Dual-purpose milk and beef value chain development in Nicaragua: Past trends, current status and likely future directions

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Dual-purpose milk and beef value chain development in Nicaragua: Past trends, current status and likely future directions

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Acronyms

AI	artificial insemination
ALBANISA	Alba de Nicaragua S.A.
CANICARNE	Cámara Nicaraguense de Exportadores de Carne Bovina
CANISLAC	Cámara Nicaraguense del Sector Lácteo
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CIAT	Centro Internacional de Agricultura Tropical
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CISA-AGRO	Compañia de Insumos Agropecuarios
CONAGAN	Comisión Nacional Ganadera de Nicaragua
CRS	Catholic Relief Services
DGPSA	Dirección General de Protección y Sanidad Agropecuaria
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuaria
FAO	Food and Agriculture Organization
FDL	Fondo de Desarrollo Local
IDB	Interamerican Development Bank
IICA	Interamerican Institute for Agricultural Cooperation
ILRI	International Livestock Research Institute
INIFAP	Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias
INTA	Instituto Nicaraguense de Tecnología Agropecuaria
MACESA	Matadero Central S.A.
MAGFOR	Ministerio de Agropecuario y Forestal
MEFCCA	Ministerio de la Economía Familiar, Campesina, y de Cooperativas Agrícolas

NGO	non-government organization
NITLAPAN	Instituto de Investigación y Desarrollo Nitlapan
OIE	World Organization of Animal Health
PES	payments for environmental services
UCA	Universidad Centroamericana
UNA	Universidad Nacional Agraria

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Executive summary

Nicaragua has always been an agricultural country. It has produced enough to supply internal demand as well as to export crops and livestock products. During 2012, the agricultural sector represented 17.2% of gross domestic product (GDP) composition. Within the agricultural sector, the livestock sector represents the most important economic activity, producing in 2011 about 39% of agriculture's GDP. Within the livestock sector, poultry has been the most dynamic. In addition, the livestock sector is an important driver for income generation. In 2011, it generated 81,921 permanent jobs in the rural sector, equivalent to 59.2% of the rural employment of the country (MAGFOR 2013).About 84.3% of the permanent jobs were performed by men, 12.1% by women, and 3.7% by children younger than 10 years old, presumably family members who helped on routine chores on the farm. In addition, the sector generated 426,941 temporary jobs across the milk and beef value chain. Of these temporary jobs, 85.5% were performed by men, 13.0% by women, and 1.4% by children under 10.

With regard to consumption, almost half of the families in Nicaragua consume fluid milk (48.7%), and an overwhelming majority (86%) consumes cheese. Dairy products contribute 6.5% of the energy in the Nicaraguan diet, and families spend about 13.7% of total food purchases on dairy products. As to meat consumption, most families consume chicken (76%), followed by beef (44%).Beef contributes 1% of caloric consumption and families spend about 9% of total food purchases on beef. Average per capita daily protein intake in 2009 was 55 g; of this, 31.3% was of animal origin. However, per capita annual consumption, in fluid milk equivalents, shows a clearly decreasing trend (–2.5% per year), from 116 kg in 1995 to 73 kg in 2011.With respect to meat consumption, beef has the least growth, averaging 1.7% a year compared with 6.9% for pork and 11.9% for poultry. Until the 1990s, beef in Nicaragua was the principal meat product demanded by domestic consumers. However, since 1995, beef has been displaced by chicken, which accounted in 2011 for 65% of total meat consumption as against beef's 26%.

The most important livestock production system is the dual-purpose scheme. Most dual-purpose farms are small. More than half of the national herd (i.e.51%) is in the hands of farmers who own less than 10 ha. Total herd size is 4.14 million head of cattle; this involves136,687 producers. More than 75% of the income comes from milk sales. Women play an important role in these production systems, especially when men take on seasonal off-farm work, for example, harvesting sugarcane and picking coffee, and women are left to perform the tasks of milking, taking care of the livestock, and manufacturing artisan cheese. Furthermore, on many of the small farms, women are the head of the household. Unfortunately, there is no information or statistics related to the role of women in livestock-related activities. An important research thrust for ILRI´s gender program is understanding the role of the different family members in livestock-related activities in order to design sound technological interventions.

The main constraints faced by small farmers at the farm level are (1) low productivity caused by (a) low feed and forage availability and quality, especially during the dry season; (b) lack of control and preventive measures against diseases and parasites; and (c) low genetic potential; and (2) absence of basic infrastructure (milking facilities, fencing, water supply).The main constraints at the supply chain level are (1) low credit availability; (2) poor public infrastructure (energy, roads, water); and (3) weak market access for products brought about by (a) low milk and beef prices due to seasonality and abundance of intermediaries (this creates more transaction costs along the value chain by capturing a lower price) and (b) low incentives for quality improvement.

Nicaragua is very competitive in terms of beef export prices and this is reflected in the export growth rate the beef sector has been experiencing. During the period 2000 to 2012, beef exports increased at an annual rate of 17.4%. In addition, the value of beef per exported tonne also increased during the same period at an annual rate of 6.6%, thus reflecting a value-added additional gain. Likewise, dairy exports have increased at an annual rate of 21.9%, showing great dynamism. However, milk producers were capturing more than 63% of the final price paid by consumers in 2000 and this proportion has been steadily decreasing throughout the last 12 years, capturing less than 42% of the final price by 2012.These figures suggest that other actors across the milk value chain (processors, distributors, retailers) are obtaining a greater piece of the pie relative to a decade earlier. If these differences were not translated into better services to producers (i.e. technical assistance, more credit availability), then it could be a major bottleneck that might affect the competitiveness of the entire milk value chain. A good research question for the CRP L&F is: What is the impact of increased beef (and milk as well) exports on the welfare of the value chain actors, including consumers? Increased exports obviously benefit exporters (meat-packing plants, dairy plants, artisan cheese exporters), but what effect does this have on local demand for animal protein as well as on the proportion of final product price retained by producers?

The dairy manufacturing sector can be divided into two: the 'formal' and the 'informal' sectors. The formal sector has signed contracts with producers, thereby ensuring a more stable price throughout the year. In addition, they have a payment system based on milk hygiene and they pasteurize the milk that is collected. Between 2006 and 2012, the industrial processing capacity of the formal sector almost doubled, with a sharp increase in the proportion of milk flowing through the larger plants and the semi-industrial cheese sector. The growth of the formal sector has been due to the installation of efficient milk collection centres and to a more stable payment system that reduces price fluctuations between dry and rainy seasons. The informal sector is formed by a large group of small-sized 'artisan' cheese factories, perhaps 3000 of them in the whole country, supplying the domestic and export markets, in this case, through a large network of intermediaries. These small artisan cheese factories have little or no quality control and buy milk of the lowest quality, paying the lowest price. This artisan product is mostly undertaken by women for local and domestic consumption. The average price paid by the formal sector is about 25–27% higher than the price paid by the informal sector.

The feed sector is private sector-led, that is, available feed resources, such as concentrate feeds, hay, silage, or seed from improved grasses and legumes, are privately owned and most transactions occur among private farmers throughout the country. The government plays a minor role in promoting new forage-based technologies. This role is mostly led by non-government organizations (NGOs), farmer cooperatives, or large dairy plants because it is in their interest that farmers increase livestock productivity by adopting feed and forage technologies. The seed market for improved grasses has grown dramatically since 2000, averaging more than 52% per year, reflecting the dynamics of the livestock sector, especially the export markets for both milk and beef, which have grown 21.9 and 17.4% per year, respectively, during the same period. Unfortunately, there is no information on the proportion of seed sales to smallholder farmers. Comparing 2011 versus 2001, the productivity of milk per cow decreased by 15.5%, but the productivity of beef increased by 66.4%, which means that producers chose to produce more beef than milk during this decade. When comparing the value of production per cow in these two periods of time, the value of production per cow was 18.1% higher in 2011 compared with that in 2001 (USD 437.60/cow vs. USD 370.70/cow, in nominal USD).Thus, the adoption of improved forage-based technologies that occurred during the last decade appeared to have gone to produce more beef relative to milk.

In terms of animal health, the World Organization for Animal Health (OIE) states that the institution in charge of monitoring it in the country, DGPSA, had a performance index of 37% compared with 51% for the Central American region when the institution was evaluated in 2009.This meant that the institution was not capable of functioning properly and could not carry out all of its duties. There is no veterinary inspection in the more than 600 small artisan cheese factories, or in the estimated 3000 milk collection centres, or in the 266 small rural abattoirs. Thus, the risk of health hazard for the domestic population remains large. Likewise, there is currently no mechanism in place between the public and private sectors to work together on common issues of strategic importance for producers, the public sector, and consumers.

The number of livestock producers receiving credit is very small in Nicaragua. Of the estimated 136,687 producers who owned cattle during the 2011 national agricultural census, only 4777 producers (3.5%) availed of livestock-related credit. In contrast, about 27.3% of producers received credit for crop-related activities, almost eight times more than for livestock-related activities. This difference is mostly explained by the fact that credit for crop-related activities is short term (i.e. for the duration of the crop, usually 4 to 6 months). Credit allocated to livestock producers vary from 18 months for steer fattening to more than 2 years for cow–calf operations. Banks prefer to lend money for the short term. In addition, livestock farms that obtained loans in 2011 varied by farm size. Farms less than 13.7 ha received proportionately less credit than those with more than 13.7 ha and this proportion increased as farm size got larger. Thus, there was a higher probability to obtain credit if farms were larger. Lack of credit is one of the biggest problems faced by the Nicaraguan livestock sector, especially by women engaged in this area of production, probably because it is still considered an activity for men. The data presented by FIDEG (International Foundation for Economic Global Challenge) in 2005 show a great gender gap in terms of credit. In fact, in 2004, from the total amount of credit for the livestock sector, 98% was received by men and only 2% went to women. Furthermore, women, who represent 23% of the farmers, only received 15% of the agriculture and livestock credit. Men, in turn, received 84%.The nominal interest rate for agricultural loans is 24% per year. With an inflation rate of 7% in 2013, the real interest rate is about 17%, much higher than international lending rates, which are about 3–4% a year in real terms.

Livestock production growth has, until now, been almost purely private-sector-driven. There has been limited support from the public sector and public good investments/actions are minimal. This has resulted in significant negative externalities. In the environment, this investment imbalance has contributed to major land degradation, erosion of biodiversity, water pollution, and greenhouse gas emission. In public health, the livestock subsector has become a major source of public health risks, such as those presented by bovine spongiform encephalopathy or mad cow disease (BSE). Unless there are sufficient mitigating public policies and investments, these adverse impacts would likely continue to manifest themselves. Currently, there are none. The establishment of schemes of payments for environmental services (PES) would be of strategic importance in reversing or mitigating these negative impacts. ILRI can play an important role in designing such schemes.

Due to its small size, Nicaragua does not have the capacity to do strategic or adaptive research. Its approach has been to make strategic alliances with regional (i.e. CATIE) and international agricultural research centres (i.e. CIAT, CIMMYT) as well as centres from large Latin American countries such as INTA from Argentina, EMBRAPA from Brazil, and INIFAP from Mexico, whose human resource capacity and resources are greater and better than INTA´s. In the specific agenda for livestock research, INTA, the institution in charge of generating new agricultural technology, has prioritized the adaptation of forage-related technologies and its effect on animal nutrition, especially during the dry season. Thus, most activities of INTA´s personnel have centred on the evaluation of improved grasses for direct grazing, hay and haylage making, cut-and-carry systems, silage, and silvopastoral systems.

In addition, many NGOs working in Nicaragua on livestock development provide technical assistance to smallholder farmers. Such is the case of Technoserve and Catholic Relief Services (CRS) from the United States. These NGOs serve as a 'bridge' between smallholder farmers, local livestock associations, and government institutions to supply the much-needed technical assistance that the government cannot meet. It is expected that this strategy will continue in the next decade.

Introduction

Nicaragua has an estimated human population in 2013 of 6.0 million, 51% are women and 49% are men. Population growth rate is 1.8%.Median age is 21 years. Literacy rate is 70% and life expectancy is 70 years. The country covers an area of 130,000 km2 (BCN 2013).

Gross domestic product (GDP) growth was 5.2% in 2012 with an annual income per capita of USD 1731 (BCN 2013). Annex 1 shows GDP growth and income per capita during the period 2000 to 2012.Average GDP growth during this period was 3.3% and per capita income was 3.2%.Nicaragua is considered the poorest country in Central America and the third poorest country in Latin America after Haiti and Bolivia.

Nicaragua has always been an agricultural country. It has produced enough to supply internal and external demand for crops. In 2012, the agricultural sector represented 17.2% of GDP composition (Indexmundi 2012).Within the agricultural sector, the livestock sector in Nicaragua represents the most important economic activity, producing in 2011 about 39% of agriculture's GDP. Within the livestock sector, poultry has been the most dynamic. During the last 15 years, poultry production has increased at 9% per year, followed by beef (6.5%), then milk (4.6%); the least increase was seen in pork (2.7%) (FAO 2013).

In terms of land use, Nicaragua has about 54% of agricultural land (about 3.2 million ha) under permanent pasture with grazing cattle (MAGFOR 2012).The remaining is allocated to agriculture. Therefore, livestock is the most important activity in terms of land use and overall contribution to agricultural economy.

It is important to point out that land is mainly in the hands of men; only 18% of rural women in Nicaragua are land owners (UNIFEM 2009), which means that, even if women are involved in livestock activities, they have limited access to primary resources such as land.

In addition, the livestock sector is an important driver for income generation. During 2011, the livestock sector generated 81,921 permanent jobs in the rural sector, equivalent to 59.2% of the rural employment of the country (MAGFOR 2013).Annex 2 shows the employment generated by the sector in terms of permanent and temporary jobs as well as by gender and age. As shown, 84.3% of the permanent jobs in livestock-related activities were performed by men, 12.1% by women, and 3.7% by children younger than 10 years old, presumably family members who helped on routine chores on the farm (MAGFOR 2013).In addition, the livestock sector generated 426,941 temporary jobs across the milk and beef value chain. Of these temporary jobs, 85.5% were performed by men, 13.0% by women, and 1.4% by children under 10.

In2001, the livestock sector generated 66,136 permanent jobs categorized as follows: (a) 54,048 in the production of milk and beef (81.7%); (b) 8450 jobs in processing (12.8%); and (c) 3638 jobs in marketing (5.5%).Of these jobs, about 20.0% of the production-generated jobs were estimated to be performed by women; 30% of the processing- and marketing-generated jobs were done by women (Francis Smith 2004).Most jobs in the livestock sector are performed by men, but women play a significant role in the industry. Yet, their role as producers is unrecognized. They suffer from discrimination dictated by cultural patterns that do not recognize them as 'producers' but rather as 'family support' or 'domestic workers' (OXFAM 2013).

The value chain actors

The dual-purpose and beef value chains are composed of several actors described below. For purposes of illustration, Figure 1 shows the dual-purpose value chain and Figure 2 shows the beef value chain.

Cow–calf operators

This segment comprised mostly small (49,466) and medium (33,948) cattle farmers who utilize the dual-purpose production system (Pérez 2013). More than 95% of the milk and beef produced in Nicaragua come from this system, which involves raising the male calf and selling it after weaning. The cow is milked with the calf close by. Furthermore, these cows have a high percentage of Bos indicus (i.e. Brahman) genes or are crossed with B. taurus breeds. Their feeding is based on extensive pasture-based systems with low milk and beef productivity (Pérez 2013). Milk production is highly seasonal. Most milk (70%) is produced during the 6-month rainy season when pasture production and quality are highest. Milk productivity is low: about 4 kg/cow per day, ranging from a high of about 5 kg/day during the 6-month rainy season to about 2–3 kg/day during the dry season. Producers either sell their milk on-farm or send it to milk-collecting centres.

These farmers sell their weaned calves at 12 months of age to middlemen who, in turn, sell them to steer fatteners. The average weight of weaned calves is about 100 kg. They also sell their culled cows mostly to rural butchers who slaughter them at municipal abattoirs.

Steer fatteners

This segment is constituted by large farmers (approximately 12,803) who buy 100-kg weaned calves from intermediaries and fatten them to 400 kg. They are then sold to meat-packing plants.

Intermediaries

Estimated to be about 2500 intermediaries (Arias 2012) participate in the value chain through buying and selling of cattle for the following purposes: reproduction, fattening, and slaughter. Intermediaries buy mostly weaned male calves from small farmers and then sell them to large farmers for fattening.

Abattoirs

Nicaragua has 266 small rural abattoirs (Pérez 2013).Most of these are owned by municipalities (146); some are privately owned (120).By law, these slaughterhouses are supervised by the Ministry of Public Health and by the veterinary service of the Ministry of Agriculture. However, in practice, this rarely happens. In addition, these abattoirs have food safety deficiencies because of low-quality equipment and poor infrastructure. Likewise, because of their

small size, by-products such as blood and tissue are not properly discarded and therefore present an environmental problem as they contaminate water sources. However, these abattoirs meet an important social role, providing service to small farmers because they are strategically located throughout the rural area.

Meat slaughterhouses

Nicaragua has four slaughterhouses that process beef certified for export: San Martin, Nuevo Carnic, Macesa, and Nova Terra. All of the beef for export is processed in these plants. About 85% of the meat processed here is for export and the remaining 15% goes to the domestic market. These four plants together slaughter about 90% of the beef produced in the country (Arias 2012).The beef for the domestic market is sold to supermarkets, hotels, and restaurants through two channels: middlemen and their own meat packer´s distributors.

Milk collection centres

These centres play a key role because they collect milk from thousands of small farmers who produce small quantities of milk. It is estimated that about 3000 collecting centres operate in the country (Arias 2012).These centres might be owned by milk plants, private entities, or cooperatives. They are generally located in sites with good access to roads and have good infrastructure (energy, potable water) and hygienic conditions.

Small rural artisan cheese factories

More than 600 artisan cheese factories exist. Most of them are family owned and are located in the farms where the milk is produced and turned into cheese. About half of the milk produced in the country is processed through these artisan factories. Most of the cheeses are consumed locally and some are exported to neighbouring countries such as El Salvador. The types of cheese produced in these artisan factories are all fresh, with varying degrees of solid content, and a shelf life that varies from 5 to 10 days (Arias 2012).Women producers are fairly concentrated in these activities (milk, cheese, and artisan pressed cheese known as cuajada), but their businesses tend to be under-recognized as such because they are made from home and therefore perceived as housework (Flores et al. 2011).

