Brazilian Agriculture: Is it all about the Large Farms?

L'agriculture brésilienne : s'agit-il uniquement de grandes exploitations ?

Brasilianische Landwirtschaft: Geht es nur um die Großbetriebe?

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International observers of Brazil are often astonished by the extremely large farms in the Brazilian Centre-West (*The Economist*, 2010), and sometimes infer that those operations are broadly representative of Brazilian agriculture. The success of Brazil's large farms has contributed to the debate among scholars, policymakers and international aid agencies regarding the optimal farm size(s) to accelerate agricultural and economic growth. Are Brazil's large farms a target size for farms in other regions of the world, such as the Guinea Savannah of Sub-Saharan Africa? How about for farm consolidation efforts in China? Yet despite the enthusiasm for Brazil's agricultural success, and the assumed predominance of large farms, there is little evidence in the literature to support their superior role over small and medium-sized farms in Brazil's agricultural growth process.

Our purpose is to evaluate the role of Brazil's large farms – defined here as having more than 500 hectares (ha) of area – *vis-à-vis* other farm sizes in Brazil's agricultural performance. Specifically, we test whether Brazil's large farms have achieved the highest rate of total factor productivity (TFP) growth over the 1985–2006 period among five farm size classes, and we analyse the distribution of farms by agricultural production value in 2006 over those size classes. While large farms have certainly played a central role in Brazil's agricultural success, so too have the small and medium-sized farms. To start, note that the 1995/96 Agricultural Census recorded over 2,000 farms that were larger than 10,000 ha each, and 37 that were larger than 100,000 ha. Despite the booming growth of soybeans and other commodities grown mainly on Brazil's large farms, the 2006 Agricultural Census demonstrated that 98 per cent of farms in Brazil operated less than 500 ha, and that this majority was responsible for nearly two-thirds of the value of production.[1]

The distribution of farms in Brazil by size and output: A snapshot

Based on data from the Agricultural Censuses in Brazil (IBGE, various years), the number of farm establishments has been remarkably stable between 1970 and 2006. There were 4.924 million farms in 1970 and 4.920 million in 2006.[2] There has also been considerable stability in the farm size distribution over time. The share of farms smaller than 10 ha declined by just one percentage point over the 36 years to 50.3 per cent, while the share of farms over 1,000 ha only rose from 0.8 per cent to 1 per cent. Thus, in spite of developing an agricultural frontier, land reform programmes, and other elements of dynamism, the Gini index (a measure of land size inequality) across agricultural establishments did not budge from 0.85 between 1975 and 2006 (Hoffmann and Ney, 2010).

> "Les exploitations de taille petite et moyenne représentent presque les deux-tiers de la valeur de la production agricole."

In the present article, farms operating less than 500 ha are defined as small and medium (Table 1). In 2006 there were roughly 102,000 farms over 500 ha, which we characterise as large. The large farms controlled 56 per cent of the agricultural land and

Table 1: Number of farms, area and value of output by farm size (2006)

Brazil/size classes	Farms (number)	Area (hectares)	Output (1000s of R$)	Farms	Area	Output
				Share		
Brazil	5,175,636	333,680,037	163,986,295			
0 ha	255,019	–	1,039,387	0.05	0.00	0.01
0–5 ha	1,840,807	3,313,885	11,434,903	0.36	0.01	0.07
5–20 ha	1,373,142	14,774,650	23,470,720	0.27	0.04	0.14
20–100 ha	1,234,802	52,604,220	36,170,441	0.24	0.16	0.22
100–500 ha	370,130	75,603,795	32,286,484	0.07	0.23	0.20
500+ ha	101,736	187,383,487	59,585,360	0.02	0.56	0.36

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produced 36 per cent of Brazil's agricultural output value in that year. Although the share of output produced by large farms has been rising over time, small and medium-sized farms were responsible for 64 per cent of the value of output in 2006.

