Use of barter contracts in Mato Grosso state, Brazil[1,2]

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Abstract – In the 21st century, the grain production in Brazil has significantly expanded. The country has become the most important producer and exporter of soybean. This production growth is due to the expansion of the agricultural frontier in the Cerrado region. Because the grain production in the Cerrado region is carried out at a large scale – from a few hundred to several thousand hectares –, farmers need to obtain resources for inputs, such as seeds, fertilizers, and agrochemicals. Many farmers obtain inputs through barter contracts. They barter inputs for future harvest with local input vendors and multinational grain trading companies. Barter contracts have helped farmers to expand their production. However, farmers who financed their production through barter contracts found it difficult to increase their profit and expand their production scale. This study compares farm management between farms with barter contracts and farms without barter contracts. Farm surveys in two municipalities in Mato Grosso state, Brazil, have shown that farmers who finance their inputs with barter contracts have few options in input procurement and grain sales. However, farmers who finance their inputs with bank loans have many options for input procurement and grain sales. These options allow them to increase their profit and to expand their production scale.

Keywords: Cerrado, farm management, finance, grain production.

Utilização das operações de troca em Mato Grosso

Resumo – No século 21, a produção de grãos no Brasil expandiu-se significativamente. O País tornou-se o mais importante produtor e exportador de soja. Esse crescimento da produção deve-se à expansão da fronteira agrícola na região do Cerrado. Pelo fato de a produção de grãos no Cerrado ser empreendida em grande escala – de algumas centenas a vários milhares de hectares –, os agricultores precisam obter financiamento para insumos, como sementes, fertilizantes e agroquímicos. Muitos agricultores obtêm insumos por meio das operações de troca ("barter"). Trocam insumos para futuras colheitas com vendedores locais de insumos e empresas multinacionais de comercialização de grãos. As operações de troca têm ajudado os agricultores a expandirem sua produção. No entanto, os agricultores que financiaram a produção por meio das operações de troca tiveram dificuldade para aumentar os lucros e expandir sua escala de produção. Este estudo compara a gestão agrícola entre os agricultores com e sem as operações de troca. Levantamentos agrícolas em dois municípios de Mato Grosso mostraram que os agricultores que financiam seus insumos por meio das operações

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de troca têm poucas opções na aquisição de insumos e venda de grãos. No entanto, os agricultores que financiam os insumos com empréstimos bancários têm muitas opções no aprovisionamento de insumos e venda de grãos. Essas opções permitem aumentar seus lucros e a escala de produção.

Palavras-chave: Cerrado, gestão agrícola, finanças, produção de grãos.

Introduction

Currently, Brazil is the world's largest producer and exporter of soybean. In 1990, Brazil's share of soybean production and exports in the world was 19% and 25%, respectively, which increased to 38% and 45% in 2020. In the past 30 years, whereas the United States increased its production by 1.8 times, Brazil increased its production by 6.3 times. During the same period, whereas the United States increased its soybean exports, including soybean grain, meal, and oil, by 2.6 times, Brazil increased its soybean exports by 7.8 times. South America, including Argentina, has become the most important soybean-supplying region in the world, providing two-thirds of soybean on the world market (Usda, 2022) (Table 1).

Brazil has also become one of the principal exporters of corn in the world. Until the end of the 1990s, national production barely satisfied domestic consumption. However, corn production significantly increased in the 2010s, and the country started exporting. By the end of the 2010s, Brazil became the second-largest exporter after the United States (FAO, 2022).

In recent years, one of the essential factors of the growth in grain production in Brazil has been the expansion of the agricultural frontier. The country's mid-west tropical region has a biome called the "Cerrado." The word Cerrado means "closed" in Portuguese. The area was named Cerrado as it was not used for economic activities until the 1960s. People thought the land in the biome had no use owing to its poor soil fertility and remoteness from major cities. However, some studies found that this biome had sufficient precipitation for agriculture, and with soil improvement, it would be suitable for cultivation (Hosono et al., 2016). The Brazilian

Table 1. Principal soybean producers and exporters.

	Country	Production				Exports			
		1990	2000	2010	2020	1990	2000	2010	2020
Volume (1,000 MT)	Argentina	10,750	21,200	54,500	48,800	7,966	20,277	42,455	42,867
	Brazil	20,340	34,700	69,000	128,500	14,229	22,188	43,012	110,781
	United States	52,354	72,224	91,470	96,667	22,461	34,073	52,447	59,835
	Others	23,748	32,174	46,001	65,028	11,904	9,398	19,309	31,060
	World	107,192	160,298	260,971	338,995	56,560	85,936	157,223	244,543
Share (%)	Argentina	10	13	21	14	14	24	27	18
	Brazil	19	22	26	38	25	26	27	45
	United States	49	45	35	29	40	40	33	24
	Others	22	20	18	19	21	11	12	13
	World	100	100	100	100	100	100	100	100

Note: exports include exports of soybean, soybean meal, and soybean oil.

Source: Usda (2022).

government started to develop the Cerrado region in the 1970s.

After a few decades, this development started to bear fruit. In Brazil, the southern region in the temperate zone was the center of agricultural production for many years. By the turn of the century, the soybean production in the mid-west region, where the Cerrado is mainly located, surpassed production in the southern region. The production of other agricultural products, such as corn, cotton, sunflower, and beef, simultaneously increased. Currently, the mid-western state of Mato Grosso is the most important agricultural state in the country (Hongo & Hosono, 2012).

