e-ISSN 2007-3496 *América Latina en la Historia Económica*, *30*(2), 2023, 1-35

http://dx.doi.org/10.18232/20073496.1374

Articles

The complex evolution of Brazilian cotton production

La compleja evolución de la producción algodonera brasileña

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Abstract. Today Brazil is the world's second leading source of cotton, reprising the role it played for a brief time in the early 19th century. But this history of its production is a complex one of both growth and stagnation, and includes profound changes in the types of cotton exported and where and how it was produced. It went from being a product of small farmers to one grown primarily on large estates. Our essay explores these changes over time and offers an analysis of how production shifted from the Northeast to the Southeast and ended finally in the Center-West of the country and why it went from a being net importer of cotton to a major exporter in just the past thirty years.

Keywords: cotton; international commerce; agriculture.

Resumen. Hoy, Brasil es la segunda fuente mundial de algodón, retomando el papel que desempeñó durante un breve periodo a principios del siglo XIX. Pero esta historia de su producción es compleja, tanto de crecimiento como de estancamiento, e incluye cambios profundos en los tipos de algodón exportados y dónde y cómo se producía. Pasó de ser un producto de pequeños agricultores a uno cultivado principalmente en latifundios. Nuestro ensayo explora estos cambios a lo largo del tiempo y ofrece un análisis de cómo la producción se desplazó del nordeste al sudeste y terminó finalmente en el centro-oeste del país y por qué pasó de ser un importador neto de algodón a un gran exportador en tan solo los últimos 30 años.

HOW TO CITE: Klein, H. y Vidal, F. (2023). The complex evolution of Brazilian cotton production. *América Latina en la Historia Económica*, *30*(2), 1-35. DOI: 10.18232/20773496.1374

Palabras clave: algodón; comercio internacional; agricultura.

JEL: N56; N76.

Received: may 29th, 2022.
Accepted: june 13th, 2022.
Published: march 6th, 2023.

Introduction

In the twenty first century Brazil has emerged as the world's second largest exporter of cotton. This sudden expansion of national production represents the third distinct cycle in the history of cotton cultivation in Brazil whose cultivation preceded the arrival of the Europeans and would end with Brazil becoming a major world exporter. Our survey of this history is based on an extensive documentary and statistical review of the information on cotton cultivation in Brazil from the 18th century to the present. This review has allowed us to observe the different stages through which this crop has passed. It uses a regional historical approach and has as fundamental variables: the change and displacement of the production regions over time, the characteristics of the type of cotton that is grown and marketed, the dynamics between production for the internal and external market, as well as the characteristics of the type and size of producers. We also evaluated other intervening variables such as the relationship between growth and stagnation of production, the causes that originate the end of each stage, cultivation practices, production amounts, and production value, by region and over time.

At the end of the 18th century Brazil was the world's largest exporter of *Gossypium barbadense* (also known as arboreal or bush cotton) with production concentrated in two northeasters states. Brazil's importance in international exports went into relative decline as United States production of *Gossypium hirsutum* (also known as herbáceo or upland cotton), entered the market in the late 18th and early 19th century. But during the "cotton famine" crisis of the US Civil War in the 1860s, Brazil re-emerged again as a major world producer. Thereafter the Northeastern producers maintained a relatively stable volume of exports with a final boom in exports occurring before and after World War I.

The next phase of cotton production would occur after World War I. As early as the 1870s upland cotton began to be grown in São Paulo, but that state would not become the dominant producer until the 1930s. This shift in centers of production and in the type of cotton produced was also reflected in changes in consumption. By the 1930s the primary consumption of cotton was the internal market and Brazil's expanding textile and clothing industries, although the country still maintained modest exports. But this period ended in the 1980s as disease and the end of tariff protection reduced production to such an extent that Brazil could no longer supply even its internal market and it became a major importer of cotton in the 1990s. At the same time significant production of bush cotton in the northeast came to an end and even the small southern and southeastern farms producing upland cotton began to decline. In the decade of the 1990s Brazil for the first time in its history become a significant importer of cotton.

The third and final period in this history of Brazilian cotton production occurred at the beginning of the twenty-first century when Brazilian farms again began to grow cotton, but this time in the newly developed region of the Center-West where thousand-hectare cotton farms became

the norm. Today Brazil is currently the fourth largest grower of cotton in the world, surpassed by India, China and the United States and is also a major consumer of the product for its extensive textile sector. It is now the second leading world exporter of the product, shipping about 9 000 000 bales, against 15 000 000 sent into the world market by the United States. How this recent expansion occurred and how it relates to earlier periods of growth is the central theme of this essay.

Phase 1

This phase can be said to have begun before the arrival of Portuguese colonists in Brazil, since they adopted the native American *Gossypium barbadense* plant as their source for cotton. Wild cotton plants pre-date modern man, with several varieties scattered around the world, and there were several different continental centers where the plant was domesticated (Wendel, Brubaker, Alvarez, Cronn & Stewart, 2009). Both in the American continent and in Asia there is evidence of domesticated cotton since at least 6 000 years ago and complete textiles date from at least 3 000 years BC. In coastal Peru cotton of the *Gossypium barbadense* variety, sometimes called kidney cotton for the shape of its pods, or bush cotton for its growth on small trees or bushes, was cultivated as early as 2 500 BC (Stephens & Moseley, 1974, p. 110). In Brazil there is evidence of its use by the Native Americans in western South America prior to the arrival of the Portuguese (Amaral, v. II, 1958; Souza, 1851, p. 126). In turn East Indian produced cotton cloths were to be found throughout Eurasia since the beginning of the Christian era, and already by the 15th century East Indian cotton was well known in Europe and would became a staple in Portuguese world trade (Riello, 2013).

Thus, cotton was cultivated by the Portuguese from the earliest period of colonization. In this first phase the dominant plant was the *Gossypium barbadense* which in the Guianas and Brazil obtained two crops per annum and usually remained productive for five to six years (Baines, 1835, pp. 290-291). It produced an extra-long staple cotton and was initially highly desired in the first cotton weaving looms of Europe.[1] Already in the 16th century Brazilian cotton lint was being imported into northern European markets.[2] But its major growth came in the 18th century with the direct support of the Portuguese government. To settle the northern frontier of its colony the Portuguese government under Pombal established two merchant monopoly companies. The Companhia Geral do Comércio do Grão-Pará e Maranhão was founded in 1755 to develop Maranhão, and the Companhia Geral de Pernambuco e Paraíba was established four years later to promote the further expansion of production in Pernambuco. These private merchant companies were given monopolies over slave imports and cotton exports. While cotton produced by African slave labor dominated in the Maranhão province and began with the merchant company support, in the case of Pernambuco cotton was already being produced by small free farmers well before the establishment of the company (Carreira, 1988; Diegues Jr., 1950; and Martins & Melo, 2018). It would appear that Maranhão began exporting cotton before Pernambuco, and that this began in

[1] "The European water frame permitted the production of a cotton yarn strong enough to be used as warp, a longer longitudinal thread. Warps allowed cloth to be made entirely with cotton but required a longer cotton fiber than a fiber imported from Eastern Europe and Asia" (Pereira, 2017, pp. 11-12).

[2] The chronicler Gabriel Soares de Souza mentioned a shipment of sugar and cotton leaving from Bahia in the 16th century (Souza, 1851, p. 126). On early Brazilian cotton imports into Europe, see Wadsworth & Mann (1931, p. 23).

the 1770s on an annual basis, whereas Pernambuco did not enter the trade on a serious basis until the 1790s.[3] Maranhão remained the primary exporter and over two thirds of its exports went to England throughout most of the 19th century.[4]

Brazil, of course, was not the only American region producing cotton and until the 1780s the British imported most of their American produced cotton from the French West Indies. But the growing conflict with France and the slave uprisings in Saint Domingue in 1791 led the British to seek new American imports and they turned to Brazil as a major supplier (Krichal, 2013, pp. 17, 20). The first Brazilian cotton imported into England seems to have occurred in 1781. [5] Already in the year 1786 some 2 000 000 out of the 20 000 000 tons of cotton imported into England came from Brazil (Baines, 1835, p. 304). By the next year it exported some 2 500 000 tons (Donnell, 1872, p. 43). The first cotton from the United States also appeared to have been first imported in the 1780s and it became significant by the 1790s (Baines, 1835, p. 302). Both the United States and Brazil thereafter were among the principal foreign suppliers for cotton for the British textile industry for most of the 19th century.[6]

Initially Brazil's production of long-fiber cotton was considered of better quality than short fiber of the so-called upland cotton that was being produced in the United States and was initially more suitable for the production processes then adopted in English manufactures (Pereira, 2017). This allowed Brazil to maintain a prominent position in cotton exports to the English market for many years.[7] In the period from 1785 to 1815, Brazil represented a fifth of cotton imports to Liverpool and the United States only started to take the lead in the next few decades.[8] By 1820 England was importing 152 000 000 pounds of cotton, of which Brazil accounted for 19%. Despite the fact that England had obtained preferential treatment in Brazil and became a major market for British exports in this period, the value of raw cotton exports of Brazil to England exceeded the value of British cotton goods imported into Brazil until 1825.[9] The intrinsic quality of Northeastern cotton and its adaptability to the technical conditions required by the market did not mean that the exported product was of good quality. Fraud and poor packaging were a constant complaint from importers and from Brazilian government officials (Albano, 1918, p. 23; Soares,

[3] It was estimated that cotton exports from Maranhão began in 1760 and by 1807 had reached a total of 3 400 000 tons, and that Pernambuco cotton exports began in the 1790s and totaled 2 300 000 tons by 1807, in Alden (1984, pp. 636-637).

[4] Pereira (2017, p. 14). Although cotton was dominant in Maranhão, the primary export from Pernambuco remained sugar, followed by cotton, see Arruda (1980, p. 228). On the pre and post company slave trade to Pernambuco, see Lopes (2017, chapter 2).

[5] As reported in the 1830s, Pernambuco cotton was in high demand and its price was only exceeded by that of Sea Island George cotton. Moreover, "the supply of cotton received in this country from Brazil is considerable, and tolerably regular" (Baines, 1835, p. 305).

[6] On methods of cotton production in late 18th century Northeastern Brazil, see Camara (1797). On the methods of production in Maranhão in the mid-19th century, see Turner (1859).

[7] In the 1810s Brazilian cotton exports to England alone averaged over two thirds of the value of all these exports in the period from 1814-1821, in Arruda (2016, p. 179, table 1).

[8] Already in the period 1806-1815, US cotton imports represented 57% of all foreign cotton entering England, compared to 19% for Brazil (Krichal, 2013, p. 22; Donnell, 1872).

[9] This is impressive given the fact that Brazil accounted for 8% of British cotton goods exports to 1850 compared to 11% to the United States, its largest market, see Pereira (2017, p. 14). There were three major treaties enabling special tariffs for England, that of 1808 opening all ports, 1810 giving England preferential treatment and the 1827 treaty which limited tariffs to 15%. See Haber (1997, p. 245).

1860, pp. 47-53). Although Brazilian imports remained the second most important foreign cotton for British producers in the period from 1820 to 1833, its volume remained relatively stable while imports from the United States in this period more than doubled (see table 1).

