Vol. 62, p. 1075-1091, jul./dez. 2023. DOI: 10.5380/dma.v62i0.85703 e-ISSN 2176-9109

UFPR

DeMA DESENVOLVIMENTO E MEIO AMBIENTE

BIBLIOTECA DIGITAL DE PERIÓDICOS BDP | UFPR

revistas.ufpr.br

The tobacco small farmers and impact of restrictive credit policies on the planted area in Brazil: assessment of tobacco control policies

Pequenos produtores de tabaco e o impacto de políticas restritivas de crédito na área plantada no Brasil: avaliação de políticas de controle de tabaco

Camila de Moura VOGT[1], Augusto Mussi ALVIM[2*]

[1] Federal University of Pará (UFPA), Belém, PA, Brasil.

[2] Pontifical Catholic University of Rio Grande do Sul (PUC-RS), Porto Alegre, RS, Brasil.

[*] Contact email: augusto.alvim@pucrs.br

Article received on April 20, 2022, final version accepted on July 3, 2023, published on November 24, 2023.

ABSTRACT: Brazil is one of the greatest tobacco producers, just behind China, and the largest tobacco exporter in the world. On the consumer side, the harmful effects of smoking on human health have led to a debate on control policies. In addition, the initiative to become a member of the Framework Convention Tobacco Control (FCTC) and the creation of the Brazilian Tobacco Control Policies (PNCT in Portuguese), both in 2005, has contributed to the implementation of various measures to reduce the demand for tobacco in the country. Furthermore, to promote agricultural diversification, the Brazilian Central Bank has gradually restricted credit to small tobacco farmers in the National Program for Strengthening Family Farming (PRONAF in Portuguese). In this context, this paper aims to estimate the impact of credit restriction on tobacco production according to the productive structure of family farming. The results of the study show that the greater the rural credit restrictions imposed in alternative scenarios, the more significant the reductions in tobacco areas and income. Also, the increase in revenue from other agricultural activities mainly affects the group of farmers with 5 to 100 hectares, which shows the potential of this policy as an alternative to reduce tobacco dependence.

Keywords: tobacco, rural credit, PRONAF, PNCT.

RESUMO: O Brasil é um dos maiores produtores de tabaco, atrás apenas da China, e o maior exportador do mundo. Pelo lado do consumidor, os efeitos negativos do tabagismo na saúde humana têm contribuído para o debate

sobre políticas antitabagistas. Nesse aspecto, o Brasil também tem protagonismo ao tornar-se membro da Convenção-Quadro para o Controle do Tabaco (FCTC) e ao criar as Políticas Brasileiras de Controle do Tabagismo (PNCT), ambas em 2005. Essas iniciativas contribuíram para a implementação de medidas para reduzir a demanda por tabaco no país. Para incentivar a diversificação agrícola e a menor dependência pelo tabaco, o Banco Central do Brasil vem gradativamente limitando o crédito rural por meio do Programa Nacional de Fortalecimento da Agricultura Familiar (PRONAF) para os produtores que possuem o tabaco como uma das atividades na propriedade. Nesse contexto, o objetivo deste trabalho é estimar o impacto da restrição ao crédito rural na produção de tabaco levando em consideração a estrutura da agricultura familiar no sul do Brasil. Os resultados do estudo mostram que, quanto maiores são as restrições impostas nos cenários alternativos, maior são também as reduções nas áreas e na renda oriunda do tabaco. O aumento da receita de outras atividades agrícolas afeta principalmente a faixa de produtores de 5 a 100 hectares, mostrando o potencial dessa política como uma alternativa para reduzir a dependência do fumo.

Palavras-chave: tabaco; crédito rural; PRONAF; PNCT.

1. Introduction

Brazil is the second –largest tobacco producer and one of the main exporters in the international market. The decline in production in the United States of America and Zimbabwe has allowed rapid growth in Brazilian exports to the international market. On the demand side, increasing large buyers such as China, Germany, Japan, the Republic of Korea, Russia, and the Far East have encouraged tobacco production in Brazil (Cavalcante *et al*., 2017). The main Brazilian tobacco markets are European Union (42%), Far East (28%), North America (10%), Eastern Europe (8%), Africa/Middle East (6%), and Latin America (6%) (COMEX, 2014).

Tobacco production is 12% of the Family Agricultural sector GDP, and the Tobacco Value Chain is about 7% of the Brazilian agribusiness GDP (Guilhoto *et al*., 2006), although the short-term economic benefits of tobacco are not compensated by the long-term losses in terms of food insecurity, farmers' debt, diseases and environmental damage (WHO, 2017).

The adverse effects of smoking on human health and the environment have led to death, disease, and pollution worldwide. The health problems caused by tobacco can be gathered in two aspects: diseases that affect farmers (producers) and diseases associated with smoking (consumers). The first group is rural workers who handle pesticides and drying tobacco and are exposed to these contaminants for an extended period (Pinto *et al.,* 2020). Another critical issue related to human health is frequent intoxication caused by Green Tobacco Sickness (GTS). This problem arises due to the absorption of nicotine through the skin during handling and exposure to tobacco leaves. The health risks arising from tobacco consumption are already well-defined. Currently, smoking is responsible for the deaths of 1 in 10 people worldwide (accounting for almost eight million deaths annually). If the current growth trend continues, 10 million deaths will occur by 2030 (WHO, 2019).

Related to adverse environmental effects, tobacco production is associated with reduced soil fertility and biodiversity and increased water pollution, deforestation, and GREENHOUSE gas (GHG) emissions. Specifically in the case of soil

and water, the studies point out contamination with pesticides and other chemical components (Kutub & Falgunee, 2015; WHO, 2017; Pinto *et al*., 2020). In addition, the largest tobacco companies expanding their operations and production in poor and developing countries due to the availability of labor and less restrictive environmental regulation (Kutub & Falgunee, 2015; Hendlin & Bialous, 2020).

Guided by evidence of the adverse health and environmental impacts of smoking, many countries (mainly developed countries) have implemented legislation and policies to reduce tobacco consumption. In the case of Brazil, the country became a member of the Framework Convention on Tobacco Control (FCTC) and the Brazilian Tobacco Control Policies (PNCT)[1]. In 2005, it contributed to implementing several measures to decrease the demand for tobacco (Costa *et al.*, 2004; Catalano & Gilleski, 2021). On the consumption side, the Brazilian government uses higher taxes, prohibition of advertising and, mainly, educational programs, and the prohibition of smoking in public places to decrease tobacco consumption.