The production scale of farmers in the Cerrado is very large compared with that in the southern region. It ranges from a few hundred hectares to more than one thousand hectares (Chaddad, 2016). Therefore, it is indispensable for farmers to obtain credit to finance inputs, such as seeds, fertilizers, and agrochemicals. At the initial stage of the colonization of the Cerrado region, the public sector provided an important part of finance for production. After the debt crisis in the 1980s and the economic reforms that followed, the role of the public sector was reduced. The private sector started to finance production. Farmers obtained finance from input vendors and multinational grain trading companies through barter contracts. Through such contracts, farmers bartered their future harvest with inputs required for production. In the 1990s, the Brazilian government created agricultural security called Rural Product Note (Cédula de Produto Rural: CPR). Barter contracts with CPR became the standard practice for financing inputs for grain production in the Cerrado (Silva, 2012).

Barter contracts help farmers access inputs for production. However, some farmers complain that the interest rates of barter contracts are higher than bank loans, and barter contracts limit their options for input procurement and grain sales. Once farmers obtain inputs with barter contracts, they have little room to exercise their management capacity to increase profit.

This study aims to identify the difference between farmers who use barter contracts and those who use other modalities to finance their production. Section 2 explains the expansion of soybean production in the Cerrado region, focusing on the use of barter contracts to finance production. Section 3 presents the outline of the survey. Section 4 discusses and interprets the result of the survey. Finally, Section 5 summarizes the findings of this study.

Expansion of agricultural frontier in the Cerrado

The main factor for grain production growth in Brazil is the expansion of the agricultural frontier in the Cerrado. Figure 1 presents the five regions in Brazil. The south is the traditional agricultural region in Brazil, with a mid-latitude of 22th to 33th south. The mid-west is the emerging agricultural region in the tropics, with a mid-latitude of 7th to 24th south. The Cerrado biome is mainly located in the mid-west region.

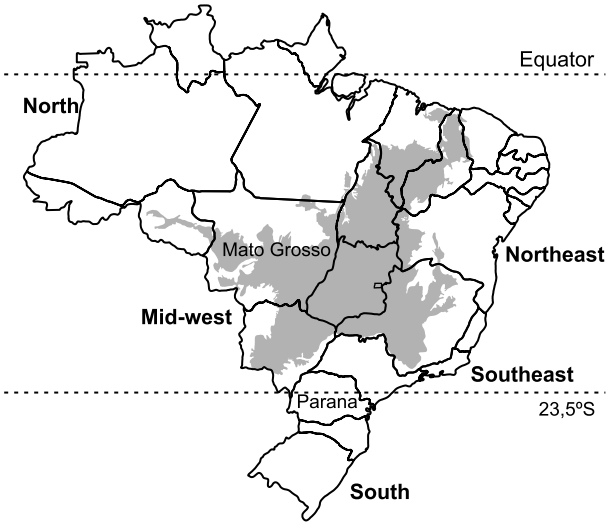

Figure 1. Regions in Brazil.

Note: the gray-shaded area is the Cerrado biome.

The national grain production statistics show the expansion of the agricultural frontier in the mid-west region (Conab, 2022a). Figure 2 presents the evolution of soybean and corn production, showing the regional share of the south and mid-west regions.

In the 1970s, the south region produced more than 80% of soybean and more than half of corn in the country (Figure 2). After the government started developing the Cerrado in the 1970s, the production in the mid-west region started to pick up. Its production surpassed that of the south. First, it surpassed the production of soybean at the end of the 1990s, and then, at the beginning of the 2010s, it surpassed that of corn. By the end of the 2010s, the mid-west accounted for 50% of soybean and 55% of corn produced in the country. The region became the leading producer of grains in the country.

Expansion of agricultural frontier

The main factor for the growth in production in the mid-west region is the expansion of the agricultural frontier. In 1975, the Brazilian government announced the Cerrado Development Program (Programa de Desenvolvimento dos Cerrados, known as the Polocentro project). The government aimed to develop 3.7 million ha in the mid-west states by building infrastructures like roads, silos, warehouses, and agricultural extensions. The government also provided preferential loans to farmers. After implementing the Polocentro project, the government launched a development project with assistance from the Japanese government. It was called PRODECER (Programa de Cooperação Nipo–Brasileiro para o Desenvolvimento dos Cerrados). (Hongo & Hosono, 2012; Hosono et al., 2016).

In addition to the efforts exerted by the public sector, private companies and agricultural cooperatives organized colonization projects. Numerous farmers with small farms in the south region and their children joined these colonization projects and immigrated to the Cerrado, hoping to obtain larger farms. For example, between 1970 and 1990, 35 private companies and cooperatives carried out 104 colonization projects and developed 3.9 million ha (Jepson, 2006).

