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Vertical coordination in the Brazilian milk supply chain: the case of 3B Agro LTDA

CASE STUDY

Silas Simeon Hayer^a, Jefferson Andronio Ramundo Staduto^b and Dietrich Darr^{Ⓢc}

^a*Student at faculty of Life Sciences, Rhine-Waal University of Applied Sciences, Marie-Curie-Str. 1, 47533 Kleve, Germany*

^b*Professor at The Western Paraná State University, R. da Faculdade, 645 - Jardim La Salle, Toledo - PR, 85903-000, Brazil*

^c*Professor at Faculty of Life Sciences, Rhine-Waal University of Applied Sciences, Marie-Curie-Str. 1, 47533 Kleve, Germany*

Abstract

The dairy business is characterized by generally low profit margins due to a very competitive market environment. Dairy farmers and milk processing companies, therefore, constantly seek to optimize their technical production processes in pursuit of further cost reductions, e.g. by means of improving herd management, milking and feeding practices. In addition, innovative business strategies may create competitive advantage in response to market conditions. While vertical coordination or even integration have been established successfully in most sectors of animal husbandry including poultry, pork and beef production, this strategy is mostly limited to supplying contracts and input support within the dairy sector. Various organizational models of increasing vertical coordination in dairy production exist, with great variation in terms of operational performance and profitability. Using the example of 3B Agro LTDA's dairy production located in the municipality of Toledo, Brazil, the case study illustrates the significant efficiency potential that currently exists in the Brazilian dairy supply chain. The prevalence of short-term contractual commitments and an influential role of independent intermediaries give room to considerable opportunism of market participants, various principal-agent problems and severe issues regarding milk quality. The case study illustrates that, vertical coordination can increase control and efficiency along the supply chain. It also points out the importance of strong managerial competencies and capabilities of dairy farm managers in order to exploit fully the efficiency potential provided by vertical coordination.

Keywords: vertical coordination, contract farming, supply chain, dairy industry, incomplete contracts, principal-agent problem, business expansion

JEL code: D22, L14, Q13

[Ⓢ]Corresponding author: dietrich.darr@hochschule-rhein-waal.de

A teaching note has been prepared for this case study. Interested instructors at educational institutions may request the teaching note by contacting the author or IFAMA

1. Introduction

On 30 July 2017, Jandir Bombardelli sat in his office in Toledo, a municipality in the west of the federal state Paraná in Brazil. As the owner and manager of 3B Agro LTDA, a milk production and wholesale company, he had just finished a phone call with one of his dairy farmers who was complaining that he was unable to break-even this year and requested more support for his operations. It was just half a year since Jandir Bombardelli took over 3B Agro LTDA from the dairy Lactobom, which had initially implemented and financed the vertically coordinated milk production system around Toledo. Due to the substantial capital requirements and poor initial financial performance of the business, the dairy company decided to drop the milk production business after almost 8 years. At this moment, several questions were bothering the entrepreneur: will the operational advantages of the vertically coordinated milk production and wholesale system really outweigh its challenges and translate into stable profits in the long run? How could the profitability of the business be improved for the benefit of the owner and the contracted milk producers? Was there any value in expanding the business, now that it was independent from the dairy?

2. Toledo far above the Brazilian average

Toledo is a municipality located in Paraná, close to the border of Uruguay and Argentina. It covers an area of 1,198 km² and has a population of 135,538 residents (IBGE, 2017; Linke, 2015). The humid subtropical climate with mild winters (Linke, 2015), in combination with clay soils with high mineral contents create very favorable conditions for intensive agriculture. Local farmers primarily plant soy and corn with two to three harvests per year. The agribusiness sector is the biggest contributor to the regional economy. Animal husbandry alone constituted 76.4% of the total gross production value of the municipality with a value of €488 million in 2016. In animal husbandry, dairy production was the third most important contributor, being only surpassed by poultry and pork production. Historically, the center of dairy production was mostly centered to the south, near to the capital Curitiba. However, in the last decades, the dairy industry in Toledo has been growing substantially not only in terms of total output, but also with regard to the level of know-how and technology applied in dairy production. This is reflected in the increase of the average milk yields per cow in the municipality (Figure 1). From 1990 to 2015, the total production output has increased by 205%, while the milk yields simultaneously increased by 285% to an average of 5,340 kg/cow/year (IPARDES, 2017). The municipality is the 10th largest in cow's milk production in Brazil.

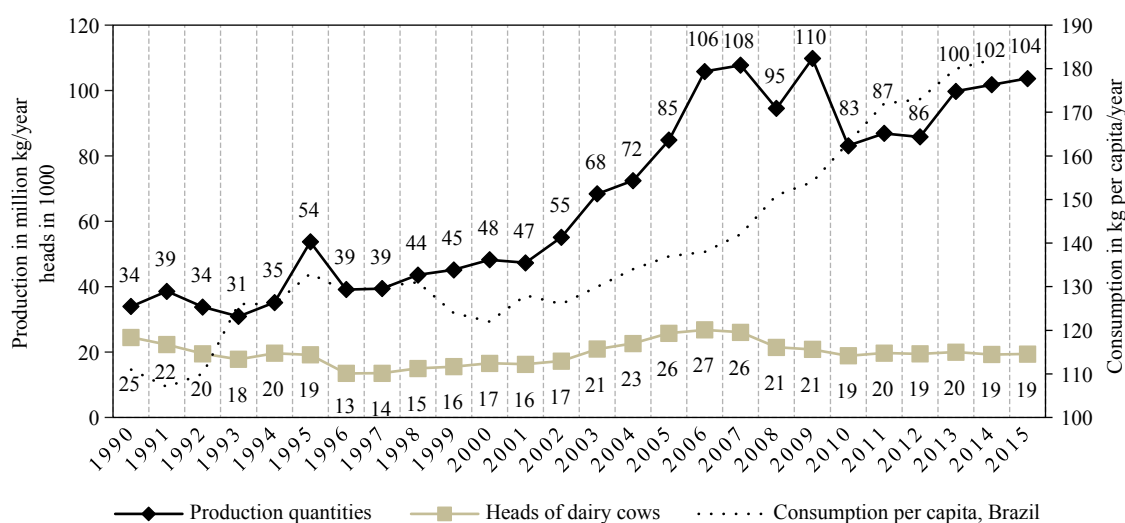


Figure 1. Production quantities of milk, heads of dairy cows in Toledo and consumption of milk equivalents *per capita* in Brazil (IBGE, 2017; IPARDES, 2017).

