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CIÊNCIAS AGRÁRIAS:

Estudos sistemáticos e pesquisas avançadas 3

Atena Editora
Ano 2023

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Ciências agrárias: estudos sistemáticos e pesquisas avançadas 3

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Dados Internacionais de Catalogação na Publicação (CIP)

C569 Ciências agrárias: estudos sistemáticos e pesquisas avançadas 3 / Organizadores Raissa Rachel Salustriano da Silva-Matos, Fernando Freitas Pinto Júnior, Jonathas Araújo Lopes. – Ponta Grossa - PR: Atena, 2023.

Formato: PDF
Requisitos de sistema: Adobe Acrobat Reader
Modo de acesso: World Wide Web
Inclui bibliografia
ISBN 978-65-258-0968-7
DOI: https://doi.org/10.22533/at.ed.687231601

1. Ciências agrárias. I. Silva-Matos, Raissa Rachel Salustriano da (Organizadora). II. Pinto Júnior, Fernando Freitas (Organizador). III. Lopes, Jonathas Araújo (Organizador). IV. Título.

CDD 630

Elaborado por Bibliotecária Janaina Ramos – CRB-8/9166

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Ponta Grossa – Paraná – Brasil
Telefone: +55 (42) 3323-5493
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CIÊNCIAS AGRÁRIAS

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APRESENTAÇÃO

As correntes ideológicas que cercam o ambiente agrário têm promovido muitas discussões dentro do conceito de sustentabilidade e saúde humana, além de estudos acerca do uso de recursos da natureza e dos animais. Tendo em vista esse panorama atual, cada vez mais o estudo das Ciências Agrárias é visto como uma necessidade a fim de desencadear diálogo e novas visões que futuramente possam contribuir para com a humanidade.

Nesse sentido, diversos pesquisadores junto a órgãos de pesquisa nacionais e internacionais tem unido forças para contribuir no âmbito agrário, e assim possibilitar novas descobertas neste setor. Este estudo constante possibilita o surgimento de novas linhas de pesquisa, as quais podem desencadear soluções para entraves que afetam a produtividade na agropecuária.

Dessa forma, partindo dessa perspectiva de aprimorar o conhecimento por meio de pesquisas, o livro “Ciências Agrárias: Estudos sistemáticos e pesquisas avançadas 3” surge como uma ferramenta prática que apresenta estudos com temas variados aplicados em diferentes regiões, a fim de proporcionar novas visões, indagações e contribuir para o surgimento de possíveis soluções para problemáticas que afetam o cenário agrário atual.

Pensando nisso, o presente material contém 21 capítulos organizados em temas que variam de sustentabilidade a assuntos pertinentes à saúde animal, além de estudos voltados para uma maior produtividade no campo das grandes culturas.

Raissa Rachel Salustriano da Silva-Matos
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THE GREEN REVOLUTION AND THE PARTICULARITIES OF ITS ADOPTION IN BRAZIL

Data de aceite: 02/01/2023

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This paper is part of a Ph.D. research, and was supported by CAPES [Brazilian Federal Foundation for Support and Evaluation of Graduate Education - CAPES] under Grant number PDSE - 88881.361715/2019-01.

References were managed and created by Mendeley.

ABSTRACT: The Green Revolution was a program designed to increase agricultural production through the concept of monocultures' industrial agriculture. Its technological package was also implemented in Brazil, but it was done in a particular way due to the internal agenda of Brazilian governments, and to the way both countries managed the geopolitical arena after World War II. The objective of this paper is to analyse these particularities and describe how the green revolution was adopted in Brazil. The work was carried out based on a wide theoretical review in books, articles, and reports, with secondary data from IBGE and CONAB, which were used to build the chronology and the interlacing of events. The appraisal allows the authors to demonstrate that the green revolution played a secondary role both in terms of geopolitics, as well as in terms of its technical execution since it was complementing agriculture modernization public policies that were already being developed in the country.
KEYWORDS: Brazil, adoption, Green Revolution, geopolitics, particularities.

RESUMO: A Revolução Verde foi um programa destinado a aumentar a produção agrícola através do conceito agricultura industrial de monoculturas. Seu pacote tecnológico também foi implantado no Brasil, mas de forma particular devido à agenda interna dos governos brasileiros e

à forma como ambos os países administraram a arena geopolítica após a Segunda Guerra Mundial. O objetivo deste artigo é analisar essas particularidades e descrever como a revolução verde foi adotada no Brasil. O trabalho foi realizado com base em ampla revisão teórica em livros, artigos e relatórios, com dados secundários do IBGE e da CONAB, que serviram para construir a cronologia e o entrelaçamento dos acontecimentos. A apreciação permite aos autores demonstrar que a revolução verde desempenhou um papel secundário tanto em termos geopolíticos, quanto em termos de sua execução técnica, uma vez que foi complementar as políticas públicas de modernização da agricultura que já vinham sendo desenvolvidas no país.
PALAVRAS-CHAVE: Brasil, adoção, Revolução Verde, geopolítica, particularidades.

INTRODUCTION

The term 'Green Revolution' has historically been linked to the cultivation of hybrid seed varieties and the spread of agricultural practices that led to an increase in grain yield since the 1940s in North America and Southeast Asia. The program is designed to increase production through seed breeding, the intensive use of industrial inputs (fertilizers, pesticides and herbicides), mechanization (tractors and irrigation), a whole set of practices aimed at standardizing monocropping management. This set of practices, referred to in the literature as 'industrial agriculture', increases the scale of production, but at a high cost due to the increase in inputs, although it demands less labor.

The awarding of a Nobel Peace Prize in 1970 accredited plant pathologist Norman Borlaug as the creator of the green revolution (EASTERBROOK, 1997; SWAMINATHAN, 2009; PATEL, 2013). His production technique was first brought to Mexico and then to India and the Philippines, making their grain yields nearly double, and significantly increasing food security in those countries, as it was disclosed by him and others. All three countries had part of their population starving because of food shortage. For this reason, these projects raised an important flag that was to end world hunger. A strong narrative that was ratified in lectures, reports, and articles, the main reason for his award, but that never became a reality.

Several researchers delved deeper into several facts around these projects and came up with a different perspective from the main narrative that was disclosed in the media. Authors from within and outside Brazil, such as Moniz Bandeira (1978), Buainain et al. (2014a), Alves (2013), Alcántara (1974), and Patel (2013) converged into an extensive content of facts and data that guided articles and theses that will be cited in the course of this paper. The first part of this article, therefore, seeks to promote a dialectic between the points of view of these studies, to broaden the understanding of what was sought by this movement called 'the green revolution'.

Unlike countries like Mexico and India, which had technological packages pre-formatted in the United States and implemented by the Rockefeller Foundation in their lands, Brazil had been seeking to find internal solutions to the food problem of its population.

The Brazilian 'agricultural problem', in the beginning of the 20th century, was its inability to diversify its food production. Successful rice cultivation projects in 1906 (BESKOW, 1986 cited by CHELOTTI and CASTANHO, 2006), and with wheat in 1920, had already been achieved in the state of Rio Grande do Sul (a temperate climate region in the south), without greater investments in technology. These results, however, could not be achieved in the Southeast or in the Midwest plateau, regions of tropical climate with a biome called 'cerrado', where the soil has high acidity levels (high pH).

In 1949, a report prepared by a Joint Technical Committee Brazil-United States explained the limitations found in Brazilian agriculture, which were the result of little progress in cultivation techniques in the country (CASTRO, 1984). After almost three decades of investments in the industrialization of the country, a large part of the labor force had moved from the countryside to urban areas in search of jobs. These were families who cared for their livelihood and now had to buy their food. This change further increased the bottleneck in the surplus production capacity in rural areas. Thus, the modernization of agriculture became a major priority for Brazilian governments in the 1950s, although it was already an emergency that had not been prioritized previously.