TABLE 1. IMPORTS OF RAW COTTON INTO ENGLAND, 1820-1833

Origin	*USA*	*Brazil*	*Turkey & Egypt*	*Other foreign*	*Sub total all foreign*	*British colonies*	*Total*
1820	89 999 174	29 198 155	285 350	2 045 147	121 527 826	30 144 829	151 672 655
1821	93 470 745	19 535 786	856 868	2 504 180	116 367 579	16 169 041	132 536 620
1822	101 031 766	24 705 206	395 077	1 534 483	127 666 532	15 171 096	142 837 628
1823	142 532 112	23 514 641	1 334 547	1 988 773	169 370 073	22 032 430	191 402 503
1824	92 187 622	24 849 552	7 719 368	1 278 720	126 035 262	23 344 820	149 380 082
1825	139 908 699	33 180 491	18 938 246	7 245 229	199 272 665	28 732 626	228 005 291
1826	130 858 203	9 871 092	10 032 400	755 153	151 516 848	26 090 553	177 607 401
1827	216 924 872	20 716 162	5 071 519	1 279 873	243 992 426	28 456 483	272 448 909
1828	151 752 289	29 143 279	6 926 288	1 579 711	189 401 567	38 359 075	227 760 642
1829	157 187 396	28 878 386	5 986 385	1 070 800	193 122 967	29 644 444	222 767 411
1830	210 885 358	33 092 072	3 401 710	639 823	248 018 963	15 942 489	263 961 452
1831	219 333 628	31 695 761	8 081 024	697 691	259 808 104	28 866 749	288 674 853
1832	219 756 753	20 109 560	9 113 890	598 048	249 578 251	37 254 274	286 832 525
1833	237 506 758	28 463 821	987 262	1 696 108	268 653 949	35 002 888	303 656 837

Source: Donnell (1872, pp. 79-177).

Brazilian production in that period was primarily arboreal or tree cotton, which required little investments to enter into production, and the profitability of its export attracted both small and large farmers in the Northeastern region. Although there were large landowners using slave labor cultivating the crop, there was a significant participation of small landowners, renters and even squatters. The processing of cotton was in the hands of small traders who bought cotton from producers and sold it to exporters after processing (Andrade, 2011, pp. 158-159).

But new technological transformations occurred in cotton processing and fabric production in the early 19th century which allowed the use of other cotton varieties in the English textile industry.[10] This resulted in the United States becoming the main source of cotton supply to England (Watts, 1871, p. 5). Although Brazilian exports also grew in this period, they now fell below 5% of total English cotton imports even though their exports to England had doubled by mid-century. Thus, by the 1850s Brazil was exporting on average of around 124 000 bales (51 000 000 tons of cotton) per annum to England, but this was well behind cotton imports from the East Indies and the United States (see table 2).

[10] On the causes for the growth of cotton exports in the United States in the 19th century, see Olmstead and Rhode (2008, pp. 1123-1171) and Wright (1978, chapter 4).

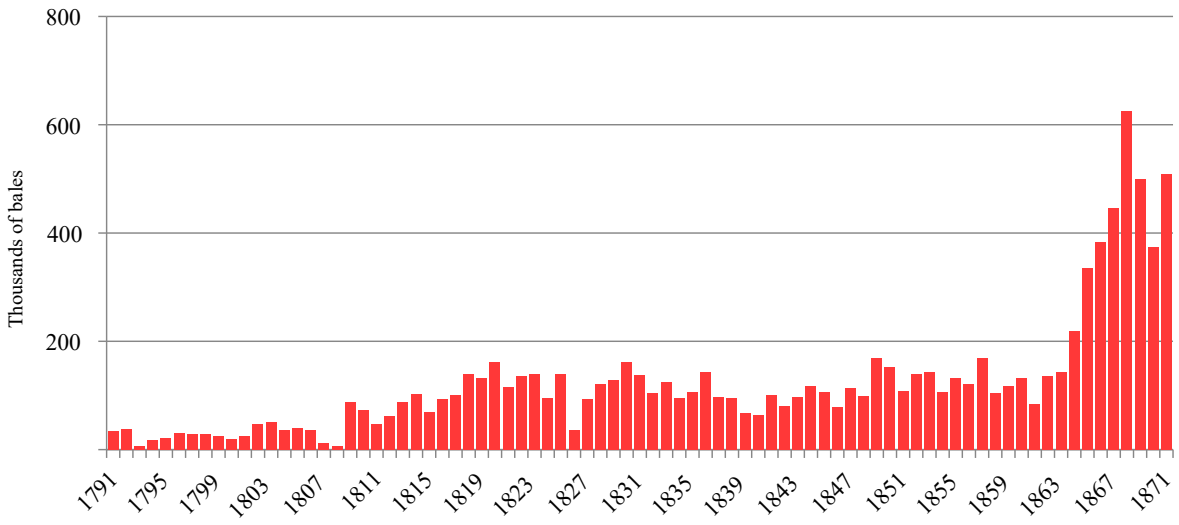
TABLE 2. IMPORTS OF RAW COTTON INTO GREAT BRITAIN (IN BALES), 1852-1861

Year	*USA*	*Brazil*	*West Indies*	*Egypt*	*East India*	*Total*	*Average weight per bale*	*Total in pounds*
1852	1 794 698	142 839	9 468	189 230	221 379	2 357 614	418	785 482 600
1853	1 531 709	132 174	7 710	106 522	485 385	2 263 500	426	901 987 600
1854	1 667 902	107 037	8 252	81 218	308 184	2 172 593	408	886 417 900
1856	1 626 086	134 528	6 708	113 961	396 027	2 277 310	396	901 814 700
1856	1 758 295	121 521	11 323	113 111	469 508	2 463 768	414	1 019 999 900
1867	1 481 717	168 340	11 467	75 528	680 466	2 417 588	403	974 287 900
1858	1 855 340	108 886	6 897	101 405	350 218	2 422 746	419	1 018 130 000
1869	2 086 341	124 867	8 338	99 876	509 688	2 829 110	421	1 191 065 300
1860	2 580 843	103 050	9 956	109 985	562 852	3 366 686	421	1 417 374 800
1861	1 842 610	99 120	10 390	97 280	987 530	3 036 930	415	1 260 326 900

Source: Williams (1868, p. 8).

This pattern of cotton imports to England was broken with the closure of North American ports to cotton exports during the US civil War. The result was a massive increase of Brazilian exports to England, as England encouraged alternative sources to expand production to meet its needs. Brazil succeeded in tripping its exports in a short period of time, reaching 384 000 bales by 1865 and 624 000 bales by 1868, and increased its share to 19% of all cotton imports to England (see graph 1).

GRAPH 1. BRAZILIAN RAW COTTON IMPORTS INTO GREAT BRITAIN, 1791-1871 (IN BALES)

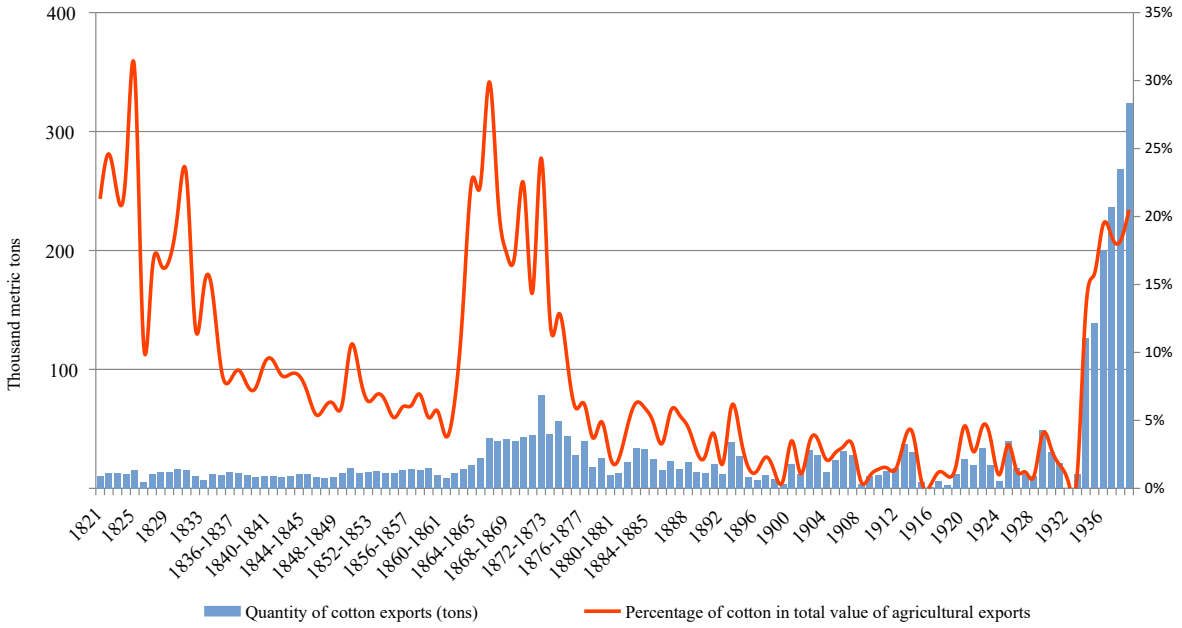


Sources: Smithers (1825, table 1, p. 147); Donnell (1872).

Except at the beginning and middle of the 19th century, and in early 20th century the share of cotton exports in the total value Brazilian exports was quite limited. Throughout the years 1821 to 1860, Brazilian exports remained practically stable, but their share in Brazilian exports fell from a quarter to 5% of the total as coffee came to dominate Brazilian exports (see graph 2). In this period, production and exports were concentrated in the Northeast. In the middle of the 19th century, in some provinces, such as Maranhão, Paraíba, Ceará and Alagoas, cotton represented about 80% of the value of exports, but they were a reduced percentage in Bahia and Pernambuco due to their high sugar exports. Of these cotton exports, 80% went to England, 10% to Spain and 5% to France (see table 3).

Given the small investments required to produce cotton and its adaptability to semi-arid conditions, cotton growing in the Northeast was carried out on all sizes of farms. It also became a crop associated with livestock, as cotton residues could be used to feed animals (Koster, 1941, p. 452; Lirbório, 2017, p. 104; Nogueira 2009, p. 4). In Maranhão the cultivation was carried out on large farms by slave labor, while in other areas of the Northeast, production by small non-slave producers was important. In Pernambuco and neighboring regions cultivation methods were rudimentary differing little from traditional Amerindian practices. The plow was almost unknown, plant diseases were not treated and seeds were not selected (Albano, 1918, p. 33). Not only was the agriculture rudimentary, but so was the ginning and packaging processes (Koster, 1941 p. 452).

GRAPH 2. QUANTITY OF BRAZILIAN COTTON EXPORTS (IN TONS) AND THEIR IMPORTANCE IN THE VALUE OF TOTAL AGRICULTURAL EXPORTS OF BRAZIL 1821-1939



Source: IBGE, *Anuário estatístico*, years 1939-1940.

