Policy framework for dairy development in Senegal
Policy framework for dairy development in Senegal

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Acronyms

AAT    African animal trypanosomosis
ADB    African Development Bank
AFDI   French Agency for International Development
AGOA   African Growth and Opportunity Act
AHAM   Animal health accreditation mandate
AI     Artificial insemination
ANCAR  National Agency for Rural and Agricultural Counsel
ANSD   National Agency of Statistics and Demography
BSE    Bovine spongiform encephalopathy
CBPP   Contagious bovine pleuro pneumonialia
CIMEL  Centres for Modernization of Livestock
CNAG   National Centre for Genetic Improvement
CRZ    Centre for Zootechnical Research
CSAG   Secondary Centre of Genetic Improvement
DB     Dairy board
DIREL  Livestock Directorate
ECOWAS Economic Community of West African States
EISMV  Interstate School of Veterinary Science and Medicine
FDA    Food and Drug Agency
FMD    Foot and Mouth Disease
FNRAA  National Fund for Agricultural and Agrifood Research
FONSTAB Support fund for animal sheds
GDP  Gross domestic product
GIA  Genetic Improvement Act
IETS  International Embryo Transfer Society
ILRI  International Livestock Research Institute
ISRA  Senegalese Institute for Agricultural Research
KDB  Kenya Dairy Board
LOASP  Framework law on agroforestry and pastoralism
LSD  Lumpy Skin Disease
NCGI  National Committee for Genetic Improvement
NESSAD  National Epidemiological Surveillance System of animal diseases
NGO  Non-governmental organization
NISDEL  New Sectoral Initiative for Livestock Development
NPFTTS  National program against trypanosomosis
OECD  Organisation for Economic Cooperation and Development
OIE  World Organisation for Animal Health
PAPEL  Livestock Support Project
PDESOC  Livestock Development Project in Eastern Senegal and Upper Casamance
PNDE  National Program for Livestock Development
PNIA  National Artificial Insemination Program
PRODAM  Agricultural Development Project of Matam
PSIA  Special Program for Artificial Insemination
SCC  Semen collection centres
SDB  Senegalese Dairy Board
WAEMU  West African Economic and Monetary Union
XOF  CFA franc
Acknowledgements

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Executive summary

In Senegal, as in most tropical countries, genetic improvement has always been the cornerstone of dairy policies. Since the first experiments in 1964, the crossings of low-producing indigenous breeds with high-value exotic breeds has always been the main strategy to increase milk production in the country. Hence, the review of policies, plans and programs relating to genetic improvement of the national dairy herd is essential for an overall assessment of dairy policies, including germplasm issues.

Policies targeting the dairy sector encompass various areas such as livestock development (health, nutrition and genetic improvement) and access to resources (land, water and rural infrastructure). They also included structuring policies (organization of dairy industries, farmers’ associations), fiscal and trade policies (tariﬀs and non-tariﬀ barriers, safety and quality, subsidies), and macro-economic and investment policies. For this study, the emphasis was primarily on genetic improvement and animal health policies.

The legislative framework to address health issues related to live cattle rests on policies such as the animal health accreditation mandate, sanitary policy, the national program against trypanosomosis, and the national system for surveillance of animal diseases. Dairy germplasm (semen, embryos) is not speciﬁcally taken into account, as evidenced by the lack of national health standards for imported germplasm.

The hypothesis is similar for genetic improvement policies. Although the legislative framework (genetic improvement act) deﬁnes the conditions of production, import and distribution of dairy germplasm, the lack of national zootechnical standards applicable to germplasm imports makes the legislation inoperative. Moreover, under the privatization of veterinary service delivery, the state ceased to provide artiﬁcial insemination (AI) services, which are entirely carried out by private veterinary practitioners. Currently, the state assumes poorly, if at all, its supervisory functions; hence, leaving private operators to police themselves.

The viability and sustainability of policies to improve dairy production depend to a large extent on the operability of the existing legislative framework. The latter must be complemented by the development of zootechnical and health standards serving as guidelines for the production, trade and distribution of semen, embryos and live germplasm. This would require institutional reforms to put in place a more effective and visible dairy board capable of contributing to the conception and implementation of dairy policies.
1. Introduction

In Senegal, milk is a product of significant economic, sociological and nutritional importance. The country faces increasing demand reaching 291 million litres per year in 2012. The supply of dairy products is largely insufficient to meet the national demand. Senegal’s total imports of dairy products reached USD 121 million in 2012 (FAO 2013).