On the demand side, the Brazilian government has prioritized the diversification of small tobacco farms in their production efforts. It has been a major challenge since joining FCTC, as multinational tobacco companies have significant economic influence in the southern region of Brazil, according to Portes *et al.* (2018). The National Program for Diversification in Tobacco-Cultivated Areas (PNDACT) was established in 2005 as one of the measures of the PNCT to reduce the farmers' economic dependence on tobacco. The program provides research projects, training and technical assistance, and rural extension to diversify farm activities. Also, the Brazilian Central Bank established a gradual restriction on subsidized credit to small tobacco farms from the National Program for Strengthening Family-based Agriculture (PRONAF) in the same year.

The PRONAF's more restrictive agricultural policy should be related to reducing the cultivated area of tobacco farms. It was also expected to reduce adverse environmental effects, mainly reducing the economic incentives for tobacco cultivation. However, the tobacco regulation policies' environmental aspects have received less attention from researchers and policymakers than their health and disease impacts.

This article thoroughly examines the impact of credit restrictions on small-scale tobacco farms and their cultivated areas. It is essential to highlight the potential benefits of the National Program for Tobacco Control (PNCT) in reducing the harmful effects of tobacco on both the environment and farmers' health. The first section provides an overview of Brazil's tobacco industry and the PNCT's mechanisms for restriction clearly and concisely. The second section estimates the effects of credit restrictions on tobacco production and the resulting impacts on rural credit and farms in Brazil. Understanding the significance of such restrictions is imperative to ensure a healthier and more sustainable tobacco industry in Brazil.

[1] Article 18 of the WHO FCTC explicitly states, "In carrying out their obligations under this Convention, the Parties agree to have due regard to the protection of the environment and the health of persons concerning the environment in respect of tobacco cultivation and manufacture within their respective territories." (WHO, 2017).

2. Tobacco's production restriction policies overview

Evidence that smoking harms health has led many countries to adopt measures to control tobacco. The FCTC is the most binding global agreement for controlling tobacco. The Convention, signed by 192 countries, regulates tobacco consumption and production worldwide with measures that cover health and environmental problems. It includes health treatment, health warnings, and the adoption of further control and restrictions on advertising, illegal trade, prices, and production subsidies.

Levy *et al.* (2012) found a significant decrease in smokers, which can already be verified because of the successful control policies worldwide. As a result, mortality rates from tobacco-related diseases, such as cardiovascular, respiratory, and lung cancer declined. Also, the social movements for global tobacco control have stimulated the search for alternatives to tobacco incomes, supporting farmers in changing their livelihoods.

The Food and Agriculture Organization of the United Nations (FAO, 2003) studies indicate that restriction policies' impact on tobacco demand depends on countries' resources invested in non-tobacco activities. Improving the capabilities of this country would require investments in agricultural diversification and alternative labor markets, which will take time. Following Vargas & Campos (2005), small farms cultivating tobacco in Brazil's Southern states represent 92% of the labor in agriculture. Therefore, FCTC policies must efficiently replace this activity; otherwise, they may create unemployment and increase rural poverty.

As Warner's (2000) analysis shows, the tobacco industry estimates that 33 million people are involved in this global market, and they must turn to other economic activities. In addition, the transition to non-tobacco systems requires financial support to develop new managerial and entrepreneurial skills in tobacco farmers (Beach *et al.,* 2008). These specific characteristics of tobacco producers make transitioning to non-tobacco activities challenging, mainly in low and middle-income countries.

The primary efforts to control tobacco commercialization and production have been the taxation of consumption. However, according to studies conducted in such markets as China and other developing countries (Taylor *et al.,* 2000; Teh-Wei *et al.*, 2008), higher taxes have a direct impact consumption on reducing and production.

In the last decade, tobacco control measures in the form of tax increases and production cuts, have also caused a significant change in the global market chain. Goger *et al.* (2014) have shown that tobacco companies in this period have gone through mergers, acquisitions, and joint ventures, which has led to a crucial spatial reorganization. They have moved to developing countries, especially Asia and Africa, to consolidate their position. In the same period of FCTC policies, there has also been a rise in industrial concentration and an increase in vertical integration between tobacco companies and producers. As per the authors, the tobacco industry exhibits high concentration, with a handful of companies possessing significant market power in the supply chain. Conversely, small-scale producers hold limited market power.

Prowse & Moyer-Lee (2014) have demonstrated that the tobacco production chain became more buyer-driven and vertically integrated due to

changing demand and supply patterns. The factors that have contributed the most to increased vertical integration and globalization of the tobacco chain are on the demand side: population growth and income, urbanization, and more extensive participation of women in developing countries' workforce; and on the supply side: market liberalization, higher product differentiation, and strict process control and production standards.

The cigarette industry is concerned about the future of market consumption and production. In 2017, one of the most critical players in cigarette production, Philip Morris, announced that it is designing a smoke-free future (Fortune, 2018). Their strategy is to use the traditional tobacco market for "harm reduction" products through heat-not-burn technology. The new product is a method of delivering the tobacco experience by heating rather than igniting it. According to studies released by the US Department of Health and Human Services (FDA, 2018), the company stated that the benefit compared with traditional products is to reduce many of the potentially harmful compounds that form at high temperatures when tobacco is combusted. Those new facts may allow the tobacco industry to produce with fewer legal constraints

2.1. Production restriction policies in Brazil

In 1985, the Brazilian National Program of Tobacco Control (PNCF) was the first national effort to tobacco regulation. However, since 1980 Brazil has had local laws restricting tobacco use in specific places (Romero & Costa e Silva, 2011). In addition, Brazil has been a pioneer in adopting several initiatives and contributing to the FCTC negotiations. As a result, the country stands out worldwide in implementing tobacco control measures along with Australia, Canada, Panama, Turkey, and Uruguay. However, since the signing of the international treaty, conflicts related to economic interests have become more evident and caused difficulties in such implementation.

