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EDITORIAL

Prezad@s leitores,

É com enorme prazer que anunciamos e publicamos a terceira edição da revista Organizações Rurais e Agroindustriais em 2017. Essa edição é um marco importante na história da revista, pois é a primeira vez, desde sua concepção no início da década de 1990, ainda com nome de "Cadernos de Administração Rural", que publicamos uma edição 100% em língua estrangeira. Isso significa que todos os artigos foram traduzidos para língua inglesa, na intenção de avançarmos no nosso processo de internacionalização.

Essa conquista poderá nos permitir uma melhor inserção na literatura internacional das temáticas de organizações rurais, além de multiplicar os conhecimentos gerados para outras fronteiras, divulgando a variedade de temas e abordagens do agronegócio brasileiro.

Em particular, os artigos do V.19, 3, 2017 tratam de temas e métodos diversos como: i) redes de cooperação em organizações familiares; ii) análises de Hedge em mercados agrícolas; iii) políticas de reforma agrária; iv) redes e inovação no agronegócio brasileiro; v) preferências do consumidor e vi) expansão agrícola.

- COOPERATION NETWORKS AND TRANSFORMATIONS IN THE FOOD PRODUCTION AND DISTRIBUTION SYSTEMS OF FAMILY FARMING IN THE NORTH COAST OF RIO GRANDE DO SUL, BRAZIL

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Boa leitura a todos,
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Editor

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ORGANIZAÇÕES RURAIS & AGROINDUSTRIAIS

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COOPERATION NETWORKS AND TRANSFORMATIONS IN THE FOOD PRODUCTION AND DISTRIBUTION SYSTEMS OF FAMILY FARMING IN THE NORTH COAST OF RIO GRANDE DO SUL, BRAZIL

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ABSTRACT

This article mobilizes the theoretical approaches of novelty production and collective actions to analyze the construction of innovative organizational strategies in the North Coast of Rio Grande do Sul, Brazil, focusing on the sociotechnical transformations triggered by them. Based on documentary and field research conducted between August 2013 and April 2016, through observant participation and semi-structured interviews with family farmers, social mediators and researchers, it was possible to identify the consolidation of a peculiar network of collective actions, involving several social actors in the management of new and relevant media, which transform conventional food production and distribution systems. Evidenced as a 'novelty' in emergency, this articulation of social actors is largely related to the precepts of sustainability, reciprocity, sharing of knowledge, heterogeneity and dynamism of social action. Such interrelated devices seem to indicate a change in the development dynamics in the rural area of the study region.

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RESUMO

Este artigo mobiliza as abordagens teóricas de Produção de Novidades e de Dispositivos Coletivos para analisar a construção de estratégias organizacionais inovadoras no Litoral Norte do Rio Grande do Sul, com foco nas transformações sociotécnicas por elas desencadeadas. A partir de pesquisas documental e de campo realizada entre agosto de 2013 e abril de 2016, por meio da participação observante e entrevistas semiestruturadas com agricultores familiares, mediadores sociais e pesquisadores, foi possível identificar a consolidação de uma rede peculiar de dispositivos coletivos, que envolve diversos atores sociais na gestão de novos e relevantes meios, os quais transformam sistemas convencionais de produção e distribuição de alimentos. Evidenciada como uma 'novidade' em emergência, essa articulação de atores sociais está amplamente relacionada com preceitos da sustentabilidade, reciprocidade, compartilhamento de conhecimentos, heterogeneidade e dinamismo da ação social. Tais dispositivos inter-relacionados parecem indicar uma alteração na dinâmica de desenvolvimento no espaço rural na região de estudo.

Keywords: Collective Actions, Novelty Production, Rural Development.

Palavras-chave: Dispositivos Coletivos, Produção de Novidades, Desenvolvimento Rural.

1 INTRODUCTION

The socio-environmental crises, which currently affect agriculture and generate consequences for the Brazilian society as a whole, highlight the limited idea of modern technology linked to a development project that benefits a small part of the population (ALMEIDA, 2009). Although this modernization process has begun decades ago and has been constantly criticized both in relation to the generated results in the recent past and in the present as well as its influence on the future, it is still hegemonic in rural areas and continues to generate a series of socio-environmental impacts. The displacement of distinct production factors based on the local tradition and the obscuring of expressions and originalities built by the unique characteristics of each people and culture are notorious.

The standardization of science and technology resulting from the modernization processes led agriculture to disconnect from local social contexts, ecology, time and space, the production of products from specific local qualities, and the family as a principle of social

organization (PLOEG, 1994). Although this disconnection process of the agriculture as a sociocultural practice has predominated in society, not all social groups remained uncritical o their effects. Many farmers resisted this process in different ways and, instead of experiencing it as a disintegration of their living worlds, transformed the new code of communication and rationality that was imposed to them. According to their needs and interests, they interrelated different materialities associated with modernity and tradition (ARCE; LONG, 2000).

The rethinking on the role of farmers, both in research and in practical experimentation, as well as in the creation of public policies, involves the understanding that their initiatives are relevant in the configuration of social and material space, since they provoke readjustments, recreations and transformations in rural areas. This daily work, which puts different wisdom and knowledge in 'interface situations'[1], provokes the establishment of negotiation processes and adjustments of meanings, generating distinct knowledge resulting from accommodation between interests and points of view from the involved actors, whether social mediators, farmers or public managers.

The richness and dynamism of these processes creates a scenario where there are constant transformations of the rural space and the practices developed in there. Thus, it is expected that there are socio-technical conditions favorable to novelty production in agriculture. This key term was coined from the need to particularize or evidence 'innovative' phenomena underway in rural areas. A novelty can be understood as a modification or a break in existing routines, or a new practice or way of doing, presumably with potential to promote improvements in existing routines (PLOEG *et al*., 2004). Such modifications or breaks of routines do not only contemplate those related to the production process, being related to forms of production organization and to the creation and consolidation of social organizations and institutional arrangements.

With the purpose of analyzing the construction and articulation of innovative organizational strategies in the North Coast of Rio Grande do Sul, Brazil, this article interrelates the perspective of novelty production (PLOEG *et al*., 2004) with the collective action approach proposed by Mormont (1996). For Mormont (1996), it is possible to understand collective action as a form of social mobilization around an objective or a claim. Based on this theoretical perspective, the farmer's point of view, particularly the family farmer, is highlighted, as well as it is shown that each uncertainty, driving the constitution of these collective actions, may have different values depending on the related situation. These understandings allow us establishing analytical connections between the decisions of a farmer accepting a great uncertainty in an area and facing the possibility of meeting some security in other areas and therefore following innovative paths (MORMONT, 2014).

The two theoretical approaches were mobilized for the analysis of field information obtained from social mediators and farmers' families in daily activities, such as work in street markets, appointments and meetings, activities on crops and their relationship with researchers and public managers in the region[2]. These activities were developed in the first phase of the study, between August 2011 and August 2013, and in the second phase, between September 2013 and July 2016, respectively, as rural extensionist and researcher of one of the authors. The extensionist activity was carried out at the Associação Riograndense de Empreendimentos de Assistência Técnica e Extensão Rural/Associação Sulina de Crédito e Assistência Rural (EMATER/ASCAR – RS), institution from the official rural extension service of the State.

This information was generated through essentially qualitative methodological tools carried out in the municipalities of Três Forquilhas, Terra de Areia, Itati, Osório, Maquiné, Dom Pedro de Alcântara and Torres, located on the North Coast of Rio Grande do Sul, Brazil (Figure 1). These tools included documentary research, participant observation and 64 semi-structured interviews, from which 38 were directed to family farmers and 26 to social mediators working in the region.

Besides this introduction, this article is divided into four main sections: in the first, the discussion about the novelty production perspective is deepened and, in the second, the collective action approach is presented more detailed. In the third, the focus is on the family farmers experiences in the construction of cooperation networks. In the fourth and last one, the considerations on the articulation between the collective actions and innovative dynamics of region's rural development are elaborated.

[1]Interface situations are defined as critical intersection points among different systems, fields or social domains, in which there are tendencies to find discontinuities according to differences of values and interests (LONG; PLOEG, 1989).

[2]This field research is correlated to the doctoral dissertation of the first author from the Graduate program in agroecosystem of the Federal University of Santa Catarina, defended in September 2017.

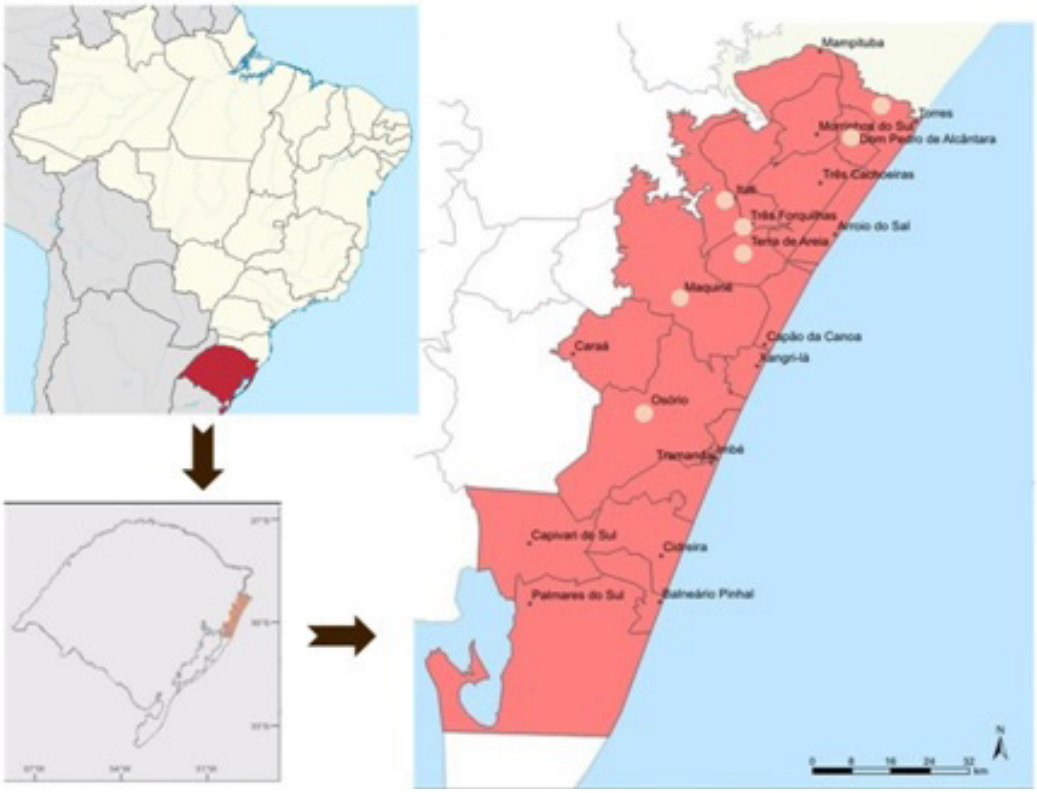

FIGURE 1 - Location of the North Coast region of Rio Grande do Sul and municipalities from the family farmers involved in the research. Adapted from: SPGG (2014)

2 KNOWING THE NOVELTY: THE DYNAMICS OF ITS EMERGENCE

The notion of novelty production seeks to highlight the complexity of the different agriculture styles and opposes the idea normally connected to factors as standardization, externalization and globalization of practices and artifacts. The novelties perform "breaks" and "disqualifications" in relation to the hegemonic logic of society and the institutional context (WISKERKE; PLOEG, 2004; OOSTENDIE; BROEKHUIZEN, 2008). On the other hand, the innovations, especially the far-reaching technological ones, seek the substitution of limiting inputs by artifacts manufactured by the industry and adapted to certain interests that aim to induce institutional changes, whose core is the capitalist accumulation (VENTURA; MILONE, 2004).

The novelty differentiation can be verified by three central points: i) the knowledge used for its construction is contextualized; ii) the practices involved in this construction are internalized or endogenous; and iii) the processes and artifacts created in these processes are territorialized (OOSTINDIE; BROEKHUIZEN, 2008). The first peculiarity is tied to the fact that the knowledge mobilized by social actors in the novelty production has a contextual character. It is constructed correlated to the socioeconomic, environmental, cultural and institutional context where the actors are inserted. After the interaction between the several types and sources of tacit and scientific knowledge in the novelty construction, new knowledge is constructed and then rooted in practices and epistemologies of these social actors (STUIVER, 2004; STUIVER, 2008).

The internalization of the novelty emergence, in turn, is related to the profitability and sustainability of novelties, since it involves the reduction of the use of external resources from the territory and from the production unit and hence the optimal use of internal resources (OOSTINDIE; BROEKHUIZEN, 2008; STUIVER, 2008). Thus, the novelties are born in a certain social and spatial site, resulting from a set of local social

relationships and constructions performed in networks of social actors. The novelty emergence is therefore a territorialized process, dependent on the time, ecosystems and cultural repertoires to which the work processes are associated (WISKERKE; PLOEG, 2004). In this sense, territory is understood here other than a space delimited by peculiarities or similar production activities with established geographical borders, but as a result from actions of social actors seeking for resolution of shared problems (PECQUEUR, 2005; BONNAL; CAZELLA; DELGADO, 2011).

This set of characteristics leads to the finding that the radical character of novelties is evident in the possibility of breaking with productivist and purely economic patterns, which disconnect society from nature and devalue the cultural identity of social actors. Therefore, the novelties incite transformation processes that start from the micro level and can reach the macro. Accordingly, they are considered by Ploeg et *al.* (2004) as "transition seed" to a new paradigm of rural development.

The transformation processes resulting from the novelties are based on the reconnection of society with nature, through the agriculture development and the promotion of the co-production of interaction forms and reciprocal transformation of social and natural. In coproduction, the use of locally available natural resources allows recreating them, which occurs through dialectical articulation with the reconstruction and strengthening of sociocultural identities of actors involved in a cyclical system with natural resources (PLOEG, 2006; OOSTINDIE; BROEKHUIZEN, 2008). The reconnections driven by the novelties allow constructing new development projects, whose foundations are based on socioeconomic, cultural and environmental dimensions.

From the analysis of several studies aimed to investigate endogenous innovative processes in rural areas, which break the patterns and rules established by the dominant regime, Oostindie and Broekhuizen (2008) propose an analytical framework that identifies four distinct trajectories for the novelty emergence. The first refers to "resource improvement". In this trajectory, nature is constructed, reconstructed and differentiated within a long historical process, in which particularities emerge that show characteristics from the involved natural resources. In turn, as they result from coproduction processes, these resources are shaped and remodeled through the constant interaction between society and nature.

The second trajectory concerns the "fine tuning" between the farmer and an extensive list of growth factors[3], which are continuously identified and corrected. Following the theory of limiting factors, the f growth factor that falls below the necessity limits the whole development process of a given agricultural activity in that locality. Therefore, the fine-tuning in the adjustment of these factors is often what promotes the novelty emergence. This is a dynamic process, since when correcting the original limiting factor, another one can arise in its place.

The third trajectory is associated with the "transposition of borders", i.e., the inclusion of new domains and activities by farmers. These activities may include food processing and marketing, as well as measures and strategies related to nature protection, among others. When these actions imply the expansion of intervention frontiers beyond production units, much more complex social organizations and networks may emerge. In this way, new experiences are translated into new knowledge that, in turn, inspire new practices.

The last trajectory refers to the "reordering of resource use". When addressing the connection of elements in an innovative way, such reordering is not restricted to the limits of the production unit nor to the agricultural activities *stricto sensu*. The novelty can arise from the interrelationship with elements belonging even to non-agricultural sectors. The trajectories associated with the novelty emergence do not necessarily occur linearly, one by one, in the presented order. They can be concomitant and follow a random order, since they are directly related to the decision-making of social actors in the specific situations of daily life.

These distinct trajectories are an inherent part of the development of certain agriculture styles, especially those linked to family farming. The search for autonomy from family farming segments ends up guiding the planning and operationalization of a heterogeneous rural development project, which is strengthened in the tangle of organizational processes that merge different social agency forms[4].

[3]Growth factor for agriculture means the set of determining characteristics of limitations and potentialities from agricultural production processes. Examples include the inclusion of nutrients in the soil composition, the absorption capacity of these nutrients by the roots of plants and the water availability in the soil over time (OOSTINDIE; BROEKHUIZEN, 2008).

[4]One of the first authors to deal with this notion was the English sociologist Anthony Giddens (1989). For Giddens, the agency refers not to people's intentions to do certain things, but above all to their ability to put these things into practice. The agency depends on the individual's ability to generate changes in relation to a pre-existing state of affairs or course of events, which implies that all agents, even those in subordination positions, appropriate a particular type of power and can exert influences.

3 COLLECTIVE ACTIONS AS STRATEGIES TO OVERCOME ADVERSITIES

According to Mormont (1996), there are three main areas of uncertainty that promote the construction of counter-hegemonic forms of cooperation by farmers: the ecological or technical-ecological, the economic, and the social or socio-political. The first one refers to the change of practices required in the technical-productive system in view of the new requirements of environmental protection and conservation, including regulated by specific environmental laws. Although there is currently consensus on the existence of pollution from agricultural sources, there are no precise ecological models which allow a given region assigning an exact pollution level to each agricultural practice. This situation is even more complex in contexts of high socio-environmental diversity, as in the case of Brazil.

Faced with the scenario resulting from years of intense environmental impact, technical-ecological alternatives to avoid this impact are still imprecise for farmers. Although information has been facilitated in recent years by internet access or even the television media, some farmers find it difficult to access explanations in their local environment, especially regarding the limitations and cost-benefit of the implementation of a certain differentiated process in its production system. The need to adapt the production system to environmental legislation is often linked to the reduction of cultivated area and even to the transformation of the working way in agriculture. With this, farmers constantly seek the best productive use of the area based on techniques less harmful to the environment.

The second field is related to the doubt about the estimation of production cuts and yield losses. In this case, the uncertainty is built on the possible influence of the practical and technical changes in the economic strategy of development of the activity, organization of work and medium-term perspectives of farmers. In this way, the decisive factor for the farmer becomes the degree to which these changes will influence, in practice, his daily life.

The possible economic restrictions resulting from adherence to such adjustments should be viewed less as monetary as strategic. Although the proposed compensations are often exclusively monetary, such as the differentiation in the price of the produced food, it is possible that the farmer logic leads him to accept some new (and reversible) practices, not to be executed in its entire production unit, but only in specific plots. On the other hand, the logic of another farmer can lead him to adopt measures that suppose a complete reversal of the production system and hence demand bigger compensations (MORMONT, 1996).

Experiences involving farmers in the process of organic conversion, whose agricultural work system is transformed from a conventional model to an ecologically based model, illustrates this reflection. While some farmers initiate this process by applying new techniques in only part of their production unit, others opt for the change the entire production system. The first strategy highlights the need for farmers to test the potential of such changes over time, as well as to analyze the implications of these choices, then if they deem it important and/or interesting, to implement them later in their entire production area.

The second type of decision, among other factors, may be associated with the possibility of future economic gains, coming from the reach of a "premium price", which is defined as the price differential between the products coming from this production system and the conventional one (MEIRELES, 2003). The range of factors influencing farmers' reaction to the need for such changes is extensive. The farmer's age, the perspectives of family succession in the performed work, gender issues and access to technical assistance and participation in rural extension actions prepared by local institutions are only a few examples (STROPASOLAS, 2011).

The third field of uncertainty is sociopolitical and, according to Mormont (1996), to understand it, it must be considered that every decision made by the farmer implicitly includes a definition of his agricultural *metier*, his identity[5] and the relational field in which such identity is recognized. Certain requirements for changing work practices do not correspond often to the farmer's professional identities, which, depending on how they are performed, can lead to uncertainty of identity maintenance and, in certain cases, to the redefinition of that identity.

These transformations refer to technical improvements in which there is a production that presents ecological and economic advantages. Although the reduction in the use of external resources in production is a catalyst factor for a less degrading agriculture, regarding the environment, the farmer needs specific knowledge to achieve this result. In order to meet this shortage, some specialized technical institutions maintain a productivist and significantly selective social contract with farmers. In other words, only farmers who fit the best of their technical work system will be involved in this search for innovation (MORMONT, 1996).

[5]Identity is understood here as a content, strongly expressed in discourses, as a field of relationships in which the individual is recognized for his abilities (MORMONT, 1996).

This perspective differs substantially from the approach that conceives the farmer as an agent for nature, landscape and environment. It is assumed that the farmer has greater reflection abilities on the needs of socio-technical transformations than an individual unfamiliar with the locality due to his knowledge on the environment, which may occur with the technicians who play the role of technical assistance and rural extension (MORMONT, 1996). For instance, if the farmer is a beekeeper, he will certainly know the detailed contribution of plant diversity to the maintenance of bees in the region and can therefore understand how urgent is the need to work with new agricultural practices that less damage the ecosystem.

Regarding this third area of uncertainty, the environment represents a specificity capable of being associated with certain agricultural products and that can be traded in short circuits or even receiving a regional identity seal. Thus, through the product and the relationship built with the markets, the farmer reconnects the environment to his agricultural activity. Each of these possible identity conformations - which are not incompatible with one another - presupposes social spaces of negotiation and adjustment in relation to specific demands.

4 THE DYNAMICS OF RESOURCE REORDERING: FARMERS AND THEIR LIAISONS ON THE NORTH COAST OF RIO GRANDE DO SUL, BRAZIL

In the North Coast of the State of Rio Grande do Sul, Brazil, situations regarding socioeconomic uncertainties were expressed due to the opportunities for commercialization of products from family farming are concentrated in the coastal municipalities of the region, which present an expressive flow of tourists in the summer, and in the metropolitan region of Porto Alegre, where is the Supply Center of Rio Grande do Sul (CEASA/RS).

In the coastal municipalities, the deliveries of these products are relevant in the commercial establishments located along the roads and even the sales at home. However, these marketing forms are restricted to the summer season, since tourists increase local consumption. However, the commercialization for CEASA/RS is even more significant due to the high quantity of products demanded in continuous flow. Nevertheless, for most of these farmers, commercialization at CEASA/RS depends on intermediaries who transport production to the points of sale and retain most of the profit made on sales.

Due to the uncertainty on their product destination and with technical support from whom, a collective of 27 family farmers from three municipalities in the region created in September 2006 the Mixed Cooperative of Family Farmers of Itati, Terra de Areia and Três Forquilhas (COOMAFITT). This collective action was created with the purpose of fostering new spaces for the exchange of information and facilitating access to different trade markets for the products from family farming.

Since then, this group has been strengthening and expanding, currently being composed of 208 farmers from the municipalities covered by the cooperative. The evolution of COOMAFITT is resulting particularly from its access to two public policies between 2008 and 2010 to support the so-called institutional markets: Food Acquisition Programme (Programa de Aquisição de Alimentos - PAA) and the Brazil's National School Lunch Program (Programa Nacional de Alimentação Escolar - PNAE) in 2010. Through the PAA, the purchased food is intended for people in situations of food and nutritional insecurity, those assisted by the social assistance network, and food and nutrition organizations (BRASIL/MDS, 2015). By PNAE, food purchased from family farmers is offered to students in public primary schools (BRASIL/FNDE, 2011).

Most importantly, these marketing channels, especially PNAE, were the most important consumer markets for the production sale for the current 201 families from cooperative farmers. It is worth noting that the scope of these initiatives is mediated by a variety of actors who act as animators and facilitators of rural development construction processes. This mediation is carried out more regularly and intensely by EMATER/ASCAR - RS and by two Non-Governmental Organizations (NGO), Ação Nascente Maquiné (ANAMA)[6] and the Ecological Center[7]. The advisory actions of these organizations have shown to be significantly important to the paradigm changes of the region's family farming.

This mediation facilitated for cooperative managers to get in touch with other collective arrangements of family

[6]Founded in 1997, ANAMA concentrates its research and extension work in the municipality of Maquiné, RS, Brazil, and its surroundings. The NGO seeks to mediate between local reality and other institutional instances related to research, extension, community action, organized social movements and formulation of public policies, having as a guiding line the environmental issue allied to the valorization of cultural diversity. To this end, it counts on the partnership of different groups and local institutions, besides with financing mainly from the Federal Government (ANAMA, 2015).

[7]Created in 1985 in the municipality of Ipê, in the Serrana region of Rio Grande do Sul, the NGO arose with the aim of developing organic farming through projects and technical assistance together with families from ecological farmers. Currently, it develops projects financed by the Federal Government and international institutions, such as KFW, the German development bank, in two distinct regions of Rio Grande do Sul: the Serra and the North Coast (CENTRO ECOLÓGICO, 2010).

farmers in order to enable the distribution of their products at different points of delivery. Therefore, through partnerships, especially with the Cooperative of Consumption and Commercialization of Small Rural Producers of the North Coast[8], the members of COOMAFITT have little by little built relationships that extend beyond the objectives of solving their logistics problems.

The contact with this collective action that, as well as COOMAFITT, also arose due to the need to overcome economic uncertainties of family farmers, favored the construction of ties among the members from different cooperatives, which resulted in meetings and technical visits among them. The exchange of technical and administrative information and the building of ties of trust favored by these moments made the COOMAFITT farmers to understand the importance of establishing alliances with other partners linked to the world of family farming.

In the North Coast, this knowledge interaction provided improvement for COOMAFITT partners on their agricultural practices and the gain in scale to meet the demand of the Conceição Hospital Group in the city of Porto Alegre[9] and the restaurant of the Federal University of Santa Maria, through the institutional purchasing modality of the PAA. Besides these marketing channels, the cooperative provides food for three municipalities in the North Coast through the simultaneous donation of the PAA and for 15 other municipalities via PNAE.

Something similar happened with COOPVIVA, which currently comprises 53 members and started to supply products for the public sector of the municipality of São Leopoldo through the simultaneous donation of the PAA, and the Food Bank (note) of Porto Alegre. Moreover, public organizations in nine municipalities purchased food from their members through the PNAE. According to surveys conducted by the administrative sectors from both Cooperatives, their actions together currently benefit more than 65 thousand people via PAA and around 350 thousand by the PNAE.

The favorable results with the access to these public policies allowed the technical-ecological uncertainties, mainly regarding the change of production system from the conventional to the ecological[10], were minimized for the members from both cooperatives. Since 2010, an informal group that gathered around six families of ecological farmers from the municipalities of Osório, Maquiné, Terra de Areia, Três Forquilhas and Itati, was supported and assisted by COOMAFITT in the search for new farmers interested in the conversion to ecologically based farming. With the support of rural extensionist agents of EMATER from these municipalities, the Cooperative invested in field, meetings and technical visits with its partners, environmental education work in schools of the region and, as a form of dissemination, participation in seminars, fairs and regional events. All these activities have turned to the importance of implementing a differentiated agriculture, respectful to the environment and valuing local knowledge, without losing sight of income generation for family farmers.

The group of ecological farmers grew and involved farmers, technicians and consumers in their transformation, first in an association and later in a participative conformity assessment body (Organismo Participativo de Avaliação da Conformidade - OPAC), the OPAC Litoral Norte. This body is accredited by the Ministry of agriculture, livestock and food supply (MAPA) and has the autonomy, guided by the Organic Law[11], to certify the organic production[12] of the group. The successful experiences resulted from this process joined some families from the municipalities of Dom Pedro de Alcântara and Torres to this collective action. The initial set consisting of six members became a collective action of 22 families, from which currently 12 have certified products. From these 12 families, seven are linked to COOMAFITT and two to COOPVIVA, and all provide their certified products to the institutional market.

[8]With headquarter in the municipality of Osório and constituted in 2010 by family farmers, COOPVIVA is directly advised by the extensionist agents of the EMATER offices located in the surrounding municipalities. Besides the host municipality, the cooperative covers five other municipalities: Maquiné, Caraá, Rolante, Santo Antônio da Patrulha, and Terra de Areia.

[9]The Conceição Hospital Group (Grupo Hospitalar Conceição - GHC) is composed by the hospitals Conceição, Criança Conceição, Cristo Redentor, and Fêmina, as well as a Emergency Care Unit, 12 health clinics of the Community Health Service, three psychosocial care centers and one Center for Technological Education and Health Research. Linked to the Ministry of Health, this structure forms the largest public network of hospitals in the South of the country, attending 100% through the National Health System (GRUPO HOSPITALAR CONCEIÇÃO, 2016).

[10]Through technological adaptations that allow the sharing of local and introduced techniques, this production system differs from the conventional agriculture model because it does not make use of agrochemicals and is not dependent on nonrenewable natural resources. Practices linked to such a system range from respect for animal creations and concern not to generate waste, reusing as much material as possible from their activities, until the participation of farmers in collective actions.

[11]Article 2 of the Federal Law 10,831 provides as organic certification the act by which an accredited conformity assessment body gives written assurance that a clearly identified production or process has been methodically evaluated and is in conformity with the current organic production standards (BRASIL, 2007).

[12]Food of plant or animal origin produced without the use of synthetic fertilizers, pesticides and transgenic. The cultural practices that base the production of these foods are aimed at establishing the ecological balance of the agricultural system (MAPA, 2015).

This contact among organizations was so promising that the president of OPAC Litoral Norte, in 2013, became vice president of COOMAFITT, further strengthening relations among organizations.

By joining for disagreeing with the certification of organic products operated by commercial certifiers and opting for a differentiated form of access to the organic seal for their products, these farmers reinforce participatory certification. It is an alternative institutionality contrary to the conventional model of certification by auditing performed by private companies. This situation reiterates the importance of articulating these collective actions so that significant transformations occur in the conventional form of agricultural production (LONG; PLOEG, 1994).

The operation in the institutional market, besides opening spaces for commercialization, encouraged the production of differentiated foods and brought farmers closer to consumers. In the specific case of PNAE, farmers started to relate and negotiate directly with nutritionists and directors of municipal schools that receive their food. This proximity allowed Cooperatives not only understanding the demand for food in schools, but also to offer new products to compose school meals. For instance, in view of the need for baked goods in the institutional market, COOMAFITT decided to expand its network of partnerships.

Thus, the demand for these foods came to be attended by the Association of Women Farmers for Community Development of Três Forquilhas (AMADECOM). This collective action of women farmers linked to a rural family agro-industry[13] of baked goods and native fruit pulp is accompanied by the NGO Centro Ecológico. The search for overcoming economic uncertainties, but especially of socio-political nature, allowed maintaining the collective identity of working women in the countryside.

Associated to COOMAFITT, the farmers of AMADECOM started delivering bread in 2012. The expansion of the supply of local products outside the North Coast of Rio Grande do Sul highlighted the importance of local raw materials for these families. As the main ingredient in the preparation of bread (wheat flour) is not cultivated in the region, the cassava, pumpkin and even pulp of juçara palm fruits are now used as a differentiated raw material and of local origin[14].

The connections among these collective actions also enabled the associates of COOMAFITT and OPAC Litoral Norte together with the City Hall of Capão da Canoa and the local EMATER, where the "Prove Capão" Fair was created at the end of 2011, a permanent space for family farming products. Thus, besides the institutional market, the organization has opened doors to the short marketing chains, which differ from the traditional market due to the proximity between producers and consumers. The "Prove Capão" Fair received the support of a parliamentary amendment and is currently held every Saturday in the municipality of Capão da Canoa, involving approximately 60 merchants that gradually see their incomes increase.

5 FINAL CONSIDERATIONS: THE CONFIGURATION OF AN ORGANIZATIONAL INNOVATION IN THE FIELD

The foundations of the articulation of these family farmers are based not only on economic aspects, but also on the social, political and institutional dimensions, in which social actors played a prominent role in the ongoing transformation. The interrelationship of agencies enabled the search for new forms of market access, the emergence of new production and organizational processes, and the definition of alternative institutions. These cooperation networks and their varied collective actions represent an emerging novelty.

The main reasons that lead us to consider the construction of these links between COOMAFITT, COOPVIVA, OPAC Litoral Norte and AMADECOM as a novelty are primarily because the creation of these networks has triggered a new relationship dynamic with the society. The production of food by family farmers in the institutional market and in short-chain markets implies a more direct contact in the marketing between farmer and consumer.

Secondly, this integration of social actors radiates, beyond the North Coast of Rio Grande do Sul, the idea and practice of a new relationship between society and nature, mainly through ecologically based agriculture developed by an increasing number of farmers in the region. A third reason refers to the fact that the social actors organized in

[13]Rural family agro-industry is understood as the form of organization in which the family produces, processes and/or transforms part of its agricultural and/or livestock production, aiming primarily its commercialization. This activity differs from food processing and raw material for self-consumption. While processing for self-consumption usually occurs in the kitchen of the farmer family, the family agro-industrialization takes place in a specific physical space, constituting a new socioeconomic enterprise (ESTEVAM; MIOR, 2014).