There exist around 450 to 800 registered dairy farms in Toledo (Souza, 2017), 27 larger dairy companies that operate within the region and 6 dairy companies that are located in Toledo itself. Compared to the Brazilian average, the farmers' production methods tend to be more advanced and their average yields higher. This is related to the favorable environmental conditions and exceptional infrastructure in Toledo, which led to the establishment of large agricultural cooperatives and a competitive agribusiness industry. Furthermore, the prefecture of Toledo implemented various support programs to foster the development of the agricultural sector.

The heterogeneity in the Brazilian dairy farming structure (Balcão *et al.*, 2017; Zoccal and Stock, 2011) can also be observed in Toledo. Production systems either gravitate towards small-scale extensive dairy farms with less than 30 dairy cows (Category 1, Table 1), which are typically diversified in several areas of animal husbandry, characterized by pasture-based feeding systems, low levels of production technology and comparatively low productivity. On the other hand, in the region there are numerous large-scale intensive dairy farms with more than 200 dairy cows (Category 4, Table 1), advanced production technologies and high input levels, such as climatized stables, in-house feeding systems and the use of concentrated feed.

3. The development of the Brazilian dairy sector

The Brazilian dairy sector has undergone significant changes during the past 30 years. Until the 1990s, it had been tightly controlled by governmental market interventions for farm gate¹ as well as consumer prices. Along with the establishment of the Mercado Comum do Sul (Mercosul) in 1991 economic reforms were implemented that led to the opening up of the Brazilian dairy sector to international competition. This induced the modernization of the dairy industry and farm-level practices and significantly increased the competitiveness of the Brazilian dairy sector (Siqueira *et al.*, 2011). Even more importantly, the dairy industry benefited significantly from the overall economic growth, most notably induced by the Plano Real² in 1994, which contributed to a rise in *per capita* incomes and spurred domestic demand for nutritious and high-value animal products (Figure 1). As a consequence, the total milk production increased by 142% to 34 million tons from 1990 to 2016, making Brazil the fourth largest producer of cow's milk in the world (IBGE, 2017; IDF, 2017). At the same time, the average milk yield per cow increased by 129% from 759 kg/cow/year to 1,740 kg/cow/year, indicating significant improvements in production technology (IBGE, 2017).

Even though Brazil has become one of the largest global milk producers, its overall influence on the international milk supply is only marginal given the predominant importance of the domestic market. The nation has traditionally been a net importer of dairy products. In 2017, Brazil's imports for dairy products

¹ Farm gate prices are the prices that farmers receive at the point of sale.

² The *Plano Real* was a set of fiscal and economic policies implemented to stabilize the Brazilian economy and control inflation. These policies permitted robust economic growth that continued during the following decade.

Table 1. The dairy farming structure in Brazil in 2009. Source: Zoccal and Stock (2011).¹

| Cat. | kg raw milk/ cow/ day | Cows/ farm | kg raw milk/ farm/ day | Milk production | | Total number of farms | | Dairy cows | | kg raw milk/ cow/ year | Cows/ farm |
|------|-----------------------------|---------------|---------------------------|-----------------|------|-----------------------|------|------------|------|------------------------------|---------------|
| | | | | 1000 t | % | number | % | 1000 units | % | | |
| 1 | <4 | <30 | <100 | 5,682 | 18.9 | 1,062,620 | 87.9 | 12,769 | 56.9 | 445 | 12 |
| 2 | 4-7 | 30-70 | 100-400 | 8,819 | 29.4 | 103,348 | 8.55 | 5,247 | 23.4 | 1,681 | 51 |
| 3 | >7-12 | >70-200 | >400-2,000 | 9,027 | 30.1 | 36,597 | 3.03 | 3,051 | 13.6 | 2,958 | 83 |
| 4 | >12 | >200 | >2,000 | 6,509 | 21.7 | 6,455 | 0.53 | 1,368 | 6.1 | 4,757 | 212 |
| | | | Total | 30,037 | 100 | 1,209,021 | 100 | 22,435 | 100 | 1,339 | 19 |

¹ Cat.: category.

accounted for a value of €460.58 million and exports valued at €92.27 million (IBGE, 2017). Its main trade partners were Paraguay and Argentina. While the effect of the international milk price on the average farm gate prices in Brazil is not very pronounced (Figure 2), the combination of a somewhat inelastic domestic demand and short-term variations in milk supply caused considerable price volatility (O'Connor and Keane, 2009).

The Brazilian dairy industry is characterized by a considerable degree of seasonality. Seasonal variations in milk supply occur, since many Brazilian dairy farmers use pasture as their main feeding method (Zoccal and Stock, 2011). During the dry seasons, the so-called 'entre-safra' (between harvests), the lack of precipitation limits the farmers' ability to sufficiently feed their cows. Consequently, milk supply decreases and milk price increases during these months, before it decreases again in September (Figure 2). Furthermore, the price of concentrated feed significantly affects the Brazilian dairy market (Pullis Veturini, 2015). Soy and grain maize are the most important concentrate sources for feed rations in Brazilian dairy farming. Thus, sufficient supply of these crops can considerably reduce production cost and lower milk prices.