After several presidents leaving agriculture in the background, the entry of the military in the government in 1964 marks the beginning of a period of increased investments in agriculture, which culminates in the implementation of the green revolution in the early 1970s. These investments aimed at three fundamental demands: research, technical assistance, and rural credit. The first two led up to the creation of institutions such as EMBRAPA (Brazilian Agricultural Research Corporation) in 1973, and EMBRATER (Brazilian Technical Assistance and Rural Extension Company) in 1974.

The other leg of this tripod was based on the release of credit lines for financing modernization projects, for which the SNCR (National Rural Credit System), that had already been created in 1965, received heavy contributions in the late 1960s and early 1970s (GRISA and SCHNEIDER, 2015). These were mostly directed to the center-south region where the focus of expanding agricultural frontiers was, and because it was ideal for large-scale agriculture.

Most of these resources came from external loans, which generated a significant increase in the country's external debt, especially with the increase of international interest rates during the oil crisis (1973). When the military took over the government in 1964, the Brazilian external debt represented 15.7% of the gross domestic product (GDP), and when they left the government in 1984, this percentage was equivalent to 53.8% of GDP[1].

Despite the indebtedness, all the investment made in Brazilian agriculture has paid off. The grain harvest in 1975 was of around 45 million tons, increasing to 83 million in 2000 and a forecasted 240 million tons in the 2019 harvest (CONAB, 2020). 433.3% increase in 44 years. However, this increase has a much slower profile before the year 2000 (84.4%),

1 Data source: Adjusted IMF / CBB / IMF. Links to data: https://goo.gl/oLtsL6, http://goo.gl/J9LpNR, http://goo.gl/kcrtWR.

than afterward (189.2%). Should this growth be all ascribed to the green revolution? Since it all started in the 1970s, a steeper growth was to be expected, firstly because there was a great expansion of agricultural frontiers in the 1970-80 period, and secondly because the main goal of the technological package implemented by the green revolution was to increase productivity.

So, the question this study intends to answer is: how was the implementation of the green revolution in Brazil, compared to those carried out by Borlaug's projects in Mexico, India and the Philippines? Based on this guiding question, having as reference the social, economic and environmental situations found in these countries, this article aims to analyze the particularities of the adoption of the green revolution in Brazil and its consequences. To achieve this goal, an extensive literature review was carried out on articles, books, and reports, using secondary data from research and statistical public institutions that will be presented in the materials and methods section.

MATERIALS AND METHODS

This article was elaborated from research carried out for a doctoral thesis on the development of agriculture in Brazil. The thesis´s final goal is to study the transition processes from conventional agriculture to agroecology. This, by its turn, is inserted within a reality that the literature calls the agricultural model's duality, which explains an agro-economy characterized by the existence of two sectors, one of which is the industrial agriculture, aiming at the export of commodities, and the other sector the family agriculture, which provides food for the domestic market. The scope of this work includes an analysis of the evolution of the former, that is, the export agriculture.

The green revolution, of course, had a major impact on the world. However, the way it was implemented, the motivations, the behavior of the countries involved, and its consequences, were not the same. Using the bibliographic method, through an extensive literature review in articles, books, and reports, both Brazilian and foreign, it became possible, initially, to go through a dialectical investigation between the worldview of the creators of the green revolution´s technological package, and the studies carried out by various authors who researched about the implementation of these projects, the technical and political issues that orbited around them, and the consequences for the countries that hosted these projects.

The research is basic, based on the researcher's interest in supporting his doctoral thesis, and carries out a historical study that extends, mainly, between the 1930s and 1970s. Data approach is qualitative, and the analysis uses secondary data from the last three Agricultural Censuses, Demographic Censuses for surveying population and GDP (gross domestic product), and, also, PNAD (National Household Sample Survey) to survey the illiteracy index, all made available by IBGE (Brazilian Institute of Geography and Statistics).

The historical series referring to crops were surveyed through CONAB (National Supply Company), and the cost of food in São Paulo calculated by FIPE (Economic Research Institute Foundation).

THE GREEN REVOLUTION

After the 2nd World War, the world is going through a period of great transformations due to important scientific and technological advances, as well as cultural and behavioral changes, headed mainly by the United States, due to the new world order created by the Bretton Woods System[2]. Technological developments in the media and industrial mass production, as well as the speeches of freedom and equality peppered by abundant film production, fueled the dream of rapid economic growth, whose concept came to be known as the American Way of Life. This concept started to be presented to the world as a civilizeng model to be followed, a model that is even present in the inaugural speech of American President Harry S. Truman in January 1949 (TRUMAN, 1949). In this speech, the term 'underdeveloped' was used for the first time in a text with international circulation. By presenting a model based on technological modernization, he was pointing out to the underdeveloped countries that this would be a standard to be reached through the help and international cooperation that was being offered to them by the 'First World' (ESTEVA, 1992; ESCOBAR, 2007 cited by FREITAS, CRUZ and RADOMSKY, 2016). At that time, the world was being offered two models with different social and economic proposals: capitalism and communism. The concept of development had, then, become a global issue, with an intense competition of two leaders – USA and USSR – for allies.

The possibility of development - understood as an improvement in the quality of life due to technological modernization - raised hopes and stimulated several initiatives in all societies, both in urban and rural areas (NAVARRO, 2001). One of these initiatives, as recorded by its mentor, took place in Mexico in the 1940s. In 1944, the plant pathologist Norman Borlaug (1914-2009) started a research project on high-yield dwarf wheat in Mexico, in partnership with Rockefeller Foundation, in a suitable area offered by the Mexican government. The objective was to help the 'fragile' Mexican agriculture that was experiencing extreme difficulty, through the introduction of the use of fertilizers, irrigation, and hybrid seeds. In this project, the scientists created new varieties of high-yield wheat and maize that made Mexico not only self-sufficient in wheat production but became an exporter of the product in 1963. Borlaug's production technique was taken to the Philippines and India, making their production almost double, significantly increasing food security in those countries, as broadcast by the media. For this accomplishment, the researcher received the Nobel Peace Prize in 1970 (EASTERBROOK, 1997; SWAMINATHAN, 2009; PATEL, 2013).

In the 50s and 60s, other countries started adopting the concept of high yielding

2 Federal Reserve History. Creation of the Bretton Woods System (July 1944). Digital Article is available at https://www.federalreservehistory.org/essays/bretton_woods_created. Accessed 16 Feb. 2020.

in the fields, among them, Pakistan and Brazil. The United States, that had already been using the system, began to export wheat in 1960, which stimulated the demand for new markets. In 1968, the president of the United States Agency for International Development, William Gaud, called the new technological achievements in agriculture 'the green revolution' (GAUD, 1968), a title that came to be used by current literature, and what led Borlaug to be called 'the father of the green revolution'. Brazil, in turn, initially tried to import technology in the 1950s, which did not work for technical and political reasons. Technical reasons were because the seeds produced in the northern hemisphere were developed for a temperate climate (not adequate for the tropics); and, politically speaking, the focus of the governments in the 1940s-50s was on industrialization. In the external front, in turn, although the relationship between Brazil and the United States was classified by (HIRST, 2011) as 'automatic alignment', Brazilian presidents, in that period, were seen by the American government as biased towards communism, which led them not to support investments in Brazil during the 1950s.