The long confrontation between the government health departments and the tobacco industry delayed the ratification of the FCTC in Brazil. Cavalcante *et al.* (2017) pointed out that the tobacco industry had broadly campaigned that the Convention would ban tobacco cultivation, and the country's adherence to the treaty would have a strong negative impact on the livelihoods of 200,000 tobacco-producing households. Finally, after two years of debates (2004 and 2005), the Federal Senate approved the ratification of the FCTC (Legislative Decree n. 1,012). After this, in October 2005, the PNCT was created. According to INCA (2015), cigarette consumption per capita in Brazil has decreased since 1980 (around 46% from 1989 to 2010).

Despite its social and economic importance in Brazil, mainly in the Southern region, tobacco production has some negative aspects, which include social, environmental, and health issues. Lecours *et al*. (2012) have reported that the main negative externalities of the activity are associated with the communities involved in tobacco production.

The PNDACT in the PNCT aimed to reduce the economic dependence of tobacco producers on this culture. Signatory countries should promote national and regional policies to support rural extension, training, and research projects to implement strategies for product diversification, thus creating new opportunities for income generation (Cavalcante *et al*., 2017). However, the measures

related to crop diversification are the leading cause of tension since they have created a conflict between tobacco production representatives and tobacco policy control (Portes *et al*., 2018).

The tobacco industry and those involved in production have acknowledged the economic benefits to farmers, such as higher profitability than other crops, steady demand for tobacco, and industry support for integrated production. However, social sectors have raised concerns about the negative impact on farmers' health, the unhealthy and demanding working conditions, and their discontent and indebtedness to the industry. As Portes *et al.* (2018) affirmed, besides discussing the economic advantages of cultivating tobacco, two other conflicts have influenced the implementation of restrictive policies. The first concern is the importance of advancing diversification in tobacco-growing areas as an opportunity to reduce the global prevalence of smokers, as emphatically justified by the members of social sectors. From the standpoint of tobacco production-related sectors, diversification would imply adding other crops to tobacco-cultivated areas, preserving tobacco growth areas while there is demand. The second conflict involving tobacco farming is related to the government's constraints to ensure advances in crop diversification, even with the PNDACT.

Despite the political conflicts surrounding its implementation, an initial analysis of the impact of the PNCT on tobacco production has not revealed a clear cause-effect relationship. As mentioned, tobacco production and exports can be more readily associated with demand and supply and increased productivity and investment in innovation. The studies that evaluate the PNDACT in selected producers in South Brazil emphasize the difficulties of local governance in supporting alternatives to tobacco production (Vargas & Oliveira, 2012; Riquinho & Hennington, 2014). The producers also have much heterogeneity related to the territory and communities, creating barriers to the PNDACT policies (Vargas & Oliveira, 2012; Deponti & Schneider, 2013).

An essential economic instrument to encourage agricultural diversification and reduce the tobacco planted area has been restricting rural credit to tobacco producers since 2001 (Table 1)[2]. In Brazil, credit is granted as loans for agricultural activities subsidized by the government under specific payment terms and lower interest rates than similar credit lines in the market. Rural credit financing policies have played a strategic role in tobacco production, especially in Santa Catarina, Paraná, and Rio Grande do Sul.

The Brazilian production structure is made up mostly of small farms. The farm average size is 14.22 hectares, and only 17% are devoted to tobacco production, according to the Tobacco Growers Association of Brazil (AFUBRA, 2017). Despite the small area, tobacco represents 40% of farmers' income on average, 124% higher than other cultures. It explains how a small production can have such a high impact on farmers' revenues. Additionally, tobacco is a temporary crop producing only one crop annually for Brazilian farmers. Therefore, it allows farmers to grow other products in the off-season (corn, beans, and soybeans). This practice guarantees income beyond tobacco and complements the income of tobacco producers.

[2] The resolution of the Brazilian Central Bank announces the National Monetary Council's decisions.

The main restrictions on tobacco rural credit and the resolutions from the Brazilian Central Bank focus on the PRONAF's credit. The program was created in 1996 to transfer resources to family farmers at more affordable interest rates and terms to stimulate agricultural production. PRONAF has competitive rates concerning the rural credit market.

In 2001, the Brazilian Central Bank Resolution N. 2900 restricted the PRONAF's credit, not allowing financial support for tobacco production. The policy proposal by the Brazilian Central Bank was gradually restricting investments in tobacco crops aiming their replacement with new activities following the resolution and rules defined (see Table 1).

Since the 2005 resolution the tobacco industry stakeholders have been trying to slow the implementation of tobacco restrictions to protect their revenues. Later, other resolutions suggested that tobacco farmers' income from non-tobacco crops should not exceed 20% of their overall income to qualify for loans. However, the new resolution issued by the Brazilian Central Bank for rural credit no longer applies directly to tobacco funding. As a result, the percentage of non-tobacco income for granting loans to tobacco farmers is no longer limited (N. 4.584, dated June 29th, 2017).

According to Cavalcante *et al*. (2017), tobacco companies build complex power relationships and strengthen themselves economically and politically. Their study claims that the political bias in the re-

TABLE 1 – Summary of the Central Bank of Brazil's (Bacen) resolutions on the utilization of Pronaf by small farmers from 2001 to 2017.

Brazil Central Bank Resolution	**Description**
Number 2.900, 31st of October 2001	Activities do not relate to tobacco
Number 3.299, 15th of July 2005	I. 20% of income from non-tobacco activities
Number 4.107, 28th of June 2012	I. 25% of income from non-tobacco activities crop 2012/2013 II. 35% of income from non-tobacco activities crop 2013/2014 III. 45% of income from non-tobacco activities crop 2014/2015
Number 4.136, September 27th, 2012	I. 20% of income from non-tobacco activities crop 2012/2013 II. 20% of income from non-tobacco activities crop 2013/2014
Number 4.339, 20th of June 2014	I. 20% of income from non-tobacco activities crop 2014/2015
Number 4.446, November 20th, 2015	I. 20% of income from non-tobacco activities
Number 4.483, 03rd May 2016	I. 30% of income from non-tobacco activities crop 2016/2017 II. 40% of income from non-tobacco activities crop 2017/2018 III. 50% of income from non-tobacco activities crop 2018/2019
Number 4.513, August 24th, 2016	I. 20% of income from non-tobacco activities crop 2016/2017 II. 25% of income from non-tobacco activities crop 2017/2018 III. 30% of income from non-tobacco activities crop 2018/2019
Number 4.584, June 29th, 2017	Activities do not relate to tobacco

SOURCE: Brazilian Central Bank (2018).

sults is due to the support and financing of political candidates provided by such companies. They have been elected for municipal, State, and Federal offices, strengthening the representation of Congress members to defend tobacco companies' interests. Tobacco multinationals also have an essential role: obtaining credit to finance such inputs as fertilizers and agrochemicals from financial institutions and the government. Banks do not have direct contact with tobacco growers but with the companies that act as guarantors of the farmers taking the loans.

