Chapter

Cocoa Production and Distribution in Bahia (Brazil) after the Witch's Broom

Hélio Rocha Sousa Filho, Marcos de Almeida Bezerra, Raildo Mota de Jesus and Jorge Chiapetti

Abstract

Theobroma cacao production in the state of Bahia (Brazil) suffered crises due to a combination of falling prices, the end of subsidized credit, droughts, international supply and witches' broom disease. The objective was to verify the distribution of the cocoa crop in the state of Bahia and to analyze the indicators of harvested area, production and productivity, starting from the crop crisis that started in the late 1980s. Data were collected from the Brazilian Institute of Geography database. and Statistics, period from 1988 to 2019. Cocoa production is present in 26% of the municipalities, distributed in nine economic regions, especially in the east of the state. Harvested area decreased by 30.7%, production by 65.4% and productivity by 50.1%; numbers that demonstrate the dimension of the problem. In the economic regions, there was a separation of two periods: 1988–1999 and 2000–2019. In the first, the indicators show higher numbers that decrease with the deepening of the crisis. In the second, cultivars resistant to witches' broom and new management and production techniques were implanted, measures related to the behavior of the indicators. Thus, decades after the cocoa farming crisis, increasing production and productivity levels remains a challenge.

Keywords: cocoa cultivation, agricultural production, harvested area, productivity, crisis cocoa

1. Introduction

The cocoa tree (*Theobroma cacao*) is cultivated in tropical areas. Its importance is connected to its seed, the cocoa bean, a commodity traded on international stock exchanges. Driven by the consumption of chocolate-based products, world demand for cocoa beans has been increasing in recent years [1]. In the nineteenth century, most of the cocoa produced in the world came from Latin America, from the tropical zone [2]. In recent years, statistics indicate that Africa has the highest levels of cocoa bean production in the world, followed by Central and South America, Australia, and Asia [3].

In Brazil, cocoa production cannot cover the industry's shortfall in supply, making the country's installed capacity dependent on the importation of cocoa beans [4]. The Brazilian context of insufficient production arose from a combination of factors that contributed to the cocoa production crisis [5]. Witches' broom was one such factor, being a disease of the cocoa tree caused by the *Moniliophthora perniciosa* fungus, one of the most devastating parasites for cocoa production [6]. The fungus infects the plant and leaches nutrients for its growth, in addition to affecting the fruits and causing the loss of beans [7].

After the outbreak of witches' broom on cocoa plantations in South America and the Caribbean, cocoa bean production recorded a fall of 50–90% [8]. In Brazil, witches' broom had previously been recorded in the eighteenth century in the Amazon region, although it was first recorded on cocoa plantations in Northeast Brazil, in the state of Bahia, in 1989 [9].

A crisis began in cocoa production in Bahia at the end of the 1980s, caused by a combination of events such as a drop in prices, the end of subsidized credit, droughts, increased supply from other countries, and fungal diseases. In this scenario, the spread of witches' broom throughout Bahia's cocoa crop aggravated problems in production and productivity, causing unemployment and rural exodus [10]. The fall in production also affected the cities that depended on cocoa cultivation in some way, causing a drop in the circulation of merchandise, decreased municipal tax revenue, and an increase in social problems [5]. One analysis indicated an interdependence between Brazil's cocoa production and that of Bahia, as there was a successive decline in production in Bahia between 1990 and 2004, which impacted national production [11].

Considering the cocoa crisis that began in Bahia in 1989, this study used the harvested area, production, and productivity indicators to investigate the impacts the crisis caused on the cocoa crop. According to the literature, indicators are tools of investigation, measurement, and information on the state of a system, and may be applied to understanding phenomena or processes, managing complex issues, and in decision making [12, 13].

In the context presented above, it is relevant to understand the panorama of cocoa culture in Bahia in the last three decades, after the outbreak of witches' broom, which is one of the factors that most contributed to the decrease in Brazilian cocoa production [10, 11]. On a global level, it is important to gather information on the evolution of cocoa cultivation after an agricultural crisis, especially in Bahia, Brazil, one of the most traditional and most important cocoa-producing regions in the world [14]. The behavior of the indicators may indicate appropriate strategies for crop recovery and the construction of policies that enhance the development of cocoa culture, since positive results in agriculture are drivers of improved quality of rural life [13]. Thus, this study aimed to verify the distribution of cocoa culture in the state of Bahia and analyze the harvested area, production, and productivity indicators, from the crop crisis that began at the end of the 1980s.