Large milk plants

In this segment, there are six plants (Parmalat, Eskimo, Prolacsa, Centrolac, Nilac, and La Exquisita) that are modern in terms of infrastructure, hygiene, and equipment. They have processed in 2011 about 47% of the milk produced in the country. They produce all sorts of dairy products (fluid milk, fresh and mature cheeses, yogurt, ice cream, butter, milk powder), mostly for the domestic market but some for export. These plants get their milk supply from large farms, which have cooling tanks, or from milk-collecting centres.

Milk retailers

These retailers can be categorized into three: (a) pulperías (small retail shops); (b) mercados (wet markets), and (c) supermarkets. The pulperías are very small and they are distributed in both rural and urban areas across the country. They are family-owned and with more than 15,000 shops operating, there is about one pulpería for every 8 to 10 blocks in any town or city. The pulpería is inside the house, attended to by family members. The pulperias bring additional family income to the household by using the low opportunity cost of family labour to attend to them. Depending on the time of day, the pulpería might be attended by an adult female of the household or by children after school or by an adult male. The pulpería sells all the basic needs (milk, bread, eggs, toilet paper, deodorant, salt, sugar, aspirin etc.). The area ranges from 8 to 15 m2. Most of them have cooling equipment in order to sell dairy

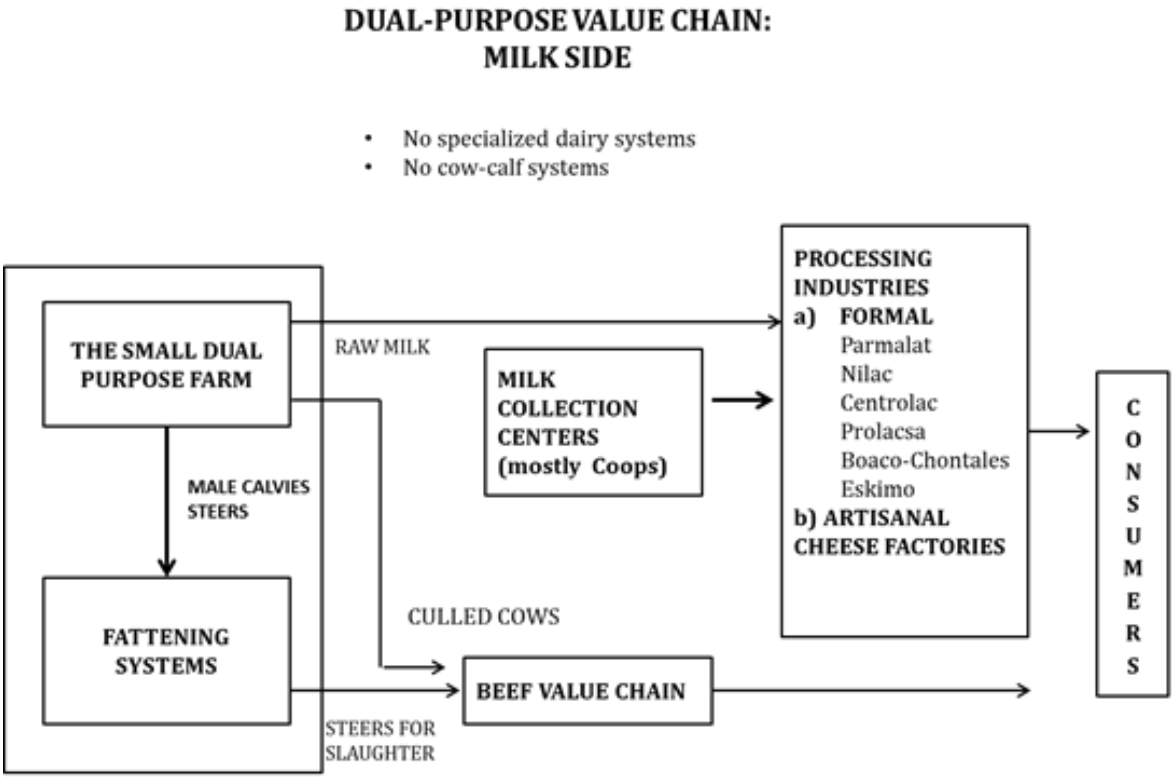
products and soft drinks; some sell poultry but not beef. The mercado (wet market) is another outlet that sells dairy products, especially cheese and butter. These mercados are larger than supermarkets and they sell almost everything (fruits, vegetables, meat, dairy products, shoes, clothing, grains, oils, etc.).Every small town has a wet market and medium to large cities might have several. A major characteristic of wet markets is that most food is sold fresh, without refrigeration. Dairy products found in wet markets include fresh cheese and butter only because of the lack of cool chain. Finally, the supermarket is another outlet where dairy products could be found. Supermarkets are usually located in medium to large cities and they are becoming more popular because they can offer very competitive prices for the food quality that they offer and the infrastructure is better than that found in wet markets. In terms of consumer prices, wet markets and supermarkets offer the lowest prices. Pulperías have the highest prices but, in exchange, they offer the convenience of providing the basic needs very close to home and in small quantities.

Beef retailers

These retailers can be divided into three categories: (a) butcher shops, (b) wet markets, and (c) supermarkets. Butcher shops used to be very popular in the past (i.e. 10–20 years ago), but now supermarkets have become more popular, especially in medium to large cities. There are about 163 butcher shops in and around the capital city Managua (Schutz et al. 2004).In rural areas, wet markets are the most common place to buy meat, but they lack refrigeration. Animals are slaughtered usually at midnight and they are transported to wet markets, arriving at dawn.

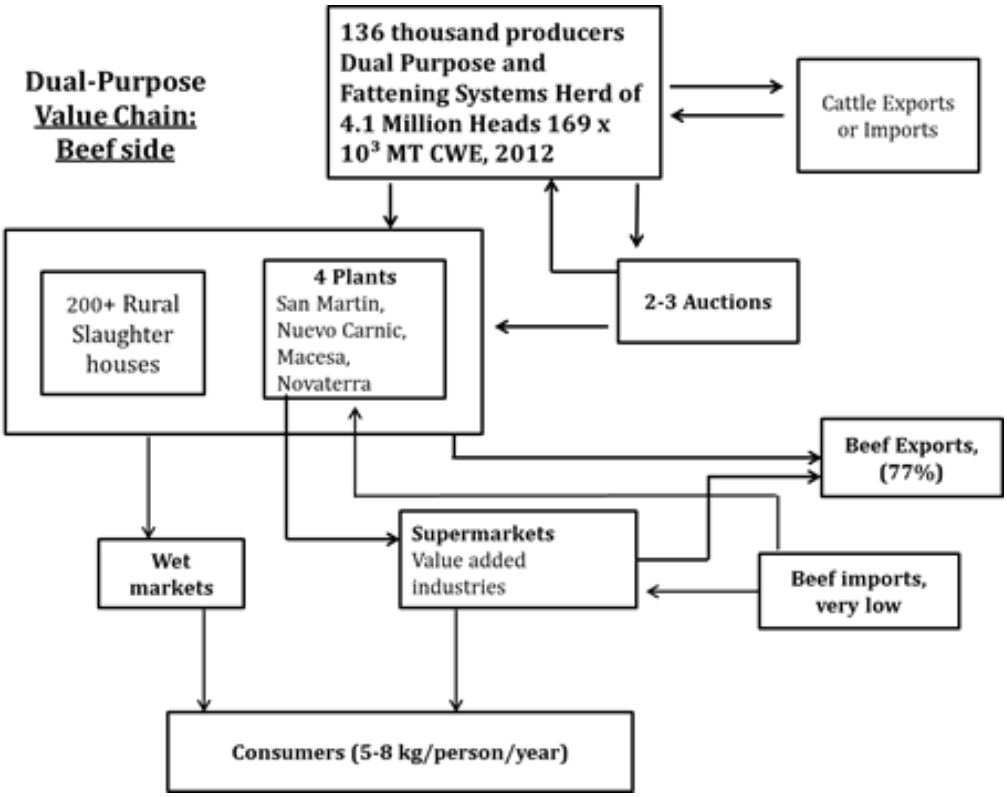
In the following chapters, a detailed description will be made with regard to the different segments of the value chain for milk and beef.

Figure 1.Dual-purpose value chain: milk-side



Source: Pérez (2013).

Figure 2.Dual-purpose value chain: beef-side



Source: Pérez (2013).

Consumption and expenditures

In terms of per capita consumption of milk and meat products for the overall population, Table 1 shows the trend from 1995 to 2011 for milk, beef, poultry, and pork. With regard to milk, the per capita annual consumption in fluid milk equivalents shows a clearly decreasing trend (–2.5% per year), going from 116 kg in 1995 to 73 kg in 2011.As to meat consumption, beef is the meat that has grown less, averaging 1.7% a year compared with 6.9% for pork and 11.9% a year for poultry. Until the 1990s, beef in Nicaragua was the principal meat product demanded by domestic consumers. However, since 1995, beef has been displaced by chicken, which accounted in 2011 for 65% of total meat consumption as against beef's 26%.

Table 1. Per capita consumption of milk, beef, poultry and pork during the period 1995 to 2011

Year	Milk	Beef	Poultry	Pork
	(Litre of fluid milk/year)	(kg fresh meat/year)		
1995	116.1	6.30	6.40	1.23
1996	103.2	7.68	6.60	1.22
1997	105.9	6.73	6.60	1.21
1998	114.2	5.83	6.65	1.26
1999	92.1	6.10	7.45	1.32
2000	94.0	6.52	9.61	1.37
2001	94.1	6.20	11.09	1.41
2002	89.2	5.93	10.86	1.44
2003	81.5	7.37	11.81	1.40
2004	82.2	7.86	12.63	1.43
2005	86.8	7.74	13.25	1.49
2006	85.4	7.72	15.42	1.75
2007	80.1	7.53	16.28	2.00
2008	71.4	7.85	16.35	2.13
2009	73.4	7.53	15.97	2.20
2010	75.0	7.06	17.93	2.38
2011	73.7	7.60	18.53	2.59
Mean annual growth (%)	–2.5	+ 1.7	+ 11.9	+ 6.9

Source: MAGFOR (2012).

Table 2 shows the minimum daily wage rate for Nicaragua and the volumes of fluid milk and amounts of beef, pork, and poultry meat the daily wages could buy for a particular year from 2000 to 2012.As shown, the purchasing capacity of the minimum wage rate has been constantly increasing since 2000.A daily wage rate in 2000 could only buy less than 4 litres of milk; by 2012, it could buy almost 5 litres. The situation for meat is very similar.

A daily wage in 2000 could buy about half a kilo of beef or pork and almost 1 kg of poultry meat. In 2012, this figure was about 0.83 kg for beef and pork and more than 1.5 kg for poultry. Thus, the reason for consumers' reduced milk consumption might be one of preference, demanding more of poultry meat and less of dairy products.

Table 2. Minimum daily wage rate and purchasing power for milk, beef, pork, and poultry meat during the period 2000 to 2001

Year	Minimum daily wage rate (USD)	Purchasing power for milk(in litres)	Purchasing power for beef (in kg)	Purchasing power for pork (in kg)	Purchasing power for poultry(in kg)
2000	1.67	3.85	0.55	0.52	0.98
2001	1.66	3.60	0.48	0.51	0.94
2002	1.71	3.48	0.52	0.57	1.09
2003	1.82	3.43	0.59	0.65	1.18
2004	1.88	3.62	0.61	0.66	1.09
2005	2.05	4.03	0.57	0.64	1.19
2006	2.30	4.31	0.62	0.65	1.23
2007	2.58	4.53	0.65	0.72	1.27
2008	3.34	4.61	0.75	0.82	1.36
2009	3.53	4.47	0.83	0.87	1.51
2010	3.56	4.74	0.88	0.91	1.60
2011	4.08	5.51	0.97	0.87	1.71
2012	4.14	4.88	0.83	0.84	1.56

Source: MITRAB (2013); data calculated by author.

To seek alternatives and new ideas that will encourage the development of the beef agro-enterprise, it is important to examine successful changes and technology developments that have occurred in 'clusters', such as those for the poultry agro-enterprise. The vigorous dynamics of the poultry sector resulted from profound transformations in all links of its agro-industrial chain. That is, it experienced major technological and organizational advances in the links of primary production, processing, marketing, and distribution of end products. The result of this process was fast growth in productivity and competitiveness of the agro-industrial chain as a whole.

Consumption and expenditure patterns, by poverty level

Almost 43% of the Nicaraguan population was in the poor and extremely poor categories in 2005.However, this figure had decreased to 26.5% by 2009 (Table 3).In terms of area of residence, about 71.9% of people in the rural areas were in both the extreme poor and poor categories in 2005, decreasing to 46.4% by 2009.In the urban areas, this figure was 19.7% in 2005 and 11.3% in 2009.In terms of gender, poverty and extreme poverty affects men and women equally (FIDEG 2013). The main reason for the decrease in poverty level has been the policy instruments put in place by the socialist government that came to power in 2007 in terms of housing, energy, production, and food subsidies, including free-lunch school programs. Another reason could be the family remittances. In 2012, 23.7% of households received remittances from abroad, 4 percentage points higher than that observed in 2009 (FIDEG 2013).

Table 3. Percentage of poverty in Nicaragua during the years 2005 and 2009

Area of residence	Extremely poor (%)[1]		Poor (%)[2]	
	2005	2009	2005	2009
Total	11.2	5.5	31.6	21.0
Urban	3.8	1.5	15.9	9.8
Rural	20.5	10.7	51.4	35.7

1. Defined as people living with an income under USD 1.25/day
2. Defined as people living with an income under USD 2.50/day.

Source: INIDE (2010).

Table 4contains the percentage of families that consume the main food items in Nicaragua, the contribution of energy consumed in the diet, and the proportion of spending allocated to each food item.

As shown, the diet of the Nicaraguan families consists mainly of rice and beans. About 98% of families consume rice and 96% consume beans. Rice contributes 22.4% of total energy consumption and almost 11% of total food spending. Beans contribute 10% of energy consumption and 7.6% of total food spending.

Table 4. Percentage of families in Nicaragua that consume the main food items, contribution of energy consumed in the diet, and proportion of spending allocated to each food item in 2009

Product	% of family consuming the product	% energy contribution to total diet	% of total food spending
Dairy		6.5	
Fluid milk	48.7	0.6	6.0
Cheese	86.0	5.9	7.7
Eggs	72.9	1.5	3.7
Meat		6.0	
Beef	44.4	1.0	9.0
Chicken	75.6	3.6	9.9
Fish/pork	25.4	1.4	6.3
Beans	96.3	10.0	7.6
Cereals		42.0	
Rice	98.0	22.4	10.9
Maize	80.2	3.5	8.3
Wheat	67.2	13.6	11.7
Sugar	98.5	12.0	5.6
Oil	96.7	12.0	5.8
Fruits		3.0	
Banana/plantain	63.9	2.9	5.8
Orange/other	43.0	0.1	3.9
Roots and tubers	28.6	1.1	1.6
Vegetables		3.0	
Potato	56.5	0.5	2.1
Tomato	84.4	0.1	2.2
Onion	94.7	0.1	1.6
Cabbage	31.9	0.3	1.3
Others	38.6	0.5	1.8
Other foods		2.9	1.1

Source: INIDE (2010).

Almost half of the families in Nicaragua consume fluid milk (48.7%) and an overwhelming majority (86%) consumes cheese. Dairy products contribute 6.5% of the energy in the Nicaraguan diet, and families spend about 13.7% of total food purchases on dairy products.

With regard to meat consumption, most families consume chicken (76%), followed by beef (44%).Beef contributes 1% of caloric consumption and families spend about 9% of total food purchases on beef. The average per capita daily protein intake during 2009 was 55 g; of this, 31.3% was of animal origin (INIDE 2010).

Table 5 shows the annual per capita consumption, by area of residence and poverty level, in 2009 as discriminated by type of consumption. As shown, food is where people spend most of their income across all poverty levels and areas of residence. People in rural areas spend 56.6% of their income on food, compared with 42.8% in urban areas. With

regard to poverty level, the extremely poor population spends more than 60% of their income on food compared with the national average of 43%.

Table 5. Percentages of annual per capita consumption, by area of residence and poverty level, in 2009 as discriminated by type of consumption in Nicaragua

Ranking of expenditure	Area of residence			Poverty level		
	National	Urban	Rural	National	Poor	Extremely poor
Food	47.2	42.8	56.6	43.2	58.2	60.8
Housing	14.5	16.3	10.8	15.7	11.5	11.8
Personal use	10.1	10.0	10.2	10.3	9.5	8.7
Utilities	9.0	10.7	5.4	9.6	7.3	7.3
Health	5.3	5.0	6.0	5.5	4.8	4.1
Education	5.8	6.3	4.5	6.3	4.4	3.7
Transport	4.9	5.0	4.7	5.6	3.0	2.6
Others	3.2	3.9	1.8	3.9	1.4	1.1
Total	100	100	100	100	100	100

Source: INIDE (2010).

The second type of expenditure, by ranking, was housing across all categories of income (between 11% and 16% of total income), followed by items of personal use (clothing, shoes), which varied from 9% to 10% of total income. Expenditures on utilities (energy, water), varied from 5to 11%. Expenditures in the extremely poor category were proportionately lower in health, education, and transport.

Table 6contains the top 10 food items most consumed by the extremely poor, the poor, and the national average. Food items were standardized by weight on a dry matter basis to allow comparison. As shown, maize is ranked number one and accounts for 18.6% of total consumption by weight of the 10 most consumed items in the diet of extremely poor families (i.e. living under USD 1.25/day per person). Milk products (either as fluid, condensed, evaporated, or powder) are ranked second and account for 15.4% of total consumption of the diet of extremely poor families. In the case of poor families (i.e. living under USD 2.50/day per person), milk products came number one, accounting for 16.0% of total consumption. Likewise, for the overall population, milk products were ranked number one and accounted for 15.1% of total consumption of the top 10 food items consumed by weight. Thus, milk products are considered of strategic nutritional importance by Nicaraguan families, even though overall consumption of milk has been decreasing during the last 15 years.

