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NORTHEAST BANK OF BRAZIL'S ROLE IN PROMOTING ENTREPRENEURIAL INNOVATION IN FAMILY FARMING THROUGH RENEWABLE ENERGY FINANCING

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ABSTRACT

Objective: This study aims to analyze the influence of Banco do Nordeste (Northeast Bank of Brazil) in promoting innovative entrepreneurship in family farming through its renewable energy financing policies.

Method: A quantitative research methodology was employed, involving a survey of 164 family farmers located in the rural areas of Rio Grande do Norte. The collected data were subjected to confirmatory factor analysis (CFA) and multiple linear regression (MLR) to assess the relationships between entrepreneurial innovation, renewable energy adoption, and competitive advantage in family farming.

Results: The findings demonstrate that innovative entrepreneurship facilitated by Banco do Nordeste's financing policies significantly contributes to 59.5% of the development in family farming. Furthermore, renewable energy adoption is shown to have a considerable influence, accounting for 39.3% of the entrepreneurial innovation by lowering operational costs and minimizing environmental impacts. These results underscore the critical role of Banco do Nordeste in supporting regional development and encouraging sustainable practices among family farmers.

Conclusions: The study concludes that Banco do Nordeste's renewable energy financing policies are instrumental in fostering entrepreneurial innovation and promoting the sustainable development of family farming. This emphasizes the need for increased awareness and dissemination of such financing programs to enhance their effectiveness. Additionally, the development of a framework for analyzing entrepreneurial innovation in family farming offers a valuable resource for future research and policy development.

Keywords: Family Farming, Innovation, Entrepreneurship, Renewable Energy, Northeast Bank of Brazil

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1 INTRODUCTION

According to the Global Entrepreneurship Monitor (GEM) survey, approximately half of the Brazilian population desires to become an entrepreneur, demonstrating that entrepreneurship is an attractive alternative for Brazilians, as well as a job and income option. Some factors are influential, such as improving the legal environment for entrepreneurs, training, education and consolidation of the internal market (GEM, 2018). However, there are some limitations for entrepreneurship and innovation in family farming, such as government policies and financial support. According to Batista et al. (2023), potential structural and infrastructural socio-productive limitations hinder the possibilities of spreading sustainable entrepreneurship and consolidating local development.

Although family farming plays a fundamental role in the country's internal supply, especially as stable income of many Brazilians, specific problems still persist in enabling sustainable development for rural producer's settlement in the countryside (DA SILVA et al., 2016). According to the authors, although there are several policies to promote family farming, there is still not enough knowledge and clarification for everyone, making these benefits almost inaccessible to family farmers.

Agriculture is one of the most important economic sectors in the world, employing more than one billion people, which represents 3% of all Gross Domestic Product (GDP) (FAO, 2016). The most predominant form of agriculture in the world is family farming, which produce on about 70% to 80% of the cultivated land, as well as producing around 80% of all world food (FAO, 2014). Family farming is still, in many parts of the world, a significant factor in food production (VOGT; ALBIERO; SCHMUELLING, 2018). In Brazil, family farming represents 70% of food production, 64% of rural occupations and 10% of the national GDP (SOLANO, 2017). Coherently, it is necessary to recognize that family farming needs special attention and promotion for its development.

Oliveira, Gazolla and Schneider (2007) report that family farming is responsible for maintaining the farmers in their field, given their adaptability of agricultural crops, flexibility and their capacity (VACCARO et al., 2018; REHMAN et al., 2024). Large-scale agriculture is becoming an important force for promoting sustainable rural development and agricultural production (LI et al., 2020). However, from Prado, Domingues and Souza (2023), the regional economic impacts of climate change on the agricultural crops productivity linked to family farming indicate that the North and Northeast regions of Brazil were negatively affected.

In this context, the production practices using sustainable means and models are a fundamental component of supporting innovation in family farming business model, in order to achieve greater competitiveness in the sector in which it operates (GUINÉ, 2018). In this sense, innovation is understood

as a process of searching for something new, allowing the organizations to increase their competitive advantage and consequently better face competitiveness.

Family farming is a comprehensive activity for the Brazilian population, as it contributes to the largest food production for the country. In addition to its importance, there is also its impact on the social economic aspect, where it stands out as a form of income for rural producers, by facilitating families' settlement in rural areas and by generating income flows throughout the year and improving their quality of life.

Therefore, a relevant concern in family farming refers to its productivity, considering its impact on food production, as well as on the jobs generation in the rural sector. According to Khan, Matos and Lima (2009), technological innovations are essential for productivity gains in the agricultural sector. Thus, the authors state that a necessary condition for the survival and the continuity of an agricultural activity is the insertion of a technological element to increase productivity.

