Ciência Rural, Santa Maria, v.53:10, e20220261, 2023 http://doi.org/10.1590/0103-8478cr20220261
ISSNe 1678-4596
AGRIBUSINESS

# The role of rural credit policies in agricultural income generation in family farms in Pernambuco State, northeastern Brazil - spatial trend and future scenarios

**Camilla Silva Motta dos Santos[1*] Marcos Aurélio Vasconcelos Freitas[1] Neilton Fidelis da Silva[2] Leandro Andrei Beser de Deus[3] Jorge Henrique Alves Prodanoff[4]**

[1]Programa de Planejamento Energético, Universidade Federal do Rio de Janeiro (UFRJ), 21031-596, Rio de Janeiro, RJ, Brasil. E-mail: camillasms@gmail.com. *Corresponding author.
[2] Programa de Pós-graduação em uso Sustentável de Recursos Naturais, Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte, Natal, RN, Brasil. Instituto Virtual Internacional de Mudanças Globais, Universidade Federal do Rio de Janeiro (UERJ), Rio de Janeiro, RJ, Brasil.
[3]Instituto de Geografia, Universidade do Estado do Rio de Janeiro (UERJ), Rio de Janeiro, RJ, Brasil.
[4]Departamento de Recursos Hídricos e Meio Ambiente, Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, RJ, Brasil.

**ABSTRACT**: Agriculture is central in Brazil's political and socioeconomic history; agricultural exploitation is mainly conducted by families, creating a type of agriculture developed in small rural properties named family farming. In Brazil, family farming accounts for a very diverse group of businesses, of which 91% of all the establishments are family establishments that build different production strategies according to different degrees of potentiality and precariousness. This study evaluated the role of rural credit policies in developing family farming activities with agricultural income generation in northeastern Brazil on various family-based farms. For this, the authors conducted a case study in Pernambuco, analyzing the spatial relationship between the distribution of family farms and the access to credit resources from the National Program to Strengthen Family Farming from 2006 to 2017 and the change probabilities in types of farms considering the next 10 years, given the maintenance of conditionsreported in the analyzed period. Results indicatedthe weakening of productive potentiality of farming activities in family farms in Pernambuco, with a significant change in the distribution of family farm types, a reduction in the participation of Specialized Farms and an expressive growth of Farms with Rural Residents. The findings also indicated the relevance of access to rural credit in the supply of production needs of different family farm types and development of farming activities with income generation.
**Key words**: family farming, rural credit, public policies, agricultural income, territorial planning.

## O papel das políticas de crédito rural na geração de renda agrícola na agricultura familiar do estado de Pernambuco, nordeste brasileiro - tendência espacial e cenário futuro

**RESUMO**: A agricultura é central na história política e socioeconômica do Brasil, a exploração agrícola é realizada principalmente por famílias, criando um tipo de agricultura desenvolvida em pequenas propriedades rurais denominada agricultura familiar que abrange 91% dos estabelecimentos rurais no país. O presente trabalho tem como objetivo avaliar o papel das políticas de crédito rural no desenvolvimento das atividades agrícolas com geração de renda em diferentes tipos de estabelecimentos familiares do Nordeste Brasileiro. Para isso, foi realizado estudo de caso no estado de Pernambuco onde foi analisada a relação espacial entre a evolução da distribuição dos tipos de estabelecimentos familiares e o acesso aos recursos de crédito do Programa Nacional de Fortalecimento da Agricultura Familiar no período de 2006 a 2017 e as probabilidades de mudança nos tipos de fazendas, considerando os próximos 10 anos, dada a manutenção das condições encontradas no período de análise. Os resultados indicam o enfraquecimento da potencialidade produtiva das atividades agropecuárias pela agricultura familiar em Pernambuco, com mudança significativa na distribuição dos tipos de estabelecimentos familiares, redução da participação dos estabelecimentos especializados e crescimento expressivo dos estabelecimentos com residentes rurais. Os resultados indicaram, também, a relevância do acesso ao crédito rural no suprimento das necessidades produtivas nos diferentes tipos de estabelecimentos familiares e em viabilizar o desenvolvimento de atividades agropecuárias com geração de renda.
**Palavras-chave**: agricultura familiar, crédito rural, políticas públicas, renda agrícola, planejamento territorial.

## INTRODUCTION

Family farming is a social category with globally recognized livelihood and forms of production. Such farming contributes to rural economic development and plays a fundamental role in food production, food security, and eradicating poverty (BECOT & INWOOD, 2020; GUTH et al., 2022; IKUEMONISAN & AJIBEFUN, 2021; ZAHAIKEVITCH et al., 2022). In addition, BAKER

Received 05.05.22 Approved 12.05.22 Returned by the author 02.01.23
CR-2022-0261.R3
Editors: Leandro Souza da Silva Raquel Breitenbach

et al. (2016) highlighted that this form of agricultural production is widely touted as the most "sustainable."

