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THE CHANGING FACE OF MILK PRODUCTION, MILK QUALITY AND MILKING TECHNOLOGY IN BRAZIL

Debora Costa
Douglas J. Reinemann
Nigel Cook
Pamela Ruegg

The Babcock Institute for International Dairy Research and Development
University of Wisconsin, College of Agricultural and Life Sciences
240 Agriculture Hall, 1450 Linden Drive
Madison, Wisconsin 53706-1562

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The Babcock Institute
College of Agricultural and Life Sciences
240 Agriculture Hall, 1450 Linden Drive
Madison, Wisconsin 53706

Phone: 608-265-4169; Fax: 608-262-8852
Email: babcock@cals.wisc.edu
Internet: http://babcock.cals.wisc.edu

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THE CHANGING FACE OF MILK PRODUCTION, MILK QUALITY AND MILKING TECHNOLOGY IN BRAZIL

Debora Costa, Douglas J. Reinemann, Nigel Cook, and Pamela Ruegg*

Executive Summary

This introductory paper gives an overview of milk production in Brazil and discusses a series of recent regulations implemented to improve milk quality with the purpose to assert the Brazilian dairy industry as a competitor on the international market. It also points out the economic advantage of setting design guidelines for milking machines that would be best suited to Brazilian crossbred cows. See Babcock Institute's *Updates 2004* for further discussion on the milking characteristics of three different types of crossbred cows as well as the effect of using calves for milk letdown stimulation.

* Debora Costa is a Graduate Research Assistant in the Department of Dairy Science; Douglas J. Reinemann is a Professor in the Departments of Biological Systems Engineering, Dairy Science and the UW Milking Research and Instruction Lab; Nigel Cook is an Assistant Professor in the College of Veterinary Medicine; and Pamela Ruegg is an Associate Professor in the Department of Dairy Science and the Leader of UW-Team Quality Milk at the University of Wisconsin-Madison.

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I. Introduction

Structural changes in the dairy industry are occurring in many milk-producing countries. These structural changes are occurring at an especially rapid pace in Brazil, which has the second largest number of dairy cows in the world (Table 1). An overall decrease in cow numbers paired with an increase in the number of cows per farm has lowered the number of Brazilian milk producers. This trend is accompanied by an increased use of technology, requiring the development of new skills to manage farms.

Table 1: Cow Milk Production, Number of Dairy Cows and Productivity per Cow in Selected Countries, 2001

Country	Milk Production (tones)	Number of Dairy Cows	Productivity (l/cow/yr)
1. India	80,500,000*	88,401,000*	911*
2. USA	74,995,000	9,115,000	8,228
3. Russia	33,000,000	12,500,000	2,640
4. Germany	28,200,000	4,448,000	6,340
5. France	24,766,000	4,353,000	5,689
6. Brazil	**22,580,000**	**16,045,000**	**1,407**
7. United Kingdom	14,719,000	2,203,000	6,681
8. Ukraine	13,200,000	5,375,000	2,456
9. New Zealand	13,300,000	3,520,000	3,778
10. Poland	12,030,000	2,991,000	4,022
11. Australia	11,330,000	2,281,000	4,967
12. China	10,255,000	5,680,000	1,805
13. Italy	11,700,000	2,169,000	5,394
14. Netherlands	11,291,000	1,551,000	7,280
15. Mexico	9,786,000	6,900,000	1,418
16. Japan	8,300,000	1,124,000	7,384
17. Argentina	9,400,000	2,400,000	3,917
18. Canada	8,377,000	1,156,000	7,247

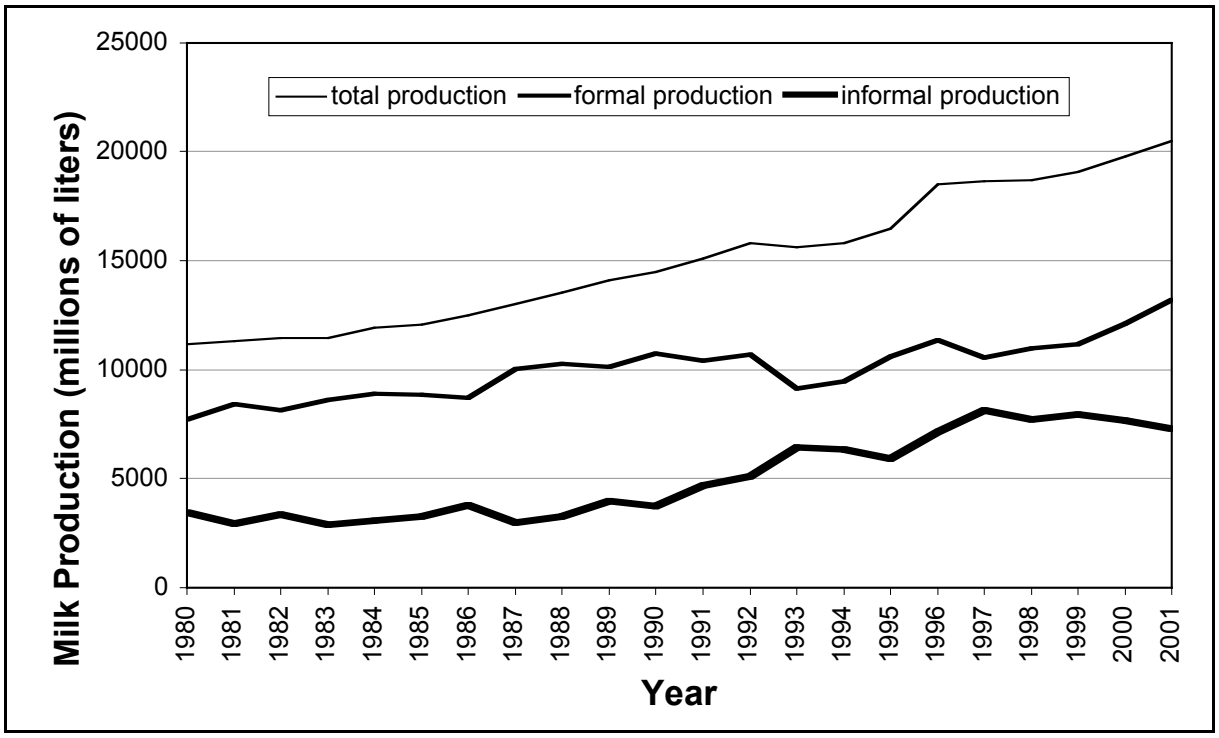
*Including water buffalo cows (56% of India's milk production comes from water buffalo cows).

Source: ZMP, National Statistics, FAO, and USDA. Adapted from International Dairy Federation (IDF) Bulletin no. 378/2002.

The Brazilian dairy industry has a large number of milk producers covering a wide range of production practices and management strategies. Raw milk is distributed through a concentrated, "formal" processing system of dairy plants or through a similar sized "informal" milk distribution system in which raw milk is sold directly from the farm to the end user (Figure 1). The raw milk supply in Brazil is steadily increasing in response to increased consumer demand for dairy products and increased emphasis on milk quality and food safety.

The recent progress and stabilization of Brazil's open economy, combined with its large percentage of dairy imports, has accelerated the concentration of milk processing. Small local cooperatives and processing industries have merged into fewer numbers of large, regional, national, or multinational companies. Consumer and milk processor demands for improved raw milk quality have resulted in the enactment of national regulations that will be phased in throughout the country in the coming years.