The farmers who emigrated from the south region to the Cerrado converted tropical savannah into agricultural land. Table 2 presents the evolution of agricultural land use in the Parana and Mato Grosso states from 1970 to 2017. Parana is a traditional agricultural region in the south, whereas Mato Grosso is an emerging agricultural region in the mid-west. Setting the area in 1970 as 100, the table presents each year's area as an index. Although the total agricultural land in Parana has not changed, it has expanded more

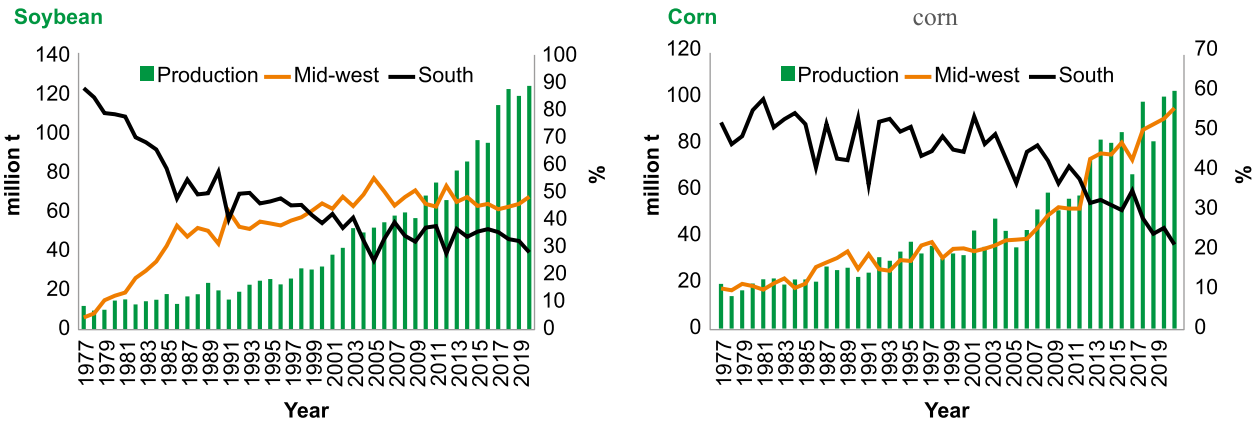

Figure 2. Soybean and corn production by regions.

Source: Conab (2022a).

Table 2. Evolution of agricultural land use.

State	Year	Total	Permanet crop	Temporary crop	Natural pasture	Planted pasture	Natural forest	Planted forest
Paraná (South region)	1970	100	100	100	100	100	100	100
	1975	107	90	130	93	122	83	199
	1880	112	73	150	85	148	83	305
	1985	114	48	159	79	169	85	399
	1995	109	24	140	76	196	88	348
	2006	105	75	162	73	127	119	302
	2017	101	16	179	46	125	118	463
	(ha)	14,741,967	209,533	6,093,129	836,166	3,372,977	2,781,196	949,327
Mato Grosso (Mid-west region)	1970	100	100	100	100	100	100	100
	1975	127	70	66	32	55	82	157
	1880	200	214	205	38	100	155	343
	1985	219	225	288	36	143	164	179
	1995	289	280	401	23	325	249	464
	2006	282	674	868	16	376	222	477
	2017	318	164	1409	15	424	230	1376
	(ha)	54,922,850	99,608	9,765,991	3,995,697	19,907,291	19,838,583	201,102

Note: area in 1970 = 100.

Source: IBGE (2022a, 2022b).

than three times in Mato Grosso. The figures in Mato Grosso indicate that farmers first converted natural pasture to planted pasture and forest and then to fields with temporary crops.

Introduction of new technologies

Besides expanding the agricultural frontier, introducing new technologies has contributed to the growth of grain production in the Cerrado. These technologies include new soybean varieties for a tropical zone, no-tillage farming, genetically modified (GM) varieties, and double-cropping techniques.

The Brazilian government started to develop the Cerrado at the beginning of the 1970s. During that time, soybean demand rapidly increased in the international market due to the low supply of fishmeal. Soybean meal substitutes fishmeal, a protein source in compound animal feed. Its price surged in the international market after the United States government banned its export. In response to this situation, the Brazilian government considered soybean a strategic commodity and promoted its production in the Cerrado. By increasing the production and export of soybean and its derivatives, such as soybean meal and oil, the government aimed to improve its trade balance and food security. Japan, which heavily depended on soybean imports from the United States, cooperated with the Brazilian government for agricultural development in the Cerrado through PRODECER (Warnken, 1999; Koike, 2007).

Soybean is a crop in temperate zones. It blooms when daylight hours become shorter. It is difficult to produce a conventional soybean variety in a tropical zone, where daylight hours do not vary throughout the year. To promote soybean production in the Cerrado, the Brazilian Agricultural Research Corporation (Empresa Brasileira de Pesquisa Agropecuária: EMBRAPA) developed a soybean variety that is insensible to

daylight hour changes. This variety was named Doko, after Doko Toshio, the former chairman of the Japan Business Federation, who paid attention to the agricultural development in the Cerrado from an early stage. This variety is widely spread in the Cerrado. (Hongo & Hosono, 2012; Hosono et al., 2016).

The technologies used for the large-scale grain production in the Cerrado were no-tillage farming and GM varieties. In no-tillage farming, farmers sow seeds without tilling. With this technique, farmers can maintain soil moisture and prevent soil runoff. They can also save the time and money required for tilling. However, without tilling, farmers cannot eliminate weeds. Thus, they need to apply various kinds of herbicides to eliminate all types of weeds, which then increases the production costs. GM varieties help solve this problem. By combining a herbicide and a GM variety that is tolerant to the herbicide, farmers can eliminate weeds with only one kind of herbicide. The combination reduces the cost of herbicide and its application. Later, a GM variety with pest tolerance was developed. This variety helped farmers obtain higher yields.