2. Material and methods

The cocoa-producing municipalities in the state of Bahia in Northeast Brazil made up the study area. The cultivation of cocoa is of great economic and social importance for Bahia, which is one of the main cocoa producers in Brazil. Economic division of the regions was adopted for the analysis, according to Law no. 6.349 of

17th December 1991, which divided the state into fifteen regions and was adopted by the Superintendência de Estudos Econômicos e Sociais da Bahia (Superintendence of Economic and Social Studies of Bahia) [15]. This division was chosen because it groups the municipalities by economic and commercial characteristics, whereby one or various productive activities identify and determine regional potential [16, 17]. Thus, it may be possible to establish in which regions cocoa culture has the greatest representation.

Information was collected from a database, based on publications by the Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics) (IBGE). Information from the Produção Agrícola Municipal (Municipal Agricultural Production) (PAM) survey, which provides data on a municipal, state, and national scale, was also used. The PAM survey is carried out on all production units wholly or partially dedicated to agriculture or livestock. This research is the result of a monthly systematic agricultural survey of annual consolidation [18]. Harvested area, quantity produced (production), and mean yield (productivity) of the permanent cocoa crop in beans, in the municipal and state territories, were selected as indicators. These three indicators were chosen for their availability of access to a chronological series of data. The time frame analyzed was between 1988 and 2019, totaling 32 years. This time frame is from the year before witches' broom was recorded in Bahia up to the last year in which consolidated data are available.

To carry out the analyses, data on harvested area (hectare), production (tons), and productivity (kilogram per hectare) were initially accessed through Table number 1613 of the PAM survey, via the IBGE system of Automatic Recovery. The consolidated values of the variables on state level basis from the database were used in the analysis. Subsequently, the cocoa-producing municipalities in Bahia were selected and classified according to economic region. After this stage, annual values of each of the harvested area, production and productivity indicators of each economic region were calculated, resulting in matrices of 32 × 3, displaying the 32 years observed as rows and the three indicators as columns. The data were auto-scaled and subjected to principal components analysis (PCA). This exploratory method was applied for its capacity to reduce the dimensions of the data and identify inter-relationships between the observations and variables [19]. Execution of the principal components analysis (PCA) will establish patterns of behavior for the indicators, highlighting similarities and/or differences in the evolution of agricultural activity in the regions. Analysis calculations were executed using Past software (Hammer Copyright. 2018, version 3.2, NOR).

3. Results and discussion

The state of Bahia has 417 municipalities, with cocoa production being distributed in 26% of these municipalities (**Table 1**). The data also show growth of around 17% in the quantity of cocoa-producing municipalities when comparing 1988 and 2019. This demonstrates resilience in cocoa cultivation in this period, even with the drop in bean prices, the end of subsidized agricultural credit, and the emergence and spread of witches' broom, which contributed to the third major crisis of the sector [11].

In 1979, the Comissão Executiva do Plano da Lavoura Cacaueira (Executive Commission of the Cocoa Tree Crop Plan) (CEPLAC) carried out a survey on the distribution of the cocoa area in Bahia and its production. In this study, it was found that the cocoa cultivation was present in 83 municipalities, in seven sub-regions, and that some municipalities had the potential to expand their cultivated areas [20].

Region	Municipalities			
	Cocoa producer in 1988	**Cocoa producer in 2019**	**Producer and non-producer in 2019**	**P/T 2019* (%)**
Metropolitana de Salvador	1	1	10	10
Litoral Norte	1	1	20	5
Recôncavo Sul	17	20	33	60
Litoral Sul	47	52	53	98
Extremo Sul	13	18	21	85
Sudoeste	14	17	39	43
Nordeste	0	0	47	—
Paraguaçu	2	0	42	—
Baixo Médio São Francisco	0	0	8	—
Piemonte da Diamantina	0	0	24	—
Irecê	0	0	19	—
Chapada Diamantina	0	1	29	3
Serra Geral	0	0	33	—
Médio São Francisco	0	1	16	6
Oeste	0	1	23	4
State total	95	112	417	26

**P/T 2019: percentage of cocoa-producing municipalities in 2019.*

Table 1.
Distribution of the number of cocoa-producing municipalities in the economic regions of Bahia (1988–2019).

According to the most current data from 2019, cocoa production was recorded in nine economic regions in Bahia.

The Litoral Sul and Extremo Sul regions have the highest percentages of cocoa-producing municipalities, with 98% and 85%, respectively. This demonstrates the representativity and importance of cocoa in this part of the state. When examining the history of cocoa in Bahia, it can be noted that a high number of cocoa-producing municipalities are concentrated in these regions. This is not by chance, as cocoa culture began in the south of the state [11]. Another stand-out region is Recôncavo Sul, with cocoa production in more than half of its municipalities, demonstrating that cocoa is also a representative crop of the economy of this region.