The causes of the loss of Brazilian competitiveness over the years 1820 to 1860 are multiple. Several memoirs and studies of the period point to the problems related to the baling and commercialization process. Although the Brazilian fiber was of high quality, the bales arrived mixed with low quality cotton. Finally, recent studies have also emphasized the high tax burden on cotton exported by Brazil (Pereira, 2017). These multiple causes reduced Brazil's competitiveness, which thus remained a secondary supplier in the growing European cotton market.

Nevertheless, there were two periods of growth in cotton exports in the 19th and 20th centuries (see graph 3). The first was during the American Civil War when the US left the market creating a "cotton famine" (Watts, 1871, pp. 7, 12-13). England seeking alternative supplies started to stimulate the expansion of production in several countries, including Brazil. As early as 1857 the Cotton Supply Association was established to develop alternative supplies. India was the principal area of initial activity, but the English also found Brazil a good area for growing cotton.[11] Although several Northeastern provinces, such as Pernambuco, Maranhão, Pará, Ceará, Rio Grande do Norte, Bahia, and Paraíba produced cotton for export, it would be in the province of São Paulo, with no history of production or export until 1861, that the Association would begin its experiments with

[11] "Here the cotton plant had been naturalised for ages, whilst the soil and climate were found to be well suited to its cultivation" (Watts, 1871, pp. 12-13).

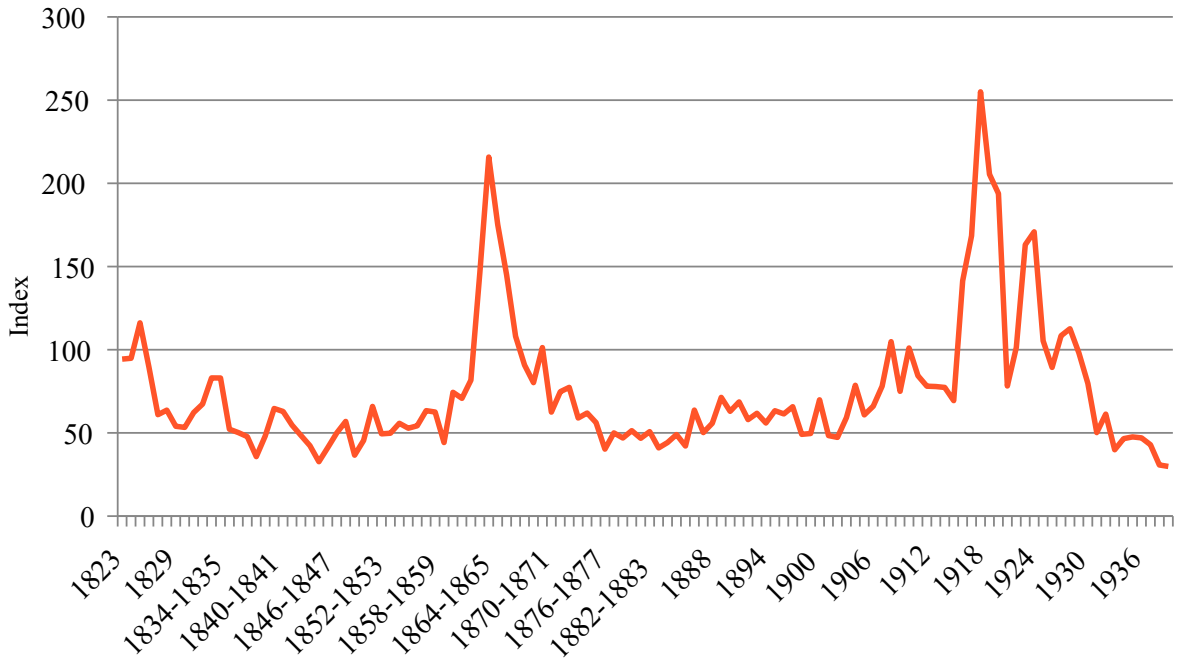
TABLE 3. BRAZILIAN EXPORTS OF COTTON BY PROVINCE, 1849-1850

Province	*Arrobas*	*Value (mil réis)*	*Value of cotton in total provincial exports (percentage)*
Maranhão	409 378	1 954 637	22
Pernambuco	203 178	1 048 271	14
Alagoas	177 968	1 121 317	49
Paraíba	176 078	864 869	58
Bahia	95 913	466 398	41
Ceará	43 043	204 553	88
Pará	3 544	13 877	1

Source: *Coleção dos Mapas Estatísticos do Commercio e Navegação do Imperio do Brasil, com suas províncias e países estrangeiros 1849-1850* (1855, p. 311).

the New Orleans seed (Watts, 1871, p. 85).[12] Prices and demand were high and this drew small producers to concentrate on cotton and British merchants provided advances to farmers so that they could concentrate on cotton cultivation (Beckert, 2004, p. 1414).

GRAPH 3. AVERAGE VALUE OF BRAZILIAN EXPORTS OF COTTON IN GOLD POUNDS (1821-1823=100)



Source: IBGE, *Anúario estatístico*, years 1939-1940.

[12] On the development of cotton in São Paulo, see Canabrava (1984; 1979, pp. 1173-1219).

Average prices for Brazilian cotton exports doubled between 1860-1861 and 1865-1866 and exports tripled between 1850 and 1860 and its share of the Liverpool market increased from approximately 5% to 12% of all cotton imports. At the same time the share of cotton in total Brazilian agricultural exports increased in value from 6% to 18% in the same period. But with the end of the Civil War, the price gradually decreased. In 1870/71 prices returned to pre-war levels, putting an end to the euphoria of the cotton boom for Brazil. Nevertheless São Paulo, now had become an important producer and exporter, and by the 1870s was the second largest exporter after Pernambuco and accounted for a fifth of production. An 1875 Brazilian survey of imperial cotton production found that São Paulo production yielded extraordinary profits.[13]

Cotton production in the state of São Paulo was different from the Northeast not only in the type of cotton grown, but also in the form of its organization. The small farms which dominated São Paulo production in the 19th and 20th century, were primarily cotton producers and only produced food for local consumption. Moreover, landowners and workers both participated in its profits through land rentals or sharecropping. All agree that this system encouraged a large labor force to participate in growing and harvesting the crop, and enabled poor workers to share in the profits of production. This proved to be a highly efficient system beneficial to both farmers and landowners, but it could lead to conflict over contracts.[14] For all local producers, the internal market now became fundamental due to the rapid expansion of the national textile industry (Canabrava, 1984, pp. XI-XIV). Not only was the growing national market satisfied, but enough cotton was exported that even by 1871-1872, the value of imported cotton cloth, which came mostly from England and France, was close to the value of the raw cotton exported.[15]

The demand for local cotton increased steadily due to the rapid growth of the national textile industry in the late 19th and early 20th century. By the time of the 1920 industrial census there were 266 cotton spinning and weaving factories in Brazil, employing 92 000 workers (Ministerio da Agricultura, 1920, vol. v, 1ª, pp. XVI-XXII, XXIV, LXXII, LXXIII). Considering all fabric manufacturing establishments, there were 319 that year, of which 112 were in São Paulo. Cotton was the dominant cloth produced, with wool and linen fabrics of lesser importance.[16] Moreover the two types of cotton crops in the two different centers, were still produced. As late as 1920 the Northeast still accounted for 63% of cotton output. However short strand upland cotton from São Paulo became important for local industry as both São Paulo and the traditional Northeastern states now primarily serviced national industry. But exports never stopped in this entire period.

[13] According to Moreira (1875, pp. 81-85) um *alqueire* of seed (36.72 liters) generated 240 arrobas of the product (or 3 524 kilos) worth 1:200 $000 milreis, with production costs of only 300$ 000 milreis. Large green, small green, white and black seeds were used in the Province. The proportion of raw and ginned cotton was 7 per cent.

[14] While acknowledging the economic rationality of the system and its benefits, Brannstrom (2010, pp. 177-178) argues that conflict between land owner and cotton producer was inevitable. On the capitalist nature of the process, see Prado Jr. (1966, pp. 52-54).

[15] Of the value of Brazilian exports, 81% went to England and 9% to France. In turn 85% of imports into Brazil came from England and 7% from France, in Soares (1876).

[16] Ministerio da Agricultura, Industria e Commercio (1924, p. XXXVIII). According to the 1920 excise tax data, 535 433 927 meters of cotton fabrics would have been *consumed*, against 2 097 818 meters of linen fabrics and 3 613 826 meters of wool fabrics.

Phase 2

The period from 1920-1999 represented a new period of growth and also of effective modernization of Brazilian cotton production, but ended in the worst crisis in the history of Brazilian cotton. It was in this period that earlier research led to the creation of new seed varieties and São Paulo cemented its position as the dominant cotton producer as it began to replace coffee on large estates. There was also a second international boom in cotton exports in the 1920s due to rising prices which reflected the recovery of international demand after the crisis of World War I. Some 24 000 tons of cotton were exported, corresponding to 5% of Brazilian exports. But in that same year, the local market already consumed a large share of national cotton production. It has been estimated that from 1900 to 1925 the national cotton textile industry doubled every decade. National cotton textiles production was 33 000 000 meters of cloth in 1900, 75 000 000 meters 1910 and 186 000 000 by 1920. The 17 factories in 1900 increased to 54 factories in 1920 and 64 in 1925. In this same period workers in these factories went from 4 570 in 1900 to 38 000 in 1925, and the looms increased from 2 838 to 20 560 (Pestana, 1926, pp. 63-65, 89-90). In 1920 the production of 332 000 tons of seed cotton (*algodão em caroço*), which consists of seed and lint before cleaning, would produce about 113 000 tons of cotton lint, of which only 24 000 tons were exported, and the rest was destined for the internal market.[17] São Paulo was by this date the unquestioned dominant producer of cotton, followed by Pernambuco (see table 4).

As of the 1920 census there existed 92 000 cotton farmers, with a planted area of 379 000 hectares, representing 6% of the cultivated area that year. The production was 332 000 tons of cotton seed and the average was 878 kilograms of cotton lint produced per hectare and the average area cultivated was just 4.1 hectares. Cotton represented 16% of the value of the production of agricultural crops, against 25% for coffee and 24% for corn (Ministerio da Agricultura, Industria e Commercio, 1924, p. xix). By now the state of São Paulo led in national cotton production, with 20 000 farmers growing cotton on 102 000 hectares producing 105 000 tons of cottonseed. This represented about one third of national production, with average productivity per hectare similar to the Brazilian average. The second state in terms of production was Pernambuco, followed by Paraíba and Ceará. Together, the northeast was still the most important region, representing two thirds of production with an average cultivated area of 5.7 hectares.

A major transformation in cotton cultivation would occur after the crisis of the 1930s, which would be carried out mainly in São Paulo. The crisis of coffee production in the 1930s would result in the coffee economy losing its dynamism and resulted in territorial displacement of coffee production within the state and to other states. At the same time, there were major changes in land ownership and use in the state, with an important process of subdivision of properties (Albuquerque, 1981, p. 180; Gonçalves & Ramos, 2008, pp. 28-29).

[17] This estimate is based on the 1920 census. It stated that São Paulo produced 11 000 000 arrobas of seed cotton, equivalent to 55 000 tons of raw cotton, which gives a return of 34%. This is close to the 35% estimate given in Paiva (1996, p. 167).