Table 6. Top 10 food items most consumed by extremely poor and poor families and the national population of Nicaragua in 2009.Food items were standardized by weight on a dry matter basis to allow comparison

Rank order	Food item	Extremely poor	Poor	National population
		Consumption (%)		
1	Maize	18.6	14.0	8.2
2	Milk	15.4	16.0	15.1
3	Rice	12.3	13.2	12.3
4	Beans	11.0	8.9	6.8
5	Plantain	10.9	9.6	9.0
6	Sugar	6.3	6.1	6.0
7	Sweet bread	3.8	3.4	3.8
8	Eggs	2.8	3.1	3.1
9	Cooking oil	2.4	2.6	2.6
10	Tortilla	2.1	3.7	5.6
Total		85.6	80.5	72.5

Source: INIDE (2010).

Table 7 contains the adjusted weight of the 10 most consumed food items that contribute to the construction of the poverty line of the extremely poor population of Nicaragua in 2009 by both weight on dry matter basis and by food cost. The poverty line of the extremely poor population is constructed based on per capita food consumption (in kg on a dry matter basis) multiplied by the unitary price of each particular food item (in USD per kg on a dry matter basis) divided by the caloric need of the extremely poor population, estimated to be2268 calories/day.

As shown, milk products contribute 11.7% to the value of the extreme poor poverty line by weight and 4.8% by food cost. Beef does not contribute to the construction of the poverty line by weight because its consumption is very low. However, beef contributes 5.5% to the construction of the poverty line by food cost of the basic diet of the extreme poorly population of Nicaragua. It was not possible to obtain information on dairy and meat consumption by age or gender.

Table 7. Adjusted weight of the top 10 most consumed food items by the extremely poor population of Nicaragua in 2009, by both consumption by weight and by food cost

Food item	Food consumption by weight (%)	Food item	Food consumption by cost(%)
Rice	14.2	Rice	13.5
Milk	11.7	Tortilla	10.7
Tortilla	9.4	Coffee	9.6
Maize	9.0	Beef	5.5
Sugar	8.0	Beans	5.0
Plantains	6.2	Milk	4.9
Beans	6.1	Sugar	4.8
Simple bread	5.3	Bread	4.4
Sweet bread	3.7	Cooking oil	4.2
Cooking oil	3.2	Poultry meat	4.1

Source: INIDE (2010).

Production

As explained earlier, the most important livestock production system is the dual-purpose. Most dual-purpose farms are small. Table 8 shows the distribution of farms with cattle by size in 2011.About 88% of the farms have less than 70 ha of land. In addition, more than half of the national herd (i.e.51%) is in the hands of farmers who own less than 10ha. Total herd size is 4.14 million head of cattle. The Ministry of Agriculture and Livestock (MAGFOR 2012) estimates that Nicaragua has about 136,687 producers who own cattle, with more than 75% of the income generated by milk sales. The three main advantages of the dual-purpose system are (1) reduced risk because of variations in milk and beef prices, (2) income diversification, and (3) lower incidence of mastitis because of suckling of calves.

Table 8. Number of cattle farms by farm size, herd inventory, and extent of improved and natural pastures in Nicaragua during 2011

Farm size (ha)	Number of cattle farms	Extent of improved pastures (ha)	Extent of natural pastures (ha)	Proportion of improved pastures (%)	Number of animals (head)	Stocking rate (head/ha)	Proportion of national herd size (%)
<35	101,192	171,394	443,220	27.9	1,176,685	1.91	28.4
35–70	19,053	175,893	441,287	28.5	850,502	1.38	20.6
70–140	9995	193,752	475,933	28.9	818,552	1.22	19.8
140–350	5041	221,508	520,524	29.9	789,839	1.06	19.1
> 350	1406	184,519	420,463	30.5	500,844	0.83	12.1
Total	136,687	947,068	2,301,429	29.1	4,136,422	1.27	100.0

Source: CENAGRO (2012).

The average herd size is 30.3 head per farmer. Because of their small size, many of these cattle farms also engage in other complementary activities such as cultivation of staple crops (i.e. maize, beans, plantain, and cassava).Crops help diversify the risk, improve food security, use family labour more efficiently, and ensure feed for livestock (in the form of crop residues for dry-season feeding).

As shown in Table 8, the proportion of improved pastures slightly increases as farm size gets larger. On the other hand, stocking rate decreases as farm size gets larger. This may seem contradictory, as improved grasses actually increases stocking rate. However, small farms usually have higher stocking rates than large farms because they use other complementary sources such as crop residues for dry-season feeding and forage available in public roads (Fujisaka et al. 2005).On the other hand, large farms tend to have a quicker turnover rate (i.e. higher weight gain or milk yield) because nutrient availability is greater from lower stocking rates (Holmann et al. 2003).

The main constraints faced by small farmers at the farm level are (Pérez 2013):

(1) Low productivity caused by (a) low forage availability and quality, especially during the dry season; (b) lack of control and preventive measures against diseases and parasites; and (c) low genetic potential; and

(2) Absence of basic infrastructure (milking facilities, fencing, water supply).

The main constraints faced by small farmers at the supply chain level are (Pérez 2013):

(1) Low credit availability;

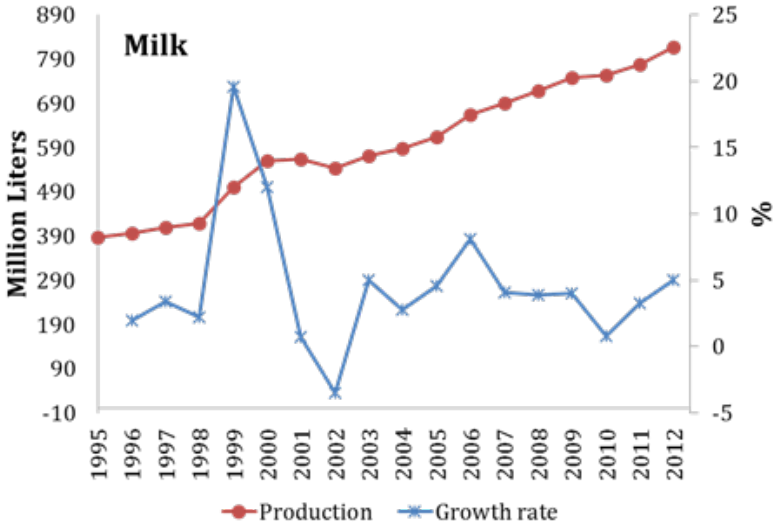
(2) Poor public infrastructure (energy, roads, water)

(3) Weak market access for products caused by (a) low milk and beef prices due to seasonality and abundance of intermediaries, creating more transaction costs along the value chain by capturing a lower price, and (b) low incentives for quality improvement.

These constraints will be explained in detail in the following chapters.

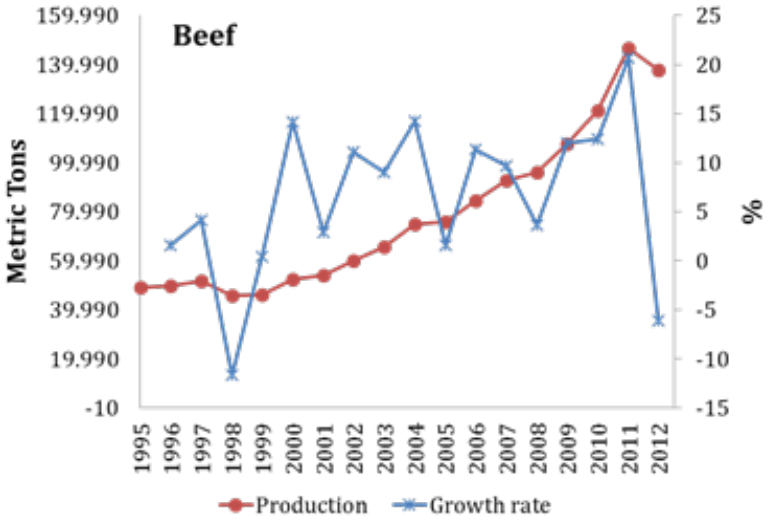
Figures 3 to 6 show the national milk, beef, poultry, and pork production trends and growth rates since 1995.As shown, pork is the sector which has grown less (2.7% per year), followed by milk (4.6% per year).Beef production has been increasing at an annual rate of 6.5%, whereas poultry production has been the most dynamic, increasing at an annual rate of 9.0% per year.

Figure 3. Milk production and growth rate in Nicaragua from 1995 to 2012



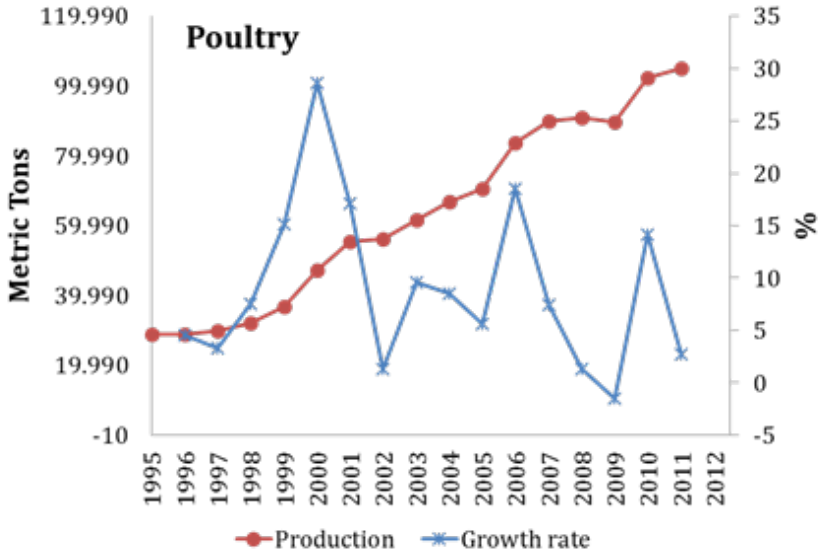
Sources: FAOSTAT (2013); MAGFOR (2013).

Figure 4. Beef production and growth rate in Nicaragua from 1995 to 2012



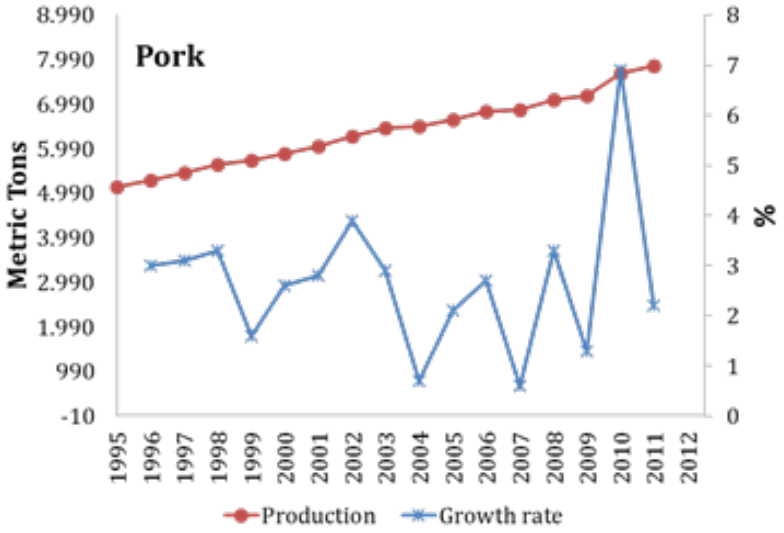
Sources: FAOSTAT (2013); MAGFOR (2013).

Figure 5. Poultry production and growth rate in Nicaragua from 1995 to 2012



Sources: FAOSTAT (2013); MAGFOR (2013).

Figure 6. Pork production and growth rate in Nicaragua from 1995 to 2012.



Sources: FAOSTAT (2013); MAGFOR (2013).

Livestock production regions

Figure 7 shows the proportion of milk and beef produced in the country, by region, in 2011 (MAGFOR 2012).A brief description of the different livestock-producing regions follows:

(1) Dry region. This area is characterized by low annual rainfall (<1000 mm) and high-fertility soils of volcanic origin. Elevations vary from 600 masl to sea level (Pacific Ocean) and average temperature is around 25 to 28°C.The most common export crops are sugarcane, peanuts, and the fruits mango and guava. The most common crops for domestic consumption are plantain, maize, rice, and beans. The estimated milk and beef production was 17.9% of total production in 2011. All of the dairy plants and most slaughterhouses are located in this region

because the capital city is located here. The region has the best public infrastructure in terms of paved roads, electricity, potable water, phone, and internet services. More than 50% of the human population lives in this region. This region used to be the main milk-producing area in the 60s and the 70s and the area where steers for beef production were prepared because infrastructure was (and still is) better.

(2) Northern region. This area is characterized by medium-to-high-fertility soils and higher annual rainfall (1100 to 1300 mm).Elevations range between 600 and 1200 masl and average temperature is around 20 to 23°C. Most common export crops are tobacco and coffee and most common crops for domestic consumption are maize and beans. The estimated milk and beef production was 11.1% of total production in 2011. Rural infrastructure is moderate to deficient.

(3) Central region. This area is characterized by medium-to-low-fertility soils and annual rainfall that varies between 1200 and1500 mm. Elevations are between 300 and 600 masl, and average temperature is around 23 to 26°C. There are no export crops in this region. The most common crops for domestic consumption are rice, maize, and beans. The estimated milk and beef production was 25.4% of total production in 2011. Rural infrastructure is moderate to deficient. This region used to be the main supplier of steers for fattening in the dry region during the 1960s and 1970s. It became the most important milk- and beef-producing region during the 1980s and 1990s. Rural infrastructure was greatly improved during this time but it still is considered moderate compared with the dry region.

(4) Humid region. This area is characterized by low-fertility soils and an annual rainfall that varies between 1500 and3000 mm. Elevations are from 300 to sea level (Caribbean). Average temperature is around 25 to 28 C. Export crops in this region are palm oil and cacao. Crops for domestic consumption include maize and beans. The estimated milk and beef production was 45.6% of total production in 2011. It has become the most important livestock-producing region since the 90s. Rural infrastructure has been improving since the 90s but it is still poor and considered the most deficient in the country in terms of roads, electricity, phone, and internet services. Most of livestock production has been at the expense of deforestation.

Figure 7. Proportion of milk and beef produced in Nicaragua, by region, in 2011

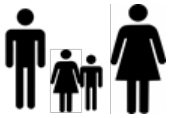
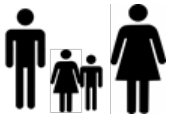
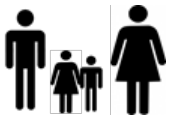
Role of women in livestock production

Women play an important role in these production systems, especially when men take on seasonal off-farm work, for example, harvesting sugarcane and picking coffee, and women are left to perform the tasks of milking, taking care of livestock, and manufacturing artisan cheeses. Furthermore, on many of the small farms, women are the head of the household. Unfortunately, there is no information or statistics related to the role of women in livestock-related activities. An important research question for ILRI´s gender program is defining the role of different family members in livestock-related activities in order to design technological interventions.

Agurto and Guido (2005) estimated that, of the total women-owners of land (only 18% of rural women), about 20% worked full-time in livestock production, about 8% engaged in crop-related activities, and 72% combined both livestock and crop-related activities in 2004. The 2011 Agricultural Census indicates that 23% of producers are women, but gender and livestock studies specify that the absence of a reflection on the role of women in livestock fails to give women´s contribution this activity the same dimension as men and obscures their role as livestock producers, regardless of leadership and ownership of land or livestock(Flores and Torres 2012).

Women who are involved in livestock production but are not owners of land or cattle tend to be unrecognized by society and themselves as producers, even if they are actively participating in primary production, which is based on a family economy where women´s work and contributions (including unpaid domestic chores) are key to producing quality products (Vanderschaeghe and Lindo 2014).Table 9 illustrates the types of activity men, women, and family are engaged in to produce milk. This information was obtained from three different case studies in the north and western parts of the country between 2009 and 2013 by the Millennium Challenge Account, GIZ, OXFAM, and the Association of Producers and Exporters of Nicaragua (APEN). It reveals that no matter how involved women are in most of the production stages, they are rarely recognized as producers.

Table 9. Gender role in different milk-producing activities in Nicaragua

Type of work	Men	Women	Family
Planting and pasture management			
Cattle management (sanitary, reproductive)			
Production management (feeding and pasture)			
Milking			
Product management (hygiene, cleaning, and handling equipment)			
Care of people and assets, as well as administering family resources			

Source: Vanderschaeghye et al. (2013).

Producer prices and competitiveness

Table 10 contains the producer prices for milk and beef paid at the farm level since 2000. The mean price of milk has averaged USD 0.302/litre, which is about 25% less than the international milk price. In addition, Nicaragua is the country that has the lowest milk price in Central America (Zuñiga 2011), thus making it very competitive. With regard to beef, the mean price paid to producers during this period averaged USD 0.98/kg liveweight. FAO uses as reference for the international price of beef two of the most competitive exporting countries, Argentina and Australia. As shown, the price paid to producers during the same period was 11% lower, similar to Argentina (USD 0.88/kg liveweight), but the beef price paid to producers was 20.4% higher in Australia than in Nicaragua, thus making this country very competitive in terms of beef and milk production.

Table 10. Producer prices for milk and beef in Nicaragua during the period 2000–2012 compared with international prices of New Zealand for milk and of Argentina and Australia for beef

Year	Raw milk price (USD/litre)[1]	International milk price of New Zealand (USD/litre)[2]	Beef price (USD/kg liveweight)[1]	International beef price (USD/kg liveweight)[3]	
				Argentina	Australia
2000	0.276	0.264	0.76	0.87	0.67
2001	0.295	0.278	0.89	0.77	0.72
2002	0.294	0.193	0.90	0.50	0.88
2003	0.274	0.255	0.86	0.66	0.91
2004	0.255	0.297	0.83	0.65	1.13
2005	0.243	0.312	0.82	0.76	1.31
2006	0.244	0.334	1.10	0.70	1.31
2007	0.257	0.661	1.09	0.73	1.41
2008	0.326	0.595	1.07	0.82	1.32
2009	0.374	0.404	0.75	0.74	1.27
2010	0.370	0.513	0.70	1.48	1.44
2011	0.361	0.610	1.39	1.89	1.77
2012	0.353	0.506	1.62		
Mean	0.302	0.402	0.98	0.88	1.18

1. FAO (2013).
2. WCDR (2013).

However, even though the country might be competitive in terms of international milk prices, it is worrisome that producers are capturing less the proportion of the final milk price paid by consumers. Table 11 contains the farm gate price paid to milk producers, the price paid by consumers, and the proportion of the end price captured by producers. As shown, producers were catching more than 63% of the final price paid by consumers in 2000 and this proportion has been steadily decreasing throughout the last 12 years, getting less than 42% of the final price by 2012. These figures suggest that other actors across the milk value chain (processors, distributors, retailers) are obtaining a greater piece of the pie relative to a decade earlier. If these differences are not translated into better services to producers (i.e. technical assistance, more credit), then it could be a major bottleneck that might affect the competitiveness of the entire milk value chain.

