REVISTA CONTRIBUCIONES A LAS CIENCIAS SOCIALES

Perception of grain farmers in the brazilian Cerrado regarding the consumption of bioinputs: a case study

Percepção dos produtores de grãos do Cerrado brasileiro sobre o consumo de bioinsumos: um estudo de caso

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ABSTRACT
Sustainable agricultural practices aim to improve soil quality, promote biodiversity, preserve the water cycle, capture carbon, and promote the welfare of the rural-workers and an-imals, while producing foods with profitability. However, little is known about the conditions and motivations that lead the farmers to know, adopt and implement these sustainable practices, such as, for example, the use of bioinputs. Thus, the objective of this study was to qualitatively analyze the perceptions of grain farmers of the Brazilian Cerrado regarding the use of bioinputs on their properties. For that, semi-structured face-to-face interviews were conducted with farmers from the Rio Verde region, in the state of Goiás. After transcribing the audio of the interviews, the texts obtained were analyzed by Atlas TI software. Content analysis was performed through the elaboration of codes created by deduction and induction. Thereby, concepts such as knowledge, long-term vision, experimentation, cost-benefit ratio, asset specificity, influencers, regulation, and independence were indicated by the interviewed farmers as important opportunities and/or limitations for the adoption of bioinputs.

Keywords: innovation, regenerative systems, sustainable technology.

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RESUMO
As práticas agrícolas sustentáveis visam melhorar a qualidade do solo, promover a biodiversidade, preservar o ciclo da água, capturar carbono e promover o bem-estar dos trabalhadores rurais e dos animais, ao mesmo tempo que produzem alimentos com rentabilidade. Porém, pouco se sabe sobre as condições e motivações que levam os agricultores a conhecer, adotar e implementar essas práticas sustentáveis, como, por exemplo, o uso de bioinsumos. Assim, o objetivo deste estudo foi analisar qualitativamente as percepções de produtores de grãos do Cerrado brasileiro quanto ao uso de bioinsumos em suas propriedades. Para tanto, foram realizadas entrevistas presenciais semiestruturadas com agricultores da região de Rio Verde, no estado de Goiás. Após a transcrição do áudio das entrevistas, os textos obtidos foram analisados pelo software Atlas TI. A análise de conteúdo foi realizada por meio da elaboração de códigos criados por dedução e indução. Assim, conceitos como conhecimento, visão de longo prazo, experimentação, relação custo-benefício, especificidade de ativos, influenciadores, regulação e independência foram apontados pelos agricultores entrevistados como importantes oportunidades e/ou limitações para a adoção de bioinsumos.

Palavras-chave: inovação, sistemas regenerativos, tecnologia sustentável.

1 INTRODUCTION

Agrifood systems are constituted by farmers, agrifood companies, advisory suppliers, research organizations, public policies, in addition to markets, value chains, among other actors. However, sustainable agrifood systems can ensure the provision of food security and nutrition, while safeguarding the economic, social, and environmental conditions for future generations. For this, are necessary sustainable agricultural practices, such as agroecology, agroforestry, organic agriculture, holistic management, and regenerative agriculture (Matt, 2023).

Sustainable agricultural practices are based on principles such as soil and ecosystem restoration, together with biological interactions and ecosystem services, as well as the in-tegration between plants and animals, including crop rotation and succession, with em-phasis on efficient water use and soil and surface carbon sequestration. In addition, sustainable agricultural practices aim to offer higher yields, resilience to climate instability, and a healthier life for agricultural and animals' communities (Gosnell et al., 2019; Mpanga et al., 2021; Day & Cramer, 2022; Gosnell, 2022).

Thus, concepts such as soil, production systems and, marginally, social aspects have been related to sustainable agriculture. On the other hand, sociopolitical concepts, transition processes, and transformation processes, necessary for sustainable food production, are practically absent, thus far, from some sustainable practices, such as regenerative agriculture (Tittonell et al., 2022).

This way, understanding the factors that influence the decision-making of farmers to accept and adopt sustainable agricultural practices, is essential to understand the process of transition from conventional agriculture to sustainability in agricultural systems (Dessart, Barreiro-Hurlé & Van Bavel, 2019), as well as to meet the expectations of consumers regarding the sustainable origin of the food produced (Cunha & Spers, 2011).