Family farming comprises a network of 500 million establishments globally and is responsible for approximately 50%–80% of the global trade of perishable food (FAO/IFAD, 2019).GRAZIANO DA SILVA (2019) highlighted that in addition to family farming being recognized as a social category in the agricultural sector, the United Nations General Assembly announced 2019 to 2028 as the United Nations' Decade for Family Farming.

Despite the significant participation of family farming in the agricultural sector in Brazil (90% of total farms)—according to the most recent data available published by the Brazilian Institute of Geography and Statistics (IBGE, 2017)—the debate on its importance for the country's development has only come to the forefront in the mid-1990s. This discussion was enabled by the debates on sustainable development, employment and income creation, food security, and local development. Until then, no national policies catered to the specific social segment of family farming.

The consolidating process of institutional recognition of family farming within the state had the decisive engagement of policymakers sympathetic to this project. The sector began to rely more intensely on public policies that considered its needs with the institution of the National Program to Strengthen Family Farming (PRONAF) in 1995. The program aimed to provide subsidized credit to small producers and integrate it into other rural development policies to support infrastructure development and technical assistance.

Conversely, the importance of the agricultural sector in developing the rural economy and food production in the country is remarkable. On the other hand, the lack of evaluation of logistical and technological conditions, credit access, and technical assistance represents a potential obstacle to rural economic development.

From the presented context, we hypothesized that access to rural credit is a fundamental factor in enabling the development of agricultural activities with income generation on family farms and an important issue in enabling these activities as a form of social reproduction. Among the greater Brazilian regions, the northeastern region has stood out when considering the total number of family farms; it has an expressive sector working on family farming which is representative in its own context.

Motivated by the need to implement policies that develop the public sector in Brazil and analyzing the significance of family farming in Northeast Brazil, this study evaluates the role of rural credit policies in developing family farming activities with agricultural income generation in various types of family-based farms. To achieve our goals, we carried out a study in the Pernambuco State. This choice was made based on the likeness of this area with the region's distribution standards of family farm types.

We analyzed the spatial relationship between the evolution of family farm types distribution and the access to credit resources by PRONAF (the central Brazilian rural credit policy) and the change probabilities in types of farms. We considered the next 10 years, given the maintenance of the observed conditions in the evolution of the spatial distribution of family farm types and their access to rural credit resources from 2006 to 2017. This time range was selected based on the availability of official data.

*Family farming in official brazilian statistics*

The Brazilian Census of Agriculture obtained the range of family farming from two classifications: i) according to the legal viewpoint established in the requirements of the 9.064/17 Decree, which provides for the Family Unit of Agricultural Production; ii) in the ranking developed by the Food and Agriculture Organization of the United Nations (FAO) in cooperation with the National Institute for Colonization and Agrarian Reform (INCRA) (FAO/INCRA, 1995).

When comparing the family farm range in both classifications, one can observe that the adopted requirements significantly influence the scope of the family farms. According to the legal criteria, in Brazil, in 2017, 3,897,408 family farms were working in agriculture and husbandry. This range increased to 4,638,176 farms (an approximately 20% increase) when considering the FAO/INCRA categorization criteria.

Concerning the difference in the scope of family farms between each classification, the legal text reduces the range of family farming to establishments that earn at least half the family's income in economic activities developed internally. Therefore, it excludes enterprises whose family income acquired more external resources that could be explained by multiple factors, such as resources derived from family retirements, work developed outside the farm, or resources originating from government financing.

In this study, we opted to consider the family farming range defined by FAO/INCRA in their

report, allowing for a broader understanding of the diversity implied in the country's family farming.

*Overview of family farming in brazil and the northeastern region*

Family farming represents Brazil's largest category in the agricultural sector when considering all farms, and plays a vital role in generating income, employment, and food production. The official statistics shown that Brazil had 5.073.324 farming establishments in 2017, of which 4.638.176 were classified as family farms, which represented 91% of all establishments.

Conversely, considering the land area, family farms occupy 117.64 million hectares, representing 33.5% of Brazil's total farming area. These data demonstrated a highly concentrated agrarian structure in that non-family farms, fundamentally inserted in the agribusiness chain, represents only 8.6% of total farms, yet they occupy 66.5% of the total farming area.

Regarding the occupational category, the family-based production system accounted for almost 80% of the staff occupied in farm establishments in the analysis. This indicated the importance family farming holds in generating employment within the agricultural sector in the country.

On the other hand, the remaining 20% of the workforce employed works in non-family agriculture. In this term, MATTEI (2006) analyzes the recent behavior of agricultural employment in Brazil and highlights the modernization process. While it remodels the productive systems and expands monocultural practices, it subsequently has an effect of rising the substitution of human labor in favor of mechanical force in several stages of the production process.

This is also reflected in the lesser participation of family farming in the production value and generated incomes in national agricultural production. It might be explained, in general terms, as a consequence of being less inserted in the productive processes led by corporate cultures and having less access to technological incorporation in the productive process.