Figure 1. Distribution of Brazilian Milk Production: Significance of the Informal Market



Source: 1980-1997: Cadeia de Lácteos no Brasil: restrições ao seu desenvolvimento (the milk product chain in Brazil, constraints to its development) 1998-2001 EMBRAPA Dairy Cattle Research Center website http://www.cnpgl.embrapa.br.

In order to improve the national dairy market and assert itself as a competitor on the international scene, Brazil's dairy industry must experience gains in productivity through increased scale of production and improved milk quality in the coming years. However, the ultimate structure of the Brazilian dairy industry must respond to the natural and human resources of the country. Small to large Brazilian farms characteristically use crossbred cows suited to their environmental conditions and types of feed available to Brazilian farmers.

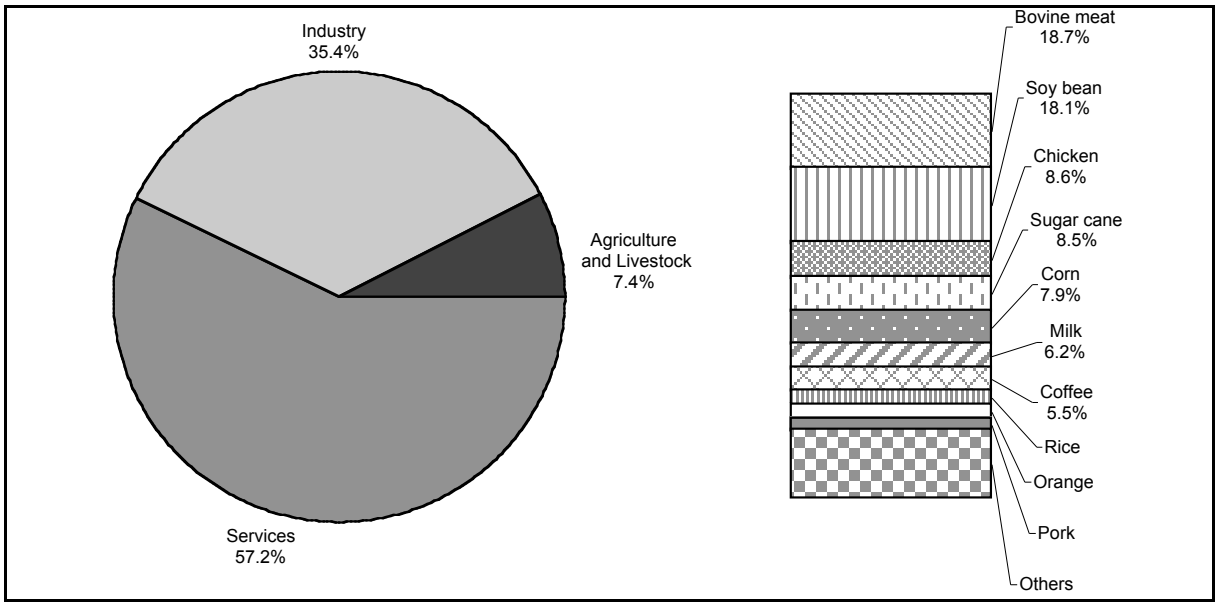
This paper, an initial report of a study funded by the Babcock Institute, is intended to quantify some of the milking characteristics of the types of crossbred cows currently used in Brazil, provide information regarding the optimal genetic mix for Brazilian conditions, and specifically, to examine the type of milking machines best suited to Brazilian cows.

II. Milk Production

According to the International Dairy Federation (IDF), Brazil is presently the sixth largest milk-producing country in the world, following the US, India, Russia, Germany and France (Table 1). Milk is the sixth most important economic product of the agricultural sector of the Brazilian GDP (Figure 2) and its production has increased in recent years by two to four percent annually (Table 2). As a result, dairy exports are rising (Table 3) and dairy imports are falling significantly (Figure 3). This increase in exports paired with decreased imports is also the result of a stagnated Brazilian economy, which reduces the population's overall demand of dairy products.

The total number of Brazilian dairy farms is difficult to determine, due to the large presence of an informal milk production and distribution system in Brazil. According to the last Intituto Brasileiro de Geografia e Estatística (IBGE) census (1995-1996), there were approximately 1.8 million dairy farms, 75 percent of which were mainly dedicated to dairy activity. In 2001, the estimated number of dairy farms had decreased to approximately 1.2 million [20].

Figure 2. Brazilian GDP & Segmentation of the GDP of Agriculture & Livestock, 2002



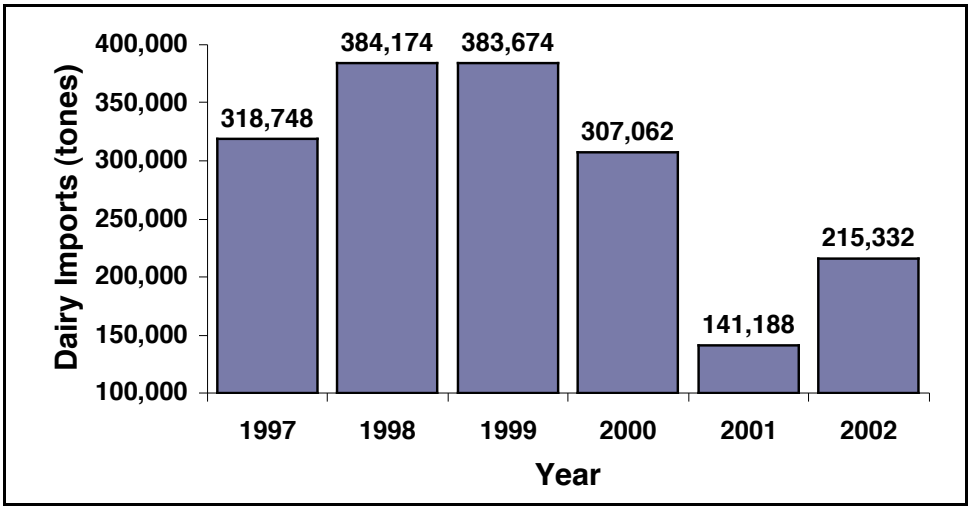
Source: IBGE/CONAB/CAN/DECON – adapted from EMBRAPA Dairy Cattle Research website http://www.cnpgl.embrapa.br.

According to data published by Empresa Brazileira de Pesquisa Agropecuária (EMBRAPA) (Table 2), the average productivity of Brazilian dairy cows in 2001 was 1,127 liters/cow/year, which is about one-fourth of that in Australia (4,967 liters/cow/year), and one-eighth of that in the US (8,228 liters/cow/year) (Table 1). In Table 1 Brazilian milk production was overestimated and number of dairy cows was underestimated, and resulted in higher cow productivity, which was not considered here. To calculate total Brazilian milk production it is necessary to estimate informal milk production, which may not be very precise.

Considering a lactation length of 270 days, the low daily average of approximately 4.2 liters/cow/day is undoubtedly due to a large number of non-specialized producers who use cows for both milk and beef. On average, these dual-purpose cows yield about one liter/cow/day. While a large number of farms have an annual average yield greater than 15 liters/cow/day.

Most Brazilian dairy farms have small herds of crossbred cows that are milked by hand. Production practices vary from low-input grazing to high-input free stall barns and milking parlors. Low-input grazing systems tend to work well with crossbred cows, while high-input systems favor Holsteins.

Figure 3. Brazilian Dairy Imports, 1997-2002



Source: EMBRAPA Dairy Cattle Research Center website http://www.cnpgl.embrapa.br.