For that, the models and theories related to the acceptance, adoption, use, and/or diffusion of technologies in the field cover several areas, such as innovation and management, including sociology and even psychology (El Bilali, et al., 2021). Likewise, the factors that determine the use of technologies in agriculture are related to ease of use, social and emotional factors, the environment, and the context in which they occur, beliefs, attitudes, perceptions, behavior, social norms, economic incentives, institutional environment, and cost. Therefore, a combination of theories should be used in studies related to the adoption of sustainable agricultural practices for a better understanding of decision-making (Runhaar et al., 2017; Hyland, Heanue & Mckillop, 2018; Schoonhoven & Runhaar, 2018).

Thus, one of the most prominent models in the field of acceptance and adoption of technologies is the Unified Theory of Acceptance and Use of Technology - UTAUT Venkatesh et al., 2003), which integrates several other acceptance models, such as the Motivational Model (Deci & Ryan, 2008), Technology Acceptance Model (Davis, 1985), Innovation Diffusion Theory (Rogers, 1995) and Theory of Planned Behavior (Ajzen, 1985). Therefore, the behavioral intention of adopting and using new technologies is related to the expectation of effort (or perceived ease of use), the expectation of performance (or perceived usefulness), social influence, facilitating conditions, hedonic motivation (related to consumer behavior), cost-benefit and habit (Venkatesh, Thong & Xu, 2012; El Bilalt et al., 2021).

Regarding the motivations that lead the farmers to adopt and implement practices that contribute to biodiversity, it is possible to mention subsidies, investments, recognition, autonomy, cost-effectiveness, pressure from other farmers, and knowledge. However, as for the ability to adopt sustainable technology, the highlights are the availability of new business models, financing, market conditions, cost-benefit, community support and trust, values, pressure from other farmers, knowledge, communities that have already adopted the technology, research, government support and the involvement of the third sector (Runhaar et al., 2017; Schoonhoven & Runhaar, 2018).

Nevertheless, in recent years, there has been a growing consumer demand for food with sustainable origin. In this way, new markets and opportunities have emerged for farmers, such as the sustainable farming inputs, for example, biofertilizers and biopesticides, have expanded as farmers look for alternatives to conventional chemical inputs (Matt, 2023).

Biological inputs or bioinputs are products, processes, or technologies of microbial, plant or animal origin, which can positively affect agricultural production (Souza, Castilho & Macedo, 2022). According to Goulet (2021), the bioinputs were looked on as an alternative to agroindustry, reserved for ecological farmers. However, nowadays, it is known that all farmers, whether indus-trial or ecological, can benefit from the development and use of bioinputs. Furthermore, bioinputs can be a lever for rural economic and social development, through the construc-tion of biofactories, would promote economic activity and create rural jobs (Goulet, 2021).

Therefore, markets for agroecological food and inputs are shaping ecological forms of agriculture. Like this, processes that set up these markets, have an impact on agricultural systems and practices. This way, Le Velli et al. (2023) suggests that the evolutionary path of agroecology depends on how both input (upstream) and output (downstream) markets are structured.

Then, given the conditioning factors of the adoption and practice of sustainable agri-culture, in particular, the adoption of the use of bioinputs, in parallel, theories and models of technology adoption, understanding what drives or prevents the transition from conventional agriculture to a most sustainable model is critical to overcoming the barriers that prevent the adoption of sustainable technology. Like this, transforming agriculture into a sustainable system requires the sensitivity of farmers regarding values, beliefs, worldviews, and paradigms that need to be identified.

This way, to know the main factors related to the adoption of sustainable agriculture in the Brazilian Cerrado, the objective of this study was to qualitatively analyze the perception of grain farmers, from Rio Verde, in the state of Goiás, regarding adoption of the use of bioinputs on its properties.

2 METHODOLOGY

To understand the perceptions of grain farmers, from Rio Verde, in the state of Goiás, to adopt of the use of bioinputs on its properties, semi-structured face-to-face and individual interviews were conducted with six farmers, between January 9th and 11th, 2023.

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.

The analysis of the transcribed interviews was performed using the content analysis technique. This technique consists of transcribing interviews, creating codes, and grouping the codes obtained into categories based on their similarities (Bardin, 1977).

For that, the first stage of the analysis was performed based on the transcription of the recorded interviews, to recognize the text to be analyzed. Subsequently, the hypothesis and objectives to be achieved at the end of the analysis were formulated, and a coding system for segments of the texts was defined, to categorize and classify, allowing for better understanding of the meaning of the registered unit, through Atlas Ti software (2023).