On top of the base milk price, most dairies pay various kinds of price premiums to farmers. The most important premium relates to the farmers' daily supply quantities of milk. The resulting price differential can amount to more than € 10/100 kg milk³ (Figure 3), which can considerably influence the economic performance of the individual dairy farm. These price differentials reflect the power dynamics between dairy companies and dairy farmers, which can also be observed in the dairy industries elsewhere (Gorton *et al.*, 2015).

Another price premium is linked to the quality parameters of the milk, such as its fat and protein content, bacteria cell count and somatic cell count⁴. Even though quality premiums are common throughout the world, they are far from being the norm in Brazil (de Souza Lima Júnior, 2011). The majority of the Brazilian dairy companies does not use this instrument and dairy farmers, therefore, have only limited incentives to improve the quality of their raw milk (Botaro *et al.*, 2013). Thus, it is not unusual in some regions to find small-scale farmers who do not have cooling tanks to store their milk, or who still manually milk their cows

³ One liter of milk typically weighs between 1.02 and 1.03 kilograms.

⁴ While the bacteria cell count indicates the amount of external contamination of the milk, caused e.g. by contaminated milk transport equipment or insufficient external cleansing of the cow's udder prior to milking, the somatic cell count relates to the number of white blood cells (leukocytes) in the milk, which increase in response to infections. Thus, lower cell counts indicate better milk quality. The Brazilian food quality standards permit 300,000 bacteria cells and 500,000 somatic cells per ml of milk.

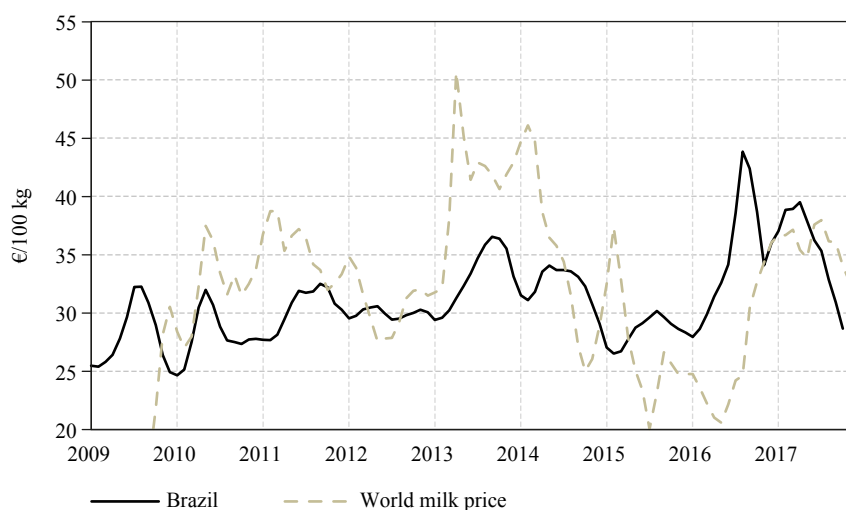


Figure 2. Average Brazilian farm gate milk prices, average world milk price (SMP + Butter Oceania) (CLAL, 2018; IBGE, 2017).

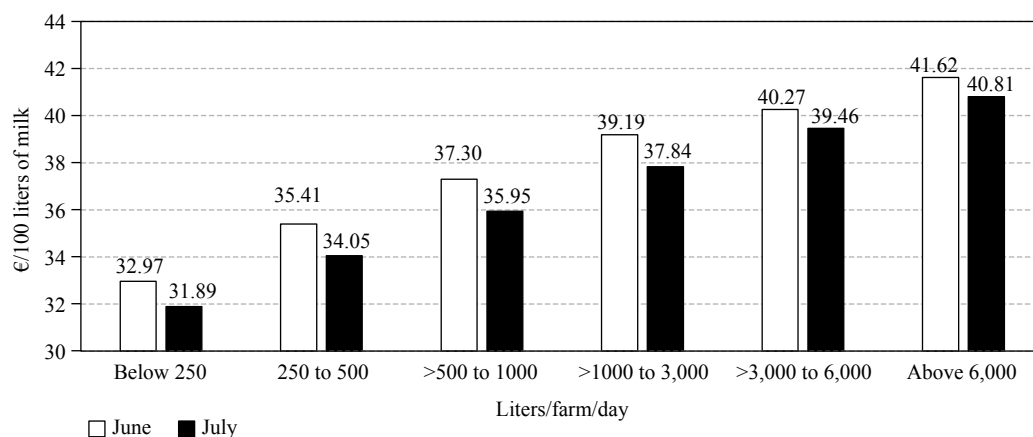


Figure 3. Average Brazilian farm gate prices for various supply quantities (daily milk supply in kg) for June and July, 2017 (MilkPoint, 2017).

(de Souza Lima Júnior, 2011; Marcondes *et al.*, 2017). In the region of Toledo, two dairies have adopted quality premiums, among them the dairy Lactobom and Nestlé, which was the biggest dairy company in Brazil in 2011 (Carvalho, 2011).

Milk quality and quality standard enforcement have been a constant concern for the Brazilian government and population (Rocha *et al.*, 2016). In order to further improve the national milk quality, the Government of Brazil enacted new food quality standards for raw and processed milk on 29 December 2011 as part of the instructive normative N° 62 (GoB, 2011). It also prescribed minimum standards for milk production and processing, such as practices applied during milking, storage on farm and transportation to the processing sites.

Considerable criticism has been raised with regard to the effectiveness of the existing food quality regulation in Brazil. Despite some efforts to enforce these regulations, a considerable share of the raw and processed milk on the markets does still not meet the quality requirements (Bonamigo *et al.*, 2018; Novaes *et al.*, 2017) and various incidences of food fraud have been reported. For example, some farmers diluted their milk with water or added antibiotics to it; or dairy companies mixed truckloads of low-quality or contaminated milk with milk of higher quality to conceal the contamination. Effectively disclosing and penalizing such fraud and more generally enforcing existing quality standards therefore remains a major priority in the Brazilian dairy sector.