TABLE 4. PRODUCTION OF COTTON BY STATE BY NUMBER OF COTTON FARMS, THEIR SIZE AND OUTPUT, 1920

States	*No of farms*	*Hectares cultivated*	*Quantity produced (tons)*	*Kilos of cotton per hectare*	*Average area of cotton farms*	*Average production (kg)*
São Paulo	19 764	109 788	104 584	953	5.6	5 292
Pernambuco	10 406	70 013	61 978	885	6.7	5 956
Paraíba	9 944	49 007	35 797	730	4.9	3 600
Ceará	2 811	30 762	29 426	957	10.9	10 468
Rio Grande do Norte	2 062	15 798	18 344	1 161	7.7	8 896
Bahia	3 886	18 508	15 910	860	4.8	4 094
Alagoas	5 225	16 474	15 634	949	3.2	2 992
Sergipe	4 021	16 053	14 593	909	4	3 629
Maranhão	2 401	22 633	13 616	602	9.4	5 671
Minas Gerais	11 690	10 429	8 667	831	0.9	741
Piauí	2 486	5 902	5 315	901	2.4	2 138
Pará	8 380	6 870	4 036	588	0.8	482
Paraná	482	2 165	1 782	823	4.5	3 696
Goiás	5 117	1 023	925	904	0.2	181
Rio Grande do Sul	422	1 222	610	499	2.9	1 445
Santa Catarina	2 068	727	372	511	0.4	180
Rio de Janeiro	45	501	302	602	11.1	6 707
Espírito Santo	339	437	263	601	1.3	775
Mato Grosso	162	132	80	604	0.8	492
Amazonas	42	86	52	602	2	1 233
Território do Acre	31	63	51	810	2	1 645
Distrito Federal	1	6	4	600	6	3 600
Total Brasil	91 785	378 599	332 338	878	4.1	3 621
Nordeste total	43 242	245 150	210 613	859	5.7	4 871

Source: Source: Ministerio da Agricultura, Industria e Commercio (1924, vol. III, 2a. parte, Agricultura, p. XXVII).

e-ISSN-2007-8496

There were also important advances in the production process. Since the early years of the 20th century, studies were developed to improve cotton cultivation, particularly at the Instituto Agronômico de Campinas (IAC), a research institution of the government of the State of São Paulo which had been created in 1887.[18] It soon became one of the most important centers of research in Brazil, with a fundamental role in the development of crops in general, but especially with coffee and cotton. The institute began working on cotton in 1907 and its work intensified after the creation of the Cotton Section in 1922 which would be responsible for new seed development (Albuquerque, 1981, pp. 137-138; Junqueira, 1936, pp. 8-9; Albuquerque, Ortega & Reydon, 1986, pp. 79-132; Neto & Freire, 2013, pp. 49-83).

In this post 1930 period there was also an integration of agronomic research, seed production and distribution services, technical assistance and the fiber market. Research programs until 1970 were aimed at improving fibers, increasing productivity and resisting diseases and the maturity of the fiber and an increase in its productivity. There were also new research centers created or older ones now devoted to cotton studies. Thus, the Instituto Agronômico de Campinas launched the improved seeds known as IAC-17 and IAC-18 which resulted in an average increase in productivity on the order of 30%. The Northeast also received greater attention in the development of cotton technology adapted to the region after the installation of the National Cotton Research Center of Embrapa –the Brazilian Agricultural Research Corporation– in Campinas Grande in Paraíba in 1975. Embrapa was a government created agricultural research organization which would become the largest such center in the tropical world and was fundamental in the modernization of all aspects of Brazilian agriculture (Freire & Medeiros, 1980, pp. 383-413; Beltrão, 2003, p. 14).

In addition to the use of cotton to produce the fiber used for yarn production, in the 20th century seed began to be used industrially in Brazil for the production of vegetable oil. Before World War I the country exported the seed and imported cottonseed oil in a volume of 1 000 000 kilograms per annum, mainly from the United States. Palm oil and linseed oil were also consumed nationally (Ministério das Relações Exteriores, 1941, pp. 189-194).[19] It was in this post war period that cottonseed oil became a major consumption item in Brazil. As in other Latin American countries, the leadership in this industrial process fell to the Bunge group, through Sanbra Sociedade Algodeira do Nordeste Brasileiro S. A., its subsidiary in Brazil. It began to produce cottonseed oil in 1929 which quickly became one of the most consumed food oils in Brazil, until its replacement by soybean oil at the end of the century (Costa & Silva, 2020).

All these changes led to the massive growth of cotton production after 1920. Between 1920 and 1960 the number of cotton farms increased by a factor of five and thereafter maintained a high level of production until the late 1990s. Over this period there was also a shift in Southern production as Paraná increased its participation and by 1980 it would become the largest Brazilian cotton producer. In that year, the Center-West also began to produce cotton. The decline of Northeastern production in this period meant the loss of participation of tree cotton, which was only produced in that region. Arboreal production systematically declined from 35% of production in 1956, to 24% in 1973 and 14% in the 1980 census and its production would practically disappear as of the 1990s (see table 5).

[18] The Instituto Agronômico was created by D. Pedro II in 1887 and passed under State control in 1892.

[19] According to Costa & Silva (2020), Brazil launched its cotton oil *Salada*, the first such product on the market, in 1929.

TABLE 5. COTTON PRODUCTION BY STATE, AND REGION, FOR AREA AND OUTPUT, 1920-1996

	1920	*1940*	*1950*	*1960*	*1970*	*1980*	*1996*
				Number of farms			
Brazil	91 785	442 407	351 432	453 481	358 156	260 422	93 688
Northeast	43 242	286 753	245 532	342 645	205 120	193 425	54 089
Center-West	5 279	16 053	9 306	13 497	16 951	6 508	5 455
São Paulo	19 754	100 700	72 934	54 418	49144	14 419	5 934
Paraná	482	17 220	4 439	22 822	68675	34 898	20 527
				Cultivated area (hectares)			
Brazil	378 599	2 412 484	2 037 411	2 180 800	1 485 280	1 044 457	640 124
Northeast	245 150	885 127	1 213 764	1 546 399	425 569	422 056	182 918
Center-West	1 155	5 107	10 430	32 022	86 442	61 662	152 103
São Paulo	109 788	1 416 482	719 623	408 297	531099	236 687	91 315
Paraná	2 165	24 884	27 222	131 131	373287	263 731	171 039
				Production (in tons)			
Brazil	332 238	1 284 895	769 528	956 249	1 261 704	1 170 597	816 743
Northeast	210 613	392 059	295 377	356 209	100 923	124 634	78 763
Center-West	1 005	2 637	4 026	18 139	114 540	106 385	269 439
São Paulo	104 564	840 598	445 559	442 046	610 222	433 388	150 967
Paraná	1 782	27 785	18 695	112 903	397 063	452 490	267 433
				Share of State in total production (pergentage)			
Northeast	63	31	38	37	8	11	10
Center-West	0	0	1	2	9	9	33
São Paulo	31	65	58	46	48	37	18
Paraná	1	2	2	12	31	39	33

Sources: IBGE, *Censos demográficos*, *Censos agrícolas* e *Anuários estatísticos*, years 1920-1999.

e-ISSN-2007-8496

Even as Brazil turned more inward in its cotton production, it remained a significant world producer. In the 1960s and 1970s, Brazil was the fifth largest cotton producer in the world and also the fifth largest exporter of cotton lint. At that time, the country had more than 12% of the world area planted in cotton with more than 3 600 000 hectares and almost half of the population of the Northeast directly or indirectly, lived off cotton and its by-products. Not only in the semi-arid Northeast, but also in other producing regions, cotton farming was the least risky agricultural activity. The cultivation of cotton, whether rain fed or irrigated, single or intercropped, required between 0.3 to two employees per hectare depending on the exploitation regime. In the Northeastern semiarid, in the drier areas, cotton was not an option, but was in fact the only crop capable of generating income (Beltrão, 2003, pp. 14-15).

The 1980 census contains detailed information on the productive structure of cotton. In that year there were more than 500 000 producers, distributed in a relatively equal way among those dedicated to tree and herbaceous cotton. This was roughly the same number of producers as in the agricultural census of 1960, although the Northeastern region then accounted for two thirds of the cotton farmers (IBGE, *Censo agrícola*, 1960, p. 52, table 36b). Although the area dedicated to tree cotton as late as 1980 accounted for two thirds of the total area cultivated with cotton, its production represented only 12% of the total, showing a brutal difference in land productivity, and probably labor productivity as well. Given the low costs of entry into even herbaceous cotton production, in São Paulo and Paraná a third of cotton farmers were tenants and sharecroppers, a percentage higher than in the Northeastern states (Salinas, 2009). In the Northeastern states arboreal cotton production was intercropped with livestock in about a third of farms, compared to only one fifth of the herbaceous cotton growers who also produced livestock. In both types of cotton there were a large proportion of small farms, but there was a great difference between the arboreal and herbaceous cotton crops in output. The average production per producer was eight times higher in the herbaceous; considering the production per hectare the proportion increased to twelve times (see table 6).

The evolution of the harvested area in cotton in the state of São Paulo is impressive. Modest at the beginning of the 1930s, it rose to above 1 000 000 hectares in the 1940s and 1950s and accounted for almost a third of all cultivated lands in the state, and gradually decreased thereafter reaching under 400 000 hectares by the late 1980s and absorbing only around 5% of cultivated lands in the state. However significant increases in productivity by area, allowed the state to maintain an average annual production on the order of 500 000 tons throughout the decades of the 1940s to the 1980s, even with the effects of the boll weevil after 1983 (see graph 4).