Total factor productivity growth by farm size: 1985–2006

While there is still an agricultural frontier in the Brazilian *cerrado* – the vast savannah first converted to farmland in the Centre-West in the 1970s, and more recently in parts of the North and Northeastern regions – agricultural growth in Brazil has not relied on the expansion of area. Total area in agriculture has declined since the 1980s, and output growth has relied on improvements in total factor productivity (TFP). TFP growth is a measure of the growth in output that is not accounted for by the growth in conventional inputs, and thus reflects contributions from technical change and improved efficiency. Unlike single factor measures of productivity, such as value of output per hectare (land productivity) or value of output per worker (labour productivity), TFP is a comprehensive measure of performance because it accounts for all measurable factors of production. While many authors have estimated Brazil's agricultural TFP growth at the national and state levels, the present article is the first to estimate TFP growth by farm size.[3]

Table 2: Growth of output and inputs in Brazil by farm size: 1985–2006 (%)

Region/size class	Output	Land	Family Labour	Purchased Inputs	Capital Stock
Brazil	***84***	***–11***	***–29***	***150***	***–1***
0–5 ha	102	–26	–27	106	60
5–20 ha	76	–12	–31	91	18
20–100 ha	53	–10	–28	61	–12
100–500 ha	43	–16	–34	96	–12
500+ ha	159	–9	4	285	11

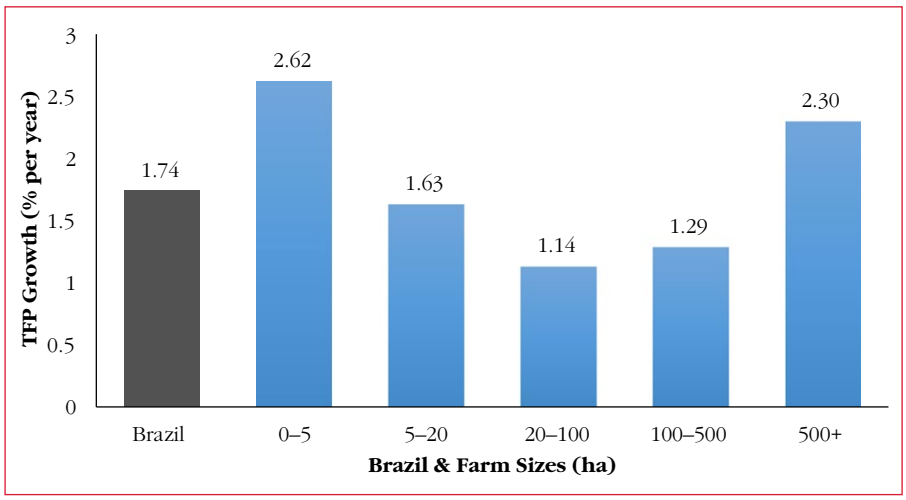
Notes: 1. Value of output growth in constant 2006 R$. 2. Land in pasture equivalent hectares, calculated from relative land rental rates in each region. 3. Family labour in adult male equivalent units, with male=1, female=0.75, and under 14 years=0.5. 4. Purchased input growth in constant 2006 R$. 5. Capital stock measured as an index based on machines, perennials and animals. See Helfand *et al*. (2015) for additional data and methodology details.

Prior to discussing agricultural TFP growth between 1985 and 2006, we examine how output and inputs varied over farm sizes in this period (Table 2). For Brazil as a whole, the total value of agricultural output (deflated to 2006 values) increased by 84 per cent over the period, or by approximately 3 per cent per year. Output grew fastest on the largest and the smallest farms, those over 500 ha (159 per cent) and those under 5 ha (102 per cent). The national output gains were achieved with 11 per cent less land and 29 per cent less family labour. Land utilised in production declined across all farm size classes, and family labour rose only on farms over 500 ha for which hired labour is quantitatively more significant than family labour. Purchased inputs – including fertiliser, seed, animal feed, hired labour, and other items – appear to have played a critical role in output growth, especially on the largest farms where they increased by 285 per cent. Perhaps due to over-investment in tractors during the period of subsidised credit in the 1970s and 1980s, the capital stock changed little for most farm size classes between 1985 and 2006. Capital did, however, grow on the smallest farms (60 per cent), led by investments in tree crops and machines.

