adoption or non-adoption. It is observed that farmers who chose not to adopt the use of bioinputs on their properties predominantly rely on input supply companies, along with technical consultancy from input resellers, as their main sources of knowledge and updates on biological products.

However, it is important to highlight that these technical companies, which often originate from conventional input resellers, may play a role in distancing farmers from adopting bioinputs. This occurs because the consultancies from these resellers have historically positioned themselves around the use of chemical substances, such as pesticides, which creates a perception of antagonism towards biological products. Consequently, rural producers may develop a sense of distrust regarding these consultancies when the focus is on adopting bioinputs. Specific studies are still needed to understand the reasons behind this distancing, but the hypothesis raised is related to the historical promotion of chemical products by these companies.

On the other hand, farmers who chose to adopt bioinputs on their properties remain updated through events, training courses, lectures, educational and research institutions, and regenerative agricultural organizations, acting as key agents in the learning process and, simultaneously, as disseminators of experiences acquired through agricultural practices resulting from the adoption of new technologies and agricultural innovations.

Therefore, offering various sources of technical knowledge can influence the interest of grain farmers in adopting this technology in the field. This information is relevant to the bioinputs industry, which can leverage these insights to improve the main forms of technology diffusion that reach farmers.

Public policies related to biological inputs, such as the National Bioinputs Program, created in 2020, may be important for South American countries such as Brazil. This is because the federal government's promotion of biological products does not aim to break away from conventional agriculture or chemical inputs but rather to promote the coexistence of chemical and biological inputs towards the so-called bioeconomy. Biodiversity is a resource that can be explored and used to improve the ecological sustainability of agriculture.

Thus, sharing knowledge, quality technical assistance, and appropriate environmental policies, along with clear social, environmental, and economic indicators, are essential elements to motivate the adoption and expansion of bioinputs.

REFERENCES

Adesina, A. A., & Zinnah, M. (1993) Technology characteristics, farmers' perceptions and adoption decisions: A Tobit model application in Sierra Leone. *Agricultural Economics*, 9(4), 297–311. https://doi.org/10.1016/0169-5150(93)90019-9

Brasil. Decreto N° 10.375, de 26 de maio de 2020. Diário Oficial da União, 27 de maio de 2020. https://www.planalto.gov.br/ccivil_03/_ato2019-2022/2020/decreto/D10375.htm

Brasil. Decreto Nº 11.940, de 07 de março de 2024. Diário Oficial da União, 08 de março de 2024. https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2024/decreto/d11940.htm

Cerveira, R., Pompeu, G. B., & Cunha, C. F. (2024). Perception of grain farmers in the Brazilian Cerrado regarding the consumption of bioinputs: a case study. *Contribuciones a Las Ciencias Sociales*, 17(1), 2576–2589. https://ojs.revistacontribuciones.com/ojs/index.php/clcs/article/view/4261.

Day, C., & Cramer, S. (2022). Transforming to a regenerative U.S. agriculture: The role of policy, process, and education. *Sustainability Science*, 17, 585–601. https://doi.org/10.1007/s11625-021-01041-7

Ejjem, A. A., Aremu, C., Ajakaiye, O. O. P., Ben-Enukora, C., Akerele-Popoola, O. E., Ibiwoye, T. I., & Olaniran, A. F. (2023). Perspectives on communicating 21st-Century agricultural innovations to Nigerian rural farmers. *Journal of Agriculture and Food Research*, 11, 100511. https://doi.org/10.1016/j.jafr.2023.100511

Getahun, A. A. (2020). Challenges and opportunities of information and communication Technologies for dissemination of agricultural information in Ethiopia. *International Journal of Agricultural Extension*, 8(1), 57-65.

Hair, J. F. et al. (2009). *Multivariate data analysis*. Pearson: New York, 7th Ed.

Hardoim, H., Martins, E., & Martins, E. (2023). Remineralizadores e a fertilidade do solo. *Informe Agropecuário*. 44(321), 79-92. https://www.alice.cnptia.embrapa.br/alice/bitstream/doc/1156764/1/Eder-Agricultura-sustentavel-tropical.pdf

Hurley, P. D., Rose, D. C., Burgess., P. J., & Staley, J. T. (2023). Barriers and enablers to up-take of agroecological and regenerative practices, and stakeholder views toward 'Living Labs'. In: *Evaluating productivity, environmental sustainability and wider impacts of agroecological compared to conventional farming systems*. Cranfield University and UK Center for Ecology and Hydrology. (pp. 33).

Isaya, E. L., Agunga, R., & Sanga, C. A. (2018). Sources of agricultural information for women farmers in Tanzania. *Information Development*. 34(1), 77–89.