From 1999 to 2017, tobacco loans decreased from 17.6% (total number) and 16% (total value) to less than 1% (both the total number and total value) (Tables A.1 and A.2). It also shows that as from the year 2001 loans migrated from PRONAF to others. Interest rates in private rural credit lines can reach 8.5% p.a., and PRONAF's highest interest rates are 5.5% p.a. (CNA, 2017), 3% below those of the market because the government subsidizes the program's credit.

The government has not provided subsidies to tobacco production since 2001. Nevertheless, the 2017 Brazilian Agricultural Census data shows that around 94% of tobacco producers have used PRONAF for non-tobacco activities.

3. Methodology

In the method to analyze the possible effects of a more intense credit reduction on tobacco small farmers assembled by the size of the property, three variables are initially estimated:

(i) Tobacco Revenue,

(ii) Revenues from other activities (non-tobacco agriculture activities) and

(iii) the percentage of tobacco revenue. Other variables, such as Total Farms Revenue and tobacco yields, are obtained from the Brazilian Agriculture Census (2017) and Brazilian Tobacco Yearbook (2017).

In Figure 1, the basic scenario considered the profile of farmers in 2016 and the resolution nº. 4,584 that maintains the prohibition of granting credit for costs and investments for tobacco production. As previously commented, this resolution does not prohibit the granting of credit for other activities by the tobacco farmer.

The mandatory minimum production value targets (%) for agricultural products other than tobacco (as defined in alternative scenarios – Figure 1) are simulated. This restriction or rule allows the producer to continue to receive funding for other crops, such as corn, rice, and beans. It is considered to simulate the effects of resolution nº 4,483 of May 2016, which was withdrawn by pressure from the major tobacco industries. Moreover, it is also considered a more intense restriction on credit to tobacco farmers, not provided for by any previous resolution, but which simulates the effects of a more robust economic tool to control tobacco production and stimulate the diversification and environmental protection.

In general, all alternative scenarios consider that the producer maintains the production value of non-tobacco (income), simulating the area of tobacco to be reduced in each alternative scenario. From this point, each tobacco farmer can reduce the planted area of tobacco following the restrictions imposed to maintain the PRONAF credit to non-to-

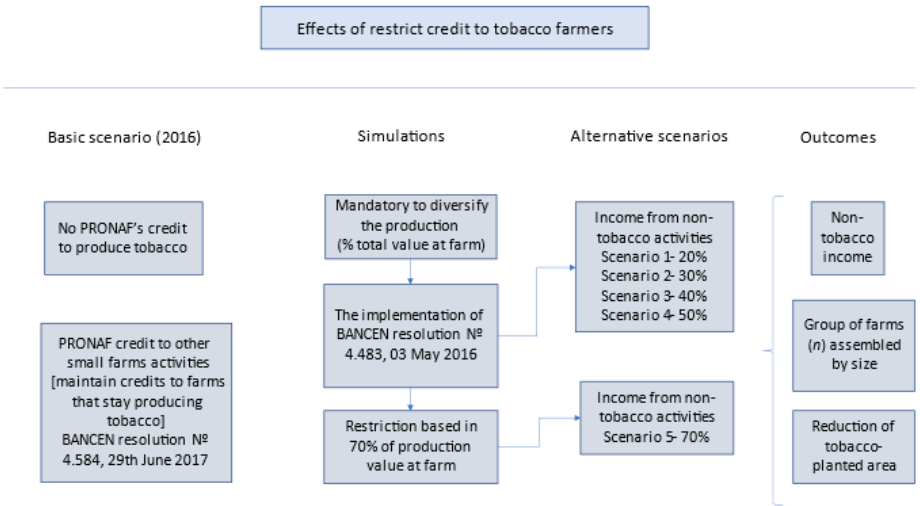

FIGURE 1 – Design of simulated restrictive credit policies for tobacco farmers.
SOURCE: authors (2022).

bacco cultures. To assess the impact of reduced financial incentives for tobacco production in Brazil, this analysis focuses on the short and medium-term effects under the assumption that farmers must maintain their production and financing decisions from the previous harvest. It is referred to as the "basic scenario" (2016) in the study.

Alternative scenarios are briefly presented in Figure 1. These scenarios are delimited based on possible alternatives to restricting PRONAF to tobacco farmers sorted by the size of the planted area. For each alternative scenario, different percentages of production value (revenue) are defined with products other than tobacco, which must be met for farmers to receive agricultural credits from PRONAF. The percentages range from 20% to 50% of revenue from non-tobacco activities, according to resolution nº 4,483. Furthermore, 70% as a target to be achieved allows a substantial diversification or less planted area of tobacco for farmers. Considering the economic importance of tobacco and the small farmers' dependence on tobacco revenue, the challenge for tobacco-restrictive policies is to provide a smooth transition to a new economy less dependent on tobacco production.

Each farm's size range comprises six groups. According to Table 2, the Agricultural Census (IBGE, 2017) confirmed that most farms (76.1%) have less than 20 hectares. Thus, most of the tobacco farms are smaller than the minimum size for agricultural holdings in the region, which is 20 hectares, according to the Brazilian National Institute of Colonization and Agrarian Reform (INCRA). Nevertheless, the same group of farmers represents 67.5% of the total area and 65.7% of the total revenue, which shows the representativeness of this group of producers for the totality of tobacco farms.

TABLE 2 – Characteristics of tobacco-producing properties according to the Brazilian agricultural census of 2017.