Table 11. Farmgate price paid to producers and milk price paid by consumers in Nicaragua during the period 2000 to 2012 and the proportion of final price retained by producers

Year	Producer price	Consumer price	Proportion of final price retained by producers (%)
	(USD/litre)		
2000	0.276	0.434	63.6
2001	0.295	0.461	64.0
2002	0.294	0.491	59.9
2003	0.274	0.530	51.7
2004	0.255	0.518	49.2
2005	0.243	0.508	47.8
2006	0.244	0.534	45.7
2007	0.257	0.569	45.2
2008	0.326	0.723	45.1
2009	0.374	0.788	47.5
2010	0.370	0.750	49.3
2011	0.361	0.741	48.7
2012	0.353	0.848	41.6

Sources: FAOSTAT (2013); INEC (2013).

Imports and exports

Beef exports: volume and value

Table 12 shows the volume and value of beef exports for the period 2000 to 2012.Aspreviously mentioned, Nicaragua is very competitive in terms of beef export prices and this is reflected in the export growth rate the beef sector has been experiencing. From 2000 to 2012, beef exports increased at an annual rate of 17.4%.In addition, the value of beef per tonne exported also increased during the same period at an annual nominal rate of 6.6%, thus reflecting a value-added additional gain if we consider that annual inflation rate in the United States is about 3% per year.

A good research question is: What is the impact of increased beef (and milk as well) exports on the welfare of the value chain actors, including consumers increased exports obviously benefit exporters (meat-packing plants, dairy plants, and artisan cheese exporters), but what effect does this have on local demand for animal protein as well as the proportion of final product price retained by producers?

Table 12.Volume and value of beef exported from Nicaragua during 2000 to 2012

Year	Volume of beef exported (t/year)	Annual growth(%)	Value of beef exported (USD million)	Value of beef per exported tonne(USD)	Value increase(%)
2000	19,433		46.3	2383	
2001	22,155	14.0	60.7	2740	15.0
2002	29,172	31.7	67.0	2297	– 3.6
2003	26,588	– 8.9	67.8	2550	11.0
2004	32,723	23.1	92.2	2818	10.5
2005	33,978	3.8	100.0	2943	4.4
2006	27,753	–18.3	76.9	2770	– 5.9
2007	50,868	83.3	160.9	3163	14.2
2008	51,822	1.9	178.1	3436	8.6
2009	64,589	24.6	215.6	3338	– 2.8
2010	80,200	24.2	299.4	3733	11.8
2011	101,387	26.4	419.3	4136	10.8
2012	104,005	2.6	451.4	4340	4.9

Source: FAOSTAT (2013).

Beef exports: destination countries

Table 13 shows the destination countries of Nicaraguan beef exports in 2012.As shown, more than 81% of the beef is exported to two countries. Venezuela represents the major market, accounting for 46.4% of total beef exports, followed by the United States with 34.7% of the market share. Likewise, Venezuela is the first customer for Nicaragua when it comes to frozen beef meat imports. Nicaraguan frozen meat exports to Venezuela were around USD 210

million in 2012. The United States occupies the second position with around USD 133 million imports in 2012; it was the first importer of fresh/chilled beef meat from Nicaragua with more than USD 26 million in 2012.

Nicaragua is currently negotiating a free-trade agreement with the European Union and it is expected that this new market will give Nicaraguan beef a great opportunity as the European Union pays a higher price than the United States. However, for this to happen, Nicaragua needs to put in place a beef traceability system. (This will be discussed in detail later in the document in the section on animal health.)

Table 13. Destination of beef exports from Nicaragua in 2012

Country	Value of exported beef (USD million)	Share (%)
Venezuela	209.4	46.4
United States	156.2	34.7
El Salvador	46.2	10.2
Taiwan	15.1	3.4
Costa Rica	12.3	2.7
Russia	5.0	1.1
Panama	3.1	0.7
Guatemala	1.8	0.4
Mexico	0.8	0.2
Japan	0.5	0.1
Others	0.7	0.2
Total	451.4	100.0

Source: CETREX (2013).

Beef imports: volume and value

Table 14 shows the volume of beef imported into Nicaragua during the 2000 to 2011 period. Imported volumes are very small to nil, representing less than 0.2% of total beef production. Most beef cuts are small importations for the restaurant market in order to offer beef cuts from Angus breed (which are not produced in Nicaragua) to high-end customers who are willing to pay a premium price for beef.

Table 14. Volume of beef imported into Nicaragua during the period 2000 to 2011

Year	Beef preparations and sausages	Boneless beef	Total
		(t)	
2000	3	128	131
2001	1	206	207
2002	0	184	184
2003	127	273	400
2004	127	51	178
2005	98	107	205
2006	133	58	191
2007	169	31	200
2008	103	21	124
2009	133	75	208
2010	150	56	206
2011	168	92	260

Source: FAOSTAT (2013).

Table 15 contains the value of imported beef as well as the value of beef per imported tonne into Nicaragua during the same period. As shown, the value of imported beef is very similar to the value of beef per exported tonne shown

in Table 12.The fact that the values are similar might imply that imported beef cuts are of similar quality to Nicaraguan beef and it might be a response to a greater local demand for certain cuts.

Table 15.Value of imported beef to Nicaragua during the period 2000 to 2011 and the value of beef per imported tonne

Year	Beef preparations and sausages (USD000)	Boneless beef	Total	Value of beef per imported tonne (USD)
2000	3	302	305	2328
2001	3	476	479	2314
2002	0	476	476	2587
2003	241	797	1038	2595
2004	303	168	471	2646
2005	295	298	593	2893
2006	368	192	560	2932
2007	408	155	563	2815
2008	292	192	484	3903
2009	397	341	738	3548
2010	504	344	848	4117
2011	567	577	1144	4400

Source: FAOSTAT (2013).

Dairy exports: volume and value

Table 16 contains the amount of dairy products exported from Nicaragua from 2000 to 2012.Showing great dynamism, dairy exports have increased at an annual rate of 21.9%.Milk powder exports have increased more than 300% per year, from a little over 300 t/year in 2000 to more than 10,000 t in 2010. Evaporated milk increased 51% a year. Fluid milk exports went from nothing exported in 2000 to more than 25,600 t in 2012.Cheese exports have been growing at 17.1%.The only exported dairy product that decreased during this period was yogurt because the only dairy plant that produced yogurt for the export market (El Eskimo) sold its license to produce the French brand 'Yoplait' to another dairy plant (Sigma Foods) located in Costa Rica in 2008.

Table 16. Quantity of dairy products exported from Nicaragua during the period 2000 to 2011 (t/year)

Year	Cheese	Fluid milk	Milk powder	Evaporatedmilk	Yogurt	Total (in fluid milk equivalents)[1]	Export annual growth rate (%)
2000	16,049	3	315	189	758	149,115	
2001	12,837	0	398	138	835	120,955	– 18.9
2002	10,989	0	1109	277	1593	112,074	– 7.3
2003	16,179	0	1562	225	864	160,612	43.3
2004	17,453	8	2320	233	883	178,249	11.0
2005	15,648	11	1641	260	899	155,525	– 12.7
2006	3182	47	77	264	416	31,755	– 79.6
2007	27,253	569	3277	392	803	274,811	765.4
2008	29,391	5737	8518	493	39	339,624	23.6
2009	28,535	19,645	9297	668	37	352,457	3.8
2010	26,022	26,881	10,450	863	20	346,710	– 1.6
2011	30,211	19,038	8242	1057	4	359,313	3.6
2012	32,716	35,601	8036	1295	1	401,588	11.8

1. It takes on average about 8 litres of fresh fluid milk to produce 1 kg of milk powder, 9 litres of milk to produce 1 kg of cheese, 2.3 litres to produce 1 kg of yogurt or evaporated milk, and 5.8 litres to produce 1 kg of condensed milk.
Source: FAOSTAT (2013).

Table 17 shows the value of exported dairy products and the value per exported tonne in fluid milk equivalents during the same period. As shown, value per exported tonne has been increasing over time, growing at an annual rate of 11.8% and thus reflecting a value-added effect during this period.

Table 17. Value of dairy products exported from Nicaragua during the period 2000 to 2011 (in USD 000)

Year	Cheese	Fluid milk	Milk powder	Evaporated milk	Yogurt	Total	Value of exported milk (USD/t fluid milk equivalent)
2000	19,716	0	771	271	1298	21,516	148.3
2001	11,950	0	1016	173	1452	14,591	120.6
2002	18,634	0	2742	464	2145	23,985	214.0
2003	20,484	0	3495	370	1514	25,863	161.0
2004	22,620	103	5721	401	1492	30,337	170.2
2005	24,038	87	4836	464	1493	30,918	198.8
2006	6254	41	235	620	642	7792	245.4
2007	49,701	347	12,401	824	883	64,156	233.5
2008	65,563	5020	43,004	1072	50	114,709	337.8
2009	76,816	15,551	34,231	1256	47	127,901	362.9
2010	68,744	21,288	43,179	1622	29	134,862	389.0
2011	80,870	14,685	36,197	2006	5	133,763	372.3
2012	94,700	27,500	41,500	2458	1	166,159	413.8

Source: FAOSTAT (2013).

Dairy exports: destination countries

Table 18 shows the countries where exported milk from Nicaragua was shipped in 2012. More than 80% of dairy exports went to three countries: El Salvador has the greatest market share (50.3%), followed by Guatemala (15.8%), and Venezuela (14.5%). Most cheese is exported to El Salvador, whereas most milk powder is exported to Guatemala. Most fluid milk exports have gone to Venezuela in ship tanks to supply their state-owned dairy plants, which were confiscated from private firms.

Table 18. Destination of dairy exports from Nicaragua in 2012

Country	Milk powder	Fluid milk	Cheese	Total	Share (%)
			(USD million)		
El Salvador	11.0	0.4	71.0	82.4	50.3
Guatemala	25.3	0.5	0.1	25.9	15.8
Venezuela	0	23.7	0	23.7	14.5
Honduras	4.7	0.8	11.2	16.7	10.2
United States	0	0	12.0	12.0	7.3
Costa Rica	0	1.9	0.5	2.4	1.5
Singapore	0.6	0	0	0.6	0.3
Dominican Republic	0	0.2	0	0.2	0.1
Total	41.5	27.5	94.7	163.7	100.0

Source: CETREX (2013).

Dairy imports: volume and value

Table 19 shows the volume of dairy products imported into Nicaragua from 2000 to 2011.These imported dairy products are filling small niches. Most imported cheeses are of European origin—Manchego from Spain, Gouda and Edam from The Netherlands, Emmental from Switzerland, and Brie from France and have demand among rich people and the diplomatic community. Most of the imported fresh fluid milk has the lactose component removed for small population niches with high purchasing power.

Table 19. Quantity of dairy products imported into Nicaragua during the period 2000 to 2011 (t/year)

Year	Condensed milk	Fresh fluid	Milk powder	Evaporated milk	Yogurt	Cheese	Total (in fluid milk equivalents)[1]
2000	321	352	7249	163	66	593	66,070
2001	264	432	4121	137	13	624	41,070
2002	339	392	2926	143	10	805	33,363
2003	822	587	1233	133	6	482	19,877
2004	895	807	2758	153	2	322	31,316
2005	406	962	527	172	51	491	12,465
2006	432	1162	1539	153	45	703	22,762
2007	492	839	2363	131	111	688	29,346
2008	368	863	1535	497	397	669	23,354
2009	427	942	1651	155	508	607	23,615
2010	430	1112	1963	141	753	674	27,432
2011	435	1204	2298	202	487	724	31,805

1. It takes on average about 8 litres of fresh fluid milk to produce 1 kg of milk powder, 9 litres of milk to produce 1 kg of cheese, 2.3 litres to produce 1 kg of yogurt or evaporated milk, and 5.8 litres to produce 1 kg of condensed milk.

Source: FAOSTAT (2013).

Table 20. Value of dairy products imported into Nicaragua during the period 2000 to 2011 (in USD 000)

Year	Condensed milk	Fresh fluid milk	Milk powder	Evaporated milk	Yogurt	Cheese	Total
2000	465	205	14,887	157	85	1586	17,385
2001	370	265	12,046	124	19	1823	14,647
2002	480	240	6560	123	15	2206	9624
2003	1517	343	2983	130	12	1379	6364
2004	1476	428	6200	140	4	1115	9363
2005	527	559	1407	153	63	1874	4583
2006	592	634	4898	167	59	2649	8999
2007	706	551	9487	172	152	2891	13,959
2008	805	694	7595	2237	715	3436	15,482
2009	917	725	7275	397	904	2912	13,130
2010	902	1188	8247	240	1279	3264	15,120
2011	840	1083	6329	330	1945	2184	12,711

Source: FAOSTAT (2013).

Dairy imports: countries of origin

Table 21 shows the countries where most of the imported dairy products came from in 2011. New Zealand is the country where most of the milk powder is imported from, followed by Costa Rica and the United States. Most fluid milk comes from Costa Rica, followed by Switzerland, majority in the form of ultra-high pasteurized (UHT) milk. Most imported cheese comes from the United States in the form of mature, long-shelf-life cheeses such as Mozarela, for

pizzas, Cheddar, and others such as Provolone, Emental, Gouda, and Brie. New Zealand is the most important trading partner of imported products, followed by Costa Rica and the United States.

Table 21. Countries of origin of dairy products imported into Nicaragua in 2011

Country	Milk powder	Fluid milk	Cheese	Other dairy products	Total	Share (%)
			(USD 000)			
New Zealand	4219	0	0	347	4566	36.2
Costa Rica	717	603	865	1859	4044	32.0
United States	348	0	1211	1664	3223	25.5
Switzerland	0	480	0	0	480	3.8
Panama	0	0	0	307	307	2.5
Total	5284	1083	2076	4177	12,620	100.0

Source: MIFIC (2013).

Value addition and marketing

Dairy manufacturing sector

The dairy manufacturing sector can be divided into two: 'formal' and 'informal'. The formal sector has signed contracts with producers, and therefore, a more stable price is ensured throughout the year. In addition, they have a payment system based on milk quality and they pasteurize the milk that is collected. This sector, in spite of steady growth, still collects less than half the milk (42%) produced in the country (Table 22).

Table 22. Milk production and milk processing capacity in industrial plants, 2000–2012

Year	National milk production (million litres)	Proportion of milk collected by plants (%)	Milk processed at industrial plants (litres/day)
2000	560.0	8	122,740
2001	564.5	10	154,660
2002	544.1	12	178,880
2003	571.5	14	219,205
2004	587.1	14	225,190
2005	614.1	16	269,190
2006	664.5	17	309,490
2007	691.1	19	359,750
2008	718.9	22	433,310
2009	747.8	27	553,170
2010	753.3	34	701,700
2011	778.3	38	810,290
2012	817.2	42	932,000

Source: MAGFOR (2012).

The formal sector includes two types of enterprises. The first is a group of firms (Table 23) processing, with relatively modern technology, between 50,000 and 200,000 litres/day, oriented toward the domestic market (Parmalat and Eskimo) or the export market (Prolacsa, Centrolac, and Nilac). The second group is composed of plants (semi-industrial) of intermediate size and technology (La Exquisita, La Montaña, and the Boaco and Chontales cooperatives), mostly dedicated to cheese production for domestic and foreign markets (particularly El Salvador).Between 2006 and 2012, the industrial processing capacity of the formal sector almost doubled, with a sharp increase in the proportion of milk flowing through the larger plants and the semi-industrial cheese sector, according to data provided by the Ministry of Agriculture and Forestry (Table 23).The growth of the formal sector is attributed to the installation of efficient milk collection centres and to a more stable payment system that reduces price fluctuations between dry and rainy seasons.

Table 23. Processing capacity of main dairy plants in Nicaragua since 2006

Year	Seed sold (t)	Seed annual growth rate (%)	New pasture area planted (ha) [1]
2000	6.7		1914
2001	16.4	144.8	4686
2002	27.3	66.5	7800
2003	63.8	133.7	18,229
2004	77.0	20.7	22,000
2005	100.3	30.3	28,657
2006	188.5	87.9	53,857
2007	404.8	114.8	115,567
2008	342.5	– 15.4	97,857
2009	231.1	– 32.5	66,029
2010	289.1	25.1	82,600
2011	220.3	– 23.8	62,943
2012	387.6	75.9	110,743
Total	2355.4	52.3	672,882

1. na=not applicable (Centrolac started operations after 2006).
Source: Perez (2013).

The informal sector is formed by a large group of small 'artisan' cheese factories, estimated to be 3000 in the whole country, supplying the domestic and export markets, in this case, through a large network of intermediaries. These factories have little or no quality control and buy milk of lowest quality, paying the lowest price. They are usually located in rural communities distant from collection centres and semi-industrial cheese factories. Production has decreased because of the growth of collection centres; it has become difficult to obtain milk. This artisan product is mostly made by women for local and domestic consumption (Flores et al. 2011).

The formal sector has been increasing in part because of the introduction and dissemination of milk cooling tanks (networks) in several regions of the country, which allowed the transport of milk to processing plants located near the capital, Managua. It is expected that this sector will continue to increase because the export market for Nicaraguan milk (mostly other Central American countries) is increasing by more than 20% a year. This has very good implications for smallholder farmers because the cooling network continues to expand and this has a direct benefit through higher prices. However, other value chain actors, such as intermediaries, are negatively affected by the increased capacity of the cooling network because their role is reduced or eliminated.