The second half of the 1980s and the decade of the 1990s was a period of acute crisis in national cotton culture. In the mid-1980s, the boll weevil plague spread. First identified in São Paulo and Paraíba in 1983, it appeared in Paraná the following year. Two harvests after its first appearance, the insect appeared in all the main cotton producing areas. As it was a well-known pest, and with control methods already developed in other countries, containment or even eradication plans were developed, but the operational limitations and the social and economic consequences of a radical plan made its execution unfeasible (Braga Sobrinho & Lukefahr, 1983; Miranda & Rodrigues, 2015, pp. 9-46; Pimentel, Moreira, Barreiro, Crisostomo, & Braga, 1983). By the 1983-1984 harvest, there was a decline in areas planted with cotton and a significant decline in productivity (Azambuja & Degrande, 2014; Campanhola, Martin & Schattan, 1988). Although the boll weevil represented an extraordinary event in the trajectory of cotton cultivation, it ultimately had a limited effect on Brazilian production. Thus, if we compare the average production

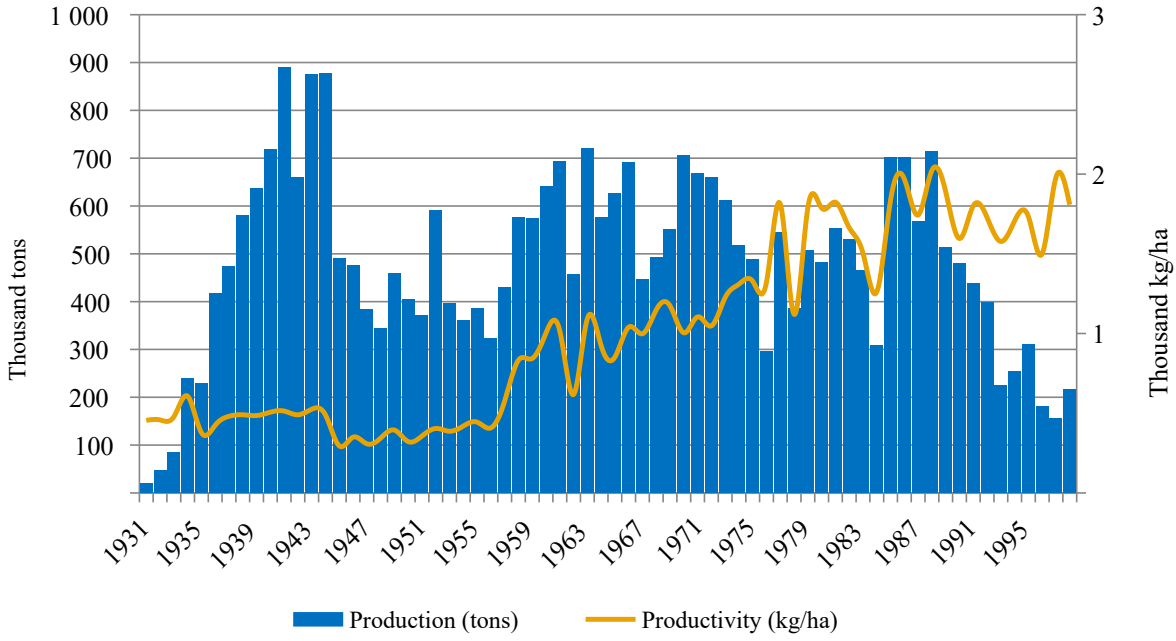
TABLE 6. CHARACTERISTICS OF *HERBACEO* AND *ARBÓREO* COTTON FARMS IN 1980

	Arbóreo Cotton			*Herbáceo Cotton*		
	Farms	*Production*	*Area*	*Farms*	*Production*	*Area*
Total	271 371	156 156	1 655 595	260 422	1 170 597	1 044 457
Status of producer (percentage)						
Owner	71	83	85	60	63	67
Renter	6	4	3	19	23	19
Sharecropper	7	5	5	6	10	8
Squatter	16	8	7	15	3	6
Destiny of production (percentage)						
For coop	5	14	14	4	13	11
For industry	4	14	15	10	46	32
For intermediary	84	70	69	82	40	55
Economic activity of producer (percentage)						
Agriculture	69	77	67	80	95	88
Ranching	24	14	23	15	2	8
Agriculture & Ranching	5	8	8	4	2	4
Size of farms producing cotton (percentage)						
Less than 10 ha	40	15	10	59	15	22
10 -100 ha	49	47	44	35	50	47
100- 1 000 ha	11	33	38	6	28	26
1 000 -10 000 ha	1	5	8	0	6	6
10 000 ha or more	0.0	0.1	0.2	0.0	0.1	0.1
Area cultivated in cotton (percentage)						
Less than 1 hectare	16	4	1	38	1	4
1-2	20	7	4	21	3	7
2-5	31	19	15	24	13	19
5-10	14	18	15	9	15	16
Less than 10 hectarers	81	48	36	92	32	45
10-100 ha	14	43	48	7	48	41
100-500 ha	0	8	13	0	15	11
500+ ha	0	1	3	0	5	3

Source: IBGE, *Censo agropecuário*, 1980 in *Recenseamento geral* (1980, vol. 2, t. 3).

of the five years before 1983 and the five years after, there was an increase in the average annual production by 30%. Yet in the following years there would be a profound crisis in Brazilian cotton culture, which lasted until the end of the 20th century. Not only did production decline, but exports virtually disappeared in the 1970s and again in the 1990s, such that Brazil was forced to import cotton to satisfy national consumption (see graph 5).

GRAPH 4. COTTON PRODUCTION AND PRODUCTIVITY IN SÃO PAULO, 1931-1998



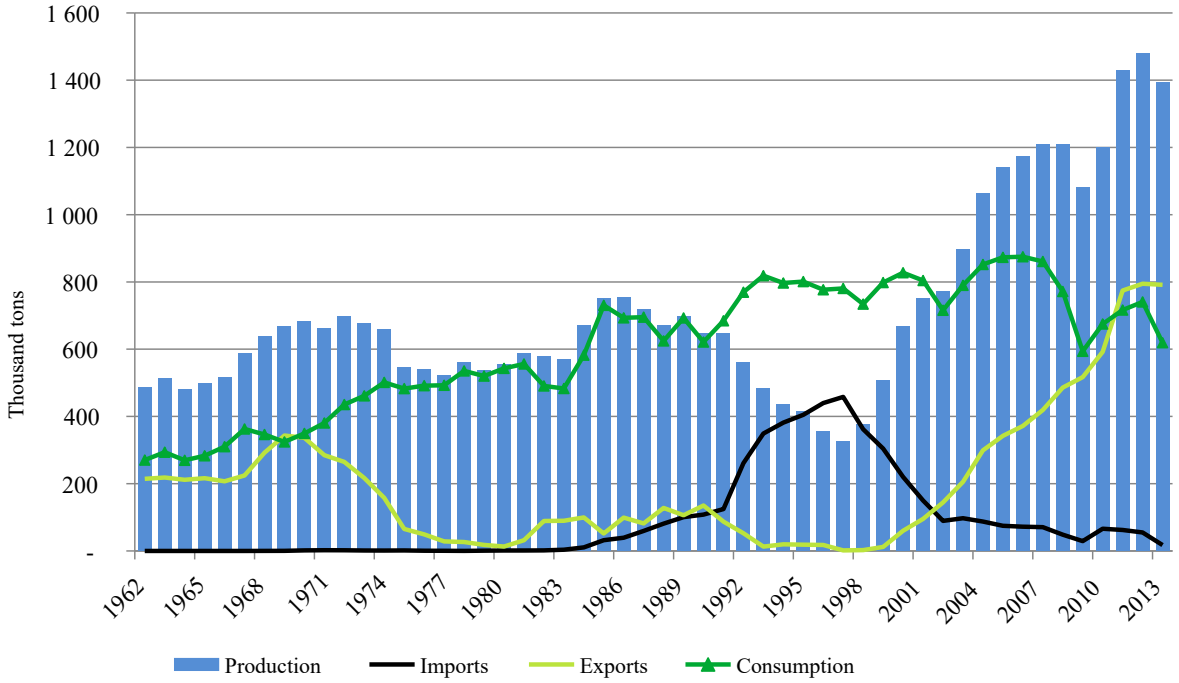
Source: Araújo et al. (2006).

The key cause for this collapse was a change in government policies with the adoption of the Washington consensus and the abolition of all protective tariffs on agricultural imports. Thus, from the decade of the 1980s to the decade of the 1990s Brazil went from being a net exporter to a major importer of cotton. This occurred when the world stocks of cotton were elevated and world prices were low. In addition to the cheaper foreign product, and the removal of tariffs, the financing conditions (in terms and interest) for the purchase of cotton in the international market were developed within Brazil. In 1988, as a protection and stimulus mechanism for the national textile industry, there was a reduction in the tariff on imported cotton from 50% to 10%, and the tariff was eliminated altogether in 1990. This abruptly exposed the domestic production of cotton to foreign competition, which at the time was abundant and even subsidized by the North American government. Finally, the terms of credit offered for financing cotton imports were better than those available for financing national production (Gonçalves & Ramos, 2008 p. 37). The prices received by the farmers, which were already declining, fell even further. At deflated prices there was a 50% drop between the average price paid for cotton between the 1980s and the 1990s.

The result of these changes was a dramatic decline in Brazilian cotton production. Cultivated area went from over 2 000 000 hectares in the last five years of the 1980s, to just 800 000 hectares between 1995 and 1999. The same occurred with the production of seed cotton which declined in half in the same period (see graph 6).[20] Although the effects were felt in all regions, the Northeast was particularly affected. By the end of the decade of the 1990s average production was only a

[20] Gonçalves (1997), Lima-Campo (2002), Macdonald (1997), Coelho (2002). The question of price integration is addressed by Gonçalves & Gonçalves (2008, pp. 1-34); Barbosa & Nogueira Jr. (2002, pp. 79-108).

GRAPH 5. BRAZILIAN PRODUCTION, IMPORTATION, EXPORTATION AND APPARENT CONSUMPTION OF COTTON LINT, 1961-2019 (THREE YEAR MOVING AVERAGE)



Note: Consumption = production + imports – exports.
Source: FAOSTAT, years 1961-2019.

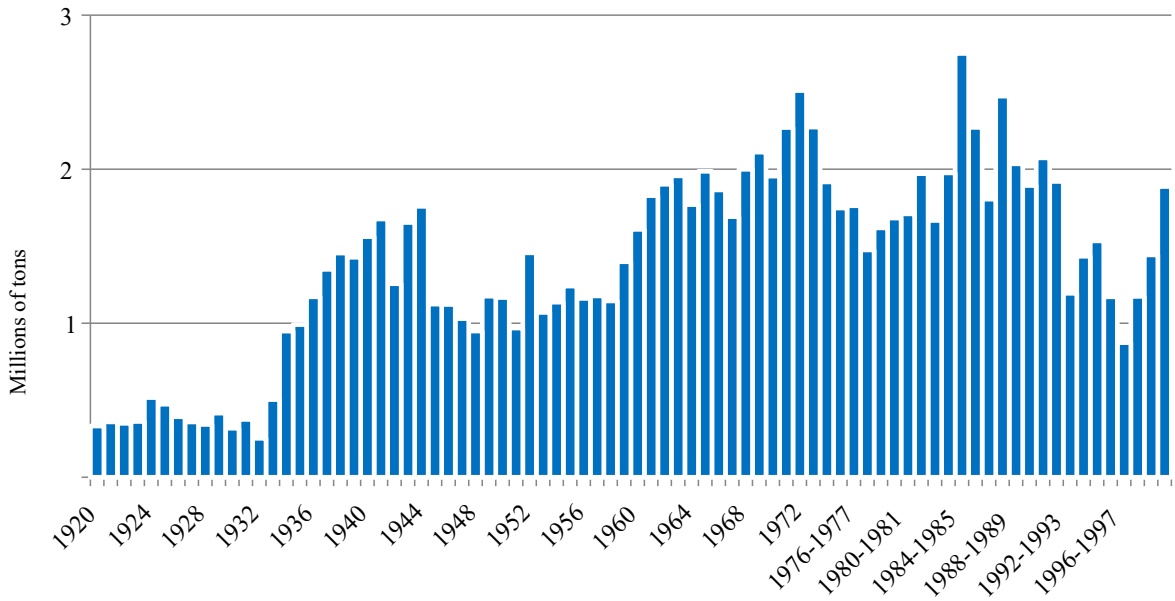
quarter of the average of the 1980s. It has been estimated that between 1985 and 1989 cotton farming generated about 2 100 000 jobs; ten years later employment in the sector would be just 736 000 workers, of which 278 000 were in the Northeast. Unlike the Sothern states, there was no alternative economic activity to replace cotton in the states of the Northeast. The effects on the countryside, cities, personal income and public finances were dramatic (Biehl & Zandonadi, 1998, p. 12; Santos, 2000).