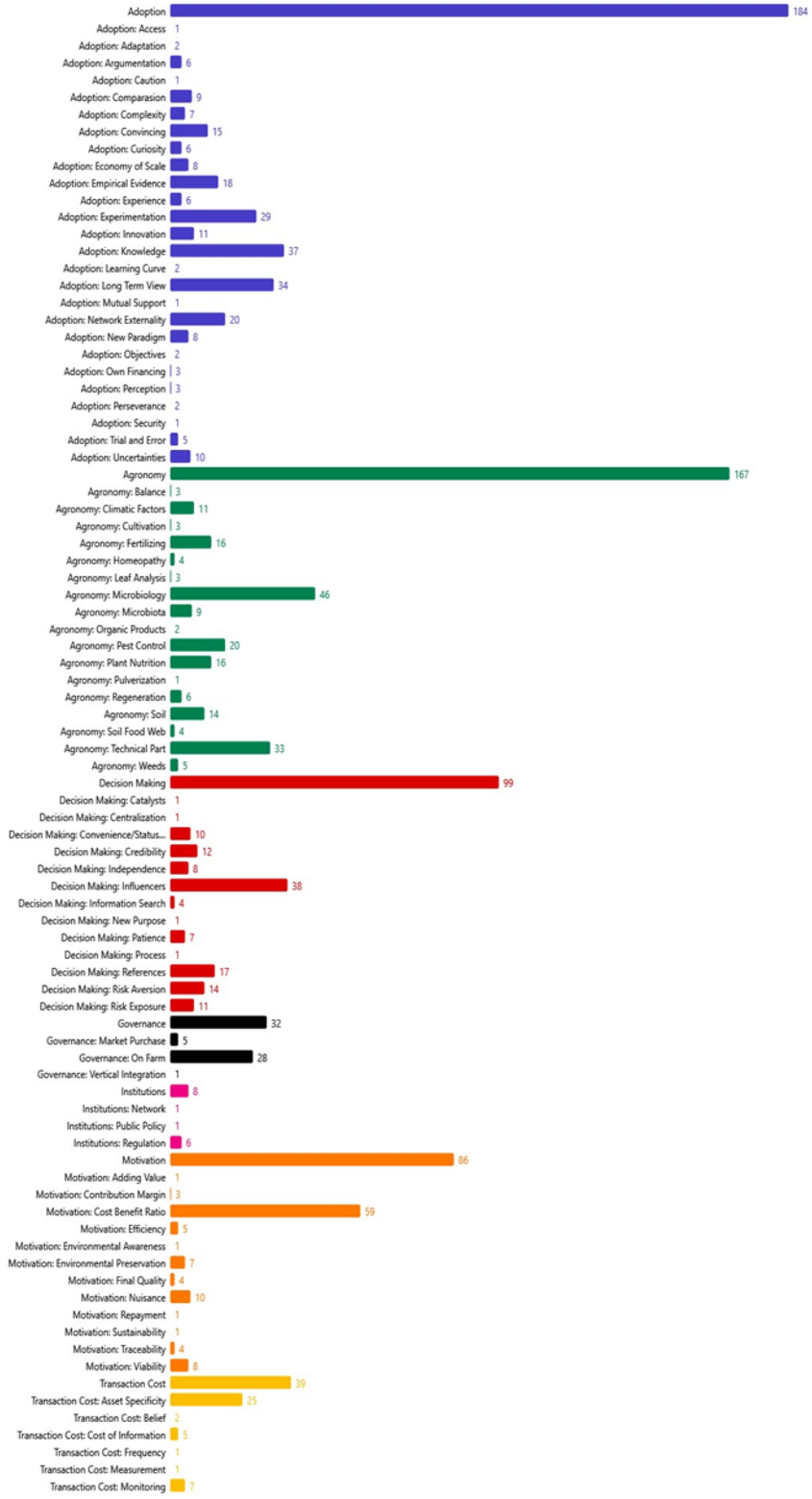
The codes created were elaborated via deduction, through preexisting concepts derived from the theoretical models observed in the literature review, and via induction, through concepts that emerged from the semi-structured interviews. Thus, codes with theoretical, functional, or descriptive similarities were grouped into categories and discussed according to the themes and theoretical models selected (Figure 1).

Figure 1. Categories and codes made from the qualitative analysis of the content of the interviews with the farmers

Source: Atlas TI software.

Then, after the elaboration of the categories created from the aggregation of several similar codes, the quantification of the citations referring to the categories and codes was performed, as shown in Figure 2. The observed number of codes and citations prepared using the software Atlas TI resulted in a total of 87 initial codes and 490 citations.