Dairy herds in Europe and the US are based almost entirely on Holstein/Friesian genetics, while Indian breeds such as Gir, Guzerá, and Nelore are important components of the genetic mix in

Table 2: Milk Production, Milking Cows and Cow Productivity in Brazil, 1980-2002

Year	Milk Production (million liters/year)	No. of Milking Cows (thousands)	Productivity (liters/cow/year)
1980	11,162	16,513	676
1981	11,324	16,492	687
1982	11,461	16,387	700
1983	11,463	16,276	704
1984	11,933	16,743	713
1985	12,078	16,890	715
1986	12,492	17,330	721
1987	12,996	17,774	731
1988	13,522	18,054	749
1989	14,095	18,673	755
1990	14,484	19,072	760
1991	15,079	19,964	755
1992	15,784	20,476	771
1993	15,591	20,023	779
1994	15,784	20,068	787
1995	16,474	20,579	800
1996	18,515	16,273	1,138
1997	18,666	17,048	1,095
1998	18,694	17,280	1,082
1999	19,070	17,395	1,096
2000	19,767	17,885	1,105
2001	20,510	18,194	1,127
2002	21,063*	18,508*	1,138

*Estimation of EMBRAPA Dairy Cattle Research Center.

Source: IBGE (Censo Agropecuária e Pesquisa Pecuária Municipal [Agricultural census and Livestock Farming Municipal Research]) in EMBRAPA Dairy Cattle Research Center website http://www.cnpgl.embrapa.br.

Brazil. European breeds such as the Holstein, Jersey, and Brown Swiss offer a higher rate of milk production per cow. However, increased production is only realized when adequate environmental and nutritional conditions exist. These requirements come at a cost. Although producing less milk per cow, the Indian breeds are useful in Brazil because they serve as a source for both meat and milk. Furthermore, Indian breeds are more rugged and adapt better to Brazil's adverse tropical environment.

Table 3: Brazilian Exports of Dairy Products, 2000-2002

Product	Amount (in tones)		
	2000	**2001**	**2002**
Milk Powder	4,774	8,422	27,213
Yogurt	1,248	3,978	5,991
Fluid Milk	360	1,710	4,402
Cheese	2,416	2,270	2,123
Butter	99	2,958	370
Whey	31	33	8,928
TOTAL	**8,928**	**19,371**	**40,124**

Source: MAPA/MDIC Alice Web in EMBRAPA Dairy Cattle Research Center Website http://www.cnpgl.embrapa.br.

As milk production increases, food consumption, nutrients metabolism, and heat dissipation also increase. In environments with high temperatures, heat dissipation is difficult because there is a smaller temperature difference between the animal and the air. This explains why, in hot environments, high producing cows are more prone to heat stress than cows with low production rates [23].

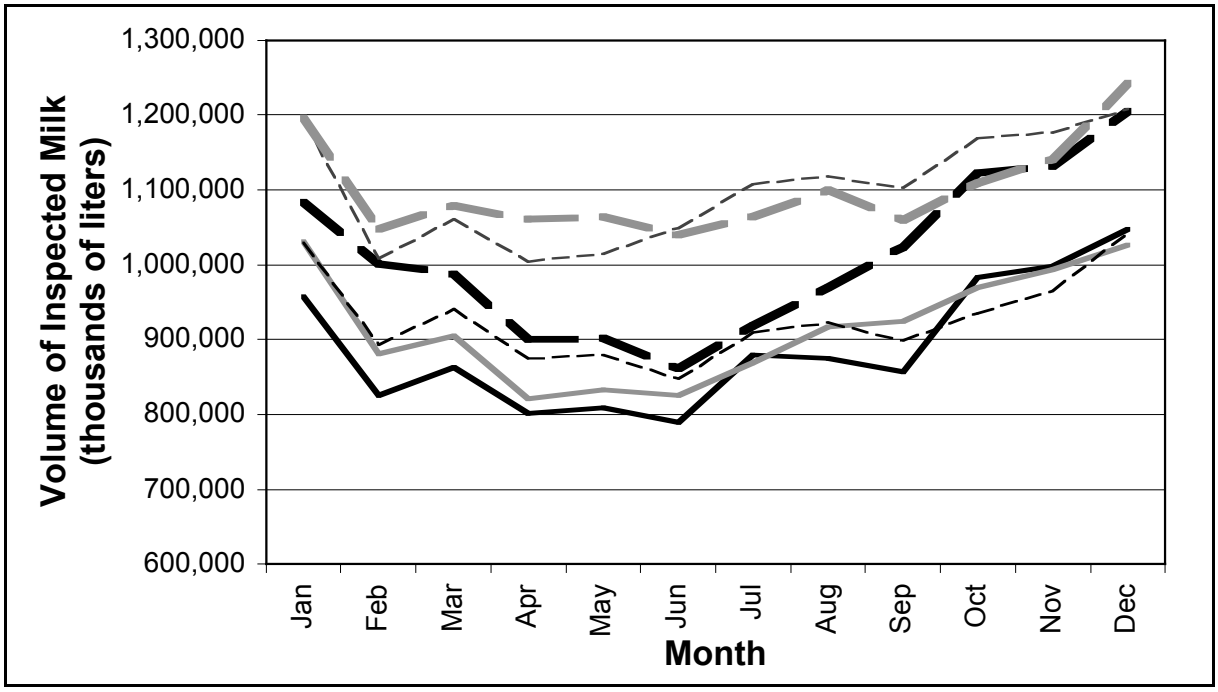
Brazilian farms using mainly European genetics are also more likely to use more intensive production technologies requiring higher levels of

investment and management. Type of breed is also correlated with the size of dairy herd and other indicators of efficiency and productivity of labor, land, and capital.

There are differences in dairy production practices among the various regions of the country. These differences are due to several factors, including differences in the environment, size and state of the dairy market, available infrastructure, and technology level. In the main milk producing regions, Gomes [14] estimated that about five percent of the farms are producing less than 50 liters/day, contributing only ten percent of the total milk production. Meanwhile, 10 percent of the farms that produce more than 200 liters/day are responsible for more than 50 percent of total production.

Traditionally, seasonal production systems were used in Brazil and produced higher yields in the rainy season when good pasture was available. However, seasonal milking has become less frequent as the difference between production in the "wet" period (from October to March) and the "dry" period (from April to September) has decreased significantly in the past two years (Figure 4). Conversely, the merging production rates between wet and dry seasons could also be attributed to the translocation of the "seasonal" producer from the formal to the informal market.

Figure 4. Oscillation of Volume of Milk Received by Inspected Industries, 1997-2002 (Seasonality)



Source: IBGE – Pesquisa Trimestral do Leite (Milk Trimesterly Rresearch) in EMBRAPA Dairy Cattle Research Center website. Adapted from Milkpoint at http://www.cnpgl.embrapa.br.

In developed countries, cooperatives play a major role in receiving and processing milk, their participation in the process ranges between 80 to 95 percent in Australia, the US, New Zealand, and Denmark. Although there is no official data about cooperatives' level of participation in the reception and processing of milk in Brazil, it is estimated that their participation today is about 40 percent. This percentage marks an obvious decline in cooperative participation when compared against the 1990s level of 60 percent. The primary reason for the weakening process of Brazilian cooperatives is their inability to keep pace with the structural changes that are necessary to become more competitive in the market [6].

The largest proportion of the dairy processing industry is made up of a few large national and multi-national companies (Table 4). Small dairy companies and cooperatives have been merging to form larger dairy industries to gain economy of scale. It is estimated that dairy plants process 59

percent of the domestic milk production, and that the remaining 41 percent (about eight billion liters/year) is sold directly to consumers in the so called "informal milk market," which corresponds to about 31 percent of the sector's gross income [18].