[14]The juçara palm (*Euterpe edulis* - Arecaceae) is a species originated from the Atlantic Forest, which occurs from the state of Rio Grande do Sul to Bahia. Besides the palm heart extracted from the inside of the petiole of its leaves, it produces a great quantity of fruits that, when ripe, has its pulp used for elaboration of varied dishes, from juices and ice creams to breads, pastas and sauces.

these networks amplify processes of collective learning, either because the action facilitates actions of involved social mediators or because the dynamization of links increases the possibilities of exchanging a relevant 'know-how', breaking the isolation of many similar ongoing initiatives.

By identifying the limitations of the modernizing development model of agriculture as a problem, these farmers articulate themselves in the reduction of uncertainties and concurrently the meeting of strategies for the valorization of local resources. For this purpose, they perform observations and consecutive comparisons between the sociotechnical systems they had hitherto as references and their new strategies. After such reflections, a conciliation diagnosis is elaborated and the decisions are made about the ways that shall base the construction of new initiatives.

As the farmers increasingly approach the working logic with ecologically based agriculture, they are seek to adapt and improve their 'old' techniques and hence accumulate knowledge about localized forms of work, contributing to reconstruction of abilities that were in disuse or that were limited to the individual domestic scope. A kind of 'retro-innovation' can be recognized in the rescue of this knowledge, in its extensions and modifications, transfers to neighbors and work group members (STUIVER, 2006).

Retro-innovation is viewed as a transformative potential asset. Although based on networks of local actors, it changes the global-local dialectic through the new forms of established relationship. For instance, it depends on farmers who have global experiences, but who keep applying their ancestral experiences. These farmers are understood as key players by actively developing relevant concepts and practices that were forgotten, reintegrating agriculture into rural development (STUIVER, 2006).

In the North Coast of Rio Grande do Sul, these experiences of agriculture reconstruction as a social process, which are set in motion by the farmers involved in the different identified collective actions, are directly linked to the confrontation of the adversities arising from the advances of modern agriculture, and uncertainties in the economic, technical-ecological and sociopolitical fields. The option to recover from the past and adapt to the present several technical and productive forms of energy and capital saving have paved the way for the consolidation of new development forms, which assure an economic return to farmers and the maintenance of their identity as family farmers.

Although many of these initiatives were already performed prior to the creation of these cooperation networks, they have undergone improvements resulting from the mix of notions and experiences among social actors. Such initiatives include the use of shading[15] in crops; the rotation of planted species in order not to deplete soil nutrients; the use of companion plants[16] to optimize cultivation areas and plant quality; practices as the syrup preparation to control pests and diseases; organic compounds for the enrichment of soil fertility and biofertilizers[17]; and even the implementation of agroforestry systems, which combine tree, fruit and timber species with agricultural crops and/or animal husbandry.

In the empirical analysis of the research, the transformation of local productive practices enables the reflection and shared search by social actors for constant improvements in their work systems in agriculture. In these processes, permeated by experience exchanges and creation of links, new border transpositions are the possible for the farmers of the region. According to Oostindie and Broekhuizen (2008), these border transpositions can be compared to an 'immersion in the unknown'. In this immersion, new liaisons are generated and therefore new knowledges are needed. This applies not only to the creation of new activities and new networks that add income and employment opportunities in rural areas, but also to the construction of new responses to the changing needs and expectations of society.

Thus, these forms of border transposition are constantly created, recreated and adapted throughout the farmers' lives. The initiative of these actors in the operationalization of such connections is evidenced by the agency effectiveness, carried out through built social relationships, surpassing the individual capacity borders and establishing collective commitments (LONG, 2001).

The organizational transformations that are ongoing in the lives of the family farmers involved in the analyzed novelties can be identified as adaptations and reactions that, as part of their daily life, favor initiatives configured as deviations from the dominant sociotechnical regime. The regime, deeply rooted in the principles and processes of the agriculture modernization, is part of a development pattern understood as purely economic and technical.

[15]Interplanting of trees, especially those from the legume family, with some permanent crops. This practice aims to protect the commercial cultivation from the sunlight and hence to improve soil fertility.

[16]Companion plants are grown together to generate mutual benefits, stimulating their development and improving soil quality. Such 'companionship' occurs in a variety of ways, such as the shading of species and the exchange and release of nutrients and chemical compounds, such as stimulating hormones and repellents.

[17]The biofertilizer is a by-product generated by the biodigestion process of organic compounds that generally have a highnitrogen concentration and low carbon concentration. The use of biofertilizers helps to maintain the nutritional balance of plants, giving them greaterdefenseagainst pests and diseases without soil disruption, as occurs with the use of readily soluble fertilizers.

Such deviations have led to new and alternative development processes in rural areas, in which the valuation of local knowledge and socio-environmental diversity is evidenced, generating re-arrangements in social and work relationships and the interaction between different knowledge, constituting learning processes, revitalizing reciprocity and trust links, as well as providing new meaning formations and reinvention of practices and techniques.

As we tried to demonstrate, it is possible to understand that access to PAA and PNAE, as well as the incentive of social mediation, enabled the structuring of articulations among collective actions, which provide a new dynamics of rural development in the region. The evolution of the COOMAFITT experience has influenced network members to challenge themselves and to broaden and diversify their production, to incorporate new family farmers, including ecologists and women, besides building new partnerships.

This expansion has generated more territorial processes of rural development and adapted to the local specificities, with incorporation of the environmental dimension. It is important to note that the leadership of the actors involved in the emergence of this novelty is related to the breaking of the rules established by the modernizing agricultural pattern and is inserted in broader processes occurring at a level of social action that extrapolates the local scale.

The experience accumulated by the different collective actions, now articulated in this cooperation network and in the concrete initiatives of access to the institutional market, is a fundamental ingredient so that government purchases can be consolidated as a tool capable of potentiating sustainable forms of food production and consumption in the region. These new forms of market and relationship with the government, which are only beginning to be undertaken, provoke new developments, opening spaces for other emergencies, such as the development of family agro-industries, which arise as the establishment of autonomous organizational forms of work, capable of adding value to primary production. Additionally, the OPAC, groups consolidated by reciprocity ties, which motivate several families to start, develop and remain in the practice of ecologically based agriculture.

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A COMPARATIVE STUDY ON DIFFERENT STATISTICAL MODELS FOR CALCULATING THE OPTIMAL HEDGE RATIO IN THE LIVE CATTLE MARKET

Um Estudo Comparativo de Diferentes Modelos Estatísticos para cálculo da Razão Ótima de Hedge no Mercado de Boi Gordo

ABSTRACT

Brazilian agribusiness has stood out in recent years for its efficiency and productivity growth, based on technology, planning, management of results, and continuous improvement of performance. In the live cattle market, the price oscillations show themselves as a risk that the producer has to minimize in order to ensure the success of his business. In this scenario, the futures market has been translated into an important hedging instrument, however, a confronting challenge is the identification of the production ratio that must be protected. Thus, this article aims to statistically compare the performance of six models for the calculation of the optimal hedge ratio in the Brazilian live cattle futures market: Ordinary least squares, BEKK, DCC by Tse and Tsui (2002), DCC by Engle and Sheppard (2001), time-varying beta correlations, and unconditional beta. The ratios were estimated for the log-returns of the daily and monthly price series of spot and futures live cattle, comprising the period from 10/2/2000 to 19/8/2014. It was noted that for the daily series, the contractual changes generate intertemporal breaks, resulting in the increased variance of the futures log-returns and the low optimal hedge ratio. For monthly series, it is concluded that the BEKK, followed by the unconditional beta are the best models when it comes to reduction of variance and maximization of the Sharpe ratio.

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RESUMO

O agronegócio brasileiro tem se destacado nos últimos anos por sua eficiência e pelo crescimento da produtividade, fundamentados em tecnologia, planejamento, gestão dos resultados e melhoria contínua de desempenho. No mercado do boi gordo, as oscilações apresentadas nos preços se apresentam como um risco que o produtor tem que minimizar para garantir o sucesso do seu negócio. Nesse cenário o mercado futuro tem se traduzido em um importante instrumento de *hedge*, mas um desafio com que se defronta é a identificação da proporção da produção que deve ser protegida. Assim, este artigo tem como objetivo comparar estatisticamente a performance (eficiência) de seis modelos para o cálculo da razão ótima de *hedge* no mercado Futuro de Boi Gordo brasileiro: Mínimos Quadrados Ordinários, BEKK, DCC de Tse e Tsui (2002), DCC de Engle e Sheppard (2001), Beta de Correlações Variantes no Tempo e o Beta Incondicional. As razões foram estimadas para os log-retornos das séries de preços diárias e mensais de boi gordo *spot* e futuro, compreendendo o período de 02/10/2000 a 19/08/2014. Constatou-se que para as séries diárias, as mudanças contratuais geram quebras intertemporais, fazendo com que a variância dos log-retornos futuros aumente e a razão ótima de *hedge* seja baixa. Para séries mensais, conclui-se que o BEKK, seguido do Beta Incondicional são os melhores modelos quando se trata de redução de variância e maximização do Índice de Sharpe.

Palavras-chave: *Hedge,* Razão Ótima de *Hedge*, Boi Gordo, Mercado Futuro, BEKK, DCC, Beta.

Keywords: Hedge*,* Optimal Hedge Ratio, Live Cattle, Futures Market, BEKK, DCC, Beta.

1 INTRODUCTION

In recent years, Brazilian agribusiness has performed well above other sectors of the economy due to efficiency and productivity growth. It should be noted that this was only possible due to investments in research and technology, planning, management of results and performance improvement (DA COSTA, GUILHOTO and IMORI 2013).

Based on the perspective that economic activity is speculative in nature, as well as in almost all segments of agribusiness (commodities), price fluctuations, from the beginning to the end of production, represent one of the risks for that activities. A situation typical of the live cattle market, where the guarantee of a certain price that covers production costs and guarantees profit is a challenge that can be faced with the use of hedging instruments available in the financial market, such as futures contract. In this scenario, BM&FBovespa's futures market plays an important role for the agents involved with commodities and for the economy.

Futures contracts can be understood as standardized contracts for buy and sell a particular commodity, in which all characteristics (quantity, quality, term, form and place of delivery, price and position fluctuation limits, etc.) are fixed a *priori* and whose negotiation does not necessarily imply the physical delivery of the traded commodity. They basically represent commitments to buy and sell a particular commodity in the future, whose settlement may be financial ($) or through physical delivery of the traded commodity.

Futures contracts therefore provide opportunities for profit or at least margins that may result in the coverage of production costs, reducing the risk of price in the physical market, which in most economic activities involves a large number of speculative elements, making market behavior unknown (HARDAKER *et al.,* 2004). Among the benefits of using futures contract, Montezano (1987) emphasizes the protection against price risk, reduction of transaction costs, increased competitiveness in the physical market (due to greater price visibility), the possibility of financing operations, and the efficient allocation of resources.

The live cattle market plays an important role within Brazilian agribusiness. Brazil has the world's largest commercial herd with more than 200 million head of cattle and the second largest cattle herd worldwide (behind only India), according to the United States Department of Agriculture (USDA) (2014). According to the Ministry of Agriculture, Brazil has been the leader in the world's largest beef exporter since 2004, with approximately 20% of all meat traded on the international market and sales to more than 180 countries. Furthermore, statistics point to a growing market due to the favorable climate and the potential for increasing agricultural areas in the country. Such factors, combined with a wide use of technology, have resulted in improvements in fertility and productivity, explaining the economic potential of the sector (IBGE, 2008).

Regarding the Futures live cattle market, Rochelle (1997) points out that because it is a non-stock commodity, the theoretical framework is still underdeveloped, since live animals do not have the same stability for the spot and futures prices, including some reasons for this assertion, such as constant production and distribution, non-existence of a fixed supply, and the possibility of storage. In this direction, Amorim Filho (2015) adds that, as well as in other agricultural markets, livestock agents are prone to high price volatility due to two factors: the time gap between the buy of feeder cattle and sell of live cattle, price forecast difficult or even impractical, which impute an inherent risk to the activity.

These factors increase the variability of prices (volatility), determined by the impossibility of fixing the supply, creating an even greater need of anticipation or price insurance for future date, since this mechanism is driven essentially by information available in the physical market (spot), which makes that the information increases the price instability of non-storable commodities (OLIVEIRA NETO and FIGUEIREDO 2008).

Due to these characteristics, studies aimed at quantifying the risk relationships inherent to the live cattle market are relevant in order to identify strategies to manage this risk, since the efficiency in its management is opposite to the implementation of efficient strategies due to their impacts and their non-static nature.

If on one hand futures contracts are widely used as a hedging strategy, on the other, it must be considered that, for this strategy to be efficient, it is necessary to estimate the appropriate production ratio that each trader should destine to futures contracts, i.e., the optimal hedge ratio.

In this context, the guiding question for this research is: *what tools can be used in order to obtain efficient market risk management strategies?* To answer this question, we aim to statistically compare the performance of six models for the calculation of the optimal hedge ratio in the Brazilian live cattle futures market: Ordinary least squares, BEKK, DCC by Tse and Tsui (2002), DCC by Engle and Sheppard (2001), time-varying beta correlations, and unconditional beta. In general terms, based on recent data from the Brazilian live cattle market, the contribution of this article is

to identify models that may be considered more statistically adequate for the calculation of the optimal hedge ratio, thus providing a risk management strategy for this market.

Following this introductory section, section two presents the literature review on the evolution of hedging theory. In the third one, the methodology is presented, in which the models for the determination of hedge ratio are described. The fourth section presents the results of each model for daily and monthly data and a comparative analysis on the efficiency of each one. Finally, the conclusion is presented, followed by the consulted references.

2 LITERATURE REVIEW

2.1 Risk and Price Risk

It can be said that the study and risk management were strongly driven by the seminal study of Markowitz (1952), which pointed out that the selection of portfolios should be made based on the return maximization and risk minimization, represented by the variance of returns, being used until present days as one of the main measures of risk.

The term risk is a multidimensional construct, but involves the idea of getting undesired or under-expected results in almost all its nuances. According to Jorion (2007), it would be the volatility of unexpected results. From a more economic perspective, although in the same direction, Morgan (1996) associates risk with the uncertainty level of future returns and describes market risk as uncertainties arising from changes in observable conditions, such as shocks of supply and demand, exchange rate and production costs.

According to Duarte Júnior (1996), risk management involves three basic concepts: return, uncertainty, and risk. There are uncertainties associated with the return that will be obtained and, when it is possible to measure this uncertainty numerically, it is called risk. Therefore, risk can be characterized as how much an event is uncertain, being the variation positive or negative around the expected return.

As noted, volatility is a term commonly used in finance to refer to the variation of an asset's returns. It can be calculated in a number of ways, and variance is one of the main used forms since the study of Markowitz (1952).

Regarding the price risk, Hull (2011) highlights that exchanges occur in a single instant in the spot market at a price adjusted by supply and demand at the moment, usually with immediate payment and delivery of the commodity. In this scenario, the supply seasonality would be on the risk of price fluctuations (price risk).

According to Pindyck and Rubinfeld (2006), in the context of commercialization, the producer would be the weakest link in the industrial chain, having upstream (the input industry) and downstream (the food processing industry), both with oligopolistic and oligopsonic characteristics, respectively, with power over the price formation, with restrictions only by the limits imposed by the competitors themselves.

Regarding the agricultural market, as well as occurs in others, the sector agents are prone to high price volatility due to two factors: the time gap between the buy of feeder cattle and the sell of live cattle, difficult price forecasts or even impracticable, which impute an inherent risk to the activity (AMORIM FILHO, 2015). In this context, the formation process, and hence the price risk, is a risk to be analyzed in an efficient negotiation strategy, where the producer must seek tools to assist in their minimization or mitigation.

As pointed out by Bhaduri and Durai (2008), the effective use of futures contracts in hedging strategies has become the focus of the debates to find the optimal hedge ratio in the empirical literature on the theme due to the advances in the trading volumes performed in the futures markets in the last, signaling the increased concern for the traders on the management of risks involved in the agricultural activity.

2.2 Hedge and Optimal Hedge Ratio

Hedging strategy or simply hedge implies to maintain positions in both spot and futures markets in order to obtain protection against possible losses arising from adverse fluctuations in the commodity prices (GOMES, 1987). It is a key instrument for traders who do not wish to be exposed to future price changes in the futures of a particular market. In the context of the live cattle market, the farmer can hedge his selling price in the futures if he imagines that the live cattle price will drop. Likewise, the refrigerator can hedge against its purchase price in the futures if it imagines that the price will drop.

It can be said that the foundations of the theoretical framework on hedge were introduced by Keynes (1930) and Hicks (1939), for which hedging meant reducing risk exposure of some economic activity. In the theoretical evolution of the theme, Working (1953) added the idea of using hedge to maximize the profit of commodity producers and processors. However, one of the main theoretical contributions with practical application was given currently by Stein (1961) and Johnson (1960), who used Markowitz's portfolio theory (1952) to maximize the hedger's expected utility, considering a portfolio composed by positions both in spot and in futures market. Specifically, Stein (1961)

developed a simple geometric technique, in which it is possible to simultaneously determine the spot and futures prices in the commodity market. With this analysis, it is possible to identify if variations in the spot and futures prices are determined by excess supply in the production chain or changes in price expectations.

In the aftermath, Ederington (1979) elaborated the first derivation of the optimal hedge ratio given by the covariance ratio of the spot and futures log-returns by the futures return variance, concluding that even those indifferent to the risk should hedge only a portion of the portfolio.

According to Guimarães (2005), expecting that future prices follow the martingale process (stochastic process without drift), the optimal hedge ratio is those that minimizes risk, being called optimal because it is determined from the imposition that the portfolio (formed by the spot and futures positions) variance is minimal (HULL, 2011). In operational terms, it can be obtained by the ratio resulting from the division of covariance between spot and futures prices by the variance of futures prices (MYERS and THOMPSON, 1989).

When determining the hedge ratio (magnitude or size of the futures market position compared to the spot position), the differences (absolute or relative) in price changes in the spot and futures markets act as complicating factors in the setting up of hedging strategies, making it difficult to determine this magnitude. Thereby, the major issue for the hedger is to determine a ratio of how much to buy or sell in the futures market for each unit, called the optimal hedge ratio.

Analyzing prices from live cattle futures contracts, Myers and Thompson (1989) showed that it is theoretically and empirically inappropriate to use the slope of line from simple regression coefficient of the spot price on futures prices to estimate the optimal hedge ratio, since it is time-constrained, whereas the simple linear regression coefficient is not.

Myers (1991) analyzed models to estimate the optimal hedge ratio for the wheat futures market and found that the GARCH model shows hedge with better efficiency, but with improvement was marginal in relation to traditional models.

Gray (1995) developed a model to estimate the optimal hedge ratio through a univariate modeling of volatility from which several studies attempted to determine it from the multivariate model of volatility.

The study of Bera, Garcia and Roh (1998) showed that the MQO estimators are not the most appropriate for determining the optimal hedge ratio, since they infer that this ratio is constant over time and alternatively tested bivariate GARCH models to be able to deal with the heteroskedasticity problem of residues.

Lee and Yoder (2005) conducted an extension to the study of Gray's (1995) general regime-switching univariate, applying a bivariate Markov-switching regime (BEKK-GARCH model) for the maize and nickel markets in the United States. They concluded that BEKK model with regime switching is more efficient for hedging strategies in relation to BEKK without regime switching.

Alizadeh and Nomikos (2004) also used the Markov-switching regime approach to calculate the optimal hedge ratio to determine the hedge ratio of minimum time variance. They tested the hedging effectiveness of oil futures contracts using univariate and bivariate regime switching models with generalized autoregressive conditional heteroskedasticity (GARCH) error structure. They concluded that regime switching in GARCH models reduces volatility and increases prediction efficiency. The hedging ratios of Markov-switching regime models are superior to others in relation to portfolio risk reduction in the oil market, and the two-regime model better describes the dynamic relationship between spot and futures prices.

In general, researchers, such as Ederington (1979), Rolfo (1980), Anderson and Danthine (1981), Brown (1985), Myers and Thompson (1989) among others followed the idea of deriving the optimal hedge ratio from concept of profit maximization, in the sense that doing so within the average-variance space is perfectly plausible, given the concurrence of the decision for spot and forward positions.

2.3 Review of the National Empirical Literature on Optimal Hedge Ratio

Chiodi *et al.* (2005) compare the effectiveness of the Brazilian soybean market in Cascavel (PR) and Sorriso (MT) in the BM&FBOVESPA Securities, Commodities and Futures Exchange (BM&F) and the Chicago Board of Trade (CBOT), estimating the equation of daily price variations in the spot market as a function of the daily variations in prices on the futures market using ordinary least squares (OLS). They found that BM&F's futures contract is more efficient than CBOT's in some months of the year in Cascavel for hedging, but in Sorriso, CBOT's futures contract is more efficient for hedging during the studied period.

Guimarães (2005) investigated whether the observations made by Myers and Thompson (1989) were valid for the Brazilian live cattle market and the effect on the estimation of daily and weekly series on the optimal hedge ratio. It was found that the use of weekly series is more appropriate for determination of the optimal hedge ratio,

since it reduces the serial autocorrelation, and that regressions with price changes result in estimates of hedge ratio close to those obtained with the general model and that these reasons decrease with the increase of the hedge horizon.

Bitencourt, Silva and Sáfadi (2006) used two methods for calculating the optimal hedge ratio in the Brazilian live cattle market: 1. the conventional (simple linear regression), assuming that the covariance matrix is constant; 2. The VaR model for the average and GARCH BEKK for the variance, which considers the temporal dependence of the matrix. The results indicate that the optimal hedge ratio is not constant over time, suggesting that the use of models that consider the temporal dependence of the series is more realistic.

Oliveira Neto and Figueiredo (2008) analyzed the live cattle hedging transactions in the futures market of the BM&F Goiás and found that the Myers and Thompson (1989) model was the most efficient, with a risk decrease of approximately 90%.

Zilli *et al.* (2008) estimated the optimal hedge ratio using the error correction mechanism (ECM) for daily, weekly, and monthly data and found that the optimal hedge ratio is very sensitive to the data frequency and that it presents better indexes when ECM is inserted into the estimation process, confirming that non-stationary series can provide erroneous estimates for the optimal hedge ratio when the cointegration relationships among the variables are not considered.

Cruz and Lima (2009) calculated the optimal hedge ratio using the error correction model of Engle and Granger (1987) and the general model of Myers and Thompson (1989) for the live cattle market in the state of São Paulo. The results showed that there is cointegration between the spot and the futures price series and there is bidirectional causality between them. For the daily series, the hedger should trade about 30% in the futures market in relation to its spot position and 55% of its spot position for weekly series. The variance of hedger income may be reduced by 52% and 78% for the use of daily and weekly series, respectively.

Aiming to identify the best method for calculating the optimal hedge ratio for the Brazilian live cattle market, as well as the differential of hedge ratios between the harvest and the off-season, besides finding out the reason why the estimates of optimal hedge ratios in the national literature are smaller than those in the international literature, Lazzarini (2010) concluded that the DCC models are the best of all when the objective is to reduce variance and increase the Sharpe ratio. The hedge ratio in the off-season should not be higher than in the harvest season. Moreover, the break in intertemporal expectation with change of contracts increases the variance on the futures log-returns series, decreasing the hedge ratio.

Rodrigues and Alves (2010) analyzed the research evolution on effectiveness and optimal hedge ratio and found evolutionary patterns in methodological procedures, despite the lack of methodological consensus in the estimates.

Souza, Cunha and Wander (2012) estimated the optimal hedge ratio and its effectiveness for the live cattle market in Goiás and found that the best adjustment model (in the first difference with obsolete terms in the BM&F's futures market price series) showed the optimal hedge ratio of 69% and its effectiveness value of 80%.

Amorim Neto (2015) evaluated futures market efficiency as a way of mitigating the risk associated with live cattle prices and found that the use of the futures contract decreases the variance of returns in the studied period (2002 to 2013) and the coefficient of variation in relation to strategies that did not use hedge.

3 METHODOLOGY

3.1 Research Classification

Regarding the type, this research is characterized as descriptive in relation to its objectives, since it seeks to describe the price behavior in the market, but not necessarily to verify the cause-effect relationship (GIL, 2006). Regarding the approach, this research is characterized as quantitative, since numerical data were used in its achievement and in the obtained results. Quantitative analysis is present in the collection and processing of data, estimation of econometric models, and analysis of results using statistical techniques (CRESWELL, 2007). The research may also be qualified as *ex-post-facto* regarding its procedures, since preexisting secondary data were used (GIL, 2006). In empirical terms, this article seeks to statistically compare the performance of six models for the calculation of the optimal hedge ratio in the Brazilian live cattle futures market: Ordinary least squares, BEKK, DCC by Tse and Tsui (2002), DCC by Engle and Sheppard (2001), time-varying beta correlations, and unconditional beta.

3.2 Analyzed Data

To calculate the optimal hedge ratio, daily and monthly closing prices were used, comprising the period from 10/2/2000 to 8/19/2014. The spot market price series was obtained from the Esalq/BM&F index and the price series of BM&F live cattle futures market was obtained from Bloomberg. Both quotes are in R$ by arroba.

The models were estimated using the daily and monthly log-returns $\left(ln\left(p_t/p_{t-1}\right)\right)$ of price series and the estimates performed in *OxMetrics* software.

Figure 1 shows the series in level with daily frequency, spot and futures, for the analyzed period.

As shown in Figure 1, both series apparently perform similarly, with few series detachments at certain periods. This shows that the futures contract of live cattle is a good asset to hedge the spot contract. The greater the correlation between both series, the more efficient will be the hedge.

As can be seen in Figure 2, futures log-returns fluctuate more than spot log-returns. This can be explained because contracts expire at the end of each month and begin at the beginning of the following month.

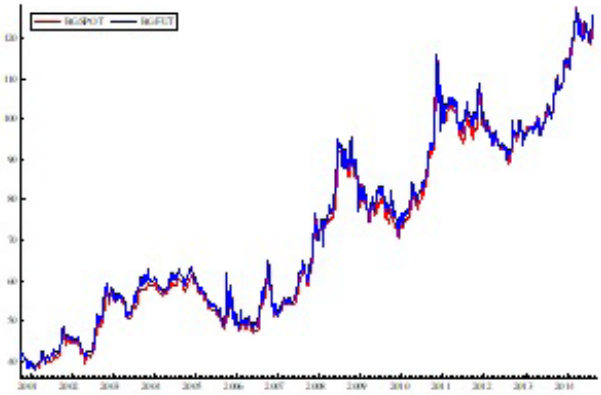

FIGURE 1 – Price for arroba of live cattle spot and futures (daily data)
SOURCE – Elaborated by the authors

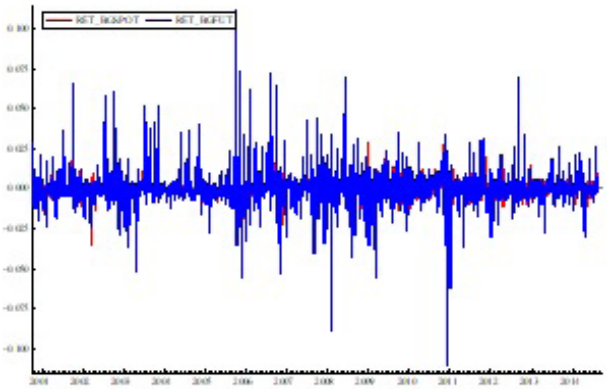

FIGURE 2 – Log-returns for arroba price of live cattle spot and futures (daily data)
SOURCE – Elaborated by the authors

It can be observed in Table 1 that the futures series average is higher than the spot series, as well as the standard deviation (in the futures log-returns, the standard deviation represents twice the spot log-returns). In part, deviations can be explained by contractual change, which leads to more extreme values, hence higher variance. A very high hedge ratio represents a very high risk taken in the futures market. All series, both in level and log-return rejected the null hypothesis of normality in the Jarque-Bera (1980) test and all p-values were zero.

When performing the Augmented Dickey-Fuller (ADF) (DICKEY and FULLER, 1979) unit root test, with no trend and no constant, both for the arroba price series of live cattle spot and futures, the null hypothesis is not rejected that the series have a unit root (p-values of 1,6640 and 1,9143, respectively). The null hypothesis is rejected

TABLE 1 – Descriptive statistics (daily series)

	BG*SPOT*	BGFUT	**RET_BG*SPOT***	RET_BGFUT
Average	71.87	73.03	0.0003258	0.0003325
Median	62.35	63.99	0.0002127	0.000165
Maximum	127.77	127.20	0.028547	0.11182
Minimum	37.7	37.5	-0.035718	-0.11023
Standard deviation	23.41	23.26	0.0046613	0.0091255
Asymmetry	0.4125	0.3710	-0.100114	0.61706
Kurtosis	-1.0346	-1.0774	5.6414	27.4577
Jarque-Bera (*p-value*)	0.0000	0.0000	0.0000	0.0000
Comments	3,412	3,412	3,411	3,411

SOURCE – Elaborated by the authors

to perform the test for the log-returns series (p – valor = 0,000). This means that the level series have unit root and the change of scale to log-return make them stationary.

The ARCH-LM test or the autoregressive conditional heteroskedasticity (ENGLE, 1982) in the series is also performed. The null hypothesis was rejected for both the spot price and live cattle futures price series $X^2(12)$ = 3399.086 and *p-valor* = 0,0000 for spot and X^2 (12) = 3396364 and $p - valor$ = 0,000 for futures prices, as well as for the log-return series X^2 (12) = 464,6553 and $p - valor$ = 0,000 for spot log-returns and X^2 (12) = 22.1566 and $p - valor$ = 0,0358 for futures log-returns, rejecting H_0 the 5% of significance. The result suggests the presence of heteroskedasticity in the residues of all four series.

Figures 3 and 4 present the series at monthly level, spot and futures, and log-returns for the analyzed period.

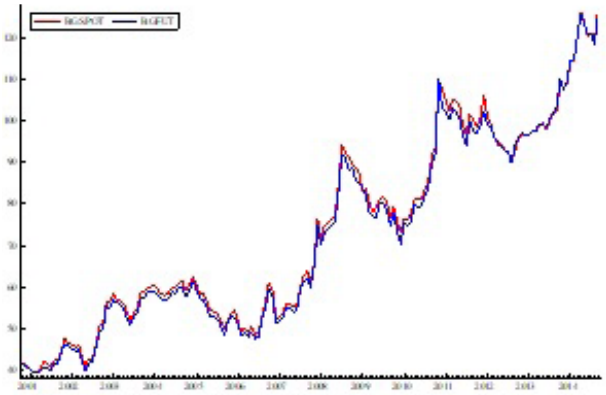

FIGURE 3 – Price for arroba of live cattle spot and futures (monthly data)
SOURCE – Elaborated by the authors

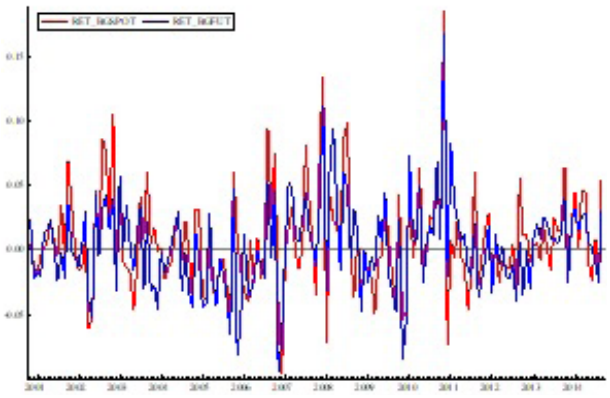

FIGURE 4 – Log-returns for arroba price of live cattle spot and futures (monthly data)
SOURCE – Elaborated by the authors

Observing Figure 3, it can be noted the existence of intervals in the log-return series that occur by the break of expected periodicities. To calculate the log-returns, it was used the log of the difference between the observation of the last business day of the month (that represents the closing) by the first working day of the same month. In addition, the values of the last prices of each month for the series in level were used. It can be noted in Figure 4 that log-returns no longer have such extreme peak values as in the daily data series.

It can be observed in Table 2 that the futures series average becomes lower than the spot series average, as well as the standard deviation that show a value similar to the spot series. The four series keep rejecting normality in the Jarque-Bera test, with p-value equal to zero.