GM varieties first spread widely in Argentina in the second half of the 1990s. In Brazil, the government formally approved the commercial production of GM soybean in 2003 and GM corn in 2008. As of 2018, 96% of soybean and 89% of corn produced in Brazil were GM varieties (ISAAA, 2018).

Other new technologies, such as early-ripening soybean varieties and double-cropping techniques for soybean and corn, have rapidly spread since the end of the 2010s. Because rainfall in the Cerrado is limited only during the several months of a year, farmers used to produce only one crop a year with conventional varieties. They chose crops such as soybean, corn, and cotton, depending on the soil condition, weather forecast, price trends, etc., in the international markets. To maintain fertility in the soil, they rotate crops over several years.

The development of early-ripening soybean varieties added another option to the cropping system. In Mato Grosso, it takes 130 to 140 days for a conventional soybean variety to mature. Early-ripening soybean varieties can reduce the ripening period to less than 115 days (Tecnologias..., 2013). If farmers plant a conventional soybean variety as a first crop, they need to wait until February to harvest it. If they plant corn as a second crop in February, the yield may drop significantly because the rainy season may end before the pollination. Rain is vital for corn pollination and determines the yield. However, if farmers plant an early-ripening soybean variety as a first crop, they can harvest it in January. Then, if they plant corn as a second crop in January, it will pollinate before the end of the rainy season, and the farmers can obtain a regular yield.

In addition, by cultivating two crops a year, farmers can share the fixed costs among the two crops, thereby reducing the production costs of each crop. Due to the advantages in yields and costs, this double-cropping system has rapidly spread in the Cerrado region since the beginning of the 2010s. As a result, corn production in the mid-west region dramatically increased, surpassing that in the south region.

Financing through barter contracts

In addition to introducing new technologies, barter contracts were essential for the growth in production in the Cerrado. Farmers were able to access agricultural inputs through barter contracts.

Agricultural production in the Cerrado is very costly due to the large production scale, poor soil quality, and tropical climate. Farmers must apply plenty of soil improvement material, fertilizers, and agrochemicals. For example, the production cost for a hectare of soybean in 2016 was 2,436 reals (US$750) in Mato Grosso, out of which 2,130 reals (US$655) are variable costs such as inputs and their application[4]. In Parana, the cost was 3,174 reals (US$977) in 2016, out

[4] The exchange rate at the end of 2016 was US$1.00 = 3.25 reals (Bacen, 2022).

of which 2,017 reals (US$621) are variable costs. Although the total production cost was higher in Parana than in Mato Grosso due to the high rent for land, the variable cost was higher in Mato Grosso (Conab, 2022b).

As shown in the latter section, in 2017, the average hectare of a soybean farm (production unit) in Parana was around 50, and that in Mato Grosso was around 1,200. The amount of capital required for an average farm to produce soybean is approximately US$50,000 in Parana and approximately US$900,000 in Mato Grosso. Therefore, it is indispensable for farmers in Mato Grosso to access outside finance to obtain inputs (IBGE, 2022b).

The Brazilian government played an active role in supporting farmers in the early years of the colonization of the Cerrado. However, the economic crisis in the 1980s forced the public sector to withdraw many supporting activities. When the demand for soybean in the international market gradually increased in the 1990s, the private sector took over from the public sector to promote the production and commercialization of soybean. In particular, multinational grain trading companies, known as ABCDs (ADM, Bunge, Cargill, and Louis Dreyfus), were very active in investing in the Cerrado. They created grain markets by building silos and processing plants in some key cities in the Cerrado (Turzi, 2017). In addition, they started to finance farmers for inputs by accepting future harvests as a guarantee. It was called barter contracts or "troca" in Portuguese.

Today, barter contracts with CPR among farmers, input vendors, and grain traders are standard in the mid-western region (Koike, 2007; Silva, 2012; Galvão, 2014; Saes & Silveira, 2014). It is called a triangular barter contract. They work as follows (Figure 3). First, the farmers who want to obtain finance for production issue CPR, specifying the amount and quality of soybean and the delivery date and place. Then, the farmers register their CPR at a local registry office. The farmers bring the CPR to local input vendors to obtain inputs. Second, the local input vendors look for grain traders who want to secure the soybean. The input vendors obtain finance from the traders in exchange for CPR. Third, the vendors provide farmers' inputs, such as seeds, fertilizers, and agrochemicals, using the finance obtained from the traders. Fourth, the farmers deliver soybeans to the traders upon harvesting as specified in the CPR. Because local input vendors have detailed information about the farmers through regular commercial transactions and technical assistance, they can monitor their production. Furthermore, the vendors can obtain information about the CPR at the local registry office and evaluate its risk.

According to the study by the Mato Grosso Institute of Agricultural Economics (Instituto Mato-grossense de Economia Agropecuária: IMEA), the most important source of finance for soybean production in the Mato Grosso state in 2017 was grain traders and input vendors. The report indicated that 52% of the finance was from them, 19% from self-finance, and 29% from

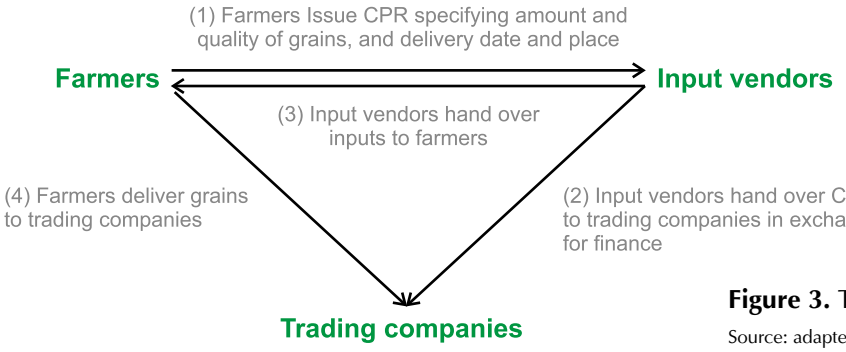

Figure 3. Triangular barter contract with CPR.
Source: adapted from Silva (2012).

public and private financial institutions. (IMEA, 2017).