There has been significant growth in the "informal" production sector. Although Brazil's dairy regulations prohibit the sale of raw (unprocessed) milk and milk products, the share of the informal sector has increased from about 37 percent of total production in 1990-92 to 43 percent in 1996-98 [4] (Figure 1). It should be noted however, that there is no consensus regarding the size of the informal market. According to Farina et al. [11], during the period of 1997-1999, the informal market made up 28 to 29 percent of the total market. In addition to the sale of the raw milk, the informal market also accounts for the self-consumption of milk and other dairy products by dairy farmers, their family, their employees, as well as other on-farm uses (calf feeding, for example). Informal distribution may be a way for some small milk producers to bypass rigorous inspections, allowing them to remain active, while minimizing the effects of low milk prices.

Research indicates that structural changes similar to those in Brazil have occurred worldwide in recent years and affected small milk producers the most. The greatest reduction in farm numbers in Brazil is occurring in the small and medium sized farm sectors.

Table 4: The 15 Top Brazilian Dairy Industries in Amount of Milk Received

Class (1)	Dairy Processor Name/Brand	Total Milk Received by Year (2) (in thousand liters)			Number of Producers (3)			Average Daily Milk Production (liters/day/producer)		
		2000	2001 (4)	2002 (4)	2000	2001	2002	2000	2001	2002
1	NESTLÉ	1,393,000	1,425,628	1,489,029	14,142	8,536	7,192	270	458	567
2	PARMALAT	919,483	941,490	947,832	15,550	15,300	12,605	162	169	206
3	ITAMBÉ	773,000	832,000	732,000	8,400	7,990	6,010	252	285	334
4	ELEGÊ	760,239	782,141	711,335	32,188	31,282	28,665	65	69	68
5	CCL*	512,687	488,131	307,766	8,925	8,191	4,512	157	163	187
6	DANONE	130,210	247,487	272,236	1,420	2,452	2,470	251	277	302
7	SUDCOOP*	181,670	209,070	230,952	4,625	6,333	6,993	108	90	90
8	CENTROLEITE*	174,902	220,533	213,503	4,205	4,725	4,905	114	128	119
9	EMBARÉ	123,471	180,081	192,378	2,863	3,203	2,884	118	154	183
10	LACTICÍNIOS MORRINHOS	146,200	207,031	188,241	7,292	7,299	4,990	55	78	103
11	LEITE NILZA*	141,449	139,937	182,568	2,615	2,384	3,031	148	161	165
12	BATÁVIA	272,775	225,659	165,276	7,505	6,820	6,529	100	91	69
13	LIDER ALIMENTOS	206,568	220,000	163,766	8,795	7,035	2,807	64	86	160
14	GRUPO VIGOR	229,629	209,743	154,158	3,693	2,039	1,525	170	282	277
15	ILPISA	121,455	127,830	117,637	858	627	729	388	559	442
16	TOTAL	6,086,738	6,371,761	6,014,227	123,076	114,216	95,487	135	153	172

(1) Classification based in amount of milk received in 2002.

(2) These figures do not take into account purchase of milk from other smaller dairy processors.

(3) On December 31st.

(4) Total does not include the milk received by DANONE from CCL due to double record (DANONE bought CCL).

* Cooperatives

Source: IBGE – Pesquisa de Pecuária Municipal (Municipal Livestock Farming Research). Adapted from EMBRAPA Dairy Cattle Research Center website http://www.cnpgl.embrapa.br.

III. Milk Price

After almost 50 years of government-regulated milk pricing, a release of prices in 1991 initiated the process of deep transformations within the Brazilian milk market. In recent years, a number of factors have influenced milk price, including the open economy in the international market, the

stabilization of the Brazilian economy, the increasing importance of milk quality in face of a competitive milk market, and the growth of the Ultra High Temperature (UHT) milk market [15].

An FAO report on average farm-gate milk prices in several countries for October 2002 shows that Brazilians, along with Argentinean and Zimbabwean farmers, were paid the lowest listed prices for their milk (US$ 0.08/kg, Table 5).

Table 5: Milk Price Survey in Selected Countries (October 2002)

Country	Milk Price (US¢/kg)	Country	Milk Price (US¢/kg)
Japan	62	Czech Republic	25
Switzerland	52	Egypt	24
Mauritania	42	Denmark	23
Malta	37	Nepal	22
Canada, Italy, Finland, Mauritius	35	Malawi	20
France, Ireland	33	Guyana, Indonesia	19
Kenya, Israel, Germany	32	New Zealand, Poland, Colombia, Pakistan	18
Sweden	31		
Belgium, USA	29	India	16
Costa Rica, China, Thailand	28	Australia, Chile	15
United Kingdom, Philippines, Mexico	27	Lithuania, Ukraine	13
		Uruguay	10
Ecuador, Netherlands	26	Argentina, Brazil, Zimbabwe	8

Source: FAO – The Milk Report, Number 9, November 2002.

The average price paid to farmers for raw milk has declined in recent years, while production has gradually increased. The extremely low prices paid to dairy farmers in 2001 resulted in a severe crisis in this sector, compelling many farmers to leave the business. Which in turn resulted in a reduction of milk available in the market, forcing several dairy processors to close down.

The milk shortage in the market improved milk prices in 2002, but not enough to profit producers since the Brazilian currency (Real) had undergone a strong devaluation. The depreciation of the Real impacted the milk market by elevating the cost of production, therefore affecting the prices of ration, fuel, fertilizers, etc. Interestingly, in 2002, milk prices did not drop during the wet season. The unusually high wet season milk prices could be attributed to the low milk availability in the market and resulted in increased dairy imports (52.5%), even in the face of a non-favorable exchange rate. Additionally, the depreciation of the Real stimulated dairy exports, which increased to 121.5 percent [24].

The drop in profit/liter was offset by increased production resulting in increased profits per farm. This specific market situation reduces the number of farms and increases production rates per farm.

Table 6: Brazilian Bulk Tank Sales, 1995-2001

Year	R$ (in millions)	Number of Bulk Tanks
1995	37	4,000
1996	43	5,200
1997	60	6,900
1998	79	8,800
1999	102	11,500
2000	120	14,000
2001 (estimate)	140	16,000

Source: Amaro in Anuário Milkbizz 2001-2002, p. 32.

In general, small farms have lower productivity per cow, lower milk quality, receive a lower price/liter for their product, and are unable to support investment in technology. As a result, these farms are forced to leave the formal milk production system. In 1990 farms producing more than 500 liters per day made up one percent of the farms and 10 percent of the milk supplied to a large dairy processor in

Minas Gerais state. In December 2000, these farms accounted for 16% of the producers and 59 percent of the milk. At the other extreme, in 1990, 62 percent of the farms produced less than 50 liters per day and supplied 21 percent of the milk to the processor, while in December 2000 they accounted for 22 percent of the farms and two percent of the same processor's milk [16].

An increasing number of private firms and cooperatives are adopting alternative systems of price differentiation for milk procurement. Bonuses and higher prices have been established according to specific quality standards and total farm volume. Small farms are usually required to invest in technology to take advantage of these higher milk prices.

