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From Backwardness to Global Agricultural Powerhouse: The Transition of Brazilian Agriculture

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1 Introduction

In 2015 Brazilian GDP fell by 3.8 per cent and in 2016 a by further 3.6 per cent, making this one of the worst recessions in its history. The result was not worse because as other sectors stagnated, agriculture came to the rescue generating production, exports, jobs and foreign currency reserves. Today Brazil's agriculture is highly modernised and one of the most productive in the world for many commodities, making the country one of the major producers and exporters of a large list of agricultural and animal commodities. But this has not always been the case. Just a few decades back Brazilian agriculture was considerably more backward, unproductive and plagued by all manner of economic, technical and social problems. Since the mid-1970s, however, the sector has experienced a fourfold increase in production using basically the same amount of land and labour. How did this exceptional transition take place?

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We answer this question in this chapter by analysing the economic history of Brazilian agriculture since the end of WWII. Until the early 1960s, frontier expansion had been the main determinant of agricultural growth, but starting in the early 1970s, modernisation accelerated substantially, and the expansion of the frontier assumed a subsidiary role. We consider the extent to which two often-cited theories of agricultural development explain the modernisation and transition of Brazilian agricultural. The first is the Hayami & Ruttan (1971) theory of induced innovation, in which technological change comes about as a natural response to resource endowments and the economic environment of the country. The second is the claim that the changes were fundamentally driven by enlightened technocrats who commanded the process of change.[1] We argue that the initial process of modernisation up to the 1990s can best be understood through the second of these approaches. Top-down technocratic policy imposed a series of reforms that sought to modernise the sector and remove the bottlenecks and inefficiencies that hindered agriculture and created obstacles with consequences for industry and the macroeconomy, which were the central objectives of the policymakers. We describe how these interventions succeeded in creating a productive agribusiness sector, for example by investing heavily in technology adapted to the realities of Brazilian agriculture. But at the same time the interventions also led to further distortions and inefficiencies in agriculture as it was used as an instrument for generating foreign exchange, controlling inflation and other subsidiary objectives. The final transformation into a major world agricultural producer only took place after the mid-1990s, once the country managed to control inflation and improve political institutions, which allowed a less interventionist policy, in which induced innovation could finally thrive.

2 Theories of Agricultural Development

Different theories have been proposed for understanding the transformation of agriculture in developing economies. We focus on two theories which have dominated the literature on Brazilian agriculture, but also address other approaches. The first assumes that, in the take-off stage,

traditional agriculture fails to respond to the needs of development; the second considers that agriculture, even traditional, is essentially responsive, merely requiring the removal of obstacles and the provision of incentives to change. The first outlook usually prescribes deep restructuring—a broad agrarian reform—to achieve a satisfactory response; the other prescribes adequate market-oriented policies to trigger agricultural modernisation.

For the Brazilian structuralists, agricultural modernisation was precluded by the country's highly concentrated pattern of land ownership. This would explain the lack of motivation of large landowners, more interested in political power, and the paltry contribution of peasants—small farmers being too weak and oppressed to make a difference. Thus, the country's agriculture remained locked at the margin of modernisation. To eliminate this obstacle, a thorough land reform would be required. Their outlook had some similarities to that of Malthusian population theory. As shown by Boserup (1965), for Malthus agricultural expansion would inevitably fall behind that of population, generating scarcity and holding up development. In both cases, the removal of exogenous obstacles would require drastic measures—an agrarian reform for the structuralists, and drastic population control policies for the Malthusians.

Boserup's approach rejects such extreme outlooks; she contended that agriculture in developing countries was far from stagnant in the face of demand pressures. When demand is small and land abundant, its use tends to be extensive; however, as demand increases, intensification would emerge in various forms, helping to expand production.

Hayami & Ruttan (1971) presented a similar approach in Chap. 3 of their major opus, where they reviewed major models of agricultural development, each relevant to specific countries and situations: the *model of resource exploration*—pertinent to Brazil along the first economic surge; the *model of conservation*, the *model of localisation*, the *model of diffusion* and Theodore Schultz (1964)'s influential *model of modern inputs*.[2] In their book, Hayami & Ruttan proposed the *induced development model,* which uses aspects of these models but goes far beyond them. Their model is clearly in line with the second outlook mentioned above. They argue that in most countries that achieved agricultural advances, there was technical

development, essentially induced by market forces. Reacting to deficiencies in the endowment of certain production factors, farmers, organised in rural pressure groups and operating in market economies, pressured for the development of means to overcome such deficiencies, leading to technological change.