TABLE 2 – Descriptive statistics (monthly series)

	BGSPOT	BGFUT	RET_BGSPOT	RET_BGFUT
Average	73.44	72.34	0.006589	0.00269
Median	64.98	63.62	0.00053	0.003513
Maximum	126.52	125.89	0.185475	0.167924
Minimum	39.1	39.21	-0.096232	-0.09451
Standard deviation	23.59	23.65	0.039734	0.036302
Asymmetry	0.38285	0.420074	0.957898	0.599519
Kurtosis	-1.0855	-1.0466	2.3058	2.2267
Jarque-Bera (*p-value*)	0.0026	0.0022	0.0000	0.0000
Comments	166	166	166	166

SOURCE – Elaborated by the authors

When performing the ADF unit root test both for the arroba price series of live cattle spot and futures, the null hypothesis is not rejected that the series have a unit root (p-values of 0.0872 and 0.1522, respectively). The null hypothesis is rejected to perform the test for the log-returns series (p-value = 0.000). This means that the level series are non-stationary, but they become stationary when removed the log-return from them.

3.3 Models Used to Estimate the Optimal Hedge Ratio

In this section, the standard and regular form for the calculation of the optimal hedge ratio is defined initially. Afterwards, traditional econometric approaches used to estimate the optimal hedge ratio are detailed: GARCH (ENGLE, 1982; BOLLERSLEV, 1986), BEKK (ENGLE and KRONER, 1995), DCC of Tsé and Tsui (2002), DCC of Engle and Sheppard (2001). Furthermore, as an original contribution of this article, two alternative proposals are detailed, which are used to estimate the optimal hedge ratio: Time-varying beta correlations (TSAY, 2013) and the unconditional beta (MERGNER, 2009).

According to Ederington (1979), the optimal hedge ratio should be those that maximizes the hedger's utility, resulting in minimized risk and maximized portfolio returns. Thus, for the live cattle market, the optimal ratio is those that minimizes the variance of the hedge portfolio:

$$Y_t = \Delta BS_t - g\Delta BF_t \quad (1)$$

where:
Y_t is the financial result (in) per arroba;
ΔBS_t is the price variation of live cattle in the spot market;
ΔBF_t is the price variation of live cattle in the futures market;
g is a scalar.

As a result of the non-stationary price series, the hedge ratio is estimated through the log-return variations in the spot and futures markets.

The objective of the hedge is to minimize the variance of the financial result per arroba, as follows:

$$VAR(Y) = \sigma_s^2 + g^2\sigma_f^2 - 2g\sigma_{sf} \quad (2)$$

where:
σ_s^2 is the log-return variance in the spot market;
σ_f^2 is the log-return variance in the futures market;
σ_{sf} is the covariance between log-returns of the spot and futures markets.

By minimizing the variance in relation to , it has:

$$\frac{\Delta VAR(Y)}{\Delta g} = -2\sigma_{sf} + 2\sigma_f^2 g = 0 \quad (3)$$

$$g^* = \frac{\sigma_{sf}}{\sigma_f^2} \quad (4)$$

It can be seen that the optimal hedge ratio is given by the covariance ratio of log-returns in the spot and futures markets by the futures return variance.

It is possible to estimate this ratio exactly as the beta OLS estimator of a simple linear regression model. However, the optimal hedge ratio is time-constrained, whereas the linear coefficient of simple linear regression is not constrained to time. Therefore, time-constrained models are expected to yield better results.

GARCH Model

GARCH model was proposed by Bollerslev (1986). The variance is added and sent to the ARCH model, so that the model becomes more parsimonious and does not have the same estimation problems as the ARCH of Engle (1982).

A GARCH model *(p,q)* can be presented as follows:

$$y_t = h_t\epsilon_t \quad (5)$$

$$h_t = \omega + \sum_{i=1}^{q}\alpha_i y_{t-i}^2 + \sum_{j=1}^{p}\beta_j h_{t-j} \quad (6)$$

Alternatively, the model can be written as:

$$h_t = \omega + \alpha(L)y_t^2 + \beta(L)h_t \quad (7)$$

with

$$\alpha(L) = \alpha_1 L + \ldots \alpha_q L^q \quad (8)$$

$$\beta(L) = \beta_1 L + \ldots \beta_p L^p \quad (9)$$

where,
y_t is the innovation in a process for the conditional average of log-returns*;*
$\epsilon_t \sim iid\ D\ (0,1)$ is a strong white noise;
h_t is the variance of y_t, time-constrained;
ω is a constant and $\alpha(L)$ and $\beta(L)$ are obsolete polynomials of order π and θ, respectively, which define the structured conditional variance.

GARCH is second order stationary, if is outside the unit circle. The order selection occurs according to

Akaine information criteria (AIC) of Akaike (1974) and Bayesian information criteria (BIC), which are represented respectively by:

$$AIC = -L(p)T^{-1} + 2pT^{-1} \quad (10)$$

and

$$BIC = -L(p)T^{-1} + pT^{-1}\log T \quad (11)$$

where:
T is the number of observations available in the series;
p is the number of parameters to be estimated;
L (p) is the log-likelihood (increasing function of).

The lower the criterion, the better the model, because these criteria are transformations that impose a signal penalty contrary to log-likelihood by the number of estimated parameters. Two other alternative criteria could be used: Hannan-Quinn Information Criterion (HQC), proposed by Hannan and Quinn (1979) and the Shibata Information Criterion (SIC), whose equations are:

$$HCQ = L(p)T^{-1} + 2pT^{-1}\log\log T \quad (12)$$

$$SIC = -L(p)T^{-1} + \log(T+2p) - \log T \quad (13)$$

In terms of estimation, in most practical cases, GARCH model (1,1) meets the modeling needs, i.e.:

$$y_t = h_t^{\frac{1}{2}}\epsilon_t \quad (14)$$

$$h_t = \omega + \alpha y_{(t-1)}^2 + \beta h_{(t-1)}, \quad (15)$$

Where, $\omega > 0$, $\alpha > 0$, $\beta > 0$ ensuring that $h_t \geq 0$. By making recursive substitutions of the term h_{t-1}, it is shown the equivalence to an ARCH (∞) model. If $\alpha + \beta < 1$, GARCH process (1,1) can be written as an ARMA (1,1), which will be second order stationary.

An important GARCH characteristic is the excess of kurtosis, even when the distribution of is normal. The kurtosis is given by:

$$K_y = \frac{3E[h_t]^4}{(E[h_t]^2)^2} = \frac{(3[1-(\alpha+\beta)^2])}{(1-(\alpha+\beta)^2 - 2\alpha^2)}. \quad (16)$$

Which is supposed to be higher than 3, since $E[h_t]^4 > (E[h_t]^2)^2$, by the inequality of Jensen, i.e., $1 - (\alpha + \beta)^2 > 1 - (\alpha + \beta)^2 - 2\alpha^2$.

All of GARCH family models are able to deal with volatility clusters. This can be observed by the dynamics of equation (1). A high value of y_{t-1}^2 leads to a high value of h_t, a high value of y_t^2 leads to a high value of h_{t+1}, and so on. Generally, the sum of α(L) and β(L) is close to one, which causes persistence of volatility.

Tests can be performed for linear and non-linear GARCH. In order to detect conditional heteroskedasticity, or ARCH effect in the residues, the ARCH-LM test, proposed by Engle (1982) is performed. The null hypothesis of the test is, in the case of an ARCH (q):

$$H_0 : \alpha_1 = \alpha_2 = \ldots = \alpha_q = 0 \quad (17)$$

Presence of the ARCH effect.

The test follows a distribution , being the significance level.

BEKK Model

The BEKK model of Engle and Kroner (1995) can be represented as follows:

$$\sum_t = A_0 A'_0 + \sum_{i=1}^{m} A_i \left(u_{t-i} u'_{t-i}\right) A'_i + \sum_{j=1}^{n} B_j \sum_{t-j} B'_j \quad (18)$$

where,
A_0 is a lower triangular matrix;
A_i and are unrestricted square matrices. for and for .
u_t is the residue

Thus, the expression represents the model variance. Due to the limited number of observations, both and are equal to 1, $\sum_t$ is positive definite, since $A_0 A'_0$ is positive definite. The model allows dynamic dependence between the volatility series.

However, the model has disadvantages, since many of the estimated parameters are statistically insignificant, causing complications in modeling.

DCC Model - *Dynamic Conditional Correlation*

The dynamic conditional correlation model has the following structure:

$$\sum_t = \Delta_t R_t \Delta_t \quad (19)$$

where,
Δ_t is a diagonal matrix with univariate GARCH;
R_t is a correlation matrix of the standardized residues.

The dynamic correlation models of Tse and Tsui (2002) differ from the DCC of Engle and Sheppard (2001) in the correlation matrix of the standardized residues.

In the case of DCC-TT, the matrix dynamics is represented by:

$$R_t = (1-\gamma_1-\gamma_2)R + \gamma_1\varphi_{t-1} + \gamma_2 R_{t-1}, \quad (20)$$

with,

$$\varphi_{i,jt-1} = \frac{\sum_{m=1}^{M} u_{it-m}u_{jt-m}}{\sqrt[2]{\sum_{m=1}^{M} u_{it-m}^2 \sum_{m=1}^{M} u_{it-m}^2}} \quad (21)$$

where,
γ_1 and γ_2 are non-negative parameters with sum lower than ;
R is an matrix N x N positive definite;
φ_{t-1} is the correlation matrix N x N.

The dynamics of the correlation matrix of the standardized residues for the DCC of Engle and Sheppard is given by:

$$R_t = diag(Q_t)^{\frac{1}{2}} Q_t diag(Q_t)^{\frac{1}{2}} \quad (22)$$

with,

$$Q_t = (1-\alpha-\beta)\bar{Q} + \alpha u_{t-1}u'_{t-1} + \beta Q_{t-1} \quad (23)$$

where,
Q_t is a positive definite N x N matrix;
$\bar{Q}$ is the unconditional variance matrix of (residue);
α and β are positive parameters whose sum is lower than .

Models with Time-varying Correlations and Betas

According to Tsay (2013), another applied strategy can be the use of GARCH to obtain the time-varying correlation between the log-returns of spot and future series. In this research, univariate GARCH models were used to study these correlations, in which it is assumed that:

$$\sigma_{s+f}^2 = \sigma_s^2 + \sigma_f^2 + 2\sigma_{sf} \quad (24)$$

and

$$\sigma_{s-f}^2 = \sigma_s^2 + \sigma_f^2 - 2\sigma_{sf} \quad (25)$$

In other words, the futures series variance plus the spot series is given by the sum of spot series variances and the futures series plus twice the covariance between the series. The of the spot series variance minus the futures series is given by the sum of spot series variances and the future series minus twice the covariance between the series. Subtracting the equation (25) from equation (24), it has:

$$\sigma_{s+f}^2 - \sigma_{s-f}^2 = 4\sigma_{sf} \quad (26)$$

that is,

$$\sigma_{sf} = \frac{1}{4}\left(\sigma_{s+f}^2 - \sigma_{s-f}^2\right) \quad (27)$$

By this means, it is possible to obtain the conditional covariance of the series, i.e., it is given by the difference of the variance of the sum of live cattle spot and futures series and the variance of the difference of the live cattle spot and futures series. This result is used to find the optimal hedge ratio represented by equation (4):

$$g^* = \frac{\sigma_{sf}}{\sigma_f^2}$$

The conditional variance of futures series is found through a GARCH.

Unconditional Beta Model

According to Mergner (2009), it is possible to obtain an unconditional beta from equation (4):

$$g^* = \frac{\sigma_{sf}}{\sigma_f^2}$$

where,

$$\sigma_{sf}^2 = \rho_{sf}.\sigma_s.\sigma_f \quad (28)$$

where ρ_{sf} represents the correlation coefficient between the spot and futures returns series and may be the Pearson, Spearman, or Kendall coefficient. As a natural consequence:

$$\sigma_{sf}^2 = \rho_{sf}.\sqrt{\sigma_s^2}.\sqrt{\sigma_f^2} \quad (29)$$

It is possible to obtain and through univariate GARCH models, thus reaching at the unconditional beta described in equation 30:

$$g^* = \rho_{sf}.\frac{\sqrt{\sigma_s^2}}{\sqrt{\sigma_f^2}} \quad (30)$$

4 RESULTS

4.1 Estimation of the Hedge Ratio by Ordinary Least Squares:

Estimates of the log-returns of live cattle prices in the spot market versus log-returns of prices in the futures

market for daily and monthly data are summarized in equations 31 and 32, respectively.

$$ret\_bgspot = 0,0002748 + 0,1533745\,ret\_bgfut$$
$$(0.000762)(0.0083448) \quad (31)$$
$$[0.000315][0.0000]$$

The p-values of the estimates are represented in brackets and deviations in parentheses. Estimating by OLS, it is obtained an optimal hedge ratio of 15.34%, a low value comparing with the market rates.

$$ret\_bgspot = 0,004310 + 0,847186\,ret\_bgfut$$
$$(0.001964) \quad (0.054117) \quad (32)$$
$$[0.0296] \quad [0.0000]$$

The p-values of the estimates are represented in brackets and deviations in parentheses. Estimating by OLS, the optimal hedge ratio is 84.71%.

4.2 Hedge ratio Estimation by the BEKK Model:

For the multivariate GARCH BEKK, the BEKK-diagonal model of the *OxMetrics* software is estimated to obtain the variance and covariance matrix. This model enables the matrix to be positive definite and allows a dynamic dependence of the model. Figures 5 and 6 represent the optimal hedge ratio for daily and monthly data, respectively, calculated using the BEKK model. It is worth mentioning that the multivariate GARCH models are estimated with constants in the average and variance equations.

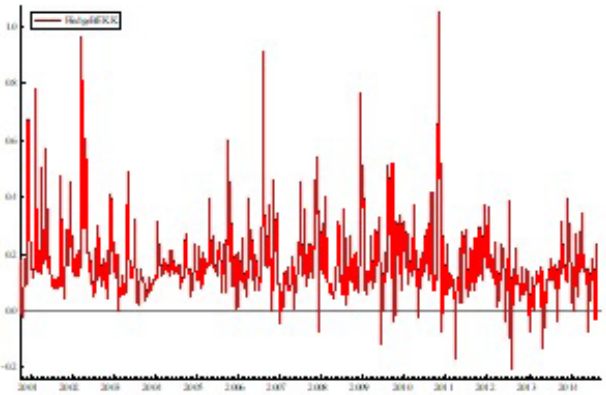

FIGURE 5 – Hedge ratio estimated by the BEKK model (daily data)
SOURCE – Elaborated by the authors

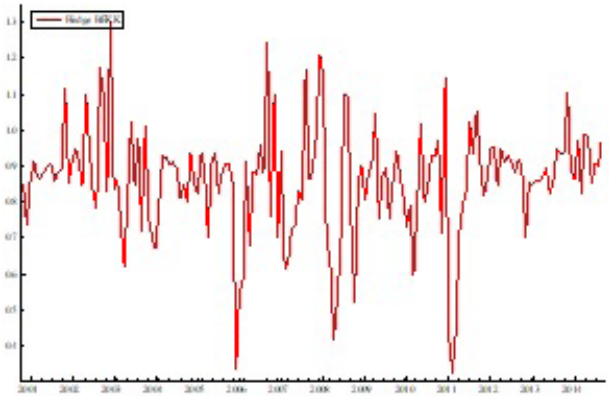

FIGURE 6 – Hedge ratio estimated by the BEKK model (monthly data)
SOURCE – Elaborated by the authors

In relation to daily data, some variations in the ratios can be noted through Figure 5. The maximum value is 1.053694 and minimum is -0.205909. Both valuesare against hedge theory and the transaction does not pay off in this case. If the ratio is negative, the hedger buys futures (if he is bought in spot) or sells futures (if he is sold in spot). When the ratio is greater than 1, it means that hedger is leveraged in spot or futures. The average ratio is 0.163663, a value lower than that practiced by the market.

Regarding the monthly data, as shown in Figure 6, the maximum value is 1.3019 and minimum is 0.3262. The maximum was against the hedge theory, because the ratio is higher than 1, meaning that hedger is leveraged in spot or futures. The average ratio is 0.85892.

4.3 Estimation of the Hedge Ratio by the DCC-TT Model:

When estimating the hedge ratio by DCC of Tse-Tsui (2002) for daily data, the model average drops in relation to the other models (0.1181). The BEKK model presents more extreme values than the DCC-TT, since the maximum in this model is 0.701231 and the minimum is 0.028292, as shown in Figure 7.

When estimating the hedge ratio by the DCC of Tse-Tsui with monthly data, the model average increases in relation to the other models (0.89201). As shown in Figure 8, the BEKK model showed more extreme values than the DCC-TT, since the maximum in this model is 1.2083 and the minimum is 0.44127.

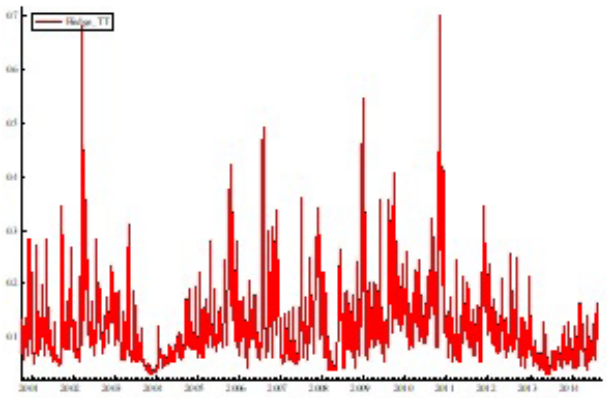

FIGURE 7 – Hedge ratio estimated by DCC-TT model (daily data)
SOURCE – Elaborated by the authors

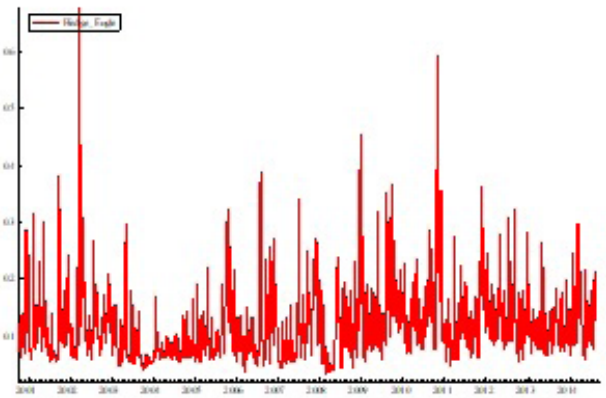

FIGURE 9 – Hedge ratio estimated by DCC-ES model (daily data)
SOURCE – Elaborated by the authors

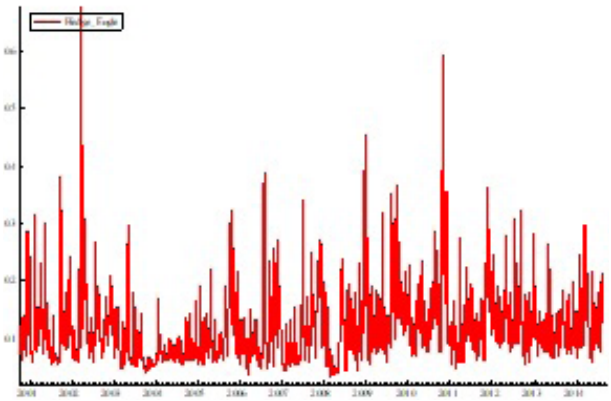

FIGURE 8 – Hedge ratio estimated by DCC-TT model (monthly data)
SOURCE – Elaborated by the authors

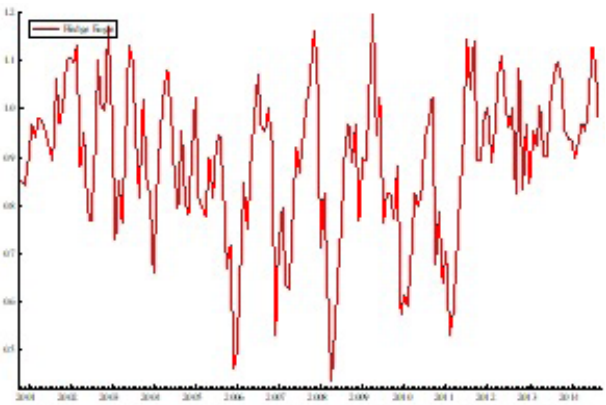

FIGURE 10 – Hedge ratio estimated by DCC-ES model (monthly data)
SOURCE – Elaborated by the authors

4.4 Estimation of Hedge Ratio by DCC Model of Engle and Sheppard (ES):

As shown in Figure 9, the DCC model of Engle and Sheppard (2001) shows lower volatility than the DCC-TT. It also has a lower average (0.116734) and lower extreme values(maximum of 0.677887 and minimum of 0.034519).

Estimating the DCC-ES model with monthly data (Figure 10), it is observed that it shows lower volatility than the DCC-TT. It also has a higher average (0.89225) and lower extreme values(maximum of 1.1962 and minimum of 0.43389).

4.5 Estimation of the Hedge Ratio by Time-varying Beta Correlations:

By obtaining the conditional covariance of the series given by the difference of the variance of the sum of live cattle spot and futures series and the variance of the difference of live cattle spot and futures series, it is possible to obtain the optimal hedge ratio for each period. The maximum value is 0.403983 while the minimum is -0.1016, with lower volatility than DCC models. However, the average hedge ratio estimated by this model was very low, only 0.018594, according to Figure 11.

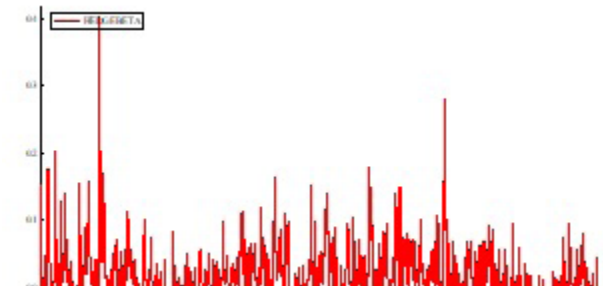

FIGURE 11 – Hedge ratio estimated by time-varying beta correlation (daily data)
SOURCE – Elaborated by the authors

Figure 12 shows the optimal hedge ratio obtained by this model, the maximum value is 1.5382 while the minimum is 0.34456, with higher volatility than the DCC models. However, the average hedge ratio estimated by this model was lower (0.87513).

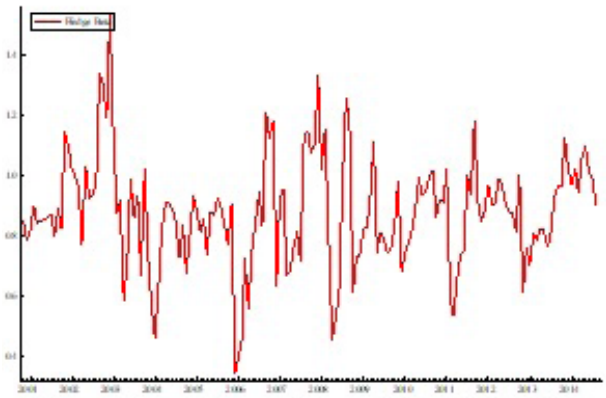

FIGURE 12 – Hedge ratio estimated by time-varying beta correlation (monthly data)
SOURCE – Elaborated by the authors

4.6 Estimation of the Hedge Ratio for the Unconditional Beta (CAPM):

When estimating the conditional variance for live cattle spot and futures series, considering monthly data, it is possible to obtain the optimal hedge ratio by multiplying the ratio of standard deviation of the spot and future log-returns by the correlation coefficient (Spearman). The maximum value is 1.2498 while the minimum is 0.44567, also showing lower volatility than the DCC and BEKK models, besides lower average (0.88085), which was only lower than the OLS ratio.

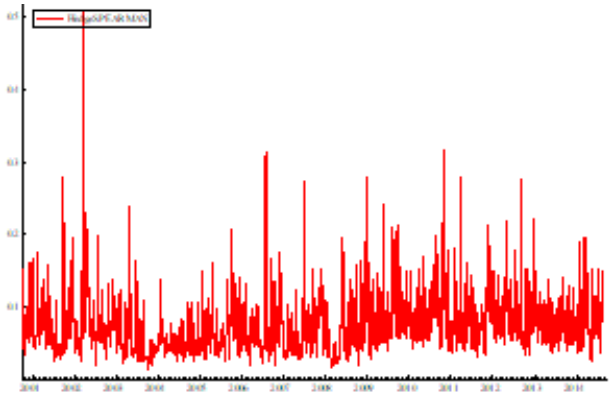

FIGURE 13 – Hedge ratio estimated by unconditional betas (daily data)
SOURCE – Elaborated by the authors

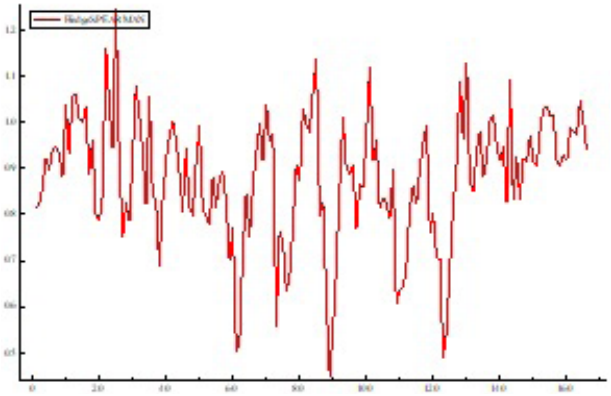

FIGURE 14 – Hedge ratio estimated by unconditional betas (monthly data)
SOURCE – Elaborated by the authors

4.7 Efficiency of Models:

One way to analyze the efficiency of optimal hedge ratio models can be to estimate the variance of hedge portfolio variance. Returning to equation 1 of the hedge portfolio:

$$Y_t = \Delta BS_t - g\Delta BF_t$$

The variance reduction is calculated in relation to the non-hedged portfolio (g = 0), i.e., the variance of the spot log-returns. Moreover, the Sharpe ratio is calculated by dividing the portfolio's average return by its variance. The used risk-free rate (R_f) was the CDI.

As shown in Table 3, the hedge ratio that most reduced the variance was that calculated by the BEKK, followed by the CAPM unconditional beta, DCC-Engle,

TABLE 3 – Efficiency of models

Strategy	Variance	Reduction of variance (%)	Sharpe ratio
Unhedged	0.001579	0.0000	4.1729
OLS	0.000633	0.5991	6.8086
BEKK	0.000587	0.6283	8.7166
DCC-TT	0.000619	0.6080	6.8625
DCC-ES	0.000618	0.6088	6.9222
Time-varying beta correlation	0.000664	0.5796	5.0403
Unconditional beta CAPM	0.000612	0.6126	7.3220

SOURCE – Elaborated by the authors

DCC-TT, and beta of varying correlations. This same order represents the models that maximized the Sharpe ratio. These results are different from those found by Lazzarini (2010) where DCC (TT and Engle) models were better at the criterion of variance reduction and Sharpe ratio maximization.

It should be noted that the unhedged strategy is the worst result, since it is a consequence of the return and risk without hedging. The second worst strategy is OLS, which is also an expected result, since all other methodologies are more accurate to capture the variability relationship between the spot and futures series.

5 CONCLUSION

The aim of this article was to identify the best model to obtain the hedge ratio in the Brazilian live cattle market, by comparing six models: OLS, DCC of Engle and Sheppard, DCC of Tsé and Tsui, BEKK, time-varying beta correlation, and unconditional beta.

Lazzarini (2010) justifies the low values of hedge ratios for daily data, suggesting that the drop in the temporal expectation with the change of contracts increases greatly the variance of futures series, reducing the hedge ratio. One solution would be to use monthly series, being the trading prices as observations of some day of the month (days 1, 15, or 30).

From this suggestion, daily and monthly data were used in this article, besides values of the last prices of each month for the series in level. Thereby, it is possible to obtain higher hedge ratios when estimating monthly data. Additionally, hedge ratios were estimated using more methodological alternatives. The models that were most successful in reducing variance and maximizing the Sharpe ratio were BEKK, followed by the unconditional beta.

In all models, for both studies, the estimated hedge ratios for daily data were also low. This leads to believe that such justification is contained in the data itself and not in the used models.

Finally, it is worth emphasizing that this study contributed to empirically evidence that there is a differentiated effect in the model choice to determine the optimal hedge ratio in futures contracts, with a direct impact on the risk management and the return of agents involved in the live cattle market.

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DISCURSIVE REPRESENTATIONS OF THE AGRICULTURAL REFORM POLICY IN BRAZILIAN SAVANNA: THE CASE OF DIRECTED SETTLEMENT PROGRAM OF ALTO PARANAÍBA (PADAP)

Representações Discursivas da Política de Reforma Agrária no Cerrado Brasileiro: O Caso do Programa de Assentamento Dirigido do Alto Paranaíba (PADAP)

ABSTRACT

The debate around the Brazilian agrarian issue was historically marked by the presence of different actors and discourses that, for the majority, assumed opposing positions and practices. Specifically, the agrarian reform policy of the 1960s, one of the main historical milestones of this issue, was also developed in the midst of this discursive plurality, which then became two specific discursive orders: the pro-reform discourse and the agricultural modernization discourse. From this conflict resulted different agrarian policies inserted in a socio-historical and political context, highlighting those directed to the rural exploration of savanna. In this sense, the present study aimed to understand the discursive representations and reveal ideological elements present in textual discourses and uttered by governmental implementers of the expansion policies of the agricultural frontier for the Brazilian savanna and beneficiaries of the Directed Settlement Program of Alto Paranaíba (PADAP). Through the analysis of the representational meaning from Norman Fairclough's discourse theory, it was possible to identify the representations involved in the formulation and implementation of this policy, highlighting the hegemony of agricultural modernization inculcated in statements that justified a priori agrarian reform.

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RESUMO

O debate em torno da questão agrária brasileira foi historicamente marcado pela presença de diferentes atores e discursos que, em sua maioria, assumiam posições e práticas antagônicas. De forma específica, a política de reforma agrária da década de 1960, um dos principais marcos históricos dessa questão, também se desenvolveu em meio a essa pluralidade discursiva, que nesse caso, tomou a forma de duas ordens discursivas em específico: o discurso pró-reforma e o discurso da modernização agrícola. Desse conflito, inserido em um contexto sócio-histórico e político, resultaram diferentes políticas agrárias, ressaltando aquelas voltadas à exploração rural do cerrado. Nesse sentido, o presente trabalho teve como objetivo compreender as representações discursivas e desvelar elementos ideológicos presentes em discursos textuais e proferidos por implementadores governamentais das políticas de expansão da fronteira agrícola para o cerrado brasileiro e beneficiários do Programa de Assentamento Dirigido do Alto Paranaíba (PADAP). Por meio da análise do significado representacional a partir da teoria do discurso de Norman Fairclough foi possível identificar as representações envolvidas nos processos de formulação e implementação desta política, evidenciando a hegemonia da modernização agrícola inculcada em enunciados que, a priori, justificavam a reforma agrária.

Palavras-chave: Reforma Agrária, Modernização Conservadora, Cerrado, Significado representacional, PADAP.

Keywords: Agrarian Reform, Conservative Modernization, Savanna, Representational Meaning, PADAP.

1 INTRODUCTION

The agrarian issue has been a recurring topic in the relationships between the State, the market and civil society, especially considering the process of building agrarian reform policies in the last 70 years, especially in Latin American countries (GRAZIANO DA SILVA, 1982; PAULINO, 2014; ROBLES; VELTMEYER, 2015, ELGERT, 2015; ROSSET, 2013; VILPOUX, 2014).

Specifically, the discussions directed to a public policy of agrarian reform in Brazil became more prominent and entered the political agenda of the State in the 1950s and 1960s, during the government of President João Goulart (1961-1964), which advocated core reforms of the country, including the reform of the land structure, marked by often unproductive large estates. Even though, according to Graziano da Silva (1982), there were different discourses and ideological positions in this period regarding the ways in which reform should be carried out, the Brazilian agrarian issue was mainly seen as a barrier to the economic and social development of the country, being large estate as the main cause of the social and economic problems of the countryside (VERGARA-CAMUS, 2012; DELGADO, 2001).

In this period, on the one hand, social movements constituted by rural workers, left-aligned thinkers on the political spectrum and politicians, such as President João Goulart, (re)produced a discourse in which they defended the realization of agrarian reform through large estate expropriation and redistribution of land in small lots. On the other hand, there was the discourse of economists, agronomists, and conservative thinkers, who also entered the agrarian debate, although they understood that the reform through the large estate expropriation was not the way necessary for economic development, proposing policies aimed at investing and financing the existing land structure, adopting a discursive position focused on capitalist production and agricultural modernization, also influenced by the discourse of the so-called 'Green Revolution' (SANTOS, 2013; SILVA, 2015).