Milk distribution channels

The description of the distribution channel in the dairy sector of Nicaragua starts at the farm level. First, there is the group of large farmers supplying the export market plants (Prolacsa, Centrolac, and Nilac) and the domestic market plants (Parmalat, Centrolac and Eskimo). They also supply milk to the semi-industrial cheese makers (mostly cooperatives). These are the farms that belong to the different milk cooling networks established in the country in the last decade. These farms usually have milk cooling tanks in the farm and produce the best-quality milk.

The milk cooling networks supply the industrial plants, but a share of the milk also goes to the semi-industrial cheese makers. In some cases, where the network main buyers are plants, the cheese makers usually play a sort of 'buffer' role, particularly when logistical problems arise. In other cases, the cooling tank network is integrated with a cheese maker (particularly a cooperative), which has developed strategies for milk and product quality improvement.

A description of the dairy chain of Nicaragua must necessarily include 'behavioural' elements that are crucial in understanding the sort of strategies open to the cooperatives, which belong to the cooling network. One of the key issues that influence the operation of the channel is 'liquidity,' with relationships between participants, particularly

dairy farmers, cheese makers and intermediaries, based on instant payment, cash transactions, or at most with payments made on a weekly basis. In addition, it is characteristic of cheese makers to use their liquidity status and act as lenders to farmers, therefore making competition for milk at the farm level much more complicated in the sense that price is just a factor among many others, and many times causes a shift in behaviour among farmers. This, in turn, increases the instability of milk intake.

The milk cooling network

Data to complete this section came from a study about the milk cooling network performed in 2007 (CANISLAC 2007) and were updated up to last year on the basis of several interviews with personnel of MAGFOR, milk plants, and milk producer cooperatives.

There are about 42 milk collection centres distributed across the country with an estimated capacity of 877,000 litres/day, ranging from the small centres'2400 litres/day to the large ones'105,000 litres/day. The mean capacity per centre is about 41,800 litres/day. About 33.3% of the cooling centres have one tank; 23.8% have two, 21.4%, three; 7.2%, four; and the remaining 14.3%, 5.About 92.5% of the milk collected is sold to the milk processing plants, 12.5% is sold to local cheese artisan factories, and the remaining 2.5%constitute local sales.

About 45.2% of the milk network belongs to dairy cooperatives, another 42.9% is owned by private individuals, and the remaining 11.9% by associations of cattle producers. Nicaraguans own91.4% of the cooling network; foreigners, mostly from El Salvador, own the rest.

About 97.6% of the cooling centres have access to commercial electricity and 85.4% have their own emergency power plants. The main source of water is wells (77.5%) and only 22.5% depend on water supplied by municipalities. Nearly 73.2% have access to cell phone providers.

The milk produced in smallholder farms is transported to the cooling centres mostly by 4-WD vehicles (73.9%), followed by foot (12.7%), by horse (12%), and last, by bicycle (1.4%).About 78% of the milk transport is done by intermediaries, followed by producers (16%), and 6% by the milk collection centres themselves. Time of milk delivery from the farm to the cooling centre varies. About 43% lasts less than 1 hour, 32% lasts between 1 and 2 hours, and 26%, longer than 2 hours. The cost of transporting milk from smallholder farms to collection centres varies. About 59.3% of the milk routes charge between USD 0.028/litre and USD 0.054/litre; the remaining 40.7% charge less than USD 0.028/litre.

Commercial transactions between producers and the cooling network are done 'verbally' in 86% of the cases; only in 14% of cases are there written contracts. Likewise, commercial relationships between cooling centres and milk processing plants depend on verbal exchanges (92.5% of the cases) and written contracts exist for only 7.5% of the cases. Thus, most of the milk traded is subject to change any time according to the supply and demand situation, both in prices and quantities.

Quality control samples are evaluated in more than 70% of the cooling centres. The alcohol test is performed in 89.5% of all milk samples. The test aids in detecting abnormal milk such as colostrum, milk from animals suffering from mastitis, and milk in which the mineral balance has been disturbed.

Acidity and reductase tests are done in 81.6% of the cases (a low-cost test for bacterial count).Density and temperature tests are administered in 71.1% of the cases (a test for detecting adulterated milk).No analyses of total milk solids or fat content are performed in the cooling network.

The production of milk delivered to the cooling network during the 6-month dry season decreases by about 30% with respect to the rainy-season output. Thus, during the dry season, milk prices are higher because of demand for more milk in more or less the same proportion (i.e. 30%).The milk cooling network charges a commission that varies

between 12% and 15% between the price paid to producers and the price charged to the dairy industry. This covers the cost of operating the cooling centre plus a small profit.

Milk markets and prices

Milk pricing is an important issue since the development of the cooperatives and the cooling network was basically an answer to farmers' demand for better prices more than a decade ago. Different factors influence the average level and variability of milk prices. The first is the growing importance of the export market demand, as has already been shown. A flatter, more elastic demand, which is characteristic of the export market, means that dairy farmers who are able to articulate with export distribution channels can expect more stable prices than those who only deal with the domestic market. However, within the domestic market, there are differences too: the prices paid by the plants and semi-industrial cheese makers who are supplying branded products to more affluent consumers are also higher and more stable. The average price paid by the formal sector is about 25–27% higher than the price paid by the informal sector.

Not all farmers in Nicaragua can supply all markets. Leaving aside issues of geography (farmers located in faraway regions of the east), there is a growing trend toward satisfying the demand for high-quality milk by plants supplying the export market and the demand for branded milk by plants supplying the domestic market. For example, the Centrolac plant, which recently opened near Managua, produces milk using the ultra-high temperature (UHT) technique mostly for the export market. It now has quality demand that was unheard of a few years ago. Milk quality, in the dairy sector, basically means the possibility to cool the milk shortly after milking as well as to avail of improved on-farm practices.

Milk cooling has produced a type of market segmentation within Nicaragua´s dairy sector, particularly at the farm level. On one hand, farmers who belong to one of the cooling networks (cooperatives or non-cooperatives) are allowed to supply quality milk for the export and branded domestic markets, shipping to manufacturing plants more than 200 km from the region of production. They are also able to supply the semi-industrial sector, even the craft cheese makers, particularly during times of the year when supply and demand are tight, and milk prices are higher. On the other hand, majority-of the farms are 'locked' within the low-quality, low and variable milk price segment, supplying exclusively to hundreds of artisan cheese makers, with almost no bargaining power.

New dairy players

The Mexican dairy group Lala announced in 2013 that it will invest about USD 48 million dollars in 2014 to build a new, modern dairy plant for the domestic and export markets in Nicaragua. Likewise, the largest dairy cooperative in Central America, Dos Pinos (from Costa Rica) just finished a new milk powder plant on the border with Nicaragua. Both countries (Nicaragua and Costa Rica) are building a new bridge over the San Juan River, on the border, in order to increase trade. It is expected that Dos Pinos will buy significant amounts of fluid milk in Nicaragua to feed the new powder plant. These two new players will certainly put pressure on available milk currently going to existing dairy plants in Nicaragua, through increases in milk prices paid to producers, as well as through more investments to increase the milk cooling network capacity. Improvement of the public road and electricity system in the main livestock watersheds would also be a priority, constituting more pressure on the government. Thus, an enhanced cooling network infrastructure will benefit smallholder farms that currently do not have access by creating new markets for their milk that would give higher prices. However, if this hypothesis were true, it might also mean that household consumption of fluid milk might decrease.

Input and services: feeds and nutrition

Structure of the feed sector

The feed sector is private sector-led—that is, available feed resources, such as concentrate feeds, hay, silage, or seed from improved grasses and legumes, are privately owned and most transactions occur among private farmers throughout the country. The government plays a minor role in promoting new forage-based technologies. This role is mostly led by NGOs, farmer cooperatives, or large dairy plants because it is in their interest that farmers increase livestock productivity by adopting feed and forage technologies. Government agencies do not enforce control measures regarding seed quality or certifications and there is no quality control for concentrate feeds.

Small, dual-purpose cattle production systems predominate in Nicaragua. Smallholder farmers face the challenge of feeding their animals during the 4-to-6-month dry season, which severely limits milk and meat production. Strategies to feed animals are numerous, reflecting the heterogeneity of both the farms and the geography of the different regions. Feed alternatives include native and improved pasture, crop residues, rice straw, hay, silage, cut-and-carry forages, and purchased concentrates. Smallholder farmers make strategic management decisions to best utilize their available cash, land, water, and labour resources. Nevertheless, farmers encounter a trade-off: the more nutritive alternatives typically cost more to produce or purchase.

Each dual-purpose cattle operation reflects a unique strategy that relies on different combinations of available resources—including local rainfall, cash payments for bales of hay to investments in more productive cows, and sources of water for cattle in the dry season—and personal objectives that include taking advantage of higher dry season prices paid for milk to dedicate to calf fattening and beef production in the dry season. Nevertheless, in particular, for small- and medium-sized livestock producers, there remains a feed gap in critical periods and resource use is suboptimal.

Low quantity and quality of available feed resources in the dry season limits the profitability and cash flow of cattle operations in Nicaragua. Dry-season milk production is significantly lower than wet-season production, in spite of high financial incentives. The cost of forage production in the dry season can be relatively high, in view of the opportunity costs of land with water and capital (Fujisaka et al. 2005).

Research to change the current situation is needed by offering lower cost alternatives for dry-season animal feeding such as improved pasture, hay, forage trees, concentrates, cut-and-carry forages, and silage of forage maize and sorghum. Optimal combinations of these options depend on available farm resources, access to and knowledge of forage-based technologies, feed management strategies, market incentives, and farmer priorities. Collaboration among and with development projects and NGOs operating in Nicaragua can improve the effectiveness of interventions.

Forage-based pasture technologies

A major effort has been made in Latin America to develop new pasture technologies aimed to increase productivity of the region's traditional extensive livestock production systems, particularly in the continent's tropical lowlands. This multinational and inter-institutional effort was carried out through the International Network for Evaluation of Tropical Pastures (RIEPT), which operated over a 20-year period, from 1976 to 1996. The Network allowed Latin American institutions to share the germplasm of existing gene banks, study the performance of new germplasm under specific conditions and compare it with that in other sites of Latin America, and establish contacts to exchange scientific information and, as a result, extrapolate research results better (Toledo 1982).

Eleven grass cultivars, most of them belonging to genus Brachiaria, have been released since RIEPT was established in Latin America. These varieties are adapted to the adverse soil and environmental conditions of the tropics (CIAT 2003). Most grasses were released in the late 1980s and early 1990s.

The seed sector

The most abundant feed resource is native pasture. However, seed companies have been very aggressive during the last 12–14 years in promoting the adoption of improved grasses, especially of *Brachiaria*, because they are better adapted to local soil and geographical conditions. Because of growing conditions, more than 95% of the improved grasses in the seed world market belong to Brazil. All seed representatives in Nicaragua sell Brazilian grass seeds. Improved grass seeds can be obtained from all *Brachiaria* cultivars (i.e. *decumbens, dyctioneura, brizantha*, and *humidicola*) as well as the new *Brachiaria* hybrids (Mulato I and II).In addition, seeds from other improved grasses such as Panicum maximum (Mombasa and Tanzania cultivars) and *Digitaria decumbens* are sold.

The process of adopting pasture technologies is quite different from that of adopting crop technologies. The adoption and establishment of new pastures on farms is a long-term, highly complex decision that requires previous analysis and involves numerous biological and economic risk factors. The adoption of improved pastures requires a medium- to long-term investment, and many benefits are not seen immediately but over prolonged periods during which substantial changes may occur in economic (for example, price changes) and environmental (for example, pest, disease, and drought) conditions. The decision of whether to invest or not in improved pastures involves a high level of risk (Holmann et al. 2004).

Holmann et al. (2004) evaluated the adoption of improved *Brachiaria* grasses from 1990 to 2003 to estimate its impact in terms of animal productivity and income in Central America and Mexico, including Nicaragua. *Brachiaria* grasses dominate the market, accounting for 90% of seed sales during this period. Information on seed sales in the local market made it possible to estimate the areas planted and the value of additional milk and beef production attributable to adoption. For the current study, the author updated the information on seed sales until 2012 and estimated the new adoption rate and seed market growth rate.

Table 24 contains the amount of seed from improved grasses sold in Nicaragua from 2000 to 2012 and the estimated amount of improved pastures planted with the seed marketed. The seed market for improved grasses has grown dramatically since 2000, averaging more than 52% per year, reflecting the dynamics of the livestock sector, especially the export markets for both milk and beef, which have grown 21.9% and 17.4% per year, respectively, during the same period. Unfortunately, there is no information on the proportion of seed sales used by smallholder farmers.

Table 24. Amount of imported seed from improved grasses sold in Nicaragua during the period 2000 to 2012 and the estimated pasture area planted with imported seed

Year	Seed sold (t)	Seed annual growth rate (%)	New pasture area planted (ha) [1]
2000	6.7		1914
2001	16.4	144.8	4686
2002	27.3	66.5	7800
2003	63.8	133.7	18,229
2004	77.0	20.7	22,000
2005	100.3	30.3	28,657
2006	188.5	87.9	53,857
2007	404.8	114.8	115,567
2008	342.5	– 15.4	97,857
2009	231.1	– 32.5	66,029
2010	289.1	25.1	82,600
2011	220.3	– 23.8	62,943
2012	387.6	75.9	110,743
Total	2355.4	52.3	672,882

1. Assuming it takes 3.5 kg of seed to plant 1 ha of improved grass.

Source: Holmann et al. (2004); MAGFOR (2013).

Table 24 also shows that about 672,882 ha of improved pastures have been planted during this period, which represents more than 71% of the total amount of improved grasses found in the 2011 Agricultural Census of Nicaragua. This amount makes sense because not all improved grasses are planted through seed. Other improved grasses, such as African Star grass (*Cynodon nlemfuensis*), which was widely adopted in Nicaragua in the 70s and 80s, are planted using plant material from the same grass.

It is expected that the trend to adopt improved grasses will continue in the near future. Export markets for milk and beef are growing at an annual rate of 21.9% and 17.4%, respectively. In addition, two new dairy players will start buying fluid milk, putting pressure to increase milk prices that will benefit producers and will provide incentives for adopting forage-based technologies to increase milk production.

In terms of animal productivity, Table 25 contains the number of cows (both dry and in production) comparing the herd in 2001 with that in 2011 as well as the milk and beef production in those 2 years to empirically determine if there had been an increase in productivity per cow. Comparing 2011 versus 2001, the productivity of milk per cow decreased by 15.5%, but the productivity of beef increased by 66.4%, which means that producers preferred to produce more beef relative to milk during this decade. However, caution should be exerted when comparing these two productivities. The climate conditions could easily introduce bias into these results. It was not possible to obtain climate data (rainfall precipitation, solar radiation, daylight hours) for these 2 years because the Nicaraguan Institute of Meteorology provides these data only by selling them and there was no budget for this expense in this consultancy. When comparing the value of production per cow in these two periods of time, the value of production per cow was 18.1% higher in 2011 than in 2001 (USD 437.60/cow vs. USD 370.70/cow). Thus, the adoption of improved forage-based technologies that occurred during the last decade appeared to have gone to produce more beef than milk.

Table 25. Number of cows during the agricultural census of 2001 and 2011, amount of milk and beef production, productivity of milk and beef per cow, and value of milk and beef produced per cow using 2011 producer prices

Parameter	2001	2011	Change (%)
Number of cows			
In production	615,587	994,418	+ 61.5
Dry	315,977	526,050	+ 66.5
Total	931,564	1,520,468	+ 63.2
Parturition rate (%)	66.1	65.4	
National production			
Milk (million litres)	564.5	782.7	+ 38.7
Beef (t)	54,077	146,761	+ 171.4
Productivity per cow			
Milk (litres/cow peryear)	606.0	511.9	– 15.5
Beef (kg/cow per year)	58.0	96.5	+ 66.4
Value of production per cow[1]			
Milk	218.77	184.80	– 15.5
Beef	151.96	252.83	+ 66.4
Total	370.73	437.63	+ 18.1

1.Valued at producer prices received during 2011 equivalent to USD 0.361/litre of milk and USD 2.62/kg ofBeef.

Sources: MAGFOR (2002; 2012).

Cost of most used feed resources

Tables in annexes 3 to 9 contain the production costs for the establishment of the most commonly used forage-based technologies (improved and native pastures, hay, silage, sugarcane, and protein bank).These tables were then used to build Table 26 that contains a summary of the most common forage-based technologies in terms of nutrient availability (crude protein and metabolizable energy), the cost to produce a tonne of biomass, and the nutrient cost per unit of crude protein and metabolizable energy.

The most widely adopted forage technology is the improved grass, mostly from Brachiaria. More than 90% of seed sales during the last decade involved Brachiaria grasses. The use of crop residues is very common throughout the country, especially for resource-poor smallholder farmers during the 4-to-6 month dry season. Cattle lose weight with this diet, but the main objective here is survival. Farmers who plant sorghum or maize and do not own cattle sell their residues to small farmers. They usually charge about USD 6/head per month. The amount of biomass in 1 ha is about 1 t of crop residues on a dry matter basis, enough to feed a head of cattle for4 months, or about USD 24/ha worth of net income. This practice is very common in Nicaragua, especially for smallholders who do not have enough pasture to survive the dry season.

Adoption rates for other forage-based technologies, such as hay, silage, and cut-and-carry forages such as sugarcane and legume (protein) banks are unknown.

However, because of the costs involved in these technologies, one would expect hay to be the second most used forage technology after improved grasses because it is cheaper than the other forage-based alternatives.

Table 26contains a summary of the most common forage-based technologies in terms of nutrient availability (crude protein and metabolizable energy), cost to produce a tonne of biomass, and nutrient cost per unit of crude protein and metabolizable energy. As shown, the cheapest source of protein and energy in the rainy season is the improved grass. Nothing beats this technology, and it is the reason that its adoption rate keeps increasing. Another reason is the smaller labour requirement needed to control weeds compared with native grasses. The second option is native pasture during the rainy season. The per-unit protein cost of native pasture is very similar to that of improved grass (USD 2.42 vs USD 2.10/t), but it is 28% more expensive per unit of energy (USD 12.13 vs. USD 9.45/t).