3 Agricultural Expansion in the First Economic Boom and Beyond

From the end of WWII to the early 1970s, agricultural growth in Brazil went through a phase of horizontal expansion**.** As mentioned, the model relevant to this period was that of *resource exploration* (Hayami & Ruttan, 1971, Chap. 3). The growth of agricultural production resulted basically from the incorporation of areas in the agricultural frontier; outside limited islands of modernisation, agriculture remained essentially traditional, with low productivity. In the 1960s the agricultural frontier was still limited to the country's South and Southeast regions. There were huge areas in the centre and the North of Brazil (the Cerrado Savannas of central Brazil; the Amazon) lightly touched by agricultural ventures, but the availability of unused or underused potential land in the Southeast and South of Brazil had declined. To continue growing, agriculture depended on technological change.

Up to the early 1970s Brazil was basically an exporter of a few cursorily processed commodities. As shown by Miller Paiva, Rui, & de Freitas (1976, Table II.21), in 1970, 78.5 per cent of the value of agricultural exports originated from three products: coffee (59.7 per cent), cotton (10.7 per cent) and sugar (8.2 per cent). Until then, large portions the rural productive resources (especially land and labour) were devoted to the production of the main export crops, (coffee and cotton in the Southeast and South, and sugar in the Southeast and the Northeast), and to basic products, consumed domestically.

Brazil's economic history in the phase of horizontal expansion highlights, along with the coffee boom, the impact of the first economic import substitution industrialisation (ISI) surge. The modernisation of

agriculture received very limited attention by the ISI strategy then implemented. Nevertheless, it succeeded in transferring income from agriculture to the urban–industrial sector, chiefly through the manipulation of relative prices against agriculture (Bacha, 1975; Oliveira, 1981). The foreign exchange—then primarily generated by agricultural exports—was maintained artificially overvalued, and the prices of agricultural products for the domestic market were compressed, in contrast to prices of industrial goods, which were subject to protectionist measures. But in the booming 1950s, the consistently overvalued foreign exchange did not hinder the income transfer; high international coffee prices compensated, to some extent, for the overvalued domestic currency. This commodity was responsible for an important portion of the country's export earnings, essential for input and equipment imports. Moreover, the performance of agriculture in meeting the demands of an expanding urban–industrial sector was satisfactory in that period. Production increased enough to assure that, by and large, the sectoral terms of trade would not negatively affect ISI, despite the rapid pace of import substitution and of the growth of urban demand for food; this was a by-product of the opening of the agricultural frontier (Mueller, 2011).

Agricultural modernisation policies were almost non-existent in the phase of horizontal expansion; an exception were initiatives to advance the production of coffee, cotton and sugar cane by the state government of São Paulo, the effects of which, although noteworthy, were limited mostly to that state (Pastore, Dias, Guilherme, & Castro, 1976). In fact, as documented by Nicholls (1970), the policy that favoured most agricultural expansion was road building; new and better roads widened the agricultural frontier, enabling production to grow with traditional methods. There were attempts at engendering technical change in other states, but with negligible results (Miller Paiva et al., 1976, Chap. 4).

The nature of the Brazilian agricultural expansion in the period emerges in the indicators calculated by Patrick (1975). Using shift-share analysis on the amount produced of Brazil's 23 major agricultural crops, he compared their 1947–1949 average physical production with that of 1967–1969. For Brazil as a whole, he estimated a 3.8 per cent annual rate of growth of production (4.3 per cent excluding coffee); he established that 91.9 per cent of that growth was due to the expansion of the area

cultivated—the *area effect*—and only 20.2 per cent to the *yield effect*. In that period, agricultural expansion relied mainly on the expansion of the frontier; increases in yield had limited impact.

It is interesting to contrast Patrick's results for São Paulo, then the more advanced agricultural state, with those for the backward, drought-prone Northeast region. Of the 3.1 per cent 1947/1949–1967/1969 growth of São Paulo, 23.0 per cent was due to area expansion but 59.8 per cent to increases in yield; as for the Northeast, of the 3.8 per cent growth in production in the period, 123.6 per cent was due to the *area effect* and −16.4 per cent to the *yield effect*. In the period, São Paulo experienced the effects of its modernisation policies, while in the Northeast, area had to expand to overcome yield reductions.

Table 15.1 reveals the backward state of Brazilian agriculture in the phase of horizontal expansion. It shows the 1949–1951 and the 1969–1971 average yields of the country's main crops of the period. They are low both by international standards, and relative to the 2013–2015 yields. In most cases, they changed little over two decades. Crops such as potatoes, coffee and sugar cane may seem to contradict this, but the evolution of these crops was influenced by the mentioned technical changes in the State of São Paulo. The stagnant state of important crops such as rice, beans and maize reveals the poor technological progress of most of Brazilian agriculture along this period (soya bean cultivation was just beginning). This contrasts markedly with the 1970–2014 performance.