The cocoa production record in the municipalities of the Chapada Diamantina, Médio São Francisco, and Oeste regions is relevant data, as they are regions without a tradition of cocoa culture. Trying to make cocoa production viable in these regions may constitute escape zones for cocoa tree diseases, expansion to new production centers, and an opportunity to increase production and generate jobs and income [21]. In addition, it enables crop diversification with the perspective of becoming a new vector of local development.

Analysis of the spatial distribution of the cocoa-producing municipalities in the regions of Bahia, demonstrates that cocoa cultivation is predominant in the east of

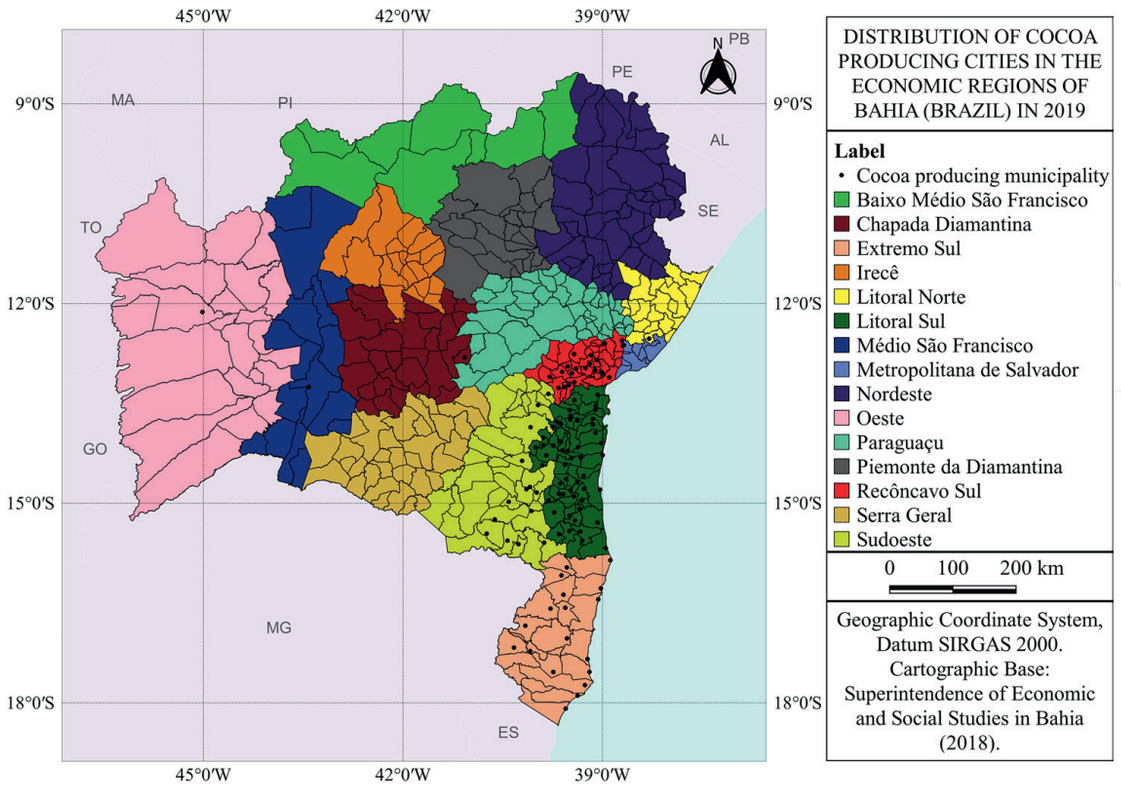

Figure 1.
Location of the 15 economic regions of the state of Bahia and distribution of the cocoa-producing municipalities in 2019.

the state, in the humid zone, in a strip close to the coast (**Figure 1**). This is due to the existence of edaphoclimatic conditions, and processing and exportation infrastructure that favor cocoa production activity [10, 22].

The edaphic and climatic conditions in the south of Bahia are beneficial for cocoa cultivation, as the plant grows in fragments of native forest, in the shade of big trees, with adequate rainfall and deep soils [4, 23]. These conditions contributed to the dissemination of the cocoa tree in the Extremo Sul region, as well as expansion to the municipalities of the humid zone of the Recôncavo Sul and Sudoeste regions.

Starting in 2010, with research and increased technology, experimental areas and cocoa production were created in municipalities in the Chapada Diamantina, Médio São Francisco, and Oeste regions, which do not have naturally favorable edaphoclimatic conditions [24]. Cocoa cultivation was implanted in the humid and sub-humid transition zone and in semi-arid locations. This new expansion is due to irrigated cocoa tree cultivation with sun exposure, the adoption of agronomic management of high technification, and highly productive cloned cultivars resistant to fungal diseases [24].