N	Farms size range		Number of Farms		Total Area		Total Revenue ('000)		Total Farm yields ('000)
	Inferior	Superior	(units)	(%)	(ha)	(%)	(%)	(%)	(R$/ha)
1	>0	5	28,748	26.8	42,455	14.2	595,069	12.2	14.1
2	>5	10	23,371	21.8	64,841	21.8	1,053,049	21.6	16.2
3	>10	20	29,414	27.5	93,716	31.5	1,557,933	31.9	16.6
4	>20	50	21,602	20.2	79,002	26.5	1,378,546	28.3	17.4
5	>50	100	3,059	2.8	13,571	4.5	238,967	4.9	17.6
6	>100	200	539	0.5	3,212	1.0	44,081	0.9	13.7

SOURCE: IBGE (2017).

When considering the yields of tobacco and other farm activities, it is possible to notice that tobacco yields are approximately 95% higher than the other activities (Table 3). According to the Tobacco Growers Association of Brazil (Afubra), tobacco yield in 2016/2017 was R$ 20,402 per hectare, and other activities yielded R$10,419.

TABLE 3 – Tobacco farms productivity according to the Association of Tobacco Growers of Brazil (AFUBRA) – crop 2016/2017.

Data description	Crop 2016/17
Tobacco Yields (R$/ha)	20,402
Other Activities Yields (R$/ha)	10,419

SOURCE: IBGE (2017).

Thus, to estimate the effects of the credit reduction (PRONAF) on Tobacco Area ($TobA_n$) from IBGE (2017), it is necessary to calculate: Other Activities Area (OtA_n), Other Activities Revenue (OtR_n), and Tobacco Revenue ($TobR_n$) in the different size groups of tobacco farms. Each farm group (n) is assembled by size, n= 1, 2, …, N (see Table 2).

To estimate the following equations 1 to 3, it considers the Tobacco Yield (Ty), Other Activities Yields (OtY) detailed by Afubra (see Table 3), and the Total Farm Area (TfA_n) and Total Revenue (TR_n) from IBGE (see Table 2).

The Other Activities Area (n) is calculated as a difference between Total Farm Area (n) and Tobacco Area:

$$OtA_n = TfA_n - TobA_n \qquad (1)$$

The Other Activities Revenue (n) is the result from Other Activities Area (n) multiplied by Other Activities Yield:

$$OtR_n = OtA_n * Oty \qquad (2)$$

Using Total Revenue (n) (Table 2) and Other Activities Revenue (n) (equation 2), we calculated Tobacco Revenue:

$$TobR_n = TR_n - OtR_n \qquad (3)$$

After estimating the Tobacco Revenue by farm size group, four scenarios were estimated with restriction policies, as shown below in Table 4.

Finally, it is important to highlight that for all scenarios, the main restriction is the percentage of tobacco revenue for each group of farms. As previously detailed, the ratio between tobacco and other activities revenue is constant in each scenario.

In the next section, the results show the changes in tobacco areas due to the credit restrictions (PRONAF) for each farmer group from the Brazilian Agriculture Census (2017).

4. Results and discussion

The group of tobacco producers brings together 106,733 farms in Brazil (IBGE, 2017), a Tobacco Total Area of 177,834 thousand hectares (60%), and Other Activities Total Area of 118,962 thousand hectares (40%), see Table 5. Also, these farms produced 3,628,170 thousand Reais of tobacco and 1,020,379 thousand Reais of Other Activities Revenue in 2017 (Table 5). These data reinforce the economic importance of tobacco for smallholders and the potential damage to health and the environment resulting from this activity, especially for producers in southern Brazil.

Table 5 presents the variables calculated as mentioned earlier in the methodology. The incomes from tobacco and other agriculture activities are presented for each group of farmers, and the

TABLE 4 – Alternative scenarios considering tobacco revenue constraint.

Scenario	Revenue from Other Farm Activities	Δ Tobacco Area	Description
1	20%	$= \left\{TR_n - \frac{OtR_n}{0.20}\right\} \div Ty$	Based on the PRONAF restriction. The Brazilian Central Bank Resolution N. 4.513, dated August 24th, 2016.
2	30%	$= \left\{TR_n - \frac{OtR_n}{0.30}\right\} \div Ty$	
3	40%	$= \left\{TR_n - \frac{OtR_n}{0.40}\right\} \div Ty$	
4	50%	$= \left\{TR_n - \frac{OtR_n}{0.50}\right\} \div Ty$	
5	70%	$= \left\{TR_n - \frac{OtR_n}{0.70}\right\} \div Ty$	Restriction based on the average dependence on tobacco revenue

SOURCE: authors (2022).

corresponding areas in hectares are calculated for these activities. The results confirm that the greater dependence on revenue from tobacco occurs in groups 2, 3, 4, and 5. In brief, the revenue from these properties changes between 73% and 83% of the total revenue, reaffirming the tobacco dependence, mainly in the farms that have between 5 and 100 ha (91% of the total).

It is of concern to note that the farms with tobacco activity follow a pattern that highlights the negative impact on the environment and human health. In addition, since the primary source of revenue and production area is tobacco, there is a push for more intensive use of soil, fertilizers, and pesticides. This also creates an incentive to reduce forest or reforestation areas.

The smaller tobacco income dependence occurs in the range 1 and 6, with farms from >0 to 5 hectares and >100 to 200 hectares. The income dependence is around 50% (Table 5). In groups 1 and 6, the farmer is less dependent on tobacco. For example, in group 1, it is observed that 64% of the planted area is used for other agricultural activities. For group 6, farmers have 67% of their area destined for activities other than tobacco. Consequently, these farmers are less dependent on tobacco revenue.

Table 6 shows the variation between the total area of tobacco in 2016 and the total area of tobacco after the imposition of restrictions for each scenario (by a group of farmers and total). For all scenarios, the income restriction to the whole group of producers has the expected effect of reducing the cultivated area. The total variations are from -6% in scenario 1 to -66% in scenario 4 (based on PRONAF restriction resolution) and -85% in scenario 5. In all scenarios, the most affected farmers are those with areas between 20 and 100 ha, representing 37% of the total tobacco area in the base scenario.

Scenario 1 represents the PRONAF restrictions on the tobacco revenue, with a mandatory inferior limit to other agriculture activities of 20%. In this case, the tobacco revenue is restricted to

TABLE 5 – Calculated tobacco and other cultures area and revenue by size (ha, thousand R$, %).