Thus, rural public policies aim to meet agricultural establishments' limitations in terms of structure, access to rural credit, technology, technical training, and technical assistance. Therefore, the promotion of these actions reflects in agriculture dynamic in general. For non-family farming, the instruments are in the Agricultural and Livestock Plan; for family farming, they are included in the Family Agriculture Crop Plan.

From 2006 to 2017, investments in agriculture grew mainly due to the amount allocated to non-family agriculture, with possible effects on the total number of agricultural establishments, which had a reduction of 2%. The total arable area grew by 5% driven mainly by properties of more than 1,000 hectares. However, in absolute terms, the number of establishments that benefited was low since family establishments, which correspond to the largest number of Brazilian agricultural establishments, received 14% of the amount of resources earmarked for the period (IBGE, 2006, 2017).

Regarding access to the financial system, when analyzing the annual totals allocated to agricultural credit with the number of agricultural establishments in the country, SCHEUER (2019) points to a negative variation of 15% in the level of access since, in 2006, 18% of establishments obtained access to rural credit. In 2017 16% of agricultural establishments had access to credit. Given this phenomenon, the author reinforces the likely contribution to the reduction in the number of agricultural establishments observed in the period, driven by the reduction in the number of establishments with an area equal to or less than 0.1 ha, consisting mainly of family farming establishments.

About the development of agricultural income in the country from 2006 to 2017, because of the data released in the Agricultural Census, SOUZA et al. (2020) highlighted evidence of a significant concentration of income, since in 2006, the gross rural income was concentrated in 0.62% of rural establishments that declared an annual income above 200 minimum wages and in 2017 the same income class comprised 0.60 % of total agricultural establishments. In this context, the authors emphasize the importance of controlling market imperfections and promoting instruments that enable productive inclusion and reduce inequalities in rural areas.

In Brazil's rural area, the northeastern region gathers almost half of the total family farms and has a more representative family farming sector than the national average. According to the 2017 Census of Agriculture, there were 2,198,227 family farms in the region, representing 94.6% of total local farms, against 91% of the Brazilian average. In addition, family farming occupied about 50% of the total area used in farming activities, employing 90% of the staff performing farming activities in the region.

To characterize the family farms in the country, we created a typology considering studies that established family farming types to produce public

policies, such as ABRAMOVAY (2000), ANDERSEN et al. (2007), HERRERO et al. (2014), TAVERNIER & TOLOMEO (2004), GRASKEMPER et al. (2021), and NYAMBO et al. (2019).

A typology was then created based on adapting the method developed by SCHNEIDER & CASOL (2014), in which the family farming range was segmented from income indicators, resulting in classes that allow an analysis of the sector's economic diversity. The typology classified family farms into three types: i) Specialized Farms (agricultural income over 50% of the total establishment income); ii) Farms with Multiple Sources of Income (farming income between 21% and 50% of the total establishment income); iii) Farms with Rural Residents (less farming income, corresponding to only 20% or less of total income).

Thus, in the northeastern region, Farms with Rural Residents comprise 1,319,570 establishments, where the primary monetary input comes from other incomes of the producer (93%), corresponding predominately to retirement and pension incomes. Specialized Farms, comprises 533,022 establishments; farming activities income is the main source, accounting for about 77.1% of the total establishment income. Farms with Multiple Sources of Income comprises 345,635 establishments; the main sources of income originate from other incomes achieved by the producer (63%) and from farming activities (32%).

This indicated that the farms' integration into the markets in the northeastern region is low, and farmers are strongly reliant on retirement and pension income. The significant presence of Specialized Farms and Farms with Multiple Sources of Income shows potential for increasing the development of farming activities as a social reproduction strategy.

## MATERIALS AND METHODS

We conducted an exploratory survey of theses, dissertations, scientific papers, public management laws, and acts. Furthermore, secondary data was drawn from official Brazilian statistics referring to the agricultural sector made available in the Census of Agriculture from 2006 to 2017.

For defining the family farming range, we evaluated the requirements of the classifications used in the official statistics, identifying their contours while aiming to align the approach to this study's objectives.

To characterize the family farms in the country, we created a typology adapted from the method developed by SCHNEIDER & CASOL (2014), where the range of family farming was segmented according to income parameters, resulting in classes that underline the economic diversity of the sector.

The typology was defined using the municipality as the smallest spatial unit analyzed. Given the available data, we opted to work with the municipality's most common family farm type, allowing us to identify areas where each type of family farm prevails.

Once the study's spatial frame was defined, we analyzed the evolution of family farming in the agricultural sector and the progress of family farms from 2006 to 2017. The evolution in the spatial distribution of family farm types and their access to credit resources by PRONAF was drawn from the Land Change Modeler in IDRISI 17.0 software.

The Land Change Modeler is a predictive module in the IDRISI environment, whose functionalities are organized into a set of five main task areas expressed as environments: Change Analysis, Transition Potential Modeling, Change Forecast, Implications, and Planning (EASTMAN, 2012).