This monitoring status by the Americans changes, however, with the rise to power of the military in 1964, a fact that had the support of the American government, assisted by the CIA (Central Intelligence Agency). Pinto, Fleischer, and Pandolfi (1994) cite a survey conducted by Leacock (1990) which 'reveals that the CIA and the American Embassy, headed by Lincoln Gordon, had a much more radical reading of the Goulart government than it really was, in contrast to the reading made by the State Department, which was much more moderate'. The American government recognizes the military government even before president Goulart left the country for exile. Marshal Cordeiro de Farias (Armed Forces chief of staff in the Jânio Quadros administration) admitted to having requested fuel from the United States, which carried out a military logistical support operation with a fleet of oil tankers and some escort ships. This fact is also found in Lincoln Gordon's statements. Pinto, Fleischer, and Pandolfi (1994) affirm that, after the coup, there was financial support, renegotiation of the Brazilian debt and other actions that left no room for doubts about Johnson's support. Among these 'other actions', there was then full support for the implementation of the Green Revolution in the country, which emerges to 'modernize Brazilian agriculture and ensure for the United States the Brazilian dependence on American products and technology, in addition to preserving the interests of its institutions on Brazilian soil' (ALVES, 2013).

The implementation of the Green Revolution concept in the 1960-1970 period follows, to a certain extent, the Theory of Induced Innovation (TII) (HAYAMI and RUTTAN, 1971 quoted by OLIVEIRA, 2014) according to which if farmers did not adopt the proposed technological innovations, these should be induced to bring about a technical change in agriculture. This could not happen, however, without adequate cultivars for the *Cerrado* biome (present in the southeast, midwest, and part of the northeast regions, covering about 200 million hectares), which stretches for more than half of the country´s arable land, and whose main characteristic is its acidity (high pH level). Soil acidity hampers root growth and

needs to be managed before sowing. The weakest point of the package, therefore, was the seeds, that were developed for temperate climates. In Brazil, in the 1950s, the company Agroceres (AGROCERES, 2015) had already developed hybrid corn seeds more suitable for the Brazilian climate, and another constraint, the cerrado´s soil acidity, which curtails plant growth, was also being studied. Uchoa (in 1925) and Vageler (in 1932) were already testing liming in soil management (WIETHÖLTER, 2000).

In the public sphere, in 1973, EMBRAPA (Brazilian Agricultural Research Corporation) was created, which started to research and develop cultivars adapted to the peculiar conditions of the different Brazilian biomes. Among the main high-performance varieties developed by EMBRAPA are soy, cotton, and beans (which Brazil used to import), as well as the Brachiaria pasture, which were all adapted for the cerrado. To have an idea of the impact of these new seed varieties, in 1960, the country had four agricultural products for export, and in the early 1990s, the number of products had come up to nineteen. The reflexes of the new technology also improved produce processing, which jumped from sixteen percent in the 1960s to eighty percent of these grains thirty years later (BAER, 2002).

This industrial-productivist version advocated by Gaud (1968), Borlaug (1970) and Glaeser (1987), was not accepted passively. One of the objectives of the Green Revolution, at its origin, was to address the problem of world hunger. A noble cause published according to an altruistic narrative and propagated by a country – the United States – the cradle of a capitalist and liberal state that is based on ideological assumptions for the defense of private property and free competition. Hunger is a phenomenon related to the population, and the population is a problem for the government, not for private companies. From this deduction follows the following question from the authors Foucault and Senellart (2008, p.317 quoted by PATEL, 2013): 'how can the phenomenon "population", with its specific problems and characteristics, be considered in a system concerned with issues of legal order and free individual company?' The narrative did not match the political, economic and historical obviousness.

The technological package involved inorganic fertilizers (made from by-products of petroleum), plant breeding that was being developed in California, and investment in agriculture research which existed for decades in the US (BRAND, 1945; MACCONNELL, 1953 cited by PATEL, 2013). So, why implement experimental projects in Mexico or India, and, yet, so consistent with the demands of the American government? Alves (2013), Patel (2013) and Moniz Bandeira (1978) demonstrate, with great propriety, that the Green Revolution was, above all, a solution instrument for a geopolitical matter of the first half of the 20th century: the cold war between capitalism and communism.

In a speech delivered by William Gaud in 1968, he comments that the revolution that everyone was witnessing 'was not a Red Revolution like that of the Soviets', but, rather, a green revolution (GAUD, 1968), referring, naturally, to the 'improvement' of plants, but alluding to the cold war. According to Patel (2013), the author John Harris brought a more elaborate

view regarding the use of this expression, who observed that the term was deliberately created to contrast with 'red revolution', due to the notion that developing countries would be willing to undergo far more profound changes due to a revolution in agriculture, than because of a radical political transformation. A revolution in agriculture represents life and hope, while a radical political transformation can have struggles and death. Hence, the reason for the political interests involved in the new agrotechnology (HARRIS, 1988, p.229, quoted by PATEL, 2013). It was not exactly what happened, however, in South America in the 1970s and 1980s with the advent of Operation Condor[3], although it did not invalidate the changes that occurred in Brazilian agriculture.

The interest in using the green revolution as a 'silent' spread of capitalism was crystallized in a Rockefeller Foundation strategic document produced by the Agriculture Activities Advisory Committee that said that 'hungry people are attracted to promises, but can be won by actions. Communism makes attractive promises to malnourished people. Democracy must not only promise, but deliver' (ADVISORY COMMITTEE FOR AGRICULTURE ACTIVITIES, 1951, p.4, quoted by BRINKMANN, 2009). It is interesting to note that Navarro (2001) comments that 'in the group of countries then aligned with the socialist orbit, the proposals were not essentially different concerning technological formats, changing only the institutional apparatus, the forms of ownership and the redistribution of eventual productive results'. It seems, therefore, that the technology involved in the green revolution was also being developed in the countries of the communist bloc, and could, in principle, also be offered to any country.

Now, why implement the project in countries like Mexico, India and the Philippines? The three cases have great similarities: (1) they were all going through a period of great social and political disorganization when the projects were implemented; (2) there were debates about what knowledge would be necessary for agriculture to be 'successful', which was a way of rejecting outdated academics and old techniques and valuing new high-performance technologies; (3) the intervention involved government initiative and resources, and was not an equitable and democratic movement; (4) the model used was capital intensive and required training of specialists; and, (5) the foundations that led the projects were aligned with the interests of the American government. The three countries also had a large contingent of the population in a situation of food insecurity and had political groups aligned with the communist regime (PATEL, 2013).

With so many problems, why not accept the offer of a national savior? Although this was the narrative, the projects were implemented in areas of landowners who had the means to implement technology-intensive projects. Financing was readily available. As Patel (2013) describes it, the projects of Mexico, India, Pakistan, and the Philippines would not have progressed had it not been for the subsidies given by the respective governments.

3 About "Operation Condor", see "Predatory States: Operation Condor and Covert War in Latin America" by J. Patrice McSherry (2005).

Subsidies were a way of generating surplus grain, which was one of the goals of the program. Paddock (1970, p.898) comments that, in the Philippines, the food self-sufficiency program started in 1966 increased producer prices by 50%; the Mexican government bought the wheat produced on its land 33% above the international price; and, India and Pakistan doubled the price paid for wheat. Although the chairman of the USAID committee in 1968, Thomas Morgan, argued that farmers were not always encouraged to seek credit to invest in new technologies, Gaud (1968) defended subsidies – giving the example of all the countries mentioned above and, also, Chile and Brazil – by saying that higher prices paid to the producer were essentially the first incentive for them to plant more.

Brazil also felt the effect of the Green Revolution implementation in the late 1960s. Analysing the Brazilian case, agriculture was still lagging at the time, unable to meet the demands of a fast growing population, and was accused of being responsible for delaying the industry. The topic of agricultural development had already become a theoretical and empirical object of studies since the 1950s, asserting itself, therefore, as a socio-political problem (PORTO, 1997 cited by OLIVEIRA, 2014). The military government was very interested in investments in the agricultural sector due to the impact that it would have on the industrial sector (purchase of inputs and machinery), foreign exchange generation through exports, and domestic income. As such, it spared no effort to commit resources to finance its growth. These resources, however, did not reach all regions and all sizes of farmers equitably, with a preponderance in the center-south region due to the natural expansion of agricultural frontiers, where farmers with better financial conditions and access to credit were located, and who would be more likely to develop large-scale monoculture production. The focus, therefore, was on producers who agreed to implement a technology-intensive project, who had the availability of a good stretch of land with good quality soil. The state would provide training for extensionists (specialists) and provide rural credit (subsidies).