N	Farms size range		Tobacco area		Other Activities Area		Tobacco Revenue (‘000)		Other Activities Revenue (‘000)	
	Inferior	Superior	(ha)	(%)	(ha)	(%)	(R$)	(%)	(R$)	(%)
1	>0	5	15,299	36	27,156	64	312,131	52	282,938	48
2	>5	10	37,811	58	27,029	42	771,427	73	281,622	27
3	>10	20	58,250	62	35,466	38	1,188,409	76	369,524	24
4	>20	50	55,637	70	23,365	30	1,135,106	82	243,440	18
5	>50	100	9,774	72	3,797	28	199,403	83	39,564	17
6	>100	200	1,063	33	2,149	67	21,694	49	22,387	51
Total	---	---	177,834	60	118,962	40	3,628,170	78	1,020,379	22

SOURCE: authors based on Agriculture Census* 2017 and Brazilian Tobacco Yearbook** 2017.

80% in Scenario 1. Therefore, this scenario has not negatively affected the total area of smallholders with less than 20 ha and more than 100 ha of agricultural land (Table 6). On the contrary, these tobacco revenue restrictions have negatively affected small farms with more than 20 ha and less than 100 ha (farm groups 4 and 5), reducing 9,925 ha in scenario 1. As a result, the farm group farms 4 and 5 have reduced the area to 7,908 ha (14%) and 2,017 ha (21%), respectively.

Scenarios 2 and 3 consider a progressive rise of other agriculture revenue to 30% and 40%, constraining tobacco revenue production. In these scenarios more restrictive rules are applied to reduce the planted tobacco area by about 54,635 ha (31%) and 92,791 ha (52%), respectively (Table 6). The group most affected by these restrictions are farms with more than 50 ha and less than 100 ha in Scenarios 2 and 3. As a result, these farms reduced the total planted tobacco area by about 5,249 ha and 6,865 ha, respectively.

Scenario 4 represents the scenario with the most significant restriction among those predicted by the resolution of the Central Bank of Brazil. Scenario 4 represents the scenario with the most significant restriction among those predicted by the resolution of the Central Bank of Brazil. In this scenario, all groups of producers with an area smaller than 100 ha show a reduction in the planted area of tobacco. In scenario 4, there is a reduction in the total tobacco area of 117,115 ha (66%), respectively. The group of farmers with areas greater than 5 ha and less than 100 ha are the most affected by this restrictive policy. For example, groups 2, 3, 4, and 5 have a reduction of 63%, 69%, 79%, and 80% in the tobacco area, respectively.

Some studies show that the PRONAF policies have benefited more capitalized farmers than family

TABLE 6 – The calculated variation in planted tobacco area for five alternative scenarios.

N	Farms		Tobacco area (BOU)	Alternative Scenarios - Δ Tobacco Area based on the PRONAF restriction									
	Size range		(ha)	20%		30%		40%		50%		70%	
	Inferior	Superior		(ha)	%	(ha)	%	(ha)	%	(ha)	%	(ha)	%
1	>0	5	15.299	0	0	0	0	0	0	-1.431	-9	-9.356	-61
2	>5	10	37.811	0	0	-5.603	-15	-17.106	-45	-24.008	-63	-31.895	-84
3	>10	20	58.250	0	0	-15.988	-27	-31.081	-53	-40.137	-69	-50.487	-87
4	>20	50	55.637	-7.908	-14	-27.795	-50	-37.739	-68	-43.705	-79	-50.523	-91
5	>50	100	9.774	-2.017	-21	-5.249	-54	-6.865	-70	-7.834	-80	-8.943	-91
6	>100	200	1.063	0	0	0	0	0	0	0	0	-593	-56
	Total		177834	-9925	-6	-54635	-31	-92791	-52	-117115	-66	-151797	-85

SOURCE: IBGE, 2017 and research results.

farming, not only in tobacco culture (Souza *et al.*, 2015; Resende & Mafra, 2016). It is reported that this program's distribution is distorted among Brazilian regions and cultures (Silva Marioni *et al.,* 2016; Capellesso *et al*., 2018). The alternative scenarios' results confirm that only producers with more than 100 ha and less than 200 ha are unaffected by the imposed restrictions. Although producers with areas smaller than 5 ha are not affected by these measures in scenarios 1, 2, and 3, in scenario 4, this group of producers has a reduction of 1,431 ha (9%).

In scenario 5, not foreseen by the Resolution of the Central Bank, producers with more than 100 ha and less than 200 ha have their planted area of tobacco reduced. In this scenario, all producers suffer the impacts of restrictions on the maximum income from tobacco. Scenario 5 considers restrictions to 30% on tobacco income. For this reason, there is a strong incentive to reduce tobacco production. The negative impact is more brutal on smaller holdings with more than 5 ha and less than 100 hectares (farm groups 2 to 5). As a result, the total tobacco area decreased by 152 thousand hectares, accounting for 85% of the total cultivated area.

In brief, restrictions on tobacco income currently affect tobacco production and could be an essential policy to stimulate other agricultural activities on tobacco farms, reducing environmental impacts and health problems. Thus, restrictions equal to or more challenging than 40% of the tobacco revenue are necessary to incentivize a significant reduction in tobacco areas. Nevertheless, these results serve as an alert to policymakers regarding the potential of the PNCT.

5. Conclusions

Brazil has achieved significant progress in the reduction of cigarette consumption. However, the impact of restrictive policies on tobacco production is less discussed than the health problems. Even though the country has structured policies to diversify tobacco production, their effectiveness must be evaluated. PRONAF restrictions have changed the financing of tobacco. In 1999 the program was responsible for 86% of the loans granted to tobacco production and in 2017, for less than 1%. Moreover, producers have migrated from PRONAF to other credit lines because the government reduced the subsidies for tobacco production. The PNCT policy has been applied to reduce tobacco dependence and to stimulate non-tobacco production/revenue of other agriculture activities through the Central Bank Resolution n. 4,513.

Even with the PRONAF restrictions, rural credit is still essential to small farms; around 97% of tobacco farms use the loans for non-tobacco productions (off-season production). Consequently, the results have shown that even the less restrictive resolution has caused a decrease in tobacco areas in all scenarios. Thus, increasing other activities' revenue (as in Resolution n. 4,513) would impact mainly farm groups from 5 to 100 hectares, reducing area and revenue from tobacco.