In recent years, CEPLAC has recommended integrated management in the control of fungal diseases of cocoa trees such as witches' broom, the main pest affecting cocoa plantations in Bahia. The strategies that make up integrated management of witches' broom are culture control, chemical control, biological control, and the insertion of genetically enhanced cultivars [25]. The integrated approach has assisted in production continuity [14]. The large-scale adoption of these strategies may positively interfere in cocoa culture indicators in the producing regions.

Until the mid-1980s, the state of Bahia produced 400 thousand tons of cocoa [14, 26]. Between 1988 and 2019, graphic analysis of the data on the harvested area,

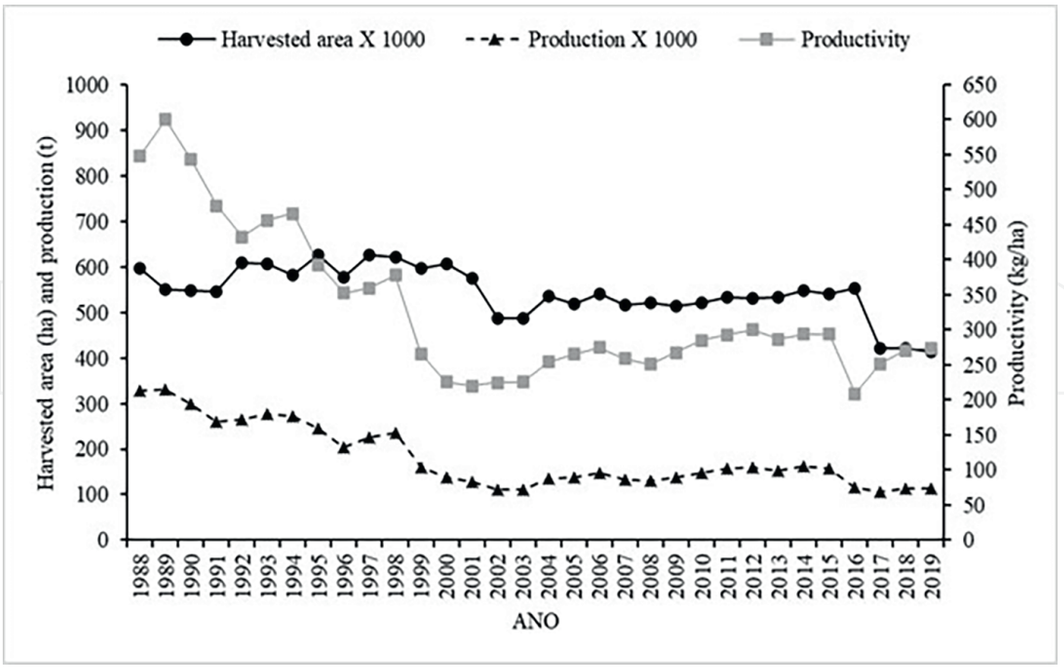

Figure 2.
Evolution of the harvested area, production, and productivity indicators of the cocoa crop in the state of Bahia, between 1988 and 2019. Harvested area (scale of 0–700,000 hectares); production (scale of 0–400,000 tons) and productivity (scale of 0–650 kilograms per hectare).

production, and productivity indicators demonstrates the occurrence of variations and lower final numbers (**Figure 2**). Although witches' broom is indicated as the main cause of these alterations in the 1990s, other factors contributed significantly, such as the fall in the supply of subsidized agricultural credit and the decrease in the price per ton of cocoa beans in the 1980s and 1990s [27].

The harvested area indicator shows a reduction of around 8% in the first four years. From 1992 onwards, there are positive and negative fluctuations, with a general decrease until 2002, when a value of 487 thousand hectares was recorded. From then on, there was an increasing trend until recording 553 thousand hectares in 2016, although this fell value to 413 thousand hectares in 2019. In addition to the fluctuations in harvested area, it decreased by 30.7% between 1988 and 2019.

The production indicator showed a reduction of 66%, between 1988 and 2002. From 2003 onwards, there is a trend of growth until 2015. However, in 2019 production decreased again, recording around 113 thousand tons, which is a fall of 65.4% in relation to 1988. It should be highlighted that despite the reduced production in periods of crisis, cocoa continues to be one of the main agricultural products in the south of Bahia [28].

In the mid-1990s, the decline in cocoa production in Bahia and the need to renew cocoa plantations led the federal government to launch the Cocoa Crop Recovery Program. This program offered credit for producers to invest in recovering plantations and controlling witches' broom. Government technical bodies recommended measures to combat witches' broom disease: phytosanitary pruning, fungicide application, biological control and replanting of cocoa plantations, using clones of resistant cultivars [23].