The livestock sector went through a similar state of affairs. Between 1950 and 1970, in the beef cattle industry the number of animals grew and the production of beef increased (see Table 15.2, below), but as shown by Mueller (1974, Chap. II), the beef cattle production was mostly extensive or ultra-extensive in the period. There were localised exceptions, but as a rule the main problems—which even in the early 1970s appeared intractable—were: inadequate sanitary control; animal diseases; low genetic quality of the heard; low calving indexes; large mortality of calves; low quality pastures; and poor management. Due to inadequate sanitary conditions, beef exports were minimal—in 1970, the value of beef cattle meat exports amounted to only 3 per cent of the total agricultural exports (Miller Paiva et al., 1976, Chap. 3.c). As we show in Table 15.2, however, changes afterwards were remarkable.

Table 15.1 Average yields of major crops, 1950, 1970 and 2014

Crop	I 1949–1951	II 1969–1971	III 2013–2015	% Δ I–II	% Δ II–III
Cotton (a)	–	2,028	3,752	–	85.0%
Rice	1,603	1,430	5,320	–10.8%	272.0%
Potatoes	4,814	7,260	28,336	50.8%	290.3%
Coffee	406	975	1,387	140.1%	42.3%
Beans	695	642	1,047	–7.6%	63.1%
Sugar-cane	38,921	45,926	73,387	18.0%	59.8%
Manioc	12,946	14,655	14,717	13.2%	0.4%
Corn	1,170	1,365	5,322	16.7%	289.9%
Soya beans (b)	1,483*	1,186	2,941	–20.0%	148.0%

Yields in kilograms/hectare. (a) 1949/1951 comparable data for cotton were not available; (b) data for soya beans available starting in 1952; *1952/1954 average

Source: IBGE, Estatísticas Históricas (1946–1971); IBGE, Sidra (2016)

Table 15.2 Brazil, livestock sector, 1961, 1970 and 2014

	1961	1970	2014
Cattle (million animals)	76.2	97.9	212.4
Animals slaughtered (million)	7.1	9.6	40.4
Production weight (million tonnes)	1.4	1.8	9.7
Carcass weight (kg/animal)	1,917	1,930	2,408
Chicken			
Animals slaughtered (million)	0.123	0.333	5690.7
Production weight (million tonnes)	0.123	0.366	12,519.5
Pig meat			
Animals slaughtered (million)	8.0	11.3	37.1
Production weight (million tonnes)	0.53	0.77	3.19
Carcass weight (kg/animal)	667	683	860
Fresh milk			
Dairy cattle (million)	7.4	9.5	23.0
Production (million tonnes)	5.2	7.3	35.1

Sources: fao.org/faostat, accessed 3/1/2017. IBGE (1990). IBGE sidra.org br. Accessed 5/1/17

During this period, the other livestock sectors—poultry, milk and pork—also exhibited very low technological performances. Suffice it to say that no exports of chicken and pig meat were recorded. Low productivity and sanitary problems strongly hindered external sales.

In sum, by the early 1970s Brazilian agriculture was still "traditional" almost everywhere. Production increased, due mostly to the incorpora-

tion of land and of traditional inputs. Because of the high priority given to ISI, there were negligible efforts to induce agricultural modernisation. As we show below, the situation changed remarkably afterwards.

4 Agricultural Expansion in the Phase of 'Conservative Modernisation'

From the 1970s onwards, there were noticeable increases and diversification in the production of the modern sector of agriculture. As can be seen in Fig. 15.1, the harvest of grains and oilseeds[3]—a proxy of Brazil's agricultural performance—experienced a strong growing trend.

Progress started modestly along the 1976/1977–1983/1984 harvests (production increased from 46.9 million to 52.4 million tonnes), and accelerated between 1983/1984–1999/2000 (production rose from 52.4 million to 83.0 million tonnes) and, quite remarkably between the turn of the century and the 2014/2015 harvests (from 83.0 million to 207.7 million tonnes).[4] In the 23 years between the 1976/1977 and the 1999/2000 harvests, production grew 77 per cent, from 46.9 million to 83.0 million tonnes; and it grew an outstanding 250.2 per cent in 13 years, between 1999/2000 and 2014/2015 harvests, reaching 207.7 million tonnes.

Figure 15.1 shows that growth in the 1976/1977–1999/2000 period took place with limited addition of cultivated area. The expansion of production occurred with very little addition of land under cultivation (from 37.3 million to 37.8 million ha). In the 1999/2000–2014/2015 period, the area cultivated increased 53.2 per cent. In the first period (1976–1999) production expanded mostly by means of a more intensive use of land in settled areas of the Southeast and South regions; in the 1999/2000–2014/2015 harvests, there was a significant incorporation of areas in the frontier—notably in the Cerrado savannahs of Central Brazil. The marked increase in output was due to gains in yield, made possible by technical change, both in the previously settled regions and in the Cerrado areas incorporated since the early 1970s (Rezende, 2003).