PHASE 3

If the opening of the economy, which integrated domestic prices with foreign prices, was initially a negative factor in Brazilian cotton agriculture, it started to represent a stimulus for continuous increases in productivity. Nevertheless, the development in new cultivation practices, new regional production centers, and the expansion of production of all crops had an impact on cotton production as well.[21] The new large-scale production structure of the Brazilian Cerrado region stimulated systematic increases in productivity for cotton, which had an important domestic market, but slowly allowed for the penetration into the international market as local producers could now compete with international ones. Thus, the average productivity of cotton kept increasing

[21] For a survey of this transformation, see Klein & Vidal (2018).

GRAPH 6. BRAZILIAN PRODUCTION OF SEED COTTON, 1920-1999



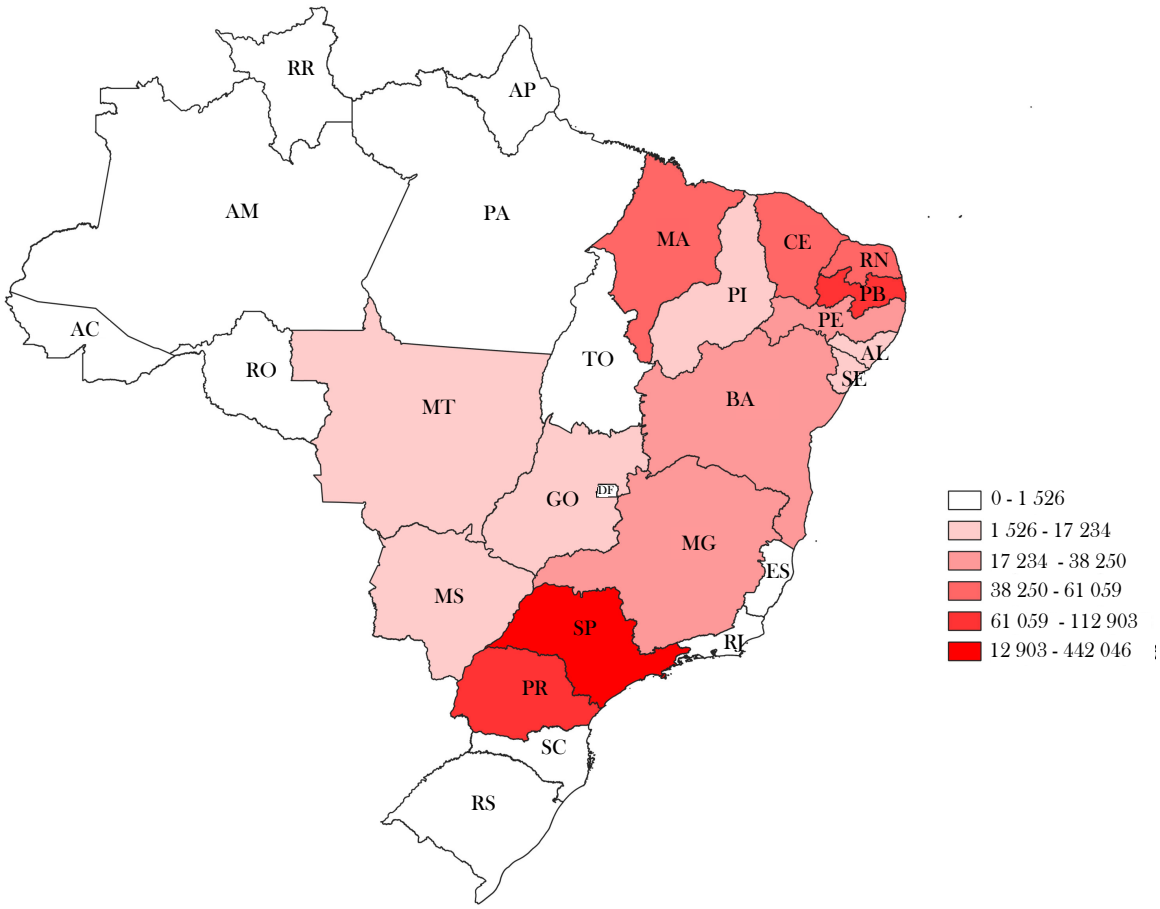
Sources: IBGE, *Séries históricas e estatísticas*, years 1920-1999; Companhia Nacional de Abastecimento (hereon CONAB) (2020c).

from the early 1990s. By 2000-2002 it had increased two and a half times above the earlier period and increased another 30% in the following decade (FAOSTAT, 2000-2002). So rapid was this increase in productivity, that Brazilian yields of seed cotton per hectare, which in 1980 was only 40% of that obtained in the United States, passed that of the United States in 1999 and is currently about 36% higher than that of the United States (see graph 7).

Furthermore, Brazil benefited from the exceptional increase in prices that started in the first decade of the 21st century and intensified in the following decade (Alves, Barros & Bacchi, 2008; Coelho, 2004). Thus, planters were more than able to expand production as the local cotton prices began to expand in this period (see graph 8).

The causes of this exceptional performance can be credited to such advances as no-tillage farming and the introduction of genetically modified seeds. Also, such new lands as the Cerrado were opened up to cotton production and the Embrapa Cotton Research Center played a fundamental role making this possible in encouraging cotton production in the Cerrado (Lirbório, 2017, pp. 152-153). Cotton is one of the crops with the highest incidence of pests, so a fundamental issue was the management of pest control, with several of these plagues, such as the boll weevil, endemic. Pest control can represent 30% of the total production cost, due to the need for numerous sprayings (Xavier, 2018, p. 21). This explains why the first genetically modified organisms introduced in Brazil were aimed at resistance to pests or resistance to the main pesticides used in cotton cultivation (Goodman, Sorj & Wilkinson, 1990, p. 33). Although previously introduced in other countries, the first approval of genetically modified seeds for commercial use in Brazil occurred in 2005. By 2019 there were 22 transgenic cotton seeds approved for sale in Brazil, the majority tolerant to insects and herbicides ("Informativo", 2019). In the latest harvest, the area

MAP 1. COTTON PRODUCTION BY STATE, 1960

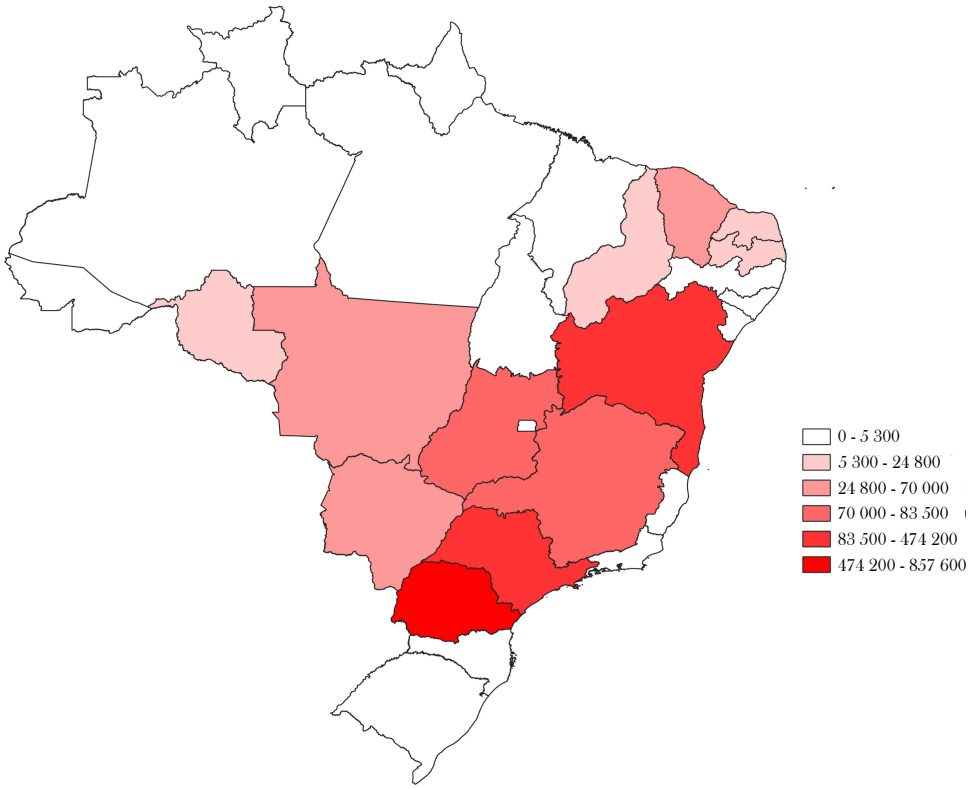


Source: IBGE, *Censo agricola* (1960).

planted with transgenic cotton, represented about 90% of the area planted in cotton, a ratio similar to the corn and soybean crops. Here as well multinationals dominate the market for genetically modified seeds (Xavier, 2018, p. 49). Nevertheless, Embrapa still plays a fundamental role and has even allied with the Monsanto Company to carry out genetic improvements of cotton lines and cultivars containing Monsanto's technology using Embrapa's germplasm, which allowed Embrapa to launch new cotton cultivars on the market (Xavier, 2018 p. 58; Lirbório, 2017, p. 151).

Cotton farming is now centered in the Cerrado region where it grown almost exclusively on large farms. Average productivity per hectare in the Cerrado has multiplied by four compared to the early 1990s. Cotton within the Cerrado district was predominantly in Mato Grosso and in the Northeastern savanna areas of the Cerrado which are mainly in Bahia (see map 3). Today, these two states grow 90% of the national cotton production, 73% in the state of Mato Grosso and 17% in western Bahia (CONAB, 2020a). The states of São Paulo and Paraná, previously important produc-

MAP 2. COTTON PRODUCTION BY STATE, 1989



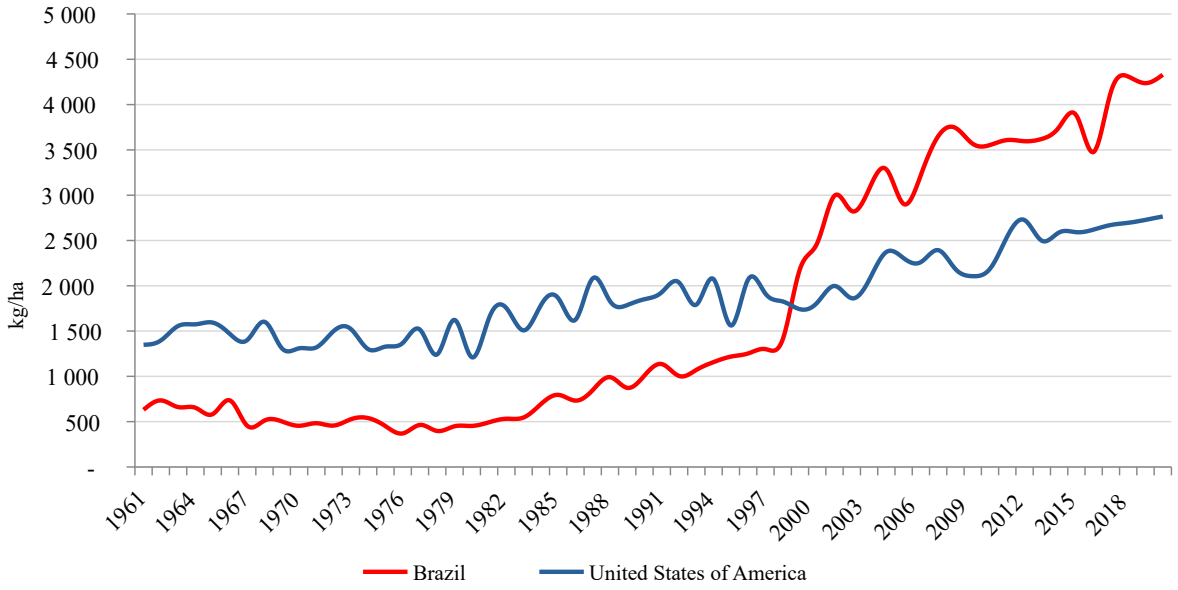
Source: Conab (1990).

ing centers, currently have a marginal position in the market. Even within the two leading states of Mato Grosso and Bahia, there is also a high concentration of production in a few municipalities (see table 7).