The productivity indicator showed an increase between 1988 and 1989, from 549 kg/ha to 600 kg/ha. Productivity then decreased to a certain level between 2000 and 2003, recording around 226 kg/ha. Despite oscillations, from 2003 onwards,

there was a general trend of increase until 2015. In 2016 production decreased to 209 kg/ha, the lowest recorded yield, this year falling within the period of one of the most severe droughts in Bahia's history, whereby rainfall levels fell below the average, resulting in negative consequences for agriculture and livestock in general [29]. In 2019, productivity reached 274 kg/ha; however, compared with 1988, this is a decrease to the order of 50.1%.

Analysis of the production and productivity indicators shows a positive trend from the beginning of the 2000s, which coincides with the start of the movement substituting traditional cultivars for clones resistant to witches' broom [30]. In the 2000s, CEPLAC started a program of cocoa tree improvement in Bahia that resulted in highly productive cultivars that were resistant to the disease [31].

The cocoa culture problems in Bahia are dealt with on various fronts, with the aim of recovering the losses caused by the crisis. One of the initiatives observed is production for the fine aroma cocoa market, which already has 50 local brands of chocolate in the south of Bahia [10]. This market pays a higher value for cocoa beans in relation to traditional production; however, the production of fine aroma cocoa requires the selection of plant varieties and special care in the ripening, harvest, and post-harvest of the cocoa. This is all done with the aim of achieving distinctive sensory characteristics of aroma and outstanding flavor [32].

The evolution of the cocoa crisis certainly did not affect the harvested area, production, and productivity indicators in the same way or at the same time in all the cocoa-producing regions of Bahia. Thus, through the principal components analysis (PCA), it was possible to observe the interactions between the three indicators as well as the relationships between the observations from 1988 to 2019 (**Figure 3**). Among the ten cocoa-producing regions of Bahia, Chapada Diamantina, Médio São Francisco, and Oeste did not have enough data to be included in the analysis, as production in these regions only began in 2010.

In the Metropolitana de Salvador region, the two PCs (first two components) explain 99.64% of the total variation. PR (production) and PD (productivity) contribute the most to PC1 (first component); HA (harvested area) has the largest contribution to PC2 (second component). The biplot graph for PC1 versus PC2 demonstrates a trend towards separation of 1988 to 1999 from 2000 to 2019. In PC1, the positive vectors of HA, PR, and PD are more related to the period of 1988 to 1999. The results indicate that in most of the period between 1988 and 1999 the indicators were higher (**Figure 3a**).

In the Litoral Norte region, the two PCs explain 99.76% of the total variation (**Figure 3b**). HA and PR contribute the most to PC1; PD has the largest contribution to PC2. The biplot graph for PC1 versus PC2 demonstrates a separation of 1988 to 1999 from 2000 to 2019. In PC1, the positive vectors of the three variables are related to the period of 1988 to 1999, in addition, the lower distance between the HA vector and PR indicates a greater correlation between the two indicators. The data demonstrate that the indicators were higher between 1988 and 1999.

In the Recôncavo Sul region, the two PCs explain 99.67% of the total variation (**Figure 3c**). HA and PR contribute the most to PC1; PD has the largest contribution to PC2. The biplot graph for PC1 versus PC2 demonstrates a separation of 1988 to 1989 from 1990 to 2019. In PC1, the positive vectors PR and PD are more related to 1988 and 1989. The data indicate less variation of the indicators between 1990 and 2019 and higher values.

In the Litoral Sul region, the two PCs explain 99.92% of the total variation (**Figure 3d**). PR and PD contribute the most to PC1; HA has the largest contribution