Completing the project's commercial strategy, the inputs (except the seeds) would be supplied by American multinationals. According to Alves (2013), there was a strong presence of multinational companies linked, at the time, to the Rockefeller group such as Cargill (food production and processing), American Coffee (coffee marketing), and EMA (mechanized agricultural services company). Also, the foundation itself invested in the acquisition of farms in Ubatuba-SP (MONIZ BANDEIRA, 1978), as well as becoming a partner in the Brazilian seed producer Agroceres in 1955 (AGROCERES, 2015), which was already breeding seeds adapted to tropical regions.

The Brazilian government also played an active role in this process by opening institutions such as EMBRAPA, which researched seed improvement, EMBRATER (Brazilian Technical Assistance and Rural Extension Company) in 1974 for training extensionists and assisting farmers, and the SNCR (National Rural Credit System), created in 1965 to manage rural credit. According to Grisa and Schneider (2015), the reformulations in the agricultural credit subsidy and the minimum price guarantee policy (Decree-Law no. 79 of

19 Dec 1966) played the role of 'inducing the expansion of the agricultural frontier, basically for the Southeast and Midwest regions' (Ibid, p.130).

With the military in power, the spread of capitalism was taken for granted, and therefore the geopolitical issue was not a concern for the US government anymore. However, Brazil needed money, a lot of money, to finance all the investment that was being carried out at the time (not just in agriculture). This theme will be treated in more detail in the next section, which deals with the development of agriculture in Brazil, and which will be related to the implementation of the green revolution model at the end of the article.

THE DEVELOPMENT OF AGRICULTURE IN BRAZIL

With the industrial revolution implemented by President Getúlio Vargas in the 1930s, there was an increase in the exodus of workers from the countryside to the city, which caused an increase in the urban population and the demand for the purchase of food. These factors put pressure on the agricultural sector that was unable to satisfactorily meet this demand, which was considered to be one of the obstacles to the development of industrialization in the country. This problem was attributed to the fact that production was insufficient and that the population had a low income (CASTRO, 1984). In the 1950s, rural areas were home to 64% of the Brazilian population (IBGE, 2020) and 22.5% of GDP (BONELI, 2006), which demonstrates the economic weight that agriculture held in national accounts, although it was assuming a tendency of growth at decreasing rates due to the expansion of the industry. During this period, agriculture was, therefore, placed at the focus of government policies and social interests, and also inspired a growing set of theoretical debates (NAVARRO, 2001). This dynamic motivated the government and the business elite to mobilize for the implementation of an agriculture modernization program in the country.

A campaign carried out by the Vargas government that was extremely relevant to the expansion in agricultural production was the 'march to the West', that had its focus on encouraging the occupation of areas in the western frontier, but which also motivated an internal migration to the Cerrado region in the Midwest. According to Melo (1985 cited by (BUAINAIN et al, 2014a), 'in the 1940s, 85% of the increase in agricultural production was due to the expansion of cultivated areas; for the 1950s, the figure was 72%; for that of 1960, 65%. [...] The occupation was not a peaceful process [...] and what was one of its objectives – to establish a reasonably equitable agrarian system – was entirely undermined'. Adding to this fact the strong performance of political oligarchies in the central-south region of the country, the result was a great concentration of land ownership. These properties ended up benefiting from technological innovations, cheap and unexplored land, capital subsidized by the government and the rising of labor cost (an attraction for labor), factors that created substantial advantages for large-scale production (BUAINAIN et al, 2014a).

The country's industrialization project ran up against the absence of base industries

(raw materials, energy, and fuel). Vargas made good negotiations with the American government at the beginning of the 2nd world war and managed to make steel production viable in the early 1940s. In the 1950s it was the oil industry, and hydraulic power generation received large investments in the 1960s. Although industries were the priority of the 1940s and 1950s governments, modernizing the agricultural sector was becoming urgent. According to the IBGE, between 1900 and 1980, Brazilian GDP grew a hundredfold, and per capita income, tenfold. Between 1945 and 1960, in the post-war period, the Brazilian GDP grew around 6.3% per year. Therefore, there was a growing population, with per capita income on the rise, but experiencing constant shortages and had no greater availability of products for consumption because exports still did not generate enough foreign exchange to import industrialized products (PRADO, 2010). In the mid-1950s, industry growth no longer depended on the political will of the government, but it occurred naturally due to the demand of the new Brazilian consumers.

In 1949, the Brazilian government held a meeting of the Joint Technical Commission Brazil-United States, in which all the limitations found in Brazilian agriculture were made explicit, as a result of little progress in cultivation techniques (CASTRO, 1984). The commission´s report ratified the existing bottleneck in the capacity of rural areas to supply food to the Brazilian population, which even led the government to import food, and which was also putting pressure on inflation. The report brought up the country´s inability to produce food surpluses, which corroborated the need for the modernization of agriculture to become a major government priority between the 1950s and the 1970s. And that´s exactly what the development plans created in the 1950s brought about, by starting to emphasize investments in the agricultural sector, including placing the need for investment in small producers and showing sensitivity to the reflection of the great concentration of land ownership for the sector's development. Despite this deference to small scale agriculture, the programs that came in the course of the 1960s gave a clear preponderance to the emergence of modernization of large-scale agriculture (CASTRO, 1984).

According to Schneider and Cassol (2013, p.7) with the exhaustion of the agro-export model of coffee and the intensification of industrialization by import substitution after the Second World War, the scenario of the Brazilian economy changes significantly. 'As of the 1950s, claims for land and social rights emerge in areas and regions that had not been colonized by European immigrants, such as the rural Northeast'. Social pressure leads the State to create the Land Statute (Law nr. 4.504 /1964) which, through its Art. 4, legitimizes dualism in the Brazilian agrarian formation with the segmentation of agricultural establishments into four fundamental categories: the *latifúndios* (land properties), rural companies, family properties and smallholdings (Ibid, p.7). Common characters in the Brazilian countryside such as the peasant and the settler did not appear in the statute. In 1966, the National Agrarian Reform Plan was created, which would later operationalize this duality of agricultural models. The inequality arising from this dualism can be demonstrated

by the Gini index of land concentration that reaches 0.855 in 1975 (GASQUES, VIEIRA FILHO, and NAVARRO, 2010).

The duality in rural areas (RODRÍGUEZ, SEPÚLVEDA, and ECHEVERRI, 2001; BIGGS and ELLIS, 2001), fueled by the existence of the sectors of industrial agriculture, focused on the export of commodities, and small scale agriculture, providing food for the domestic market, started to characterize Brazilian agriculture from the 1960s onwards. This concept was also disseminated by the Argentine economist Raúl Prebisch, whose school of thought – known as CEPAL – described that the society of underdeveloped countries had as a characteristic a 'structural heterogeneity' (PRADO, 2010). Prado Júnior (1979), in turn, defends the thesis that Brazil was thought to be an agrarian exporting colony from the beginning, which made the country go through economic cycles such as sugar, cotton, rubber, and coffee that, after 430 years of history, begins to change with the need for agricultural diversification defended by Vargas in 1930.