This study development uses tools from Change Analysis and Change Forecast environments. For the construction of the analyses, it was necessary to have two thematic images on different dates (T1 and T2), covering the same area and having identical attributes (rows, columns, and thematic classes). The scenes used were the thematic maps of the predominance of types of family farming establishments per municipality in the state of Pernambuco in the years 2006 and 2017.

In the Land Change Modeler's Change Analysis environment, a map of spatial trends of changes was generated, with a 3rd order polynomial, which presented the areas where a greater number of establishments failed to generate agricultural income, making the presence of establishments of rural residents predominant. This map made it possible to point out critical regions in relation to the transformations that took place in the analyzed period. The results obtained by the model overlapped with the municipalities that presented a reduction in family farms' access to PRONAF resources.

In view of the results obtained, a matrix that comprises a mathematical representation of the Markov Chains was generated. The Transition Matrix is a square MxM stochastic matrix, where the elements represent the probability of changing from one theme to another in an estimated future time (MARKOV, 1971; CONSTANTINOU, 2007).

In the generated matrix, the elements represented the probabilities of changing from one

type of family farm to another in the next ten years, given the maintenance of the found conditions in the evolution of the spatial distribution of family farm types and their access to rural credit resources. The transition probabilities were derived from samples for the years 2006 and 2017. Results constituted subsidies for the construction of future scenarios for 2027 and further discussion of the results.

## RESULTS AND DISCUSSION

Pernambuco is representative space that allows for a more detailed analysis of the social and economic diversity in family farming. According to the Census of Agriculture, this study encompasses the evolution of family farming in the state between 2006 and 2017.

Family farming is the majority category in Pernambuco state's agricultural sector. In 2017, the state accounted for 281,688 farming establishments, of which 271,036 were classified as family farms, corresponding to 96% of total establishments.

Among the family farm types in Pernambuco (Table 1), the most preeminent group was Farms with Rural Residents, comprising 166,178 establishments, where other producer incomes, mostly retirement and pension incomes, are credited to their primary monetary input. In this group, agricultural production does not have much economic and productive significance; although, it can be relevant to exploring self-consumption and allowing for their continuity in rural areas.

The second group comprises the Specialized Farms, accounting for 69,598 establishments, in which farming is the primary source of income and represents, on average, 80% of total income. The third group comprises the Farms with Multiple Sources of Income, accounting for 34,720 establishments. In this group, the main sources of income are credited to other producer incomes (63%) and farming activities (34%).

The last Censuses of Agriculture show significant changes in the distribution of different family farm types. Between 2006 and 2017, a significant reduction in the participation of Specialized Farms and an expressive growth of Farms with Rural Residents occurred. This indicated the weakening of the productive potentiality of farming activities on family farms in Pernambuco. This is reinforced by the proportional rise in incomes whose sources are non-farming activities within the total income of family farms.

Table 1 - Classification of family farming establishments in Pernambuco.

| Variable | Specialized establishments | | Multiple sources of income establishments | | Establishments with rural residents | |
|---|---|---|---|---|---|---|
| | 2006 | 2017 | 2006 | 2017 | 2006 | 2017 |
| Total Farm Establishments | 127,008 | 69,598 | 26,448 | 34,720 | 131,793 | 166,718 |
| Farming activities Income (%) | 96.7 | 87.4 | 34.5 | 34.0 | 4.4 | 3.8 |
| Other establishment Incomes (%) | 0.2 | 1.1 | 3.4 | 3.4 | 5.2 | 2.1 |
| Other incomes received by producer (%) | 3.1 | 11.5 | 62.1 | 62.6 | 90.3 | 94.1 |
| Farming activities income (%) - Vegetable products | 80.1 | 34.1 | 12.4 | 9.2 | 1.9 | 0.9 |
| Farming activities income (%) - Animals and animal products | 14.3 | 45.9 | 20.6 | 23.9 | 2.4 | 2.8 |
| Farming activities income (%) - Agroindustry products | 2.3 | 7.3 | 1.4 | 0.9 | 0.1 | 0.1 |
| Other establishment incomes (%) | 0.2 | 1.1 | 3.4 | 3.4 | 5.2 | 2.1 |
| Other incomes received by producer (%) - Activities outside the establishment (%) | 0.9 | 3.6 | 17.0 | 18.1 | 17.6 | 19.5 |
| Other incomes received by producer (%) - retirements and pensions incomes (%) | 1.4 | 5.7 | 36.7 | 37.9 | 63.5 | 66.5 |
| Other incomes received by producer (%) - Government programs - originated incomes (%) | 0.8 | 2.3 | 8.4 | 6.6 | 9.3 | 8.1 |

Source: Based on IBGE information of Census of Agriculture 2006 and 2017, special data tabs.

The main spatial distribution of family farm types in Pernambuco in 2006 and 2017 (Figure 1) shows that in 2006 there was a balanced distribution in the state regarding the prevalence of family farm types with a larger concentration of the predominance of Specialized Farms in the mesoregions of Mata Pernambucana, Agreste Pernambucano, and Recife's metropolitan area.