Januário, T. R. (2023). *Comunicação para o agronegócio: Estratégias e perspectivas profissionais no Rio Grande do Sul* (Trabalho de Conclusão de Curso.). Curso de Relações Públicas: Bacharelado, do Departamento de Ciências da Comunicação da Universidade Federal da Santa Maria, Campus Frederico Westphalen, Rio Grande do Sul, Brasil. http://repositorio.ufsm.br/handle/1/31170

Kivlin, J. E., & Fliegel, F. C. (1967). Differential perceptions of innovations and rate of adoption. *Rural Sociology*, 32(1), 78–91.

Lemke, S., Smith, N., Thiim, C., & Stump, K. (2024). Drivers and barriers to adoption of re-generative agriculture: Cases studies on lessons learned from organic. *International Journal of Agricultural Sustainability*, 22(1), 2324216.

Lima, J. S. (2023). *Avaliação econômica das práticas agrícolas: um estudo comparativo de custos na agricultura regenerativa e tradicional no cerrado* (Dissertação de mestrado). Mestrado em Agronomia. Programa de Pós-Graduação em Ciências Agrárias. Instituto Federal Goiano, Campus Rio Verde, Goiás, Brasil. https://repositorio.ifgoiano.edu.br/handle/prefix/4307

Marques, G. V. (2022). *Um breve estudo sobre a agropecuária regenerativa e a sua viabilidade econômica em pequenas e médias propriedades* (Trabalho de Conclusão de Curso). Bacharelado em Ciências Econômicas. Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brasil. http://hdl.handle.net/11422/22270

Mpanga, I. K., Schuch, U. K., & Schalau, J. (2021). Adaptation of resilient regenerative agricultural practices by small-scale growers toward sustainable food production in north-central Arizona. *Current Research in Environmental Sustainability*, 3, 100067. https://doi.org/10.1016/j.crsust.2021.100067

Mtega, W. P. (2021). Communication channels for exchanging agricultural information among Tanzanian farmers: A meta-analysis. *International Federation of Library Associations and Institutions*, 47(4), 570–579.

Munyua, H. M., & Stilwell, C. (2013). Three ways of knowing: Agricultural knowledge systems of small-scale farmers in Africa with reference to Kenya. *Library and Information Science Research*, 35(4), 326–337.

Negatu, W., & Parikh, A. (1999). The impact of perception and other factors on the adoption of agricultural technology in the Moret and Jiru Woreda (district) of Ethiopia. *Agricultural Economics*, 21(2), 205–216. https://doi.org/10.1016/S0169-5150(99)00020-1.

O'Donoghue, T., Minasny, B., & Mcbratney, A. (2022). Regenerative agriculture and its potential to improve farmscape function. *Sustainability*, 14, 5815. https://doi.org/10.3390/su14105815

Prager, K., & Posthumus, H. (2010). Socioeconomic factors influencing farmers' adoption of soil conservation practices in Europe. In Napier, T.L. (Ed.), *Human dimensions of soil and water conservation*, (pp. 388). New York: Nova Science Publishers Inc.

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York: Simon & Schuster.

Ruzzante, S., Labarta, R., & Bilton, A. (2021). Adoption of agricultural technology in the developing world: A meta-analysis of the empirical literature. *World Development*, 146, 105599. https://doi.org/10.1016/j.worlddev.2021.105599

Ryan, B., & Gross, N. (1943). The diffusion of hybrid seed corn in two Iowa communities. *Rural Sociology*, 8(1), 15–24.

Silva, L. C., Leal, J. P., Neto, & Santos, I. A. (2020) Comunicação rural e internet: Protagonismo da população do campo. *Revista Internacional de Folkcomunicação*, 18(41), 186-203. https://doi.org/10.5212/RIF.v.18.i41.0010

Soto, L., Cuéllar Padilla, R. M., Rivera Méndez, M., Pinto-Correia, T., Boix-Fayos, C., & De Vente, J. (2021). Participatory monitoring and evaluation to enable social learning, adoption, and out-scaling of regenerative agriculture. *Ecology and Society*, 26(4), 29. https://doi.org/10.5751/ES-12796-260429

StataCorp. (2023). Stata Statistical Software: Release 18. College Station, TX: StataCorp LLC.

The Jamovi Project (2022). *Jamovi Software* (Version 2.3). https://www.jamovi.org

Valente, F. (2024). Insumos Biológicos no Brasil. *AgroAnalysis*, 44(3), 33-37.

Vidal, M. C., Saldanha, R., & Veríssimo, M. A. A. (2020). Bioinsumos: o programa nacional e a sua relação com a produção sustentável. In D. M. Gindri, P. A. B. Moreira & M. A. Veríssimo (Orgs.), *A Sanidade vegetal: uma estratégia para eliminar a fome, reduzir a pobreza, proteger o meio ambiente e estimular o desenvolvimento sustentável* (pp. 486). Florianopolis: CIDASC.