Until 2002, some of the milk produced in Brazil was not refrigerated on the farm and was transported in 40-quart cans that were picked up at the farm once or twice a day. National regulations described below were enacted to gradually phase out the supply of un-refrigerated milk. On-farm refrigeration allows milk to be picked up at the farm once per day or every other day with tanker trucks, as compared to daily pick-up for un-refrigerated milk. Farms are required to invest in expensive bulk tanks. Cooperatives and companies have been financing refrigeration systems for producers and/or groups of producers to assist them in making this transition. The refrigeration system substantially reduces per unit cost of transportation and has been widely adopted by progressive dairy plants in recent years [18] (Table 6). The implementation of these systems will be mandatory in July of 2005 (for South, Southeast and West-Center regions) and July of 2007 (for North and Northeast regions) (Table 7).

Table 7: Requirements Relative to Bacterial Counts, Somatic Cell Counts, Antibiotic Residues and Temperature Limits for Refrigerated Raw Milk

Milk analysis required for each producer or each bulk tank from a community of producers	By: 07.01.2005 Regions: S/SE/WC By: 07.01.2007 Regions: N/NE	From: 07.01.2005 To: 07.01.2008 Regions: S/SE/WC From: 07.01.2007 To: 07.01.2010 Regions: N/NE	From: 07.01.2008 To: 07.01.2011 Regions: S/SE/WC From: 07.01.2010 To: 07.01.2012 Regions: N/NE	From: 07.01.2011 Regions: S/SE/WC From: 07.01.2012 Regions: N/NE
Standard Plate Count (SPC), in CFU/ml, (geometric mean over a period of 3 months, at least 1 analysis per month)	Maximum: 1.0×10^6, for dairy processors which already have established these requirements prior to this regulation	Maximum: 1.0×10^6, for all dairy processors	Maximum: 7.5×10^5	Maximum: 1.0×10^5 (each producer) Maximum: 3.0×10^5 (each bulk tank from a community of producers)
Somatic Cell Count (SCC), in cells/ml, (geometric mean over a period of 3 months, at least 1 analysis per month)	Maximum: 1.0×10^6, for dairy processors which already have established these requirements prior to this regulation	Maximum: 1.0×10^6, for all dairy processors	Maximum: 7.5×10^5	Maximum: 4.0×10^5
Antibiotic residues or other inhibitors of microorganisms' growth: limit established in the National Program of Residue Control (Ministry of Agriculture)				
Maximum temperature of milk storage: 7ºC in the farm and 10ºC in the dairy processor				
Limit of existence of milk type C (raw or pasteurized)	By: 07.01.2005, Regions: S/SE/WC By: 07.01.2007, Regions: N/NE			

Source: Ministry of Agriculture, Brazil, Instrução Normativa 51, published in 09/20/02.
In: Conselho Brasileiro de Qualidade de Leite (Brazilian Council of Milk Quality) website http://www.cbql.com.br

IV. Milk Quality

Milk quality has been an issue of intense debate in Brazil for the last six to seven years. A stable economy and reduced inflation have increased the competitiveness of the dairy industries, as

well as stimulated the demand for high quality dairy products. Such changes have a direct impact upon raw milk production practices.

The Brazilian Ministry of Agriculture, EMBRAPA and the University system have established a program called Programa Nacional de Melhoria da Qualidade de Leite, (PNMQL). This program has established a set of guidelines for milk production, milk storage, and milk transport.

In April 2002, the Brazilian government implemented regulations (Instrução Normativa N.37) approving the formation of official laboratories whose purpose is to inspect milk quality at the farm and industry level.

Five months later, the Ministry of Agriculture published the "Instrução Normativa N.51," which defines quality standards for different grades of milk are defined. The document also laid out regulations on production practices, milk cooling on the farm, and milk transport by refrigerated tank trucks. The official implementation of these regulations began in 09/20/02 (Table 7).

Pasteurized milk in Brazil is classified as types "A," "B," and "C." Milk type A must be pasteurized and packaged on the farm. The raw milk must have a total bacterial count (TBC) less than 10,000 cfu/ml and the pasteurized product must have a TBC less than 1000 cfu/ml. Type B milk is processed in the dairy plants. The TBC of the raw milk must be less than 500,000 cfu/ml and the pasteurized milk must have TBC less than 80,000 cfu/ml. Type C milk is the cheapest and most available of the three types (95 percent of the national production). TBC for Type C raw milk can be as high as 1×10^8 cfu/ml, but the pasteurized milk must have TBC less than 300,000 cfu/ml [8].

Beginning in 2005, new requirements will gradually be enforced, with slower implementation in the North and Northeast Regions. The goal is to have all milk produced within the country, regardless of region, meet the same standards of quality by 2012 (Table 7). One primary objective is to eliminate the Type C milk from the market, therefore not allowing the processing of raw milk with standard plate count over 1 million cfu/ml. The new regulations will also apply to animal health, and the levels of antibiotic residues permissible in raw milk, as well as SCC limits for all milk types. There are also regulations on other aspects of dairy herd and plant management. These new rules mark an important step in upgrading milk quality awareness at all levels of dairying, from producer to consumer.

Requirements introduced in the new regulations have already resulted in changes in milk quality and the way milk is being produced. Of paramount importance is the need to cool the milk both at the farm and during transport to the dairy plant. As a result, most of the large companies, and even some small cooperatives, are now collecting a large part of their milk under refrigeration. Such efforts are most visible in the southern and southeast regions of Brazil.

V. Milking Machines and Milking Practices

The new regulations requiring milk refrigeration on farms will force many farms to increase production through improved labor productivity, increased productivity per cow, and increased cow numbers, in order to support the investment in this equipment. For many farms this means adopting machine milking or changing from bucket type milking systems to pipeline milking systems.

The minimum performance requirements for milking machine installations are specified in International Standard ISO 5707 and ASAE (American Society of Agricultural Engineers) standard ASAE518. Standards are being developed in Brazil based on the ISO document (Table 8). Recent revisions of these standards have shown significant progress towards moving the Brazilian system from dimensional to performance-based standards. However, the guidelines in both the ISO and ASAE standards are based on the milking characteristics of high producing European breeds. Sizing of milking machines can have a dramatic impact on:

1. The initial cost of the installation;
2. The amount of water and chemicals required for cleaning and sanitation;

3. The subsequent cost of cleaning and sanitation; and
4. The electrical energy requirements for milking and cleaning.

Table 8: Norms Used in Brazil for Milking Machines Design

Reference of the Norm Used	Fundaments of the Norm
ISO 3918	Terminology for components
ISO 5707	Function and Dimension
ISO 6690	Standard tests for checking and calibration

Source: Amaro in Anuário Milkbizz 2001-2002, p.36.

Over-sized milking machines will place a significant economic burden on the farmer. Appropriate guidelines for milking machine design can ease the already difficult economic situation of many small and medium-sized farms faced with the challenges of the new regulatory environment. The three main design criteria for milking machines are:

1. The peak milk flow rate of cows,
2. The amount of air admitted during milking unit attachment, and
3. The amount of air used by milking machine components.

The ISO standard specifies a performance requirement of vacuum stability in the milkline within two kPa of the intended set point. Design tables are presented as guidelines to achieve this requirement in normal practice. These tables are based on the average peak milk flow harvesting rates of four and 4.5 liters/min. The average for high producing Holstein cows is about 3.5 liters/min. Thus the ISO guidelines have been set at levels significantly above the expected values, in order to provide a margin of safety. The ultimate implementation of the machine will depend on the choices made by users as to how much "safety" they wish to purchase and maintain. The ASAE guidelines imply a greater margin of safety by using a peak flow rate of 5.5 liters/min, which represents the fastest five percent of cows in the US. It must be noted however, that these design tables are only guidelines and neither standard precludes the use of a different set of criteria for specific applications.