In 2017 there was a growth in areas with a predominance of Farms with Rural Residents throughout the state, especially in the mesoregions of Sertão Pernambucano, São Francisco Pernambucano, and Agreste Pernambucano. The areas with a prevalence of both Farms with Multiple Sources of Income and of Specialized Farms started to concentrate in the mesoregions of Mata Pernambucana and in Recife's metropolitan area.

The analysis of the evolution of family farming types in Pernambuco indicated that, even though this class still holds a significant share of the agricultural sector, the income generation with farming activities has decreased in most of the state.

This study evaluated the relationship between the distribution of family farm types in Pernambuco and their access to credit resources from PRONAF between 2006 and 2017, aiming to evaluate its influence on agricultural income generation in family establishments.

A map drawn from the trend of change model is shown in figure 2, with the direction usually followed when there is a transition of areas with a predominance of Multiple Function Farms and of Specialized Farms to areas where Farms with Rural Residents prevail. The results obtained by the model overlapped with the municipalities that presented a reduction in family farms' access to PRONAF resources.

The trend of changes model indicates that the highest inclinations of change to areas where Farms with Rural Residents prevailed are in the southwest portion of the state, between the mesoregions of Sertão Pernambucano and São Francisco Pernambucano; where the largest areas that show a reduction in the access to PRONAF resources are also reported. These results indicated a strong relation between access level to rural credit resources and the development of farming activities with income generation in the different family farm types.

From the results, a transition matrix was generated based on Markov chains, shown in table 2, with the probabilities of change from one type of farm to another if the current credit access conditions are maintained, in an estimated time (T3), referring to the interval of ten years. The change probabilities are derived from samples between instants T1 and T2 corresponding to 2006 and 2017.

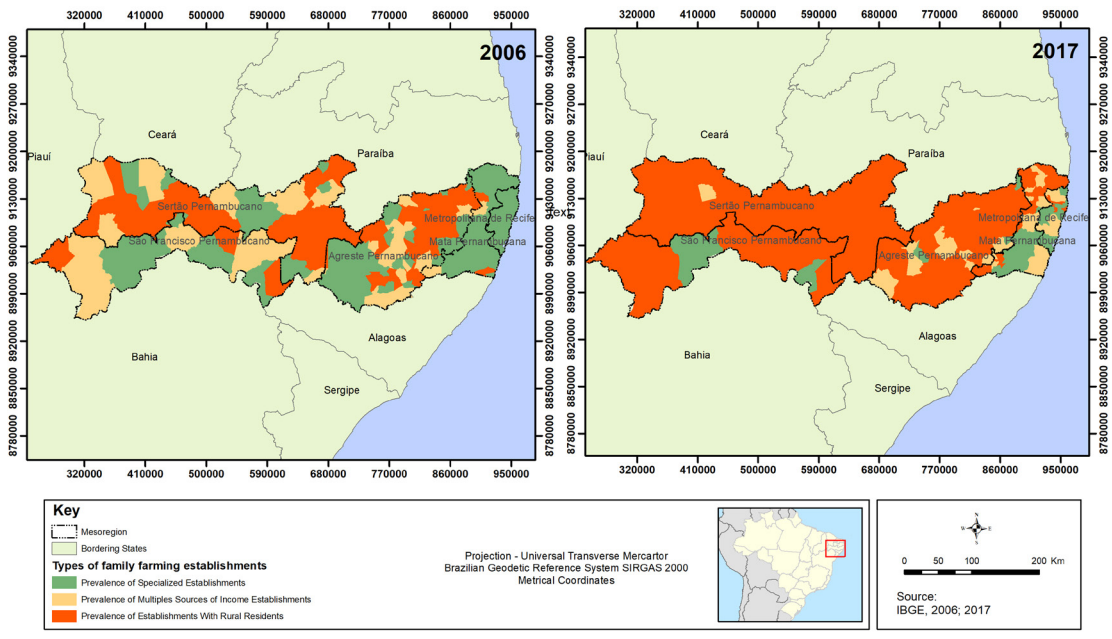


Figure 1 - Distribution of family establishment types in Pernambuco.