Recently, with a greater emphasis on environmental sustainability concerns, the search for clean energy use has been more intensified. High initial costs slowed the advancement of the use of this type of energy as a means for rural production. According to Simas and Pacca (2013), Xie et al. (2020) and Le and Sarkodie (2020), renewable energy has a decisive contribution to the country's sustainable development. For Houston, Gyamfi and Whale (2014) and Ridzuan et al. (2020), in agriculture, the efficient use of energy is a priority for its sustainability.

In this sense, the Banco do Nordeste do Brasil (BNB) emerges as a development and promotion agent for rural entrepreneurship, as an agent for promoting public policies, by promoting sustainable development in the Northeast Region of Brazil through financial support to agents regional production. BNB operates in around two thousand municipalities, covering nine States of the Brazilian Northeast Region (Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte and Sergipe), and the north areas of both the States of Minas Gerais and Espírito Santo.

As the largest institution in South America focused on regional development, BNB operates as a body that executes public policies, being responsible for implementing specific programs for family farming such as the National Program for Strengthening Family Agriculture (PRONAF). In addition, BNB holds the Agroamigo, a Rural Microfinance Program that aims to improve the social and economic profile of family farmers in the Northeast and north of Minas Gerais and Espírito Santo, whose results as of September 2019, record an application of more than R$16.9 billion in credits since its creation, comprising more than 5 million contracted credit operations with more than 1.27 million active customers (BNB, 2019).

In such perspective, the study's guiding research question is: What is the influence of BNB as a driver of entrepreneurial innovation in family farming through its renewable energy financing policies? The objective of this study is to analyze the influence of entrepreneurial innovation, made possible by BNB as a driver of family farming, through its renewable energy financing policies, by the analysis of 164 family farmers located in the rural area of the state Rio Grande do Norte (RN).

2 THEORIES

2.1 ENTREPRENEURIAL INNOVATION

For Schumpeter (1934), the entrepreneur is the one who destroys the economic order, through the introduction of new technologies and new combinations of productive means, to provide improvements in economic development. The development of the economy is intrinsically linked to entrepreneurship, when an organization or an individual transforms resources or economic assets in search of business creation and its maintenance (OLIVEIRA et al., 2015; THAWESAENGSKULTHAI; CHATMARATHONG; KOIWANIT, 2024). For Zica (2008), support is essential, through the strengthening of organizational mechanisms or policies, with the aim of boosting entrepreneurship, and consequently the economic growth of a country.

For Baumol (1996), there is a relationship between economic growth and entrepreneurship because a decline in entrepreneurship is implied when there is a decrease in economic growth. According to Fontenele (2010) and Mansour (2024), there is a strong relationship between a country's level of entrepreneurship and its economic growth. However, there is disparity in economic progress between nations, however, economists know that local institutions play a significant role in a country's economic growth (REDFORD, 2020).

Stevenson and Jarillo (1990) highlight entrepreneurship as the process by which individuals, on their own or within organizations, seek opportunities without considering the resources they currently control. In this context, entrepreneurship becomes a key factor, especially under quick changes conditions, since companies intensively compete to obtain competitive advantages (MARTIN-ROJAS et al., 2020).

According to Shane and Venkatraman (2000), entrepreneurship is a process of identifying and exploring economic opportunities, for creating and evolving goods and services. A recent definition of entrepreneurship means establishing opportunities identification behavior, visualizing and assuming risks, generating a new business or process, capitalizing on the resources achieved (PRINCE; CHAPMAN; CASSEY, 2021). Yu (2020) highlights those entrepreneurial activities motivated by opportunity, and not

by necessity, tend to be higher in a more specialized or more concentrated area in the context of creative industries.

For Hisrich, Peters and Shepherd (2014), entrepreneurship denotes acting when faced with an opportunity that the entrepreneur believes his action to be viable and profitable, but which presents a certain level of uncertainty and risks. It then requires an evaluation and action from this opportunity to create a new product, service or business, in search of a reward in the form of satisfaction and economic and social independence. Kasseeah (2016) highlights that entrepreneurship can be identified as a tool for promoting development. For the author, countries or regions that facilitate entrepreneurship consequently benefit from their economic development.

Entrepreneurship is the ability to transform ideas into real things, combined with creativity, innovation and risk-taking (BALRAJ; VELMURUGAN, 2017). Thus, the importance of rural entrepreneurship occurs, as a way of developing society, whether in creating jobs or providing increased income for the rural population (KHAZAELI et al., 2018).

Schumpeter (1934) states that a country's economic development has three fundamental pillars: bank credit, entrepreneurship and technological innovation. Entrepreneurship is essential for the country's economy, since it is beneficial for any social and economic lives. It is considered as the main factor of innovation and dynamism of the economy. However, Brazil still lacks public policies to encourage entrepreneurship, to support entrepreneurs, considering that most companies are micro and small size, and consequently generating a large number of jobs and income for the Brazilian population (DORION et al., 2012; DORION et al., 2022).