Vargas' initiative takes as reference the success obtained in Rio Grande do Sul with innovations in the cultivation of rice in 1906 (CHELOTTI; CASTANHO, 2006), and with wheat in 1920, the latter a result of subsidies provided by Vargas himself when he was governor of the state (PESAVENTO, 1983). Diamond (1997) explains that the most common varieties of modern agriculture – such as rice, corn, wheat, and soybeans – were "domesticated" by the man in temperate climates, which explains the success of rice and wheat plantations in the country´s south. This fact, however, imposes great obstacles for its planting in countries with a tropical climate such as those in Latin America and Africa, which receives a very large amount of sun and heat. Upon reaching the republic´s presidency in 1930, Vargas expands the incentives for wheat production for the rest of the country, as its main objective was for Brazil to stop importing the product. However, all the effort placed in this program demonstrated, in 1955, that 75% of the production was still coming from Rio Grande do Sul, which ratified what Diamond said about seeds and temperate climates, and showed the production technical constraints of these cultures in tropical regions and, mainly, in the cerrado.

This phase of wheat expansion, with a strong state subsidy, ended in 1956 with the arrival of Juscelino Kubistchek in the government. The most important reasons that led to the collapse of wheat production were technical issues related to the tropical climate, constant crop failures, low price-productivity ratios, fraud in marketing the product and, also, geopolitical issues that led President Kubistchek to carry out a wheat exchange agreement (at unbeatable prices) for strategic radioactive ores (MONIZ BANDEIRA, 1978). Kubistchek, therefore, breaks with Vargas' national populist developmentalism, towards developmentalism with strong support from international capital. The exchange of wheat for radioactive ores, which should have been done with the reciprocal transfer of technology, demonstrates one of the concessions made by the government to obtain external financing.

The new government, therefore, makes important changes that were supposed to

'open the doors' for the implementation of the agricultural model of the green revolution in Brazil. The Rockefeller and Ford foundations began to operate in Brazilian agriculture, working together with government institutions to bring further development. The reconciliation of Brazil's economic interests with American geopolitical interests should have set the beginning of the Green Revolution´s implementation in Brazil in the late 1950s (ALVES, 2013). But it didn´t. The fact that the American government believed that Presidents Juscelino Kubistchek, Jânio Quadros and João Goulart had communist tendencies, and that, in this case, the American institutions would not be safe, meant that the green revolution would only be implemented under a different political ideology, what only happened under the military regime.

In the 1960s, social movements were pushing for agrarian reform as a solution to the economic problems of the rural sector. Despite the creation of public institutions and the approval of new public policies, agrarian reform in the military government was quite restricted. On the other hand, agriculture modernization was, now, the priority. The Rural Credit Policy was created by Law nr. 4,829 / 1965 which provided credit lines for investments in agriculture. This credit policy was based on the new Land Statute, which led it to be written in a very general way, making access easier to larger landowners. In the period 1970-86, government subsidies transfers from the banking sector to agriculture was of the order of R$89.48 billion (US$ 80.53 billion at Aug/1994 prices), which represented 11.4% of agriculture's GDP (BACHA; DANELON; BEL FILHO, 2005). This was mostly financed by foreign loans.

The SNCR (National Rural Credit System) started to receive more resources to become 'the main stimulating and financing mechanism for the agriculture modernization policy and, consequently, the expansion of rural extension services throughout the country' (GRISA and SCHNEIDER 2015). Its resources were driven towards investments in large-scale agricultural projects, necessary to enable its high technological standard. (CASTRO, 1984) was referring to the technological package of the Green Revolution, but the money was also used in opportunities to expand agricultural frontiers to the center and the west. This fact will also concur to deepen the duality of agricultural models in the country: that of modern agriculture (industrial agriculture) aimed at exporting, and that of smallholders (small scale agriculture) aimed at supplying the domestic market.

Discussing the evolution of thought about rural development, Rodríguez, Sepúlveda and Echeverri (2001) identify in the literature two major strands of thought: the first, of an economic nature, is centered on the productive aspects and the economics of development; the second, of a multidisciplinary character, expands the scope of study and privileges historical, social and cultural issues, and its main influence is rural sociology and anthropology. In the 60s and 70s, when the concepts of the green revolution were implemented, the development plans of the military governments and the institutions created at that time show the influence of the modernist concept, which is aligned with the economic character.

Regardless of the structural changes already mentioned, in the early 1970s, the most repressive period of the military dictatorship, the government had in economic growth the ideal banner to legitimize the regime before a part of society (SANZ; MENDONÇA, 2017), at that moment represented by the middle and upper classes. Prado, in a lecture given in 2010, states that 'the growth of the economy brought the appearance of normality, and there were significant gains in all sectors of the population. [...] This gave some comfort to the dictatorship, which did not need votes to legitimize itself, but growth'. Besides, privileging industrial agriculture meant generating foreign exchange through the export of agricultural commodities and consumption of industrialized products (machinery and inputs). The aspect of polyculture, in turn, returns to the scene after the military leaves government in 1984, when, then, the rural movements resurface to claim 20 years of silence.

Biggs and Ellis (2001) join Rodríguez, Sepúlveda and Echeverri (2001) when working with the evolution of the concept of rural development, using definitions that can be related to different times and regions within the history of Brazil. The four concepts are as follows: (1) the concept of the dual economy created by Julius Herman Boeke refers to the coexistence of two economic sectors within the same space, separated by different levels of development, technology and demand patterns, capital intensive and technologically more advanced, and another labor intensive and technologically primitive, which describes the simultaneous presence of traditional and modern sectors in a (post)colonial economy; (2) the concept of small farm efficiency comprises that small producers are rational and efficient economic agents, which can be related to small properties in the south and southeast that have managed to establish themselves in the market due to the support of local governments in training, rural extension, financing and social organization in the form of associations and cooperatives; (3) the concept of process-participation and empowerment has characteristics of social organization around sectoral demands such as movements in the field carried out by CONTAG and MST in the late 1980s and 1990s; and, (4) sustainable livelihoods that are well aligned with what we see today in areas that use agroecology guidelines, that is, agriculture developed on social, economic and environmental premises, respecting the particularities of sustainable agriculture.

For Navarro (2001), in the last 50 years, there have been two moments when rural development has been raised to a condition of singular preponderance in Brazilian history, inserting itself in the socio-economic agenda, instigating debates in the academic environment and moving organized groups to social action. The first of these moments represent the period that stretches from the postwar to the late 1970s; and the second moment, which is outside the temporal scope of this work, refers to the mid-1990s when 15 years of meager economic results motivated the resurgence of the debate on development. The changes that occurred in the postwar period give a notion of rural development molded into the "spirit of the time", whose modernizing dynamics were being shaken by the admirable capitalist expansion of the "golden years" (1950-1975 period). This concept corroborates

the economic development aspect of Rodríguez, Sepúlveda, and Echeverri (2001), Boeke's concept of the dual economy (Biggs and Ellis 2001), the duality of agricultural models (RANGEL, 1981), as well as Prebisch´s structural heterogeneity (PRADO, 2010), which all describe the existence of two sectors in the same economy, demonstrating the coexistence of the modern and the traditional, which is very clear in Brazil due to the existence of industrial and small scale agriculture.

The modernization of industry and agriculture, as explained by Rangel (2005), ended up generating technological unemployment both in the countryside and in the city, which resulted in an immense contingent of surplus workers, a situation that began to put pressure on the government due to increasing tensions and disturbances in the countryside (KOHLHEPP, 2015). On the other hand, in the early 1970s, the North region was not yet integrated into the internal market which was being organized by the industrial sector and, also, the government saw the Amazon area as a 'demographic void' to be filled (RANGEL, 2005). Faced with this scenario, the military government began to work on the idea of state-led agrarian colonization, through which the surplus labor would be mobilized for the Amazon area, as an agrarian reform proposal. This strategy assumed, in principle, the engagement of this workforce, and it could, also, guarantee greater security and vitality of occupied spaces in border control.