Table 15.1 shows the recent yields of major agricultural products; the contrast with those of the first phase is stark. Crops such as maize, then

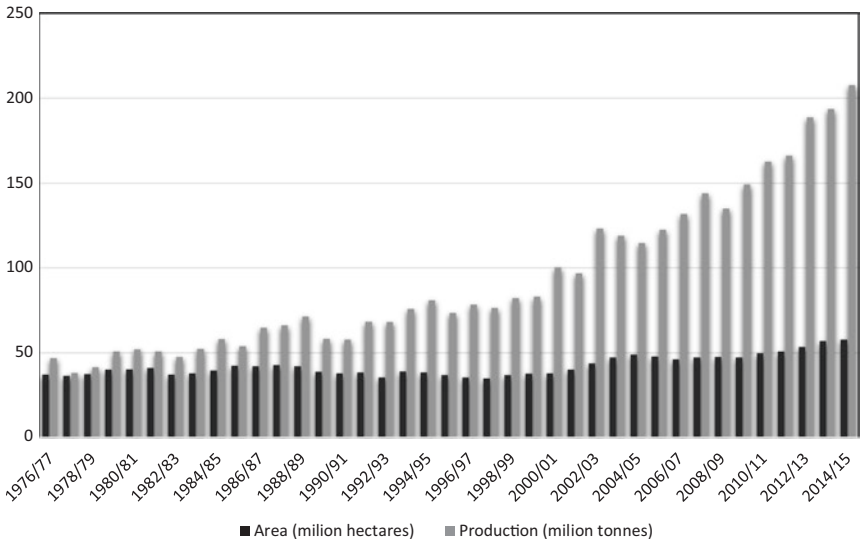

Fig. 15.1 Brazil, area cultivated and production of grains and oilseeds, 1976/1977–2014/2015. Source of the data: CONAB (2016)

grown mostly for internal use, became "internationalised" in the second phase; its yield increased from an average of 1365 kg/ha (kilograms per hectare) in 1969–1971 to an average of 5322 kg/ha in 2013/2015. The yield of sugar cane increased from an average of 45.9 tonnes/hectare in 1969/1971 to an average of 73.4 tonnes/ha in 2013/2015. The yield of soya beans showed an apparently modest rise, from an average of less than 1500 kg/ha in the first phase to an average of 2941 kg/ha in the 2013/2015 years. The cultivation of soya beans, which started relatively modernised in the South of Brazil, advanced rapidly—with increasing technology—in the Cerrado savannahs.

The advance of the crop sector was translated into a rapid increase and diversification of exports. Today Brazil is one of the main exporters of commodities such as soybeans (ranked 1st worldwide in 2013), sugar (ranked 1st), coffee (ranked 1st), and maize (ranked 3rd), as well as a major exporter of cotton, tobacco, and oranges juice, among other crops (faostat.fao.org, 2017).

There have also been outstanding changes in the beef, poultry, pork, eggs and milk sectors. The problems of the first phase were consistently tackled alongside the second phase, transforming the livestock sector into a leading world player. Table 15.2 presents features of this transformation. Starting with chicken meat, at the end of the 1st phase only 333,000 animals were slaughtered and 366,000 tonnes were produced. As mentioned, chicken meat exports were insignificant. By 2014 the changes in this segment were astounding. The number of animals slaughtered reached almost 5.7 billion, with a total weight of 12.6 million tonnes; in 2013 Brazil was the main exporter of chicken meat, with a total value exceeding US$ 7 billion.[5]

The beef cattle sector also experienced remarkable change. Table 15.2 shows that between 1970 and 2014 the cattle herd increased 117 per cent, the number of animals slaughtered 321 per cent and the total production weight 439 per cent—quite a substantial increment in productivity. In 2013 Brazil's total beef cattle exports ranked second (after India) totalling US$ 5.3 billion. As for pig meat, in the 1970–2014 period the number of animals increased 228 per cent, but the production weight rose 414 per cent, reflecting strong gains in productivity. In 1970 the idea of Brazilian pig meat exports would be considered absurd; but in 2013 the country was the fifth largest world exporter of the commodity.

As for milk, up to the mid-1980s, disruptions in production often turned Brazil into a net importer, but with technological improvements the situation changed. Table 15.2 shows a 142 per cent increase in the milk herd, and a sizable 381 per cent increment in production between 1970 and 2014. The sector also experienced marked qualitative improvements.