Figure 2. Quantity of citations presented in the categories and codes, made from the qualitative analysis conducted in the interviews with farmers



Source: Atlas TI software.

3 RESULTS AND DISCUSSION

To direct the discussion of the present study on the perception of farmers regarding the adoption the use of bioinputs in their properties, the most cited categories and codes were highlighted. Thus, it is possible to observe that the qualitative analysis of the categories showed the Adoption as the most cited category by farmers, with 184 citations, and within this category, Knowledge, Long-Term Vision, and Experimentation were the most cited codes, with 37, 34 and 29 citations, respectively, as shown in Figure 2.

After, the second most cited category was Agronomy (167 citations), with emphasis on the following codes: Microbiology (46 citations) and Technical Part (33 citations). In sequence, the Decision-Making category (99 citations), the codes Influencers (38 citations) and References (17 citations) are followed by the Governance category (32 citations) and the On-Farm code (28 citations). In turn, the Motivation category (86 citations) is highlighted by the Cost–Benefit Ratio code (59 citations); then, the categories Transaction Cost (39 citations) and Institutions (8 citations) have the codes Asset Specificity (25 citations) and Regulation (6 citations), respectively, as the most cited, according to Figure 2.

On the other hand, less cited codes, such as Uncertainty (10 citations), Convenience (10 citations), Risk Aversion (14 citations), Exposure to Risk (11 citations), and Nuisance (10 citations), were also essential for the decision-making of farmers regarding the adoption or non-adoption of bioinputs on their Properties (Figure 2).

The qualitative analysis of the texts transcribed showed that there are several factors related to the adoption of bioinputs on farms, including the knowledge about bioinputs management, the cost–benefit ratio of this new tool, the independence regarding the purchase of chemical inputs, and the importance of references/influencers, which already adopt bioinputs technology and are used as disseminators of knowledge, or as bearers of error experience and hits in the sustainable process.

In general, an important limiter of the adoption and implementation of sustainable process is related to the lack of knowledge. This is because farmers still have a certain unfamiliarity about the daily life of sustainable management, since this technology needs the frequent presence of the farmer in the field, following the development of plants, and the control of pests and diseases, due to the decrease in the use of commercial chemical inputs. However, farmers understand that the adoption of bioinputs should be viewed in the long run, due to decades of addition of chemical

inputs, which can act in the macro and microorganisms in the soil chain, impairing the regenerative cycle of the system. Thus, experimental areas managed with biological inputs, organic matter, and chicken bed, among other biological compounds, have been evaluated by the farmers themselves regarding the increased productivity of grains crops.

However, it is important to note that the production of biological inputs on-farm, from plant extracts, leaf litter from the preservation areas of the properties, or from processed animal waste, are considered the main form of governance structure, due to the distance from the input producing markets, increasing production costs; the specific environmental conditions of the Cerrado region; and the fact that the possibility of producing the input on-farm allows independence from companies producing biological inputs.

Therefore, the specificity of the biological inputs results in an on-farm governance structure, that is, the production of biological compounds is performed within the farm. For this, the production of the biological input itself requires an appropriate infrastructure, which can be made possible by medium and large farmers or by producer groups, such as cooperatives, promoting the economy of scale in the sector. However, the production of biological inputs on-farms requires specific protocols, in addition to regulations, which do not currently exist in Brazil.

In any case, the farmers interviewed are uncomfortable with the high cost of conventional agricultural production, especially regarding the costs of chemical inputs and, with the dependence on companies producing agricultural inputs, in addition to the chemical residue present in the environment. Therefore, the presence of influential farmers in the field of sustainable cultivation is essential for the dissemination of knowledge and for facilitating the access of new farmers to sustainable techniques, in the Rio Verde region.

On the other hand, despite the knowledge of sustainable techniques and the economic and environmental importance of this practice, one of the farmers interviewed prefers not to adopt the use of bioinputs on his property, due to uncertainties and lack of knowledge about the management of technical, in addition to risk aversion, as well as the cost-benefit ratio of the conventional system which, for this particular producer, is still attractive, as shown by the quote from its interview: *"(...) Every year I do the same management more or less. So, it is producing well and the last five years I am doing more or less the same. Do not change. It is equal to the cake recipe. I'm not changing. It is going well. (...) If it falls (the crop), spending less the risk is*

lower too. In corn you are not without urea. How do you do without urea? It (the corn) does not respond".