The other forage-based technologies (hay, silage, and cut-and-carry options) are not used during the rainy season because they are expensive. It thus makes sense to use them only during the dry season. Comparing the dry-season options, the most profitable alternative from the protein-cost perspective would be to adopt corn silage and legume protein banks in cut-and-carry systems (i.e. USD 10.75 and USD 10.87/t, respectively).From the energy-cost perspective, the most profitable options for dry-season feeding would be supplementing cattle with sugarcane and hay (USD 25.86 and USD 26.63/t, respectively).Thus, feeding the herd with a combination of sugarcane and legume in cut-and-carry systems would provide smallholder farmers with the best cost-effective energy and protein alternatives for dry-season feeding. The problem with these alternatives is that they are relatively costly to produce (USD 255 and USD 57/t of dry matter biomass) compared with other forage-based resources and therefore, for resource-poor farmers, this might be a constraint to adoption.

The use of concentrated feeds is the most expensive option from the perspective of energy and protein cost and represents the least profitable alternative to producers.

Table 26. Nutrient availability and cost per unit of metabolizable energy (ME) and crude protein (CP) for different feeding systems in dual-purpose cattle farms in Nicaragua

Feeding system	Nutrient availability		Cost to produce 1t of dry matter(USD)	Nutrient cost	
	Crude protein (%)	ME(Kcal/kg dry matter)		USD per unit of CP	USD per unit of ME
Improved grass[1]					
Rainy season	9.0	2.00	18.9	2.10	9.45
Dry season	4.0	1.30	49.8	12.45	38.31
Native grass[2]					
Rainy season	8.0	1.60	19.4	2.42	12.13
Dry season	3.0	1.10	40.4	13.47	36.72
Hay	3.1	1.60	42.6	13.74	26.63
Corn silage	7.3	2.10	78.5	10.75	37.38
Legume protein bank[3]	23.5	1.70	255.35	10.87	150.20
Sugarcane	2.0	2.20	56.90	28.45	25.86
Concentrate feed	15.5	2.70	512.5	33.06	189.8

1. Brachiaria brizantha, unfertilized.
2. Jaragua grass (Hyparrhenia rufa).
3. Cratylia argentea.

Source: Adapted from Holmann (1999).


GRUPO RENACER
LACTEOS
NUEVA VIDA

Input and services:animal health

Organization, function, and structure of veterinary services

The animal health services operate under MAGFOR through the General Directorate for Livestock and Agriculture Health Protection (DGPSA, for its Spanish acronym). DGPSA is structured into six departments: Department of Disease Control and Epidemiology, Animal Quarantine, Farm Inspection and Traceability, Department of Genetics, Laboratory for Veterinary Diagnostics and Food Microbiology, and Laboratory for Chemical and Biological Residues (Cordon 2012).

The functions of DGPSA are to (a) promote, organize, monitor, coordinate, and execute activities related to animal health; (b) establish the basis and parameters for animal health laws and to supervise, certify, and verify its fulfilment; (c) enforce and monitor the prevention, control, and eradication of diseases, risk analysis, quarantine and control of movement of animals; (d) propose the normative aspects of animal health for importation, exportation, transit, and mobilization of live animals, and its control and monitoring; and (e) establish requisites for the introduction to the country of animal products, veterinary drugs, biological and biotechnological products, and chemical and food products for animal use and consumption.

In Nicaragua, there are 535 veterinary pharmacies and 66 private veterinary clinics officially registered in DGPSA. About 400 veterinarians work in the country, 140 of them in DGPSA and the remaining 260 in the private sector. Of the 140 vets working for the government, 25 of them do veterinary inspection in major slaughterhouses and 17 vets visit dairy plants.

However, according to the World Organization for Animal Health (OIE), the DGPSA had a performance index of 37% compared with 51% for the Central American region when the institution was evaluated in 2009.This meant that the institution was not capable of functioning properly and could not carry out all of its duties. There is no veterinary inspection in the more than 600 small artisan cheese factories, or in the estimated 3000 milk collection centres, or in the 266 small rural abattoirs. Thus, the risk of exposure to health hazards by the domestic population remains large. Likewise, there is no current mechanism in place between the public and private sectors to work together in common issues of strategic importance for producers, the public sector, and consumers.

This situation worried the government because Nicaragua was at that time negotiating a free trade agreement with the European Union and having an efficient plant and animal health service system was top priority. Since 2009, the Nicaraguan government has prioritized the implementation of OIE recommendations:

(1) In the area of trade, the DGPSA needs to (a) improve the quarantine system on borders with neighbours by establishing four new offices and one new quarantine facility with a new incinerator, increasing personnel, and improving technical cooperation at the regional level; and (b) develop and implement a bovine traceability system of international standards.

(2) In the area of animal health, (a) implement a program to eradicate brucellosis and tuberculosis, and (b) re-enforce the capability to rapidly detect animal health hazards, increasing the human resource network from 40

to 60 veterinarians and from 28 to 60 para-professionals, including the provision of transport and communication equipment.

(3) In the area of public veterinary health, (a) re-enforce pre- and post-mortem inspection mechanism for all animal species in all rural abattoirs, and (b) improve the system of drug registration.

(4) In the area of laboratory facilities and equipment, reduce the number of regional laboratories but increase the quality of equipment and the speed of results.

(5) In the area of regulatory services, develop a national program for continuous education for veterinarians and para-professionals.

The operating budget of DGPSA (the animal health component) in 2009 was USD 2.4 million and the recommended budget by OIE was USD 13 million. About 58% of this budget in 2009 came from donations and regional projects with a limited time span. Thus, this budget was insufficient and unsustainable (Cordon 2012). Currently, there is a loan provided by the Inter-American Development Bank (IDB) to the Government of Nicaragua to implement the recommendations of OIE by investing in critical aspects where DGPSA needs improvement.

Major diseases and their control

Major diseases in Nicaragua include brucellosis, tuberculosis, piroplasmosis, anaplasmosis, and mastitis. Table 27 contains the economic estimates of the damage of these diseases at the national level (Cordon 2012), which account for about USD 20 million per year.

Serological screening is done with cattle in dual-purpose farms for brucellosis and tuberculosis as their milk is bought by dairy plants that export milk and other dairy products.

Other diseases such as anthrax, black leg, and hemorrhagic septicemia have been reported in the country and are effectively controlled through prophylactic vaccination.

Bovine leukosis is a commercial disease prevalent in the country but with little or no impact in productivity and it has no official control campaign in the country.

Another disease that has been reported in Nicaragua is infectious bovine rhinotracheaitis (IBR), a highly contagious, infectious disease that is caused by bovine herpesvirus-1 (BHV-1). In addition to causing respiratory diseases, this virus can cause conjunctivitis, abortion, encephalitis, and generalized systemic infections. IBR was originally recognized during the early 1950s in feeder cattle in the western United States. The IBR virus can persist in clinically recovered animals for years. The virus remains inactive until the animal is placed under stress.

Table 27. Estimates of economic damage at the national level on a yearly basis caused by major bovine diseases

Product	Disease			
	Brucellosis[1]	Tuberculosis[1]	Piroplasmosis andanaplasmosis[2]	Mastitis[3]
	(USD million)			
Milk	7.31	0.52	NA	0.66
Beef	0.61	4.1	NA	NA
Live animals	1.05	0.51	4.91	NA
Total	8.95	5.35	4.91	0.66

Source: Cordon (2012).

Beef traceability program

This program constitutes a main challenge not only to the Animal Health Department of DGPSA but to MAGFOR as well. It represents an opportunity for Nicaragua to demonstrate its capacity to produce beef under safe conditions based on individual identification of animals. Nicaragua has already signed a free-trade agreement with the European Union and this program is a requisite before EU buys beef from Nicaragua at prices 20–25% higher than those paid by the United States.

The establishment of this program should be viewed not only as an opportunity to sell beef to other markets at a higher price but also to effectively control animal diseases.

This program started in 2006 with the approval of a law to implement it through a pilot project in three municipalities involving1500 producers and 104,000 head of cattle (DGPSA 2006).This pilot project was used to fine-tune the methodology to implement the program. Later, in 2010, with financial help through a USD 3 million loan from the Inter-American Development Bank, the program continued to expand to other areas of the country. Currently, there are 820,000 head of cattle identified (about 20% of the national herd inventory) in about 44,500 registered farms (about 33% of the farms with cattle).The goal is to have the traceability program fully implemented by 2017 (Juan Carlos Miranda, Traceability Program head, pers. commun.).The successful implementation of the program necessitates the participation of three actors: (a) the government, through DGPSA; (b) the cattle producers; and (c) the slaughterhouses.

Each producer should register his or her farm in the corresponding municipality to obtain a unique code as well as all calf births in order to get an ID for each animal corresponding to that particular farm. The cost of the ID per animal varies between USD 2 and USD3/head and is paid by the producer .Personnel from DGPSA go to the farm to tag the born animals .DGPSA records the farm, the owner, the breed of the animal, and the birth date. If the animal is sold at weaning, the producer has to report the sale to the municipality and another tag is placed in the ear of the animal with information of the new owner. All future transactions involving the same animal are recorded in the same way until the animal reaches the slaughter house. The meat-packing plant keeps a record of all animals slaughtered, the amount of beef obtained from each animal, and the destination of the products from each animal.

Food safety

There are safety concerns about food of animal origin. One major risk comes from pathogens, which can come from the animal itself (zoonosis), from the product (beef), or from food contamination during slaughtering. Other risks involve substances that are utilized in animal production (veterinary products or stimulants for growth and for milk production), which could leave residues. Finally, risks could also come from other contaminants, such as preservatives, disinfectants, or contaminated water, during the process of processing, transport, and marketing.

The majority of establishments for food processing and markets in Nicaragua rarely meet the sanitary standards required by the Ministry of Health (Marvin Rodriguez, head, Animal Health Department, Ministry of Agriculture and Forestry, pers. commun.).Thus, gastrointestinal infections and intoxications from food poison occur as a consequence of lack of hygiene in the preparation and manipulation of food.

In the capital Managua exist about 7000 locals where food is manipulated; these are supervised by 57 hygiene inspectors from the Ministry of Health. The inspectors focus their efforts only in the 900 food outlets located in the nine main markets of Managua. Most food of animal origin in the majority of these outlets do not have adequate refrigeration and many facilities do not have cooling equipment. Thus, if meat is not sold and consumed on the same day, the risk of food poisoning is large. In addition, more than half of the milk produced in the country is sold unpasteurized. The Ministry of Health, even with the legal mechanisms to enforce procedures for registration of food and beverages and certification to operate and handle food products, lacks the budget and personnel to inspect most food outlets in markets, food distribution centres, and food processing facilities.

Food safety hazards in dairy products

The main bacterial problem detected by the National Laboratory for Veterinary Diagnosis and Microbiology of Foods is Staphylocias, produced by *Staphylococcus aureus* (Cordon 2012), which is a type of bacteria commonly found in the skin and hair as well as noses and throats of people and animals. These bacteria are present in up to 25% of healthy people and are even more common among those with skin, eye, nose, or throat infections.

Staphylococcus can cause food poisoning when food gets contaminated and then it is not properly refrigerated. Other sources of food contamination include the equipment and surfaces on which food is prepared. These bacteria multiply quickly at room temperature to produce a toxin that causes illness. *Staphylococcus* is killed by cooking and pasteurization.

Random tests of 1395 dairy products in 2009 showed that 7% of samples were contaminated by *Escherichia coli* (Cordon 2012), a bacteria that lives in the intestines of humans and other animals. Although most types of *E. coli* are harmless, some can cause bloody diarrhoea, kidney failure, and even death.

Another public health problem is the use of preservatives in milk, which is common among cheese processors, such as formalin, a chemical added to milk to retain its freshness and prevent it from spoiling. It is a human carcinogen listed by the International Agency for Research on Cancer.

Food safety hazards in beef products

The main public health problem detected by the National Laboratory for Veterinary Diagnosis and Microbiology of Foods is cysticercosis. In 2009, veterinarians inspected more than 492,000 main slaughterhouses and found 2.5% of the samples with cysticercosis (Cordon 2012).Cysticercosis is an infection with a tapeworm at the larval stage (cysticerci). Inside the body, cysticerci can develop in a number of tissues such as the muscles, subcutaneous tissues, eyes and brain; those that are located in the central nervous system cause neurocysticercosis, the most severe form of the disease. Humans become infected when they consume undercooked beef. Most infections result in dizziness, abdominal pain, diarrhoea, headache, and nausea.

Input and services:Genetic improvement

The national livestock herd of Nicaragua is composed mainly of B. indicus genes, mostly from the beef breed Brahman. It is estimated that about 60% of the herd has Brahman genes (Denis Salgado, general manager, Albagenetica, pers. commun.). Another special breed present in the country is Angus, which has been recently used in crossbreeding schemes with Brahman to produce Brangus, but its population is extremely small (i.e. less than 0.1%).Common dairy breeds include Brown Swiss, Holstein, and Jersey, but, like the Angus breed, these are used mostly in crossbreeding schemes with the local cow population.

Breeding practices

As mentioned earlier in the document, most livestock herds in the country use the dual-purpose production system based on forage-based pasture technologies. Thus, cows spend most of the time grazing. The most common breeding practice is to have breeding bulls all the time with the cows under grazing conditions. The cow–bull ratio is about 20 to 25 cows per breeding bull. This ratio ensures an annual pregnancy rate of about 65%, which is the country average. Some specialized dairy or beef herds that use artificial insemination (AI) have breeding bulls in confinement and use them as a last resort when the AI use on a particular cow does not work.

As a breeding practice, most producers try to maintain a genetic makeup as close to an F1 as possible that is, they would use either F1 bulls (i.e. Holstein × Brahman) on the breeding herd or they would use beef bulls (i.e. Brahman bulls) on breeding cows that have more than 50% dairy genes or vice versa (i.e. use dairy bulls on cows that have more than 50% genes from beef breeds). The rationale behind this practice is to have an F1 animal that has enough genetic potential to produce milk as well as beef. Most smallholder farmers cover operating cost from the sale of milk and net profit is obtained when they sell weaned calves or cull cows.

Use of artificial insemination

Sixteen companies in the country sell semen, mostly from proven sires, which are all privately owned. Available semen include those from Brahman, Angus, Brown Swiss, Holstein, Jersey, Nellore, and Guzerath. Semen from synthetic breeds include Siboney from Cuba (which is 5/8 Holstein and 3/8 Brahman) and Gyr Holando (5/8 Holstein and 3/8 Gyr). The cost of most semen varies from USD 7 to USD 12/straw.

Currently, the government, through MAGFOR, has no livestock improvement strategy or policy. In fact, there has never been a genetic improvement strategy at all. However, since 2007, efforts have been made through Albagenetica, a private corporation that receives para-fiscal funds from the governments of Nicaragua and Venezuela to promote the use of AI by subsidizing the cost. Albagenetica also produces semen from local sires with pedigrees for the domestic market and also imports semen like the other 15 private companies based in the country.

Albagenetica began to promote the use of AI in 2007.At that time, it was estimated that less than 1% of the cow population was served by AI. During the last 6 years Albagenetica has made a significant effort to increase AI use,

creating 60 groups, which, on average, have eight producers per group. Albagenetica trains one producer in each group in the use of AI (as an inseminator) and provides each group with a semen tank plus all the required supplies (nitrogen, semen, plastic gloves, etc.).About 40,000 cows are currently under the AI program of Albagenetica, which represents about 2.7% of the total cow population in the country. It is estimated that the other 15 private companies serve about 60,000 cows for an estimated total of 100,000 under AI programs (Denis Salgado, pers. commun.).This amount is equivalent to 6.7% of the cow population and the goal in the next 5 years is to reach 15% of total population.

Input and services: knowledge systems

Knowledge about new livestock production technologies and management innovations are generated by several actors in Nicaragua:(a) the Nicaraguan Institute of Agricultural Technology (INTA); (b) five universities: Universidad Nacional Agraria (UNA) in Managua, Escuela Internacional de Agricultura de Rivas (EIAR), Universidad Católica del Trópico Seco (UCTS) in Estelí, Universidad Nacional Autónoma de Nicaragua (UNAN) in Leon, and Universidad de Ciencias Comerciales (UCC) in Managua; and (c) technical schools called CETAs (Centros de Enseñaza Técnicos Agropecuarios), which are distributed among the 16 states that conform to the political system of the country. INTA has collaborative agreements with most of them and this cooperation is usually through internships and bachelor theses from students in animal science and veterinary faculties that these local centres and universities have.

INTA does not do research in agriculture. Its mandate is to adapt technology generated by other centres and adapt them to local conditions and transfer this knowledge to farmers (Luis Urbina, director for livestock research, INTA, pers. commun.).INTA is a government institution that has collaborative agreements with an international research centre, CIAT (International Research Center for Tropical Agriculture), a regional research centre, CATIE (Tropical Agronomical Center for Teaching and Research), and three foreign national agricultural research centres (EMBRAPA from Brazil, INTA from Argentina, and INIFAP from Mexico).

The agreements with INIFAP and INTA deal mostly with training of professionals in the fields of statistical analysis, crop and livestock production, and extension. The agreement with EMBRAPA is about exchange of forage germplasm and seed multiplication, whereas that with CIAT is broad, covering research adaptation in cassava, rice, beans, land use systems, and forages. Current collaborative research is about (a) *Brachiaria* genotypes of *humidicola* and hybrids adapted to poorly drained soils; and (b) adaptation of the Quesangual system (agroforestry systems with crops and livestock,) measuring the effect of trees on soil micro- and macrofauna, crop and livestock production, carbon sequestration, and gas emissions (Ing. Luis Urbina, director for livestock research, INTA, pers. commun.).

In several priority-setting exercises with smallholder farmers, the most important bottleneck for increased livestock production has been the low quality and quantity of feed resources during the 4-to-6-month dry season. Thus, INTA has prioritized the adaptation of forage-related technologies and its effect on animal nutrition, especially during the dry season. Thus, most activities of INTA personnel, both in adaptation and technology transfer, have centred around the evaluation of improved grasses for direct grazing, hay and haylage making, cut-and-carry systems, and silage.

The 2011 Agricultural Census indicated that 17.5% of farms received agricultural and forestry technical assistance and/or training. Most of these activities (60.39%) were developed by government institutions (Ministry of Agriculture and Forestry, INTA, IDR, INAFOR).Cooperatives and NGOs developed 37.45% of the total activities (Ortega et al. 2013).