Across both periods the value of exports increased systematically, but there was a rise in the rate of increase in the second period. The volume of agricultural exports rose by 105 per cent from 1973 to 1999, but then it increased 483 per cent from 1999 to 2016.[6] The acceleration of agricultural exports is due both to the improvements in supply emphasised in this chapter and to the increased demand for agricultural and food products in the 2000s. It is beyond the scope of this paper to determine the relative importance of each of these factors regarding exports.

5 Foundations of Brazil's Recent Technological Advance

We focus now on two possible explanations of the modernisation which took place in Brazilian agriculture—a process that occurred with impressive results in a relatively short period. We examine first, whether these changes were brought about by market-forces-induced technological development, such as that of the Hayami & Ruttan (1971) theory. Incidentally, this theory was widely acknowledged in Brazil during the 1970s and 1980s.

According to Hayami & Ruttan, in most countries that achieved agricultural advances, technical development was brought about by market forces. Reacting to deficiencies in the endowment of certain production factors, farmers, organised in rural pressure groups and operating in free-market economies, pressured for the development of means to overcome such deficiencies, leading to technological change, and to increases in production and productivity.[7]

In corroboration of their theory, Hayami & Ruttan (1971, Part III) offer the cases of the USA and of Japan. For the USA, the main limitation was the scarcity of labour—strongly felt in in the nineteenth century. This was conducive to the development and diffusion of labour-saving mechanical technologies by agricultural R&D organisations. In Japan, the main deficiency was the scarcity of land. In the nineteenth century, development of effective land-saving chemicals and biological technical changes had already started. The events in both countries led to significant agricultural advances, not due to actions of enlightened planners, but brought about by pressure coming from farmers in the two countries—exerted through rural pressure organisations. These led to efforts in R&D fields that overcame the respective shortfalls in productive factors. In other words, change was induced by growing costs that the scarcity of the productive resources entailed. Market forces and farmer pressure brought about the development of mechanisation in the USA, and chemical and biological technologies in Japan. Thus, both countries avoided the problems of the shortfalls of productive factors, achieving noteworthy agricultural expansion.

We contend that the theory of induced development does not hold up in the case in Brazil. In the 1970s, when the technological development of agriculture started to accelerate, basically neither land nor labour were scarce. Of course, unused potential land in the old agricultural frontier was shrinking, but investments in transportation infrastructure could make additional potential land available in new frontier areas; and labour—at least unskilled—was far from scarce. Moreover, farmers' organisations that might effectively pressure for technological change were few. Such pressure certainly began taking place in the early twentieth century in the state of São Paulo, where the influence of coffee growers led to measures to overcome agronomic problems affecting them (Pastore et al., 1976). But there was no similar movement when the more recent effort for technical development began to unfold.

To a large extent, what took place starting in the late 1960s was the effect of actions and measures created by enlightened technocrats. The theory induced institutional innovation by Hayami and Ruttan (1971) had a great influence on agricultural economists and other agricultural experts. This view emphasized the importance and complexities of technical change in agriculture. In addition, several other changes were introduced in Brazil in the late 1960s and 1970s, as discussed below.

The import substitution strategy adopted after WWII, already mentioned above, was quite successful in promoting industrialisation and economic growth. Between 1947 and 1961 the Brazilian economy grew, in real terms, 128 per cent, and industry, 262 per cent (Baer, 2001, p. 63). The implementation of the strategy relied substantially on ad hoc measures; an instance was the above-mentioned transfers of income from agriculture in the first phase, achieved basically through artificially compressed agricultural prices and by the maintenance of an overvalued foreign exchange—to a large extent generated by agricultural exports.

Since growth involved the recourse to foreign capital (as loans and as direct investment), there were mounting balance-of-payment pressures (Baer, 2001, p. 69). Likewise, in this period the tax structure remained inadequate for the needs and subsidies of ISI, and there were growing fiscal deficits, financed by the creation of money, resulting in mounting inflation, which peaked in the early 1960s. Moreover, the Brazilian finan-

cial system was progressively out of tune with the needs of a modernised urban industrial sector; the country did not even have a Central Bank.[8]

In the early 1960s, however, the ISI strategy began losing its impetus. Due to a legacy of problems, growth decelerated, unemployment increased sharply, and balance-of-payment deficits got out of hand. And the economic problems intensified political conflicts, the main origin of which lay in two opposing views about the future of the Brazilian development: on one extreme was the left, demanding radical reforms; on the other, factions on the centre-right and right, rejected the radical stance, claiming that to recover growth the creation of institutions for the efficient functioning of a market economy was necessary.