Our preliminary work suggests that the peak milk flow rate of typical crossbred Brazilian cows is about 2.5 liters/min., a rate substantially lower than that of Purebred Holstein cows. A set of design guidelines appropriate to Brazilian conditions could thus produce substantial economic savings for Brazilian farmers.

Another aspect of typical dairy farms in Brazil is the use of calf suckling before, after, and sometimes, during milking to:

1. Promote milk letdown,
2. Prolong lactation,
3. Restrain and calm cows during milking, and
4. Better calf growth rate.

Calf suckling is most commonly practiced with cows that are 50:50 crossbred with Holstein genetics, although many farms with 75:25 Holstein genetics continue to use calf suckling. Calf suckling adds a tremendous amount of labor to milking, as well as special requirements for milking parlors.

In future Babcock publications, data collected from several Brazilian farms in cooperation with the University of São Paulo State at Botucatu, on milking characteristics, milk production, and milk quality for cows with varying degrees of Holstein genetics, both using and not-using calf suckling will be further examined to:

1. Quantify the milking characteristics of the type of cows used in Brazil, so that appropriate guidelines can be set forth for the Brazilian dairy system.
2. Examine the influence of calf suckling on milking characteristics, milk production, and milk quality.
3. Examine the overall effect of cross breeding on productivity and milk quality on Brazilian farms.

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Appendix A: Abbreviations

IDF: International Dairy Federation

IBGE: Brazilian Institute of Geography and Statistics (Brasileiro de Geografia e Estatística)

CONAB: National Company of Supply (Companhia Nacional de Abastecimento)

CNA: Confederation of Agriculture and Livestock of Brazil (Confederação da Adricultura e Pecuãria do Brazil, previously Confederação Nacional da Agricultura)

DECON: Department of Economics (Departmento de Economia)

EMBRAPA: Brazilian Agricultural Research Corporation (Empresa Brazileira de Pesquisa Agropecuária)

MAPA: Ministry of Agriculture and Livestock (Ministério da Agricultura, Pecuaria e Abastecimento)

MDIC: Ministry of Development, Industry and Exterior Commerce (Ministério do Desenvolvimento, Indústria e Comércio Exterio)

Tariff rate quota: The use of a reduced tariff rate for a specified volume of imports, while imports beyond these volumes face a higher tariff rate.

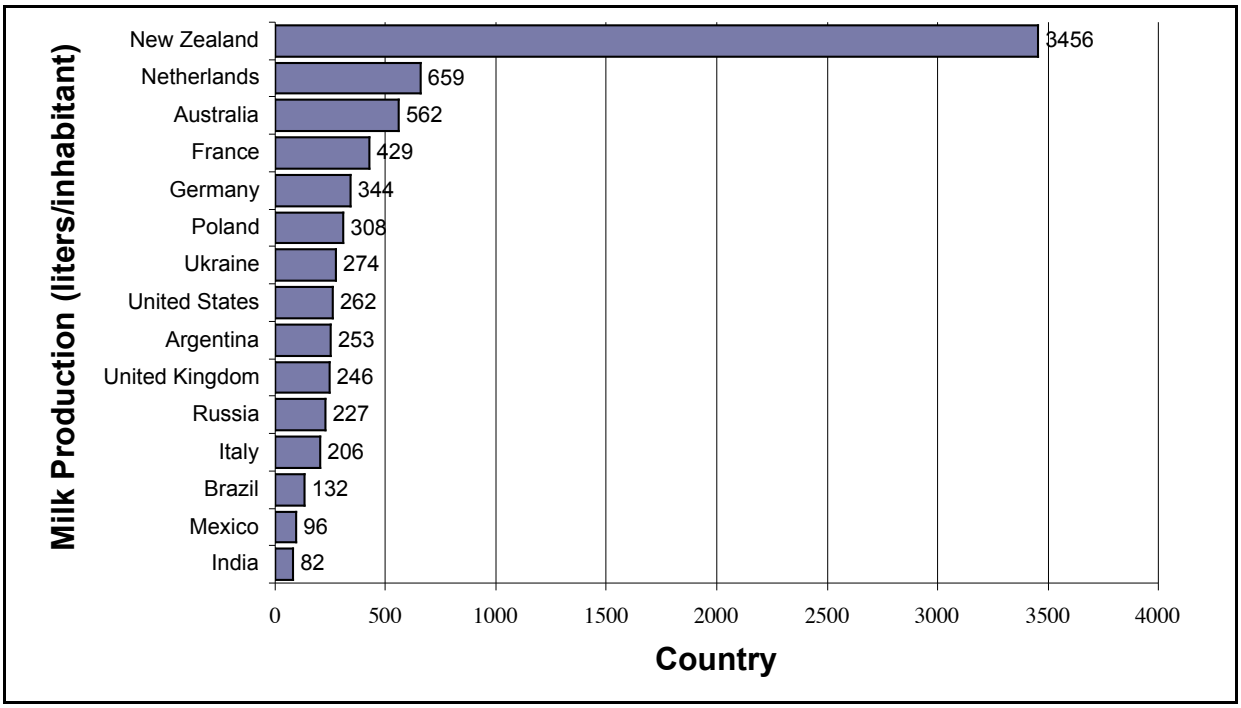
PNMQL: National Program for Improvement of Milk Quality (Programa Nacional de Melhoria da Qualidade de Leite)

Appendix B: Maps, Figures and Graphs

Figure 5. Map of Brazil with States and Regions

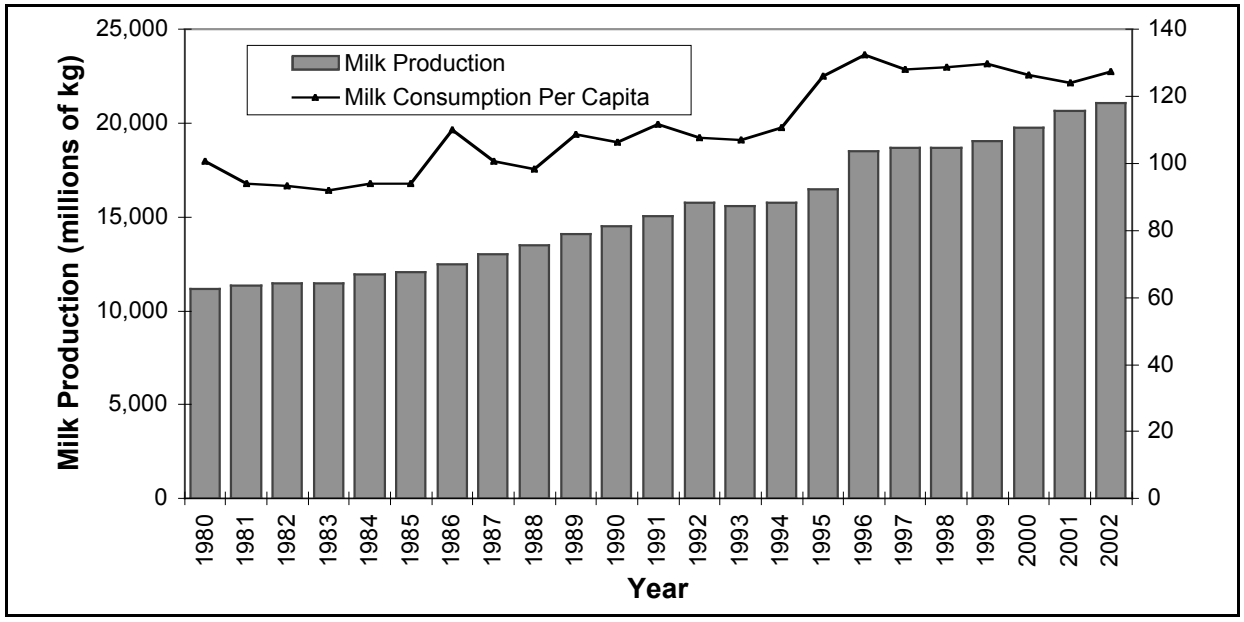
Source: IBGE – Pesquisa Trimestral do Leite in EMBRAPA Dairy Cattle Research Center website. Adapted from Milkpoint http://www.cnpgl.embrapa.br.