The more restrictive the alternative scenarios are, the more significant the reduction in the tobacco area. While these policies aim to limit tobacco production, they are also expected to promote other agricultural activities to reduce dependence on tobacco. Additional policies should be implemented to encourage crops with higher added value, such

as organic agriculture. Furthermore, it is essential to establish new connections between farmers and consumers and provide funding for innovation and adopting pro-environmental technologies to increase profitability from non-tobacco sources. These efforts will help to reinforce alternative revenue streams for families and reduce their tobacco dependence.

However, it is essential to emphasize that the methodology has limitations once it uses an average non-tobacco size production. Furthermore, it is not possible to determine the specific type of tobacco (Virginia, Burley, or Oriental) that has an impact on production and the market. Considering the world's efforts to reduce tobacco consumption, it is crucial to build alternative scenarios for the producers and develop new strategies and sound environmental practices. Nowadays, even with technical diversification programs, there is no financial encouragement to produce non-tobacco crops that decrease the dependence on tobacco income. The farms cultivate temporary crops during tobacco production (off-season). Thus, with a more challenging restriction and more significant support to smallholders from the government, the Central Bank resolutions may incentivize diversification and pro-environmental behavior.

The results have been calculated by analyzing the productivity per hectare based on data obtained from the 2017 Census and Afubra. It is important to note that any changes in the productivity of tobacco crops (R$/ha) could significantly impact the results. For instance, increasing revenue per hectare of non-tobacco crops would reduce the need for credit restrictions. Conversely, if tobacco productivity per hectare increases, it would increase the need for restriction.

References

AFUBRA Database. *Associação dos Fumicultores do Brasil*. Available in: <http:// www.afubra.com.br>. Access on: jun. 2023.

AFUBRA − Associação dos Fumicultores do Brasil. Brazilian tobacco yearbook 2017. *Gazeta Grupo de Comunicações,* p. 1-128, 2017. Available in: <http:// www.afubra.com.br>. Access on: jun. 2023.

Banco Central do Brasil. *Matriz de dados do crédito rural.* Available in: < https://www.bcb.gov.br/pt-br/#!/c/MICRRURAL/>. Access on: jun. 2023.

Beach, R. H.; Jones, A. S.; Tooze, J. A. Tobacco farmer interest and success in income diversification. *Journal of Agricultural and Applied Economics*, 40(1), 53-71, 2008. doi: 10.22004/ag.econ.45045

Banco Central Do Brasil. *Legislação e normas*. Available in: < https://www.bcb.gov.br/estabilidadefinanceira/buscanormas>. Access on: jun. 2023.

Capellesso, A. J.; Cazella, A. A.; Búrigo, F. L. Evolução do Pronaf crédito no período 1996-2013: redimensionando o acesso pelos cadastros de pessoa física. *Revista de Economia e Sociologia Rural*, 56(3), 437-450, 2018. doi: 10.1590/1234-56781806-94790560305.

Catalano, M. A; Gilleski, D. B. Impacts of local public smoking bans on smoking behaviors and tobacco smoke exposure. *Health Economics*, 30, 1719-1744, 2021. doi: 10.1002/hec.4280.

Cavalcante, T. M.; Pinho, M. C. M.; Perez, M. C.; Teixeira A. P. L.; Mendes, F. L.; Vargas, R. R.; Carvalho, A. O. R.; Rangel, E. C.; Almeida, L. M. Brasil: balanço da Política Nacional de Controle do Tabaco na última década e dilemas. *Cadernos de Saúde Pública,* 33, 2017. doi: 10.1590/0102-311X00138315

CNA − Confederação da Agricultura e Pecuária do Brasil. *Guia do Crédito Rural - Safra 2017/2018.* Available in: <https://www.cnabrasil.org.br/assets/arquivos/bibliotecas/guia_do_credito_rural_versaoonline.pdf.> Access on: sep. 2018.

COMEX STAT. *Ministério da Indústria, Comércio Exterior e Serviços*. 2014. Available in: <http://comexstat.mdic.gov.br/pt/home>. Access on: set. 2018.

Costa e Silva V. L.; Fishburn B. Tobacco use and control: determinants of consumption, intervention strategies, and the role of the tobacco industry. *Toxicology*. 20;198(1-3):9-18, 2004. doi: 10.1016/j.tox.2004.01.014.

Deponti, C. M.; Schneider, S. A extensão rural e a diversificação produtiva da agricultura familiar em áreas de cultivo de tabaco no Rio Grande do Sul: o caso de Dom Feliciano-RS. *Revista IDeAS Interfaces em Desenvolvimento, Agricultura e Sociedade*, 7(2), 176-2013, 2013. Available in: < https://revistaideas.ufrrj.br/ojs/index.php/ideas/article/view/112/111.

FAO − Food and Agriculture Organization of the United Nations. Issues in the global tobacco economy: selected case studies. *Food and Agriculture Organization of the United Nations*. Rome, 2003. Available in: < http://www.fao.org/docrep/006/y4997e/y4997e00.htm>. Access on: jun. 2023.

FAOSTAT − Food and Agriculture Organization of the United Nations. *FAO Statistics Database*. Available in: <http://www.fao.org/faostat/en/#home>. Access on: jun. 2023.

FDA − US Department of Health and Human Services. *Tobacco Products Scientific Advisory Committee*: the IQOS heating system. Available in: <https://www.fda.gov/downloads/AdvisoryCommittees/CommitteesMeetingMaterials/TobaccoProductsScientificAdvisoryCommittee/UCM594323.pdf>. Access on: set. 2018.

Fortune Magazine. *Marlboro maker Philip Morris says it wants to quit cigarettes. Anti-smoking advocates are skeptical*, 2018. Available in: <http://fortune.com/2018/01/04/philip-morris-quit-cigarettes-tobacco-free/>. Access on: jun. 2023.

Goger, A.; Bamber, P; Gereffi, G. The tobacco global value chain in low-income countries. *Durham: center on globalization, governance & competitiveness*, Duke University, 1-48, 2014. doi: 10.13140/RG.2.1.2377.0080

Guilhoto, J. J. M.; Ichihara, S. M.; Azzoni, C. R.; Silveira, F. G. Comparação entre o agronegócio familiar do Rio Grande do Sul e do Brasil. *Teoria e Evidência Econômica*, 14, 9-36, 2006. Available on: < https://mpra.ub.uni-muenchen.de/38040/1/MPRA_paper_38040.pdf>.