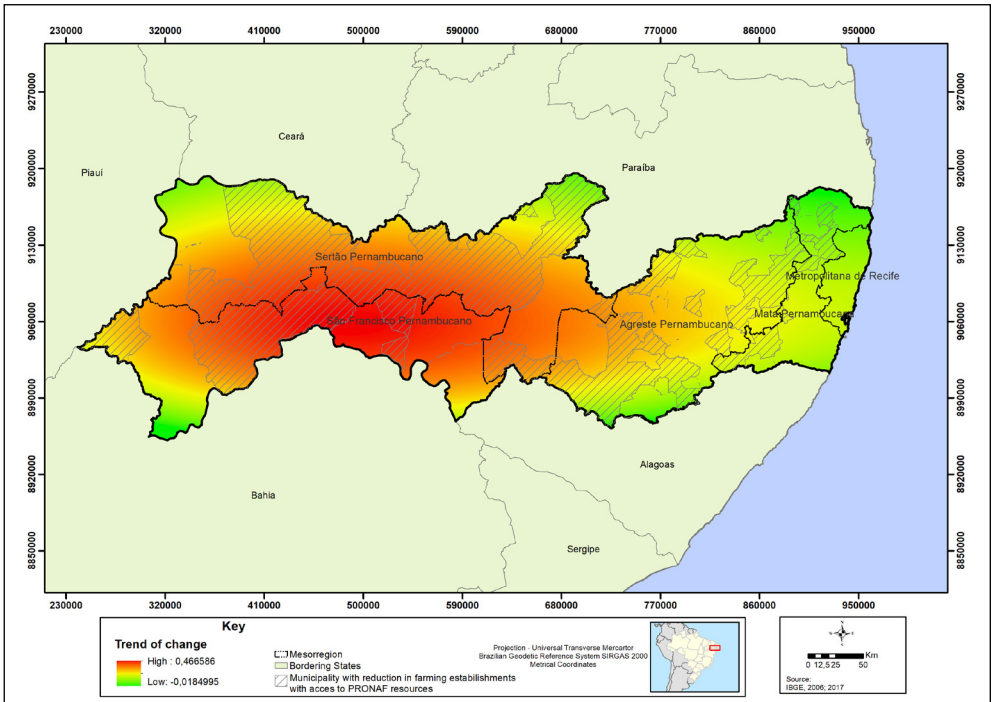


Figure 2 - Spatial trend of change from areas with a predominance of Multiple Function Family Establishments and Specialized Establishments to areas with a predominance of Family Establishments with Rural Residents and areas with a decrease of establishments with access to PRONAF resources in Pernambuco.

The instant selection allows indicating the future trend based on the sample presented, through the change observed in time "t" and time "t+1." Thus, based on Markov chains and including a future narrative, a reference scenario and an alternative scenario for 2027 were carried out.

In the reference scenario, the trend model based on Markov chains is marked by a significant decrease in access to rural credit and agricultural income obtained in family farming establishments in the state. The trend indicated for the next 10 years is a transition to a predominance of Family Farms establishments with Rural Residents (where farming activities income is not significant) throughout the territory.

Thus, the low agricultural financial support that occurred recently will be reproduced in the future with restricted rural credit. Therefore, without incentive for the development of farming activities, we probably have reduced income generation as social reproduction way. This scenario reinforces the strong trend of Multiple Function Farms and Specialized Farms transitioning to Farms with Rural Residents (94% and 53%, respectively).

An alternative way to change the situation predicted in the reference scenario would, in an

Table 2 - Classes transition probability for the year 2027 (%).

| | Multiple sources establishments | Specialized establishments | Establishments with rural residents |
|---|---|---|---|
| Multiple function establishments | 0.06 | 0.00 | 0.94 |
| Specialized establishments | 0.19 | 0.28 | 0.53 |
| Establishments with rural residents | 0.01 | 0.00 | 0.99 |

alternative scenario, evaluate the demand for credit and consider different possibilities in allocating rural credit resources. In this sense, many studies (ANETOR et al., 2016; DE CASTRO & TEIXEIRA, 2012; BAHŞI & ÇETIN, 2020; CARRER et al., 2020; FAO/INCRA, 1995; GAZOLLA & SCHNEIDER, 2013; SUESS-REYES & FUETSCH, 2016) recommend for small farms allocating rural credit aimed at farming, and, for farms with the low-income generation, using rural social credit aimed at farming enterprises.

In this scenario, in areas where Multiple Function Farms and Specialized Farms prevail, the allocation of credit policies should strengthen production conditions and fortify means that allow for the generation of economic surplus, thus keeping agricultural income significant. Alternatively, in areas with more Farms with Rural Residents, where the available means of production is insufficient to generate an economic surplus from farming. The rural credit programs should aim at perfecting access to production resources, goods, and technical assistance. Thus, it could impact the strengthening of livelihood and agricultural activities.

CASTRO (2012) point out that farming activities as a social reproduction strategy applied by family farmers is more beneficial than the monocultural farming corporate segment when considering the opportunities to exploit the available local workforce and environmental resources and highlights the following:

"The segment's generation of income, by becoming inserted in the market, employs a part of the population of small towns and rural communities in addition to containing the migration to larger urban centers."

In this sense, the scenarios for 2027 contributed to this discussion by indicating the impact of decreasing access to rural credit in the segment's income generation and considering an alternative scenario aiming to strengthen livelihood and develop agricultural activities, given its relevance in Pernambuco's rural space.

## CONCLUSION

This study investigated the changes in the distribution of family farm types and their direction while taking into consideration the farms' access to financing through the main Brazilian rural credit policy.

In this regard, the study uses analysis generated from data from family farming activities carried out in the state of Pernambuco, a representative space of family farming types distribution in the Northeast Region of Brazil. In this analysis, the results validated the starting hypothesis adopted in the investigation, reaffirming that access to rural credit is a fundamental factor in enabling the development of agricultural activities with income generation on family farms.