Considering that the agrarian reform was part of the President Goulart's government plan, the Brazil's landowner and industrial elite tried to mobilize themselves in order to exercise a force contrary to this movement. These interests were crucial for the accomplishment of a coup d'état in 1964, instituting a military government in the country. However, as soon as the military assumed the governance, the agrarian issue was not forgotten and that Law no. 4,504/64, also known as the 'Land Statute', was drawn up and enacted in the first year of the regime in order to accomplish the agrarian reform in the country (ROBLES; VELTMEYER, 2015).

According to Carvalho (2011), the 'Land Statute' considered both an agrarian policy, aimed at transforming the country's land structure, marked by unproductive large estate that should be expropriated, as well as an agricultural policy, which is concerned with establishing incentive programs and the development of the rural economy, which would support the integration of agriculture and livestock with industry. It is worth noting, however, that this text did not ignore the demands from other discourses related to the agrarian issue, such as social movements of rural workers, which helped to characterize the conceptual chaos involving the Statute (SILVA, 2015).

Based on the "Land Statute", the first expansion programs of the agricultural frontier were developed for the Brazilian savanna, a biome until then little explored by the agricultural activity of great extension (PIRES, 2000). According to Santos et al. (2014), these savanna colonization policies used a combination of agrarian reform discourses and agricultural modernization that transformed some regions of the biome into national agribusiness poles, as seems to be the case of the Directed Settlement Program of Alto Paranaíba (PADAP), the inaugural policy of this biome's farm (SASAKI, 2008).

Thus, in the face of the "conceptual chaos" that involved the agrarian issue during the 1960s and 1970s and the discursive conflict of the period, we aimed in this study to **understand the discursive representations and to reveal ideological elements present in the constitutive political expansion discourses of the agricultural frontier to the Brazilian savanna, especially regarding the PADAP.**

In this respect, we will take the perspective of critical discourse analysis (CDA) (FAIRCLOUGH, 2001, 2003; RESENDE, RAMALHO, 2006) as a theoretical and methodological support, recognizing the contributions of this approach to the study of agrarian reform processes (MacDONALD, 2003; KOLAWOLE, 2012; SOUZA; SILVA, 2013; MORAIS, 2014; CABRAL et al. 2016) and highlighting the representational meaning of discourses that constitute the discursive *corpus* of the formulation processes and implementation of this program.

It is also relevant to bring the conceptual aspects and nomenclature used to deal with those who labor on land or take sustenance from it. The legislation itself is imprecise in this respect and has disregarded traditional agricultural production, such as the peasantry and family farming since the Land Statute (BRASIL, 1964). The generic term 'producer' is

used, which causes the erasure of cultural, historical and social singularities of peasants directly or indirectly affected by State action. One specificity found is the term 'settler', widely used to treat those benefited by agricultural modernization programs, such as farmers from other regions, and specifically regarding the PADAP, its vast majority are Japanese descent. In this article, we use the terms producer (rural), small rural producer and settler, aware of the intentional absence of the peasantry in the analysis corpus.

Thus, besides this introduction (1), this study will be divided into sessions that will comprise a discussion on the agrarian issues and the agrarian policies in the savanna (2); methodological procedures and categories of representational meaning in CDA (3); the PADAP contextualization and the analysis of the discursive corpus in question (4); finally, the final considerations of the study (5).

2 THEORETICAL FRAMEWORK

2.1 The Agrarian Issue in Brazil: Discourses, Ideologies and the Land Statute

Broadly speaking, the so-called Brazilian agrarian issue can be divided into three moments of discussion: the term's emergence between 1930-1945 (motivated by the international transformations of capitalism); the debate on the agrarian issue as a guide to the Brazil's economic development between 1945 and 1965; and the period of authoritarian or conservative modernization between 1966 and 1990, marked by the implementation of technical and scientific capital and the modernization of the countryside (DELGADO, 2001, ROBLES; VELTMEYER, 2015).

According to Rodrigues (2015, p. 21), the agrarian issue is directly related to the "high concentration of land appropriation, which places the rural population in a subservience situation, promotes degrading work conditions and generates effects and social ills in urban centers".

In this direction, despite the existence of different political movements and interests, it is possible to affirm that two broad-ranging discourses were highlighted during the 1950s and 1960s, marked by distinct characteristics regarding the Brazilian rural environment. The first was related to the prioritization of agrarian reform, seeking to achieve its social purpose, reducing inequalities in land ownership in the rural production means. On the other hand, the second discourse was based on the defense of the industrialization and modernization of agriculture, based on a developmental proposal aimed at assisting growing urban areas and the external market (DELGADO, 2001).

In relation to the first discursive order, however, Graziano da Silva (1982) argues that there were different narratives about agrarian reform in the country, highlighting four of them: the moderate proposal of the Communist Party of Brazil (PCB), which sought to attract bourgeoisie sectors for the reform and set a ceiling of 500 hectares per lot; the radical proposals of the Peasant Leagues, which sought land redistribution, even resorting to armed disputes among those involved; the moderate narrative of the Catholic Church, committed to the expropriation of large unused estates and the sale of them to peasants in expropriated areas; as well as narratives of more radical sectors of the Catholic Church itself that believed in the agrarian reform through the association of peasants to unions that would develop a class consciousness.

However, Soares and Castro (1986, p. 43) broadly understand the concept of agrarian reform as:

> [...] the revision and readjustment of the juridical-social and economic-financial norms that govern the land structure of the country, aiming at the valorization of the farmworker and the production increase through the social, rational distribution and utilization of the agricultural property, the better organization and extension of rural credit, and the improvement of rural man's living conditions.

Later, despite several theoretical influences from previous periods, the groups that were positioned in the discourse for agrarian reform began to organize from the 1950s and 1960s, so that their demands took on greater scope and entered the political agenda during the government of João Goulart (1961-1964), which had nationalism and economic development as its guidelines, which would be achieved through grassroots reforms, including agrarian reform. In this period, it should be noted that the country's land structure, composed of large unproductive estates, was seen as a barrier to industrialization and economic development, as well as corresponded to the cause of most of the rural social problems, such as hunger, poverty, illiteracy, among others. In this sense, the agrarian reform proposal presented in João Goulart's Three-Year Plan (1963-1965) consisted of a large estate expropriation process (CARVALHO, 2011).

For Jango, agrarian reform would be the main means for Brazilian economic development, since it was based on the premise that the farmworker who owned his land would have a higher income and would thus help with the industry's investment in the country. In this direction, the government of Goulart elaborated a decree

establishing norms for the agrarian reform, creating in 1963 the Superintendence of Agrarian Policy (SUPRA), which would promote the execution of expropriation plans and projects of areas characterized as unproductive or uneconomically exploited rural lands; as well as the establishment of rural workers in these areas and investments in productive capital and technical assistance (SANTOS, 2013). According to Carvalho (2011), another important event in this context was the creation of the National Confederation of Rural Workers (CONTAG) in 1963, a trade union body that advocated agrarian reform and other rights for farmworkers. Also in 1963, the federal government created the Statute of the Rural Worker.

On the other hand, from the point of view of groups aligned with the agricultural modernization discourse, such as some economists from the University of São Paulo, statistical and economic information were the basis for claiming the non-existence of the 'agrarian issue' in Brazil, since the land structure until then was not considered as a relevant economic and social problem and should only be modernized and exploited more efficiently. Moreover, Brazil in that period was positioned as a food country importer, so that investment in high-scale production was also a demand for these groups (DELGADO, 2001).

Thus, this chain of actors was aligned with the agricultural modernization discourse, understood by Martine (1991) as the generic process of increasing agriculture integration in the industrial capitalist system, especially through technological innovation and rupture with traditional production relationships characteristics from peasants, based on subsistence agriculture. According to Silva (2015), due to the social, historical and cultural context in which these subjects were inserted, they were considered as unfit for the incorporation and use of new technologies of high specialization.

This narrative was influenced by the American functionalist discourse on the agriculture role in the economy, which would have five economic functions: "Supply labor for industry; generate adequate food supply; supply raw materials for industries; increase agricultural exports [and]; transfer real income to the urban sector" (DELGADO, 2001, p. 161).

Another relevant actor in the construction and legitimation of this discourse was the Institute for Research and Social Studies (IPES), a conservative orientation research agency whose main activities were developed in the 1960s, mainly seeking to disrupt the political project of João Goulart. IPES carried out studies proposing a land reform project aimed at the formation of a rural middle class, based on owners (small, medium or large) who already had capital and knowledge for modern and mechanized rural production, progressively eliminating unproductive large estates, even though the large estate structure was not criticized and the equalized land distribution was not defended.

In other words, agrarian reform for the IPES could not be based solely on land distribution (expropriation and land distribution to individuals and groups), so that this process should be aligned with the notion of agriculture modernization and the end of unproductive large estate and smallholding. This policy was based on the idea ofthe land tax instead of the land confiscation by the State. Thus, the government would act progressively, implanting the family rural middle class in unproductive lands and financing the activity of these groups (SILVA, 2015).

Furthermore, according to Carvalho (2011), the agricultural modernization discourse in Brazil was strongly influenced by the development of the strategy package called Green Revolution (created in the United States by the Rockefeller Institute). This policy established changes in the technical basis of food production around the world, providing technologies for the development of breed seeds, mechanization, and chemical inputs.

Amidst this situation, it was precisely the groups aligned to this perspective of the agricultural issue, allied with part of Brazilian business community, who organized politically and articulated the coup d'état of 1964, deposing President João Goulart and establishing a military dictatorship regime (GRAZIANO DA SILVA, 1982). This new government, however, did not suppress the debate related to agrarian demands. On the contrary, one of its first great actions was the promulgation of Law 4,505/64, also named "Land Statute".

According to Silva (2015), the Land Statute was influenced mainly by groups as the rural and industrial elite, who supported a conservative agrarian policy aimed at modernizing the existing land structure. However, the text presented a series of provisions that provoked contradictions and conflicts. On the one hand, agrarian reform was understood as an outlet for industrialization and economic development, although the rural elite considered this process a violation of property rights. On the other hand, the Statute also appropriated some aspects from pro-reform discourse, presupposing the land use by attending to its social function and establishing guidelines for the development of agrarian reform based on instruments as expropriation and colonization, as well as defined the payment of expropriated land through government bonds.

In this sense, the Land Statute establishes in its article 2, § 1,

> Rural land ownership fully fulfills its social function when, simultaneously:
> a) favors the well-being of owners and workers who work there, as well as of their families;
> b) maintains satisfactory productivity levels;
> c) ensures the conservation of natural resources;
> d) observes the legal provisions that regulate the fair labor relationships between those who own and cultivate it (LAW 4,504/1964 ART. 2, § 1 - LAND STATUTE).

However, Souza and Silva (2013), based on article 2, show that the Land Statute did not intend to end the large estate nor to promote a change in the Brazil's land structure, being possible to argue that although the military regime was not opposed to reforms, it did not accept that certain groups, such as peasant organizations and leftist political parties (especially the PCB) to assume the leadership for implementation and operationalization of these reforms. Additionally, the agrarian policy has assumed an economic and technical sense to the detriment of social and political aspects. As evidence of this, the agrarian reform process of the Castelo Branco government was elaborated in a top-down perspective, without the consultation of rural workers, depoliticizing the agrarian issue (SILVA, 2015).

Complementarily, some authors as Salis (2014) and Vergara-Camus (2012) understand that the agrarian reform elaborated in the military government was little about pressures of social movements (mainly because they were forbidden and persecuted): the real motivation of the agrarian reform in the period was the visualization of agrarian structure prevailing until then in the country as a hindrance to economic and industrial development, so that it would be necessary to implement measures that restructured this configuration, aimed at the modernization and technical exploration of areas constituted by large unproductive estates, mainly to meet food demands.

Thus, for Silva (2015), the Land Statute failed to promote agrarian reform because it was enveloped in a kind of conceptual chaos, which led to the development of an agrarian policy aimed at agricultural modernization that was justified simultaneously as an agrarian policy. The products of this context marked the period known as the modernization agricultural policy.

In this direction, according to Martine (1991), Brazilian agricultural modernization can be divided into three phases: conservative modernization (from 1965 to 1979), crisis and retraction (from 1980 to 1984), and recovery and super crops (1985 to 1989). We emphasize that, considering the scope of this study, we will deal especially with the first phase, named initially by the American sociologist Barrington Moore Jr. (ROBLES; VELTMEYER, 2015) due to the modernization proposal that did not directly concern with changing the agrarian structure of the country, maintaining the same pattern and social problems that constituted the Brazilian rural space for centuries.

During the period of conservative modernization, it was up to the state to "increase the production and productivity of the agricultural sector, driven by urban and external demand in a rapid growth process" (DELGADO, 2001 p. 163). Moreover, the agriculture functions would also change, so that the sector should also deepen its technical relationships with industry in order to reach the external market, a process called 'technical-agriculture-industry integration' by Delgado (2001), characterized by the strong presence of industrial products in agricultural activity (pesticides, machinery, etc.) and the industrialization of rural commodities.

Thereby, based on this context, the public expansion policies of the agricultural frontier were developed for the savanna from the 1970s onwards. Although this policy includes different aspects, in the next session we tried to describe in detail the main programs that were said to be related to the land structure implemented in the biome during that period.

2.2 Agrarian Policies in the Savanna

State action for the savanna exploitation refers to the Vargas government, starting with the creation of agricultural colonies in the states of Mato Grosso and Goiás, highlighting the colonies of Dourados (MS) and Ceres (GO). After the creation of Brasilia in the 1950s, new incentives to the settlement and rural exploration of the savanna were fostered. However, these actions were essentially based on extensive livestock farming mainly due to lack of nutrients from the biome soil, which prevented the planting and cultivation of crops, a scenario that lasted until the end of the 1960s (SANTOS et al. 2014).

However, based on the discussions involving agrarian reform and agricultural modernization, materialized in the Land Statute and in other instruments and governmental programs, the savanna returned to enter the agenda of the State as a productive space and a means to promote the economic and industrial development of the country (PIRES, 2000).

In this sense, the PADAP is the first agrarian policy of the conservative modernization period focused on the savanna occupation, formulated in partnership between the

Minas Gerais state government and the federal government in the beginning of the 1970s. However, PADAP will be better analyzed in subsequent sessions, since the discursive representations around this policy constitute the main analysis corpus of this study. Thus, we will discuss other agrarian programs developed in the savanna during this period, most of which are direct results of this inaugural policy.

These policies include the Special Development Program of Grande Dourados, the Special Program of the Geoeconomic Region of Brasilia, the Integrated Program for the Development of Northwest Brazil (POLONOROESTE), the Program for the Savanna Development (POLOCENTRO) and the Japanese-Brazilian Cooperation Program for the Savanna Development (PRODECER). These programs were characterized by the provision of credit and technical assistance by the State to settlers and producers installed in plots of land with productive capacity that met the standards for agricultural modernization (BITTAR, 2011; TANTURE, 2013; SANTOS et al. 2014).

In turn, POLOCENTRO, created in 1975 in the face of the positive evaluation of PADAP, is similar to the last one in relation to research, technical assistance and rural credit, differing in geographical concentration: while PADAP focused on the Alto Paranaíba region, POLOCENTRO was developed in the states of Minas Gerais, Mato Grosso, Mato Grosso do Sul, and Goiás, in 12 poles of growth, with the objective of rationally incorporating three million hectares, spreading new technologies for agricultural production in the savanna, with an investment of 860 million dollars (PIRES, 2000). Despite the amount of invested resources, the program did not reflect an increase in the employed workforce in the occupied regions, also leading to a rise in the land price and a reduction in the number of small rural properties.

POLOCENTRO began to be decommissioned in 1979, coinciding with the acceleration of negotiations between Brazil and Japan for the implementation of PRODECER, which began in 1975. PRODECER was started in 1980, divided into three consecutive stages performed in several states, as indicated in Chart 1.

Name	Year	Site
PRODECER I	1980	Coromandel, Iraí de Minas and Paracatu (MG).
PRODECER II	1985	Minas Gerais, Goiás, Mato Grosso, Mato Grosso do Sul and Bahia.
PRODECER III	1995	Pedro Afonso (TO) and Balsas (MA).

CHART 1 - Stages of PRODECER
Source: Prepared by the authors based on Silva (2000)

PRODECER differs from previous programs precisely in the collaboration character and presence of Japanese government at different levels, such as "the selection of areas, the granting of credits, the monitoring of productive activities, and the evaluation of performance" (SILVA, 2000, p. 122), whose actions are developed mainly by the Agricultural Promotion Company (CPA)/Campo, formed by Brazilian and Japanese capital.

Another program developed in the savanna during this period was the Special Program of the Grande Dourados Region (PRODEGRAN), in 1976, which aimed to explore the agricultural potential of the state of Mato Grosso, comprising an area of approximately 6 million hectares near the municipality of Dourados.

3 METHODOLOGICAL PROCEDURES

Based on the theoretical problematization and foundations presented previously, this study is characterized as a descriptive investigation and of qualitative nature. The discursive analysis corpus comprised essentially texts related to the PADAP formulation and implementation process, systematized from Figure 1. After being collected, the statements were organized (as well as transcribed in the case of interviews) and structured in a text editor software.

As a theoretical and methodological approach to corpus analysis, the critical discourse analysis (CDA) was adopted in the aspect developed by Norman Fairclough (2001, 2003). According to Resende and Ramalho (2006), this perspective allows analyzing social practices through discursive practices or discourses with a performance function in reality. For Fairclough (2001), discourse is understood as both a form of action by which people act and produce effects in the world as well as on other people, and as a form of representation. It is emphasized that several discourses that constitute the domains of social life tend to compete with each other, so that some end up assuming higher positions of power (GRIVINS; TISENKOPFS, 2015; FREITAS et al. 2016; HOWLEY; HOWLEY; EPPLEY, 2013; SOUZA; SILVA, 2013). Therefore, discourses can be shaped and shape social structures.

Furthermore, the CDA has as interest to understand the conditions of production, distribution and consumption of texts, highlighting the context in which they were produced. In this way, it was seek to analyze the purposes of discourses, revealing power relationships among the different actors and considering possible ideological meanings of these statements (FAIRCLOUGH, 2013; MacDONALD, 2003).

Sources of corpus collection	Description	Dates
PADAP expropriation files	Set of texts describing legal and administrative procedures related to PADAP. It involves technical studies, decrees, petitions, requirements, minutes of meetings, legal decisions, certifications, among others. They are in the Library of the Federal University of Viçosa - Rio Paranaíba Campus	
Interviews	Interview with policy maker involved in the formulation and implementation of PADAP (Interviewee 1);	8/31/2011
	Interviews with policy maker involved in the formulation and implementation of PADAP (Interviewee 2);	9/3/2011 11/14/2011 5/23/2012
	Interview with researcher, director of one of the policy assistance agencies, Ruralminas, during the formulation and implementation period of PADAP (Interviewee 3)	8/30/2009
	Interviews with settlers of Japanese descent, employee of the Cotia Farming Cooperative, settled by PADAP (Interviewee 4)	3/14/2009 6/22/2009 11/13/2009
	Interview with a researcher from the Federal University of Viçosa, active in the PADAP region (Interviewee 5).	10/18/2010
	Interview with settlers of Japanese descent, employee of the Cotia Farming Cooperative, settled by PADAP (Interviewee 6)	2/18/2010
Legislations	Law 4,504/64 (Land Statute), Decree 72,786/73	
Other sources	Interview with Alysson Paolinelli, one of the policy makers (held by the Alto Paranaíba region news portal); Book "Portal of savanna: the stories and adventures of the pioneers in the clearing and creation of the largest agricultural region in Brazil", which tells the PADAP formulation and implementation in the perspective of Japanese descent settlers (SASAKI, 2008).	

FIGURE 1 - Description of the procedures for corpus collection
Source: Elaborated by the authors

In the Fairclough's CDA context, ideology is understood as a set of socially and historically constructed meanings of reality that reproduce domination relationships among groups of subjects (FAIRCLOUGH, 2001; CHIAPELLO; FAIRCLOUGH, 2002). In this way, some discourses can be understood as ideological practices, since it contributes to the construction of values and norms with greater legitimacy in a broad conjuncture. Specifically regarding this research, senses to certain actors are attributed in a public policy to the detriment of others based on ideological discourses, thus contributing to the reproduction of domination and subordination relationships (MacDONALD, 2003).

Fairclough (2003), based on Haliday, recognizes that discourse has social functions/meanings and proposes that CDA should consider three main types of discourse meanings, namely: actional (the genres by which social practices are propagated); representational (the representation of social reality aspects and its actors through discourses); and identificational (referring to the constructions and negotiations of identities coming from the discourses, characterized by the styles) (RESENDE; RAMALHO, 2006).

According to Fairclough (2003), this meaning classification is only an analytical tool, since these meanings are simultaneously interconnected in social reality. However, considering the purpose of this article, we will deal specifically with the representational meaning of the discourses, involving the formulation and implementation of the PADAP. This type of methodological choice was also employed by Melo (2013), Resende (2008), and Paiva, Garcia and Alcântara (2017).

According to Fairclough, the representational meaning can be analyzed from the following categories: the representation of the social actors, the interdiscursivity, and the semantics of words. The first one refers to "the ways as social actors are represented in texts, which can indicate ideological positions in relation to them and their activities", therefore, "the analysis of such representations can be useful

in the unveiling of ideologies in texts and interactions" (RESENDE; RAMALHO, 2006, p. 72). Fairclough (2003) rescues the theory of representation of social actors developed by Theo van Leeuwen, from which the representations can be evaluated by (a) inclusion/exclusion; (b) pronominalization; (c) grammatical role; (d) active or passive voice; (e) personalization or impersonalization; (f) nomination or classification; (g) specific or generic. In this research, it was sought to explore how actors involved in PADAP were represented in the analyzed corpus. These actors refer to policy makers (subjects that acted on the political formulation and decision-making), expropriated landowners, peasants working near the expropriated area, settlers from Japanese descent who received land, among others.

In turn, interdiscursivity refers to "the heterogeneity of a text regarding articulation of different discourses", in "[...] harmonious or controversial dialogical relationships" (RESENDE; RAMALHO, 2006, p. 72). Thus, according to Fairclough (2003, p. 128), "the dialogic/polemical relationship is a way in which texts mix different discourses, but their 'own' discourses are often mixed or hybridized". This analysis focuses in the way as texts are articulated through other discourses and statements that permeated the context of policy formation, among which stand out the Land Statute, agricultural modernization, the Green Revolution, pro-agrarian reform movements, among others.

Finally, regarding the semantics of words, Fairclough (2001; 2003) states that this is part of disputes within other hegemonic disputes. Therefore, the lexicalization of meanings are collective constructs involving "[...] struggles among conflicting assignments of meanings - and semantic variation is seen as a factor of ideological conflict, since the meanings can be politically and ideologically invested" (RESENDE; RAMALHO, 2006, p. 75). In the analyzed corpus, it was sought to evidence lexical choices that represent and reproduce ideological discourses, especially when dealing with the justifications for the accomplishment of the studied policy.

The analysis from the categories of the representational meaning of discourse allowed understanding certain aspects related to PADAP, especially regarding its reproduction context. In this way, the results of this research are presented in the next section.

4 RESULTS AND DISCUSSION

In this session, we seek to develop the analysis of the representational meaning of discourses related to the formulation and implementation stages of the PADAP. Initially, as part of the analysis, it is necessary to discuss the context in which this policy and related discourses were constructed.

4.1 Development Context of PADAP

PADAP is considered the inaugural expansion policy of the agricultural frontier for the savanna. The program formulation process began in 1972 and its subsequent implementation occurred in 1973, specifically comprising the municipalities of São Gotardo, Rio Paranaíba, Ibiá and Campos Altos, located in the Alto Paranaíba region, MG, Brazil. PADAP was characterized by the distribution of land expropriated by the federal government and by a colonization process, in which rural producers selected by the Cotia Farming Cooperative (Brazil's main agricultural cooperative at the time, consisting essentially of Japanese immigrants) granted plots of land where productive activity would be developed through an agricultural credit program integrated with technical and technological assistance offered by state rural research and extension agencies and public universities.

The context in which the program was developed is directly related to the discussions around the model of agrarian and agricultural policy adopted by the military government from the Land Statute. The productive activity performed in the territory that comprised PADAP until the mid-1960s consisted basically of small and medium-sized rural properties organized in a family farming or small-scale farming system, surrounded by a large area characterized as unproductive large estate, owned by an businessman at the time residing in Belo Horizonte, MG, Brazil. It is worth highlighting that, during this period, the Alto Paranaíba region experienced a severe economic crisis and a shortage of resources (SASSAKI, 2008).

Alongside this context, in the early 1970s, a group of technicians from National institute of agrarian development (Instituto Nacional do Desenvolvimento Agrário - INDA), an agency that preceded the National institute of colonization and agrarian reform (INCRA), in partnership with the state government of Minas Gerais, through the Minas Gerais development bank, developed a pioneering agricultural credit program called integrated rural credit program (Programa de Crédito Rural Integrado - PCRI), in which the state offered loans and credit to producers in the Triângulo Mineiro region, MG, by presenting a schedule of activities to be developed in the field based on technical information provided by the assistance of INDA technicians. This policy consisted of the first program of its kind in Brazil and was the embryo for PADAP (SANTOS et al. 2014).

Thus, it was from the experience of the PCRI applied in the Triângulo Mineiro region, together with an economic diagnosis and the emergence of a crisis in the food supply throughout the world and that directly impacted Brazil that political leaders, especially from the city of São Gotardo, MG, together with actors from state and federal government agencies, worked together to develop a new program focused on agricultural modernization in the Alto Paranaíba region, however, covering a larger area. This area was initially glimpsed by the recognition of a large estate of approximately 60 thousand hectares, located in the municipalities of Rio Paranaíba, São Gotardo, Campos Altos, and Ibiá. This area, however, comprised not only the large property, whose actual size was approximately 30 thousand hectares, which spread among other small and medium-sized properties.

From the idea of policy formulation, the Cotia Farming Cooperative, the Brazil's main agricultural cooperative at the time was contacted to "assume" the project through political articulation among local leaders and government agencies (SASAKI, 2008). However, in front of the difficulty of negotiations with the owner of the large estate, which, according to Sasaki (2008), also involved ethnic and cultural prejudice against Japanese-born cooperates, the president of the Cotia Cooperative used his "access" to the federal government, where an expropriation decree was articulated.

Thus, from this articulation, the Decree 72,786 of September 13, 1973 was instituted, thus establishing the area to be expropriated "for social purposes", justifying such action as a land reform policy. The decree initially provided for the expropriation of an area of 61,570 hectares distributed among 53 owners. However, it should be noted that, through protest and resistance actions, owners of properties with less than 100 hectares included in the polygon area demarcated to be expropriated would no longer be under the effect of the decree.

Thus, 25,542.04 ha were allocated to 95 plots of PADAP in the municipalities where the program was implemented, considering the ownership repossession process for small producers affected by the expropriation. The remaining area for the distribution of plots was allocated for small producers, whose activities had already been carried out in the region for many years, in family traditions, which had land expropriated, under the condition that they were explored according to PADAP standards. However, there was little support given to the remnants, and these were even classified as owners of limited aspirations (SASAKI, 2008).

It is important to note that the settlement lots offered to Cotia settlers, farmers of Japanese descent, many of them with agronomic training, had an area between 250 and 500 hectares, a size defined by technical knowledge actors involved in the formulation of the program because they assumed that a lower area would not be feasible for the desired mechanization and productivity levels. This was a *sui generis* characteristic of PADAP in the face of land expropriation experiences in Brazil, especially considering the size of other settlements developed in the country (especially after the period of conservative modernization), whose average area would be 40 hectares. It is also worth mentioning that the Cotia Cooperative would be interested in expanding its operation area and guaranteeing lands to the children of its cooperative located in the interior of Paraná, since the state no longer offered availability of land to them. It is noteworthy that many settlers of Japanese descent had agronomic training, including experiences in countries as the United States, which influenced the development of the modernization model based on farms[1], replicated in PADAP.

Besides the Cotia Cooperative's role, the program was developed supported by several companies and public organizations, such as the Agricultural research agency of the state of Minas Gerais (EPAMIG), the Technical Assistance and Rural Extension Company of the State of Minas Gerais (EMATER), Rural Foundation of Minas Gerais (Ruralminas), federal universities (mainly UFLA and UFV), and the Development Bank of Minas Gerais, which offered resources and technologies for research and rural credit aimed at mechanization, improvement of inputs and planting of crops that until then were not developed in the savanna, such as garlic, soy, carrot, maize, among others.

4.2 Analysis of the Representational Meaning of PADAP Formulation and Implementation Discourses

Taking as reference the context in which the PADAP was developed, we will discuss the representational meaning of discourses related to the formulation and implementation processes of this policy. To this end, we

[1]Although the discussion on farms and farmerization of agriculture is extensive, it should be pointed out briefly that the model of agricultural production and land use in PADAP is based on the North American model, based on small and medium-sized properties, whose agricultural production is highly mechanized. The context of inequality of access to rural credit and high interest rates for the acquisition of agricultural machinery would then lead to a farmerization process, taking large estates, now divided into smaller, productive plots from an economic point of view, but not considering democratization aspects of land ownership, leading to the unsustainable permanence of the peasantry, replaced by farmers.

will try to highlight the representation of the social actors involved in the program, as well as the interdiscursivity and the semantic meaning of words used in these discourses.

Thus, considering the analysis corpus used in this study, the presence of capitalist ideologies and agricultural modernization in the appropriation of agrarian reform discourse by policy makers of the military government is evident in the formulation and implementation process of PADAP. This sense is highlighted as common in different agrarian policies developed over the years in diverse contexts worldwide (e.g. ELGERT, 2015; VERGARA-CAMUS, 2012; KOLAWOLE, 2012; SOUZA; SILVA, 2013).

Decree No. 72,786, published in September 1973, which expressed the terms for the expropriation of area to be used in the program, evidences this direction when defining,

> Art. 1 It is declared of **social interest**, for the **expropriation purposes**, under the terms of **articles 18, letter "d" and 20, item VI, of Law No. 4,504** of November 30, 1964, a land area measuring approximately 56,754 hectares (fifty-six thousands, seven hundred and fifty-four) hectares from **several owners**, located in the municipalities of Paranaíba, Campos Altos and São Gotardo, in the State of Minas Gerais [...] (DECRETO LEI Nº 72,786/73, emphasis added)

It is important to highlight that the "social interest" through which the expropriation of the area in question was justified based on articles 18, letter "d" and 20, item VI, present in the Land Statute. The letter "d" of article 18 justifies that it is considered a social interest "to allow the **social and economic recovery** of regions" (emphasizing that the expression "social recovery" refers to broad abstract and generic meaning regarding the 'social' concept, which can also assume an economic aspect), evidencing the centrality of the project's economic dimension, especially when considering item VI, article 20 of the same law, which assigns priority to expropriation to "lands whose current use, studies carried out by the Brazilian Institute of Agrarian Reform prove **not to be adequate to its vocation of economic use**" (DECRETO LEI Nº 72,786/73, emphasis added).

It is noted that the article 18 of the Land Statute presents eight justifications (from letters "a" to "h") for expropriation assuming social interest, including "condition the land use to its social function", which refers to other aspects of rural activity, such as the conservation of natural resources, the well-being of owners, workers and families; and "promote the **fair and proper distribution of property**", evidencing a 'pro-agrarian reform' interdiscourse. Likewise, article 20 presents in its section I that the expropriation of smallholding and large estate is a basic priority. Such discourse makes it possible to highlight the exclusion of interests related to the equated land distribution and to the solution of social problems of the countryside, similarly as it shows how the ideological discourse of agricultural modernization operates through the universalization (THOMPSON, 1995) of economic interests to the detriment of other interests as a means to legitimize politics.

In addition, the interdiscursivity present in Decree 72,786/73 shows that the choice of discourses legitimized by the Land Statute that would justify the expropriation of the area destined to the implementation of PADAP represented essentially the interests of groups aimed at the agriculture modernization, disregarding social aspects resulting from land concentration in the region and the living conditions of smallholders. Moreover, there are no references in the Decree to the terms 'large estate' and 'smallholding', demarcating a non-concern with the modification of these types of land structures in the program and simultaneously classifying all the owners that constitute the polygon to be expropriated as economically unfit and thus barriers to the country's economic development. It should be noted, however, that Article 3 of the same Decree establishes that properties inserted within the expropriation area with an area lower than 100 hectares would be excluded from the effects of the text, although they could benefit from the program structure.