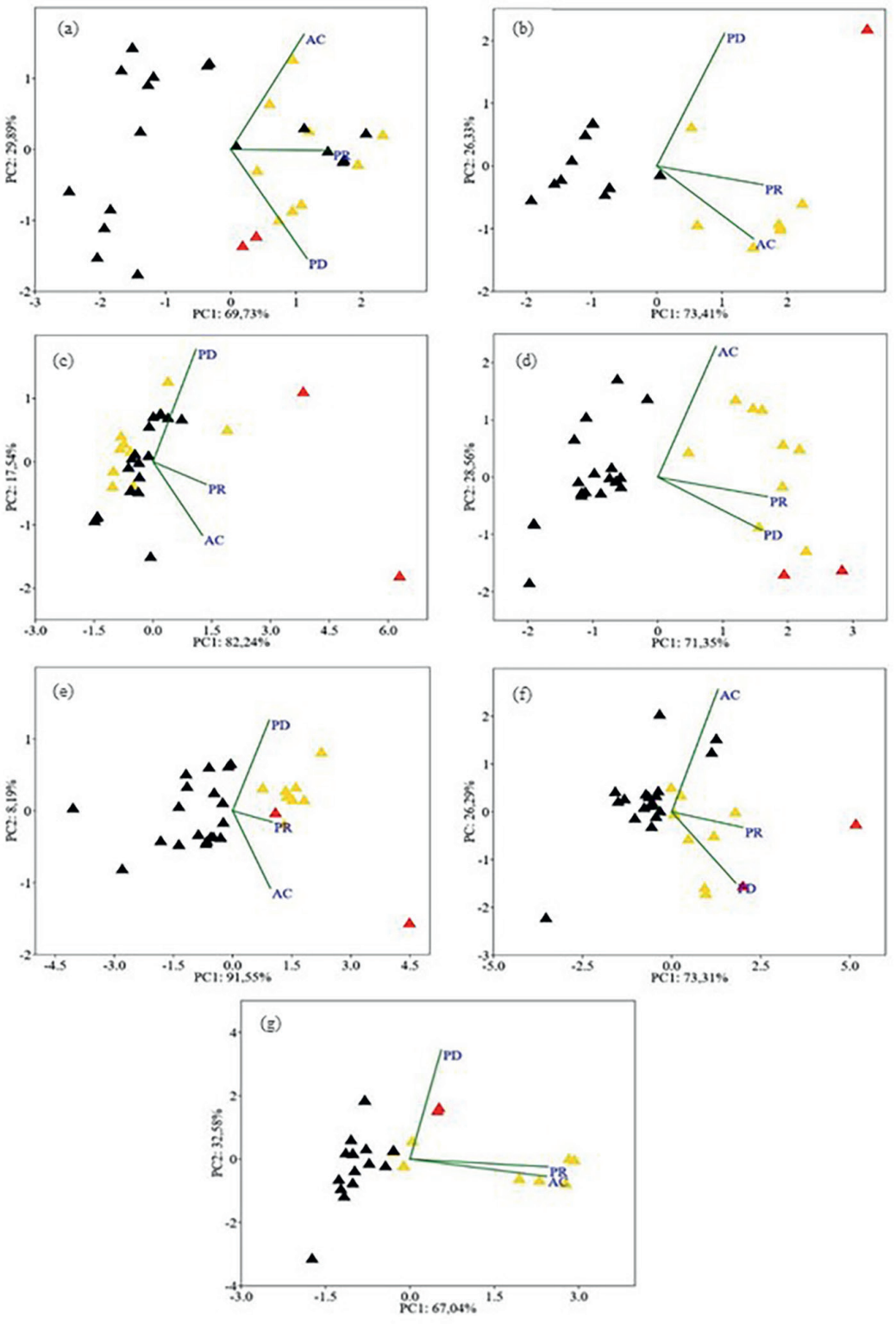

Figure 3.
Principal components analysis carried out on cocoa crop indicators in seven economic regions in the state of Bahia, from 1988 to 2019 (▲1988–1989; ▲1990–1999; and ▲2000–2019). Data from the Produção Agrícola Municipal (Municipal Agricultural Production) survey of the IBGE, using three indicators, HA: harvested area; PR: production; PD: productivity. On the graphs for (a) região Metropolitana de Salvador, (b) Litoral Norte, (c) Recôncavo Sul, (d) Litoral Sul, (e) Extremo Sul, (f) Sudoeste, and (g) Paraguaçu the first two principal components (PC) are demonstrated and explain approximately 95% of the data variability in all the analyses.

to PC2. The biplot graph for PC1 versus PC2 demonstrates a separation of 1988–1999 from 2000 to 2019. In PC1, the positive vectors HA, PR, and PD are related to the period of 1988–1999, in addition, the lower distance between the PR vector and PD indicates a greater correlation between the two indicators. The data demonstrate that the indicators were higher between 1988 and 1999.

In the Extremo Sul region, the two PCs explain 99.71% of the total variation (**Figure 3e**). HA and PR contribute the most to PC1; PD has the largest contribution to PC2. The biplot graph for PC1 versus PC2 demonstrates a separation of 1988–1999 from 2000 to 2019. In PC1, the positive vectors HA, PR, and PD are related to the period of 1988–1999. It can also be seen that from 1990 to 1999 the points are much more clustered, indicating proximity of the values. The data demonstrate that the indicators were higher between 1988 and 1999.