We calculate Brazil's agricultural TFP growth by separately estimating translog stochastic production frontiers for the aggregate sample and for each farm size class at the national level over the 21 year period covered by the 1985, 1995/96 and 2006 censuses. Similar to the observed output growth in Table 2, TFP grew slowest for the farm size classes in the middle of the size distribution (Figure 1). Unlike in Table 2, however, TFP growth was faster on the smallest farms (2.6 per cent per year) than on the largest (2.3 per cent per year). The picture that emerges from the growth in production and productivity is that large farms succeeded in increasing output and TFP at a strong rate of growth. But it is the small farms, those operating less than 5 ha, that exhibited the greatest improvements in productivity among farm size classes.

In Brazil it is the small farms that have exhibited the greatest improvements in productivity among farm size classes.

Figure 1: TFP growth in Brazil by farm size (1985–2006)



An intriguing finding is that TFP growth has been slowest for farms in the middle of the size distribution. There are several as-of-yet untested hypotheses that might explain this lacklustre performance. One is size-dependent technology. Large farms, for example, have led the growth process in the Centre-West where soybeans, corn and cotton have expanded rapidly in recent decades based on heavy investments in machinery and purchased inputs. A portion of the small farms, on the other hand, has done extremely well by combining modern technologies with abundant family labour. Institutions, in the form of contract farming or co-operatives have often played a key role in these success stories by assisting farmers to overcome the transactions costs associated with accessing input and output markets. Examples can be found with chickens, pigs and horticulture, to name just a few.

A complementary hypothesis is that Brazil's public policy has focused on the small and the large producers and has, to a certain extent, ignored the middle. Policies toward the sector have been divided between the Ministry of Agriculture – which focuses on large commercial 'agribusiness' enterprises – and the Ministry of Agrarian Development which has focused on 'family farms'. Thus one approach to further boosting Brazil's agricultural productivity and competitiveness may be to identify the obstacles facing mid-sized farms. One such policy was created in the early 2000s – the National Program to Support Medium Agricultural Producers (PRONAMP) – but it does not appear to have evolved beyond a special line of credit. Another option is to study the distribution of medium-sized farm performances and test for technical inefficiency. Should a group of farms achieve higher TFP growth than other farms in the mid-sized farm class sample, then it would likely prove beneficial to determine the policies and factors driving those differences.

Family farm in Paraná, Brazil. © Miguel Angelo Perondi.

> "Kleine und mittelgroße Betriebe erwirtschaften fast zwei Drittel des Produktionswerts."

Characterising Brazilian farms in 2006 by value of output

In this section we characterise farms by total agricultural production value, or scale. Notably, 9.5 per cent of Brazil's farms produce over 86 per cent of the output value. Do all of these 'large-scale' farms operate more than 500 ha; that is, are they large farms by area? Moreover, how are these farms geographically dispersed; is it accurate to characterise Brazil's large-scale farms as producers in the Centre-West? To answer these questions, we analyse the scale of production across the distribution of farm sizes.

To allow comparison with Alves and Rocha (2010), a prominent contribution regarding the role of scale in Brazil, we categorise farms into four groups. The first group, which according to microdata from the 2006 Agricultural Census accounted for approximately 10 per cent of Brazil's farms, had zero production to report. These were farms of all

sizes, and probably reflect under-reporting, the presence of new operations that had not yet begun to produce, and crop failures. The second group consists of more than 3 million farms, or 61 per cent of the total. This group generated less than US$ 7,200 of production per year. These include many older farmers as well as those who produce for subsistence and are not well integrated into markets. A third group of nearly 1 million farms, or 19 per cent of the total, produced between US$ 7,200 and US$ 36,000 of output per year. This group was responsible for about 10 per cent of the value of agricultural output.