In short, from this text, it is possible to observe the interdiscourse with the important 'conceptual chaos' in the Land Statute (SILVA, 2015), whereas considers and proposes instruments for agrarian reform aiming at a social function of equalization of the land structure, simultaneously allows reproducing the ideological discourse of agricultural modernization for economic purposes.

In the same way, it is possible to observe such discursive confusion and the traits of agricultural modernization ideology when considering the concept of 'settlement' presented by Bergamasco and Norder (1996, p. 8, emphasis added), understood as

> [...] the creation of new agricultural production units through government policies aimed at reordering land use **for the benefit of landless or little land workers.** As its meaning refers to the fixation of the worker in agriculture, it also involves the availability of adequate conditions for land use and the encouragement of social organization and community life.

Thus, when compared to the representation of the word 'settlement' in the program's name, it is evident the disconnection to this concept and the non-concern of the formulators to benefit actors harmed by the agrarian issue. The definition of the lot area (between 250 and 500 hectares), directed to Cotia cooperates with technical knowledge and production means, characterizes this colonization process in line with the purposes of conservative modernization (DELGADO, 2001). As evidence of this and as observed in the PADAP files, some settlers of the same family received lots of neighboring land, whose production happened without obeying a demarcation of confrontations, configuring the formation of properties with an area larger than1000 hectares, i.e., new large estates.

Still as an example of the representation of capitalist ideology and agricultural modernization in this program, an attorney general of the state of Minas Gerais argued in a petition addressed to the federal court that,

> [..] aiming at the **rational use of those lands**, provided for art. 20 of the Land Statute, thus providing economic and legal solutions to the matter, in order to **reduce the existing gap between industrial and agricultural development**, the petitioner, in the Public power body in charge of the **promotion and execution of Agrarian Reform**, comes by the present to expropriate judicially the cited properties, [...].

In this fragment, the petitioner seeks to justify expropriation for the purposes of a "rational use of the land", i.e., it relies on the discourse of an instrumental rationality, aimed at achieving ends in a utilitarian way, referring in this case to the agriculture modernization process. This type of argument is also often used as a means of justification and legitimation of capitalist ideology (CHIAPELLO; FAIRCHLOUGH, 2002).

It is important to note that these discourses were also situated in a macroeconomic context in which Brazil was an import country, although it was seen internationally as an "agricultural power". Thus, according to the following texts, extracted from interviews with two policy makers (actors who participated in the decision making and implementation of the policy) of PADAP, it can be noted that the agricultural modernization discourse was supported on the discourse of a so-called "global supply crisis" to inculcate its ideological effects in the formulation and implementation processes of the program,

> [there was a] world chart showing the following: **there are more people willing to buy from Brazil,** and Brazil has to prepare to offer (INTERVIEWER 1, emphasis added).

> **Brazil would crash**, that is when we had the need to look for alternatives. Where to produce? Through preliminary studies already existed and through a concentrated effort, we identified a savanna that was a **great alternative** for Brazil. We have more than 200 million hectares of savanna. We had a small technology, although we had initial confidence and in less than 20 years we have developed a more advanced technology that the world knows for tropical agriculture, which became important to the people inasmuch as farms no longer supply the world's needs [...] (PORTAL SG AGORA - Interview with Alysson Paulinelli, 2015, emphasis added).

Thus, it is possible to perceive with the use of expressions as "There are more people willing to buy from Brazil", "Brazil would crash" and "great alternative for Brazil" the ideological strategy of unification through symbolization (THOMPSON, 1995) of a Brazil's developmentalist project that would necessarily involve the agriculture modernization.

In this sense, as traits of the developmentalist discourse present among technical staff members of the State, one of the interviewees argues that PADAP was not seen as an experience or adventure, but as "the **only possible way** for national agricultural development" (INTERVIEWER 3). In addition, another fragment representing this discourse is present in,

> [PADAP] **was the basis for all this development**. The farmers were able to **accept technologies that we were suggesting**, they participated in the innovation process and developed the savanna here as a **base for other regions** (PORTAL SG AGORA - Interview with Alysson Paolinelli, 2015, emphasis added).

However, another interpretation of the formulation and implementation processes can be presented. One interviewee, when asked about the justifications that led to the savanna's agricultural exploration, stated that the interests were linked to demands other than the need for internal supply following urban sprawl or international trade agreements. In the words of the interviewee,

> [The variable] that weighed the most [in the program development] was the demand of children from Japanese immigrants who had already saturated their capacity to produce, mainly in São Paulo and Paraná states, since they were never in general owners of large areas, then there was no longer one generation with agricultural potential, there was more than potential, there was education and interest to keep on the land (INTERVIEWER 1).

Thus, we understand that the savanna exploitation policies were aligned with the combination of potential

agricultural entrepreneurs, represented by the generation of Japanese rural producers, plus the discourse focused on the need for "development" of the state of Minas Gerais and thus of Brazil itself, who until that time was a food importer. Thus, it was convenient for those involved that the agricultural exploitation policy of the savanna be developed by people with experience and production means for such purposes.

In short, the objective of those involved in PADAP would be to implement an agricultural modernization project based on farmerization, mechanization and the strong presence of scientific capital, especially by the presence of high level researchers from Brazilian universities, such as UFLA and UFV. According to one of the interviewed settlers, Japanese descendant and agricultural engineer:

> The idea was that PADAP's **agrarian reform was not social** like the others, it was **only economic**. The plantation should use technology in lands of sufficient size to support mechanization. A group from here went to the United States to work on the farms to learn how to do it there. Cotia paid for everything. It was to have a lot of productivity. Doing like the Americans. It was the settler and the machines. We came young, no family, without machine, there was no way to produce, it **was never intended to be family farming. It had to be all modern** (INTERVIEWED 4).

The justification of the unemployment model of instrumental character adopted is made in the discourse of this settler:

> Here, everything was large estate, unproductive land, without any small property, no... I do not know this story about 100 hectares. **People here did not enter in reform because they had no interest.** If I wanted I could... They threw sugar on the tractors. Then, the army came to protect us. They called the people of sparrow (INTERVIEWER 4).

In this sense, the choice for the official colonization model is justified, mediated by the Cotia Cooperative, an organization marked by its investment strategies and programs in Science and technology of its cooperates. It was not convenient for the actors involved in the formulation of this policy to allocate the state effort in the development of the 'agrarian issue' in the region, structurally changing the rural working conditions in the savanna, starting from the region's own producers and landowners. However, in the policy formulation and implementation process, 'conceptual chaos' (SILVA, 2015) becomes evident in the discourse of policy makers, especially through the use of the Land Statute as an instrument for legitimizing the reproduction of an ideological discourse aimed at agricultural modernization.

5 FINAL CONSIDERATIONS

In this study, we seek to understand, through the categories of the representational meaning of discourse offered by the CDA, the discourse representations involving the formulation and implementation processes of the PADAP, especially highlighting the discourses (re) produced by policy makers and settlers who received lands in the policy area and their representations around the Brazilian 'agrarian issue'. We understand that this proposal innovates by revealing empirical representations of a little discussed policy from a reference of public policies and discursive analyses.

We understand that the agrarian reform proposal advocated by agronomic engineers and conservative economists, endorsed by the military government and used as a legal justification for the implementation of PADAP, had as its main characteristic an ideological discourse aimed at promoting agricultural modernization, distancing itself from pro-agrarian reform discourse assumed by social movements of the countryside and political leaders of the left during the 1960s (especially in the government of João Goulart).

However, this study does not question the program results, although several papers show impacts in the Alto Paranaíba region and in the savanna region as a whole, showing the economic growth and the increase in social indicators, even though emphasizing damages and negative impacts to the environment from agricultural modernization with a focus on extensive irrigated planting, use of chemical pesticides, and deforestation of the native vegetation of the biome (SANTOS et al. 2014).

However, it should be highlighted that the agricultural modernization project adopted through a colonization program did not consider the possibility of focusing the policy resources to the population already established in the region, composed of families of producers distributed in small and medium-sized properties, which mostly did not have basic education and did not have production means that would at first attend to the exploration objectives and strategies of the field through mechanization and integrated credit.

On the contrary, these subjects and their social and historical conditions were not considered in the formulation process, which was reflected in existing

conflicts in the implementation and adaptation of them to the credit policy and technical assistance due to their unfamiliarity with own discourses of the financial market and scientific knowledge (SASAKI, 2008). We also note that terms like "peasantry" were silenced in the analyzed discursive representations.

The PADAP formulation and implementation process also highlights the conflict and the conceptual and discursive chaos involved in the Land Statute insofar as the program used agrarian reform instruments, but the main interest in question was not based on the land redistribution seeking to serve social ends and to combat the ills of the countryside.

It is also important to highlight the importance of research and reflect on the discursive practices of a past and already consolidated agricultural and agrarian policy. Even if they reflect the historical and political context of the 1970s, the ideological clash between the social function of the land and its rational use is still present today, not only in the agrarian issue, but also in the urban issue. In this sense, we argue that the CDA can still provide greater impetus for the analysis of public policies and discussions around this theme.

Even if more than 40 years have passed, the actuality of discursive practices and the appropriation of different meanings by capitalist discourse still remains. The analysis of public policies can incorporate the dimension of discourse, which is always performative and affects reality, thus revealing the diverse interests of policy makers and other social actors involved in the whole political process. In other words, the experiences surrounding the PADAP increase the debate about the agricultural and agrarian policies of the Brazilian savanna and serve as reference for the understanding of contemporary conjunctures in this space, as well as for the formulation of new policies.

As limitations, we recognize that the cut used in this study did not conform to all the discourses involved in the policy formulation and implementation processes, nor understood the voices of all actors as an extension of this discursive corpus.

It is suggested to analyze other discourses in future studies, as well as to develop analysis on the actional and identificational meanings involved in the development of PADAP or other agrarian policies that marked the period of conservative modernization in Brazil. In the same way, it is suggested an extension of the study when considering other agrarian reform practices that happened in the Alto Paranaíba region from the 1990s, some of them even involving areas that received incentive due to PADAP.

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NETWORK AND INNOVATION AT THE BRAZILIAN AGRICULTURAL RESEARCH CORPORATION

ABSTRACT

Brazil is a major producer of food, fiber and renewable energy, having great importance for the world's food security. The country has substantially invested in Research, Development and Innovation (RD&I) in the last four decades and the Brazilian Agricultural Research Corporation (Embrapa) has been coordinating this effort. This study aimed to explore the association between centrality measures for research networking and the generation of innovations by Embrapa research centers and their partner institutions. The study analyzed patent applications from Embrapa between the years 1980 and 2009. The methodological techniques applied were social network analysis, correlation and simple linear regression. Results indicate that the greater centrality in research centers networks of Empraba were associated with higher levels of innovation. Results also evidenced the importance of networks, such as the National Agricultural Research System (SNPA, in portuguese), on generating innovation for agriculture. These findings suggest that public policies promoting agricultural innovation should be designed to strengthen collaboration among institutions and not only with individual scientists.

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1 INTRODUCTION

Brazil is a major producer and exporter of food, fiber and renewable energy, having great importance for the world's food security. The Brazilian agribusiness represents almost two thirds of the national Gross Domestic Product (GDP) (CEPEA-USP and CNA, 2012), considering the overall sum of farming, processing and inputs from manufacturing sectors.

Davis and Goldberg (1957) defined agribusiness as the sum of all production and distribution operations of agricultural supplies, farming operations, storage, processing and distribution of agricultural products as well as their produced items.

To achieve such accomplishments in agribusiness, Brazil has made important investments in Research, Development and Innovation (RD&I) in the last four decades. The creation of the Brazilian Agricultural Research Corporation (Embrapa) was a major milestone in this process, whose work added to other incentives, led the country to substantial production increases, turning Brazil into one of the world´s leaders in the sector (Gouvea and Kassicieh, 2012).

Therefore, from a broad perspective, organizations such as Embrapa are also important for the national agribusiness development because the sector constantly faces new challenges, for instance, changes on regulations, consumer preferences, new competitors, new pests and diseases among others. Thus, the knowledge from several sources is needed to deal with such changes, requiring a dense network of connections. Most of these problems cannot be solved by a single farmer, which demands changes in different segments of the value chain (The World Bank, 2006).

Following this logic, there is an organized partnership for agricultural research in Brazil called the National Agricultural Research System (SNPA). It includes institutions such as Embrapa, the State Agricultural Research Organizations (OEPAS), universities and other organizations related to agriculture research (Cornell University et al., 2017).

Historically, the RD&I in agriculture hve been encouraged by the Brazilian Federal Government. Recent signs of this effort are the Innovation Law, the Constitutional Amendment 85, the Agribusiness Sector Fund (CT-AGRO) and the ABC Plan (Low Carbon Emissions Agriculture). The Law No. 10973 / 2004, called Innovation Act, regulated by the Governmental Decree 5563, was created to encourage and legitimate innovation, simplifying interactions among universities, research institutions and the production sector.

Recent studies have explored the influence of collaboration in generating innovation, showing that networks have a positive effect in generating knowledge. The most recent work can be found at: Protogerou et al. (2013), Temel et al. (2013), Uddin et al. (2013), Paula (2014), Wang and Hsu (2014), Pinto et al. (2015), Shiri et al. (2015).

Considering the importance of the Brazilian agribusiness and the already existing national network of institutions focused on research and innovation for agriculture formalized as the SNPA, in which Emprapa research centers play a major role, it is very important to better understand the relationship between collaboration and accomplishing innovation. In this sense, the major goal of this work is to explore the association between social network and the generation of innovations among Embrapa research centers and its partner institutions.

However, it is important to be aware that the context of innovation is complex and varied. According to Robertson and Langlois (1995) its environment has great possibilities for efficient relationships, which there is some level of uncertainty if public policies will always be adequate for a substantial share of industries. According to the authors, attempts to implement policies could be even destructive. Therefore, improving the knowledge on how these relationships happen is essential to reduce the risks of governments deteriorate instead of improving current environments, which is another important contribution of this work in the long run.

2 LITERATURE REVIEW

2.1 Innovation Networks

Inter-organizational networks for innovation, or simply innovation networks, are complex networks of relationship between companies, universities and other research organizations associated with the generation and sharing of relevant knowledge for technological innovation (Malerba and Vonortas, 2009).

For Björk and Magnusson (2009), social networks have been recognized for their importance for improving learning and creating new knowledge. This phenomenon happens through communities that spontaneously form groups of people looking for knowledge share that promotes innovation. Thus, network analysis helps to explore the structural and relational aspects of social networks within an organization.

For Wang e Hsu (2014), the development of a relationship has a positive impact on innovation. According to the authors, relationships develop progressively when organizations learn from the interactions among themselves and commit even more enthusiastically to the relationship. During this process, partners learn about resources, strategies and business context of other sectors. In this regard, management should not concentrate only in innovation systems, but also in support learning on how to relate with partners.

An important characteristic of innovation networks is that the innovation process is interactive and systemic, which means that learning occurs by means of interactions. The ability to generate, apply and disseminate new knowledge transcends the sphere of individual companies and starts to happen through constant interaction among companies and other organizations. The formation of innovation networks can be also motivated by the desire to reduce uncertainty and complexity inherent to innovation, especially regarding factors associated with demand (Alves et al., 2004; De Pellegrin *et al.*, 2007).

2.2 Structural Aspects

For Newman (2006), a network is a set of items, called vertices or nodes with connections between them called edges or lines. Structural characteristics are aggregated to the characteristics of relationships between nodes, which leads to a scenario where both structural and relational characteristics are important for network analysis.

According to Jackson (2008), the set N = {1, ... , N} is a set of actors that are involved in a network of relationships. The author emphasizes that actors can be individuals, companies or other organizations. For example, Protogerou et al. (2013) found that educational institutions and research centers tend to have a more active and prominent role in the networks examined.

Some structural characteristics have implications for network analysis, such as the actor's position in the network, what can influence the movement of assets, information and status causing asymmetry of resources. This allows some actors to acquire more competitive benefits of their relational ties in the network than others, as discussed in the next topic.

Burt (1992) stated that more central actors have higher social capital than other network members. This happens because these actors can have control over the relationships of others, taking advantage from knowing something the others do not know, besides mobilizing individuals without intervention of other actors.

Therefore, information about how an actor is central can be very important. In the same way, indications about an actor´s position in a network can be helpful. The centrality, as reported by Jackson (2008), is a micro measure for comparing actors, reporting how a particular actor relates to the entire network.

To Steiner (2006), the centrality that characterizes the relative position of actors in a network increases as the actor gets a greater number of connections with other actors. Many different measures of centrality have been developed and each of them intends to identify different aspects of the concept. This work adopts two centrality measures: degree centrality and betweenness centrality. In a study addressing a similar subject, Uddin et al. (2013) identified that degree and betweenness centrality values of authors in a co-authorship network influence the performance (i.e., citation count) and formation (i.e., tie strength) of scientific collaborations.

Degree centrality means how intensely an actor is connected. The centrality measure for an individual actor refers to the actor's degree *d (ni),* which is obtained by the number of relationships that are linked to it. The degree of an actor is a score ranging from 0 (where the actor is considered isolated) when there are no adjacent actors, and up to *n - 1*, when an actor has relations with all other actors in the chart, where *n* represents all actors in the network (Wasserman and Faust, 1994).

The degree centrality (*CD (ni*)) of an actor is obtained by the Equation 1:

$$C_D(n_i) = d(n_i) = x_{i+} = \sum_j x_{ij} = \sum_j x_{ji} \quad (1)$$

where,
ni represents an actor;
d(ni) corresponds to the actor's degree;
n refers to the number of actors in a network;
X i + is the degree of an actor
∑xij is a matrix notation, which corresponds to the degree of an actor.

For Wasserman and Faust (1994), action happens on the network in an actor with a high degree centrality. An actor with a high degree is in direct contact or adjacent to many other actors. Therefore, this actor should be recognized as a great relational information channel. In fact, this actor is a key player in the network and occupies a central location. On the other hand, if the actor is completely isolated (*d (ni) = 0*), the removal of this actor from the network has no effect on current relationships.

This measure intuitively shows how well a point is connected with its environment and it can be assumed that the corresponding agent has a central role because it is well connected and "in the thick of things" (Scott, 2017). According to Yan and Ding (2009), actors with a higher degree centrality tend to have a greater capacity to influence others.

In the studies from Abbasi et al. (2011), Eslami et al. (2013) and Guan et al. (2016), a high score on degree centrality was associated to a higher innovation activity resulting from network collaboration.

However, for Hansen, Shneiderman and Smith (2011), the degree centrality is a simple counting of the total number of connections linked to an actor and can be considered as a kind of popularity measure, being a rough measurement that does not recognize the difference between quantity and quality. The authors illustrate that this measure does not distinguish between an actor that is the president of the United States to another who is a student who dropped out school. Therefore, it is important to also present a more complex centrality measure, which is the betweenness centrality.

Betweenness Centrality is a centrality measure proposed by Freeman (1977) based on how well situated an actor is in terms of its distance to other actors. In the betweenness centrality, the actor acts as mediator among the others. Therefore, according to Wasserman and Faust (1994), an actor is central when it is among other actors in their geodesic (shortest distance that joins two actors). This implies that, to have a great betweenness centrality, the actor should be among many of the actors through their geodesics. Scott (2017) considers that betweennes centrality will eventually become the most complex centrality measures to calculate.

Wasserman and Faust (1994) found that having a large betweenness centrality allows more control over

the flow of information, or even more control over the interactions between actors. Everett and Borgatti (2005) share the same assumption, adding that a greater degree of centrality is positively related to social capital.

For Yin *et al*., (2006), individuals with high betweenness centrality in a network are pivotal for knowledge flow, which is critical for the development of new products and innovative ideas. Studies by Ferriani et al. (2009), Abbasi et al. (2012) and Guan et al. (2016) found a positive influence of betweenness centrality towards a tendency to generate innovation.

The Equation 2 that calculates betweenness centrality for an actor, presented by Jackson (2008), is as follows.

$$Ce_i^B(g) = \sum_{k \neq j : i \notin \{k,j\}} \frac{P_i(kj)/P(kj)}{(n-1)(n-2)/2} \quad (2)$$

where,
Pi(kj) is the number of geodesics (shortest path) between k and j;
P(kj) is the total number of geodesic between k and j;

According to Jackson (2008), the betweenness centrality takes values between 0 and 1. The closer the betweenness centrality of actor *i* is to 1 means that it is positioned with maximum short paths connecting *k* and *j*; and the closer to 0 means that the actor i is less critical for *k* and *j*.

Hansen *et al*., (2011) understand the betweenness centrality as a measure of the frequency that a particular actor is found in the shortest path between two other actors. The intermediate actor could be considered as a "bridge" that allows estimating how much the removal of this actor would break the connections among other actors in the network. This raises the concept of structural gap, which is a missing link between two actors. Wherever two or more groups cannot connect, it can be argued that there is a structural crack that is waiting to be filled.

3 METHODOLOGY

This is a quantitative research, where secondary data were used. The study is characterized as documental and retrospective (Marconi et al., 2003). This approach was chosen because it allows identifying patents, which has documented information, being a rich and stable database, available from official sources, which granted reliable access to information (Gil, 2002).

3.1 Research Data

Embrapa was selected for this study because it is responsible for coordinating the Brazilian National Agricultural Research System (SNPA) and for being considered one of the main institutions of the national innovation system in the Brazilian agribusiness, playing a key role on agricultural research in the country.

Embrapa is also known for its strong use of intellectual property protection and has served as a model for other centers on how to manage technology and technology transfer to other companies and institutions (Cornell University et al., 2017).

Embrapa, as leader of the strong SNPA network, involves its 46 research centers, each specialized in a particular topic (Correa et al., 2014). These institutional characteristics signalize the previous existence of centrality in the network to be studied.

Present in all regions of Brazil and generating knowledge and technology for tropical agriculture, Embrapa has over 9,700 employees, of which about 2,500 are researchers. Its annual budget is around 3 billion Brazilian Reais (BRL) (Embrapa, 2017).

According to the Organization for Economic Co-operation and Development [OECD] (1997), patents are fundamental S&T indicators for measuring innovation. Thus, patent data, considering both requests and concessions, correspond to an intermediate result of innovation activity and are an indicative of the innovative capacity of a company.

Secondary data related to patents used in this research are from the National Institute of Industrial Property (INPI) database. Data were analyzed considering the inventor's name and affiliation to one of the Embrapa research centers, since the database has only Embrapa as depositor or holder and not specific centers. This happens because patent applications are carried out by a central office at Embrapa Headquarters in Brasilia-DF.

As semantic search engine for the database e-Patents from INPI, the keyword used was "Embrapa". In this way, all patent applications made by Embrapa were located, which included all patents applications already granted, under analysis, rejected, in process of forfeiture, filing and in extinction.

For network analysis, it was considered the network of actors formed by organizations that include Embrapa research centers and their partner organizations. For linking inventors to their respective Embrapa center, the Brazilian academic curriculum database from the

National Council for Scientific and Technological Development (CNPq) named "Plataforma Lattes" was used. The inventor's affiliation to a given Embrapa research center was checked for the year the patent application was made.

By 30th July 2013, the search found 282 patent applications for Embrapa, done between 1980 and 2009. During data processing, some data were excluded due to methodological issues, since they did not contain enough information that would be necessary for the analysis, and most of them were related to classified patent applications. After this step, a total of 222 patent applications were left for analysis. From these data, it was possible to identify 64 actors in the organizational patent network, being 30 Embrapa research centers and 34 Embrapa institutional partners. From these data, an analysis of social networks was carried out, as presented in the next topics.

3.2 Method of Analysis for Social Networks

An observation can be linked to another through network connections. Therefore, if there is a connection between the actors *i* and *j,* this indicates that the actors can influence each other so that their variable attributes become similar to each other (Robins, Lewis and Wang, 2012).

The network analysis approach, according to Salmon *et al.*, (2013), is centered on the use of networks to describe information or implied concepts of conscience and relations between the actors.

For this work, the social network analysis was performed using the free software Gephi, version 0.8.1, which enables the exploitation and manipulation of networks and graphs. Its architecture is flexible and multitasking, which allows working with complex data sets, producing valuable visual results. It also provides easy and comprehensive access to network data and enables spatialization, filtering, navigation, manipulation and grouping, enabling dynamic visualization of network. Furthermore, the software provides metric results for the measures that were used in this study, namely: number of players, number of relational ties and measures of centrality (Bastian, Heymann and Jacomy, 2009).

The degree centrality and betweenness centrality in the patent generation networks were analyzed through the Gephi software. Chart 1 summarizes the centrality measures adopted.

In addition to the centrality of the network analysis, statistical analyzes were also performed and are presented in the following section.

CHART 1 – Summary of the centrality measures

Centrality measure	Definition	Result interval
Degree centrality	Number of relationships that are incident on an actor.	From 0 to n - 1 (where n is the total number of actors on a network)
Betweenness centrality	Frequency that an actor appears in the shortest paths among the actors of the network.	Of 0-1 (the closer to 1, the more central is the actor and the closer to 0, the less central is the actor)

Source: Adapted from Wasserman and Faust (1994)

3.3 Statistical Analysis

Correlation and simple linear regression were used to understand associations between centrality and the generation of innovations. Therefore, for the correlation analysis, the indicator used was the Pearson product-moment correlation coefficient or simply Pearson´s correlation coefficient, which measures the relative strength of a linear relationship between two numerical variables in which the correlation coefficients range between -1 for a perfect negative correlation, and +1 for a perfect positive correlation. The higher the quality of the setting (or linear association) the closer to -1 or +1 will be the value of the coefficient R (Berenson, Levine and Krehbiel, 2011; Martins and Domingues, 2011).

A simple linear regression analysis was also performed, where a single independent numerical variable X is used to estimate the numerical dependent variable Y. The regression analysis allows to identify the type of the mathematical relationship between the dependent and independent variables and to quantify the effect of the changes that the independent variable has on the dependent variable (Berenson, Levine and Krehbiel, 2011).

The quality of the adjusted model is measured by R^2, called R-squared, that describes the amount of variation in the response that is explained by the least squares line. Its value ranges from 0 to 1 (Diez, Barr and Çetinkaya-Rundel, 2012).

The linearity, nearly normal residuals and homoscedasticity of the residuals, necessary for the linear regression analysis, were tested by the scatterplots of the data and residuals plot, residuals histogram and normal probability plot of residuals (Diez, Barr and Çetinkaya Rundel, 2012).

Therefore, in order to verify the association between the generation of innovation and the position of the actors in the networks, simple linear regression analysis was used.

As a measure for generation of innovation, the data was tested separately for each measure of centrality. The actors analyzed were Embrapa research centers and positioning measures were degree centrality and betweenness centrality.

Results are presented showing the scatterplots with the least squares lines, the equations of the regressions lines, the R-squared (R^2) and the p-values. The equations were tested using least squares regression. For this, the open-source R statistics software combined with RStudio software was used. A 95% confidence level was used for all tests.

4 RESULTS AND DISCUSSION

4.1 Analysis of the Centrality for Embrapa Innovation Networks

Two measurements were considered: degree centrality and betweenness centrality. These parameters were analyzed separately within the organizational patent network.

Table 1 shows the 30 Embrapa research centers and their individual measures regarding patents applications between 1980 and 2009, degree centrality and betweenness centrality.

TABLE 1 – Number of patent applications made between 1980 and 2009 and centralities of the Embrapa research centers

Embrapa research centers	Patents applications	Degree centrality	Betweenness centrality
Embrapa Instrumentation	50	12	0.28
Embrapa Genetic Resources and Biotechnology	30	11	0.28
Embrapa Food Technology	28	7	0.29
Embrapa Southeast Livestock	7	6	0.13
Embrapa Agrobiology	8	5	0.05
Embrapa Tropical Agroindustry	6	5	0.12
Embrapa Coffee	3	5	0.07
Embrapa Goats and Sheep	4	4	0.06
Embrapa Maize and Sorghum	13	4	0.05
Embrapa South Livestock	6	4	0.1
Embrapa Cerrados	11	3	0.13
Embrapa Temperate Agriculture	9	3	0
Embrapa Dairy Cattle	8	3	0.03
Embrapa Environment	9	3	0.05
Embrapa Soybean	9	3	0
Embrapa Swine and Poultry	3	3	0.05
Embrapa Cotton	1	2	0
Embrapa Western Amazon	2	2	0
Embrapa Eastern Amazon	10	2	0.02
Embrapa Rice and Beans	5	2	0
Embrapa Beef Cattle	8	2	0.02
Embrapa Semi-Arid	1	2	0
Embrapa Wheat	8	2	0
Embrapa Vegetables	5	1	0
Embrapa Pantanal	1	1	0
Embrapa Acre	1	0	0
Embrapa Agriculture Informatics	1	0	0
Embrapa Soils	1	0	0
Embrapa Coastal Tablelands	2	0	0
Embrapa Grape and Wine	2	0	0

Source: Data based on INPI and CNPq

A total of 30 Embrapa research centers, alone or together with partners, sent patent applications to INPI in the period between 1980 and 2009. The average number of patents per center was 8.4. It is important to remark that 9 of the 30 centers stood above this average.

Embrapa Instrumentation showed the highest degree centrality for organizational patent networking. As for the betweenness centrality, that unity was the second most central actor along with Embrapa Genetic Resources and Biotechnology, second only to Embrapa Food Technology. From the total of 222 patent applications assessed, Embrapa Instrumentation, alone and with partners, accounted for 50 requests, representing the Embrapa center with the largest number of patent applications in the period. Second in the ranking was Embrapa Genetic Resources and Biotechnology, with 30 applications, being also the unit with the second highest value for degree centrality and betweenness centrality.

It should be noticed that the Federal University of Rio de Janeiro (UFRJ), an important partner of Embrapa, had the third highest score for degree centrality (8) and the fourth largest value for betweenness centrality (0.27). UFRJ had 6 patent applications in partnership with Embrapa research centers.

The Embrapa Food Technology had 28 patent applications individually or with partners, being the center with the third highest number of patent applications. It also held the third position among Embrapa centers for degree centrality.

Five Embrapa centers showed a zero value for degree centrality and betweenness centrality, namely, Embrapa Coastal Tablelands, Embrapa Grape and Wine, Embrapa Acre, Embrapa Agriculture Informatics and Embrapa Soils, having only one or two patent applications each. Pictures 1 and 2 clearly show the position and impact of the four institutions that reached the highest number of patents as well as the highest degree centrality and betweenness centrality.

In general, these results have shown that there is a positive relationship between network centrality and generating innovation. However, according to Björk and Magnusson (2009), centrality presents some limits. These limits are related to the argument that high quality innovative ideas can be seen as a stage function, where until a given level, high network centrality will also provide high-quality innovation, but above that level, being better connected will not necessarily be positive (Björk and Magnusson, 2009).