Agricultural expansion offers an instance of the nature of this political confrontation. The left embraced the structuralist interpretation generated by agrarian and social studies (de Castro, 1979); it claimed that, by failing to grow adequately, agriculture was an obstacle to development; the root of the problem was Brazil's huge disparity of land distribution (which remains to the present). For the structuralists, the few owners of large farms—the "latifundistas"—were concerned with political power and land speculation and not with productivity and efficiency; as for the large number of landless peasants, they were regarded as too weak and oppressed to make a difference. The main structuralist policy prescription was that of agrarian reform, expropriating land from large landholdings, transferring it to small farmers and agricultural workers—groups regarded as more responsive to the requirements of development.[9] The opposite view, however, contended that what agriculture needed was institutional change, allowing it to grow with rising productivity. An agrarian reform would require excessive resources; besides, it would upset revered property rights.

In 1964 the confrontation between the extremes was resolved by a military coup crushing the radical reform attempts of the left and establishing the 1964–1984 authoritarian regime. And, as shown by Resende (1992), the main economic objectives of the new regime were: to induce economic growth, led by market forces; raise productive employment; contain inflation; lessen sectoral and regional imbalances; induce investments—public and private, domestic and foreign; revert the tendency of high balance-of-payment deficits; and curb the foreign debt. To control

inflation the main instrument would be the reduction of fiscal deficits, through tax reform and cuts in public expenditures. And, in order to limit foreign sector distortions, a foreign exchange reform was prescribed (Corrêa do Lago, 1992).

The new regime claimed that it would maintain a free-market economy, but that, to create conditions for growth and modernisation, it would be necessary to impose economic reforms and significant central planning. Measures were deemed necessary for agricultural modernisation to take place; yet a radical agrarian reform was not considered necessary. This was, in a nutshell, the basis of the "conservative modernisation" strategy that was implemented.

The second half the 1960s saw the emergence of the *domain of technocracy*. Modernising reforms were imposed, establishing the environment for a rapid resumption of growth, under the heavy guidance of technocrats in all policy areas (Baer, 2001, Chap. 5; Resende, 1992). Technocrats substituted the political appointees of the past, establishing a strong tutelage over the "free-market" development process. After the imbalances of the past were addressed, the technocrats began implementing a vigorous import substitution strategy—at a quite higher level than that of the 1950s. It brought about a period of substantial growth and of structural transformation (de Castro, 1985). There was an important participation of the public sector in this, and of a burgeoning segment of public enterprises (Baer, 2001: Chap. 12).

It is important to consider that the nature of political institutions during this period facilitated the implementation of the agricultural policies we are describing. Many countries have had the intention of adopting similar policies to modernise agriculture but without achieving similar results. Brazil's authoritarian military regime that delegated policy implementation to technocratic bureaucracy provided the setting in which policymakers had both the intent and the power to implement the modernising reforms.

In the late 1970s and in the 1980s the strategy generated very high costs in terms of both an explosive foreign debt and of an accelerating inflation. The end of the military regime in 1984 and the return to democracy brought about the end of the *domain of technocracy,* but it left significant marks in the Brazilian economy.

We focus now on the nature and results of actions of the *domain of technocracy* to modernise agriculture. Promotion of industrialisation was the main goal of the military regime, but for this an adequate performance of agriculture, both for the adequate supply of products for growing urban–industrial markets, and for the provision of foreign exchange through exports, was deemed fundamental; the modernisation of agriculture was considered vital for this. We now turn to the actions undertaken.

6 The Construction of "Conservative Modernisation"

The central agents of agricultural modernisation were an active class of entrepreneurial farmers. If the typical agricultural producers of the 1970s and beyond had been the archetypal absentee landlords, the impacts of the modernisation measures undertaken would have been modest. However, in portions of the South and Southeast regions there already was a significant reserve of entrepreneurial farmers willing to innovate. These farmers, prompted by incentive policies, mobilized much land that was previously extensively used in the settled regions of the South and Southeast, as well as land in frontier areas that were made accessible by new transport infrastructure. These entrepreneurial farmers were fundamental for the modernised expansion of agriculture of the second phase.

The main foundations of the agricultural development strategy were:

- *Erection of an effective research system in tropical agriculture*. The first steps towards this were taken in the late 1960s, and efforts were intensified in the 1970s and afterwards. The construction of this system required the assembly of ample research facilities, the hiring and training of the personnel, and the institution of a scheme to coordinate, manage and make the system expand. For this, the federal government established a public entity, EMBRAPA (*Empresa Brasileira de Pesquisa Agropecuária*—The Brazilian Enterprise for Agricultural Research)

(Martha Jr, Contini, & Alves, 2012). In view of Brazil's geographical size and of the diversity of the country's habitats and social design, EMBRAPA was instituted as a decentralised research system, composed of units spread throughout the country, together with special thematic centres. Furthermore, the organisation enlisted the collaboration of other organisations involved in agricultural research (state research units, universities—in Brazil and abroad—and private organisations).