Barter contracts are attractive for both farmers and trading companies. For farmers, accessing inputs with barter contracts is relatively easy compared with bank loans. Because farmers specify the number of bags to deliver in barter contracts, they can avoid risks against changes in grain price, interest rate, or exchange rate. For trading companies, triangular barter contracts allow them to assure grains from farmers without incurring high costs of collecting information from individual farmers (Silva, 2012; Johann et al., 2017).

Some studies closely looked at the use of barter contracts among farmers. For example, with data from two farms in Paraná and Mato Grosso states during four seasons, Scremin et al. (2020) analyzed which financing modality (self-financing, bank loans, and barter contracts) was more advantageous for farmers. They concluded that the production cost per hectare was lower with barter contracts than with other modalities.

This study shares an interest in the difference between financing modalities. However, instead of monetary cost in each modality, this study focuses on farmers' options for input procurement and grain sales in each financing modality. Furthermore, the study analyzes how the difference in options influences their production scale in the long run.

Materials and methods: farm survey

The grain production in the Cerrado significantly increased in the 2000s and 2010s. As shown in the following sections, during this period, while some farmers kept producing in a few hundred hectares, others expanded their production scale to more than 1,000 ha. The question is, "what is the difference between these two types of farmers?" To answer this question, the author conducted a field study about farm management in two municipalities in Mato Grosso in August 2017.

The study results indicate that barter contracts limit farmers' options in input procurement and grain sales. Farmers who did not expand their production scale mainly used barter contracts to finance their inputs. The barter contracts specify how they procure inputs and sell their grains. However, farmers who expanded their production scale to more than 1,000 ha obtained loans from public and private financial institutions. In this case, the farmers can choose how to procure inputs and sell their grains. The following sections explain the characteristics of the surveyed area and farms and outline the survey.

Surveyed area and farms

Mato Grosso is the largest soybean and corn-producing state in the country. Compared with farms in the traditional agricultural region, farms in Mato Grosso are large-scale (IBGE, 2022d). Table 3 presents the number of soybean farms and their harvested volumes and areas according to their production scale in 2017. The figures cover Brazil, Parana (a traditional agricultural state in the south), and Mato Grosso (an emerging agricultural state in the mid-west).

The production scale between these two states is very contrasting. The total production volume in Mato Grosso is almost twice the volume in Parana. However, the number of soybean farms in Mato Grosso is less than one-tenth of that in Parana. Thus, on average, the production scale for each farm is much larger in Mato Grosso than in Parana; it is 1,249 ha in Mato Grosso and 50 ha in Parana. In Mato Grosso, most farms are over 500 ha, whose share is 49% in number and 94% in soybean production. In Parana, most farms are less than 100 ha, whose share is 89% in number and 35% in soybean production.

The author surveyed soybean farmers in two municipalities in Mato Grosso: Lucas do Rio Verde (LRV) and Tangará da Serra (TS). The author chose these two municipalities because a local cooperative and an input vendor facilitated

Table 3. The production scale of soybean farms (2017).

	Scale	Numbers			Participation		
		Unit	Volume (t)	Area (ha)	Unit (%)	Volume (%)	Area (%)
Brazil	X < 10 ha	80,937	1,414,153	425,773	34	1	1
	10 ha ≤ X < 100 ha	113,051	12,182,441	3,575,928	48	12	12
	100 ha ≤ X < 500 ha	29,697	22,308,269	6,613,458	13	22	22
	500 ha ≤ X	12,560	67,251,391	20,107,499	5	65	65
	Total	236,245	103,156,254	30,722,658	100	100	100
	Average per unit		437	130			
Paraná (South)	X < 10 ha	32,852	627,322	183,836	39	4	4
	10 ha ≤ X < 100 ha	42,062	4,800,766	1,366,788	50	31	32
	100 ha ≤ X < 500 ha	8,566	6,287,884	1,764,909	10	41	41
	500 ha ≤ X	1,110	3,536,376	955,930	1	23	22
	Total	84,590	15,252,348	4,271,463	100	100	100
	Average per unit		180	50			
Mato Grosso (Mid-west)	X < 10 ha	121	2,819	852	2	0	0
	10 ha ≤ X < 100 ha	1,744	301,761	95,660	25	1	1
	100 ha ≤ X < 500 ha	1,724	1,542,134	479,691	24	5	5
	500 ha ≤ X	3,508	27,931,820	8,286,522	49	94	93
	Total	7,097	29,778,534	8,862,725	100	100	100
	Average per unit		4,196	1,249			

Source: IBGE (2022c).

access to farmers in the area. Table 4 presents the evolution of the soybean-harvested area in Mato Grosso and the two municipalities.