From a gender perspective, data from the 2011 Census revealed that only 22.4% of all women producers have received technical assistance/training. According to a Nitlapán (UCA) study, technicians (usually men) from public or private entities tend to ignore women who exercise more farm-level administrative functions, assuming that they do not have enough knowledge on livestock. This attitude and stance from technicians come from a male perspective that only recognizes other men as equal (Flores et al. 2011).

INTA´s Re-structuring

INTA´s budget for livestock-related activities during 2013 was about USD 320,000.Half of this budget went to salaries and the remaining half for operations. About 50% of this budget comes from the government and the other 50% from special project funding. Personnel from INTA engaged in livestock technological adaptation and innovation activities are composed of 20 professionals (five veterinarians and 15 animal scientists). Six of these professionals have MS degrees and the remaining 14 have BS degrees. All of these professionals are male, even though the government passed a law where at least 35% of professionals working in government agencies must be females.

Until 2013, INTA´s mandate had been on adaptation of technology developed by other centres and transfer of this knowledge to farmers. This transfer of technology was made through 150 extension agents working not only in livestock but also in crops and seed multiplication as well. Each of these extension agents worked with 10 to 12 agricultural promoters, and each promoter worked with 10 producers. An agricultural promoter is generally a producer with leadership qualities in charge of facilitating the transfer of knowledge to other farmers within the community. This methodology appears to be efficient. Other NGOs, such as Technoserve and Catholic Relief Services (CRS), who currently are executing agricultural projects in the country, are using the same methodology to reach smallholder farmers.

This mandate changed in 2014.Now, INTA will not do transfer of technology, only adaptation and innovation of agricultural technologies. The transfer of technology will now be made by a new government entity called the Ministry of Family Economy, Peasantry, and Agricultural Cooperatives (MEFCCA).It is expected that this new institution will work in close cooperation with INTA and the current extension agents working now for INTA will be transferred to MEFCCA.

Input and services: credit

The provision of credit in Nicaragua is all private-sector led. No lines of credit are allocated by the government to promote agricultural-related activities. The major actors providing credit to agricultural (and livestock) producers at the moment are three private financial institutions: Fondo de Desarrollo Local (FDL), ProCredit, and Bancentro.

The credit crisis

In the past, prior to 2008, there were more players involved in the provision of credit. However, the government started a campaign in 2009 to encourage farmers who had obtained credit loans not to pay them. This campaign started at the same time the world financial crisis was at its peak and most commodity prices had plummeted, affecting negatively most local prices of agricultural products as well (Manuel Bermudez, credit manager, FDL, pers. commun.). This event caused a major disruption in the banking system, which provided agricultural credit. A bank (Banex) even went broke as a result of this government-led campaign because its borrowers did not pay. As an example, FDL had allocated in 2009 more than USD 28 million in credit to the agricultural sector and lost USD 10 million between 2009 and 2010 in loans that producers did not pay back, not even after loan re-structuring.

As a result, the provision of credit to agricultural producers has significantly been reduced since 2009. It is estimated the number of clients decreased by 55–60% (Manuel Bermudez, credit manager, FDL, pers. commun.). In addition, the three private banks that continue to provide credit to farmers have modified the conditions to receive credit, the two most important modifications being:

(a) Frequency of payments. Before 2009, a producer who receives a credit loan for steer fattening could pay the loan at the end of the cycle (i.e.18 months). Now, banks oblige them to pay interest every 6 months and the principal at the end of the 18-month cycle. According to lenders, this might reduce the risk of default. In the case of cow–calf operations, which are usually covered by a 2-year loan, banks are making producers pay monthly interest using the income producers receive from the sale of milk.

(b) Provision of technical assistance. After the 2009 credit crisis, financial institutions started to create their own units of technical assistance (TAU) to reduce the risk of default. Now, credit application is accompanied by a visit of an animal scientist or veterinarian to the farm, along with the credit officer, to evaluate with the producer the purpose of the loan and to estimate the capacity to repay it. If necessary, the vet can recommend an adjustment in the credit application to include a technological component that will help the producer to increase production or productivity and thus, reduce the risk of default. In addition, periodic visits are now made by TAU staff to make sure that credit is being used following the initial agreement and that production targets are being met.

Livestock producers receiving credit

The number of livestock producers who obtain credit is very small in Nicaragua. Of the estimated 136,687 producers who own cattle during the 2011 National Agricultural Census (CENAGRO 2012), only 4777 producers availed of

livestock-related loans (about 3.5% of producers) (Table 28). In contrast, about 27.3% of producers received credit for crop-related activities, almost eight times more than for livestock-related activities (CENAGRO 2012).This difference is mostly due to the fact that credit for crop-related activities is short-term (i.e. for the duration of the crop, usually 4 to 6 months). Credit allocated to livestock producers vary from 18 months for steer fattening to more than 2 years for cow–calf operations. Banks prefer to lend money for the short term. In addition, livestock farms that received credit in 2011 varied by farm size. The number of farms below 13.70 ha proportionately received less credit than those with more than 13.7 ha and this proportion increased as farm size got larger (Table 28). Thus, there was a higher probability to obtain credit if the farms were larger.

Table 28. Number of livestock producers who received credit in 2011, by farm size

Farm size (ha)	Number of producers who received credit	Total number of livestock farms, by farm size	Proportion of livestock farms which received credit, by farm size (%)
< 0.35	204	5183	3.94
0.35to0.69	67	3286	2.04
0.70to1.69	127	10,009	1.27
1.70to3.39	162	13,785	1.18
3.4to6.79	266	17,768	0.15
6.80to13.69	493	20,292	2.43
13.70to34.19	1096	30,869	3.55
34.20to68.49	1026	19,053	5.38
68.50to136.99	760	9995	7.60
137to342	445	5041	8.83
> 342	131	1406	9.32
Total	4777	136,687	3.49

Source: CENAGRO (2012).

The lack of credit is one of the biggest problems faced by the Nicaraguan livestock sector, especially for women dedicated to this area of production, probably because it is still considered an activity for men (Agurto and Guido 2005). The data presented by FIDEG (International Foundation for Economic Global Challenge) in 2005 show a great gender gap in terms of credit. In fact, in 2004, from the total amount of credit for the livestock sector, 98% was received by men and only 2% by women. Furthermore, women, who represent 23% of the farmers, only received 15% of agricultural and livestock credit. Men, in turn, got 84% (CENAGRO 2012).

Credit conditions and risks

The nominal interest rate for agricultural loans is 24% per year. With an inflation rate of 7% in 2013, the real interest rate is about 17%, which is very high. International lending rates are about 3–4% a year in real terms (Manuel Bermudez, credit manager, FDL, pers. commun.).FDL is currently the largest lender of livestock money to smallholder farmers in Nicaragua, with around 2500 clients (about 52% of the credit is allocated to the livestock sector).

The most common amount of credit given to smallholder livestock farms by FDL varies between USD 2000 and USD 5000, and the most frequent client is a farmer who owns about 20–30 head of cattle. The risk of default (or getting behind on payments) in this group is about 4%.As the number of farmers gets larger, the risk factor remains unchanged. However, the risk factor increases to about 8% when livestock farmers own between 8 and 20 head of cattle because these producers also depend on crops for their livelihood and the risk of crop failure from lack of rainfall increases. The subsistence livestock farmers (i.e. those who own 6–8 head) have the largest risk factor, about 25%, with an average loan amount of USD 930, because of the fact that they depend mostly on cash crops for their survival.

With the TAUs of the three financial institutions operating smoothly, it is expected that the risk factor would be reduced, which, in turn, may encourage other financial institutions to start lending to agricultural producers again.

Competitiveness

Competitiveness of the milk value chain

There is very little up-to-date information on production costs and profit margins across the milk value chain. Available data are from 2003 (IICA 2004) and 2007 and these are related to only on-farm production costs. In 2003, the total cost of producing a litre of milk at the farm level was USD 0.231 and the mean producer price paid during that year by the industry was USD 0.274 for a profitability of 18.6%.In that same year, the international price for milk paid to producers in New Zealand, which has the most competitive dairy industry in the world, was USD 0.255/litre.

Likewise, when analysing the producer price for milk paid in Nicaragua and comparing this to the price paid to producers in New Zealand for extended periods of time (Table 10), the average milk price in Nicaragua during the period 2000 to 2012 had been USD 0.302/litre compared with USD 0.402/litre in New Zealand. In addition, milk prices paid to producers in neighbouring countries are also higher than those paid in Nicaragua. For example, in 2012, producers in Costa Rica received about 18% higher milk prices than milk producers in Nicaragua; in El Salvador, 38%; in Guatemala, 15%; and in Honduras, 12% (SIECA 2013).

Another empirical evidence for estimating how competitive an industry is could be gleaned from export/import data. As described previously in Table 16, dairy exports from 2000 to 2012 have increased at an annual rate of 21.9%. Imports of dairy products represented less than 3% of total domestic production and dairy exports represented about 49% of total production in 2012. Thus, Nicaragua is a net exporter of dairy products.

Estrada and Holmann (2008) estimated the competitiveness of smallholder farmers in Nicaragua in 2007. The analysis indicated that smallholder dual-purpose production systems were competitive if the social price of milk was more than USD 0.270/litre. Under the assumption that the average powdered whole milk price is going to be USD 3000/t for the next 5 years, the social price for rehydrated milk at the plant was about USD 0.400/litre. At this price, all of the pasture-based systems analysed (both dual-purpose and specialized ones) were competitive. The average profitability of the system (annual net revenues divided by capital invested) was 5.1%, with few cash surpluses available for bringing about a process of modernization in dairy production. Given that the net revenues from the system were very low, there will be limited cash surpluses unless producers modernize their cattle- and/or milk-production systems. Therefore, the required investment would have to come from outside the sector.

Thus, in spite of the competitiveness of smallholder dual-purpose farms in Nicaragua and the potential for increasing yields, the analyses by Estrada and Holmann (2008) suggest that current production systems are not capable of generating sufficient surpluses to make necessary investments in refrigerated tanks and in the planting of forage for dry-season feeding. These investments are costly but can be depreciated over long periods and therefore do not affect significantly total costs (even though they have an important component of tradable goods). The limiting constraint in 2007 was the availability of capital for making the change, and the revenues of the current system did not allow for this (Rivas and Holmann 2005).

Although the potential exists for increasing and solidifying the competitiveness of these systems, credit loan institutions and/or the government need to make efforts to make these investments possible. The fact that these investments are recovered in the following 4 years should make a good argument for promoting them.

As mentioned before in section 6.2, in 2014, two large players will come into play in the milk value chain: the Lala Mexican group and the Dos Pinos cooperative of milk producers from Costa Rica. They are expected to buy significant amounts of fluid milk from domestic producers. To achieve this, investments in new cooling networks will need to be made by the private sector to collect additional milk. This, in turn, will motivate producers to increase milk yields through the adoption of improved forage-based technologies, but it will require financial institutions to provide credit for adoption to take place. In addition, the government will have to improve the rural infrastructure, especially through the construction of new roads and providing electricity.

Competitiveness of the beef value chain

Like the case of the milk value chain, there are no up-to-date information on production costs and margins across the beef value chain. The latest figures are from 2002 (Table 29).As shown, the highest benefit–cost ratio (BCR) across the value chain belongs to the steer fattener, followed by the slaughterhouse, then by the intermediary, and last by the retailer. Overall, the beef value chain has a BCR of 1.93, which is very good. However, this table does not include information on gross margins and costs of the cow–calf operations, only about the steer fattener. Holmann et al. (2008) found in Costa Rica that steer fattener operations were more profitable than cow–calf operations. Thus, information about the producer´s BCR might be misleading and overestimated.

Table 29. Cost structure of the beef value chain in Nicaragua during 2002

Value chain actor	Gross margin	Cost	Net margin	Benefit–cost ratio
		(USD/kg carcass)		
Steer fattener	1.958	0.814	1.144	2.40
Intermediary	0.021	0.014	0.007	1.50
Slaughterhouse	0.589	0.364	0.226	1.62
Retailer	0.477	0.387	0.090	1.23
Total	3.045	1.579	1.467	1.93

Source: Schutz et al. (2004).

After interviewing several actors of the beef chain, which included producers, slaughterhouses, government officials, and personnel from the beef export chamber, the main conclusions about the beef value chain are as follows:

(a) Producers do not have access to technical assistance. The associations of producers or cooperatives have not filled this vacuum. Many of these organizations are politicized or are being used by their representatives to secure political positions. On the other hand, the government, through MAGFOR, does not have a strategy for the livestock sector.

(b) Producers do not have access to credit that would enable them to adopt new technologies to increase beef production but which require a significant amount of capital that they do not have. The government started a campaign during 2009 to encourage farmers who had obtained loans not to pay them. As a result, provision of credit to agricultural producers has since then significantly declined.

(c) Competition to reach consumers is becoming a fierce battle between slaughterhouses and supermarkets. Now, supermarkets are creating their own enterprises to provide themselves with products such as fruits, vegetables, and beef. Thus, they are buying directly from steer fatteners and avoiding intermediaries. This is good from the viewpoint of animal welfare because animals go directly from the farm to the slaughterhouse and avoid the trauma of frequent transportation. This also facilitates the traceability of animals and reduces transaction costs. In addition, supermarkets are developing contracts with groups of producers in order to obtain beef with certain qualities that consumers are demanding but which require better feeding and breeding practices.

(d) Likewise, all export meat-packing plants are creating their own retail distribution channels to receive part of the profits that retailers obtain and, like supermarkets, are making strategic alliances with groups of producers to reach consumers with different qualities and price differentiation. In addition, the export slaughterhouse

> MACESA has bought a farm and fattens 9000 steers annually, slaughtering them during the period January to March when supply of beef is lowest. MACESA buys these animals from smallholder farms but specifies certain characteristics (F1 Brahman–Angus with a 180–200 kg weight at 1 year old).To achieve this, producers need to have in place a good forage-based feeding system with improved grasses during the rainy season and with a sound feed strategy during the dry season, which includes cut-and-carry legumes and hay from improved grasses.

These events will gradually eliminate the intermediaries. As supermarkets and slaughterhouses try to reduce transaction costs by reaching the producer directly, it is hoped that smallholders will benefit by receiving technical assistance and probably credit lines to adopt new forage-based and breeding technologies to improve beef quality.

Externalities

Livestock production growth has, until now, been almost purely private-sector driven. There has been limited supporting public sector/public good investments/actions. This has resulted in significant negative externalities. In the environment, this investment imbalance has contributed to major land degradation, biodiversity erosion, water pollution, and greenhouse gas emission. In public health, the livestock subsector has become a major source of public health risks, such as bovine spongiform encephalopathy or mad cow disease. Unless there are sufficient mitigating public policies and investments, these adverse impacts would likely continue to manifest themselves. Currently, there are none.

Livestock are considered a way out of poverty for poor smallholder farmers in the developing world. The production of livestock in grazing, dual-purpose systems in Nicaragua generates both positive and negative impacts on the environment. This creates a challenge to promote livestock production systems which can concurrently provide economic benefits that foster social development while ensuring environmental sustainability.

The main negative environmental impacts caused by dual-purpose, grazing production systems are on soil, water, biodiversity, landscape, and air (Silvestri et al. 2012).Negative impacts on soil are erosion, compaction, and degradation as a result of overgrazing, especially on hillside areas, including soil fertility loss. The main negative impact on water is decreasing infiltration as a result of overgrazing and soil compaction. The negative impact on biodiversity is the loss of flora (as a consequence of overgrazing), which leads to a change in plant composition: annual plants, with less nutritive value as fodder, become more abundant; palatable species disappear. Major negative impacts on landscape and air are (a) deforestation and fragmentation of native ecosystems; (b) overgrazing, which allows for less accrual of carbon; and (c) releases to the atmosphere of carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O).

The establishment of schemes of payments for environmental services (PES) would be of strategic importance in reversing or mitigating these negative impacts. ILRI can play an important role in designing such schemes.

Livestock sector development strategies and activities

The government of Nicaragua, through MAGFOR, is currently launching a major livestock development program called 'Program to Improve the Competitiveness of the Livestock Sector' (IICA 2012). The document program is currently under preparation and it is expected to be ready in 2014. The document sets up the government strategy for the livestock sector for the next decade. The program has four objectives:

(1) Increase the productivity of milk and beef per animal and per hectare through the establishment of improved grasses and legumes;

(2) Mitigate environmental degradation by reducing greenhouse gas effects of the livestock herd and carbon sequestration through the promotion of silvopastoral systems, which include improved grasses, shrub legumes, and trees;

(3) Improve milk and beef quality and safety along the milk and beef value chain; and

(4) Reduce rural poverty by generating employment and provision of services to the livestock sector along the milk and beef value chains.

In addition, the program contemplates the coordination of the efforts currently being executed in the livestock sector by NGOs (which provide technical assistance and credit), international cooperation agencies, and private companies such as dairy plants, slaughterhouses, and semen and forage seed providers.

To meet these four objectives, the program will focus on four components: (a) support services; (b) credit; (c) animal health; and (d) environment.

(a) **Support services.** The purpose of this component is to elaborate a proposal to strengthen (1) the capacity of local farmer organizations to provide technical assistance and training to small and medium-sized farmers, especially in the field of pasture improvement, dry-season feeding, animal nutrition, mineral supplementation, silvopastoral systems, animal health management, and genetic improvement strategies; and (2) the collaboration among public institutions with other actors of the civil society and international cooperation agencies working in the livestock sector to maximize the use of human and financial resources to achieve the common goal of improving the competitiveness and well-being of smallholder dual-purpose farmers.

(b) **Credit.** The rationale for this component is that farmers who own cattle have low access to credit. In addition, credit is only short term and the bottleneck is long-term credit for needed investments such as pasture establishment and acquisition of animals to increase stocking rate in the short term .Likewise, the real interest rates of lending agencies are extremely high, making the credit financially unsustainable. Thus, this component will develop and propose a line of credit with a value chain approach considering all actors from production to processing. This component will propose financial products by production system, herd size, and actors

along the milk and beef value chain, with emphasis on the expected return of the investments proposed and appropriate real interest rates and payment conditions.