An increasing number of dairy companies have recognized the importance of quality guarantees to consumers for improving their brand image and market position. A case in point is the dairy Lactobom, which has built a strong brand recognition for superior quality milk products in the region over the past years. The establishment of a quality premium was instrumental in improving the quality of raw milk supplied by their dairy farmers, which in turn was a precondition for the manufacturing of high-quality dairy products. Building on their strong brand recognition, the dairy can now charge a price premium compared to the industry average thereby boosting its profit margin despite higher costs. This has allowed the dairy to expand and build up a second production facility with a capacity of 90,000 liters of milk per day around the municipality Ponta Grossa. Due to numerous requests from farmers and distributors throughout the region, the company is currently evaluating to build even another processing facility in a neighboring federal state. These facts all illustrate that their strong brand driven by their focus on highest product quality has created considerable business opportunities.

4. The milk supply chain

Approximately 30% of the raw milk on the Brazilian dairy market is not captured by dairies and is distributed through informal channels (IDF, 2017). This mainly refers to dairy farmers who sell their raw milk directly to local consumers or distributors, intermediaries or small processing plants. Yet, most of the raw milk produced by dairy farmers is sold to a local dairy (Figure 4). Toledo differs substantially from other regions in Brazil in this regard. Due to its advanced supply chain and agricultural industry, only a negligible portion (0.01%) of the milk is sold directly to consumers by dairy farmers.

The dairy companies process the raw milk into products, such as cheese, yoghurt and milk with long shelf life (UHT), for example. These products are then sold to distributors or directly to retailers. While some dairies operate their own network of (branded) distributors, most sell through wholesalers. Dairies or distributors also supply the institutional market, which refers to governmental programs such as ‘leite das crianças’ (milk of the children), supplying locally produced milk to schoolchildren. The dairy companies are either relatively small, local, private-owned dairies, such as Lactobom – or establishments of large multinational companies, such as Nestlé. While Lactobom is considered a medium-sized dairy with approximately 150 supplying dairy farmers and a processing volume of 140,000 liters per day, multinational dairy companies such as Nestlé have up to 4,400 milk suppliers and a processing capacity of 4.63 million liters per day (LeiteBrasil, 2016). In addition, there also exist a number of milk processing companies owned by farmer cooperatives, which traditionally are important players in the agricultural sector in Paraná (Ricardo *et al.*, 2015). Many of these cooperatives are engaged in multiple branches of production agriculture, including crop production and animal husbandry. They typically provide technical assistance to their members and the opportunity to market all their different production outputs. A few of these cooperatives have also integrated forward in the value chain by operating food processing enterprises and/or opening their own retail stores. One of these cooperatives is Primato with several supermarkets in the region.

Even though the dairy companies and cooperative dairies in the region of Toledo differ in terms of size and ownership, the interactions between dairy companies and dairy farmers are remarkably similar. Milk delivery contracts are typically concluded orally and are terminable on immediate notice, which means that farmers can switch from one dairy to another within one day. In return, the dairies do not have to engage in long term commitments with the farmers and therefore can adjust farm gate prices whenever necessary. Furthermore, farmers typically carry the transport cost to the dairy. Specialized contractors, so-called ‘freteiros’ (transporters), are contracted by the dairy companies to secure and operationally handle the raw milk procurement. Most dairy farmers only interact with their ‘freteiro’, through which they also receive

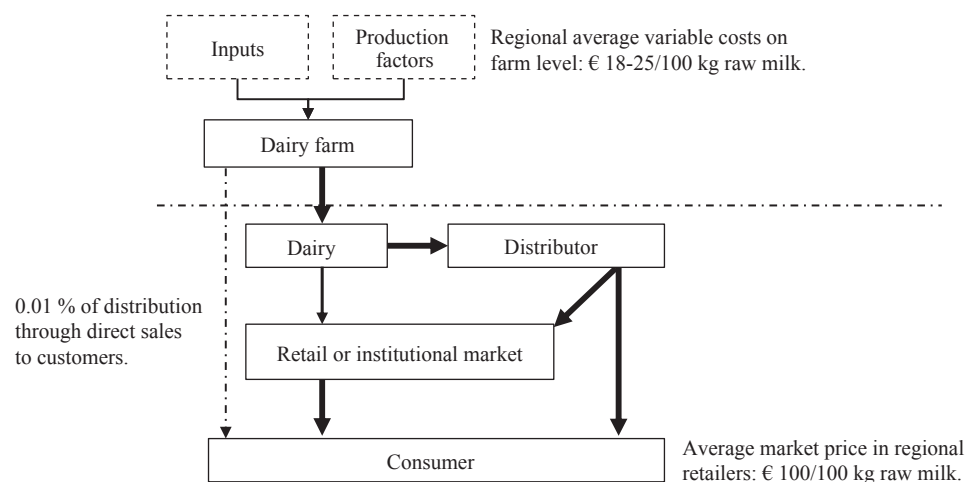


Figure 4. Simplified depiction of the milk supply chain in Toledo.

their monthly paychecks. This leads to a situation where farmers typically trust the intermediary more than they trust the dairy company. Hence, significant room exists for principal-agent problems and opportunistic behavior of all market participants. For example, 'freteiros' contracted by one dairy could potentially sell milk to other dairy companies that bid a higher price without necessarily passing on all proceeds to the farmers; in the absence of long-term supply relationships farmers and dairy companies lack incentives to invest in long-term improvements of production technologies and raw milk quality; and dairy companies fiercely compete for supplying agreements with dairy farmers, particularly the larger ones. Therefore, the 'freteiros' can enter in a bargaining process of their own with the dairy company to achieve higher profit margins. For example, Nestlé gained market share in the region by winning over the 'freteiros' from other dairies, thereby taking over nearly all the farmers that interacted with these intermediaries. Thus, these intermediaries play a vital role in the supply chain (Bonamigo *et al.*, 2018). The dairy companies increasingly understand the importance of building a more long-term relationship with their suppliers. For example, the owner of Lactobom makes regular personal farm visits to its largest milk suppliers to discuss the anticipated development of the milk farm gate prices and other topics thereby aiming to foster a closer relationship and to increase supplier loyalty.