LRV is located in the mid-north of the state, which is the most significant soybean production zone (IMEA, 2022). It is along the BR-163, the major highway that runs north-south through the state. The federal government started the colonization project in the municipality in the 1980s. By 2007, the soybean production area expanded to more than 200,000 ha. Afterward, the area did not expand very much. In this municipality, the author sought permission from a local cooperative, Cooperativa Agrícola Lucas do Rio Verde, and interviewed seven of its members. The author also interviewed local input vendors, grain traders, and personnel in the cooperative.

TS is located in the state's mid-south, along the BR-364 highway that runs northwest

Table 4. Evolution of soybean harvested area in Mato Grosso.

State/municipality	hectares			1995 = 100	
	1997	2007	2017	2007	2017
Mato Grosso	**2,192,514**	**5,075,079**	**9,264,356**	**231**	**423**
Lucas do Rio Verde	100,000	215,535	217,587	216	218
Tangará da Serra	24,000	48,000	105,000	200	438

Source: IBGE (2022d).

of Cuiabá City. The soybean production in this locality has increased since the middle of the 2000s. From 2007 to 2017, the harvested area doubled, reaching more than 100,000 ha. With the help of Agro Amazonia, a leading input vendor in Mato Grosso and a local producer, the author interviewed four farmers in the area.

Survey outline

The objective of the survey is twofold. The first is to determine the relationship between financing modalities and their input procurement options and grain sales options. The second is to determine the relationship between financing modalities and changes in production scale over time. The author conducted in-depth interviews with owner farmers using a semi-structured questionnaire. The survey asked farmers about their profile, including their age, the year of their colonization, the initial and actual farm size, the actual grain production scale, the numbers and types of agricultural machinery, and the use of labor force (family, permanent, and seasonal). Additionally, the survey asked farmers about their finance, procurement, and sales management.

Table 5 presents the various management options available to farmers. Farmers need access to finance for inputs. From the lowest interest rate to the highest, the available options are "green soybean" or cash-forward contracts, barter contracts with CPR, public and private loans from financial institutions, and self-funding. Farmers can procure inputs from either local input vendors (revendas) or multinational companies that are manufacturers of agrochemicals (multinacionais). Farmers can procure individually or as a group (pool de compra). Moreover, farmers can either procure a package of standard inputs (pacote) or choose individual items and brands (a la carte).

Farmers have the following options regarding grain sales: delivering as specified in the barter contracts, selling with future contracts before the harvests, or selling in spot markets after the harvests. The buyers are input vendors, trading companies, or local processing plants. Farmers can directly sell to buyers or through brokers or cooperatives. They can deliver grains directly by transporting them from the field (balcão) or after processing (beneficiado); processing means removing foreign objects and drying them in silos to adjust the humidity. Farmers with their own silos can process and store grains there and wait until the price goes up. If they use the silos of others, they need to pay fees for processing and storage.

Results and discussion

Table 6 presents the profile and management characteristics of farmers of the 11 surveyed farms in LRV and TS. The farmers are listed in the order of their soybean production scale.

The common characteristics of the farmers are as follows. They were colonized in the 1980s and are now around 50 years old. They introduced the double-cropping system with soybean as the first crop and corn as the second. They own their agricultural machinery. Besides family labor, they have permanent staff and hire temporary labor in busy seasons. They combine no-tillage agriculture with GM varieties. Some farmers produce non-GM soybean varieties as there is a demand for non-GM varieties at a premium price. All farmers produce GM corn varieties because there is no demand for non-GM corn varieties in the area.

There are some differences among the farmers. Whereas some farmers maintained their production scale of several hundred hectares since the beginning of the colonization, others increased their scale to a few thousand hectares. Some farmers produce not only on their farms but also on rented farms.

The survey result suggests that the use of barter contracts and management efforts in finance, procurement, and sales can determine whether farmers can expand their production or not. These are discussed in detail in the following sections.

Table 5. Farmers' decision-making options for procurement and sales.

Area	Item	Options	Charecteristics
Procurment	Finance	Green soybean (soja verde)	Borrowing money in exchange for future harvest (cash forward contract). Interest rate is the highest
		Barter contracts (trocas)	Financing production in cesurity for harvest. Interest rate is high
			Payment is with grains or cash (R$ or US$)
		Private loans	Loans from private financial institutions with low interest rate in R$ or US$
		Public loans	Loans from public fund with low interest rate in R$. There is a maximum amout according to type of producers
		Self-finance	In general, self-finance does not cover all production costs
	Supplier	Input vendors (revendas)	With technical assistance, small lot, relatively expensive
		Manufacturers (multinacionais)	Without technical assistance, large lot, relatively inexpensive
	Unit	Individual	Individual purchase from input stores
		Group	Group purchase from manufacturers. Less expensive than individual purchase
	Form	Package (pacote)	Combination of standard inputs with generic agro-chemicals
		Customized (a la carte)	Customers specifies input brands, including latest technologies
Sales	Method	Barter contract (Troca)	Delivery of harvest based on barter contract
		Future contracts	Future contracts with fixed delivery date, quality, quantity and price
		Spot sales	Sales is negotiated upon sales with local price
	Buyer	Input vendors (revendas)	Delivery of harvest based on barter contract
		Trading companies	With barter contracts, future contracts or spot sales
		Processing plants	Future contracts or spot sales wit local processing plants
		Brokers	Mediation of sales
		Cooperatives	Price information gathering, preparation and storage at silos
	Form	Without preparation (balcão)	Delivery upon harvest in the fields
		Prepared (beneficiado)	Sales after preparation in silos
		Prepared and stored	Sales after preparation and storage in silos

Sources of finance

Farmers need to finance to procure inputs, such as seeds, fertilizers, and chemicals. Because the production scale in the Cerrado is enormous, self-finance cannot cover all the capital required for production. Farmers need to seek external finance.