In the new reality of productivist agricultural properties, Rangel (2005) clarifies that there is no longer a need to maintain workers within their lands, moving on to a specialized production entrepreneurial system in which the use of wage labor becomes seasonal, without involving the whole family. This meant the end of self-consumption agriculture produced by the peasant families within the property. Thus, according to this author, the new capitalist farm, with the capacity to occupy different locations employing advanced technologies, starts to require the availability of small farmers disposed in small independent plots of land, not too far away, capable of housing families that are able of produce for their consumption and nearby markets, under stable conditions, from which large farmers would recruit seasonal wage labor. These people could also perform non-agricultural services such as building houses, corrals, barns, etc. or work on the improvement of their production. This system was intended to create, according to Rangel (2005), a complementarity between the two models. On the one hand, the capitalist export monoculture company, capable of occupying land previously unsuitable for agriculture, and on the other, smallholder's polyculture farming producing food for their consumption and the domestic market.

Alongside the agrarian colonization projects, in the 1970s, rural development programs were implemented in the poorest regions (in the northeast and north), of which it was assumed that the 'natural' result would be a process of change in the way of producing food, which would leverage production and productivity, and would seal a virtuous relationship with an increase in income (ALMEIDA; PESSOA, 2010), which did not happen. And it actually couldn't have happened. The small farmers, who were the focus of such

programs that were meant to bring development 'to that place', did not have an education level high enough to apply the new technologies (according to 1976 PNAD, the illiteracy rate in the rural area of the northeast reached 64.5%), which makes rural extension even more necessary, and there was also the issue of financing investment through government programs, available but unattainable or unwanted by small farmers. Were these new technologies for them? In Mexico, some peasant communities consciously rejected the proposal for a green revolution (CLAWSON; DON, 1979 quoted by PATEL, 2013). Another important factor, which added to the success of the program in the southern region, but which was not part of the northeastern cultural roots, was the social organization in the form of associations.

The other Brazilian regions (South, Southeast, and Midwest) did not encounter any major problems concerning government programs aimed at the model of agricultural modernization. Rangel (2005) reminds us that, differently from the colonizing policies of the past, in this new context, the population encouraged to move was no longer the impoverished labor, but the southern farmers with an entrepreneurial spirit, who already knew this new production model and the market. While in the Midwest the expansion of agricultural frontiers walked at a fast pace, in the southern states, the diffusion of technology was further deepening socioeconomic differences among producers, which, within the dynamics related to capitalism itself, ended up being exclusive for those that did not follow the evolutionary process (CUNHA; SAVOLDI, 2010) and promoting a consolidation of properties in the market.

This first period of development ended in the late 1970s as a result of unsatisfactory results from the rural development proposals implemented in different countries concerning poverty reduction (GRISA; SCHNEIDER, 2015). The line of economic nature addressed by Rodríguez, Sepúlveda, and Echeverri (2001), found fertile soil in the cerrado, but not in the caatinga (the biome in the Northeast region). The center-south region of the country already had organizations (rural enterprises and cooperatives) that were imbued with the productivist (economic) aspect. In the north-northeast region, which has a social reality (more than half of the peasants and smallholders), geographic (the caatinga and the Amazon biome), and economic (high index of poor families) very different from the rest of the country, a multidisciplinary approach designed for the diversity of forms of agricultural production would have been more appropriate. The failure of the poverty reduction programs, combined with the stagnation of the post-war expansionist economic phase – which was followed, in Brazil, by the implementation of policies labeled as neoliberals, which came to weaken the role of the State – caused the theme of rural development be removed from the scenery of discussions (NAVARRO, 2001).

The process of expanding agricultural frontiers has not been without problems. An issue inherent to this expansion is deforestation, which, despite being inevitable, did not have an adequate legal organization, which caused the process to become troubled and

characterized by violent clashes. The lack of land ownership, the main reason for these conflicts, is a problem that mainly affects small farmers. Some technical issues were enhanced by the green revolution, such as erosion, the depletion of soil and other natural resources (water sources, natural reserves, etc.) caused by the uninterrupted use of monocultures (BUAINAIN *et al*. 2014b). Buttel (1995), discussing the agroecological transitions of the 20th century, argues that traditional small-scale indigenous agriculture has diversity as its pivot, that is, spatial variability, polyculture structure, species and genetic diversity that are essential for its maintenance. The manipulation of pesticides, in turn, brings damage both to health (including death) and to the environment (OLIVEIRA, 2014). Rangel (1962 cited by CUNHA and SAVOLDI, 2010), also states that mechanization reduced the demand for labor in the countryside, causing the rural exodus of this contingent of people to cities and, because they were not prepared to work in the urban environment, started to thicken the populations living in slums.

RESULT OF THE AGRICULTURE MODERNIZATION PROGRAM IN BRAZIL

The increase in production naturally brings positive effects to the market. With the increase in domestic supply, as well as high subsidies, the price of food fell in real terms between 1975 and 2007. Using the cost of life index of the Economic Research Institute Foundation (FIPE) for the period, the cost of food in São Paulo fell by more than 5% per year (BUAINAIN *et al*., 2014a).

Production statistics, likewise, started to demonstrate the fact of the duality of agricultural models in the country. Figure 1 shows the phenomenal growth obtained by agriculture between the 1997 and 2013 harvests. According to CONAB, the grain harvest in 1975 was of the order of 45 million tons, 83 million in 2000 and 242 million tons in the 2019 harvest (CONAB, 2019). A variation (1975/2019) of 438%, but which shows a slower growth profile before the 1999-2000 harvest, and a stronger one thereafter, which is not only due to technological advances but also, to the ability to respond quickly to market demands that characterize globalized Brazil in the 21st century.

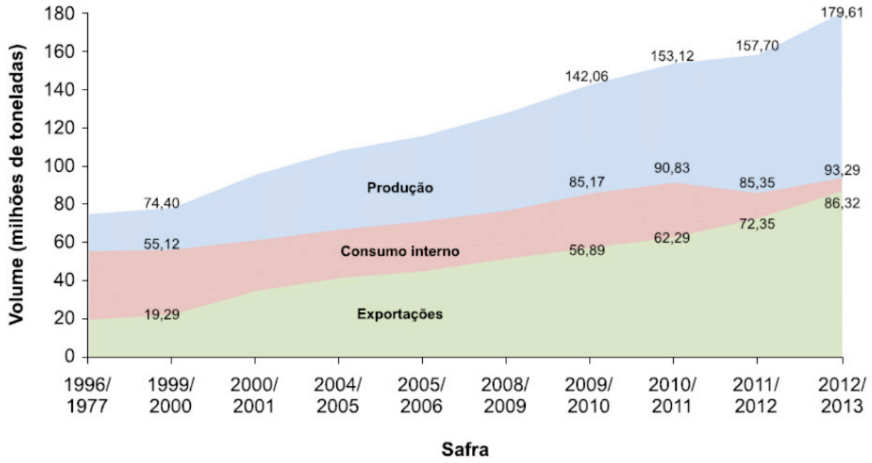

Figure 1. Production, internal consumption, and export of grains (millions of tons).

Source: Buainain *et al.* (2014a) – Public Domain EMBRAPA

The graph also shows the division between the portion of the harvest directed to domestic consumption and export markets. In the 1999-2000 harvest, 74.2% of production was consumed domestically, while 25.9% was exported. In the 2012/13 harvest, domestic consumption fell to 51.9%, while exports already reached 48% of production. Exports in the period went from 19.29 million tons in 2000 to 86.32 in 2013, which represents an increase in the production surplus (the portion not consumed internally and directed to export) of 348%, almost 2.5 times. Domestic consumption also grew by 69% in the 2000-2013 period, representing, in addition to human consumption, consumption directed towards animal feed as a result of herd growth.