5. Vertical coordination in the Brazilian milk supply chain

Vertical coordination or even integration have become common in most areas of animal husbandry, most notably in poultry, pork and beef production (Cassi and Gonçalves, 2014; MacDonald and Korb, 2011; Swinnen and Maertens, 2007; Teixeira *et al.*, 2004; Wendling Gomes and Gomes, 2008). In the dairy sector, vertical coordination is mostly limited to supplying contracts and input support (Birthal *et al.*, 2005; Dries and Swinnen, 2004). In the region of Toledo, vertical coordination is largely driven by agricultural cooperatives and large private companies in these sectors. These cooperatives and companies conclude so called production contracts with a number of specialized farmers to produce and/or fatten chicks, piglets or feeder calves. The contracted farmers receive technical advice and farm inputs and are also guaranteed by the company the sales prices and volumes at the end of the production cycle (Birthal *et al.*, 2005; Otsuka *et al.*, 2016). These types of contracts are also used in dairy production in other countries (e.g. Dries *et al.*, 2009; Dries and Swinnen, 2004). Potential issues in these relationships are mostly related to noncompliance with contractual terms and holdups (Otsuka *et al.*, 2016). The first issue arises when farmers, who have been provided with advice and other inputs by a contractor, decide to sell parts of their produce to competing contractors or the market. Incentives to engage in side selling typically occur if producers can obtain better prices outside the initially agreed upon contract. However, the threat to not prolong the contract represents an effective enforcement instrument for the original contractor in most cases (Bellemare, 2015). Holdups occur when the contracted farmers are required to invest in contract specific assets (i.e. a cooling storage), which cannot easily be divested or utilized for other contracts. This leaves the farmers with significant financial and business risk and increases their dependence on the contractor (Otsuka *et al.*, 2016). Holdups either result in an underinvestment into the assets in anticipation of post-contractual opportunism, or in a considerable lack of trust between farmers and the contractor, as a consequence of which farmers may withdraw from the agreement. Notwithstanding these challenges, literature widely agrees that contract farming can increase production efficiency through improved production and marketing methods (Otsuka *et al.*, 2016).

In the milk supply chain, vertical coordination can also refer to the outsourcing of replacement cattle rearing⁵ to contract growers. Such models physically separate the dairy farming operations into the stages of growing replacement cattle and managing the herd of lactating cows. Vertical integration models where dairy processing companies integrate backwards into dairy farming are less common than in the poultry, pork and beef sectors due to the nature of the milk production process. While beef production, for example, is a linear

⁵ Replacement cattle refers to young cattle reared on a dairy farm besides the matured dairy cows. This includes calves (aged 0-12 months) and heifers (young female cows aged 13-24 months). Ideally, heifers calve for their first time at the age of 24 months, thereby becoming dairy cows. Dairy cows produce milk during nine months per year, and turn into 'dry cows' for three months each year during their gestation. The cows will be replaced after three to four cycles on average, due to their decreasing fertility and physical state, increasing sicknesses and other influences. On average, every year 35% of the dairy cow stock is replaced. In modern dairy operations, the typical stock of replacement cattle ranges between 8 and 12 heads per dairy cow.

process of 24 months that can neatly be separated into the cow-calf, stocker, feeding and slaughtering stages (Ward, 1997), the milk production process is cyclical and does not progress in linear production stages. This increases the complexity of the production process through various feedback loops and interdependencies between the various production stages, which represents a hurdle to such vertical integration models.

A vertically coordinated milk production model, which is a step closer to vertical integration, has been pursued by the companies Lactobom and 3B Agro LTDA. They tackled the mentioned challenges by gaining sufficient managerial influence over the production process of their contracted farmers, while simultaneously retaining these farmers' control and responsibility for their operations.

6. The company 3B Agro LTDA

The dairy Lactobom first implemented their vertically coordinated milk production model in 2009 through their wholly owned subsidiary 3B Agro LTDA. After almost 8 years of operation, the dairy sold off the company in January 2017 because of its failure to deliver the expected returns. Jandir Bombardelli, the current owner of 3B Agro LTDA, has been the managing director of this company since its establishment in 2009, and managing director of Lactobom from 1990 until 2017. Before building up the vertically coordinated milk production system, he operated a farm producing replacement cattle for surrounding dairy farmers in the region. He established the vertically coordinated system after he observed that local farmers did not use their dairy cows to their full potential due to insufficient management practices. In July 2017 over 600 dairy cows rotated within the vertically coordinated system in addition to more than a thousand animals of replacement cattle (Figure 5).