In the Sudoeste region, the two PCs explain 99.64% of the total variation (**Figure 3f**). PR and PD contribute the most to PC1; HA has the largest contribution to PC2. The biplot graph for PC1 versus PC2 demonstrates a trend towards separation of 1988–1999 from 2000 to 2019. In PC1, the positive vectors of PR and PD are more related to the period of 1988–1999, while the HA vector is close to some points from the 2000s. The data demonstrate that in 1988, 1989, and some years from the 1990s, the indicators were higher than the period to 2000–2019.

In the Paraguaçu region the two PCs explain 99.61% of the total variation (**Figure 3g**). HA and PR contribute the most to PC1; PD has the largest contribution to PC2. The biplot graph for PC1 versus PC2 demonstrates a separation of 1988–1999 from 2000 to 2019. In PC1, the positive vectors HA, PR, and PD are more related to the period of 1988–1999, in addition, the lower distance between the HA vector and PR demonstrates a greater correlation between the two indicators. The data demonstrate that the indicators were higher between 1988 and 1999.

In summary, the PCAs carried out on the data on the harvested area, production, and productivity indicators of the cocoa crop, separated or tended to separate the Metropolitana de Salvador, Litoral Norte, Litoral Sul, Extremo Sul, Sudoeste, and Paraguaçu regions into two periods. The first period between 1988 and 1999 is made up of the years following the beginning of the crop crisis, where the values of the indicators are higher and suffer a decrease over the years. In the second period, between 2000 and 2019, the numbers remain lower than in the first period, demonstrating that the productive activity of cocoa did not manage to recover.

In the Recôncavo Sul region, the PCA demonstrates that the data from the 1990s and the 2000s are close (**Figure 3c**), without apparent visual separation. This indicates that in this region, the variation in the harvested area, production, and productivity indicators occurred differently to the other regions, which leads to the inference that the crisis affected the three indicators in the Recôncavo Sul region differently in comparison to the other regions.

Growth rates for the harvested area, production, and productivity indicators were estimated based on the separation of the data into two periods indicated by the principal components analysis. For the harvested area, the growth rate demonstrated that there was a decrease in almost all the regions (**Table 2**). The reduction in the areas with cocoa may be explained by abandonment and substitution of the crop, as with the incidence of witches' broom and all the other previously cited events, maintaining the crop area became a challenge for producers.

The Metropolitana de Salvador, Litoral Sul, and Recôncavo Sul regions were those that had a positive growth rate for the harvested area indicator in at least one period

Region	Harvested area (hectare)					
	Year 1988	Year 1999	GR88/99*	Year 2000	Year 2019	GR00/19* (%)
M. de Salvador	370	684	85%	617	160	−74
L. Norte	250	159	−36%	108	12	−89
R. Sul	56.240	15.597	−72%	15.405	26.266	71
L. Sul	417.052	502.678	21%	509.155	345.131	−32
E. Sul	90.056	53.046	−41%	54.948	27.691	−50
Sudoeste	32.308	25.542	−21%	26.520	13.735	−48
Paraguaçu	113	83	−27%	82	0	−100

**GR: growth rate.*

Table 2.
Growth rate of the harvested area of the cocoa crop in regions of Bahia (1988–2019).

(**Table 2**). The literature reports that between 1990 and 2004 the advance of witches' broom in 41 municipalities of the Litoral Sul region was not reflected in widespread abandonment or substitution of cocoa for other crops [11]. Regarding the Recôncavo Sul region, it should be pointed out that it is located between humid, sub-humid, and dry climate zones, which may have inhibited the incidence and distribution of witches' broom [23].

The production indicator also had a negative growth rate in most regions. Between 1988 and 1999, the Metropolitana de Salvador region was the only region that presented growth (**Table 3**). In absolute terms, this region has one of the lowest expressions in cocoa production, which may be why this growth has not been considered of great relevance to the general panorama.

Region	Production (tons)					
	Year 1988	Year 1999	GR88/99*	Year 2000	Year 2019	GR00/19*
M. de Salvador	222	386	74%	357	79	−78%
L. Norte	150	55	−63%	33	4	−88%
R. Sul	35.995	6.602	−82%	6.781	9.760	44%
L. Sul	234.035	128.154	−45%	105.326	92.469	−12%
E. Sul	37.115	16.405	−56%	17.124	6.855	−60%
Sudoeste	19.989	7.697	−61%	7.918	3.820	−52%
Paraguaçu	56	29	−48%	29	0	−100%

**GR: growth rate.*

Table 3.
Growth rate in cocoa tree production in regions of Bahia (1988–2019).