Hendlin, Y. H; Bialous, S. A. The environmental externalities of tobacco manufacturing: a review of tobacco industry reporting. *Ambio*, 49, 17-34, 2020. doi: 10.1007/s13280-019-01148-3.

IBGE − Instituto Brasileiro de Geografia e Estatística. *Censo Agropecuário 2017*. Available in: < https://www.ibge.gov.br>. Access on: jul. 2020.

INCA − Instituto Nacional de Câncer José Alencar Gomes da Silva. Comissão Nacional para Implementação da Convenção-Quadro para o Controle do Tabaco (Conicq). *Política nacional de controle do tabaco: relatório de gestão e progresso 2013-2014*, Rio de Janeiro, p. 189, 2015. Available in: < https://www.inca.gov.br/sites/ufu.sti.inca.local/files//media/document//politica-nacional_de-controle-do-tabaco-2015.pdf >. Access on: jun. 2023.

INCRA − Instituto Nacional de Colonização e Reforma Agrária. *Classificação dos Imóveis Rurais*. Available in: < http://www.incra.gov.br/tamanho-propriedades-rurais>. Access on: jun. 2023.

Kutub, Mjr; Falgunee, N. Environmental degradation due to tobacco cultivation in Bangladesh: a case study of Doulathpur, Kushtia. *Malaysian Journal of Society and Space*, 11(7), 1-8, 2015. Available in: < http://bnttp.net/wp-content/uploads/2021/06/33344712.pdf >.

Lecours, N.; Almeida, G. E. G.; Abdallah, J. M.; Novotny, T. E. Environmental health impacts of tobacco farming: a review of the literature. *Tobacco Control*, 21, 191-196, 2012. doi: 10.1136/tobaccocontrol-2011-050318.

Levy, D.; Almeida L. M.; Szklo, A. The Brazil smoke policy simulation model: the effect of strong tobacco control policies on smoking prevalence and smoking-attributable deaths in a middle-income nation. *Plos Medicine***,** 9(11), 2012. doi: 10.1371/journal.pmed.1001336

Pinto, B. G.; Soares, T. K. M.; Linhares, M. A.; Ghisi, N. C. Occupational exposure to pesticides: genetic danger to farmworkers and manufacturing workers: a meta-analytical review. *Science of the Total Environment*, 748(15), 1-14, 2020. doi: 10.1016/j.scitotenv.2020.141382

Portes, L. H.; Machado, C. V.; Turci, S. R. Trajetória da

política de controle do tabaco no Brasil de 1986 a 2016. *Cadernos de Saúde Pública*, 34(2), 1-20, 2018. doi: 10.1590/0102-311X00017317

Prowse, M. P.; Moyer-Lee, J. A. Comparative value chain analysis of smallholder burley tobacco production in Malawi - 2003/4 and 2009/10. *Journal of Agrarian Change*, 14(3), 223-346, 2014. doi: 10.1111/joac.12022

Riquinho, D.; Hennington, E. Diversificação agrícola em localidade rural do Sul do Brasil: reflexões e alternativas de cumprimento da Convenção-Quadro para o controle do tabaco. *Physis*, Rio de Janeiro, 24(1), 183-207, 2014. Available in: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-73312014000100183&lng=en&nrm=iso>.

Resende, C. M.; Martins Mafra, R. L. Desenvolvimento rural e reconhecimento: tensões e dilemas envolvendo o Pronaf. *Revista de Economia e Sociologia Rural*, 54(2), 261-280, 2016. doi: 10.1590/1234.56781806-947900540204

Romero, C. L.; Costa e Silva, L. V. 23 Anos de controle do tabaco no Brasil: a atualidade do programa nacional de combate ao fumo de 1988. *Instituto Nacional do Câncer - INCA*. Brasília, 57(3), 305-314, 2011. doi: 10.32635/2176-9745.RBC.2011v57n3.659

Souza, P. M. De; Ney, M. G.; Ponciano, N. J. Análise da distribuição dos financiamentos rurais entre os estabelecimentos agropecuários brasileiros. *Revista de Economia e Sociologia Rural,* 53(2), 251-270, 2015. doi: 10.1590/1234-56781806-9479005302004

Taylor, A.; Chaloupka, F. J.; Guindon, E.; Corbett, M. The impact of trade liberalization on tobacco consumption *In*: Jha, P.; Chaloupka, F. (Eds). *Tobacco control in developing countries*, Oxford University Press, Oxford, 343-364, 2000. Available in: < https://portal-uat.who.int/fctcapps/sites/default/files/kh-media/e-library-doc/2019/10/Trade-Liberalization-Taylor-et-al.-.pdf>.

Teh-Wei, H.; Mao Z.; Shi, J.; Chen, W. Tobacco taxation and its potential impact in China. *Paris*: international union against tuberculosis and lung disease, 1-56, 2008. available in: < https://www.tobaccofreekids.org/assets/global/pdfs/en/China_tobacco_taxes_report_en.pdf >.

Vargas, M. A.; Campos, R. R. Crop substitution and diversification strategies: empirical evidence from selected Brazilian municipalities**.** *Health and nutrition and population (HPN), Discussion Paper, Economics of Tobacco Control nº28*. Washington DC: World Bank, 9 ed., 2005, 1-33. Available in: < http://hdl.handle.net/10986/13648>.

Vargas, M. A.; Oliveira, B. F. de. Estratégias de diversificação em áreas de cultivo de tabaco no Vale do Rio Pardo: uma análise comparativa. *Revista de Economia e Sociologia Rural*, 50(1), 157-174, 2012. doi: 10.1590/S0103-20032012000100010

Warner, K. E. The economics of tobacco: myths and realities. *Tobacco Control*, 9, 78-89, 2000. doi: 10.1136/tc.9.1.78

WHO − World Health Organization. Tobacco and its environmental impact: an overview. *World Health Organization*; 2017, 2017. Available in: < https://www.who.int/publications/i/item/9789241512497>. Access on: jun. 2023.