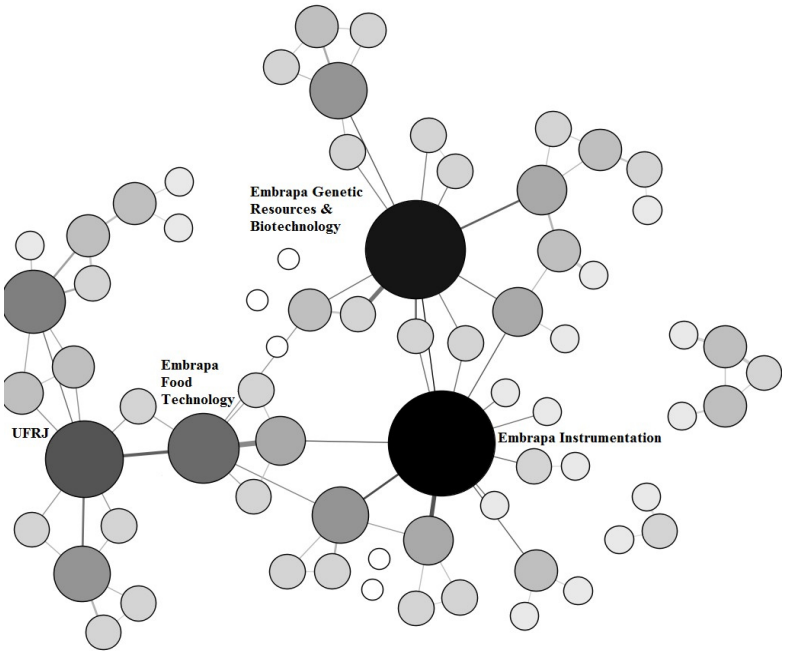

FIGURE 1 – Degree centrality for organizational patent network among Embrapa research centers and its institutional partners between 1980 and 2009
Source: Research data

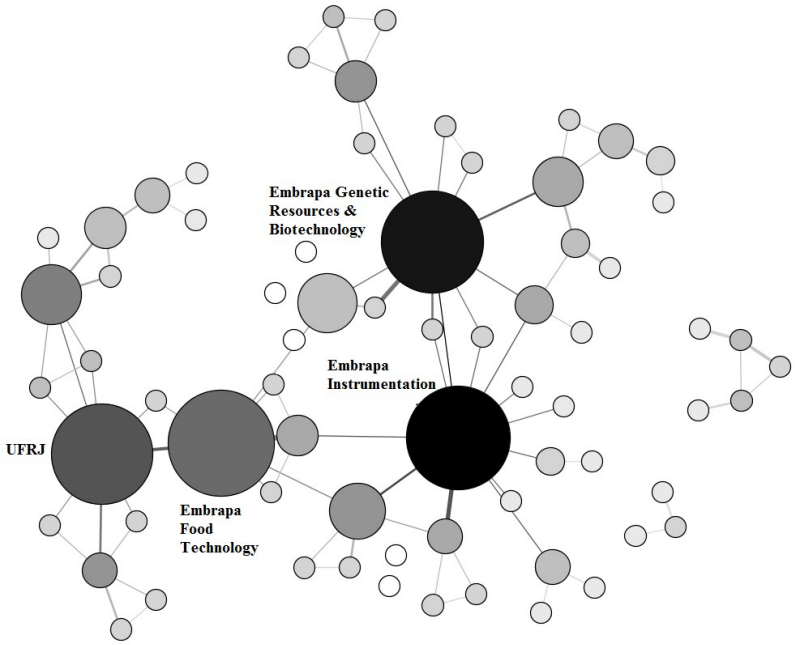

FIGURE 2 – Betweenness centrality for organizational patent network among Embrapa research centers and its institutional partners between 1980 and 2009
Source: Research data

Degree centrality and betweenness centrality are conceptually distinct, since the first measures only the number of connections one actor has and the second considers the actor as a bridge, and measures its geodesic among other actors. However, in this study it was observed that the four most central actors also reached the highest scores for both evaluations.

The four most central actors (Embrapa Instrumentation, Embrapa Genetic Resources and Biotechnology, Embrapa Food Technology and Federal University of Rio de Janeiro (UFRJ)) follow the findings from Protegerou et al. (2013) in which research centers and institutions of education have an active role on innovation networks. According to Scott (2017), these institutions are well connected to their surrounding environment and they have a central role in generating innovation.

There are indications that the centrality of the actors is contributing to innovation, as the most central actors in the network are the ones who requested the largest number of patents in the period. Thus, these actors are very important for innovation, corroborating with results from Uddin et al. (2013), in the sense that the degree of centrality positively influences innovation performance.

4.2 Relationship Between Innovation and Centrality Measures

Intending to have an overview of the innovation networks, the Pearson's coefficient between centrality measures and the amount of patent applications was calculated and shown in Table 2. Centrality analyzed measures included only Embrapa research centers.

TABLE 2 – Correlation between number of patent applications and centrality measures among Embrapa research centers between 1980 and 2009

	Number of patent applications	Degree centrality	Betweenness centrality
Number of patent applications	1		
Degree centrality	0.85	1	
Betweenness centrality	0.84	0.89	1

Source: Research data

For Berenson, Levine and Krehbiel (2011), the correlation coefficient measures the relative strength of a linear relationship between two numerical variables in which the correlation coefficients range between -1 and +1, corresponding to a perfect negative correlation and a perfect positive correlation respectively. Table 2 shows that both measures of centrality have a significant positive correlation to the amount of patent applications. Degree centrality had 0.856 as the greatest value, which according to Martins and Domingues (2011) indicates good correlation. With a value a slightly under 0.849, the correlation between the number of patent applications and betweenness centrality is also high. These high correlations between the amount of patent applications and the two-centrality measures suggest that centrality can contribute to the generation of innovation.

Aiming a deeper analysis to establish a possible functional relationship between measures of centrality and innovation, a simple linear regression analysis was also performed. Its results are presented in the next section.

4.3 Association Between Centralities and Innovation

Figure 3 represents the scatterplot of patent applications and degree centrality.

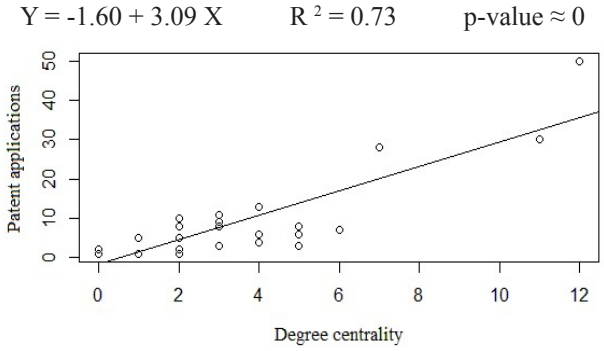

FIGURE 3 – Scatterplot of patent applications and degree centrality for Embrapa research centers between 1980 and 2009
Source: Research data

From this analysis it can be observed that 73.3% of the variability in the number of Embrapa patent applications is explained by the degree centrality. This value for the coefficient of determination indicates that the model's explanatory power is high according to Martins and Domingues (2011). As the p-value was approximately zero, it can be said that the degree centrality is a significant predictor for the number of patent applications for Embrapa centers.

The beta value was positive, reaching 3.09. This means that for each increase of one degree in degree centrality, it can be expected an average increase of 3.09 in the patent applications involving an Embrapa research center. This finding follows the same pattern as proposed by Abbasi et al. (2011), Eslami et al. (2013) and Guan et al. (2016).

Figure 4 shows the association of patent applications regarding the betweenness centrality.

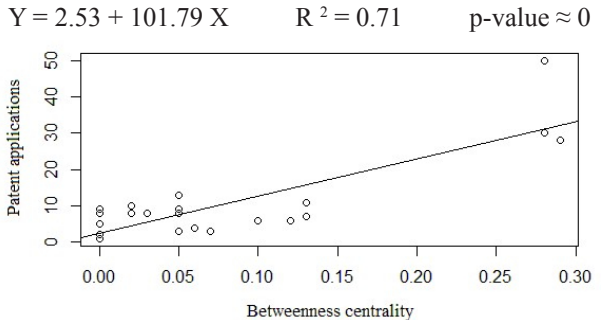

FIGURE 4 – Scatterplot of patents applications and betweenness centrality for Embrapa research centers between 1980 and 2009
Source: Research data

The betweenness centrality explains in 71% the variability in the number of Embrapa patent applications. According to Martins and Domingues (2011) this explanation power from the model is intermediate. According to Wasserman and Faust (1994), greater betweenness centrality can generate a greater control over information flow or generate control over relationships among other actors.

Since the p-value was approximately zero, it can be said that the betweenness centrality is also a significant predictor for the number of patent applications by Embrapa centers. It plays an important role for innovation on these research centers, once from the study it became clear that there is a positive and significant relationship between this measure and the number of patent applications made over the three decades analyzed.

The beta value was positive, reaching 101.79. This means that for each increase of 0.01 degree in betweenness centrality, it can be expected an average increase of 1.01 in the patent applications involving an Embrapa research center.

These results confirm the ideas defended by Yin *et al*., (2006), suggesting that actors with high betweenness centrality, by controlling the flow of knowledge, are of great importance for the development of new products and innovative ideas. Similar results showing the influence of

betweenness centrality in innovation activities were also obtained by Ferriani et al. (2009), Abbasi et al. (2012) and Guan et al. (2016).

5 CONCLUSION

Results from this work follow the findings from Protogerou et al. (2013), Temel et al. (2013), Uddin et al. (2013), Paula (2014), Wang and Hsu (2014), Pinto et al. (2015) and Shiri et al. (2015), showing association between social network and the generation of innovations among Embrapa research centers and its partner institutions. Part of the findings from Temel et al. (2013) was not similar to results from this work. The authors found that cooperation with universities did not increase tendency to innovation, while in this work Federal University of Rio de Janeiro (UFRJ) was highlighted as one of the institutions with a central position in the whole network studied.

Results regarding degree centrality complemented the findings from Abbasi et al. (2011), Eslami et al. (2013) and Guan et al. (2016), since they show that this measure has influence on generating innovation. The same happens to betweenness centrality, where results found corroborate the findings from Ferriani et al. (2009), Abbasi et al. (2012) and Guan et al. (2016).

The results herein found show that collaboration through the innovation network studied favored innovation, generating an increase in the number of patents. As previously mentioned, the success of Brazilian agribusiness came from investments in Research, Development and Innovation (Gouvea and Kassicieh, 2012), and Embrapa's research centers, together with SNPA had a relevant role in this process (Cornell University et al., 2017), also evidenced by results of this work.

It is important to mention that the findings from this work contain relevant information for setting public policies, which can be used to avoid risks mentioned by Robertson and Langlois (1995). It is important to remark that public research institutions in Brazil are overloaded with bureaucracy. This negatively affects agility and flexibility, which are fundamental features for generating innovation. The same is true for establishing collaboration among institutions and building partnerships, especially with the private sector. Therefore, to improve networking and knowledge sharing, one of the first structural changes necessary is related to rules applying to public science and development institutions. It is necessary to facilitate purchases and contracts in order to leverage innovation as a whole and for agriculture in Brazil.

Despite an evident interest in improving collaboration to catalyze innovation, a few studies were carried out to examine the impact of collaboration on innovation in emerging economies (Temel et al., 2013). This work is a clear demonstration that a solid collaboration network in an emerging economy country significantly contributes for generating innovation.

As a limitation, the data provided evidenced a naturally occurring association between variables, but they cannot by themselves show a causal connection. Experiments are suggested to explore this relationship between variables.

The networks monitoring through measures of centrality can be considered one important management implication of this study because it can help improvement on generation of innovation by research centers. Centrality analysis can be performed periodically, improving decision-making and guiding management to a better institutional positioning towards innovation.

Case studies focusing on Embrapa research centers that show more innovation could help to better understand the reasons that led to these results and would help identifying good practices that can be adopted in other centers.

Similar studies could be carried out focusing on different and specific innovation assets such as plant varieties, software and trademarks, also including other economic sectors, in order to compare innovation network behavior.

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CONSUMERS INTENTION TOWARDS PURCHASING IP CERTIFIED BEANS: AN ANALYSIS USING THE THEORY OF PLANNED BEHAVIOUR (TPB)

ABSTRACT

The patterns of consumption of food have been rapidly changing. This change has been reflecting in the increase of safer and more sustainable food consumption. Agricultural foods that are grown in Integrated Production (IP) also match the new consumer food quality patterns. In Brazil, the supply of IP certified products is still small. The objective of the present study was to evaluate the consumer perception and intention of purchasing certified beans based on the replication of the Theory of Planned Behavior (TPB). The survey was conducted in Goiania (GO), Brazil, in 2014, when 160 consumers of common beans were interviewed in a local hypermarket. Data were analyzed based on the structural equation modeling (SEM). The results revealed characteristics of consumer behavior when faced to certified beans as a hypothetical product, since they are not yet available on the market. The results indicated that the theoretical model based on the TPB used to explain the intention behavior of purchasing certified beans resulted in reasonable fit indices, but with only some of the relations among constructs were consistent with the theory. Thus, the results showed that the proposed model was adequate for explaining the consumer behavior towards the IP certified beans purchasing. As exceptions, one can refer the constructs subjective norms and perceived behavioral control toward the intention of purchasing.

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1 INTRODUCTION

Comprehending the consumer decision-making process requires knowledge in different areas such as, marketing, psychology, economy and management. Several studies on consumer behavior have sought to understand the consumer logic of consumption (Magistris & Gracia, 2008; Hoppe et al., 2012; Govindasamy & Italia, 1999). Most of these studies show that the attention on food consumption patterns is not only related to food quality and price. Some of them have investigated consumer demand, commonly measured in terms of willingness-to-pay (WTP) for products with higher levels of quality and safety, in countries such as Australia, Canada, France, Germany, Greece, Italy, UK, USA and others. Some of them also investigated consumer WTP for various food certification and labeling schemes (Birol, Roy, Deffner, & Karandikar, 2009). Other studies involved a wide array of food safety and quality issues such as food risks perceived by consumers, product quality and ethical and/or environmental issues (Caswell & Siny, 2007; Kuhar & Juvancic, 2010; Scarpa, Spalatro, & Canavari, 2002).

In this context, quality attributes such as foodborne pathogens, heavy metals, pesticide residues, food additives and veterinary residues became important elements in the consumer decision-making process. Another issue that became important from the consumer point of view was the production methods that focused on sustainable practices involving different concerns, such as those related to the environment and human health.

Consumers cannot directly recognize sustainability aspects because they are normally credence attributes. In this sense, consumers can never ascertain by themselves the presence of such attributes. They have to rely on the given information. Due to the credence aspect of such attributes, credence goods require standards or certifications to provide information to consumers, legitimating health and safety regulation (Moser, Raffaelli, & McFadden, 2011). Indeed, the standards can help consumers to evaluate the

quality of food products by increasing the transparency of the production processes and the traceability of products.

The movement toward safe foods started in Europe with the successive food crises during the last thirty years. The contaminant based 'food scares' (antibiotics, hormones and pesticides) became more concerning to consumers than hygiene standards and food poisoning. Consumers also mentioned worrying about the 'cocktail effect', which is the synergistic effect of different pesticide residues (Fontes, Giraud-Héraud, & Pinto, 2013).

In Brazil, these concerns became more popular in the 90's with the opening of the Brazilian market worldwide. Since then, the consumption patterns of the Brazilian population have been changing due to the availability of wide options of goods and services. In this process of change, the Brazilian consumers have been valuating aspects of quality and food safety with more interest (Hoppe et al., 2012). Thus, in the long-run, food safety attributes will be in equality with all the other attributes in the sense that consumers will not take it into consideration, assuming that a food product to be available in the market should be in accordance with minimum quality patterns.

In this context, Public Authorities have established 'Minimum Quality Standards' (MQS) of safety performance for food products. The government has motivated the application of certification schemes and standards in the context of voluntary agreements, which allows the certification of the quality of agro-foods.

That said, for this study purposes, we have chosen the case of Integrated Production (IP) certification taking into account the principles of the International Organization for Biological and Integrated Control (IOBC, 2004) that cover ecological, ethical and social aspects of agriculture production as well as those related to food quality and safety.

Integrated Production (IP) has been applied in Europe since the 90's to address environmental and health concerns by reducing the net chemical pesticide inputs to agriculture and improving food quality and safety. Moreover, this production system is conducted by thinking on the preservation of natural resources and social responsibility.

Following the European experience, the Brazilian Government chose IP as a certification scheme in order to fulfill global requirements for different food products. Therefore, this study focuses on IP certification.

In Brazil, the standards of IP had its legal framework established in 2010 by the Normative Instruction Nº 27 of 08/30/10 (BRASIL, 2010), although the first experience started with fruits ten years before. Very often, IP certification is interpreted as an improvement of the sanitary safety.

Originally, IP standards are classified as B2B (business-to-business) since they are targeted to guaranteeing quality and food safety within the supply chain. However, in this study, IP standards are also considered as B2C (business-to-consumer) since the Brazilian government focus is also on the final consumer. One of the objectives of IP certification in Brazil is to improve food quality and safety by guaranteeing compliance with minimum standards of production on the domestic consumer side (BRASIL, 2015).

The IP label has been used to communicate consumers about the intrinsic quality attributes to the IP produce. The label evokes credence attributes such as 'sustainably produced' and 'safe food' (Figure 1).

The IP standards for common beans were developed in the 2008/09 winter harvest; however, the norms are still not available for growers until the period of the present research. Consequently, there are no certified beans available for sale in supermarkets. Therefore, the present study was conducted considering the certified beans as a hypothetical product. Indeed, the supply of certified IP products in Brazil is still very low.

FIGURE 1 – The Brazilian label for IP certification
Source: (BRASIL, 2011)

This evidence is verified by the results from prior studies of consumer behavior; most of them were conducted with cases of organic products (Albuquerque Júnior et al., 2013, Hoppe et al., 2012). Some decisive factors that influence the purchase and consumption of organic products on the consumer point of view are health issues, environmental concerns and food safety and taste. Other attributes such as brand, image, certification, traceability and price are not pointed as the most important point in some studies (Hoppe et al., 2012). No published economic research conducted in Brazil was found from the literature review with the focus on consumer behavior towards IP production. Therefore, the present study seeks to contribute with future studies on this issue.

We focused this study on common beans (*Phaseolus vulgaris*), specifically the commercial type called '*carioca*' beans, because it is one of the staple foods preferred by 76% of local consumers according to Wander, Basinello, & Ricardo (2006).

The main objective of this study was to assess the consumer intentions towards purchasing hypothetical IP labeled common beans marketed at a supermarket in Goiania (GO), Brazil. We used the Theory of Planned Behavior (TPB) to attempt the goals of this study. TPB model is one of the most expected value models used in the literature, especially when one wants to explain human behavior in food area. The meta-analysis, proposed by Armitage & Conner (2001), confirms the efficiency of the TPB model to predict intentions and behaviors in such area.

Besides the results regarding consumer behavior, this study also provides information to stakeholders of supply chain and public administration with basic information on consumer behavior toward IP certified products aiming to establish future strategies to disseminate IP production more efficiently among consumers.

2 METHODOLOGY

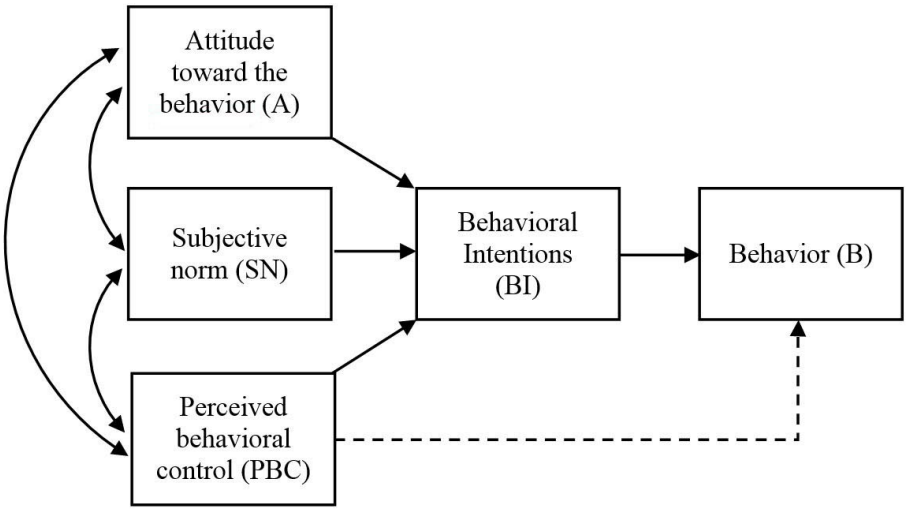
2.1 Theory of Planned Behavior

Over the past 40 years, social psychology theories have gained attention, as it is indicated by the increased use of their applications to predict and understand social behaviors in different domains. One of the most cited authors in this domain is Fishbein and Ajzen (1975).

Initially, these authors proposed the Theory of Reasoned Action (TRA) that assumes that much of human behavior is dependent on human will. Later, an extension of the TRA was proposed with the inclusion of the concept of Perceived Behavioral Control (PBC), representing the confidence of the individual in performing the behavior. According to Ajzen & Fishbein (1980), PBC influences the intention and even the individual behavior. This new approach was named Theory of Planned Behavior (TPB).

Both TRA and TPB theories suggest that an individual behavior is driven by his/her behavioral intentions to perform the behavior, and these intentions, in turn, depend on other three elements that are considered cognitive structures: a) the combination of attitudes and the influence of behavioral beliefs, b) the normative beliefs and c) control beliefs (Hattam, 2006). These beliefs are considered indirect influences on behavioral intention. Behavioral intention (BI) itself is mediated through the direct latent factors showed in the TPB model, such as, attitudes (A), subjective norms (SN) and perceived behavioral control (PBC) (Figure 2).

According to Fishbein & Ajzen (1975), the predictor 'A' represents a person's overall evaluation of the behavior; 'SN' is a person's own estimate of the social pressure to perform or not perform the target behavior, and 'PBC' refers to individuals' perceptions of their ability to perform a given behavior. The theory states that attitudes along with aspects related to the social pressure perceived, available infrastructure and an individual skills are predictors of the behavioral intentions related to a specific behavior. Ajzen (2001) considers that demographic characteristics and prior experience might also be important to the intentions formation.



Source: (Fishbein & Ajzen, 1975)

Although there is not a perfect relationship between BI and B, behavioral intentions can be used as a proxy measure of behavior. Ajzen (2001) states that the intention is the best behavior predictor. Based on this statement, the proposed model aims to verify the consumers' intention to purchase IP certified beans. Intention is the cognitive representation of an individual's readiness to perform a given behavior and it is considered the intermediate behavior antecedent.

This observation is one of the most important contributions of the TPB model compared to previous models of the attitude-behavior relationship. It is expected that the different behaviors and situations faced by an individual change the relative importance of A, SN and the PBC towards the intention prediction (Ajzen & Fishbein, 1980).

TPB is one of the models most commonly used in research related to human behavior in the food area. There are many studies on consumer behavior of organic products published under the application of the TPB (Kuhar, Slabe, & Juvančič, 2012; Kuhar & Juvančič, 2010; Magistris & Gracia, 2008; Hattam, 2006; Govindasamy & Italia, 1999; Govindasamy et al., 1998), but few of them focused on IP produce. Hoppe et al. (2012) cite some of these studies developed in Brazil.

Many of these studies reveal that consumer's attitudes towards different organic food attributes such as human health, safety, and the environment are the most important factors that explain the consumer decision-making process for organic food products. Positive attitudes towards environmental issues are positively correlated to the buying of such foods (Magistris & Gracia, 2008). In the present study, we expect similar behavior but towards an IP certified product.

With the exception of B, the variables in the TPB model are psychological (internal) constructs. Each predictor variable is measured directly or indirectly by asking respondents about specific behavioral beliefs and outcome evaluations. This approach makes different assumptions about the underlying cognitive structures and neither approach is perfect. In the present case, we decided to use the indirect measurement according to East (2009).

Overall, the motivation to purchase IP certified agro-food is almost the same of purchasing organic products. Although the concepts of production are different, both IP and organic productions are credence goods. Therefore, one can suppose that the more favorable health and environmental attitudes consumers have, the more likely they will buy IP agro-food products.

Therefore, this study counts with three hypotheses: (H_1) attitude has a direct effect on intention to purchase IP certified beans; (H_2) subjective norms have a direct effect on the intention to purchase IP certified beans; and, (H_3) perceived behavioral control has a direct effect on intention to purchase IP certified beans. In other words, TPB suggests that the more positive the A, SN and PBC is, the greater the likelihood an individual has of intending to carry out the behavior when the opportunity arises.

3 DATA COLLECTION AND SURVEY PROCEDURES

The consumers decision making process can be understood as a social phenomenon constructed from a reality made of perception, belief, attitude, motivation and social behavior. The comprehension of the interaction of all these elements depends on the understanding of the interactions among individuals. It also depends on the understanding of the interactions among them and tangible and intangible aspects that constitute the system of what is intended to investigate (Troilo & Molteni, 2003).

Data were collected in two stages during 2013 and 2014, comprising a qualitative and a quantitative research, as stated by Troilo & Molteni (2003). The authors indicate qualitative procedures to identify the consumer salient beliefs. The qualitative research was applied in Nov/2013, when 50 semi-structured interviews were administered to consumers of beans in a supermarket in Goiania (GO), Brazil. The sample size was defined according to East (2009). After applying a content analysis, the results of the interviews were used to elicit salient beliefs models, such as the most important shared beliefs about IP production found in the target sample, which was then included in the quantitative instrument.

The quantitative research involved 160 consumers of beans from a hypermarket also located in Goiania (GO), Brazil. This data was used for hypothesis tests. Most of consumers from Goiania prefer purchasing dry beans in this type of store (Wander et al., 2006; Wander et al., 2007). A previous pilot survey was administered to 24 consumers of beans in order to adjust the main aspects of the survey (Stopher, 2012).

Two diagnostic measures were used to assess the internal consistency on the dataset. One relates to each item separately, including the item-to-total correlation and the inter-item correlation. In this case, the parameter exceeds 0.50 in the item-to-total correlations and 0.30 in the inter-item correlations. The second diagnostic measure is related to the entire scale. In this case, the consistency of the entire scale was verified by the reliability coefficient with Cronbach's Alpha; values of 0.60 to 0.70 deemed the lower limit of acceptability (Hair et al., 2006). Both the pilot

and the final questionnaires were designed considering its validation and reliability according to Hair et al. (2006).

The final version of the questionnaire was constructed considering aspects such as buying behavior and consumption habits, TPB elements, and socio demographic data and was administered face-to-face by trained interviewers. The duration of each interview was about 15 min and was done in Portuguese language. Two screening questions were done before starting the interview to ensure the respondents were at least 18 years old, and also regular consumers of beans.

Afterwards, the interviewers started the process using a '*cheap-talk*' script in order to remove hypothetical bias for relatively ignorant consumers for a good evaluation (Lusk, 2003). The '*cheap-talk*' objectives were to explain consumers about the meaning of IP label, evidencing the mainly credence attributes such as '*produced by sustainable practices*' and '*free of pesticides residues*', and to explain consumers that they would indicate their responses like them would if they were actually facing that options in the hypermarket, considering the hypothetical character of the product.

A convenience sample was chosen due to budget and time constraints, even though it was considered the Hair Jr. et al (2006) orientation to determine the sample size when one intends to use the technique of Structural Equation Modeling (SEM).

4 STATISTICAL PROCEDURES

The Confirmatory Factor Analysis (CFA), which is a procedure used to test hypotheses about the structure of a data set, was applied to identify the relationship between the factors and the measurement variables. The technique of Structural Equation Modeling (SEM) was applied by using IBM AMOS® (Analysis of Moment Structures), which simultaneously estimates the model, including latent and observed variables, exogenous and endogenous variables, and the paths to these variables (Adrian, Norwood, & Mask, 2005).

SEM provides the appropriate and most efficient estimation for a series of separate multiple regression equations that are simultaneously estimated. In practice, SEM relates the hypothesized model constructs, also known as latent variables that are concepts that can be represented by observable or measurable variables. It is indirectly measured by examining consistency among multiple measured variables or indicators.

The two basic components that characterize the SEM are the path model that relates independent to dependent variables even when a dependent variable becomes an independent variable in other relationships and the measurement model that enables the analyst to use several variables or indicators for a single independent or dependent variable (Hair et al., 2006). In this technique, some of the key assumptions of standard regression analysis are violated, such as, the endogenous variables, which appear on the right hand side and are correlated with the residuals and the inconsistence of the least squares estimates (Mazzocchi, 2008).

The SEM was analyzed using the software IBM AMOS® 21. The maximum likelihood estimation (MLE) was applied because it is the most common SEM estimation procedure, more efficient and unbiased for multivariate normality assumption. The implied null hypothesis of SEM is that the observed sample and SEM estimated covariance matrices are equal, which means that the model fits perfectly. Several statistical tests were used to determine the measurement model and the specific evidence of construct validity by using goodness-of-fit (GOF) rates.

5 RESULTS AND DISCUSSION

5.1 Consumers Characteristics and Consumption Habits

Descriptive statistics analysis was applied to describe the characteristics of the respondents in terms of socio-demographic profiles. The results indicate that 63% of the respondents are female. This result converges to that reported by Wander, Basinello & Ricardo (2006), in which the profile of rice and beans consumers from the Metropolitan Region of Goiania was described. According to Blessa (2003), females are the most ftrequent hypermarkets and supermarkets consumers in Brazil.

The mode of age is between 56-65 years old (35%), while the average age is ranges from 36-50 years old, representing 25.6% of the respondents. Basically, this is the same range (between 36-45 years old) reported by Wander, Basinello & Ricardo (2006) and Wander et al. (2007) in their studies in the same place.

The majority of the respondents are married (71.3%) with family size up to 5 people (86.9%), and 65% reported having up to 12-year-old children at home. Wander, Basinello & Ricardo (2006) reported family size between 3-5 people and 80.1% of their sample had at least one child up to 16 years old. According to Moura, Silva & Batalha (2006), who characterized the profile of retail consumers from Goiania (among other cities), the number of household people has been diminishing. This evidence can influence their habits of consumption in several ways such as lower predisposition to hold monthly food shopping in large supermarkets, and greater openness to

higher value-added and convenient foods. The authors also mention that households with 2-5 people prefer to make their purchases in hyper/supermarkets.

In terms of level of education, the largest group is illustrated by the mode that represents the group of people who reported to have finished high school (36.3%), followed by the elementary school group (33,8%). Similarly, from the findings of Wander, Basinello & Ricardo (2006), the same two groups were the most frequent.

Employed people are also the majority (46.25%), followed by the retired group (18.75%) and household workers (14.38%). Two important groups in terms of acquisition power included autonomous and professional workers (represented by doctors, dentists, lawyers, etc.), representing 15.62%. Students (up to 18 years old) were 3.125% and 1.37% were considered unemployed people.

It is possible to comprehend several things about the data on household income such as the fact that the largest group is the one with 3-6 salaries that is equivalent to social classes 'B2' and 'C' according to the Brazilian Research Company Association mentioned by Moura, Silva & Batalha (2006). As observed, 23.1% of respondents did not report their income. When the non-reported income was excluded from the statistical analysis, the results did not change and the median kept in the same interval of 6-8 salaries. The most frequent household income reported by Wander, Basinello & Ricardo (2006) was 3-5 salaries (29.2%), followed by a group with 5-10 salaries (23.7%). The higher the consumer income is, the most important safety food attribute is considered, which is related to the higher levels of education and access to information of this category (Lima-Filho, Alves, Quevedo-Silva, Kondo, Arakak, & Higashi, 2013).

Regarding the purchasing and consumption habits, 83% of the respondents self-declared as being the responsible for household food shopping. Beans are purchased almost once a month (54%) or twice a month (26%), in hypermarkets (54%) and supermarkets (39%).

Farmers market, neighborhood markets, grocery shops and others represent 7% of the preferred stores to purchase common beans. Our findings are very similar to that reported by other studies on beans consumer habits in the same municipality. In terms of beans consumption, 91% of the respondents reported daily beans consumption; this result confirms the importance of dry beans in the Brazilian diet.

We have also questioned consumers if they trust in all beans label information. Approximately 57% does not trust completely on that and only 43% of them believe that the information on the labels is reliable. This result indicates that the inclusion of more information on package, such as 'IP label', needs to be included carefully and followed by a good communication towards consumers.

The evaluation of the respondents regarding beans quality attributes is illustrated in Figure 3.

Almost eight out of 10 consumers (75%) consider price and brand as the most important attributes to be evident on the beans package, followed by expiration data. Those results are in accordance to other authors that highlight the importance that consumers from Goiania give to the beans brand.

Certification labels, origin, nutritional information and cooking tips were the attributes with less importance to the group of consumers interviewed. Besides that, the attribute certification of quality figures as the fifth most important. This level of importance has to be carefully

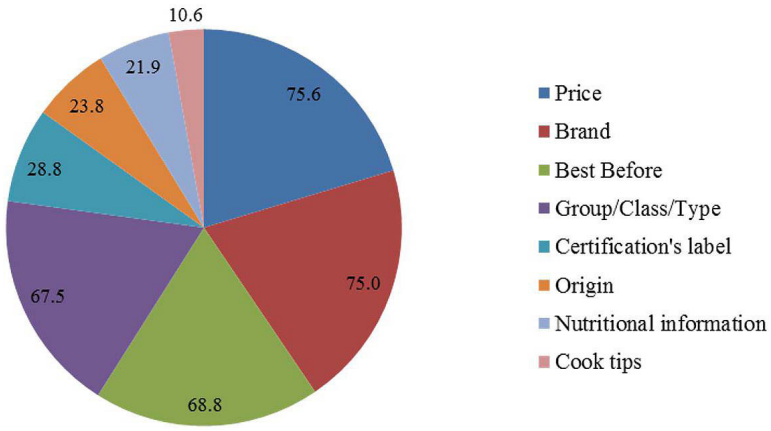


FIGURE 3 – Beans quality attributes: the importance level reported by respondents
Source: Author's elaboration

interpreted. The relative importance could be justified by the fact that IP label is a new sign of quality for consumers and represents the desire and necessity of the consumers.