Figure 6. Milk Production/Inhabitant in Selected Countries, 2001



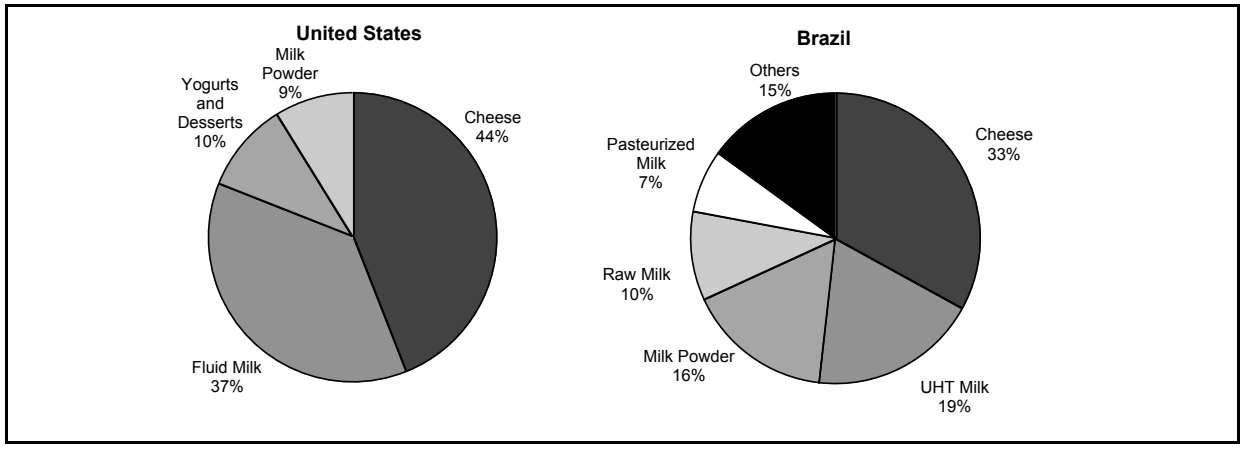
Source: FAO in EMBRAPA Dairy Cattle Research Center website http://www.cnpgl.embrapa.br.

Figure 7. Evoluation of the Brazilian Milk Production and Milk Consumption Per Capita in Recent Years



Source: IBGE, MAA, MF, SECEX/MDIC in Leite Brasil website http://www.leitebrasil.org.br/estatísticas-03.htm

Figure 8. Milk Industrialization in United States and Brazil, 2002



Source: United States: FAD – Dairy – Outlook Owner 09/05/2003 in EMBRAPA Dairy Cattle Research Center website http://www.cnpgl.embrapa.br
Brazil: CBCL/CAN/IBGE in EMBRAPA Dairy Cattle Research Center website http://www.cnpgl.embrapa.br

Table 9: Total Bovine and Dairy Herds in Brazil, 2001

Regions/ States	Bovine Herd (thousands)		% of Dairy Cattle
	Total	Dairy	
NORTH	**27,284**	**2,409**	**8.8**
Amapá	87	8	9.2
Roraima	438	84	19.2
Amazonas	864	140	16.2
Acre	1,672	166	9.9
Tocantins	6,571	482	7.3
Rondônia	6,605	719	10.9
Pará	11,047	810	7.3
NORTHEAST	**23,414**	**9,370**	**40.0**
Piauí	1,792	318	17.7
Sergipe	866	387	44.7
Rio Grandfe do Norte	788	429	54.4
Alagoas	843	547	64.9
Paraíba	918	587	63.9
Maranhão	4,483	679	15.1
Pernambuco	1,673	1,291	77.2
Ceará	2,194	1,462	66.6
Bahia	9,856	3,670	37.2
WEST-CENTER	**61,787**	**6,890**	**11.2**
Distrito Federal	113	31	27.4
Mato Grosso	19,922	1,152	5.8
Mato Grosso du Sul	22,620	2,132	9.4
Goiás	19,132	3,575	18.7
SOUTH	**26,784**	**5,860**	**21.9**
Santa Catarina	3,096	1,115	36.0
Paraná	9,816	2,165	22.1
Rio Grande do Sul	13,872	2,580	18.6
SOUTHEAST	**37,119**	**10,197**	**27.5**
Espírito Santo	1,665	390	23.4
Rio de Janeiro	1,977	578	29.2
São Paulo	13,258	2,768	20.9
Minas Gerais	20,219	6,461	32.0
BRAZIL	**176,389**	**34,726**	**19.7**

Source: IBGE Pesquisa de Pecuária Municipal e Anualpec 2003 in EMBRAPA Dairy Cattle Research website http://www.cnpgl.embrapa.br.

Table 10: Milk Production, Fat and Lactation Length in Dairy Breeds Used in Brazil

Breed	Milk Production (kg)	Fat (kg)	Lactation Length (days)	Year of Reference
Holstein	7,571	248	316	1999
Jersey	4,678	235	312	1995
Girolanda**	3,788	NA	266	2001
Gir*	2,292	98	272	1999
Guzerá*	2,248	96	248	1999
Gir Mocha*	1,738	84	216	1999

NA: not available

* Zebu breeds, ** Cross-bred cow (Holstein with Gir)

Source: National Archives of Animal Science (Arquivo Zootécnico Nacional). Adapted from EMBRAPA Dairy Cattle Research Center website at http://www.cnpgl.embrapa.br

Table 11: Ranking of the Milk Production by State

Classification	Brazilian States	Milk Production (millions of liters)	Productivity (liters/cow)	% of Production
1º	Minas Gerais	5,981	1,337	29.2
2º	Goiás	2,322	1,095	11.3
3º	Rio Grande do Sul	2,222	1,846	10.8
4º	Paraná	1,890	1,642	9.2
5º	São Paulo	1,783	1,029	8.7
6º	Santa Catarina	1,076	1,796	5.2
7º	Bahia	739	486	3.6
8º	Rondônia	476	956	2.3
9º	Pará	459	606	2.2
10º	Rio de Janeiro	447	1,146	2.2
11º	Mato Grosso do Sul	445	972	2.2
12º	Mato Grosso	443	1,073	2.2
13º	Espírito Santo	362	1,131	1.8
14º	Pernambuco	360	1,003	1.8
15º	Ceará	328	751	1.6
16º	Alagoas	244	1,410	1.2
17º	Tocantins	166	450	0.8
18º	Maranhão	155	495	0.8
19º	Rio Grande de Norte	143	803	0.7
20º	Sergipe	113	863	0.6
21º	Paraíba	106	620	0.5
22º	Acre	86	804	0.4
23º	Piauí	78	400	0.4
24º	Amazonas	38	567	0.2
25º	Distrito Federal	37	1,423	0.2
26º	Roraima	9	409	<0.1
27º	Amapá	3	500	<0.1
	TOTAL	**20,511**	**1,127**	**100.0**

Source: IBGE – Pesquisa de Pecuária Municipal. Adapted from EMBRAPA Dairy Cattle Research Center website http://www.cnpgl.embrapa.br.