According to Gartner (1985), innovation aims to implement a new idea, product, service, market or technology in a new or established organization. According to Drucker (2010), innovation is the ability to transform something that already exists into a resource that generates wealth. In this sense, the author states that innovation is the specific instrument of the entrepreneurs, how they explore change as an opportunity for a different business or service.

Evan (1966) defines innovation as a process for developing new ideas. Thus, when companies introduce innovations through technology, aiming for growth, they will also be creating a competitive advantage and possibly generating better financial results (CONTO; ANTUNES JÚNIOR; VACCARO, 2019).

For Porter (1999), the great tool for the growth and survival of many companies has been innovation, since it is considered a competitive strategy for generating competitive advantage. Economic and social gains may arise from the capacity and ability to create new things, combined with the ability to create sustainable solutions for businesses and to improve the efficiency of a system (COMPARIN, 2017). Still in this sense, the ability of entrepreneurs to innovate and carefully observe the

future improves the company's sustainability and facilitates its inclusion in new markets (DA ROCHA JUNIOR; CABRAL, 2016).

According to Hossain (2020), frugal innovation can serve low-income customers for emerging markets, as well as diffusion patterns that managers need to understand when shaping their business strategies. In this context, technological innovation has generated much interest among scholars, professionals and policymakers as a critical instrument for achieving sustainable development (OMRI, 2020). However, driving sustainable development through innovation is a complex activity, in which a large number of partners must be incorporated from a need to transfer or share knowledge in a reasonable exchange process (ZHOU; GOVINDAN; XIE, 2020).

Innovation can bring sustainability to family farming, just as new strategies to attract the next family generations, which can increase innovative and sustainable behavior through family successions (SUESS-REYES; FUETSCH, 2016).

2.2 FAMILY FARMING

Gasson et al. (1993), highlight that family farming is characterized by the owners being the administrators of their rural business, where the family is the capital owner, the work is essentially carried out by the family, the rural property is the family's place of residence, as well as the property is transmitted by assignment to the descendants.

In Brazil, a parameter for this definition is in the Ordinary law no. 11,326/2006 (BRASIL, 2006), which defines family farming as the one that carries out agricultural activities in rural areas, in an area not exceeding four fiscal modules, and by essentially using manual labor. The work of the family itself and its income come essentially from its agricultural activity.

Although the definition of family farming is imprecise, most of it refers to something around the family's rural property, the family's work or business operation (FAO, 2014). According to the Brazilian Agricultural Census (2006), a quarter of the country's agricultural area is cultivated by family farming. In Brazil, there are more than five million agricultural establishments, from which more than four million or approximately 85% of them belong to family farming. In the Northeast region, family farmers occupy an area greater than 30% of the total agricultural areas in the country and are responsible for producing approximately half of the gross value of regional agricultural production.

However, in Brazil, many family farmers still need information and technical assistance to access public policy programs, which are essential to increase and qualify the agricultural production (SOUZA et al., 2011; BEZERRA; SCHLINDWEIN, 2017). According to the authors, other obstacles can also be experienced by family farmers, such as: small land area, low availability of financial resources, lack of

technical assistance, difficulties in accessing the market, which are key issues for the competitiveness and development of rural properties.

According to data from the Center for Advanced Studies in Applied Economics (CEPEA, 2018), the agribusiness sector represents more than 20% of the Brazilian GDP. Family farming is a comprehensive activity for the Brazilian population, since it contributes to the largest food production for the country. It is not only important for the nation, but it has economic and social impact on its producers, since it stands out as a consistent form of income for them, it facilitates the settlement of the active population in rural areas, as well as generating the farmers' income and improving their quality of life.

In such scenario, a relevant concern for family farming is its proper productivity, considering its impact on food production, and the generation of jobs and income in the rural sector (MARZIN; DAVIRON; RAFFLEGEAU, 2015; PASQUALOTTO; KAUFMANN; WIZNIEWSKY, 2019; LIMA; SILVA; DE FREITAS, 2019; LI et al., 2020).

2.3 RENEWABLE ENERGY

Sustainable energy patterns have become a major concern for all countries due to their limited energy sources, their increasing population, energy prices fluctuations, the common limitations in energy supply and food security (ZHU et al., 2020; REHMAN et al., 2024) provoked a necessity to diversify the energy mix, renewable energy, the energy efficiency and improvements and to reduce CO^2 emissions (AYDOĞAN; VARDAR, 2020).

According to Xie et al. (2020), the concept of sustainable economic development refers to reducing pollution emissions and increasing production efficiency, in addition to promoting economic growth. To promote the development of renewable energy has become a key factor in solving energy and climate change problems (XIA et al., 2019). Due to the increasing use of renewable energy sources in many countries, a precise and detailed analysis from a technical and economic points of view is necessary (GHIASI et al., 2020). Although renewable energy consumption is sustainable, it may not foster environmental economic development due to the constraints of existing technical conditions (XIE et al., 2020).