Thus, it is possible to observe the perception of the farmers interviewed regarding the adoption of the use of bioinputs depends on: a) the cost–benefit relationship, since the costs of conventional agriculture are increasing, as well as the dependence of producers on commercial inputs; b) lack of knowledge about sustainable techniques, especially regarding the implementation and management of production; and c) influencers/reference figures, both for the dissemination of knowledge and for the sharing of experiences in the field.

However, this scenario is expected since the adoption and implementation of new agricultural technologies depend on the knowledge of the technique, the development of the implementation and monitoring steps, as well as the evaluation of production and profit costs, in conjunction with constant learning (Rickards &Howden, 2012; Vignola et al., 2015; Vermeulen et al., 2018).

Nonetheless, it is important to emphasize that the decision-making by the farmer, in adopting and implementing sustainable techniques on his property, is beyond the cost–benefit relationship, knowledge about sustainable technology and dependence on commercial chemical inputs, among other factors presented. The adoption of new agricultural techniques requires an integrative approach that recognizes the relationships between changes in the producer's behavior sphere; between changes in public policies; and between possible changes in practice (Day & Cramer, 2022). In any case, the adoption of sustainable practices tends to be greater when farmers known the implementation and conduct of sustainable practices, when they believe that these practices bring environmental and financial benefits with limited risks, and when they find consumers willing to pay for ecological foods (Dessart, Barreiro-Hurlé & Van Bavel, 2019; Soto et al., 2021).

Consequently, the understanding of the individual perceptions of farmers should precede efforts related to the limitations and opportunities of adoption of the use of bioinputs (Kenny & Castilla-Rho, 2022; Jaworski et al., 2023). In other words, the adoption of sustainable practices should consider the factors involved in the decision-making by farmers to adopt these practices, allowing the identification of factors that shape or limit decision-making, and subsequently, public, and environmental awareness should complement the thinking and behavior of the producer.

4 FINAL CONSIDERATIONS

The perception of rural producers in the Brazilian Cerrado regarding the adoption and implementation of sustainable practices, such as the use of bioinputs, depends on the relationship between several factors, the main ones being the cost–benefit ratio, independence from commercial inputs, and the dissemination of practical knowledge by farmers who have implemented sustainable techniques. However, the qualitative analysis presented needs to be complemented by a quantitative analysis, performed with the participation of a considerable number of producers, to contribute to a better understanding of the opportunities and limitations of the use of bioinputs based on statistical validations.

REFERENCES

Ajzen, I. (1985). From Intentions to Actions: A Theory of Planned Behavior. In: Kuhl, J., Beckmann, J. (eds) Action Control. SSSP Springer Series in Social Psychology. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-69746-3_2

Atlas.ti. (2023) *Scientific Software Development GmbH*. ATLAS.ti Mac (version 23.2.1) [Qualitative data analysis software]. Available from: https://atlasti.com

Bardin L. (1977). *Análise de Conteúdo*. Lisboa: edições. Available from: https://ia802902.us.archive.org/8/items/bardin-laurence-analise-de-conteudo/bardin-laurence-analise-de-conteudo.pdf

Cunha, C.F., Spers, E.E., Zylbersztajn, D. (2011). Percepção sobre atributos de sustentabilidade em um varejo supermercadista. *Revista de Administração de Empresas*. 51:542-552.

Davis, F.D. (1985). *The technology acceptance model for empirically testing new end-user information systems: Theory and results*. Massachusetts Institute of Technology (MIT), Cambridge (MA).

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

Deci, E.L., Ryan, R.M. (2008). Self-determination theory: A macro-theory of human motivation, development, and health. *Canadian Psychology / Psychologie canadienne*. 49(3):182–185. Available from: https://doi.org/10.1037/a0012801

Dessart, F.J., Barreiro-Hurlé, J., Van Bavel, R. (2019). Behavioral factors affecting the adoption of sustainable farming practices: a policy-oriented review. *European Review of Agricultural Economics*. 46(3): 417–471. Available from: https://doi.org/10.1093/erae/jbz019

El Bilali, H., Ben-Hassen, T., Bottalico, F., Berjan, S., Caponeel, R. (2021) Acceptance and adoption of technologies in agriculture. *AGROFOR International Journal*. 6(1):135-150.