Table 12: Brazilian Dairy Imports, 1994-2000 (in tones)

Dairy Product	1994	1995	1996	1997	1998	1999	2000
UHT Milk	9,737	52,637	85,482	119,284	135,253	124,198	95,054
Fluid Milk	1,022	3,893	164	2,152	1,222	81	-
Whole Milk Powder	50,969	138,838	112,595	96,548	128,152	140,388	106,012
Skim Milk Powder	35,716	60,078	71,123	40,487	48,763	51,429	30,586
Whey	5,618	9,689	22,208	13,214	31,495	30,471	43,129
Butter	10,825	15,909	9,833	6,187	10,529	11,373	10,296
Cheese	35,559	55,5	33,867	28,731	23,642	20,056	15,718
Other Dairy Products	6,545	19,309	44,379	13,291	24,703	11,596	8,084
TOTAL	**157,985**	**302,348**	**381,647**	**322,251**	**405,757**	**391,591**	**310,879**

Source: SECEX/MDIC adapted from statistics section of http://www.milknet.com.br

Table 13: Number of Brazilian Producers Who Declared to Have Milking Machines, 1995

States	Number of Milking Machines	
	Units	% of Total
Minas Gerais	29,216	18.4
São Paulo	3,570	2.2
Espírito Santo	2,377	1.5
Rio de Janeiro	785	0.5
Southeast Region	**35,948**	**22.6**
Rio Grande do Sul	66,372	41.7
Santa Catarina	29,382	18.5
Paraná	18,742	11.8
South Region	**114,496**	**72.0**
Goiás	2,649	1.6
Mato Grosso do Sul	1,161	0.7
Mato Grosso	447	0.3
Distrito Federal	99	0.1
West Center Region	**4,356**	**2.7**
Bahia	3,152	2
Pernambuco	208	0.1
Sergipe	139	0.1
Alagoas	92	0.1
Maranhão	88	0.1
Ceará	73	0
Rio Grande do Norte	50	0
Paraíba	48	0
Piauí	40	0
Northeast Region	**3,890**	**2.4**
Pará	256	0.2
Rondõnia	69	0.1
Tocantins	46	0
Acre	12	0
Amazonas	9	0
Roraima	7	0
Amapá	0	0
North Region	**399**	**0.3**

Source: IBGE Censo Agropecuário 1995/1996 in EMBRAPA Dairy Cattle Research Center website http://www.cnpgl.embrapa.br

Table 14: Percent Distribution of Production and Number of Producers by Size of Operation in the Largest Brazilian Milk Cooperative (Itambé), 1990 and 2000

Range of Production (liters/days)	Production (%)		Number of Producers (%)	
	1990	2000	1990	2000
<50	20.8	2.0	61.8	22.3
51-100	21.3	5.1	20.0	19.3
101-500	47.4	33.4	17.3	42.1
>500	10.5	59.5	0.9	16.3
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Itambé Yearly Report in Stock [26] data from 1990 and in Gomes [15] data from 2000.

Table 15: Consumption Per Capita of Milk and Some Dairy Products in Selected Countries, 1999

Country	Fluid Milk (kg)	Butter (kg)	Cheese (kg)	Milk Powder (kg)
Argentina	64.77	1.40	11.59	0.67
Australia	101.60	3.13	10.79	1.93
Brazil	80.18	0.45	2.69	0.63
Canada	95.28	2.67	11.25	0.91
China	2.88	0.04	NA	NA
Denmark	111.60	4.58	16.21	3.24
France	67.66	8.80	22.50	4.57
Germany	66.35	6.88	12.57	1.10
India	32.93	1.75	0.12	NA
Italy	62.16	1.70	19.57	2.25
Japan	39.01	0.66	1.73	2.08
Mexico	37.57	0.33	1.53	2.62
Netherlands	106.02	3.68	15.31	11.43
New Zealand	115.42	8.66	9.52	3.17
Russia	93.30	2.76	1.97	1.12
Spain	103.63	0.40	5.85	0.90
United Kingdom	117.69	2.94	9.91	1.33
USA	97.94	1.88	13.44	1.665

NA: not available

Source: USDA. Elaborated by Leite Brasil an adapted from Anuário Milkbizz (CD Estatísticas Volume 1).

Table 16: Use of Milking Machines by Farm Size* [26]

Number of Cows	Sample Size	% of Sample	% Have Milking Machine
<10	298	38	7
10-20	202	26	14
20-30	85	11	19
30-40	68	9	19
≥40	122	16	22
Farm Production (liters/day)			
<20	189	24	0
20-50	240	31	6
50-100	135	17	19
≥100	211	27	30
Cows Production (liters/day)			
<3	336	43	2
3-5	182	23	10
5-10	177	23	23
≥10	80	10	48

* Research conducted by EMBRAPA and Fundação Getúlio Vagas between August 1997 and May 1998. A total of 775 farmers with some dairy activity participated in this survey (only 40% of contributors had >50% of their income from dairy activity)

Table 17: Challenges to Produce High Quality Milk in Brazil in the Present and Near Future [4]

1. Training/ consciousness	▪ Extension Serivices and Technical Assistance ▪ Milk producer ▪ Milkers ▪ Transport/milk collection personnel
2. Infrastructure	▪ Milking equipments and bulk tank storage ▪ Transport ▪ Roads ▪ Electicity supply
3. Herd health control	▪ Mastitis ▪ Brucellosis ▪ Tuberculosis
4. Farm management	▪ Good farming practices ▪ Feeding ▪ Reproduction ▪ Milking and post milking procedures
5. Laboratory support, sampling and transport	▪ Somatic cell counting ▪ Bacterial counts ▪ Composition (fat, protein, total solids) ▪ Antibiotic residues
6. Data processing and information transfer	▪ Data banks (laboratory and farm level) ▪ Feedback to extensionists and farmers ▪ Valid continuing education programs ▪ Milk payment schemes ▪ Consumer education

Table 18: Milk Quality Requirements for Grading Milk

Composition	**Requirement**		
	Grade A	**Grade B**	**Grade C**
Raw Milk			
Fat (g/100g)	Min 3.0	Min 3.0	Min 3.0
Acidity (g of lactic acid/100ml)	0.14-0.18	0.14-0.18	0.14-0.18
Relative Density, 15/15ºC, g/ml	1028-1034	1028-1034	1028-1034
Crioscopy (maximum)	-0.530ºH	-0.530ºH	-0.530ºH
SNF – Solids Non Fat (g/100g)	Min 8.4	Min 8.4	Min 8.4
Total Protein (g/100g)	Min 2.9	Min 2.9	Min 2.9
Redutase (Methylen Blue)	Min 5 h	Min 3:30 h	Min 1:30 h
Standard Plate Count (CFU/ml)	Max 10,000	Max 500,000	Not defined
Somatic Cell Count (cel/ml)	Max 600,000	Max 600,000	Not defined
Pasteurized Milk			
Alcaline Phosphatase Test	Negative	Negative	Negative
Peroxidase Test	Postive	Positive	Positive
Standard Plate Count (CFU/ml)	Max 1,000	Max 80,000	Max 300,000

Source: Ministry of Agriculture, Brazil, Instrução Normativa 51, published in 09/20/02. In: Conselho Brasileiro de Qualidade do Leite (Brazilian Council of Milk Quality) website http://www.cbql.com.br