The fourth group characterises 'large-scale' farms in the present analysis, as they each produced more than US$ 36,000 of output. This final group consists of 492,000 farms, or 9.5 per cent of the total in 2006, and was responsible for over 86 per cent of Brazil's total agricultural value. Close to 80 per cent of these producers had between 5 and 500 ha (Figure 2). Notably, only 11 per cent of them had more than 500 ha, and were thus large by area. Further examination of this large-scale group reveals that 84 per cent of the farms producing between US$ 36,000 and US$ 720,000 per year had less than 500 ha. And even among the 0.5 per cent of Brazilian farms that produced at least US$ 720,000 each per year and were responsible for 51 per cent of total output value, 41 per cent had less than 500 ha. Thus, small and medium-sized farms are well represented at all scales of output.

Much like the imprecise perception that Brazil's large-scale farms are large by area, it is also inaccurate to characterise giant farms in the Centre-West of the country as representative of Brazilian agriculture. Only 12 per cent of the producers in the large-scale group in Figure 2 were located in the Centre-West, and they accounted for but 19 per cent of the output value among large-scale producers. Over 60 per cent of the farms and value of production in the large-scale group were generated by farms in the Southeast and South of the country.

Lessons and implications

Brazil's large farms – those with more than 500 ha – may make the media headlines, but they have been slightly outperformed in terms of TFP growth by farms with less than 5 ha. Moreover, small and medium-sized farms produce nearly two thirds of the value of output. And when attention is restricted to the top 9.5 per cent of producers by value – a group that was responsible for 86 per cent of output – only 11 per cent are farms with more than 500 ha. Thus, while Brazil's large farms are a critical component of its agricultural sector, it would be inaccurate to associate the sector's growth success solely with these farms. There is a diversity of performance, in terms of TFP growth and production scale, across farm sizes and products which has enabled Brazil's 'Agricultural Miracle'.

> "Small and medium-sized farms produce nearly two thirds of the value of output."

Yet Brazil's large farms have achieved strong TFP growth, and are critically important to national agricultural production. Looking to Brazil's large farms as a model for agricultural development in other regions of the world may indeed prove a successful strategy for boosting agricultural supply. But what are the implications of ignoring the contributions of the small and medium-sized farms to Brazil's agricultural success? Two considerations relate to poverty. First, as we have seen, many small farms in Brazil have been quite successful at increasing TFP. Rising productivity can be a powerful mechanism to increase income and reduce poverty within agriculture. Second, a transition from small to large farms would result in a displacement of labour from agriculture as farms mechanise. Should insufficient employment opportunities exist outside of agriculture to absorb that displaced labour, greater mechanisation may well lead to an increase in informal employment and poverty. A third point relates to the question of food security. Small farms are more likely to produce food for the domestic market, and small farmers in the presence of market transactions costs hedge price risk by producing a portion of the food they consume. The Brazilian model suggests that a balance of small and large farms may be important for producing an adequate supply of a wide range of food products for the domestic market. A final point relates to land rights. The Brazilian *cerrado* is a region that was occupied by large

Figure 2: Share of large-scale farms by farm size (ha)

Note: Large-scale here reflects more than US$ 36,000 of output per year.

In Brazil both small and large farms may be important for producing an adequate supply of a wide range of food products for the domestic market.

cattle farms long before the expansion of large farms specialising in high tech grain production. In many parts of the world, in contrast, where small-sized farms dominate, property rights are not always clear and/or considerable common property may exist. In these settings, farm expansion could be a contentious issue.

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Disclaimer

Any views expressed are the authors' and do not necessarily reflect those of the US Department of Agriculture.

Notes

1 Brazil was planning to do an Agricultural Census in 2016, but this was postponed due to the political and economic turmoil that the country has been experiencing.

2 The 2006 figure excludes 'producers without area', a new category that did not exist in previous years. This group includes permanent workers with agricultural production on the farms where they work.

3 Details regarding the agricultural data and econometric methods may be found in Helfand *et al.* (2015).

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Summary

Brazilian Agriculture: Is it all about the Large Farms?