The central element of the system is the so called 'Unidade de produção das novilhas' (UPN, heifer production unit). It is a farm operated by the employees of 3B Agro LTDA and located near the dairy, where the replacement cattle are raised and impregnated for the first time, and calving takes place for heifers as well as dry cows. After calving, the lactating dairy cows are transported to one of the contracted dairy farms called 'Unidade de produção de leite' (UPL, milk production unit), where they are milked and impregnated. As soon as the dry period commences, the cows are transported back to the UPN. In exchange for a dry cow, the UPL receives a freshly lactating cow. The livestock remains the property of 3B Agro LTDA. The UPN always keeps a certain amount of spare lactating stock, in case a cow has to be replaced on one UPL. The

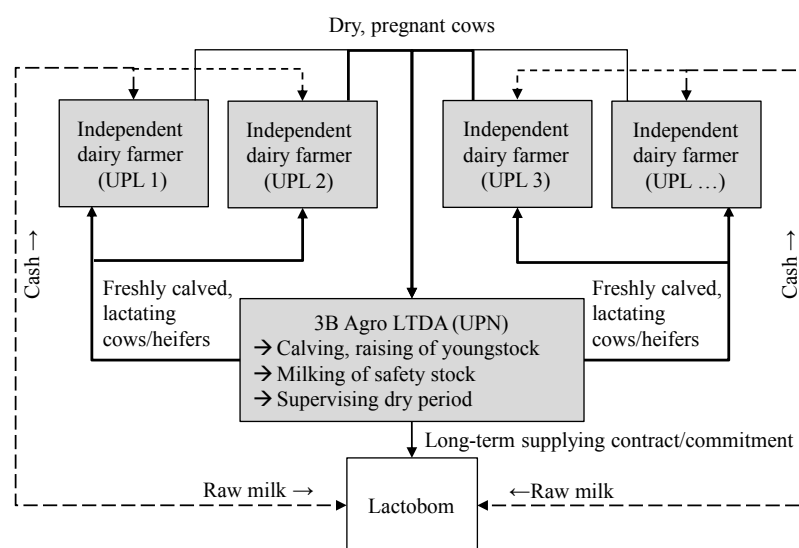


Figure 5. Simplified depiction of 3B Agro LTDA's vertically coordinated milk production and wholesale system in Toledo.

main advantage for the dairy farmers operating the UPLs is that they do not have to spend resources on raising replacement cattle and have a stock of fully lactating cattle all year round. In exchange, the farmers pay 12% of their revenues from milk sales to 3B Agro LTDA as lease payment for the livestock, which corresponds to the resources the dairy farms would otherwise spend on raising the replacement cattle according to an analysis conducted by Mr. Bombardelli. The contracted farmers are also responsible for the impregnation of the dairy cows that are on their property. The newborn calves are property of the contracted farmers and purchased by 3B Agro at market price.

The milk is fetched from the UPLs and transported to the dairy with the help of 'freteiros', which are employed full-time by the dairy company. The farmers are obliged to exclusively supply their milk to 3B Agro. As a legacy from Lactobom's previous ownership of the system, 3B Agro had to conclude a long-term supply agreement with Lactobom, according to which the milk produced by the farmers who were part of the vertically coordinated system at the time of separation from Lactobom is exclusively sold to this dairy company. Thus, these farmers receive their milk paychecks directly from Lactobom, including their quality and quantity premiums, which can amount up to € 1.60/100 kg of milk.

3B Agro also provides the contracted farmers with free technical assistance through their veterinarians to ensure optimal management practices in the dairy farms. This includes advice related to all herd and health management aspects as well as the calculation of the fodder rations on each contracted farm. Farmers are obliged to follow the technical advice provided. However, a small number of experienced farmers opposed the veterinarians' advice when they did not believe these recommendations were in their best interest. These farmers also occasionally engage in tough negotiations with 3B Agro's administration over management issues. Generally, the farmers carry all operating costs, such as insemination, fodder and medical treatment. In addition, entering the vertically coordinated system requires significant initial investments by the dairy farmers. 3B Agro LTDA requires their contracted farmers to operate an airconditioned free stall system⁶ for minimal 52 cows, the capital requirements for which can vary between € 48,000 and € 80,000. There were only a few farmers who had facilities conforming to the required standards prior to entering the system, who thus did not have to make these investments. All rights and obligations of 3B Agro LTDA and the dairy farmers are regulated in a contract (see supplementary contract).

The owner of 3B Agro LTDA also operates a concentrate feed manufacturing company in a separate legal entity, which is co-located to 3B Agro. The de-facto obligation of the contracted dairy farmers to source their concentrate feed exclusively from this company (see supplementary contract, clause 2) thus offers additional profit opportunities to Jandir Bombardelli.

Various changes to the system have been implemented during the past, and according to its owner, it is still far from being completely developed. For example, farmers initially did not have to pay for the replacement of a cow in case of death or severe sicknesses. This reduced the farmers' incentives to invest in proper medical treatment of sick animals and caused high cow mortality rates, as most farmers preferred to let a sick cow die rather than medically treat it. A replacement quota of 20% was therefore introduced, which allows farmers to replace up to 20% of their dairy cows per year; for any additional replacement the farmer has to purchase the cow at current market prices. Additionally, to prevent extreme cases of opportunism in which farmers would attempt to maximize productivity on expense of the cows' health, 3B Agro implemented a penalty system. When a cow is returned to the UPN with apparent health problems, the farmer has to reimburse the damage or, in extreme cases, will be excluded from the system. On the other side, the contracted farmers have the opportunity to report health issues of new animals and request a replacement within 24 hours after delivery (see supplementary contract, clause 1.3). However, the parameters to determine the health status of cows are not standardized and depend on the individual farmers' assessment and circumstances. Furthermore, in response to problems with milk quality, 3B Agro LTDA introduced milk quality targets stricter than the

⁶ A free-stall system denotes a confined stable construction, which offers optimal conditions for technological interventions related to thermal control, since this is one of the major concerns when it comes to dairy farming in Brazil. See Ramos and Barbosa (2016) for further information.

ones of the dairy companies. These milk quality targets are embedded in a point-based monitoring system to incentivize good practices (Table 2). Farmers are being evaluated every month based on objective evaluation criteria and can score a maximum of 100 points in these evaluations. A monthly premium is paid to farmers based on their achieved scores amounting up to € 0.70/100 kg milk.