In the Recôncavo Sul region, a positive growth rate is observed between 2000 and 2019 (**Table 3**). A study on cocoa culture in municipalities in this region indicated that the cocoa crisis at the end of the 1980s was not as intense as in the South of Bahia, as, among other reasons, cocoa culture in Recôncavo Sul was intercropped with food crops, differently to the cocoa monoculture in other regions [33]. On this point, it has been suggested that there is a relationship between agricultural crop diversity in a determined region and cushioning of the cocoa crisis.

The Litoral Sul region, the largest cocoa-producing region of Bahia and the most traditional cocoa culture, had a negative growth rate in both periods (**Table 3**). In this region, one of the factors that affected the decrease in production was alteration of the agrarian structure between 1988 and 2017. The cocoa crisis intensified agrarian processes with occupations of farms, the creation of settlements, and some of the old cocoa farms being taken over by squatters [11]. In this context, these small producers were unable, for various reasons, to achieve the level of production of the old farms and maintain the necessary farming practices.

In general, in the 1988/1999 period, all the regions had a negative growth rate for the productivity indicator (**Table 4**). The literature indicates that from the 1990s there was a decrease in productivity of the cocoa crop in Bahia associated with the reduction in agricultural credit, which hampered the use of inputs and farming practices by the farmers [27]. In addition, the witches' broom outbreak at the end of the 1980s also contributed, as it negatively impacts cocoa productivity [23, 34].

In the 2000/2019 period, it was found that only the Litoral Norte and Litoral Sul regions had a positive growth rate for productivity (**Table 4**). Regarding the Litoral Sul region, it should be highlighted that the action of research centers installed in the region may be related to this growth in productivity. CEPLAC, for example, invested in genetic improvement of the cocoa tree in seeking to overcome witches' broom and improve productivity. The renovation of crops with resistant cultivars was implemented and spread among farmers, being indicated as the measure that most created the real possibility of crop recovery [30]. In recent years, superior varieties resistant to witches' broom, if well managed, can reach over 1000 kg/ha/year [35].

Region	Productivity (kg/ha)					
	Year 1988	Year 1999	GR88/99*	Year 2000	Year 2019	GR00/19*
M. de Salvador	600	564	–6%	578	494	–15%
Litoral Norte	600	345	–43%	305	333	9%
Recôncavo Sul	640	423	–34%	440	372	–15%
Litoral Sul	561	254	–55%	206	268	30%
Extremo Sul	412	309	–25%	311	248	–20%
Sudoeste	618	301	–51%	298	278	–7%
Paraguaçu	495	349	–29%	353	0	–100%

**GR: growth rate.*

Table 4.
Productivity growth rate of the cocoa tree crop in regions of Bahia (1988–2019).

4. Conclusions

Up to 2019, cocoa production was present in 26% of the municipalities in the state of Bahia, distributed across 60% of the economic regions. The analysis also demonstrated that between 1988 and 2019, the number of cocoa-producing municipalities increased from 95 to 112, growth of around 17%. These data express the resilience of cocoa culture in Bahia, given the crisis caused by a combination of events at the end of the 1980s.

Examination of the harvested area, production, and productivity indicators indicates that the cocoa culture crisis considerably affected cocoa activity in the state. Comparing 1988–2019, the harvested area decreased 30.7%, production fell 65.4%, and productivity was reduced by 50.1%. These numbers demonstrate the extensive scale of the problem and indicate the need to confront the cocoa crisis on various fronts.

Among the cocoa-producing regions of Bahia, the highest percentages of cocoa-producing municipalities are in Litoral Sul, Extremo Sul, and Recôncavo Sul, with 98%, 85%, and 60%, respectively. This demonstrates the importance of cocoa culture as an agricultural activity that identifies these regions and generates revenue. This merits attention from government bodies connected to agriculture, through decentralized regional development policies and actions. The Chapada Diamantina, Médio São Francisco, and Oeste regions should also be highlighted for beginning cocoa production in areas outside the humid climate zone, which may constitute a promising expansion of cocoa culture with the potential to generate jobs and revenue.

Data analysis on a regional scope also demonstrates that in six economic regions the data separate, or tend to separate, two periods, from 1988 to 1999 and from 2000 to 2019. In the first period, the harvested area, production, and productivity indicators have higher numbers, although they decrease with the deepening of the events that caused the crisis. In the second period, there is the implementation of cultivars resistant to witches' broom and the adoption of new management and production techniques, combat measures that are related to the behavior of the indicators. In the Recôncavo Sul region, the data do not present an apparent separation between the two periods, which indicates that in this region the harvested area, production, and productivity indicators were affected differently by the crisis in comparison to the other regions.

It is concluded that decades after the cocoa crop crisis in Bahia, there remains the challenge of increasing levels of production and productivity, expanding the crop to new regions, and recovering traditional producers.

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Conflict of interest

The authors declare no conflict of interest.

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