Table 1 provides comparative information from the Agricultural Censuses of 1995-1996, 2006 and 2017, which aim to demonstrate the dynamics among these periods in the agricultural sector in Brazil. Regarding the number of establishments, there was an increase in the number of properties from 1995-96 to 2006 (6.5%) and a reduction from 2006 to 2017 (-1.97%), but even so, an increase of 4,4% from 1995-96 to 2017. There is an increase in the number of family farming establishments (properties with up to 4 fiscal modules, which predominantly use family labor, income predominantly from rural activity and establishment run by the family) for 1995-96/2006 of 5.5%, and a reduction in the period 2006-2017 of 10.7%.

Between 1995 and 2013, the agrarian reform program regularized land ownership for 1.23 million families (ROBLES, 2018), but the data indicate a process of land consolidation between the last two Censuses. The total number of properties was reduced by approximately 2%, and the respective total area increased by 5.3%, which could represent the continuation of the expansion of the agricultural frontier. However, the 2017 total area is still below that

of 1995-96. Therefore, this 5.3% increase represents the recovery of previously abandoned areas. The share of smaller establishments dropped by almost 11%, going from 85.17% (1995-96) to 76.82% (2017) of the total rural properties; the area corresponding to these properties also decreased from 30.49% to 23% and, consequently, the share of the gross value of production (GVP) of family farming also fell from 37.87% in 1996 to 23% in 2017. These numbers indicate the continuity of the process of consolidation of larger properties.

Agricultural Censuses	1995-96	2006	2017
Total Establishments	4.859.865	5.175.636	5.073.324
Family Agriculture Establishments	4.139.147 85,17%	4.366.267 84,36%	3.897.408 76,82%
Total Area (ha)	353 611 246	333 680 037	351 289 816
Family Establish. Area (ha)	107 816 068	80.102.694	80 891 084
Family Establish. Area (%)	30,49%	24,01%	23%
Family Agriculture Financing (Establishments)	25,3%	19,0%	15,4%
Gross Production Value (GPV)	R$ 47,8 Bilhões	R$303,6 Bilhões	R$552,5 Bilhões
% of GPV in Family Agriculture	37,87%	33,23%	23%
Labor in Agriculture (%)	13.779.889 (76,85%)	12.266.000 (74%)	10.100.000 (67%)

Table 1. Comparative Data among Agricultural Censuses 1995-96/2006/2017

Source: Agricultural Censuses 1995-96/2006/2017 and Sidra Plataform IBGE

The production of agriculture is basically explained by three factors of production: labor, land and technology (capital). According to the analysis carried out by Alves, Souza and Rocha (2012), the role of these three factors, between the 1995-96 and 2006 Agricultural Censuses, varied from 31.3% to 22.7% for work, from 18.1 % to 9.3% for land, and from 50.6% to 68% for technology. The decrease in the relative importance of labor in agricultural production is explained by the increase in tractors, which represents the level of mechanization present in agricultural establishments, which also denotes the increased importance of investments in technology in the result. Therefore, for a 100% increase in gross income, 9.3% would be explained by land, 22.7% by work, and 68% would be explained by technological inputs, which fundamentally require the availability of money and of education, to which rural companies have access, but which no longer happens to a significant portion of family farmers, as can be seen from the drop in the VBP of family farming in the three Agricultural Censuses. This indicates that just owning the land is no longer a guarantee of results. No matter how small, the farmer will need to make investments to maintain his business.

Oliveira (2007 apud FIORAVANTI, 2016) states that the fact that agribusiness is considered fundamental to the Brazilian trade balance and food production ("for the world"), collaborated "to allow the maintenance of the political and economic privileges of the landowner elite". This targeting of benefits can be observed by the increasing concentration of income in rural areas. According to IBGE data referring to the 2006 agricultural census, compiled by Alves, Souza and Rocha (2012), 11.36% of the number of agricultural establishments concentrated 86.65% of the gross value of production (GVP) of agricultural properties in the country. These are properties that have a monthly income of ten to more than two hundred minimum wages (about R$10,000 to R$200,000 per month). Conclusion, therefore, is that 88.64% of agricultural establishments have a monthly income below 10 minimum wages (BUAINAIN *et al.*, 2014a).

Another indicator of the economic privileges of large properties is the level of access to rural credit. In the period from 1970 to 1986, rural credit transferred in the form of government subsidies from the banking sector to agriculture was around R$89.48 billion (US$80.53 billion at August/1994 prices), which represented 11.4% of agricultural GDP (BACHA; DANELON; BEL FILHO, 2005). This amount was practically all directed to the central-south region of the country, where the focus of the agricultural frontiers' expansion was, at that time, that is, a region with the best possibilities of achieving greater production. The 1995-96 Census already indicates that 25.3% of family farming establishments benefited from rural loans, a percentage that dropped to 19% in the 2006 Census and to 15.4% in the last Census. Of the contingent of respondents to the 2006 Census, nearly half of them indicated that they "did not need" funding. Those who "needed the least" are in the groups of owners and producers of vegetables and flowers, demonstrating that they use their own capital or are financed by intermediary agents. A percentage of 21.8% of these farmers did not take out a loan for "being afraid of incurring in debt", who are partners and tenants and are dedicated to all types of production (GRISA; SCHNEIDER, 2015).

An important index in the evaluation of results of the green revolution model is productivity since the improvement in productivity is fundamental for an increase in production without an equivalent expansion of the cultivated area or an exacerbated increase in inputs. Table 2, updated in 2019 by Gasques et al. (2019), brings the updated FTP up to the 2017 Agricultural Census. According to the authors, 'Factors Total Productivity (FTP) can be understood as an increase in the product that is not explained by the increase in the quantity of the input, but by gains in productivity' (1). The average annual growth rate of FTP for the period 1975-2017 (2nd column) was 3.43%. To get an idea of the meaning of this number, according to the United States Department of Agriculture (USDA/ERS, 2018), the historical annual FTP rate is 1.38%, and for the period 2007-2015, it was 0.53%. Therefore, Brazilian FTP can be considered quite high.

Produce shows an annual growth rate for the period 1975-2017 of 3.82% p.a. (which reflects an increase in production of almost 5 times) and the index of inputs, in the opposite

direction, shows a constant decrease throughout the period. Here it is interesting to observe what happened in each period studied, since the projects of the green revolution have, as a characteristic, an increase in inputs such as seeds, fertilizers, and herbicides. In the period 1975-79, we have the highest index in the series (1.52%), which is also accompanied by the second-highest rate of product growth (4.35%), second only to the 2000-2009 period (5.18%). These indices depict the period of implementation of agriculture modernization, added to the expansion of agricultural frontiers and the abundance of financial resources. The index of inputs falls in the following 10 years to 1.15% (a period in which there was even unavailability of state funding) and continues to fall systematically in the following decades, reaching a historic low in the last 7 years. Therefore, there is pressure from costs in the period of implementation of the agriculture modernization program, which follows a downward trend in the rest of the series for two reasons: firstly, due to the lack of credit in the 1980s and mid-1990s and, later, by technological advances that allowed for the substitution of imports and the search for more adequate and environmentally friendly solutions. The difference between the produce and input indices indicates, in turn, an increasing gross production value for rural activities in the country.

PERIODS	1975-2017	1975-1979	1980-1989	1990-1999	2000-2009	2000-2017
INDEX						
INDEX PRODUCE	3,82	4,35	3,38	3,02	5,18	4,06
INDEX INPUT	0,38	1,52	1,15	0,23	1,03	0,22
FTP	3,43	2,79	2,21	2,78	4,11	3,83
INDEX LABOR	-0,39	0,06	0,60	-0,22	-0,06	-0,90
INDEX LAND	-0,01	0,72	0,29	-0,32	-0,19	-0,07
INDEX CAPITAL (TECH)	0,78	0,74	0,25	0,77	1,28	1,20
PRODUCTIVITY						
PROD. LABOR	4,23	4,30	2,77	3,25	5,24	5,00
PROD. LAND	3,83	3,61	3,09	3,35	5,39	4,14
PROD. CAPITAL (TECH)	3,01	3,58	3,12	2,23	3,85	2,82

Table 2. Produce, Inputs and Factors Total Productivity Annual Growth Rate (%)

Source: Gasques *et al.* (2019) – Public Domain Ministry of Agriculture, Livestock and Supply

Below the FTP are the indices for the participation of labor, land, and capital in the economic result of agricultural establishments. It can be seen that labor and land have a negative rate in the period, which indicates a strong tendency to reduce the number of employed persons, as well as the cultivated area (due to the increase in productivity).