The dairy company Lactobom initially anticipated multiple benefits from the vertically coordinated production system, such as a better control over the milk production process, supply quantities and quality of raw milk delivered; cost advantages such as reduced logistic costs due to the location of the UPN and UPLs in the vicinity of the dairy; as well as an overall increase in productivity of milk production resulting into improved competitive advantage. However, the establishment of the system required substantial investment from the side of the dairy (e.g. UPN, logistics, veterinarians and livestock), and the returns generated were comparatively low (Table 3). This ultimately led to their decision to sell-off 3B Agro LTDA. According to the current owner Jandir Bombardelli, there are no substantial profits generated through the milk sales and lease payments made by the farmers, as during most years the operations just break even. Sale of livestock is the most important source of revenues currently, since the system produces a substantial number of heifers that can be sold on the market.

Table 2. Criteria evaluated in 3B Agro's monitoring system.

| Management areas | Points | Criteria for scoring maximum points |
|---|---------|---|
| 1. Farm appearance/organization | 0 to 5 | Excellent condition |
| 2. Silage storage condition | 0 to 5 | No loose or spoiled silage |
| 3. Condition of the water troughs | 0 to 5 | Completely clean/transparent water |
| 4. Claw problems in % of cows | 0 to 15 | 0% of the herd affected |
| 5. Impregnated cows in % of cows | 0 to 15 | Over 50% successfully impregnated |
| 6. Average milk yield in liters/cow/day | 0 to 15 | Over 32 liters/cow/day |
| 7. Somatic cell count of milk | 0 to 10 | Below 250,000 cells/ml |
| 8. Bacteria cell count of milk | 0 to 5 | Below 10,000 cells/ml |
| 9. Slurry/manure management | 0 to 5 | Completely covered/ 100% used as fertilizer |
| 10. Bedding management | 0 to 10 | Excellent |
| 11. Climatization | 0 to 10 | Good |

Table 3. Estimated Profit & Loss statement¹ of 3B Agro LTDA for 2017.

| | |
|---------------------------|--|
| Total revenue | € 1,129,782 (Including sale of livestock) |
| Cost of Goods Sold | (€ 543,476) |
| Gross Profit | € 586,306 |
| Operating Expenses: | |
| Salaries | € 148,690 |
| Rent | € 73,480 |
| Utilities | € 131,540 |
| Depreciation | € 23,260 |
| Total Operating Expenses | (€ 376,970) |
| Operating Profit (EBIT) | € 209,336 |
| Interest Expense | (€ 18,750) |
| Income before taxes (EBT) | € 190,586 |
| Taxes | (€ 59,463) |
| Net Income | € 131,123 |

¹ Cost points were estimated based on data gathered during the research process. The complex structure of the company, its shared assets with other companies, and the limited availability and accuracy of bookkeeping did not allow for a more detailed depiction.

7. The vertical coordination from the farmers' perspective

Dairy farmers on the other hand could expect a number of benefits from participating in the vertically coordinated production system. For one, the system significantly lowered the barriers to entry into dairy farming, as nothing more was required to participate in the system than the required capital to build or upgrade the necessary facilities. As 3B Agro LTDA was providing all the technical expertise, high-breed cattle and other necessary production inputs, prescribed operational management and took care of marketing the raw milk, no particular qualification or previous experience was required to join the system. For example, one farmer had been operating a dairy farm with only 10 cows, and just had faced insolvency before joining the coordination system (Table 4, UPL 1). Other farmers were complete novices who had not been experienced in dairy farming at all before taking the opportunity to diversify their operations into dairy farming through this system (Table 4, UPL 2). Second, compared to traditional dairy farms, there were significant gains from efficiency improvements and specialization. As replacement cattle no longer were raised on farm, dairy farmers could fully concentrate on milking, feeding and housing of the lactating dairy cows to maximize output. This led to management steps such as milking three times per day (instead of only two times in traditional operations). Moreover, the land requirements were lower, as the farmers did not have to feed their replacement cattle. For example, the farmer who had operated a dairy farm with only 10 cows earlier was able to manage 52 cows on his property as a contracted farmer thanks to the system. On the other hand, farmers complained that their economic success relied too much on the system itself as opposed to their own management decisions. For example, they argued that meeting the high internal milk quality requirements and housing standards would force them to overinvest in high-intensity inputs, such as concentrated feed or medical treatment. Others criticized their dependency on the technical assistance provided by 3B Agro's veterinarians who were suspected to act in 3B Agro's interest rather than the interest of the contracted dairy farmer.

Table 4. Economic performance of two randomly selected dairy farms in the vertically coordinated milk production system.^{1,2}

| In € for accounting period: 07/2016-06/2017 | UPL 1 | | UPL 2 | |
|--|--------------|----------------|--------------|----------------|
| | Per cow | Per 100 kg ECM | Per cow | Per 100 kg ECM |
| Herd size, heads of dairy cows | 52 | | 52 | |
| Milk production total, t ECM/ year | 520 | | 557 | |
| Milk yield, kg ECM/cow | 9,997 | | 10,703 | |
| Total returns | 3,502 | 35.0 | 3,953 | 36.9 |
| Total costs | 3,609 | 36.1 | 3,750 | 35.0 |
| <i>Total direct costs</i> | <i>2,852</i> | <i>28.5</i> | <i>2,513</i> | <i>23.5</i> |
| <i>Total labor related costs</i> | <i>538</i> | <i>5.4</i> | <i>798</i> | <i>7.5</i> |
| <i>Total building costs</i> | <i>159</i> | <i>1.6</i> | <i>138</i> | <i>1.3</i> |
| <i>Total land costs</i> | <i>33</i> | <i>0.3</i> | <i>158</i> | <i>1.5</i> |
| Calculated and capital costs | 384 | 3.8 | 353 | 3.3 |
| Depreciation | 87 | 0.9 | 54 | 0.5 |
| Cash costs | 3,138 | 31.4 | 3,343 | 31.2 |
| Family farm income | 276 | 2.8 | 557 | 5.2 |
| Entrepreneur's profit I | -107 | -1.1 | 204 | 1.9 |
| Break-even-point I | 3,226 | 32.3 | 3,397 | 31.7 |
| Break-even-point II | 3,609 | 36.1 | 3,750 | 35.0 |
| Entrepreneur's profit II | -107 | -1.1 | 204 | 1.9 |
| Return to labor, in €/hour | 1.4 | | 3.1 | |

¹ UPL: milk production unit.