Research by Khan, Khan and Binh (2020), examines the heterogeneity of renewable energy consumption, CO^2 dioxide emission and financial development in the global panel of 192 countries, and identified that renewable energy consumption has a negative effect on CO^2 emission, while financial development has an increasing influence on CO^2 emissions.

From a policy perspective, empirical findings recommend the implementation of effective policies that promote sustainable energy and economic structural adjustment to reduce the level of atmospheric CO^2 emissions (LE; SARCODIE, 2020). Renewable energy sources have assumed a relevant role in the energy mix in recent years, and this trend is expected to continue in the future (BADAMI et al., 2020).

In this scenario, the implementation of renewable energy policies should not only focus on meeting the renewable energy objective. Site prioritization and implementation enforcement must also be considered to maintain long-term agricultural development (LAI et al., 2019).

Research by Hernik, Noszczyk and Rutkowska (2019) highlights that among the different types of renewable energy, biogas and photovoltaic plants are most strongly influenced in rural and urban districts. For Ridzuan et al. (2020), it is essential to achieve sustainable agriculture, by incorporating renewable energy in the agricultural sector as an effective measure to mitigate CO^2 emissions.

In this context, countries must continue to increase the share of renewable energy in favor of the agricultural sector growth, thus reducing the consumption of fossil energy for environmental improvements (AYDOĞAN; VARDAR, 2020).

2.4 COMPETITIVE ADVANTAGE

Barney (1991) states that when you create a product or process in which costs do not rise and when it cannot be copied by the competition, a competitive advantage is achieved. In increasingly competitive environments, as well as in constant change, it is essential for companies to seek long-term competitive advantage (WU et al., 2017). However, according to Powell (1992), by focusing on industry and competitive strategy variables, the leading organization have underestimated the role of organizational factors in producing competitive advantage.

According to Bungnasaeng et al. (2020), there is a link between managerial resources and competitive advantage in a non-static situation. For Kustyadji (2020), transformational leadership positively influences organizational competitive advantage, just as organizational commitment has a positive and significant influence on a company's competitive advantage. However, Safari et al. (2020) emphasizes that there is a relationship between psychological empowerment, burnout exhaustion, organizational commitment, creativity and competitive advantage.

In such scenario, it becomes important to take into account the various factors that can affect an organization's competitive advantage, by applying to companies different sizes and operating segments, by listing dynamic capabilities (TEECE; PISANO; SHUEN, 1997), company resources (BARNEY, 1991), organizational strategies (GULATI; NOHRIA; ZAHEER, 2000), innovation, market orientation and

organizational learning (HURLEY; HULT, 1998), entrepreneurship, market orientation market, knowledge management and cleaner production (DE GUIMARÃES; SEVERO; DE VASCONCELOS, 2018), as well as social responsibility and environmental sustainability (DE GUIMARÃES; SEVERO; DE VASCONCELOS, 2017).

According to Liu and Yang (2020), micro and small enterprises (MSEs) must strive to develop and maintain their inter-firm network and then discover its effect with their internal agility process, to overcome unexpected changes, and to create advantages from pioneering and innovation activities and boost organizational performance.

Within the agroindustry, although they face many barriers, the agricultural industry's vision emphasizes that innovation can generate competitive advantage in its business model (SIVERTSSON; TELL, 2015). The organizational and economic aspects of alliances are interactive strategic prerequisites for grouping manufacturers and processors of agricultural alliance products, which provides reliability and competitiveness (ARGAKOVA et al., 2020). Pawlak, Kołodziejczak and Xie (2019) emphasize that the presence of cooperatives favors enhances the development of agriculture in a specific region and throughout the country, leading to improved competitiveness.

3 METHOD

The research came out of a survey carried out from a descriptive quantitative approach. The non-probabilistic convenience sample (HAIR Jr. et al. 2013) consisted of 164 farmers, among BNB clients, who constitute the portfolios of family farmers located in the rural area of the state of Rio Grande do Norte (RN), and who received financial assistance to undertake and innovate through renewable energy.

The data collection included a questionnaire consisting of five questions related to each respondent's profile, as well as 20 questions (observable variables) in a statement form and divided into four Factors (Constructs). The statements have a degree of agreement and disagreement on a five-point Likert scale, which ranges from: i) 1 = Totally disagree; ii) 2 = Partially disagree; iii) 3 = Neither disagree nor agree; iv) 4 = Partially agree; and v) 5 = Totally agree. The questions that deal with the profile of the respondents were prepared by the researchers, while the questions on the Constructs: i) Entrepreneurial Innovation (EI), were adapted from studies by Black and Strahan (2002) and Alice and Ruppenthal (2012); ii) Family Farming (FF), adapted from the assumptions of Santos and Góis (2011) and Pilon (2017); iii Renewable Energy (RE), adapted from studies by Santana Filho et al. (2018) and Giddens (2015); and, iv) Competitive Advantage (CA), adapted from research by Pasqualotto et al. (2018) and, Bittencourt, Salles and Alves (2017).