APPENDIX

Regenera Cerrado – Questionnaire on the adoption of bioinput technology
Producer Registration/Profile (required answers)

1. Gender:
( ) male ( ) female ( ) I prefer not to answer

2. Age:

3. Municipality/State of the farm's headquarters:

4. Property area (in hectares):

5. Production area (in hectares):

6. Main Production:
( ) soybeans ( ) corn ( ) millet ( ) sorghum ( ) beans ( ) wheat... ( ) Other (which one?)

7. Are you a family agriculture?
( ) yes ( ) no*
*If you answered no, go to question 9.

8. If you answered yes in question 7: do you have DAP or CAF?
( ) yes ( ) no

Use of Bioinputs

Bioinputs are technologies that use microorganisms to assist in agricultural production, such as the biological control of pests and diseases or stimulants for the release of nutrients (biofertilizers) (EMBRAPA, 2020)

9. Do you know bioinput technology? (mandatory answer)
( ) Yes* ( ) No
*If you answered yes, go to question 11.

10. If you don't know bioinput technology, do you want to know? (mandatory answer)
( ) yes ( ) no Why?
*If you do not know bioinput technology, your participation ends here. Thank you.

11. If you are familiar with bioinput technology, evaluate the following statements:

	Very little	Little	Reasonable	Very much	Pretty much
I am interested in bioinput technology.					
I am willing to cultivate using bioinputs.					
I feel motivated to use bioinputs.					
I am able to grow using the bioinputs.					
I am asked to grow using bioinputs.					
I feel pressured to grow using bioinputs.					
I believe that I can cultivate by prioritizing the use of bioinputs.					
I believe I can cultivate by reducing the use of agrochemicals.					

Adoption of bioinput technology

12. How did you find out about bioinputs? (Check all that apply)

- [ ] Events/Training/Lectures
- [ ] Supplies/Consulting Companies
- [ ] Research and Teaching Institution
- [ ] Rural Extension
- [ ] Digital Media (websites, webinars, podcasts, videos)
- [ ] Printed Information (books, magazines, brochures)
- [ ] Family/Relatives
- [ ] Other Farmers/Influencers
- [ ] Training/Demonstration
- [ ] Government Agency
- [ ] Non-Governmental Agency
- [ ] Regenerative Agricultural Organizations

13. How do you stay informed about the use of bioinputs? (Check all that apply)

- [ ] Events/Training/Lectures
- [ ] Supplies/Consulting Companies
- [ ] Research and Teaching Institution
- [ ] Rural Extension
- [ ] Digital Media (websites, webinars, podcasts, videos)
- [ ] Printed Information (books, magazines, brochures)
- [ ] Family/Relatives
- [ ] Other Farmers/Influencers
- [ ] Training/Demonstration
- [ ] Government Agency
- [ ] Non-Governmental Agency
- [ ] Regenerative Agricultural Organizations

14. Classify the importance of the reasons that led you to adopt the use of bioinputs

Reasons	Unimportant	Little important	Neither important, nor unimportant	Important	Very important
Low dependence on commercial inputs.	( )	( )	( )	( )	( )
Substitution of chemical inputs.	( )	( )	( )	( )	( )
Use of locally accessible renewable resources (leaf litter, animal waste).	( )	( )	( )	( )	( )
Preservation of biodiversity.	( )	( )	( )	( )	( )
Productive capacity.	( )	( )	( )	( )	( )
Reduction of expenses with chemical inputs.	( )	( )	( )	( )	( )
Incorporation of local knowledge.	( )	( )	( )	( )	( )
Modification of ethical values.	( )	( )	( )	( )	( )
Production of goods for the specific domestic market.	( )	( )	( )	( )	( )
Production for export.	( )	( )	( )	( )	( )
Adding value to the product.	( )	( )	( )	( )	( )
Success acquired in the adoption of bioinputs by other producers.	( )	( )	( )	( )	( )
Cultural factors.	( )	( )	( )	( )	( )

15. Classify the importance of the limitations you found for the adoption of bioinputs on your property

Limitations	Unimportant	Little important	Neither important, nor unimportant	Important	Very important
Lack of knowledge about the use of bioinputs.	( )	( )	( )	( )	( )
Lack of access to extension projects on the use of bioinputs.	( )	( )	( )	( )	( )
Lack of access to extension projects on the management of bioinputs.	( )	( )	( )	( )	( )
Lack of knowledge about the production of bioinputs on your property.	( )	( )	( )	( )	( )
Lack of specific tax incentive for producers who use bioinputs.	( )	( )	( )	( )	( )
Absence of certification of bioinputs.	( )	( )	( )	( )	( )
Specificity of bioinputs.	( )	( )	( )	( )	( )
Specificity of management.	( )	( )	( )	( )	( )
Absence of cooperatives that assist in the production of local bioinputs.	( )	( )	( )	( )	( )
Insufficient technical assistance to assist in the use of bioinputs.	( )	( )	( )	( )	( )
Low-quality technical assistance to assist in the use of bioinputs.	( )	( )	( )	( )	( )
Lack of disclosure about the use of bioinputs.	( )	( )	( )	( )	( )
Lack of awareness about the use of bioinputs.	( )	( )	( )	( )	( )

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