The impact of total income reduction of farming activities observed in family farms on the local economy must be carefully monitored and evaluated. The participation of family farmers is representative both for the balance of supply in the national food market and internal control of food prices. Thus, family establishments with significant agricultural productions contribute not only to the strengthening of regional development, but also to the maintenance of the rural community by providing enhanced food security, quality and supply.

Thus, to increase the income of farming activities, it is important to expand credit access for family farmers. For this, specific political actions and programmatic guidelines are required, such as to allow the operation of financial organizations specialized in the governance of financing for the farming sector, presenting local social capital and a favorable institutional environment. It is then possible to address the main difficulties of family farmers in accessing rural credit, such as excessive bureaucracy, mandatory guarantees, delay in releasing credit and lack of information, as pointed out by Scheuer (2019).

The advertisements enabled by the research may potentially support the constitution of relevant subsidies for rural regional planning. They can work as inputs to propose public policies aimed at family farming while aiding in analyzing the impact of their implementations. Future studies can build other family farm typologies that can represent the diversity of the socioeconomic structure and the rural environment. Likewise, using the time and space analysis model more profoundly would be beneficial to evaluate and enhance the achieved results when implementing rural development policies.

## ACKNOWLEDGEMENTS

We would like to thank the "Programa de Planejamento Energético" (PPE/COPPE – UFRJ) for all the support during the research.

## DECLARATION OF CONFLICT OF INTEREST

We have no conflict of interest to declare.

## AUTHORS' CONTRIBUTIONS

All authors contributed equally to the conception and writing of the manuscript. All authors critically revised the manuscript and approved the final version.

## REFERENCES


ABRAMOVAY, R. **Agricultura, diferenciação social e desempenho econômico**. Ipea Project, Nead/MDA, World Bank. São Paulo, 2000.

ANDERSEN, E. et al. Farm management indicators and farm typologies as a basis for assessments in a changing policy environment. **Journal of Environmental Management**, v.82, p.353–362, 2007. Available from: <https://doi.org/10.1016/j.jenvman.2006.04.021>. Accessed: Feb. 19, 2020.

ANETOR, F. et al. Credit supply and agricultural production in Nigeria: a vector autoregressive (VAR) approach. **Journal of Economics and Sustainable Development**, v.7, n.2, 2016. Available from: <https://ssrn.com/abstract=2735124>. Accessed: Jan.15, 2020.

BAKER, J. R. et al. Eds. **Keeping It in the Family**: International Perspectives on Succession and Retirement on Family Farms; Routledge: Oxfordshire, UK, 2016.

BAHŞI, N.; ÇETIN, E. Determining of agricultural credit impact on agricultural production value in Turkey. **Ciência Rural**, v.50, 2020. Available from: <https://doi.org/10.1590/0103-8478cr20200003>. Accessed: Dec. 12, 2020.

BECOT, F. A.; INWOOD, S. M. The case for integrating household social needs and social policy into the international family farm research agenda. **Journal of Rural Studies**, v.77, p.185-198, 2020. Available from: <https://doi.org/10.1016/j.jrurstud.2020.05.005>. Accessed: Dec. 11, 2020.

CASTRO, C. N. **A Agricultura No Nordeste Brasileiro**: Oportunidades e Limitações ao Desenvolvimento. IPEA: Rio de Janeiro, Brazil, 2012, Texto para Discussão 1786.

CARRER, M. J. et al. Assessing the effectiveness of rural credit policy on the adoption of integrated crop-livestock systems in Brazil. **Land use policy**, v.92, p.104468, 2020. Available from: <https://www.sciencedirect.com/science/article/abs/pii/S0264837718313838>. Accessed: Jan. 08, 2020.

CONSTANTINOU, E. **Dinâmica Intra-Urbana**: Aleatoriedade e Emergência de Padrões Espaco-Temporais. Cadeias de Markov, 2007.

DE CASTRO, E. R.; TEIXEIRA, E. C. Rural credit and agricultural supply in Brazil. **Agricultural Economics**, v.43, n.3, p.293-302, 2012. Available from: <https://doi.org/10.1111/j.1574-0862.2012.00583.x>. Accessed: Feb.13, 2020.

EASTMAN, J. R. **Idrisi selva tutorial**. Idrisi Production, Clark Labs-Clark University, v.45, p.51-63, 2012.

FAO/IFAD. **United Nations Decade of Family Farming 2019-2028**. Global Action Plan.Rome. Licence: CC BY-NC-SA 3.0 IGO, 2019. Available from: <http://www.fao.org/3/ca4672en/ca4672en.pdf>. Accessed: Jan. 5, 2020.

FAO/INCRA. **Agrarian policy guidelines and sustainable development**. Brasília: MDA, 1995. p.57.