Livestock development was part of the overall government strategies for food self-sufficiency. Numerous laws encompassing animal husbandry, health, genetics, research and training, land and water resources, fiscal and trade issues, to name a few, have been developed for this purpose.

The main objective of this study is to analyse the provisions relevant to dairy development in the various policies and regulations enacted in Senegal with a focus on germplasm acquisition (locally produced and imported) and distribution. The document is organized in five chapters: the first chapter presents the global trends in the dairy industry; the second and third chapters are presenting the dairy sector and the germplasm value chain in Senegal, respectively. The fourth chapter is a review of dairy development policies, with an emphasis on germplasm development and animal health to a lesser extent, and the fifth chapter examines some recommendations to implement dairy policies in line of the country’s commitment to develop the dairy sector.
2. Global trends of dairy industry

2.1 Dairy production and consumption

Quantitative aspects

World dairy production amounted to 750 million tonnes in 2012 (FAO outlook 2012). The relative share of processed dairy products in the overall production was estimated at 5%, or 38 million tonnes in absolute value and cheese accounts for 52% of the world tonnage of dairy products. The other main products are butter and butter oil (26%), whole milk powder (11%) and skimmed milk powder (10%). Milk is almost entirely sourced from cows (83.4%) and buffaloes (12.8%). Milk from camels, goats and sheep are marginal, with 0.3%, 2.1% and 1.3%, respectively.

The main dairy producing regions in 2011 were Asia (263.3 million tonnes) and Europe (215.3 million tonnes), accounting for 66% of world production (Figure 1). Africa, with 36.4 million tonnes or 5% of world production barely surpasses Oceania, which is 30 times less populated (FAO 2013). At country level, the four largest milk producers are India (119.4 million tonnes), United States of America (89 million tonnes), China (41.8 million tonnes) and Pakistan (36.6 million tonnes). India and Pakistan have a unique feature with the predominance of buffalo milk over cow milk with 52% share for India and 63% share for Pakistan.

The average annual consumption of milk in the world is 106.1 kg per capita (FAO 2012). The highest consumption levels are in developed countries and are almost four times greater than in developing countries (237.8 kg vs. 71.1 kg).

Total milk production in Africa amounted to 36.4 million tonnes in 2011 (FAO 2013). Contrary to what is observed in other regions of the world (except Pakistan and India), the contribution of buffaloes, camels, goats and sheep reaches 25% of total milk produced in Africa. Eastern Africa (16.2 million tonnes) and Maghreb (11.4 million tonnes) account for 75% of the continent’s overall production (Figure 2). The West African region is not well endowed with cattle milk compared to East Africa and its relative productivity is even lower if we compare the size of its population to those of other regions. Hence total production in West Africa is 4.5 million tonnes compared to Sudan (7.5 million tonnes), Egypt (5.8 million tonnes), Kenya (4.3 million tonnes) and South Africa (3.3 million tonnes) (FAO 2013).
Dairy production trends

According to Food and Agriculture Organization of the United Nations and Organisation for Economic Cooperation and Development (OECD), the world milk production is expected to increase by 2.2% per year for 2011–2020 decade (Table 1) with a slower rate for the OECD countries (+0.8%) compared to the rest of the world (+3.1%). Milk production is expected to increase globally to nearly 900 million tonnes in 2020. The growth rate of milk production for the decade 2011–2020 is expected to be lower compared to previous decades with the notable exception of sub-Saharan Africa (SSA) expected to experience a higher growth rate of 0.4% as compared to the previous decade.

Table 1. Milk production: Trends for 2020

<table>
<thead>
<tr>
<th>Production (million tonnes)</th>
<th>Growth rate (%)</th>
</tr>
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<tbody>
<tr>
<td>OECD countries</td>
<td>310</td>
</tr>
<tr>
<td>Non-OECD countries</td>
<td>373.7</td>
</tr>
<tr>
<td>North Africa</td>
<td>11.1</td>
</tr>
<tr>
<td>SSA</td>
<td>25.9</td>
</tr>
<tr>
<td>Latin America</td>
<td>75.4</td>
</tr>
<tr>
<td>Asia</td>
<td>231.8</td>
</tr>
<tr>
<td>World</td>
<td>692.6</td>
</tr>
</tbody>
</table>


For dairy products, the production of whole milk powder is expected to grow at 2.5% annually, followed by butter (2.2%), cheese (1.8%) and skimmed milk powder (1%). Dairy production share of non-OECD countries is expected to increase by 2020 for each dairy product. The production of OECD countries will remain dominant only for cheeses and skimmed milk powder. The total production of dairy products will increase from 36.8 million tonnes in 2009 to 44.9 million tonnes in 2020.