Too often Brazil's agricultural sector is associated primarily with farms operating thousands of hectares in the vast savannah known as the *cerrado*. Our purpose is to demonstrate that this association is inaccurate, that there exists enormous heterogeneity within the sector across farm sizes. To this end, we separately examine how 1985–2006 total factor productivity (TFP) growth and 2006 production scale vary over farm sizes. We draw on microdata from Brazil's agricultural censuses, aggregated into five farm size classes at the municipality level. While TFP growth has been high on the largest farms, it has been slightly higher on the smallest farms. And when attention is restricted to the 9.5 per cent of farms that accounted for 86 per cent of total production value – those that we designate as 'large scale' – it is clear that most were small and medium-sized farms located in the South and Southeast. Taken together, these results indicate that Brazil's agricultural success has not been only about the large farms. As scholars and policymakers debate the costs and benefits of replicating Brazil's 'Agricultural Miracle' in other parts of the world, it is critical not to overlook the contributions of small and medium-sized farms.

L'agriculture brésilienne : s'agit-il uniquement de grandes exploitations ?

Trop souvent, le secteur agricole brésilien est associé en premier lieu à de grandes exploitations agricoles couvrant des milliers d'hectares dans la vaste savane appelée le Cerrado. Notre but est de montrer que cette association est inexacte et qu'il existe une immense hétérogénéité au sein du secteur en termes de taille d'exploitations. À cette fin, nous examinons les différences de croissance de la productivité totale des facteurs (PTF) au cours de la période 1985–2006 et d'échelle de production en 2006, selon la taille des exploitations. Nous utilisons les données microéconomiques du recensement de l'agriculture au Brésil, agrégées en cinq classes de taille d'exploitations au niveau des municipalités. Si la croissance de la PTF a été forte dans les plus grandes exploitations, elle a été légèrement supérieure dans les exploitations les plus petites. Ainsi, lorsque l'attention se limite aux 9.5 pour cent des exploitations qui représentent 86 pour cent de la valeur de la production – celles appelées "à grande échelle" – il est clair que la plupart étaient des exploitations de taille petite ou moyenne, situées dans le sud et le sud-est du pays. Au total, ces résultats indiquent que le succès agricole du Brésil n'est pas simplement dû aux grandes exploitations. Alors que les savants et les décideurs de l'action publique discutent des coûts et avantages de la reproduction du "miracle agricole" brésilien dans d'autres parties du monde, il est essentiel de ne pas négliger les contributions des exploitations de taille petite et moyenne.

Brasilianische Landwirtschaft: Geht es nur um die Großbetriebe?

Viel zu häufig wird der Agrarsektor in Brasilien hauptsächlich mit Betrieben assoziiert, die tausende von Hektar in der ausgedehnten Savanne, besser bekannt als Cerrado, bewirtschaften. Im vorliegenden Beitrag wollen wir zeigen,dass diese Assoziation so nicht stimmt und dass es eine enorme Heterogenität bezüglich der Betriebsgrößen innerhalb des Sektors gibt. Dafür haben wir untersucht, wie sich das Wachstum der totalen Faktorproduktivität (TFP) von 1985 bis 2006 entwickelt hat und wie sich der Produktionsumfang im Jahr 2006 zwischen den einzelnen Betriebsgrößen unterscheidet. Für unsere Analysen haben wir Mikrodaten des brasilianischen Landwirtschaftszensus verwendet und dabei fünf Betriebsgrößenklassen auf der Ebene der Gemeinde gebildet. Während das TFP-Wachstum auf den großen Betrieben hoch war, war es auf den kleinsten Betrieben sogar noch etwas höher. Betrachten wir die 9.5 Prozent der Betriebe näher, die 86 Prozent des Produktionswertes auf sich vereinen und die wir als „groß" bezeichnen würden, wird deutlich, dass es sich hier meist um kleine und mittelgroße Betriebe aus dem Süden und Südosten des Landes handelt. Insgesamt zeigen die Ergebnisse, dass der Erfolg der brasilianischen Landwirtschaft sich nicht nur auf Großbetriebe bezieht. Vor dem Hintergrund, dass Wissenschaftler und Politiker die Kosten und den Nutzen einer Übertragung des brasilianischen „Landwirtschaftswunders" in andere Teile der Welt diskutieren, ist es wichtig, die Beiträge der kleinen und mittelgroßen Betriebe nicht zu übersehen.