GAZOLLA, M; SCHNEIDER, S. Qual "fortalecimento" da agricultura familiar? Uma análise do Pronaf crédito de custeio e investimento no Rio Grande do Sul. **Revista de Economia e Sociologia Rural**, v.51, n.1, p.45-68, 2013. Available from: <https://doi.org/10.1590/S0103-20032013000100003>. Accessed: Jun. 16, 2020.

GRAZIANO DA SILVA, J. Agricultura familiar e sustentabilidade. **Jornal Valor Econômico**, junho de 2019. Available from: <https://valor.globo.com/opiniao/coluna/agricultura-familiar-e-sustentabilidade.ghtml>. Accessed: Mar. 05, 2021.

GUTH, M. et al. Is small beautiful? Techinical efficiency and environmental sustainability of small-scale family farms under the conditions of agricultural policy support. **Journal of Rural Studies**, v.89, p.235-247, 2022. Available from: <https://doi.org/10.1016/j.jrurstud.2021.11.026>. Accessed: Jun. 25,2020.

GRASKEMPER, V. et al. Farmer typology and implications for policy design–An unsupervised machine learning approach. **Land Use Policy**. v.103, 2021. Available from: <https://doi.org/10.1016/j.landusepol.2021.105328>. Accessed: Jun. 25, 2021.

GRISA, C. **Políticas públicas para a agricultura familiar no Brasil**: produção e institucionalização das ideias. Tese (Doutorado em Ciências Sociais) – Programa de Pós-graduação de Ciências Sociais em Desenvolvimento, Agricultura e Sociedade/UFRRJ, 2012.

HERRERO, M. et al. Exploring future changes in smallholder farming systems by linking socioeconomic scenarios with regional and household models. **Global Environmental Change**. v.24, p.165-182, 2014. Available from: <https://doi.org/10.1016/j.gloenvcha.2013.12.008>. Accessed: Jun. 25, 2021.

IBGE. Instituto Brasileiro de Geografia e Estatística. **Censo agropecuário: 2006: Brasil, grandes regiões e unidades da federação: segunda apuração**. Rio de Janeiro, 2006. Available from: <https://biblioteca.ibge.gov.br/index.php/bibliotecacatalogo>. Accessed: Nov. 13, 2020.

IBGE. Instituto Brasileiro de Geografia e Estatística. **Censo Agropecuário 2017 – Resultados Preliminares**. Rio de Janeiro, 2017. Available from: <https://censos.ibge.gov.br/agro/2017/resultados-censo-agro-2017.html>. Accessed: Nov.13, 2020.

IKUEMONISAN, E. S; AJIBEFUN, I. A. Economic Implications of Smallholders' Collaborative Groupings on Household Income and Adaptability to Climate Change in Nigeria. **Sustainability**, v.13, n.24, p.13668, 2021. Available from: <https://doi.org/10.3390/su132413668>. Accessed: Dec. 05,2020.

MARKOV, A. A. **Extension of the limit theorems of probability theory to a sum of variables connected in a chain**. Reimpresso no Apêndice B de: R. HOWARD. Dynamic Probabilistic Systems, volume 1: Markov Chains. John Wiley and Sons, 1971.

MATTEI, L. **PRONAF 10 anos**: mapa da produção acadêmica. Brasília: MDA, 2006.

NYAMBO, D. G. et al. A review of characterization approaches for smallholder farmers: Towards predictive farm typologies. **The**

**Scientific World Journal**. 2019, Article ID 6121467. Available from: <https://doi.org/10.1155/2019/6121467>. Accessed: Dec. 07, 2020.

SCHEUER, J. M. Dinâmica da agricultura brasileira em 2006-2017. **Revista de Política Agrícola**, Ano 28, n.3, Jul./Ago./Set. 2019 p.131-147, 2019.

SCHNEIDER, S; CASSOL, A. Diversity and heterogeneity of family farming in Brazil and some implications for public policies. **Cadernos de Ciência & Tecnologia**, Brasília. v.31, n.2, p.227-263. 2014. Available from: <https://seer.sct.embrapa.br/index.php/cct/article/view/20857/12815>. Accessed: Aug. 14, 2020.

SUESS-REYES, J.; FUETSCH, E. The future of family farming: a literature review on innovative, sustainable and succession-oriented strategies. **Journal of Rural Studies**, v.47, p.117-140, 2016. Available from: <https://doi.org/10.1016/j.jrurstud.2016.07.008>. Accessed: Mar. 28, 2021.

TAVERNIER, E. M.; TOLOMEO, V.Farm typology and sustainable agriculture: Does size matter? **Journal of Sustainable Agricultire**. v.24, p.33–46, 2004. Available from: <https://doi.org/10.1300/J064v24n02_05>.Accessed: Mar. 23, 2021.

ZAHAIKEVITCH, E. V. et al. Contemporary public policies to strengthen family Farming in the International Perspective: A Bibliometric Study. **Journal of Open Innovation: Technology, Market, and Complexity**, v.8, no.1, p.8, 2022. Available from: <https://doi.org/10.3390/joitmc8010008>. Accessed: Sep. 21, 2022.