Total production of seed cotton in the last five harvests of the 20th century was around 1 million tons, in the following two decades rose to more than 3 000 000 tons in the 2000s and to 4 800 000 tons in the following decade. The harvest forecast for the year 2021-2021 is approximately 7 000 000 tons (Conab, 2022a). Although there was an increase in planted area, from approximately 823 000 hectares in the 2000-2001 harvest to 1 600 000 hectares in the 2021-2022 harvest, it was the exceptional increase in productivity that explains this increase in volume of production.

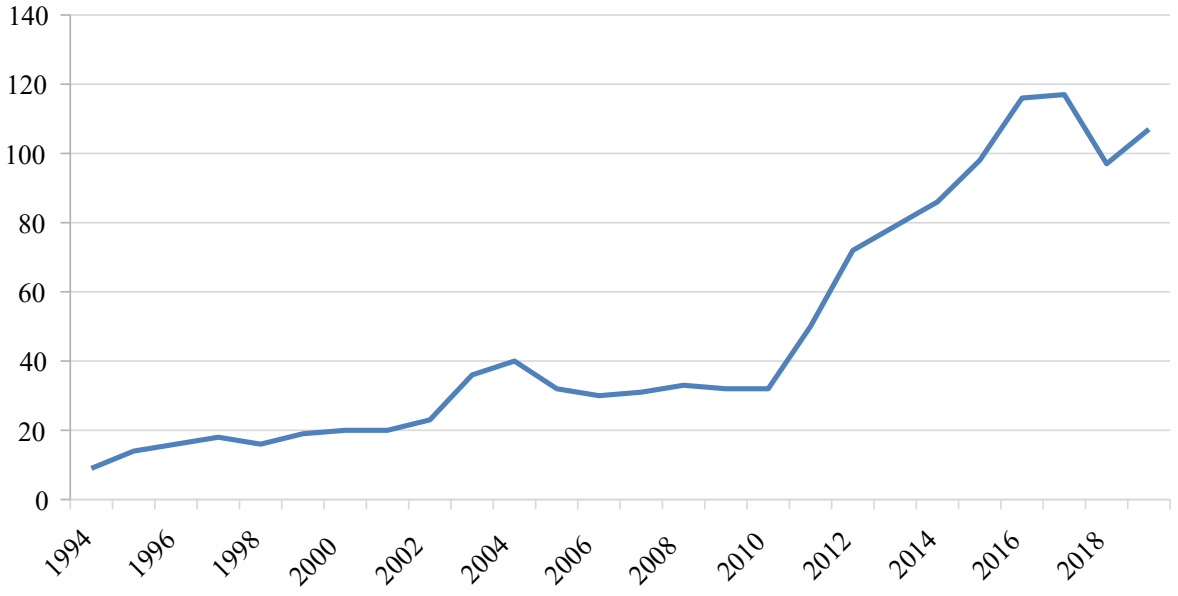
The dominance of large producers can be seen in the latest 2017 agricultural census. Whereas there were over 500 000 small producers of cotton in 1980, the elimination of tree cotton producers in the Northeast region and the total mechanization of the crop everywhere else had drastically reduced the number of producers by the latest agricultural census. There were only 3 211 cotton producers in Brazil registered in 2017. This compares to 1 600 000 corn producers, 315 000 bean producers, 236 000 soybean producers and 35 000 wheat farmers. Although there are small cotton farms of under 100 hectares, their participation is negligible. In fact, if we consider only

GRAPH 7. PRODUCTIVITY OF SEED COTTON PRODUCTION BRAZIL AND THE USA, 1961-2020 (KG/HA)



Source: FAOSTAT.

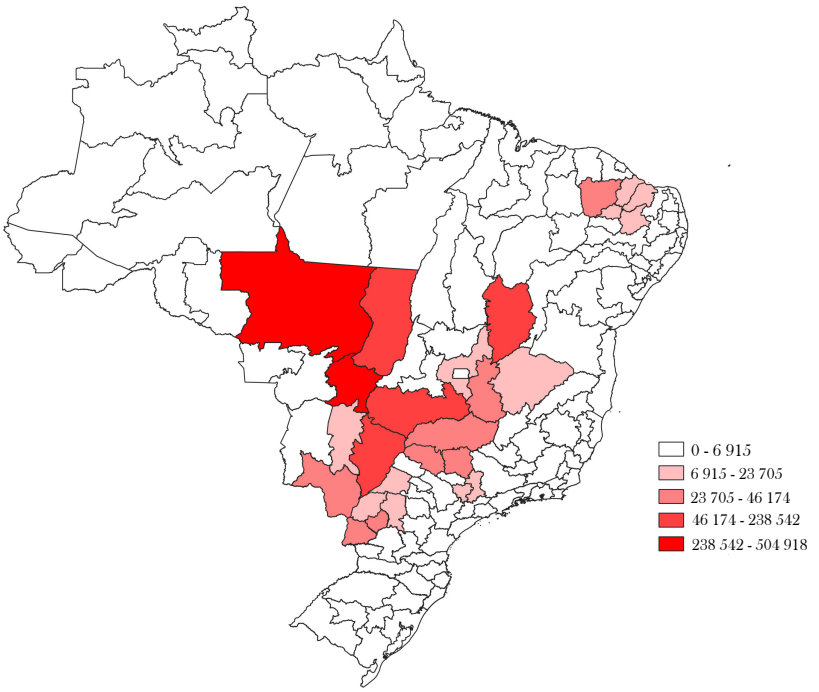
GRAPH 8. INDEX OF PRODUCER PRICE OF COTTON LINT IN BRAZIL, 1994-2019 (100=2014-2016)



Source: Source: FAOSTAT..

the 95 establishments with more than 10 000 hectares, their production accounts for 62% of total cotton output, clearly demonstrating the new characteristic of the cotton producer in Brazil in this third period (see table 8).

MAP 3. COTTON PRODUCTION BY MESOREGION, 2019



Source: IBGE, SIDRA table 1612.

TABLE 7. PRODUCTION IN TONS OF THE PRINCIPAL COTTON MUNICIPALITIES IN MATO GROSSO AND BAHIA, 2019

Mato Grosso	-	*Bahia*	-
Total Estado	4 652 784.00	Total do Estado	1 493 474.00
Sapezal	894 794	São Desidério	592 700
Campo Novo do Parecis	454 315	Formosa do Rio Preto	207 241
Campo Verde	415 800	Barreiras	155 509
Diamantino	277 468	Correntina	153 354
Campos de Júlio	255 911	Riachão das Neves	129 919
Primavera do Leste	202 710	Jaborandi	100 444
Lucas do Rio Verde	179 789	Luís Eduardo Magalhães	94 955
Sorriso	179 029	-	-
Nova Mutum	137 683	-	-
Tapurah	129 600	-	-
Paranatinga	120 859	-	-
Nova Ubiratã	107 776	-	-
Santo Antônio do Leste	95 400	-	-

Source: IBGE, SIDRA tabela 1612. Produção Brazil production = 6 893 340 tons.

TABLE 8. Main factors of cotton production in Brazil, Mato Grosso and Bahia, Agricultural Census of 2017

	Brasil				*Mato Grosso*				*Bahia*			
Size of cotton farms	*Farms*	*Production in tons*	*Value in 1000 réis*	*Area cultivated ha*	*Farms*	*Production in tons*	*Value in 1000 réis*	*Area cultivated ha*	*Farms*	*Production in tons*	*Value in 1000 réis*	*Area cultivated ha*
Less than 10 ha	1 597	710	1 192	1 300					872	411	668	859
10-20 ha	490	369	602	603					268	184	292	356
20-50 ha	460	743	1 487	763					208	416	755	427
50-100 ha	156	845	1 352	807					58	327	584	484
100-200 ha	60	2 933	11 414	1 150	3	1 350	7 257	300	21	195	360	295
200-500 ha	42	10 180	36 769	2 833	7	4 926	17 293	1 148	6	379	731	323
500-1 000 ha	46	81 026	318 691	21 010	27	71 421	281 374	18 158	1	-	-	-
1 000-2 5000 ha	106	267 735	867 202	70 103	70	214 723	686 829	53 687	9	17 228	56 047	5 340
2 500-10 000 ha	159	1 041 086	2 122 574	268 891	85	641 554	1 228 479	168 665	44	237 389	532 327	59 638
10 000+ ha	95	2 341 478	4 116 704	544 942	51	1 463 702	2 610 155	354 617	28	647 621	1 080 654	135 918
Total	3 211	3 747 105	7 477 987	912 402	243	2 397 676	4 831 387	596 575	1 515	904 150	1 672 418	208 640

IBGE, SIDRA table 6959; IBGE, Censo agro (2017).

Currently, Mato Grosso accounts for more than two thirds of both the cultivated area and cotton production in Brazil. In this state cotton is usually grown as a second crop, with millet or soybeans as the first crop, and currently about 85% of the cotton cultivated area is second crop (Bélot & Vilela, 2020, p. 13). The use of genetically modified varieties in Mato Grosso started around 2008, with Monsanto's RR (*roundup ready*) and BG (*bollgad*) technologies. Then in the 2010-2011 crop were used the *liberty link* varieties, resistant to the herbicide glufosinate ammonium, widely applied in the control of weeds resistant to conventional herbicides. But this technology has been replaced for WideStrike and RF (*roundup ready flex*), resistant to glufosinate and glyphosate. Currently, with the appearance of the Helicoverpa armigera caterpillar in the last years, second generation biotechnologies have been introduced.[22] The correct technological package is essential, as seeds, fertilizers and pesticides represent more than 80% of the crop expenses (Conab, 2020b). Another key issue is soil management. Second cycle cotton is increasingly practiced after early soybean plantings. To ensure the long-term sustainability of the activity, it is important to use more alternative crops as well as no-till practices, which favor crop rotations and the use of cover crops (Bélot & Vilela, 2020, pp. 56-57; Santos, 2019). That Brazil has so far succeeded in this enterprise is seen in the fact that in the harvest of 2019-2020 it produced five times more cotton lint on less than half the hectares than it did in 1976 (Conab, 2020c).