It is worth mentioning that the questionnaire was prepared by the researchers, as well as validated by 2 PhDs who are experts in the area of study. Accordingly, a pre-test was carried out with 15 family farmers to understand the questions and the duration of the research.

Data collection took place in person, directly with the family farmers, from September 2019 to October 2021. The questionnaire was prepared using the Google Doc tool, with an electronic form. Another form was created with the Microsoft Word software for the in-person applications, which created some difficulties. In some locations, mainly in the interior of the State, there was no internet signal available, making it unfeasible to apply the questionnaires via Smartphone. Of the applied 164 forms, 33 were collected in person, by filling out a printed form, and then which were later transferred to the Google Doc form. The remaining 131 questionnaires were collected and filled out directly on Google Doc.

After the collection, the data was purified and the existence of missing with more than 10% of non-response. Univariate outliers were then verified. However, no missing items or outliers were found, from which the research could go on.

In data analysis, a descriptive statistics technique was initially used, through measures of central tendency and dispersion, by using the Microsoft Excel® software spreadsheets (2007). Subsequently, a multivariate data analysis was used, which occurred by using Confirmatory Factor Analysis (CFA) and Multiple Linear Regression (RLM). According to Hair Jr. et al. (2013), CFA is a statistical analysis that aims to structure the observable variables into blocks, being able to confirm the new variables' relationships, in addition to determining new factors in the observable dimensions. Also, according to the authors, RLM explores the relationship between the variables, or the inference between a dependent variable and its effect of multiple variables independent of cause. Accordingly, the software SPSS® Version 21 for Windows was used to process the research data.

Normality, reliability and internal consistency tests were carried out, by using Cronbach's Alpha, Kaiser-Meyer-Olkin (KMO), Bartlett's Test of Sphericity and Total Variance Explained (HAIR Jr. et al., 2013).

4 RESULTS AND DISCUSSION

The sample comprised 66.5% (n=109) of male respondents and 35.5% (n=55) of female respondents. In terms of respondents' education, the data reveals that 38.4% (n=63) had completed or incomplete secondary education, 31.1% (n=51) had complete or incomplete higher education, 25% (n= 41) had complete or had incomplete primary education and 5.5% (n=9) responded that they had no education at all.

Regarding the monthly family income of the respondents, it highlights that 59.8% (n=98) receive up to R$ 1,908.00. Regarding the length of time in the enterprise, the majority of the respondents (37.2%) have been working in family farming for 7 years or more. With regard to the number of people who make up the family unit, 32.3% of respondents have a family with 4 members, 31.7% with 3 people, 18.9% with 5 or more members and 17.1% with 2 relatives.

4.1 CONFIRMATORY FACTORIAL ANALYSIS

KMO and sample adequacy tests and the Bartlett Sphericity test were carried out before the observable variables' validation process, to indicate whether the variables are correlated, enabling the use of the factor analysis technique (HAIR Jr. et al., 2013).

Table 1 shows that the KMO of all research variables exhibits a value of 0.907, which is above 0.5 (HAIR Jr. et al., 2013). It indicates that factor analysis is an appropriate technique for data analysis. In Bartlett's Test of Sphericity, a significance level of 0.000* was found, with a value lower than 0.05. It indicates that there is a correlation between the variables, being suitable for the use of factor analysis. In this context, a simple reliability analysis was also carried out through the calculation of Cronbach's Alpha, which presented values higher than the recommended (0.70), which statistically validates the observable variables (HAIR Jr. et al., 2013).

Table 1 – KMO, Bartlett's test and Cronbach's Alpha of all research variables

Kaiser-Meyer-Olkin measure of sampling adequacy.		0.907
Bartlett's test of sphericity	Approx. Chi-Square.	2665.832
	Df	190
	Sig.	0.000
Cronbach's alpha		0.949

Source: Data from research.

Table 2 presents the tests separately for each construct and it indicates that the KMO has a value above 0.5 for all constructs, which signifies that the factor analysis is a suitable technique for data analysis (Hair Jr. et al., 2013). Accordingly, Bartlett's Test of Sphericity was also significant (p>0.001). It indicates that there is a correlation between the variables. It is then suitable for the use of factor analysis, as well as the calculation of Cronbach's Alpha, which presented values higher than recommended (0.70) and statistically validates the observable variables of each of the constructs (HAIR Jr. et al., 2013).

Table 2 – KMO, Bartlett Sphericity and Cronbach's Alpha Tests

Constructs	KMO	Bartlett Sphericity (Chi-Square)	Cronbach's Alpha
Entrepreneurial Innovation (EI)	0.840	464.606	0.883
Family Farming (FF)	0.863	543.265	0.899
Renewable Energy (RE)	0.817	417.974	0.867
Competitive Advantage (CA)	0.856	545.710	0.910

Source: Prepared by the authors.