- As indicated above, results began to be felt already in the 1970s; initially new technologies emphasised improvements in production processes, but with time more complex developments took place, such as the creation of plant varieties adapted to the conditions of specific regions. Modernisation, which accelerated during the 1980s and beyond, owes a lot to this approach to technilogical change that significantly advanced the green revolution in Brazil.
- *Inducement policies*. From the start, inducements were deemed necessary for the adoption of modern agricultural technologies. The modernisation strategy made substantial financial resources increasingly available to agricultural producers willing to follow this path. The main policies to this effect were:
  - *The establishment of the National System of Rural Credit (NSRC).* The NSRC began, in the late 1960s, to provide abundant financing, in very generous terms, to modernising farmers. Among other things it financed the purchase of modern inputs (equipment, fertilisers, pesticides and insecticides, selected seeds), much of which was initially imported, but gradually also provided domestically. The NSRC credit was highly subsided; its interest rates were maintained far lower than the growing rates of inflation, and the principal tended not to be corrected for inflation.

    Agricultural credit expanded noticeably in the 1970s, reaching US$ 16 billion in 1974 and staying above US$ 20 billion every year of the 1975–1982 period.[10] Until the mid-1980s, the ultimate source of the financial resources for the credit policy was the Treasury, and it made use of its access to the Central Bank to create money for this.

The credit bonanza was maintained up to the mid-1980s. Cutbacks in subsidised agricultural credit occurred thereafter, and provisions for the correction of amounts due for inflation became the norm. Brazil was then, frequently, at the brink of hyperinflation and international insolvency (Carneiro & Modiano, 1992; Modiano, 1992). Moreover, in 1986 the almost automatic link between the Treasury and the Central Bank was eliminated and the use of federal funds was limited.

– *Improvement and expansion of the minimum price policy***.** In the 1970s an already existing minimum price apparatus was reformed and the role of the policy increased; however, until the mid-1980s credit policy was dominant in the modernisation strategy. Changes in this policy and the determination to continue extending financial incentives to agriculture led, increasingly, to the use of the minimum price policy (Goldin & Castro de Rezende, 1993; Rezende, 2003: Chap. 1). However, in the second half of the 1980s and the early 1990s, there were swelling problems in the administration of the policy. Sharply growing public expenditure with minimum prices and the substantial accumulation of inventories of products together with ensuing logistical problems, led to restrictions in the use of the policy.

  In the late 1980s, minimum prices became an instrument of regional development (Rezende, 2003). Setting up nationally unified—and usually remunerative—minimum prices of crops such as soya beans and cotton, the expansion of agriculture in Brazil's large savannahs (the *Cerrado*) was stimulated. The *tropicalisation* of such crops, achieved by EMBRAPA, contributed to their successful cultivation in areas previously considered unsuitable (Cunha et al., 1994). An obstacle for expansion in that area was high transportation costs resulting from a deficient transportation infrastructure. To overcome this, official minimum prices offered the Cerrado producers nearly the same compensation as those of farmers located near markets; in most of the new Cerrado areas minimum prices substantially exceeded market prices after transportation costs were deducted, and producers there tended to sell their output to the

minimum price organisation. Over the second half of the 1980s, considerable portions of the output of the Cerrado (mainly soya beans) became publicly owned and the government subsidised the growing costs of transportation and storage of products, which then were being disposed with substantial losses.[11]

- *Inducements for the expansion of a dynamic agribusiness sector.* The import substitution strategy encouraged the growth of a dynamic agribusiness sector, which became an important factor in agricultural growth and modernisation. An agribusiness comprises a set of economic activities operating in tandem with agricultural or livestock production. It involves enterprises and activities providing inputs and services to farms; the agricultural activity proper; and businesses purchasing, transporting, processing, transforming and selling the products generated by the agribusiness. In the mid-1970s, the more advanced agricultural areas of the state of São Paulo and of the south of Brazil already had incipient agribusiness complexes, linked to a few agricultural or livestock segments. From this period onwards, several new agribusiness complexes were formed and expanded, stirred by market conditions, by incentives provided by import substitution policies, and by the spread of modern technologies in increasingly diversified agricultural segments of wider geographical areas, reaching new agricultural and livestock fields. Many of the major agribusiness complexes have an important participation of foreign multinationals, and there have also emerged large Brazilian-led agribusinesses.

Finally, if in the 1970s, apart from a few commodities such as coffee, there were no Hayami & Ruttan-type farm organisations to pressure for the measures demanded by farmers as modernisation unfolded, this gradually changed (Mueller, 2009); but such organisations were not important for the conformation of the modernisation strategy.