Gosnell, H., Gill, N., Voyer M. (2019). Transformational adaptation on the farm: processes of change and persistence in transitions to "climate-smart" regenerative agriculture. *Global Environmental Change* 59: 101965. Available from: https://doi.org/10.1016/j.gloenvcha.2019.101965

Gosnell, H. (2022). Regenerating soil, regenerating soul: an integral approach to understanding agricultural transformation. *Sustainability Science*. 17:603–620. Available from: https://doi.org/10.1007/s11625-021-00993-0

Goulet, F. (2021) Characterizing alignments in socio-technical transitions - Lessons from agricultural bioinputs in Brazil. *Technology in Society*. 65:101580. Available from: https://www.sciencedirect.com/science/article/pii/S0160791X21000555

Hyland, J.J., Heanue, K., Mckillop, J., Micha, E. (2018). Factors influencing dairy farmer's adoption of best management grazing practices. *Land Use Policy*. 78:562-571. Available from: https://doi.org/10.1016/j.landusepol.2018.07.006

Jaworski, C.C., Krzywoszynska, A., Lake, J.R., Dicks, L.V. (2023) Sustainable soil management in the United Kingdom: A survey of current practices and how they relate to the principles of regenerative agriculture. *Soil Use Manage*. 1–20. Available from: https://doi.org/10.1111/sum.12908

Kenny, D.C., Castilla-Rho, J. (2022). What prevents the adoption of regenerative agriculture and what can we do about it? Lessons and narratives from a participatory modelling exercise in Australia. *Land*. 11:1383. Available from: https://doi.org/10.3390/land11091383

Le Velli, R., Goulet, F., Dufeu, I., Loconto, A., Niederle, P. (2023) When markets make agroecologies: empirical evidence from downstream and upstream markets in Argentina, Brazil and France. *Journal of Innovation Economics & Management*. Available from: https://www.cairn.info/revue-journal-of-innovation-economics-2023-3-page-21.htm

Matt, M. (2023) The role of markets and value chains in shaping sustainable agrifood systems. *Journal of Innovation Economics & Management*. 42, 1-19. Available from: https://www.cairn.info/revue-journal-of-innovation-economics-2023-3-page-1.htm

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

Rickards, L., Howden, S.M. (2012). Transformational adaptation: agriculture and climate change. *Crop and Pasture Science*. 63:240–250. Available from: http://dx.doi.org/10.1071/CP11172

Rogers, E.M. (1995) Diffusion of Innovations. 4th Edition, the Free Press, New York.

Runhaar, H.A.C., Melman, T.C.P., Boonstra, F.G., Erisman, J.W., Horlings, L.G., De Snoo, G.R. (2017) Arts BJM. Promoting nature conservation by dutch farmers: A governance perspective. *International Journal of Agricultural Sustainability.* 15:264–281. Available from: https://doi.org/10.1080/14735903.2018.1537664

Schoonhoven, Y., Runhaar, H. (2018) Conditions for the adoption of agroecological farming practices: a holistic framework illustrated with the case of almond farming in Andalusia. *International Journal of Agricultural Sustainability*. 16(6):442-454. Available from: https://doi.org/10.1080/14735903.2018.1537664

Soto, L., Padilla, R.M.C., Méndez, M.R., 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. Available from: https://doi.org/10.5751/ES-12796-260429

Souza, F.P., Castilho, T.P.R., Macedo, L.O.B. (2022). Brazilian agriculture based on ecological economics. *Sustainability in Debate*. 13(1):247-265. Available from: https://doi.org/10.18472/SustDeb.v13n1.2022.40820

Tittonell, P., El Mujtar, V., Felix, G., Kebede, Y., Laborda, L., Soto, R.L., Vente, J. (2022). Regenerative agriculture-agroecology without politics? *Frontiers in Sustainable Food Systems*. Available from: https://doi.org/10.3389/fsufs.2022.844261

Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D. (2003). User acceptance of information technology: toward a unified view. *MIS Quarterly*. 27(3):425. Available from: https://doi.org/10.2307/30036540

Venkatesh, V., Thong, J.Y.L., Xu, X. (2012) Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*. 36(1):157. Available from: https://doi.org/10.2307/41410412

Vermeulen, S.J., Dinesh, D., Howden, S.M., Cramer, L., Thornton, P.K. (2018) Transformation in practice: a review of empirical cases of transformational adaptation in agriculture under climate change. *Frontiers in Sustainable Food Systems*. 2(65). Available from: https://doi.org/10.3389/fsufs.2018.00065

Vignola, R., Harvey, C.A., Bautista-Solis, P., Avelino, J., Rapidel, B., Donatti, C., Martinez, R. (2015). Ecosystem-based adaptation for smallholder farmers: Definitions, opportunities, and constraints. *Agriculture, Ecosystems & Environment*. 211:126–132, 2015. Available from: https://doi.org/10.1016/j.agee.2015.05.013