² ECM: energy corrected milk. Since average milk compositions vary greatly from farm to farm, milk amounts are corrected for fat and protein content, which allows for a fair comparison of milk amounts and the establishment of a standard measurement unit.

Despite the fact that all dairy farmers received comparable conditions in the vertically coordinated production system, their economic performance (Table 4) as well as technical performance (Table 5) varied considerably. These differences largely reflected the unpredictable nature of biological production processes, micro-deviations with regard to location and infrastructural facilities, as well as differences between the individual farmers' professional skills, experience and motivation.

Compared to the industry average (Table 1), the contracted farmers showcased extremely high milk yields and land productivity. Nevertheless, their overall profit margins were low. Their cost structures varied considerably with regard to personnel expenses, feedstuff expenses and veterinary costs (see supplementary Table A1), despite the fact that the contracted farmers operated similar facilities.

8. Expanding 3B Agro's business?

As a way to improve the financial performance of 3B Agro LTDA in the future, Jandir Bombardelli believes that rapid growth is the only appropriate strategy. His main argument is that the slim per unit gross margins in the dairy industry ultimately reward economies of scale. In addition, he expects that larger volumes of raw milk would improve 3B Agro's bargaining power vis-à-vis the dairy processing companies. Finally, he wants to defend and exploit the significant advance 3B Agro currently has compared to its competitors with regard to operating a vertically coordinated dairy production model, as the model already started to attract some attention in the region. He knows of some private dairy companies and cooperatives that have been investigating such vertical coordination models and are currently preparing its implementation. In

Table 5. Technical performance of two randomly selected dairy farms in the vertically coordinated milk production system.^{1,2}

| Accounting period: 07/2016-06/2017 | UPL 1 | UPL 2 |
|---|---------|---------|
| Total family labor units (whole farm) | 2.0 | 1.0 |
| Total hired labor units (whole farm) | 1.0 | 4.0 |
| Labor input, hours per cow | 106.0 | 208.0 |
| Labor productivity, kg ECM per hour | 95.0 | 52.0 |
| Price for hired labor, € per hour | 2.7 | 2.0 |
| Replacement cattle, heads per 10 dairy cows | 0.0 | 0.0 |
| Fat in milk, % | 3.71 | 3.53 |
| Protein in milk, % | 3.47 | 3.25 |
| Somatic cell count, ml | 281,000 | 255,000 |
| Milking frequency, times per day | 3 | 3 |
| Seasonal milk production (Block calving) | NO | NO |
| Calving interval, days | 502 | 400 |
| Whole farm area, ha | 5.0 | 39.0 |
| Land rented, % | 0.0 | 0.0 |
| Forage area, ha | 5.0 | 22.0 |
| Share of permanent grassland, % | 0.0 | 0.0 |
| Temporary grassland on forage area, % | 0.0 | 0.0 |
| Arable land on forage area, % | 100 | 100 |
| Concentrate intake, kg per cow per day | 12,2 | 11.3 |
| Concentrate feed-input, g/kg ECM | 444 | 385 |
| Barn capacity use, % | 100 | 100 |
| Stocking rate, dairy cows per ha | 9.8 | 2.4 |

¹ UPL: milk production unit.

² ECM: energy corrected milk. Since average milk compositions vary greatly from farm to farm, milk amounts are corrected for fat and protein content, which allows for a fair comparison of milk amounts and the establishment of a standard measurement unit.

light of these arguments, Mr. Bombardelli conceives expanding the business by establishing two UPNs in neighboring regions a necessary next step. Compared to his current operations, the new establishments would be significantly larger due to the expected benefits of scale. However, according to his experience there is a natural limit of approximately 1,200 animals per UPN as otherwise the risk of spreading infectious diseases among the cows would get too large. The profitability of the new operations would be improved by significantly increasing the capacity of the contracted dairy farms to 200 cows per farm. Moreover, contracted farmers would have to prove profound professional experience in dairy farm management before they would be admitted participating in the system.

According to a quick back-of-the-envelope assessment, Mr. Bombardelli estimates that the initial capital requirement for the establishment of one UPN amounts to the costs of 1,200 heifers with an average market price of €1,400/heifer, as well as the construction of facilities and purchase of equipment of around €700,000.

9. Challenges ahead

Considering these opportunities, Jandir Bombardelli regained confidence in his project. Even though managers of Lactobom doubted the potential of the vertically coordinated production model, he believed that it could become economically viable. One of the keys to success were the experience and professional skills of the contracted farmers. Nonetheless, some questions remained: how should the system be changed that 3B Agro LTDA could improve its profitability? Does the vertically coordinated system offer sufficient incentives to dairy farmers to produce high-quality milk, or do the operational responsibilities and contractual obligations of both parties require modifications? Is it recommended to expand the business given its current challenges? As he did not have immediate answers to these questions, Mr. Bombardelli took a pen and jotted down some analyses.

Supplementary material

Supplementary material can be found online at <https://doi.org/10.22434/IFAMR2018.0080>.

Summary of the contract between farmer and 3B Agro LTDA.

Table A1. Detailed overview of the economic performance of two randomly selected dairy farms in the vertically coordinated milk production system.

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