One of the advantages of Brazilian cotton production its adaptability to cultivation without irrigation, particularly in the Cerrado biome that has regular rainfall, suitable for rain fed irrigation. In the 2016-2017 harvest, for example, 96% of production occurred in crops without irrigation and Brazil has the highest ratio of production per hectare in non-irrigated crops compared to all the other major producers of cotton in the world.[23]

In the past few years there has been a major shift in production technology with a move to planting genetically modified seeds and adopting no-till agriculture. The change in the production costs between traditional and the new technology production can be seen in two of the most important cotton producing municipalities, Campo Novo de Perecis in the state of Mato Grosso, and Barreiras in the state of Bahia (see table 9). In the harvest of 2006-2007 both municipalities used conventional methods, and in 2019-2020 both adopted the new technology and the costs are expressed in values per hectare.[24] The high cost of the seeds, seedlings, fertilizers and pesticides-insecticides is evident in the new system. The labor costs directly associated with production are negligible or nil in the new system. In the highly mechanized process, the labor factor related to the operations of machines, equipment and even airplanes are computed in the cost of this service, without segregating out their values.

[22] Bollgard II and TwinLink-GLT have been in the market for the last three or four years (Bélot & Vilela, 2020, pp. 15-16).

[23] In the US in the year 2018, some 30% of the land harvested in cotton used irrigation. USDA, NASS, Quick Stats, at https://quickstats.nass.usda.gov/?source_desc=CENSUS. In India irrigation was used on 28% of the land in cotton in the census of 2015 (*All India Report on Agriculture Census 2015-16*, New Delhi, 2020, p. 152, table 5B). In mainland China and Pakistan irrigation accounts for 80% of cotton production, and in Australia the figure is 95%. Associação Brasileira dos Produtores de Algodão. Accessed at: https://www.portaldoagronegocio.com.br/agricultura/algodao/noticias/cotonicultura-brasileira-e-campea-de-produtividade-sem-irrigacao-170092

[24] The methodology used for the cost structure in provided in two sources from Conab (2017a), the first at https://www.conab.gov.br/images/arquivos/normativos/30000_sistema_de_operacoes/30.302_Norma_Metodologia_de_Custo_de_Producao.pdf

TABLE 9. COTTON PRODUCTION COSTS IN TWO OF THE LARGEST PRODUCERS (2006-2007 AND 2019-2020)

	2006-2007 Harvest (percentages) Conventional technology		*2019-2020 Harvest (percentages) High technology*	
Costs	Barreiras, BA	C. N. Perecis, MT	Barreiras, BA	C. N. Perecis, MT
Current expenses	57.3	80.4	65.6	69.4
Operation of machines and planes	9.7	9.9	7.2	5.3
Labor	2.6	5.9	0	0
Seeds and seedlings	2.1	1.6	9.9	6.5
Fertilizers	12.7	14.2	14.8	18.9
Pesticides/Insecticides	29.9	48.8	33.5	35
Others	0.3	0	0.1	3.7
Other expenses	12.8	6	13.7	16.5
External transport	1.2	0.8	0.4	1.4
Processing	7.9	0.4	9.3	9.1
Technical assistance	1.1	1.6	0.8	1.2
Production insurance	2.2	3.1	1.7	1.5
Others	0.3	0	1.6	3.3
Financial expenses	5.3	4	3.1	3.8
Total variable cost	75.4	90.4	82.4	89.7
Depreciation	13.3	3.5	6.6	5.8
Other fixed costs	3	1.7	0.5	0.3
Total operating cost	91.7	95.6	89.5	95.8
Factor income	8.3	4.4	10.5	4.2
Fixed capital remuneration	4.5	0.9	2.5	2
Land	3.7	3.5	8	2.2
Total cost	100	100	100	100
Value of total costs (R$)	4 050.61	4 441.05	9 247.11	9 796.89

Source: CONAB (2022).

In addition to representing an agricultural product which uses lots of inputs and technology, cotton is an essential raw material for the textile sector, and there thus exists a complex *value chain* for this product. Of the inputs used in the production process, the most significant items were estimated to be pesticides (34.7%), fertilizers (25.7%), seeds (12.5%), fuels and lubricants (14.0%). In the 2016-2017 crop, inputs would total 1.3 billion dollars (Associação Brasileira dos Produtores de Algodão [here forth ABRAPA], 2011, graph A.1). It was estimated that in this highly mechanized crop approximately 10 000 people were involved in its cultivation, 170 000 were involved in the preparation and spinning of cotton fibers and textile industries, 655 000 in the clothing industry and another 384 000 workers in retail activities, for a total of 1 200 000 people across the chain (ABRAPA, 2011, tabela A.3). ABRAPA, the Brazilian Association of Cotton Producers, has estimated that the GDP of the cotton chain would represent a value in the order of 74 billion dollars (ABRAPA 2011, 2017, p. 19, tabela A.1; Buainain & Batalha, 2007).

According to United States Department of Agriculture, Foreign Agricultural Service USDA estimates, Brazil will export 2 100 000 tons (or 8 900 000 bales) of cotton lint in the 2022-2023 harvest, out of a total of 2 800 000 tons produced. It estimated that Brazilian exports will repre-

TABLE 10. MAJOR COUNTRIES IMPORTING BRAZILIAN COTTON, 2015-2020 (IN TONS)

Country	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
China, mainland	103 819	57 773	82 954	283 681	501 725	658 752
Viet Nam	135 762	105 730	166 171	134 423	217 165	339 240
Pakistan	54 366	69 893	48 844	35 291	113 037	285 351
Türkiye	97 139	94 669	113 490	67 002	146 781	239 457
Bangladesh	16 915	55 101	87 629	86 870	189 895	211 738
Indonesia	133 536	145 028	170 588	137 783	201 791	202 343
Malaysia	80 255	57 144	47 708	50 702	87 423	83 086
Republic of Korea	99 886	116 742	50 328	50 869	45 528	49 962
Thailand	40 205	37 941	24 033	21 390	24 042	18 757
Sub-total	763 898	742 037	793 762	870 029	1 529 406	2 090 706
Total world exports	834 253	804 802	834 028	915 542	1 613 670	2 125 418

Source: FAOSTAT, detailed trade matrix, accessed July 2022.

sent 21% of world cotton exports in this year, while the leading exporter, the United States, which is to export 3 100 000 tons (USDA, 2022, p. 9). As expected Brazilian exports are going to primary textile and apparel producers in the world (see table 10). Also, these agricultural exports, as with many other Brazilian agricultural products, are organized primarily by multinational trading companies and a few Brazilian ones. Such multinational companies as Cargill, ADM, Bunge, Glencore, Dreyfus, Omnicotton and Olam are among the important cotton exporters of Brazil (ABRAPA, 2022).

Although Brazil is a major world textile and apparel producer, local cotton lint production is sufficient to meet national needs and still send a majority of the cotton overseas.[25] As of the harvest of 2014-2015 more than half of production is exported, reaching an estimated 73% in the harvest of 2020-2021 (see table 11).

[25] Brazil in 2019 was the 14th largest textile manufacturer and eighth largest wearing apparel producer in the world (UNIDO, 2019, p. 65).

TABLE 11. BRAZILIAN PRODUCTION, CONSUMPTION AND STOCK OF RAW COTTON, 2013-2014, 2020-2021 (IN TONS)

Areas	*2013-2014*	*2014-2015*	*2015-2016*	*2016-2017*	*2017-2018*	*2018-2019*	*2019-2020*	*2020-2021a*
Initial stock	445.5	652.3	712.9.9	585.1	629.1	1 020.9	1 487.7	2 000.3
Production	1 734	1 562.8	1 289.2.2	1 529.5	2 005.8	2 778.8	3 001.6	2 787.9
Importation	31.5	2.1	27	33.6	30	1.7	1	1
Supplyb	2 211	2 217.2	2 029.1	2 148.2	2 664.9	3 801.4	4 490.3	4 739.2
Consumption	810	670	640	685	670	700	570	690
Exportation	748.6	834.3	804	834.1	974	1 613.7	1 920	2 010
Final stock	652.3	712.9	585.1	629.1	1 020.9	1 487.7	2 000.3	2 039.2

Notes: [a]Estimate of November, 2020. [b]Supply is the sum of stock+production+importation.
Source: Conab (2020a).

Although Brazil has become the world's second largest exporter of cotton, this product still represents a small percentage of the Brazilian export basket, given the country's representativeness in the world agribusiness market. In 2021 raw cotton exports were valued at 3.5 billion dollars, just half of the value of cellulose and just a tenth of the value of soybean exports. In the total mix of national exports, it represented 6% of all crops exported and 3% of all crops and pastoral products (Secretaria de Comércio Exterior, 2022).

Nevertheless, Brazil has been active in defending its exports. Thus, it was the lead litigant against the United States and its policy of subsidization of cotton exports. These cotton subsidies and incentives became the subject of a long-standing dispute between the Brazilian and United States governments from the time of the founding of the World Trade Organization. The dispute which began in 2002 was concluded in 2014, with the commitment of the United States to make adjustments to its program to support cotton exports, and included an additional payment of 300 000 000 dollars to all the countries, which, like Brazil, were affected by its cotton support policies.[26]

Conclusion

Thus, over six centuries after Portuguese colonists first brought American originated cotton on to the world market, Brazilian cotton has again become an even more important component of international trade. This has been a long and complex history with shifting production zones and changing farming practices. For most of its history Brazilian produced cotton has gone to satisfy the needs of the internal market. But Brazilian cotton of both arboreal and herbaceous varieties never disappeared from the world market. These cottons were important in world commerce in periods when the United States left the market, as during the American Civil War of the 1860s and around the two World Wars.

Although arboreal cotton dominated production until well into the 20th century, the Northeastern producers could not complete against the short strand cotton which had become dominant in the United States and which was introduced into the fields of São Paulo in the 1870s. In this long second phase of Brazilian cotton development it was the Southeastern and Southern states of São Paulo and Paraná, which grew to be competitive to the Northeastern producers. As internal needs for cotton grew both the traditional Northeastern as well as these new centers satisfied local demand and still exported. But this all came to an end with the crisis of the 1990s when neo-liberal policies ended tariff protection for the industry and plant diseases proved difficult to eliminate and temporarily reduced plantings. The result was a decade of major cotton imports and the elimination of exports.

But this was not the end of cotton in Brazil. As part of the modernization of Brazilian agriculture in the late 20th and early 21st century, there was also a complete renovation of Brazilian cotton production as well. The move of cotton production to the Center West opened up a new phase in national production. The adaptation of crop rotation and no till agriculture along with genetically

[26] Camex. Ministério da Economia. "Brasil e EUA assinam memorando que encerra contencioso do algodão". Found at: http://www.comexresponde.gov.br/portalmdic/sitio/interna/noticia.php?area=1&noticia=13421. See World Trade Organization, Secretariat (2014). For studies of this debate see Costa & Bueno (2004) and Paiva (2013).

modified seed ushered in a new age in cotton production. In the space of just two decades Brazil went from being an importer of cotton to becoming the second largest exporter of cotton in the world, a position it had temporarily attained two centuries before.

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