2.2 International market of milk and milk products

Size of international trade

Total traded milk amounts to 52.7 million tonnes worldwide (Table 2), which corresponds to 7% of world production. Hence international trade is relatively limited, as an overwhelming quantity of milk produced in the world is mainly used to meet domestic demand.
Table 2. World dairy market

<table>
<thead>
<tr>
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<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Change: 2012 over 2011 (%)</th>
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<tbody>
<tr>
<td>Million tonnes, milk equivalent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>World production</td>
<td>713.6</td>
<td>730.1</td>
<td>750.1</td>
<td>2.7</td>
</tr>
<tr>
<td>World trade</td>
<td>47.8</td>
<td>50.7</td>
<td>52.7</td>
<td>4.0</td>
</tr>
<tr>
<td>Consumption per capita</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>World</td>
<td>103.3</td>
<td>104.5</td>
<td>106.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Developed countries</td>
<td>233.4</td>
<td>234.3</td>
<td>237.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Developing countries</td>
<td>67.8</td>
<td>69.5</td>
<td>71.1</td>
<td>2.2</td>
</tr>
<tr>
<td>FAO Dairy Price Index (2002-2004=100)</td>
<td>200</td>
<td>221</td>
<td>198</td>
<td>-13.4</td>
</tr>
</tbody>
</table>


Dairy products account for 14% of global trade (Figure 3). This represent 6.9 million tonnes distributed as follows: cheese (2.3 million tonnes), whole milk powder (2.1), skimmed milk powder (1.6), butter and butter oil (0.92).

Figure 3. Share of global trade of dairy products in 2012.

Source: Developed from FAO (2012).

The main importing regions are Asia and Africa, which are responsible for 70% of world imports. In contrast, these continents account for only 13% of exports, which are dominated by Oceania (New Zealand in particular, which exports 80% of its production) and the European Union (Figure 4).

Figure 4. Share of the regions in the global trade of milk and milk products.

Source: FAO (2012).
Trends of the global trade

An expanding global trade

The volume of world trade has increased by 3% per year, on average, since the year 2000. Despite some noted volatility, it has grown faster than production (2% per year during the same period), which was expected as it takes time for production to adjust to changes in demand.

World trade in dairy products (especially butter, cheese, skimmed and whole milk powder) is expected to grow by 17.4% during the 2013–2022 decade (Thiele et al. 2013). Global demand is expected to remain firm, with imports anticipated to reach 66.8 million tonnes of milk equivalents by 2022. Asia will continue to be the main market, followed by North Africa, the Middle East, Latin America and the Caribbean. Dairy imports are projected to be driven by skimmed and whole milk powder (FAO 2012).

Demand driven by Asia

Asia is the largest dairy importer (27.9 million tonnes in 2012). Purchases by China, which accounts for 23% of Asian imports, will account for much of the increase in global trade over the coming years. Mexico, Saudi Arabia, North Africa and Latin America (mixture of regions and countries) are expected to be the other major players in world trade.

Trends in Africa

Dairy imports in Africa amount to 9 million tonnes (FAOSTAT 2013). The main importers are Algeria (2.8 million tonnes) and Egypt (2.1 million tonnes). Not accounting for the Maghreb countries and Sudan, Senegal is the fourth largest importer, after Nigeria, South Africa and Ghana. Dairy imports in Africa are in a growing trend, with an 84% increase in the last decade (Figure 5).

Figure 5. Dairy imports in Africa.

Rising prices

International trade in milk and milk products is also characterized by price volatility and sensitivity to shocks in the global economy. The index of international dairy prices of FAO almost doubled between 2000 and 2012 from 100 to 194, despite a decline between 2008 and 2009 following the global economic crisis.

The recent financial crisis in the global economy has caused a drop in demand for milk and dairy products in 2008, but also a dramatic increase in prices in 2009. For the first time since the mid-1990s, overall per capita consumption has declined. The impact of the financial crisis was felt in all areas of the dairy industry: production, trade, consumption and prices, leading to general stagnation, although some regional differences were noted (OECD/FAO 2013).
The growth in global milk production has slowed in 2009. Low dairy prices and the rising cost of inputs, especially livestock feed led many farmers around the world to suspend their milk production activities. Prices began to increase during the first half of 2010, leading to higher production in 2010, 2011 and 2012 (FAO outlook 2012).
3 The dairy sector in Senegal

3.1 The context

The climate and agro-ecological zones

Senegal is located at the western end of the African continent, between 12.5 and 16.5° North latitude, covering an area of 196,712 km². Senegal has a tropical, hot, humid climate with a rainy season from June–October and a dry season from November–May accompanied by hot and dry harmattan winds.