Conversely, there is a strong tendency to increase capital, which represents an augment of investments in technology. This index has a median growth in the period 1975-79, a weak performance during the “lost decade” (1980s), returns to median levels in the 1990s, but it has grown phenomenally in the last 17 years, demonstrating that technology came to strongly impact the Brazilian agriculture since the end of the 20th century.

On the other hand, labor and land productivity rates have been growing at high rates. Workforce productivity grew at an annual rate of 4.23%, which essentially reflects the improvement in the level of formal and informal qualification, and the use of equipment that increases work quality. Regarding the productivity of the land, it increases due to investments in research that result in seeds better adapted to the region it is planted, as well as products that allow for better soil preparation (GASQUES *et al*, 2019; ALVES *et al*, 2012).

DISCUSSION

The economic formation of Brazil was built based on tropical monocultures´ cycles that fed an agro-export model that reached exhaustion with the great depression of 1929. With the collapse of the international market, Getúlio Vargas was led to break 430 years of agroeconomic mimicry to make a shift to an industrialization model based on import substitution. At that time, there were only small manufacturing activities, without much market consistency. As the Brazilian oligarchic elite had savings from decades of agricultural exports and was concerned about the future of their investments, Vargas urged them to invest in their own country and worked to increase domestic income through incentives to form a middle class with consumption capacity.

The accelerated investment process in the industry starts to offer better jobs in urban areas, which leads to the exodus of families from the countryside to the city. These families, who previously produced their food, now have to buy it, which puts pressure on the agricultural sector that was unable to cope with the growth in demand. When the need for agricultural diversification comes up, the country´s dependency on food production from the south region also comes up, a situation far from ideal.

Vargas had already witnessed rice (1906) and wheat (1920) growing projects when he was Rio Grande do Sul state governor. Besides, he had Argentina as an example, which had a very diversified list of export products and which was much less affected by the fall of the American stock market in 1929. At that time, he did not know it yet, but the success of these cultivars was due to the temperate climate. Vargas, now as president, starts to implement similar projects across the country, but he comes up against the technical limitations of growing these cultivars in the central-southeast region, where the climate is tropical and the Cerrado biome is found.

With the identification of these limitations, projects to develop cultivars more appropriate for the Brazilian climate emerge, as well as solutions for high acidity soil (high

pH), as is the case in the cerrado. In the early 1930s, Brazilian researchers found, in the application of limestone, an efficient solution for the correction of acidity. On the other hand, the company Agroceres started to produce hybrid corn seeds in the 1940s, best suited for the Brazilian climate, a company that came to join the Rockefeller group in 1950.

The industrialization project is boosted by investments in base industries, which leads GDP to grow around 6.3% per year between 1945 and 1960 (IBGE, 2020). Therefore, there was a growing generation of new consumers in the country, with per capita income on the rise, whose demand for consumer products was naturally feeding the industry sector growth, but which also put even more pressure on food production.

In the early 1950s, in addition to the problems caused by retrograde agrarian structures, there were also social conflicts caused both by forces that were fighting for change and by those that resisted progressive demands (PRADO, 2010). In a time of economic growth, but politically and socially troubled, Juscelino Kubistchek took office as President in 1956, after almost having suffered a coup d'état by the military. In his government, Kubistchek opens the market to foreign industries to continue to substitute imports. To finance his government´s plan (called 'fifty years in five', which included the new capital Brasília), several loans are taken from American financial institutions, which lead his government to end with a great debt, and with serious socioeconomic problems that had been escalating and converging to a major crisis. This situation is aggravated by the political instability of Jânio Quadros and João Goulart´s governments, who came up with proposals for base reforms considered to be of communist tendency, which led to the military coup in 1964 (PRADO, 2010).

The facts demonstrate that the American government was supportive of the military coup in Brazil (PINTO; FLEISCHER; PANDOLFI, 1994). There was a request for fuel supply by the Brazilian military, which was promptly answered by the United States. A curious fact, however, the Brazilian government, on the eve of a military coup, requesting fuel. Brazil was certainly not just running out of fuel, but reaching an extreme financial difficulty. The authors affirm that, after the coup, there was financial support, renegotiation of the Brazilian debt and other actions that later came to incorporate the implementation of the Green Revolution. The narrative was to 'modernize Brazilian agriculture', but it put Brazil in a situation of dependence on American products and technology, in addition to heavy loans that took the Brazilian external debt to the level of 53.8% of GDP in 1984 when the military left the government.

The military government put in place a fiscal organization agenda which improved the economic situation in the late 1960s. With the resumption of the job market, the military sees in a strong economy a way to legitimize the military regime for effectiveness, that is, to reinforce the argument that there was compensation for the loss of freedom in economic growth. Within this context, the modernization of agriculture became an urgent matter for being a link to the supply of food to society; for becoming a consumer of industrialized inputs;

for generating income internally; for leveraging exports, generating foreign exchange; and for providing labor to other sectors (industry and services).

In the early 1970s, the first PND (National Development Plan) did not impact the sector for being too much restricted to certain areas and products. In the second PND, though, the new plan ratifies the need to "adapt the techniques to local ecological conditions", and recognizes that "the possibilities for the contribution of imported technology [were] limited". This recognition leads the government to continue investing with priority in research and rural extension, which culminates in the creation of EMBRAPA and EMBRATER, and which demonstrates that technological development was being carried out internally, through public policies and by Brazilian institutions. Large-scale monocropping projects reproduced quickly, but the growth based on the increase in productivity would only come later, with a more consistent technological advance.

According to Alves, Contini and Gasques (2008), from 1931 until the 1970s, the country's grain productivity remained stagnant. CONAB data (2020) show that the increase in productivity started to assume a more consistent profile (above 1,200 Kg/ha) in the 1979/80 harvest, exceeds the historical landmark of 1,500 Kg/ha in 1987, reaches 3000 Kg/ha in 2008, and comes up to a phenomenal 3,830 Kg/ha in the 2018/19 harvest. It can be observed, therefore, that the increase in productivity, so propagated by the green revolution, only really occurred in Brazil in the 1980s, as a result of the strong performance in research carried out by Embrapa, followed by the creation of postgraduate courses, but still investing in rural extension through Embrater. This recipe caused a real scientific revolution and made Brazilian grain production explode (Ibid., p.72-73).

Considering all the investment made by the government around agricultural modernization, as can be seen in the item 'productivity' in Table 2, most of the initial impact was due to investments in labor qualification (4.30%) and the expansion of planted areas (3.61%), although 3.58% of investment in technology cannot be underestimated. The results improved at the end of the '70s, but they dropped a lot in the '80s (the "lost decade"), and only started to assume a stronger growth trend after 1997, when new technologies, better adapted to Brazilian biomes (special emphasis for soybeans in the Cerrado), made Brazilian production jump both in production and in productivity.

It can be concluded that the process of implementing the green revolution projects in Mexico, India and the Philippines has very different characteristics from what happened in Brazil. In reality, Brazil did not have an external technological package implemented in its territory, but rather, a demand for agriculture modernization that was gradually met throughout 40 years of profound structural transformations, and through public policies elaborated by the offices that followed. Obviously, American companies and 'capitalism' did profit a lot in the process, but a fundamental part of the package – the seeds – was developed in the country. Investments' results, however, began to appear in the second half of the 1970s and became truly revolutionary at the end of the 1990s.

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