All the factor loadings' variables (Table 3) had values higher than the recommended level 0.5 (HAIR Jr. et al., 2013). It confirms the created constructs' observable variables. Also, Communality tests (Table 3) presented values greater than 0.5 for all its variables, demonstrating a low correlation between the observable variables.

Table 3 presents the four constructs, the observable variables (questions), the factor loading, the Communality, the means of the constructs, and the standard deviation to measure the responses' dispersion.

Table 3 – Constructs and observable variables

Entrepreneurial Innovation (EI)	Factorial Load	Communality
EI1) I understand that financing from Banco do Nordeste contributes to the creation of new businesses.	0.776	0.602
EI2) I understand that financing from Banco do Nordeste is important in the process of undertaking and innovating in my business.	0.881	0.776
EI3) I am aware that Banco do Nordeste has specific financing policies to boost business innovation.	0.823	0.677
EI4) I understand that Banco do Nordeste has specific financing policies to boost rural entrepreneurship.	0.890	0.792
EI5) Banco do Nordeste supports me in the search for creative solutions for my rural enterprise.	0.797	0.636
Mean: 4,682; **DP:** 0,6303		
Family Farming (FF)		
FF1) I believe that Banco do Nordeste facilitates, with its policies, access to credit for family farmers.	0.716	0.513
FF2) I understand that support from Banco do Nordeste improves my living conditions in rural areas.	0.888	0.789
FF3) I believe that Banco do Nordeste's policies aimed at family farming strengthen my rural production.	0.920	0.846
FF4) I understand that access to credit offered by Banco do Nordeste makes rural producers master of their own development.	0.843	0.710
FF5) I understand that bank credit promotes an improvement in the conditions of my rural production.	0.874	0.764
Mean: 4,707; **DP:** 0,5829		
Renewable Energy (RE)		
RE1) If I can generate my own renewable energy this would make it possible to create new sources of income.	0.751	0.564
RE2) Banco do Nordeste supports the use of renewable energy with specific financing policies such as FNE Sol (Financing aimed at Solar Energy Systems).	0.825	0.680
RE3) I understand that the use of solar energy is important to reduce the impacts of weather conditions.	0.825	0.681

RE4) Solar energy generation is important because it is a clean energy source that does not run out.	0.883	0.779
RE5) Solar energy generation is viable because maintenance is very low and it does not pollute the environment.	0.792	0.628
Mean: 4,657; **DP:** 0,6216		
Competitive Advantage (CA)		
CA1) Using renewable energy sources gives me a competitive advantage over my competitors.	0.785	0.616
CA2) I understand that innovation in my enterprise guarantees greater competitiveness for my business.	0.882	0.778
CA3) The use of renewable energy reduces the costs of my economic activity, making me more competitive.	0.884	0.781
CA4) I try to create new ideas with the aim of generating more competitiveness in my business.	0.864	0.746
CA5) The possibility of using waste from my production as a source of renewable energy gives me an advantage over my competitors.	0.868	0.754
Mean: 4,574; **DP:** 0,6755		

Source: Prepared by the authors.

In the Entrepreneurship Innovation (EI) construct, the EI4 variable presented the highest factor loading (0.890) "I understand that Banco do Nordeste has specific financing policies to boost rural entrepreneurship". In this scenario, it shows that farmers understand that BNB has financing to boost rural entrepreneurship, which corroborates with BNB's principles that are pointed out at regional development, as it aims at specific programs for family farming, with the objective improve the social and economic profile of family farmers in the Northeast region of the country. These programs cover access to specific credit to finance solar energy generation, called FNE Sol and Agrosol. The results also confirm Schumpeter (1934)' assumptions, which highlights that the economic development of a country requires three pillars, namely bank credit, entrepreneurship and technological innovation.

The analysis demonstrates that for the Family Farming (FF) construct, the FF3 observable variable "I believe that Banco do Nordeste's policies aimed at family farming strengthen my rural production" presented the most significant factor loading (0.920). It demonstrates that the BNB is an important agent for AF, which corroborates with Oliveira, Gazolla and Schneider (2007)' research, where family farming is responsible for maintaining the farmer in the field, with the possibility of adapting and making agricultural crops more flexible. Li et al. (2020) highlights that agriculture can promote sustainable rural development and large-scale agricultural production, which contributes to regional development.

For the Renewable Energy (RE) construct, the RE4 observable variable "Solar energy generation is important because it is a source of clean energy that does not run out" presented the most significant factor loading (0.883). It corroborates with the studies by Ridzuan et al. (2020) and Le and Sarkodie (2020), as the implementation of renewable energy contributes to economic development in order to reduce the level of atmospheric CO^2 emissions, effectively contributing to sustainable agriculture.

For the Competitive Advantage (CA) construct, the CA3 observable variable "The use of renewable energy reduces the costs of my economic activity, making me more competitive" presented the most significant factorial load (0.884). It corroborates with the study of Lai et al. (2019) that states that the use of renewable energy is essential to maintain agricultural development in the long term. According to Pawlak, Kołodziejczak and Xie (2019), the development of regional agriculture has a positive impact on improving the competitiveness of companies, as well as on the development of the local region.