Some farmers said they used to finance through "green soybean" or cash-forward contracts. With this contract, farmers use future harvests as collateral to borrow money. In general, the payment will be in bags of grains. Among the surveyed farmers, only one uses it, with a monthly interest rate of 2% (27% per

Table 6. Farmers' profile and management.

<Profile>													
Farmer	Number		1	2	3	4	5	6	7	8	9	10	11
	Location[1]		LRV	LRV	LRV	LRV	LRV	LRV	TS	LRV	TS	TS	TS
	Age		59	55	36	58	65	61	46	69	49	50	55
	Year started production		1984	1987	1986	1986	1986	1982	1993	1981	2007	1985	1989
Farm area	Area started	ha	150	400	400	400	400	200	1,100	200	500	1,500	0
	Current area	ha	150	400	400	1,000	1,850	1,200	2,500	2,500	2,000	1,500	3,400
Production	Soybean	ha	125	350	400	700	850	1,100	1,800	2,000	2,000	3,200	9,500
	Maize	ha	125	350	400	600	400	1,100	1,800	2,000	1,400	2,600	4,500
Machineary	Tractors	unit	3	2	4	3	5	5	6	5	7	12	9
	Planters	unit	1	1	2	2	2	1	3	2	6	5	4
	Sprayers	unit	1	1	1	2	1	1	1	2	1	3	2
	Harvesters	unit	2	1	2	2	2	2	3	4	4	5	7
Labor	Family	person	1	1	3	1	1	2	1	2	3	4	5
	Permanent	person	1	1	1	1	3	3	10	6	15	20	30
	Seasonal	person			2	3		1	5	10	6	7	5
<Management[2]>													
Finance	Barter contract		XX	X	XX	XX	XX						
	Public loans			XX							X	X	X
	Private loans							X	X		XX	X	XX
	Self-finance							XX	XX	XX		X	
Procurment	Input vendors		XX	X		XX	XX			XX			
	Trading companies			X	XX			XX					
	Manufacturers (multinacionais)								XX		XX	XX	XX
	Group purchase							X	X		X	X	X
Sales	Barter contracts		XX		X	XX	XX						
	Future contracts			XX	XX	X		XX			XX	XX	XX
	Spot sales			X				X	XX	XX	X	X	X

[1] LRV: Lucas do Rio Verde; TS: Tangará da Serra.

[2] Use of more than 50%: XX; use of less than 50%: X.

year). Some farmers reported no longer using it due to the very high interest rate.

Barter contracts are the standard method for financing inputs among farmers whose production scale is less than 1,000 ha. Using CPRs, farmers use triangular barter contracts with input vendors and grain traders. Among the surveyed farmers, No. 1 through No. 5 use barter contracts. One of them uses a barter contract with a monthly interest rate of 1% (13% per year).

More farmers are starting to use public and private loans. Among the surveyed farmers, No. 6 through No. 11 use such loans. The federal government provides loans to farmers in Brazilian

reals for the variable costs of inputs (custeio) through Banco do Brasil and cooperatives. The interest rates of the loans are different depending on the scale of the farm. Some surveyed farmers acquired a loan for medium-scale farmers (up to around 500 ha) called Pronamp Custeio, with an annual interest rate of 7.75% (All interest rates were at the moment of the survey). Other farmers acquire a loan for large-scale farmers called Custeio Agropecuário, with an annual interest rate of 8.75%. Private banks, such as the Brazilian subsidiary of Rabobank, a cooperative bank in the Netherlands, finance farmers' production. The loan can be either in US dollars or Brazilian reals. One farmer acquires a loan in US dollars with an annual interest rate of 6.65%.

Although the interest rates of public and private loans are much lower, some farmers choose cash-forward or barter contracts for the following reasons. First, cash-forward contracts are the most accessible means to finance for farmers. As they are transactions between two individual parties, all they need is to reach a mutual agreement. Second, barter contracts are more formal than cash-forward contracts. When farmers issue CPRs for their future harvest, they need to register them at a local registry office. If a farmer has good business records with input vendors, the vendors will accept the CPR and supply inputs to the farmer.

Compared with these financing modalities, farmers need to exert more administrative efforts in obtaining loans from financial institutions. During the survey interviews, some farmers commented that they were aware of the high-interest rates in barter contracts. They wanted to avoid using them if possible. However, obtaining loans from financial institutions is not an easy task for them. First, the procedures are more bureaucratic and time-consuming. Some farmers commented that they could not obtain loans in time to purchase inputs for production. Second, banks and cooperatives require farmers to prepare financial statements; however, many small-scale farmers usually do not keep good financial records. Thus, they need to hire accountants to prepare financial statements for them. Third, farmers need to have formal land titles and good credit histories. Some farmers commented that they had problems with land titles and credit histories. In the Cerrado region, the land registration system is not well organized. One land may have more than one claim. It is costly and time-consuming to resolve land disputes. In addition, during the economic crisis in the 1980s and 1990s, numerous farmers and cooperatives went bankrupt, so they have bad credit histories. These multiple barriers kept many farmers from accessing favorable loans from financial institutions.