7 The Consolidation *of Modernisation*

The picture we presented above describes a hectic agricultural policy setting, which was engendering turbulence for the agricultural sector in the 1980s and early 1990s. As shown by Dias & Moitinho Amaral (2000) and Rezende (2003), it was brought about chiefly by macroeconomic constraints and changing priorities. The efficacy of the credit policy for inducing output growth had weakened, the system became regarded as wasteful and distorting, and as an obstacle for the implementation of monetary policy (da Mata, 1982). The public sector became unable to continue funding an increasingly complex and diversified modern agriculture.[12] There was, therefore, a gradual but substantial change in direction of the agricultural strategy.

An important feature in the consolidation of modernisation was the liberalising trend of the 1990s (Mueller & Mueller, 2016). In the decade, Brazilian productive sectors—including its agriculture—were increasingly exposed to international competition. Tariffs were reduced, export prohibitions and import quotas ceased to be employed and the foreign trade bureaucracy was streamlined.

The main changes in agricultural financing were: as mentioned, the *direct* governmental funding of commercial agriculture was contained; official financing was channelled mostly to small farmers and to land-reform projects. For commercial agriculture, there emerged other sources of finance, mostly private. As for the minimum price policy, it ceased to transfer resources to producers, and the purchase of surpluses was limited. Modern, more agile instruments were created, avoiding the untenable practices of the past.

The policy changes of the 1990s evolved with ups and downs, bringing turmoil for the sector. Starting in 1994, for instance, a measure implemented by the administration of the Real Plan was an officially induced growing appreciation of the value of the Real (Baer, 2001: chap. 10). This adversely affected agricultural exports and stimulated imports, in a period of slack international commodity prices. But from 1999 onwards, agriculture received an important boost; the foreign exchange rate was allowed to float freely, producing a sharp depreciation of the Real. This,

and favourable world commodity prices, contributed to the expansion and diversification of agricultural production and exports.

It is interesting that, instead of being contained by the "hands off" policy changes, modern agriculture—prompted by a favourable institutional setting—became increasingly driven by market conditions. Between 1991 and 1998, encompassing the period of foreign exchange appreciation, the annual rate of growth of real agricultural GDP averaged a modest 2.4 per cent, similar to the rate of growth of GDP for the economy (2.8 per cent annually). But from 1999 to 2004, the annual agricultural growth rate averaged an impressive 5.4 per cent; and growth was substantial in almost every year of the period (Mueller & Mueller, 2016). As seen above, agricultural expansion continued even in the more recent period of declining trends in international commodity prices. In effect, this period since 2000 can be thought of as a third period in Brazilian agricultural history, of more market-based growth and modernisation.[13]

Notes

1. Other theories are mentioned below but have not been very influential in the literature on Brazilian agriculture.
2. Hayami & Ruttan emphasised the contribution of this author to their model.
3. Data on grain and oilseed production from CONAB (2016). Crops included: canola, rye, barley, beans, sunflower seeds, mamona, corn (maize), soya beans, sorghum, wheat and triticale.
4. It should be noted that the expansion of the modern sector in the first five years of the millennium occurred in years of very favourable external markets; undoubtedly this favoured the adoption of technology. But this continued to take place when commodity prices dipped.
5. Data on 2013 livestock exports, from fao.org/faostat/en, 2017.
6. These numbers were calculated using agicultural export indices from Brandão (2001) and from CEPEA (*Centro de Estudos Avançados em Economia Aplicada*) http://www.cepea.esalq.usp.br/br/indicador/serie-indices-de-exportacao-do-agronegocio.aspx.

7. For a critique of the Hayami–Ruttan induced innovation theory see Olmstead and Rhodes (1993).
8. Central bank functions were carried out precariously by the federally owned Banco do Brasil; this was opportune for the creation of money to cover growing fiscal deficits.
9. At the time this outlook represented a significant portion of urban public opinion. The structuralist argument was destroyed by Antonio Barros de Castro (1979), once ideologically aligned with it. He identified inconsistencies of the structuralist approach, showing how it was contradicted by the observed performance of agriculture in the 1950s and early 1960s.
10. Values expressed in current US$ dollars (no correction for the US inflation). Series obtained by Goldin and Castro de Rezende (1993).
11. The dumping of part of the surpluses on markets was also used to help contain inflation.
12. This was magnified by changes introduced by the Constitution approved in 1988. It drastically reduced the capacity of the federal government to transfer resources to agriculture in the manner of the past.
13. For a detailed analysis of this period of Brazilian agriculture see Mueller & Mueller, 2016.

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