Table 4 presents the constructs' total explained Variance, which were above 66.60% for the Competitive Advantage (CA) construct that presented the highest value of 73.51% of the data variability. This result indicates that the observable variables (CA1...CA5) contribute significantly to the understanding of the construct. Consequently, it can be said that the adoption of innovation and renewable energy provides a sustainable CA in relation to the competitors. According to Xie et al. (2020), developing countries need more proactive measures, such as increasing technological innovation capabilities and optimizing the industrial structure to coordinate the relationship between renewable energy consumption and green economic development.

Table 4 – Total variance explained

Constructs	Total Variance explained
Entrepreneurial Innovation (EI)	69.64%
Family Farming (FF)	72.45%
Renewable Energy (RE)	66.65%
Competitive Advantage (CA)	73.51%

Source: Prepared by the authors.

4.2 MULTIPLE LINEAR REGRESSION

The Pearson Correlation matrix was initially analyzed to check whether some independent variables are highly correlated and to avoid Multicollinearity, which occurs when correlations between the variables are above 0.8 (WOOLDRIGGE, 2006). The Pearson Correlation showed low correlations between the variables, with no Multicollinearity occurring between the observable variables.

According to Hair Jr. et al. (2013), a multiple linear regression (RLM) is a statistical analysis and inference between a dependent variable (Y), and its effect of multiple independent causal variables (X). According to the authors, the analysis indicates the cumulative effects of a group of independent variables (X1, X2, Xn) on a dependent variable (Y), in the same way that it highlights the effects of independent or exploratory variables ($Y = \beta1X1 + \beta2X2 + \beta3X3 +...+ \beta0$).

To carry out the linear regression in the first model, the average of the Family Farming construct (MedAF) was used as the dependent variable, with the independent variables of the Entrepreneurship and Innovation constructs (EI1, EI2, EI3, EI4 and EI5).

The questions' average on Renewable Energy was used in the second model as the dependent variable (MedER), and the questions on Entrepreneurship and Innovation (EI1, EI2, EI3, EI4 and EI5) as independent variables.

Finally, the average of the Competitive Advantage's questions was verified in the third model, as the dependent variable (MedCA), and the questions on Entrepreneurship and Innovation (EI1, EI2, EI3, EI4 and EI5), as independent variables. Table 5 presents the results of the analyses, demonstrating each RLM analyzed model.

Table 5 – Multiple linear regression

Model	Analyzed Data		Results	
	Dependent Variable	Independent variables	Tests	Values
Model 1	MedFF	EI1, EI2, EI3, EI4 e EI5	R	0.771[a]
			R^2	**0.595**
			Adjusted R^2	0.582
			Standard Error	0.319
			F	46.391
			Significant F	0.000[b]
Model 2	MedRE	EI1, EI2, EI3, EI4 e EI5	R	0.627[a]
			R^2	0.393
			Adjusted R^2	0.374
			Standard Error	0.400
			F	20.436
			Significant F	0.000[b]
Model 3	MedAC	EI1, EI2, EI3, EI4 e EI5	R	0.632[a]
			R^2	0.400
			Adjusted R^2	0.381
			Standard Error	0.456
			F	21.043
			Significant F	0.000[b]

Source: Data from the research.

According to the parameters of Hair Jr. et al. (2013), if the degree of importance of R^2 is i) below 0.3, there is a low influence; ii) if it is between 0.3 and 0.5, there is a moderate influence; iii) if it is above 0.5, it is considered as a high influence. Table 6 highlights that the highest relationship occurred between the FF (Family Farming) and EI (Entrepreneurship and Innovation) observable variables, presenting an intensity of 59.5%, characterized by a high influence (HAIR Jr. et al., 2013). These results

highlight that within the various factors (social, economic and institutional), policies that aim to promote agricultural production must address the adoption of new technologies for farmers to undertake. Thus, it is necessary to develop effective approaches to cultivate farmers' positive attitudes, awareness of social norms, perceived skills, as well as reduce perceived risks, to increase their interests in adopting new technologies (LI et al., 2020).