Autonomous farmers

Farmers' financing modality to access inputs determines how they can procure inputs and sell grains.

Regarding input procurement, farmers No. 1 through No. 6 and No. 8 mainly procured inputs from either input vendors or trading companies. As farmers No. 1 through No. 5 financed inputs through barter contracts, they needed to procure from input vendors or trading companies with whom they signed the contracts. However, farmers No. 7 and No. 9 through No. 11 mainly procured from multinational agrochemical companies. In addition, they procured as a group.

Regarding grain sales, farmers No.1, No. 3, and No. 4 mainly sold their harvest through barter contracts. They delivered their harvest based on the terms of the barter contracts. Other farmers sold their harvests either using future contracts or spot sales.

The survey results indicate that when farmers sign barter contracts, their options in procurement and sales are limited. Barter contracts are like package deals of finance, procurement, and sales. Barter contracts are convenient for farmers. Once they sign the contracts, they do not need to worry about other options. All the farmers need to do is to produce and deliver their harvest as specified in the contracts.

However, signing barter contracts has downsides for farmers. The price of inputs can be high because the farmers procure them as individuals, so they do not benefit from a volume discount. Moreover, the standard package of inputs that the vendors deliver to the farmers comes with generic agrochemicals that sometimes do not fit the farmers' needs. After the harvest, the farmers must deliver grains as specified in the barter contracts. They transport grains to traders' silos in nearby cities and hand them over without removing foreign objects and drying them to improve the harvest quality.

Farmers who do not use barter contracts, whom we call autonomous farmers, have several options and make their own decisions about procurement and sales. They directly buy inputs from the local offices of multinational manufacturers (multinacionais). The manufacturers generally set minimum sales volume. To reach this volume, autonomous farmers organize themselves into purchasing groups. With this procurement practice, the farmers can obtain volume discounts; thus, the costs will be less than those charged by input vendors. In addition, these farmers often contract agricultural consultants who advise them to procure specific brands and the latest technologies of seed varieties, fertilizers, and agrochemicals that fit their field and climate conditions.

Regarding sales, autonomous farmers have several options. Grain prices are generally low right after the harvest season because the supply is high, but the local storage capacity is limited. The price gradually increases after the harvest season is over as the balance of supply and demand stabilizes. Therefore, autonomous farmers wait for a better price. After the harvest, autonomous farmers transport grains to their own silos or silos at cooperatives to remove foreign objects and dry them to improve their quality. They avoid selling grains at low prices. Finally, the farmers decide when to sell after considering the storage cost and selling price.

Numerous autonomous farmers sell part of their grains before harvesting. They sell through future contracts to avoid risks associated with price and exchange rate fluctuations. They aim to sell at a price that can cover the production cost and gain a margin. In addition, autonomous farmers sell part of their grains at spot sales. Aside from the trading companies, they sell to local processing plants of animal feeds or bio-fuels. When the local grain supply is low, these processing plants offer a good price. The farmers sometimes hire brokers or cooperatives to bargain for a better price.

These differences in procurement and sales indicate that financing modalities affect farmers' autonomy in management. If they use barter contracts, they do not have options in procurement and sales, which means they do not have the opportunity to increase their profit. Conversely, if they obtain loans from public or private banks, they can make their own decisions on procurement and sales to increase their profit. The survey results suggest that autonomous farmers have a chance to increase their production scale.

Conclusion

Responding to the increase in demand in the international market, Brazilian farmers have rapidly expanded grain production since the end of the 1990s. By the middle of the 2010s, the country had become the world's largest soybean exporter and the second-largest corn exporter.

The Cerrado biome in the mid-west region is the center of grain production in Brazil. The grain production in the region is large scale. The minimum farm size is a few hundred hectares. Some farmers expanded their farms to more than a thousand hectares. Moreover, they have introduced new technologies, such as no-tillage farming, GM varieties, and early maturing varieties.

The farmers need to obtain external finance. The public sector used to support farmers to finance inputs. However, after the economic crisis in the 1980s, the public sector's support decreased. Then, firms in the private

sector, such as input vendors and multinational trading companies, started to finance farmers through barter contracts. With these contracts, farmers bartered inputs with a future harvest. These contracts helped farmers to expand their grain production.

However, this situation is changing. After the commodity boom in the 2000s, the cities in the region significantly expanded, and their credit and grain markets developed during the same period. Taking advantage of this development in the market, some farmers started to finance production with loans from public and private financial institutions.

This study analyzes the relationship between financing modality, procurement and sales options, and changes in production scale over time. The study found that while barter contracts make finance for inputs more accessible to farmers, they limit farmers' options in procurement and sales. Conversely, if farmers put some effort into accessing bank loans by doing paperwork and keeping a good accounting record, they would have many options in procurement and sales. These options allow farmers to increase their profit. While the farmers who use barter contracts maintained their production scale, those who use bank loans expanded their production scale.

Because the sample size is small and the focus of the study is more qualitative than quantitative, this study cannot show statistical relationships between financing modality and changes in production scale. However, this study demonstrates that when farmers have more rooms to exercise their managerial capacity, they have more chances to expand their production scale. Under Cerrado's large-scale and technology-driven grain production, managing finance is vital for growth.

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