On the other hand, the label was the focus of the research and consumers could be over valuating it. Lima-Filho *et al*., (2013) mentioned that food safety is the most relevant factor to Brazilian supermarket consumers. The presence of the quality label had less relevance as well as the nutritional information.

Finally, the consumers were asked about additional information they would consider important and what aspects they would like to see on beans packages regarding some credence attributes related to sustainability and health concerns. The results are shown in Figure 4.

Almost 80% of the respondents considered important the inclusion of information about environmental responsibility, pesticides residues and health benefits of beans on the packages, while 78.8% considered important the inclusion of information concerning the type of system of production, for instance, IP system. Information about social responsibility appears in the last position but not less important. Local consumers might not be yet familiarized with this kind of quality attributes, i.e., credence attributes. This type of information is more important to bean chain operators aiming at raising consumer awareness for those quality attributes. This positive reaction could be explained by the effect of the novelty.

5.2 Consumer Intentions Toward Purchasing IP Certified Beans

Overall, the consumer behavior intention towards purchasing IP certified beans is positive. In the proposed model, the intention to purchase IP certified beans was measured by three variables as it is illustrated in Figure 5. In a scale from 1 to 7, consumers reported their level of agreement with this statement, in which 6 indicates a very likely intention towards the proposed action. Attitude towards behavior was measured by three observed variables related to general consumer concerns on personal level of satisfaction and personal health (Figure 6).

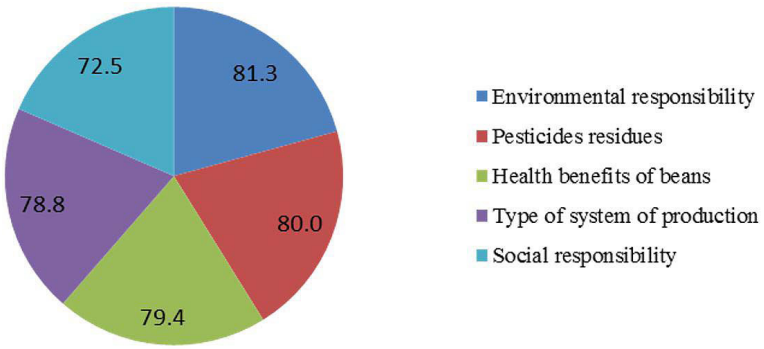


FIGURE 4 – Additional label information considered important by the respondents
Source: Author's elaboration

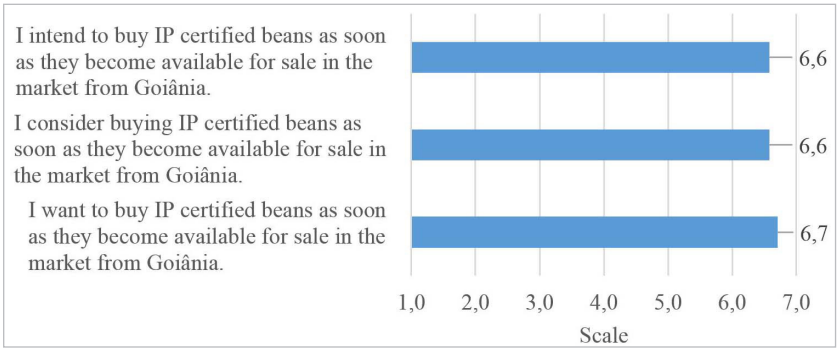


FIGURE 5 – Means of Intention
Source: Author's elaboration

Respondents were asked to rate these sentences on the same scale from 1 to 7 in which 6 means the higher level of agreement. The results demonstrate that consumers have a very likely attitude towards the behavior of purchasing certified beans. This result indicates that consumers have positive feelings about performing the behavior.

The social pressure, measured by the subjective norms, are also important in the context of assuming the behavior of purchasing IP certified beans. There are three different variables used to measure this construct (Figure 7). From a scale from 1 to 7, six was the highest level of agreement, meaning that people that are important to the respondent think he/she should purchase IP certified beans.

Finally, Figure 8 shows the three variables used to measure the perceived behavioral control. This measure indicates the extent to which the respondents feel able to enact the behavior of purchasing IP certified beans. Similarly, six indicates a high level of agreement of the consumers related to the used variables. Although consumers consider important the opinion of people that are important to them, the choice of purchasing IP certified beans seems not to depend on others. Clearly and reliable information about certified beans is also very important for the consumers to feel confident in performing the behavior.

5.3 Measurements of Constructs: Testing the Structural Model

To analyze the factors that affect the intention to purchase IP certified beans, a SEM approach was applied to examine the general fit of the proposed model and to test the hypothesis. A confirmatory factor analysis was applied to assess the measurement model and the SEM analysis to examine the overall relationships among the constructs.

The adequacy of the measurement model was evaluated by the criteria of overall fit with the data, the reliability of each of the constructs evaluated by the 'α' coefficient and the indicator loadings statistical significance.

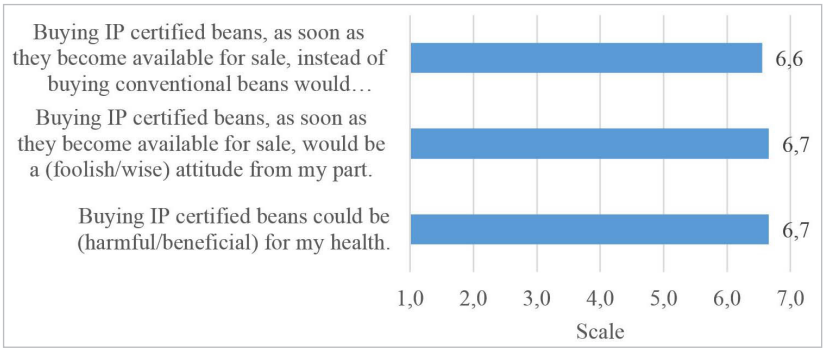


FIGURE 6 – Means of attitudes toward buying certified beans
Source: Author's elaboration

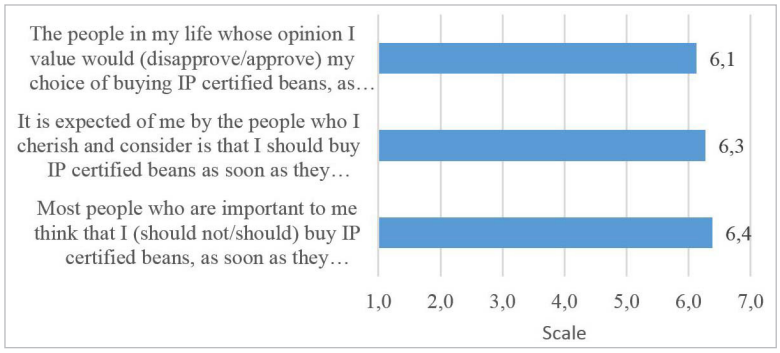


FIGURE 7 – Means of subjective norms
Source: Author's elaboration

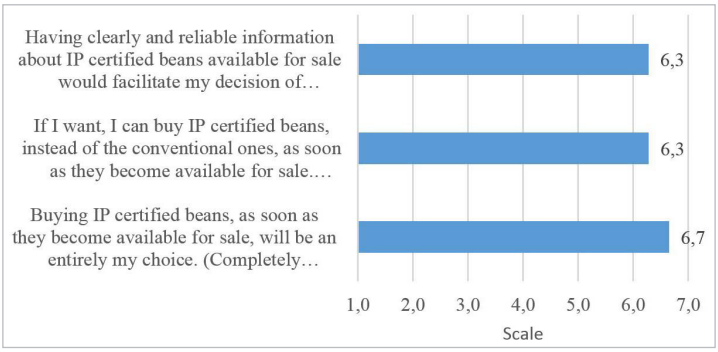


FIGURE 8 – Means of perceived behavioral control
Source: Author's elaboration

The analysis began with a general specification to which explanatory variables were dropped or added in an attempt to increase the number of significant variables and the goodness of the fitting. Since the number of items in the original proposed model was reduced, most of the explanatory variables were remained even if it was not significant. The consistency of the measurement was evaluated by the reliability test. Table 1 indicates the results for the measurement model.

The results indicate that only the 'α' value of the measuring scale PBC did not achieve the recommended level of 0.60 – 0.70. All factor loadings are greater than 0.5, indicating that the fit of the measurement model is quite reasonable. Furthermore, composite reliabilities (CR) suggest adequate reliability for all the parameters except PBC (smaller than 0.7). By using the AVE measure, the same construct PBC indicates some problems in terms of construct validity since its value is smaller than the baseline equal 0.5.

Overall, the model fit and measurement model fit assessments were considered in the model fit examination. The recommendation is using three to four fit rates and at least one incremental and one absolute index in addition to the $\chi 2$ value and the associated degrees of freedom. Commonly, a model reporting the $\chi 2$ value and the degrees of freedom, along with the CFI and the RMSEA will often provide sufficient unique information to evaluate a model (Hair, Jr., et al., 2006). The degrees of freedom are a measure of the discrepancy between the available number of observations and the constraints associated with the estimation of unknown parameters. The positive df value (29) indicates that the model is over-identified, for example, there are more elements in the covariance matrix than parameters to be estimated. In this case, estimates are possible but might be neither unique nor optimal. Table 2 shows the model fit summary.

The Chi-square statistic (80.563) is high and significant (p-value = 0.000). Considering that the implied null hypothesis of SEM is that the observed sample and SEM estimated covariance matrices are equal, these results are in the correct direction. However, additional rates must be verified to support this general impression of the goodness of the fitting since the Chi-square is sample size sensitive. In the present study, the number of observations and items were reduced and this limitation has reflected on the results. Thus, it is not possible to affirm that there is no discrepancy between the observed covariance matrix and the estimated one. As an alternative, it was used the ratio between the $\chi 2$ value and degree of freedom, indicated by CDMIN/df, that resulted an acceptable value.

The majority of these fitting indexes resulted in a satisfactory fit between the proposed model and the data, with the exception of the root mean square error of approximation (RMSEA), which should be less than 0.08. The RMSEA, in turn, indicates the discrepancy between the hypothesized model and the population covariance matrix, and it is more used to avoid problems of large sample size or large number of variables.

The goodness fit index (GFI) measures the goodness of a fit between the hypothesized model and the observed covariance matrix. The comparative fit index (CFI) is derived from the normed fit index (NFI), which indicates the discrepancy between the data and the hypothesized model. Both GFI and CFI were early attempts to produce a statistical fitting that was less sensitive to sample size.

Moreover, the standardized residual covariance matrix can be used in an ultimate analysis. According to (Byrne, 2001), values less than 2.58 suggest a good consistency between the hypothetical and the data. There is no value greater than 2.58, as shown in Table 3.

TABLE 1 – Results from the measurement model

(N=160; N. of Items=12)		Descriptive Statistics		Reliability Statistics	
Cod.	Variables	Mean	Std. Dev.	Standardized factor loading (g)	Cronbach's Alpha Based on Std. Items
	Attitude (A) / CR = 0.74 / AVE = 0.58				α = 0.679
(A.4)	Buying IP certified beans as soon as they become available for sale would be a (foolish/wise) attitude from my part.	6.7	.7934	.787	
(A.6)	Buying IP certified beans as soon as they become available for sale instead of buying conventional beans would make me feel more (unsatisfied/satisfied).	6.6	1.0687	.738	
	Subjective Norm (SN) / CR = 0.82 / AVE = 0.69				α = 0.85
(NS.2)	People who I care and consider the most expect me to buy IP certified beans as soon as they become available for sale. (Extremely unlikely/Extremely likely).	6.3	1.1435	.854	
(NS.3)	People in my life whose opinion I value would (disapprove/ approve) my choice of buying IP certified beans as soon as they become available for sale.	6.1	.8477	.807	
	Perceived Behavioral Control (PBC) / CR = 0.59 / AVE = 0.33				α = 0.593
(CP.3)	Having clearly and reliable information about IP certified beans available for sale would facilitate my decision of purchasing. (Completely disagree/Completely agree).	6.3	.7519	.584	
(CP.6)	Buying IP certified beans as soon as they become available for sale would be entirely my choice. (Completely disagree/ Completely agree).	6.7	.7786	.570	
(CP.5)	If I want, I can buy IP certified beans instead of the conventional ones, as soon as they become available for sale. (Extremely unlikely/Extremely likely)	6.3	1.1825	.564	
	Intention (I) / CR = 0.89 / AVE = 0.74				α = 0.893
(I.1)	I consider buying IP certified beans as soon as they become available for sale in the market of Goiania.	6.6	.9935	.862	
(I.2)	I want to buy IP certified beans as soon as they become available for sale in the market of Goiania.	6.7	.8437	.864	
(I.3)	I intend to buy IP certified beans as soon as they become available for sale in the market of Goiania.	6.6	1.0369	.846	

Source: Author's elaboration

TABLE 2 – Model fit summary

Measures	Estimated Model	Acceptable values
χ^2	80.563	↓ value
df	29	***
p-value	.000	↑ value
GFI	.908	≥ .90
CFI	.934	≥ .90
RMSEA	.106	< .08
CDMIN/df	2.778	1 - 5

Source: Author's elaboration

The final model comprised a total of 25 variables, with 10 observed variables, 15 unobserved variables, 14 exogenous, and 11 endogenous variables. The results of SEM Analysis (standardized) are illustrated in Tables 4 and 5. Standardized structural coefficient estimates were used to compare the relative importance of the independent variables.

Table 4 and Figure 9 show the structural model, the hypothesis tests results and SEM analysis.

As shown in Table 4, considering the factors that influence the purchase intention of IP certified beans, significant path was found only for the attitudes. The positive coefficient indicates a direct relation between attitude and behavioral intention; the more favorable the attitude is, the greater the intention of buying IP certified beans by consumers. In other words, this result reinforces the importance of the variable attitude to explain the intention to purchase, as conceived by the TPB model.

Moreover, as in this research the attitudes were positive and resulted in high means, it can be said that such consumers of certified beans have very favorable attitudes towards these products and that their beliefs strongly influence their choices. The subjective norms and PBC had no significant effect on intention of purchasing IP certified beans.

TABLE 3 – Standardized residual covariance matrix

	CP.3	CP.5	CP.6	I.3	I.2	I.1	NS.2	NS.3	A.6	A.4
CP.3	.000									
CP.5	-.081	.000								
CP.6	.564	-.521	.000							
I.3	-.336	1.595	-1.199	.000						
I.2	-.401	.999	-.243	-.102	.000					
I.1	-.660	1.560	-1.158	.274	-.149	.000				
NS.2	.576	-.412	-.125	-.771	1.035	-.227	.000			
NS.3	.701	.501	-1.331	-.853	.373	.183	.000	.000		
A.6	-1.186	-.176	-1.735	.112	.438	.853	.087	.379	.000	
A.4	.503	.211	1.717	-.104	-.096	-.887	-.194	-.119	.000	.000

Source: Author's elaboration

TABLE 4 – Structural Model and Hypothesis testing

			Estimate	S.E.	C.R.	P
Intention	<---	SN	-.011	.249	-.046	.963ns
Intention	<---	ATT	1.686	.679	2.484	.013*
Intention	<---	PBC	-.729	.731	-.997	.319ns
NS.3	<---	SN	1.000			
NS.2	<---	SN	1.428	.164	8.721	**
CP.3	<---	PBC	.989	.201	4.911	**
CP.6	<---	PBC	1.000			
CP.5	<---	PBC	1.502	.312	4.817	**
A.4	<---	ATT	1.000			
A.6	<---	ATT	1.263	.132	9.552	**
I.1	<---	Intention	1.000			
I.2	<---	Intention	.851	.062	13.765	**
I.3	<---	Intention	1.025	.077	13.343	**

NS/not significant at the 0.05 level; */significant at the 0.05 level; **/ significant at the 0.001 level
Source: Author's elaboration

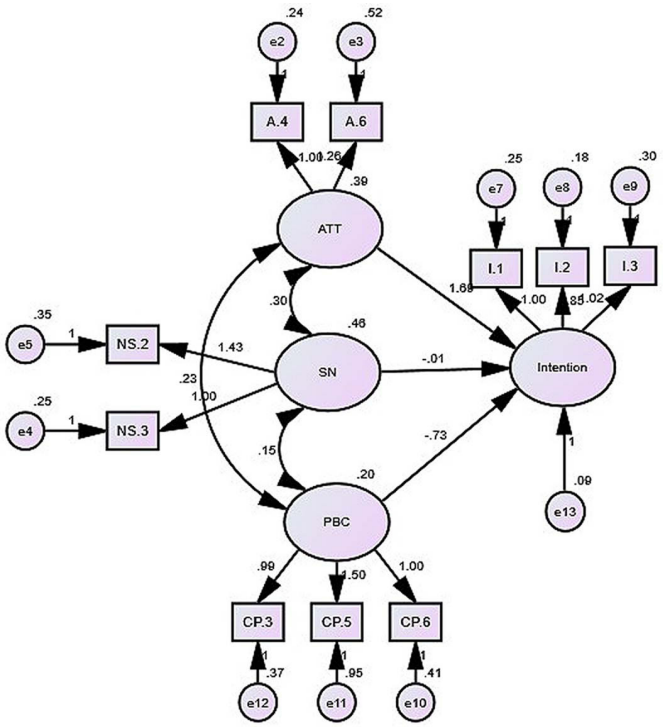


FIGURE 9 – Results of SEM Analysis (standardized)
Source: Author's elaboration

With regard to the subjective norms, the results were similar to those found in other studies in Brazil (Barcellos, 2007). From the interviewed consumers of the present study, 'people they respect and admire' are not significant elements in determining the intention of purchasing certified beans, possibly by the fact that this product is seen as a type of product that brings benefits to health. Additionally, the consumer has control over his own acts of choice and shopping.

6 CONCLUSIONS AND RECOMMENDATIONS

The results of this study reveal that the interviewed consumers have a positive attitude towards the purchasing of IP certified beans, even though this product is not currentlyavailable in Brazilian stores. This positive point might be associated to an unmet demand for safe food, free of pesticide residue and produced in a sustainable way.

Additionally, the results suggest that clear and reliable information about the certification label may favor the process of certified beans marketing since the consumer will have an easy access to IP label information. Thus, they will be more confident about what they are buying and consuming. Moreover, this can help the process of expansion of the Brazilian market of certified food products. According to Rocha (2010), mentioned by Hoppe, Barcellos Vieira & Matos (2012), there is a potential market for this type of product in the big city centers of Brazil

Furthermore, the choice and the decision of purchasing certified beans seem to be directly related to the price that will be practiced in the market. Therefore, the respondents do not feel completely able to perform the action of purchasing certified beans because the action of purchasing will be subject to the prices. If the differential price of the certified beans is greater than the consumer expectations, the consumer probably may alternatively opt for the conventional beans.

The results indicate that the theoretical model based on the TPB used to explain the intention behavior of purchasing certified beans resulted in reasonable fit rates, but it was consistent with the theory with only some of the relations among constructs. Thus, the results showed that the proposed model was adequate for explaining the consumer behavior toward the IP certified beans purchasing. As exceptions, one can refer the constructs subjective norms and perceived behavioral control towards the intention of purchasing.

However, the application of this research with a higher number of respondents could possibly produce more robust results. It is also necessary to recognize the limitations of any survey instrument when it is applied to different cultural contexts, especially in the case in which the central element is related to psychological issues.

The subjective norms in this study were not significant in the model, which indicates that the opinion of others is not a decision-making factor for the intention of buying certified beans from the point of view of the surveyed consumers. This construct was measured by only two indicators, which may have affected their performance in the modeling.

In any case, this research used a case of a hypothetical product that is not known by the surveyed consumers. This factor may also have influenced the consumer decision-making in relation to some issues raised in the model.

The consumer expectation that the certified beans can be sold in the habitual retail stores did not affect the consumer possible behavior of buying certified beans. On the opposite, the price to be charged for this product can positively or negatively influence consumer behavior in relation to the purchase of certified beans.

This study brings important contributions from the application of TPB in the field of certified food products from integrated production in the Brazilian context. It can be said, based on the literature review, that there are few similar studies conducted in Brazil. Therefore, one of the contributions of this work is related to the scientific community that can use the results of this study as a basis for similar future research.

Another contribution of this study is targeted to the various agents of the Brazilian beans supply chain. The results show that there is a great opportunity in the market for those that wish to invest in the market of certified products with sustainable and food-safety claims. The beans growers may benefit from the present results with the information that the consumer has a positive attitude toward certified beans purchase and, therefore, there is a latent demand for this type of product.

On the other hand, the retail stores should be alert to promote the certified products in a clear and reliable way, since these criteria are flagged as important from the point of view of consumers. The consumer must trust the certification label into consideration, as the quality attributes that differentiate the IP certified products are credence attributes and cannot be directly observed by consumers in the available products on supermarket shelves.

It is important to notice that the results of this study are valid only for consumers interviewed in Goiania (GO) and cannot be generalized for Brazil as a whole. So, one cannot infer behaviors and/or attitudes for all Brazilian consumers based on these results.

As recommendations for future research within the same field, we suggest performing similar research in other large Brazilian centers to promote a culture research focused on consumer behavior, which is still very few explored in Brazil. We also suggest the interaction of SDC to TPB model to stratify the results and return a better understanding about the consumer behavior with different profiles. Finally, it is important to emphasize that this type of model must be applied in situations where it is possible to have a sufficient minimum number of respondents in order to avoid problems during the model validation, such as the one faced in this research.

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EXPANSION OF AGRICULTURAL AREAS IN BRAZIL FROM 1994 TO 2013: SOYBEANS *VERSUS* CORN *VERSUS* COTTON

Expansão de Área Agrícola no Brasil de 1994 a 2013: Soja *Versus* Milho *versus* Algodão

ABSTRACT

The objective of this article was to map disparities in the increases of agricultural areas in the Brazilian mesoregions between 1994 and 2013; particularly the levels of concentration of soybeans, corn, and cotton. The methodological approach included Cluster procedures and locational Gini coefficients. The results highlighted a frontier line identified in the central-northwest area of Brazil. As for the crops, a more concentrated expansion of the agricultural area dedicated to cotton was verified in the selected mesoregions. This expansion was less concentrated in soybeans and even less concentrated in corn.

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RESUMO

O objetivo deste artigo foi mapear as diferenças em expansão de área agrícola no âmbito das mesorregiões brasileiras no período 1994-2013, com foco nas parcelas devidas à soja, ao milho e ao algodão neste processo. Empregaram-se, como abordagem metodológica, procedimentos de análise de *clusters* e coeficientes locacionais. Uma fronteira de expansão agrícola foi identificada no sentido Centro-Noroeste do Brasil. Em relação às culturas avaliadas, a expansão de área agrícola nas mesorregiões selecionadas foi mais expressiva nas áreas algodão cultivadas. Essa expansão foi comparativamente menos soja concentrada e (ainda menos) milho concentrada.

Palavras Chave: Agricultura, Uso de Solo, Safras, Análise de Cluster, Brasil.

Keywords: Agriculture, Land Use, Crops, Cluster Analysis, Brazil.

1 INTRODUCTION AND OBJECTIVE

Between 1930 and 1980, Brazil transitioned from its status as a nearly monocultural producer to a country with diversified agricultural production (BRANDÃO, 2002; FREITAS, 2014a). In order to meet the country's needs with regard to food security and safety, investments and subsidies for research were directed toward Brazilian agriculture (BARROS, 2002; MARIN *et all*, 2016), and led to a significant production increase during the last forty years.

In the first half of the 90s, domestic producers had greater exposure to international markets, which created new difficulties for Brazilian farmers. This scenario continued until 1994, especially with regard to inflation, and the sector was severely damaged because of the time lag between sowing and harvest operations. These events led to learning and solidity in the sector, which today is a main sector in the Brazilian economy. However, strategic adjustments had a variety of scattered impacts on the regions and on different crops.

On the other hand, food production remains a central concern for humanity in the twenty-first century. According to the United Nations (2015), the world population will reach 9.5 billion in 2050, and the urbanization is a notorious process in the larger developing countries in Africa, and in China and India. Meanwhile, the major food producing countries (Russia, the United States, Argentina, Canada, and Australia) do not have any more land for economically or technically profitable farming.

For Bruinsma (2009), much of the land that already employed has some sort of constraint that cannot be easily overcome (chemical, physical, endemic diseases, or lack of infrastructure). Some of this land is covered with forests, protected areas or host settlements, for example. Moreover, agricultural systems in Africa and Southeast Asia appear to be vulnerable in terms of land productivity changes and consistent changes in water demand against the backdrop of an evolving climate (IGLESIAS, QUIROGA and DIZ, 2011).

Within this scenario, Brazil emerges as an important player for future increases in agricultural area, agricultural productivity, and food production. According to Brosig *et al.* (2012), Brazil's resources allow an excess production for exports. Brazil is already an important player in several agricultural markets, such as soybeans, sugar, and meat (beef, pork and poultry), and it is expected to maintain or even expand its share by 2023 (OECD-FAO, 2014).

In international poultry markets, for instance, Brazil has overtaken the United States as the world's largest exporter based on productivity gains, as indicated in Valdes, Hallahan and Harvey (2015). At the same time, Brazil's agricultural area is expanding into new spaces in Northeast states, increasing land prices (GASQUES, BOTELHO and BASTOS, 2014).

Therefore, the objective of this article is to map disparities in the increases of agricultural areas among the Brazilian mesoregions between 1994 and 2013; particularly the levels of concentration for soybeans, corn, and cotton. These three crops accounted for 50% of the production value of Brazilian temporary crops in the period 2010–2013 (IBGE, 2015). Soybeans and corn are also important components of animal feed for dairy and meat farming with impacts on domestic food prices and are main products among Brazilian agricultural exports (SANTO, LIMA and SOUZA, 2012; FREITAS, 2014b).

2 METHODOLOGY AND DATA

This study employed data from IBGE (2015) from 1994 to 2013 on production value, harvested area, and planted area, at the mesoregion level. The study applied two processes to measure the rates of increase in agricultural area; firstly, the percentages of mean increase in agricultural area were calculated for Brazilian mesoregions according to equations (1) and (2):

$$I_{1i} = \sum_{t}^{T}\left(C_{94,t}\right)/19 \qquad t = 1995, \ldots, 2013 \tag{1}$$

where $C_{94,t}$ is the growth rate for planted area by $_i$ Mesoregion in $_t$ year compared with 1994.

As an additional control related to the effects of climatic conditions on agricultural production and also to capture short-term conditions, Indicator 1 (I_1) was measured exclusively for the period 2009-2013.

$$I_{2i} = \sum_{t}^{T}\left(C_{94,t}\right)/5 \qquad t = 2009, \ldots, 2013. \tag{2}$$

Euclidean distance was also used; this is defined as a function of the X variables associated with two sample elements, and can be expressed as (3), where *p* are variables or characteristics of each sample element and k is the number of elements.

$$d(X_1, X_k) = \left[\left(X_1 - X_k\right)'\left(X_1 - X_k\right)\right]^{1/2} = \left[\sum_{i=1}^{p}\left(X_{i1} - X_{ik}\right)^2\right]^{1/2} \tag{3}$$

An additional variable entitled Lost Area (LA) was also calculated; this corresponds to the difference between planted area (PA, intended crop) and harvested area (HA, effective harvest). As discussed by Zhao, Hitzhusen, and Chern (1991), soil erosion and land degradation have been destructive worldwide. Because of reasons such as high population pressure on land and limited fossil energy supplies, land degradation is generally more serious in the developing world. Generally, planted area is represented as a function of agricultural product market prices, input prices, and technological conditions in field operations. Meanwhile, harvested area is a function of the same variables that affect planted area as well as random variables such as climatic conditions and the incidence of pest attack and diseases, for example. As a result, LA is also a random variable.

In practical terms, four key variables were used to measure the growth of agricultural area among the Brazilian mesoregions: planted area (PA), harvested area (HA), production value (PV), and LA, where:

$$LA = PA - HA \qquad t = 1994, \ldots, T \tag{4}$$

Two steps compose the calculations. Initially, the agglomerative hierarchical method was employed to indicate the number of groups that better fit the data. In the second round, within a year-by-year analysis, pseudo-T and pseudo-F tests[1] were run. These tests indicate the number of groups that produce the best gains of information. The calculations were done using the variables expressed in growth rates (planted area), in absolute values (planted area, lost area), or normalized values (planted area, lost area, and production value).

The next stage of the methodological approach employed the Locational Quotient (LQ) and the locational Gini coefficient (LGC). LGC has been employed by Krugman (1991) for analyzing location dynamics, and other studies have highlighted its benefits related to ease of implementation and data requirements (BERTINELLI and DECROP, 2005; VAN DEN HEUVEL, DE LANGEN and FRANSOO, 2013).

This tool had also been employed in studies extending beyond agricultural analyses, for instance, for studying regional specialization in China (LU, FLEGGB and DENGE, 2011), for identifying industrial reallocations (RUAN and ZHANG, 2014) and for identifying high-tech concentrations (DEVEREUX, GRIFFITH and SIMPSON, 2004). Reveiu and Dardala (2011) also applied LQ to investigate employment statistics in Romania´s counties.

[1]These tests are standard for this methodology as described in Mingoti (2005) and SAS (2014a).

LQ indicates whether the relative importance of a specific mesoregion is greater for one crop than for all (permanent and temporary) crops combined. From LQ, it is possible to calculate LGC, which is useful for analyzing the spatial concentration of a crop in a specific area, and for identifying whether a crop is specialized in certain regions.

Based on Haddad's discussion of LQ (1989) and Isard (1960), LQ is defined as the following equation for soybeans:

$$LQ_{ij} = \left(S_{ij} / S_{i*}\right) / \left(A_{*j} / A_{**}\right) \quad (5)$$

where:
S_{ij} = planted area with soybeans in mesoregion *j*;
S_{i*} = planted area with soybeans in all mesoregions;
A_{*j} = planted area in mesoregion *j*;
A_{**} = planted area in all mesoregions.

In this context, (S_{ij} / S_{i*}) is the relative importance of mesoregion *j* in the planted area with soybeans and (A_{*j} / A_{**}) is the relative importance of mesoregion *j* in the combined planted area for all crops. LQ was also calculated in the same way for corn and cotton.

For dealing with large areas (mesoregions), the first step was to organize them by decreasing LQ for a chosen variable (planted area with soybeans, for example). Next, a localization curve was constructed for the chosen crop, and the curve point generators result as follows:

- Y coordinates were derived from the accumulated share of the chosen variable (planted area with soybeans, for example) in the mesoregions;

- X coordinates were derived from the accumulated share of the same variable (planted area) for all crops (temporary and permanent) in the mesoregions.

In both cases, the order in which data enter obeys the descending order of the LQ. In a hypothetical case of five mesoregions, the final curve would contain five points, as shown in Figure 1.

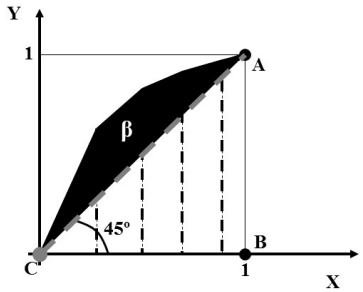

FIGURE 1 – LGC concentration area
Source: based on Krugman (1991) and Suzigan *et al.* (2003)

LGC is the ratio between the area represented by β (above) and the area of the ABC triangle, which is restricted by a 45º line. Consequently:

$$LGC = \left(\beta / 0.5\right) = 2.\beta \quad (6)$$

Then, the maximum value for LGC = 1, because the maximum value for β is 0.5. According to Suzigan *et al.* (2003), the closer the value is to 1, the more spatially concentrated the crop being analyzed is, and vice versa. In the context of a large country like Brazil, LGC will naturally tend to be relatively lower because of the dimensions of the individual mesoregions, which in many cases are larger than some European countries.

3 RESULTS

This section is composed of two subsections: the first describes the more representative mesoregions in terms of agricultural area growth rate, and the second describes the shares of soybeans, corn, and cotton in this process.

3.1 Selected Mesoregions

It is possible to distinguish two periods of growth in Brazil's agricultural areas between 1994 and 2013: 1994-2001 and 2002-2013.

Table 1 shows that between 1995 and 2001, planted areas were always smaller than the respective data for 1994, the mean growth rate was negative (-0.22% per year). Particularly during the period 1996-1998, there was a significant reduction compared to the 1994 base data. Afterwards, Brazilian agricultural areas recovered and expanded from 2002 to 2013, resulting in a mean growth rate of 2.91% per year during this period and a rising compound growth rate.