In this context, rural entrepreneurship, through family farming, is essential for the development of society, providing jobs and income for the rural population (KHAZAELI et al., 2018; LI et al., 2020). These findings are relevant, given the fact that the rural region of RN suffers from issues of drought, lack of water and electricity. Family Farming (FF) has sought to overcome those difficulties (PILON, 2017), by doing entrepreneurial and innovating alternatives to help rural farmers such as the cultivation of vegetables, vegetables and fruits, but also as manufacturing cakes and baked goods and some derivatives to boost family income. The research demonstrated a moderate influence of 39.3% between Renewable Energy (RE) and Entrepreneurial Innovation (EI). In this sense, BNB's policies for RE could be more publicized, by presenting their importance to the rural farmer, since it focuses on reducing costs, energy expenses, as well as reducing the environmental impact and focusing on people's quality of life, and since renewable energy leads to improved energy efficiency and reduced CO^2 emissions (AYDOĞAN; VARDAR, 2020; KHAN; KHAN; BINH, 2020; LE; SARCODIE, 2020). In this context, the research findings corroborate with the assumptions of Suess-Reyes and Fuetsch (2016), Khazaeli et al. (2018) and Guinea (2018), as both entrepreneurship and innovation are fundamental for the development of efficient family farming, which is in line with research by Pasqualotto, Kaufmann and Wizniewsky (2019), Lima, Silva and de Freitas (2019) and Li et al. (2020), since family farming aims to produce food, as well as generating jobs and income in rural areas. Figure 1 presents the intensity of the relationships between the research constructs, generated from the RLM results.

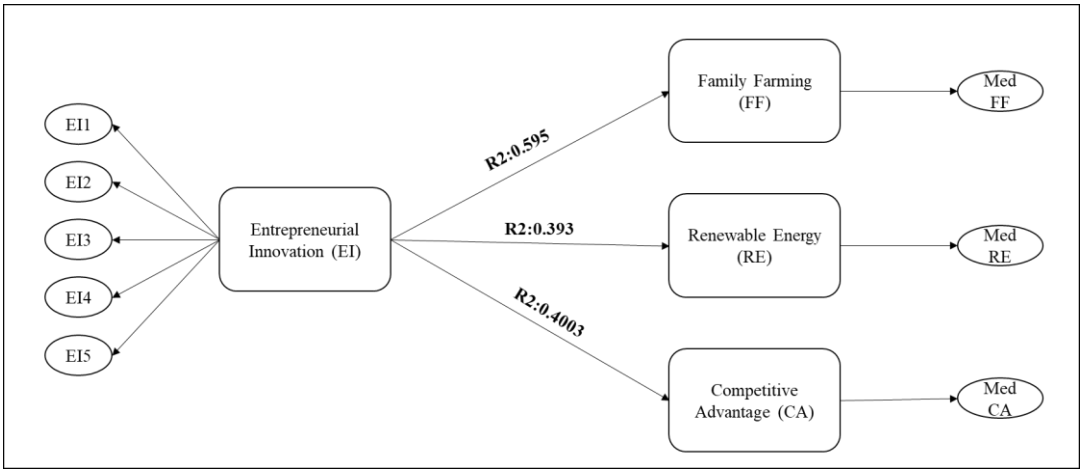

Figure 1 – Regression result of the three models generated
Source: Prepared by the authors.

5 FINAL CONSIDERATIONS

The study confirms BNB as an agent for promoting, developing and supporting entrepreneurial innovation, by highlighting specific loan and financing programs for this purpose. According to Santos and Gois (2011), since its creation in the early 1950s, the BNB has been one of the main instruments for implementing public policies to promote regional development, therefore strengthening the regional productive structure.

The results show that family farmers value BNB for supporting and financing equipment that generates solar energy, thus contributing to the producer's own energy generation, which reduces costs, contributes to improvements in environmental climate conditions and creates new sources of income. Such initiatives are encouraged by credit access programs, specifically for financing solar energy generation, such as the FNE Sol and Agrosol programs.

The academic contribution of this research reveals that entrepreneurship and innovation can contribute to the economic development and quality of life of family farmers, as well as the construction of a Framework for the analysis of entrepreneurial innovation in family farming, through its renewable energy financing policies, which can be implemented in other research.

The managerial contribution of the study highlights BNB's role in promotion and support, by allowing its employees and society to understand its importance as an agent of regional development, and by contributing to the strengthening of its role as a rural entrepreneurship driver, through the dissemination of information about financing programs for family farming for farmers who want to undertake the use of renewable energy.

The study has a social impact by providing guidelines that can help farmers involved in similar enterprises to seek programs to mitigate socioeconomic and environmental impacts. Such programs would then assist any family farmer in rural areas of the state of RN who could be victim of a drought, the lack of water, and would stabilize employment and income, and resolve the lack of public actions and rural policies of social, environmental and economic nature.

With regard to the limitations of the study, the sample of respondents was limited to BNB's customers in the state of RN. It could be expanded to other Brazilian States and other countries in Latin America. Another limitation refers to the responses' occurrence with a halo effect, which can increase or reduce the relationships between the constructs (BAGOZZI; YI, 1991; PODSAKOFF et al., 2003). Furthermore, the scale consists of a self-response questionnaire to collect data from variables simultaneously, which allows the Common Method Variance (CMV) to occur (PODSAKOFF et al., 2003; CHANG; VAN WITTELOOSTUIJN; EDEN, 2010).

It is therefore recommended that more qualitative research be carried out, as well as linking the research to other financial institutions or public organizations, to compare programs on family farming expansion, with the aim of extracting more information and other realities.

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