(c) **Animal health.** The objective of this component is to reorganize and strengthen the technical and administrative structures of DGPSA, the Animal Health Division of MAGFOR. This objective will be met by the modernization and establishment of new laboratories and the elaboration of a disease map to establish epidemiology monitoring and to increase animal health inspections and quarantine in country borders, sea ports, and airports. In addition, this component will accelerate the establishment of a beef traceability system previously described in this document.

(d) **Environment.** This component is about identifying interventions that cause a negative impact on the environment in order to design mechanisms to mitigate these impacts. These interventions include the construction of new roads, farm expansion at the expense of forest, farm waste, and processing waste as a result of rural artisan cheese making, and blood contamination from slaughtering animals in rural abattoirs. At the farm level, the component will focus on the mitigation of environmental degradation by reducing greenhouse gas effects of the livestock herd and carbon sequestration through the promotion of silvopastoral systems that include improved grasses, shrub legumes, and trees.

R&D partnership landscape

Because of its small size, Nicaragua does not have the capacity to do strategic or adaptive research. Its strategy has been to make strategic alliances with regional (i.e. CATIE) and international agricultural research centres (i.e. CIAT, CIMMYT) as well as centres from large Latin American countries such as INTA from Argentina, EMBRAPA from Brazil, and INIFAP from Mexico, whose human resource capacity and resources are greater and better than INTA´s. In the specific agenda for livestock research, INTA has prioritized the adaptation of forage-related technologies and its effect on animal nutrition, especially during the dry season. Thus, most activities of INTA´s personnel have centred on the evaluation of improved grasses for direct grazing, hay and haylage making, cut-and-carry systems, silage, and silvopastoral systems.

In addition, there are many NGOs working in Nicaragua in livestock development, providing technical assistance to smallholder farmers. Such is the case of Technoserve and Catholic Relief Services (CRS) from the United States. These NGOs serve as a 'bridge' between smallholder farmers, local livestock associations, and government institutions to supply the much-needed technical assistance that the government cannot meet. It is expected that this strategy will continue in the next decade.

Current perspectives on opportunities for pro-poor value chain development R&D

Although both history and theory suggest a preeminent role of agricultural growth in poverty reduction in poor agrarian economies, such growth today faces new difficulties. Many of these difficulties are endogenous to today's poor rural areas, others result from broader processes of global change, but some are due to changes in the dominant policy environment, emphasizing liberalization and state withdrawal. An examination of the 20th century Green Revolution suggests that active state interventions were important in supporting critical stages of agricultural market development (Dorward et al. 2004).

Nicaragua is very competitive in terms of beef export prices and this is reflected in the export growth rate the beef sector has been experiencing. During the period 2000 to 2012, beef exports increased at an annual rate of 17.4%. In addition, the value of beef per tonne exported also increased during the same period, at 6.6%, thus reflecting a value-added additional gain. Likewise, dairy exports have increased at an annual rate of 21.9%, showing great dynamism. However, milk producers were capturing more than 63% of the final price paid by consumers in 2000 and this proportion has been steadily decreasing throughout the last 12 years, capturing less than 42% of the final price by 2012.These figures suggest that other actors across the milk value chain (processors, distributors, retailers) are obtaining a greater piece of the pie relative to a decade earlier. If these differences are not translated into better services to producers (i.e., technical assistance, more credit), then it could be a major bottleneck that might affect the competitiveness of the entire milk value chain. A good research question for ILRI is: What is the impact of increased beef (and milk as well) exports on the welfare of the value chain actors, including consumers? Increased exports obviously benefit exporters (meat-packing plants, dairy plants, and artisan cheese exporters), but what impact does this have on local demand for animal protein as well as the proportion of final product price retained by producers?

Women play an important role in these dual-purpose production systems, especially when men take on seasonal off-farm work (for example, to harvest sugarcane and pick coffee), and women are left to perform the tasks of milking, taking care of the livestock, and manufacturing artisan cheeses. Furthermore, on many of the small farms, women are the head of the household. Unfortunately, there is no information or statistics related to the role of women in livestock-related activities. An important research question for ILRI´s gender program is: what is the role of different family members in livestock-related activities in order to design technological interventions?

Conclusions

This study describes and analyses the dual-purpose (beef and milk) bovine value chain in Nicaragua: its structure, actors, performance, constraints during the last decade, and the opportunities it faces in the near future. These are the highlights from the study:

(1) The main constraints faced by small farmers at the farm level are (1) low productivity caused by (a) low feed and forage availability and quality, especially during the dry season; (b) lack of control and preventive measures against diseases and parasites; and (c) low genetic potential; and (2) absence of basic infrastructure (milking facilities, fencing, water supply).At the supply chain level, small farmers face these major constraints: (1) low credit availability; (2) poor public infrastructure (energy, roads, water); and (3) weak market access for products caused by (a) low milk and beef prices due to seasonality and abundance of intermediaries, thus creating more transaction costs along the value chain by capturing a lower price, and (b) low incentives for quality improvement.

(2) The most important livestock production system is the dual-purpose. Most dual-purpose farms are small. More than half of the national herd (i.e. 51%) is in the hands of farmers who own less than 10 ha. Total herd size is 4.14 million head of cattle in the hands of 136,687 producers, with more than 75% of income being generated by milk sales.Women play an important role in these production systems, especially when men take on seasonal off-farm work, for example, harvesting sugarcane and picking coffee, and women are left to perform the tasks of milking, taking care of livestock, and manufacturing artisan cheeses. Furthermore, on many of the small farms, women are the head of the household. Unfortunately, there is no information or statistics related to the role of women in livestock-related activities. An important research question for ILRI´s gender program is what is the role of different family members in livestock-related activities in order to design technological interventions?

(3) Livestock production growth has, until now, been almost purely private-sector driven. There has been limited supporting public sector/public good investments/actions. This has resulted in significant negative externalities. In the environment, this investment imbalance has contributed to major land degradation, biodiversity erosion, water pollution, and greenhouse gas emission. In public health, the livestock subsector has become a major source of public health risks, such as bovine spongiform encephalopathy or mad cow disease. Unless there are sufficient mitigating public policies and investments, these adverse impacts would likely continue to manifest themselves. Currently, there are none. The establishment of schemes of payments for environmental services (PES) would be of strategic importance in reversing or mitigating these negative impacts. ILRI can play an important role in designing such schemes.

(4) The amount of livestock producers receiving credit is very small in Nicaragua. During the 2011 National Agricultural Census, only 4777 producers received credit for livestock-related loans, or about 3.5% of producers. In contrast, about 27.3% of producers received credit for crop-related activities, almost eight times more than for livestock-related activities. This difference is mostly due to the fact that credit for crop-related activities is short term (i.e. for the duration of the crop, usually 4 to 6 months). Credit allocated to livestock producers vary from 18 months for steer fattening to more than 2 years for cow–calf operations .Banks prefer to lend money for the short term. In addition, livestock farms that received credit in 2011 varied by farm size.

The number of farms below 13.70 ha received proportionately less credit than farms which had more than 13.7 ha and this proportion increased as farm size got larger. Thus, there was a higher probability to obtain credit if farms were larger.

(5) Nicaragua is very competitive in terms of dairy export prices and this is reflected in the export growth rate the dairy sector has been experiencing. However, milk producers were capturing more than 63% of the final price paid by consumers in 2000 and this proportion has been steadily decreasing throughout the last 12 years, capturing less than 42% of the final price by 2012.These figures suggest that other actors across the milk value chain (processors, distributors, retailers) are obtaining a greater piece of the pie relative to a decade earlier. If these differences are not translated into better services to producers (i.e. technical assistance, greater credit availability), then it could be a major bottleneck that might affect the competitiveness of the entire milk value chain. A good research question for the CRP L&F is: What is the impact of increased beef (and milk as well) exports on the welfare of the value chain actors, including consumers? Increased exports are obviously benefiting exporters (meat-packing plants, dairy plants, and artisan cheese exporters), but what effect does this have on local demand for animal protein as well as the proportion of final product price retained by producers?

(6) With regard to consumption, almost half of the families in Nicaragua consume fluid milk (48.7%), and an overwhelming majority (86%) consumes cheese. Dairy products contribute 6.5% of the energy in the Nicaraguan diet, and families spend about 13.7% of total food purchases on dairy products. As to meat consumption, most families consume chicken (76%), followed by beef (44%).Beef contributes 1% of caloric consumption and families spend about 9% of total food purchases on beef. The average per capita daily protein intake during 2009 was 55 g. Of this, 31.3% came from food of animal origin. However, per capita annual consumption in fluid milk equivalents shows a clearly decreasing trend (–2.5% per year), going from 116 kg in 1995 to 73 kg in 2011.With respect to meat consumption, beef is the meat with the least growth rate, averaging 1.7% a year compared with 6.9% for pork and 11.9% a year for poultry. Until the 1990s, beef in Nicaragua was the principal meat product demanded by domestic consumers. However, since 1995, beef has been displaced by chicken, which accounted in 2011 for 65% of total meat consumption versus beef's 26%.

(7) Due to its small size, Nicaragua does neither strategic nor adaptive research. Its strategy has been to make strategic alliances with regional (i.e. CATIE) and international agricultural research centres (i.e. CIAT, CIMMYT) as well as centres from large Latin American countries such as INTA from Argentina, EMBRAPA from Brazil, and INIFAP from Mexico, whose human resource capacity and resources are greater and better than INTA´s. In the specific agenda for livestock research, INTA, the institution in charge of generating new agricultural technology, has prioritized the adaptation of forage-related technologies and its effect on animal nutrition, especially during the dry season. Thus, most activities of INTA´s personnel have centred on the evaluation of improved grasses for direct grazing, hay and haylage making, cut-and-carry systems, silage, and silvopastoral systems. In addition, many NGOs working in Nicaragua on livestock development provide technical assistance to smallholder farmers. Such is the case of Technoserve and Catholic Relief Services (CRS) from the United States. These NGOs serve as a 'bridge' between smallholder farmers, local livestock associations, and government institutions to supply the much-needed technical assistance that the government cannot meet. It is expected that this strategy will continue in the next decade.

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Annexes

Annex 1. Income per capita and gross domestic product (GDP) of Nicaragua during the period 2000 to 2012

Year	Income per capita (USD/ year)	Per capita income growth (%)	GDP growth (%)
2000	1182	2.3	4.1
2001	1216	2.9	3.0
2002	1210	– 0.5	0.8
2003	1234	2.0	2.5
2004	1277	3.5	5.3
2005	1328	4.0	4.3
2006	1388	4.5	4.2
2007	1430	3.0	3.1
2008	1474	3.1	2.8
2009	1475	0	– 1.5
2010	1526	3.5	3.6
2011	1602	5.0	5.4
2012	1731	8.0	5.2
Average annual increase (%)		3.2	3.3

Source: BCN (2013).

Annex 2. Permanent and temporary jobs generated by the livestock sector in 2011, by sex and age

Labour category	Quantity
Permanent jobs	81,921
(a) Older than 10 year old	
Men	69,026
Women	9881
(b) Younger than 10 year old	
Men	2201
Women	813
Temporary jobs	426,941
(a) Older than 10 year old	
Men	365,214
Women	55,543
(b) Younger than 10 year old	
Men	5099
Women	1085
Total	508,862

Sources: Updated from data of Fujisaka et al. (2005), Schoonhoven et al. (2006).

1. Assuming 33t/ha as feed basis (9.9t dry matter basis).
2. Molasses.

Annex 3. Cost of establishing 1 ha of improved grass in Nicaragua in 2013

Variable	Amount	Cost (USD)
Labour for clearing[1]	11 days	38.5
Herbicide	3 litres	18.8
Labour to apply herbicide	2 days	7.0
Land preparation (with rented tractor)	1 ha	90.0
Seed	4 kg	60.0
Fertilizer (18-46-0)[2]	70 kg	41.3
Fertilizer (urea)[3]	70 kg	42.7
Labour to apply fertilizer	2 days	7.0
Labour to plant	4 days	14.0
Labour tocontrol weed	8 days	28.0
Total		347.3

Sources: Updated from data of Holmann (1999); Fujisaka et al. (2005), Schoonhoven et al. (2006).

1. Labour valued at USD 3.50/d.
2. Priced at USD 0.59/kg.
3. Priced at USD 0.61/kg.

Annex 4. Cost of maintaining 1 ha of improved grass in Nicaragua in 2013

Variable	Unit cost	Total cost (USD)
Pasture depreciation[1]		35.0
Labour for weed control (8 days/year)[2]	USD 3.50/day	28.0
Herbicide (3 litres/ha)	USD 7/litre	21.0
Fencing depreciation[3]		24.0
Fence repair[4]		24.0
Total		132.0
Productivity in 6-mo rainy season (kg dry matter [DM])	3500	USD 1.89/kg DM
Productivity in 6-mo dry season (kg DM)	1325	USD 4.98/kg DM

Sources: Updated from data of Holmann (1999) and Fujisaka et al. (2005).

1. Assuming a useful life of 10 year at establishment cost of USD 350/ha.
2. Valued at USD 3.50/d.
3. Assuming a useful life of 10 year at establishment cost of USD 240/ha.
4. Assuming a cost equivalent to 10% of establishment cost.

Annex 5. Cost of maintaining 1 ha of native grass in Nicaragua in 2013

Variable	Unit cost	Total cost (USD)
Pasture depreciation	NA	0.0
Labour for weed control (8 d/year) [1]	USD 3.50/day	28.0
Herbicide (3 litres/ha)	USD 7/litre	21.0
Fencing depreciation[2]		24.0
Fence repair[3]		24.0
Total		97.0
Productivity in 6-mo rainy season (kg DM)	2500	USD 1.94/kg DM
Productivity in 6-mo dry season (kg DM)	1200	USD 4.04/kg DM

Source: Updated from Holmann (1999).

1. Valued at USD 3.50/d.
2. Assuming a useful life of 10 year at establishment cost of USD 240/ha.
3. Assuming a cost equivalent to 10% of establishment cost.

Annex 6. Cost of producing 1 ha of hay in Nicaragua in 2013

Variable	Amount	Cost (USD)
Fertilizer (urea)[1]	140 kg	85.4
Use of machinery to cut and bale hay	1 ha	150.0
Transporting hay to storage facility	1 ha	35.0
Pasture depreciation[2]	1 ha	35.0
Storage cost	40 m^2	40.0
Total cost per hectare		345.4
Cost per bale of hay[3]		USD 69.10 each
Cost per kg of hay (dry matter basis)[4]		USD 4.26/kg DM

Sources:Updated from data of Fujisaka et al. (2005), Schoonhoven et al. (2006).

1. Priced at USD 0.61/kg.
2. Assuming a useful life of 10 year at establishment cost of USD 350/ha.
3. Assuming a yield of 500 bales of hay/ha of about 18 kg each.
4. Assuming 90% of dry matter content.

Annex 7. Cost of producing silage from corn in Nicaragua in 2013

Variable[1]	Amount	Cost (USD)
Labour for clearing	4 days	10.00
Herbicide	3 litres	18.80
Labour to apply herbicide	2 days	5.00
Land preparation (with rented tractor)	1 ha	90.00
Seed	50 kg	35.70
Fertilizer (18-46-0)	92 kg	25.00
Fertilizer (urea)	92 kg	20.00
Labour to apply fertilizer	2 days	5.00
Labour to plant	6 days	15.00
Labour for weed control	9 days	22.50
Labour for harvest, transport, chopping, and filling	45 days	112.50
Rented tractor	3 days	56.30
Silage additive (3% of total production)[2]	990 kg	99.00
Plastic for sealing	60 m	45.00
Depreciation of silage infrastructure	15 year	55.00
Opportunity cost of land (rental cost)	1 ha	89.40
Fuel cost of chopper	60 litres	41.60
Cost of chopper (rental)	5 days	31.30
Total cost per hectare		777.10
Cost per tonne of silage (dry matter basis)		78.49
Cost per kg of silage (dry matter)		USD 7.85 cents/kg DM

Sources: Updated from data of Fujisaka et al. (2005), Schoonhoven et al. (2006).

1. Assuming 33t/ha as feed basis (9.9t dry matter basis).
2. Molasses.

Annex 8. Cost of establishing and maintaining 1 ha of sugarcane to feed cattle during the rainy season in Nicaragua during 2013

Variable	Unit cost (USD)	Total cost (USD)
Land preparation (14 h of tractor)	15.00	210.00
Labour for planting (14 d)	3.50	49.00
Machinery to transport seed (2 h)	15.00	30.00
Fertilizer (100 kg NPK)	0.59	59.00
Seed (14 kg)	10.00	140.00
Total		488.00
Annual costs		
Sugarcane depreciation[1]		48.80
Labour for harvest[2]	3.50	227.50
Fertilizer (46 kg)	0.59	27.15
Fuel cost of chopper (120 litres)	1.20	144.00
Chopper depreciation[3]		150.00
Total		597.45
Cost per tonne of dry matter[4]		56.90

Source: Adapted from Holmann (1999).

1. Assuming a useful life of 10 year at establishment cost of USD 488/ha.
2. Estimated at half a day during 120 d of dry season.
3. Estimated at a cost of USD1200 depreciated over 8 year.
4. Estimated at 10.5t/ha on dry matter basis.

Annex 9. Cost of producing 1 ha of Cratylia argentea to be used as protein bank in Nicaragua during 2013

Variable	Unit cost (USD)	Total cost (USD)
Land preparation (2 h of tractor)	15.00	30.00
Labour for planting (13 d)	3.50	45.50
Machinery to transport seed (2 h)	15.00	30.00
Fertilizer (100 kg NPK)	0.59	59.00
Fertilizer (100 kg urea)	0.61	61.00
Seed (8 kg)	20.00	160.00
Total		385.50
Annual costs		
Cratylia depreciation[1]		38.55
Labour for harvest[2]	3.50	175.00
Fertilizer (46 kg)	0.59	27.15
Fuel cost of chopper (120 litres)	1.20	120.00
Chopper depreciation[3]		150.00
Total		510.70
Cost per tonne of dry matter[4]		255.35

Source: Adapted from Holmann (1999).

1. Assuming a useful life of 10 year at establishment cost of USD 385.50/ha.
2. Estimated at half a day during 100 d of dry season.
3. Estimated at a cost of USD 1200 depreciated over 8 year.
4. Estimated at 2.0t/ha on dry matter basis.

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