TABLE 1 – Brazil´s planted areas and growth rates for agricultural areas, 1994-2013

Year	Planted area (hectares)	Growth rates $_{(t/t-1)}$
1994	52,815,030	-
1995	51,853,110	-1.82%
1996	46,821,814	-9.70%
1997	48,302,405	3.16%
1998	48,509,074	0.43%
1999	50,700,694	4.52%
2000	51,819,125	2.21%
2001	51,637,167	-0.35%

Continua...

TABLE 1 – Continuation...

Year	Planted area (hectares)	Growth rates $_{(t/t-1)}$
2002	54,511,629	5.57%
2003	58,460,983	7.24%
2004	63,036,966	7.83%
2005	64,319,313	2.03%
2006	62,563,908	-2.73%
2007	62,338,730	-0.36%
2008	65,527,804	5.12%
2009	65,721,594	0.30%
2010	65,374,591	-0.53%
2011	68,158,023	4.26%
2012	69,196,172	1.52%
2013	72,434,134	4.68%
Average 1995–2001		-0.22%
Standard deviation 1995-2001		4.70%
Compound growth rate 1995-2001		18%
Average 2002-2013		2.91%
Standard deviation 2002-2013		3.35%
Compound growth rate 2002-2013		46%

Source: author based on data on Municipal Agricultural Production (IBGE, 2015)

As highlighted by Awokuse and Xie (2015), the remarkable expansion of the agricultural sector in Brazil made notable contributions to the growth of the overall economy, especially in terms of Brazil becoming a top producer and exporter of beef, broiler chickens, coffee, soybeans and oilseeds, sugar, and ethanol derived from sugarcane. According to Doğan, Arslan, and Köksal (2013) the agricultural sector has changed in recent years, taking on such diverse roles as direct/indirect contributions to feeding the population, national income, employment, supplying raw materials to industry, exports, and biological diversity.

Table 2 shows the Brazilian mesoregions in which both indicators I_1 and I_2 exceeded the respective values in terms of national means; in other words, in terms of Brazilian growth rates for agricultural area compared with 1994[2]. Forty-two mesoregions met both criteria. Geographically, these regions were located in the following regions: 11 in the north, 10 in the center-west, 9 in the south, 8 in the southeast, and 4 in the northeast. Note that half were in the North or Center-West-regions.

[2]The national mean for I_1 was 11.74% and for I_2 was 29.09%.

TABLE 2 – Selected mesoregions according to growth rates in planted area, 1994–2013

North Amapá – AP	Central-West Rio Grande do Sul – RS
East Tocantins – TO	Central-North Mato Grosso do Sul – MS
South Amapá – AP	Southwest Mato Grosso – MT
North Mato Grosso – MT	Northeast Rio Grande do Sul – RS
South Maranhão – MA	Minas Triangle/Upstream Paranaíba – MG
Northeast Mato Grosso – MT	Central-East Paraná – PR
South Amazonas – AM	Bauru – SP
Extreme West Bahia – BA	Southwest Amazonas – AM
Juruá Valley – AC	Marília – SP
East Goiás- GO	South Roraima – RR
Southwest Mato Grosso do Sul – MS	Downstream Amazonas – PA
Southwest Piauí – PI	Southwest Rio Grande do Sul – RS
Presidente Prudente – SP	São José do Rio Preto – SP
Southeast Mato Grosso – MT	Federal District – DF
Northwest Paraná – PR	Pioneer North Paraná – PR
South Goiás– GO	Itapetininga – SP
Central-South Mato Grosso – MT	Southeast Paraná – PR
Araçatuba – SP	Madeira-Guaporé – RO
North Roraima – RR	North Central Paraná – PR
Central Amazonas – AM	Central-West Paraná – PR
Northwest Minas Gerais – MG	Northeast Bahia – BA

Source: author based on data on Municipal Agricultural Production (IBGE, 2015)

After selecting the mesoregions, they were clustered according to the pseudo-T and pseudo-F tests described above. Table 3 presents the results that were generated using SAS software (2014b; 2014c).

For the variables measured at level (L), the tests indicate a maximum of 6 groups of different spaces, 5 or 6 groups for the planted area in growth rates (G), and a maximum of 6 representative groups for the normalized variables (NO). These values indicate 5 or 6 different spaces (areas) in terms of the growth rate for the Brazilian agricultural area.

TABLE 3 – Groups of mesoregions in Brazilian agricultural area, 1994-2013

Year	Variables at level (L)			Variables in growth rates (G)			Normalized variables (NO)		
	Pseudo-F	Pseudo-T	Mean	Pseudo-F	Pseudo-T	Mean	Pseudo-F	Pseudo-T	Mean
1994	3	2	2.5	-	-	-	3	2	2.5
1995	3	2	2.5	5	3	4.0	5	4	4.5
1996	4	3	3.5	6	4	5.0	4	3	3.5
1997	4	3	3.5	5	5	5.0	4	3	3.5
1998	3	2	2.5	3	2	2.5	5	3	4.0
1999	3	2	2.5	5	5	5.0	5	4	4.5
2000	4	5	4.5	5	4	4.5	3	2	2.5
2001	4	6	5.0	4	3	3.5	4	3	3.5
2002	4	5	4.5	4	3	3.5	5	4	4.5
2003	6	4	5.0	3	5	4.0	3	2	2.5
2004	6	4	5.0	3	2	2.5	3	5	4.0
2005	4	5	4.5	5	4	4.5	5	3	4.0
2006	3	2	2.5	5	3	4.0	3	2	2.5
2007	3	2	2.5	3	2	2.5	4	3	3.5
2008	4	3	3.5	4	2	3.0	3	2	2.5
2009	4	5	4.5	3	2	2.5	4	2	3.0
2010	4	5	4.5	4	3	3.5	5	2	3.5
2011	4	5	4.5	3	2	2.5	3	2	2.5
2012	4	3	3.5	3	2	2.5	3	2	2.5
2013	4	3	3.5	3	2	2.5	6	5	5.5

Source: author based on data on Municipal Agricultural Production (IBGE, 2015)

Assuming five groups (areas) of different rates of growth in agricultural area, Table 4 organizes the mesoregions according to their changing share in planted area between 1994 and 2013, where the last column to the right (C) is shown in descending order. In this column the value for the Extreme West Bahia, for instance, means that this area's share of Brazil's planted area in 2013 was 2.10 times its share in 1994.

Areas 1 to 4 experienced a participative increase of 11.41 percentage points (p.p.), 1.94 p.p., 7.21 p.p., and 3.57 p.p., respectively. These four areas accounted for 32.4% of Brazil's planted area in 1994 and for 56.53% of the country's planted area in 2013. Accordingly, they amounted a participative increase of 24 p.p. over twenty years.

Identifying the mesoregions with similar growth in planted area from 1994 to 2013 allowed creating a map showing the dynamics of Brazil's agricultural areas based on the previously selected areas 1 to 4, which is displayed in Figure 2.

Brazil´s center-northwestern axis presented a significant expansion of planted area. In recent decades, a substantial portion of the Brazilian agricultural research was devoted to the plains areas and crops located in that region. As stated by Anderson, Pardey and Roseboom (1993), growth in agriculture depends on many factors, but the most important is the investment in agricultural research. In this context, it should be noted that several mesoregions in the center-west area experienced a minimum absolute increase of five hundred thousand hectares from 1994 to 2013. According to Helfand and Levine (2004), agricultural production and total factor productivity have grown faster in this region than in other areas since 1970.

This route also projects towards eastern areas of the North. A second section that includes the north and northeast Mato Grosso, southern Amazonas, and the Juruá Valley must be highlighted, along with the state of Amapá, which represents a frontier area. The growth of these areas is probably related to specific

supply chains upstream and downstream from the farms (MASTRONARDI *et al.*, 2015), which naturally calls particular attention to sustainability in terms of social, economic[3] and environmental dimensions.

TABLE 4 – Share of selected mesoregions in planted area, 1994 and 2013

	% 1994 (A)	% 2013 (B)	C = [(B/A)-1]
North Amapá – AP	0.001%	0.011%	6.60
East Tocantins – TO	0.126%	0.630%	4.00
South Amapá – AP	0.006%	0.027%	3.32
North Mato Grosso – MT	3.092%	11.573%	2.74
South Maranhão – MA	0.292%	1.033%	2.54
Northeast Mato Grosso – MT	0.689%	2.305%	2.35
South Amazonas – AM	0.019%	0.057%	2.04
(Area 1)	**4.23%**	**15.64%**	
Extreme West Bahia – BA	1.211%	2.537%	1.10
Juruá Valley – AC	0.033%	0.067%	1.06
East Goiás – GO	0.571%	1.152%	1.02
(Area 2)	**1.81%**	**3.76%**	
Southwest Mato Grosso do Sul – MS	2.146%	4.134%	0.93
Southwest Piauí – PI	0.655%	1.235%	0.89
Presidente Prudente – SP	0.503%	0.898%	0.78
Southeast Mato Grosso – MT	1.834%	3.038%	0.66
Northwest Paraná – PR	0.676%	1.113%	0.65
South Goiás– GO	3.585%	5.766%	0.61
Central-South Mato Grosso – MT	0.167%	0.267%	0.60
Araçatuba – SP	0.543%	0.846%	0.56
North Roraima – RR	0.037%	0.057%	0.53
(Area 3)	**10.15%**	**17.35%**	
Central Amazonas – AM	0.106%	0.155%	0.46
Northwest Minas Gerais – MG	0.821%	1.192%	0.45
Central-West Rio Grande do Sul – RS	0.904%	1.264%	0.40
Central-North Mato Grosso do Sul – MS	0.782%	1.081%	0.38
Southwest Mato Grosso – MT	0.340%	0.459%	0.35
Northeast Rio Grande do Sul – RS	0.612%	0.791%	0.29
Minas Triangle/Upstream Paranaíba – MG	2.189%	2.828%	0.29
Central-East Paraná – PR	0.998%	1.279%	0.28
Bauru – SP	0.953%	1.213%	0.27
Southwest Amazonas – AM	0.021%	0.027%	0.27
Marília – SP	0.163%	0.205%	0.26
South Roraima – RR	0.024%	0.029%	0.23

Continua...

[3]In the United States, for example, the connections between lower borrowing costs in land credits and increase in farmland values have been studied and there have been discussions about a possible bubble in farmland values (GLOY *et al.*, 2011).

TABLE 1 – Continuation...

	% 1994 (A)	% 2013 (B)	C = [(B/A)-1]
Downstream Amazonas – PA	0.241%	0.294%	0.22
Southwest Rio Grande do Sul – RS	1.179%	1.427%	0.21
São José do Rio Preto – SP	1.388%	1.669%	0.20
Federal District – DF	0.159%	0.189%	0.19
Pioneer North, Paraná – PR	1.308%	1.478%	0.13
Itapetininga – SP	0.674%	0.720%	0.07
Southeast Paraná – PR	0.833%	0.885%	0.06
Madeira-Guaporé – RO	0.072%	0.075%	0.04
Central-North Paraná – PR	2.446%	2.518%	0.03
(Area 4)	**16.21%**	**19.78%**	
Central-West Paraná – PR	1.607%	1.599%	-0.01
Northeast Bahia – BA	1.027%	0.874%	-0.15
(Area 5)	**2.63%**	**2.47%**	
Selected mesoregions (areas 1-5)	**35.032%**	**58.998%**	**0.68**
Non-selected mesoregions (area 6)	**64.968%**	**41.002%**	**-0.37**
Brazil	**100%**	**100%**	

Source: author based on data on Municipal Agricultural Production (IBGE, 2015)

Another core expansion area includes east Tocantins, south Maranhão, southwest Piauí, and extreme west Bahia. According to Câmara *et al.* (2015), this area may concentrate future cropland expansion in Brazil from 2020 to 2050. Furthermore, a core of intermediate-pace expansion of planted areas includes mesoregions in northern Paraná, western São Paulo, the areas surrounding the Federal District, and the center-south of Mato Grosso do Sul.

3.2 The Shares of Soybeans, Corn and Cotton in Agricultural Area Expansion.

The second stage of this study calculates LQ and LGC for soybeans, corn, and cotton. As stated by Annan *et al.* (2013), spatial patterns of yield distributions can be crucial for their implications in crop insurance.

For soybeans, LGC had little variation along the data series, as it can be seen in Table 5. The mean LGC value was 0.295. However, outlier points were present in specific years, such as from 2001 to 2003, and 2006; this is likely the result of random events associated with agricultural production, soybean prices, exchange rates (since soybeans are an international commodity) or even infrastructure restrictions of Brazil.

Especially about Brazil´s infrastructure restrictions, 67% of the Brazilian soybeans are transported in highways (ALMEIDA, SELEME and NETO, 2013), with high production losses (NAVES, 2009 *apud* ALMEIDA, SELEME and NETO, 2013). This reality demands new strategies for transporting the product if soybeans area expansion continues. Furthermore, in line with Souza, Alves e Gomes (2014), infrastructure and rural extension improvements are public goods required for all Brazilian agricultural areas.

Additionally, the results for the last four years were below the mean level for the series, which can indicate reduced soybean concentration in the selected mesoregions in recent years. At the same time, the LQ of other (non-selected) mesoregions increased for the 2009-2013 period, which is consistent with the decline in LGC for soybeans. In terms of productivity, according to Bruce and Carriquiry (2010) changes in cultivated area do not result in lower soybean productivity because the crop experiences high levels of technological inputs and productive standardization.

A second aspect to highlight is the share of planted areas resulting from the selected mesoregions. For soybeans this share increased, reaching 73% of the total planted area with soybeans in Brazil in 2013, as seen in Figure 3. This result exceeded the respective level for all crops, permanent and temporary, especially between 1994 and 2006.

Some analysts (SAUER and LEITE, 2012) suggest that soybean expansion has been concentrated on Brazilian

savannas and has a main role in deforestation process. Ferreira and Coelho (2015) endorse such argument, mainly for the northern Brazilian states.

In the context of corn production, as it can be seen in Table 6, the mean value for the LGC series was 0.016. For such crop, LGC resulted in low or negative numbers from 1994 to 2006, but the data from 2007 to 2013 showed recent growth. Nevertheless, data from the entire series points out that corn area expansion was slightly concentrated in the selected mesoregions.

As an additional tool, partial LGCs were calculated for the years when a group of selected mesoregions had negative inputs for the LGC. This occurred in every year of the series, except for 2012–2013. Partial LGC corresponds to the coefficient matrix until the point where the contribution of the selected mesoregions is positive, excluding the group of mesoregions that had negative contributions[4] to the LGC for corn.

The results for LQ for the non-selected mesoregions reinforce that the area expansion according to the selected

1 North Amapá – AP	Area 1
2 East Tocantins – TO	
3 South Amapá – AP	
4 North Mato Grosso – MT	
5 South Maranhão – MA	
6 Northeast Mato Grosso – MT	
7 South Amazonas – AM	
8 Extreme West Bahia– BA	Area 2
9 Juruá Valley – AC	
10 East Goiás – GO	
11 Southwest Mato Grosso do Sul – MS	Area 3
12 Southwest Piauí – PI	
13 Presidente Prudente – SP	
14 Southeast Mato Grosso – MT	
15 Northwest Paraná – PR	
16 South Goiás – GO	
17 Central-South Mato Grosso – MT	
18 Araçatuba – SP	
19 North Roraima – RR	
20 Central Amazonas – AM	Area 4
21 Northwest Minas Gerais – MG	
22 Central-West Rio Grande do Sul – RS	
23 Central-North Mato Grosso do Sul – MS	
24 Southwest Mato Grosso – MT	
25 Northeast Rio Grande do Sul – RS	
26 Minas Triangle/Upstream Paranaíba – MG	
27 Central-East Paraná – PR	
28 Bauru – SP	
29 Southwest Amazonas – AM	
30 Marília – SP	
31 South Roraima – RR	
32 Downstream Amazonas – PA	
33 Southwest Rio Grande do Sul – RS	
34 São José do Rio Preto – SP	
35 Federal District – DF	
36 Pioneer North, Paraná – PR	
37 Itapetininga – SP	
38 Southeast Paraná – PR	
39 Madeira-Guaporé – RO	
40 Central North Paraná – PR	

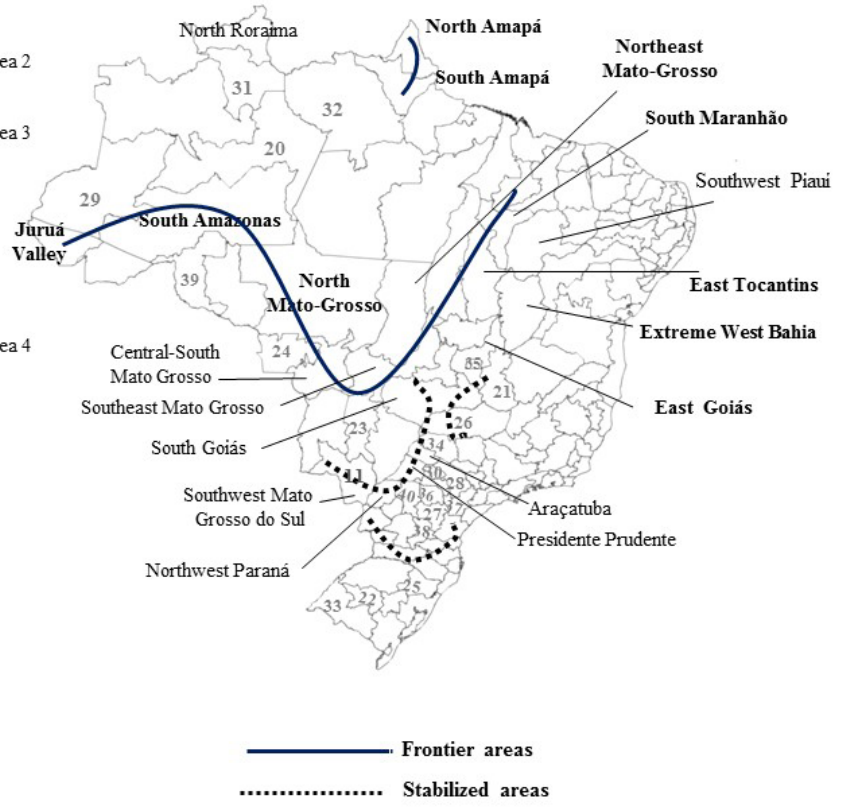

FIGURE 2 – Areas of agricultural expansion in Brazilian mesoregions, 1994-2013
Source: author based on data on Municipal Agricultural Production (IBGE, 2015)

[4]Further analyses can explore this negative contribution to understand the role that these areas play in the relatively low levels of LGC for corn. In mean terms, eight selected mesoregions had negative contributions to the LGC for corn from 1994 to 2011, which may have resulted from the specific criteria employed in selecting the mesoregions.

mesoregions was not concentrated in corn. SPAROVEK *et al*. (2016) showed that efficiency improvements are crucial for small or medium producers, which is more evident for corn[5] producers than for soybeans or cotton farmers.

TABLE 5 – LGC for soybeans and LQ for soybeans in non-selected mesoregions, 1994-2013

Year	LGC for soybeans	LQ for soybeans in non-selected mesoregions
1994	0.301	0.651
1995	0.321	0.621
1996	0.292	0.663
1997	0.283	0.669
1998	0.296	0.640
1999	0.293	0.640
2000	0.306	0.609
2001	0.318	0.591
2002	0.320	0.537
2003	0.317	0.563
2004	0.300	0.562
2005	0.296	0.557
2006	0.317	0.546
2007	0.293	0.582
2008	0.298	0.578
2009	0.299	0.578
2010	0.279	0.599
2011	0.277	0.600
2012	0.253	0.621
2013	0.234	0.652
Average	0.295	0.603

Source: author based on data on Municipal Agricultural Production (IBGE, 2015)

Since the last two years of available data indicate a changing process, only new data can highlight this phenomenon in further studies. Simultaneously, the share for selected mesoregions in the planted area with corn resembled the pattern for all crops. In other words, corn does not differ from the general pattern of importance of selected mesoregions in terms of planted area, as illustrated in Figure 4.

[5]In this context, Santana and Contini (2011) highlighted a forecasted increasing in domestic consumption (1.7% per year) for corn in Brazil from 2010 to 2030.

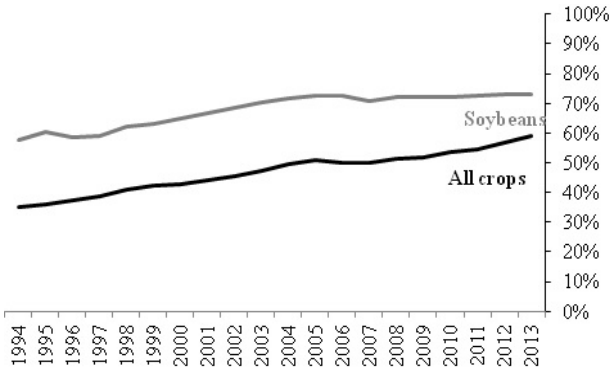

FIGURE 3 – Share of planted area in selected mesoregions, soybean and all crops, 1994–2013
Source: author based on data on Municipal Agricultural Production (IBGE, 2015)

TABLE 6 – LGC and partial LGC for corn, and LQ for corn in non-selected mesoregions, 1994–2013

Year	LGC for corn	Partial LGC for corn	LQ for corn in non-selected mesoregions
1994	-0.005	0.008	1.045
1995	-0.007	0.016	1.052
1996	0.010	0.021	1.004
1997	0.030	0.030	1.001
1998	0.000	0.023	1.060
1999	0.006	0.026	1.056
2000	0.003	0.025	1.061
2001	0.006	0.014	1.065
2002	-0.013	0.021	1.101
2003	-0.008	0.023	1.097
2004	-0.021	0.022	1.139
2005	-0.028	0.021	1.162
2006	-0.020	0.021	1.133
2007	0.028	0.039	1.043
2008	0.034	0.044	1.042
2009	0.018	0.037	1.077
2010	0.038	0.048	1.041
2011	0.037	0.050	1.056
2012	0.086	Not applicable	0.963
2013	0.124	Not applicable	0.901
Average	**0.016**	**0.027**	**1.055**

Source: author based on data on Municipal Agricultural Production (IBGE, 2015)

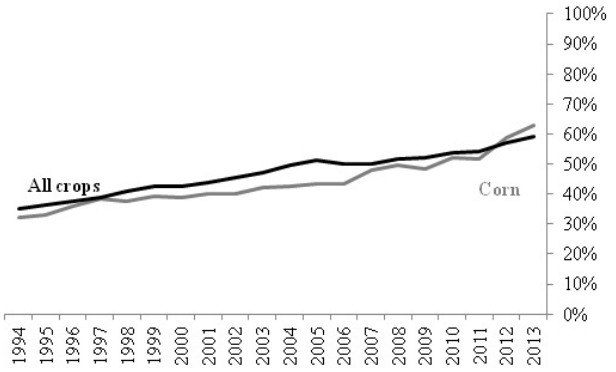

FIGURE 4 – Share of planted area in selected mesoregions, corn and all crops, 1994–2013
Source: author based on data on Municipal Agricultural Production (IBGE, 2015)

Regarding the cereal, it is mandatory to report that this crop is commonly managed in association to soybeans cycle in several Brazilian regions. The real occurrence of cereal in many areas can be underrated. Only Census data can clarify this aspect since the Municipal Agricultural Production (IBGE, 2015) does not offer any farmer individual information.

For cotton, Table 7 illustrates the ascending value for LGC. This growth is specifically located in the period 2000-2010. This phenomenon is more significant in cotton than in soybeans, and greatly exceeds the value for corn. Accordingly, the LQ for the non-selected mesoregions decreased during the studied period, representing the diminishing importance of the non-selected mesoregions in the area of cotton expansion.

The selected mesoregions were also more significant in cotton expansion than in all crops expansion, as it can be seen in Figure 5. This process is clear from 1997 and stabilizes in 2007. From 2010 on, around 90% of cotton production occurred in the selected mesoregions.

According to Santo, Lima and Souza (2012) domestic uses play an important role in Brazilian cotton demand. At the same time, for some authors (LEITE and WESZ, 2010) land prices change when cattle areas are converted in cotton or soybeans cultivated areas. This way, even indirectly cotton and soybeans change the land prices in new agricultural areas.

In comparative terms, the selected mesoregions were equally representative for the expansion in corn as well as for the expansion in all crops. For soybeans, the selected mesoregions became more significant than for corn or even for all crops. Especially in recent years, three quarters of the entire planted area with soybeans was located in the selected mesoregions. Moreover, during the twenty years of the study, the share of planted area with cotton in the selected mesoregions increased substantially, with clear difference in participative expansion *vis a vis* the all crops situation.

Regarding this matter, Carvalho, Laureto and Pena (2015) had already detected higher productivity growth rates for cotton, corn and soybeans in the 1990´s than in the 2000´s, being more evident for cotton.

In a context of area expansion guided by soybeans and cotton, even if environmental impacts happen (SAUER and LEITE, 2012), some analysts (SPAROVEK *et al.*, 2016) consider possible to find out a common base of interests between farmers and conservationist groups.

Surely, those impacts are not limited to competition for agricultural endowments, as exposed by Brum, Dalfovo and Azuaga (2009). Their analysis about Sorriso County (MT) identified a distinguishable economic growth related to soybean production as an increased level of environmental damaging as a consequence of that increased activity.

TABLE 7 – LGC for cotton and LQ for cotton in non-selected mesoregions, 1994–2013

Year	LGC for cotton	LQ for cotton in non-selected mesoregions
1994	0.187	0.861
1995	0.274	0.904
1996	0.329	0.595
1997	0.153	0.387
1998	0.375	0.762
1999	0.412	0.535
2000	0.369	0.723
2001	0.538	0.835
2002	0.534	0.692
2003	0.523	0.644
2004	0.543	1.174
2005	0.560	1.278
2006	0.640	0.958
2007	0.708	1.159
2008	0.729	0.177
2009	0.718	0.203
2010	0.739	0.172
2011	0.718	0.175
2012	0.707	0.179
2013	0.689	0.218
Average	**0.522**	**0.632**

Source: author based on data on Municipal Agricultural Production (IBGE, 2015)

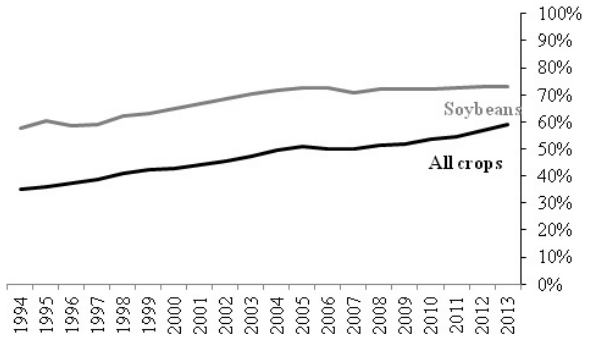

FIGURE 5 – Share of planted area in selected mesoregions, cotton and all crops, 1994–2013
Source: author based on data on Municipal Agricultural Production (IBGE, 2015)

4 CONCLUSIONS

This study investigated disparities in the growth of agricultural areas in the Brazilian mesoregions during the period 1994–2013 and focused on the shares of concentration for soybeans, corn and cotton in newly expanded areas.

The results detected forty-two mesoregions in six different areas of Brazil, according to their rates of expansion of agricultural area, which included a residual area containing the non-selected mesoregions. It was possible to recognize a concentration of mesoregions that experienced a significant growth in planted area in the central-west region of the country; this included mesoregions with an absolute increase of at least five hundred thousand hectares from 1994 to 2013. There is a clear center-northwest axis of expansion, especially towards eastern areas of the north and northern areas of the center-west.

In certain aspects, this phenomenon converges with another area of expansion comprised by east Tocantins, south Maranhão, southwest Piauí, and extreme west Bahia. Some areas with an intermediate pace of expansion in planted areas were also identified. Underlying this process, the selected mesoregions concentrated 90% of the area planted with cotton in Brazil. These values are also significant for soybeans (almost 75%) and corn (63%).

In terms of the share of growth in agricultural area per crop, the results showed the central role that is played by cotton with relation to soybeans and corn. LGC for cotton was higher than LGC for soybeans after 1998, and surpassed LGC for corn throughout the entire series. This disparity increased from 1998 to 2010 and only began to decrease in recent years. Another interesting aspect is the behavior of LGC for corn, which resembled the LGC for all crops.

Comparatively, both LGC and LQ seemed to indicate a relatively cotton concentrated expansion of agricultural areas in the selected mesoregions. This expansion is less concentrated in soybeans and even less concentrated in corn. Of course, this process can be completely different in each of the forty-two selected mesoregions, which is another point for further investigation.

This set of conclusions may support public policies related to regional aspects of agricultural expansion in Brazil, particularly for corn, soybeans, and cotton. Even though some studies, such as Câmara *et al*. (2015), have evaluated that Brazil is able to cope with environmental concerns and intense agricultural production, there is still space for debating.

Another important aspect is considering that soybean-cotton-corn expansion can diminish available area for producing other typical food products domestically consumed, such as beans, fruits, rice, wheat and edibles vegetables, roots and tuber. Kostandini, Mykerezi, and Escalante (2013) cited output choices among the factors affecting farm labor shortages. Indeed, these effects do not limit themselves to the agricultural labor markets; they also affect the final food price levels.

Other crops can also be included in future analysis, and consequent studies could include variables to identify reasons behind different growth rates, such as water availability or land and soil conditions. New studies are also welcome especially at country level and may explore the dynamics of specific mesoregions, analyze the supply of agricultural inputs in frontier mesoregions, or even measure productivity levels for other crops inside de identified areas.

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Gráficos, deberán ser insertados después de la citación de los mismos, dentro del propio texto, elaborados **preferencialmente en Excel** (ej: **Mathtype, Equation),** sin perdida de sus informaciones originales.

6. El autor principal será notificado sobre el recibimiento del original y posteriormente, será informado sobre su publicación. Los artículos que necesiten modificaciones serán devueltos al autor para la debida revisión.

7. Todos los artículos serán evaluados por consultores *Ad Hoc* por el sistema "*Blind Review"*.

8. El trabajo de los autores y consultores no será remunerado.

Los trabajos deben enviarse a través de la página web http://revista.dae.ufla.br

GUIDELINES AND ORIENTATION FOR SUBMISSION

The Journal "Organizações Rurais e Agroindustriais" has been edited three-monthly by the Department of Business Administration and Economy of Federal University of Lavras, with support from UFLA Publishing.

Emphasizing the development of knowledge in Business Administration of specific sectors, the goal of this Journal is to publish scientific articles as well as working papers developed by the academic community and collaborators in the areas of "management of agribusiness chain," "social management, environment and development," "organization/association forms", "strategic management and changing", "economy, rural sociology and extension."

The manuscripts must be written in clear, straight and objective form, under the norms of ABNT, in order to reach our readers, most of whom researchers, as well as people related to the management of organizations in public or private sectors, direct or indirectly associated to rural and agri-industrial fields.

The manuscripts can be submitted in Portuguese, Spanish and English, and must be original and not been previously sent elsewhere for publishing. Works originally published in foreign languages can exceptionally be accepted under evaluation by the Editorial Board.

Rules of presentation

1. The article must be configured for A4 paper; with 3cm of superior margin, 2cm of inferior, 3cm of right, and 2cm of left, using 1,5 lines of line spacing and justified alignment. The word processor utilized is the Microsoft Word, version 6 or later, Times New Roman font size 12. Manuscripts must not exceed the maximum of 25 pages including charts, tables, figures, illustrations and references. Manuscripts must contain a title in the heading line of the work without the authors' identification.

2. The manuscript must include an abstract in Portuguese following its title, of approximately 15 lines or 250 words, without paragraphs, containing the article's objective, methodology, results and conclusion, as well as a minimum of three and a maximum of five key-words. Abstracts in Portuguese must contain a respective version in English, including title and key-words. Manuscripts submitted in Spanish must contain an abstract and key-words in the original language, as well as in Portuguese, and English.

3. This Journal will consider a maximum of three authors per article. In case of more than three, the exceeding one(s) will be referred to as collaborator(s).

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6. The first author will be notified upon the receiving of the manuscript and informed afterwards of its acceptance for publication. Manuscripts needing reviewing will be sent back to the authors for proceedings in that sense.

7. All submissions will be evaluated by the Ad Hoc reviewers under the BLIND REVIEW system.

8. Authors and reviewers will not be paid for the work.

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