The country is generally divided into seven agro-ecological zones, from biophysical criteria and socio-economic criteria, namely: vallée du fleuve Sénégal, Niayes, Bassin arachidier nord, Bassin arachidier sud, zonesylvopastorale, Basse/moyenne Casamance, Sénégal oriental/haute Casamance. These agro-ecological zones are large areas with varying physical and human characteristics. In other words, each area is a real natural region. Each of these areas has its own potential and also its own vulnerabilities to environmental and climate risks.

Figure 6. Agro-ecological zones of Senegal.

The river valley (Vallée du fleuve Senegal) covers a band of 10–15 km, from the department of Dagana to that of Bakel. This area is composed by a set of flood plains and sandy uplands. From an ecological perspective, it includes three different areas: Walo (floodable, with heavy soils and rice development), Delta (with marine climate) and Jeri (pastoral area). In the delta, rainfed agriculture is almost non-existent and most production comes from irrigated crops. Throughout the middle valley and the delta, soil fertility is provided by flooding (leaving a layer of silt). From the point of view of climate vulnerability, the River valley is characterized by low and erratic rainfall, development of aquatic invasive plant, a reduction of fish breeding areas, coastal erosion and saltwater intrusion in the river.
The groundnut basin (bassin arachidier), with its northern and southern parts, has a large demographic weight and has been severely affected by the groundnut crisis, due to the combined effects of drought and declining world prices of groundnut. The area was marked by persistent droughts in recent decades, leading to an accelerated degradation of ecosystems, increased depletion of land (soil fertility and timber resources, soil acidification in the highlands, marine invasion in the Saloum River) and degradation of mangroves.

The area of eastern Senegal/Upper Casamance (Sénégal oriental/haute Casamance), which corresponds to the cotton zone, is characterized by large rural poverty despite strong agricultural and pastoral potential. Soils in this area are shallow and very vulnerable to wind erosion and water runoff. Lower and Middle Casamance is characterized by soil acidification, water erosion, loss of forest diversity due among other reasons to bush fires, increased salinity, acidity and degradation of mangroves in the estuary of the Casamance river.

The Niayes (a strip of 5–10 km on the coastline) is the main horticulture area in Senegal. It covers less than 1% of the country’s land mass and hosts 20% of the total population. The main ecological threats are the advancing sand dunes and remobilization of ancient dunes, soil salinization and silting of lowlands.

Forest grazing area (zone sylvopastorale), populated mainly by the nomadic Fulani population, is a main livestock rearing area of Senegal. It is a zone characterized by a sharp deterioration of forest resource and pastures, soil erosion, fragile vegetation cover and water scarcity.

The socio-economic context

Senegal’s population was estimated at 13.5 million inhabitants in 2013, according to projections by the National Agency of Statistics and Demography (ANSD) (ANSD 2012). The population growth rate is 2.4% per year. Senegal’s population is very unevenly distributed among the eleven regions. Dakar is the most densely populated region: with 4147 inhabitants per km$^2$, it hosts nearly 22% of the national population. The central and southern regions (Diourbel, Thiès, Fatick, Kaolack and Ziguinchor) are above the national average density of 68.9 inhabitants per km$^2$. Tambacounda is the least densely populated area with 11 inhabitants per km$^2$. The urban population is increasing rapidly, rising from 25% of the total population in 1960 to 43% in 2010.

The country’s gross domestic product (GDP) was estimated at USD 14 billion in 2011 and the economic growth rate at 2.4%. With a GDP per capita of USD 1083, Senegal is ranked among the LDCs (least developed countries). The economy is dominated by the service sector (62.4% of GDP), while industry and agriculture account for 21.7% and 15.9%, respectively (ANSD 2012).

The Senegalese economy is characterized by chronic trade imbalance, symbolized by a deficit of USD 2.9 billion in 2011. The main imports are petroleum products (18%), machinery and equipment (7.8%), rice (6.9%), wheat (3.2%) and dairy products (2.3%). The main exports are refined petroleum products (15.5%), phosphoric acid (14.1%), fish products (12.3%), cement (9.8%) and groundnut products (3.2%).

3.1.3 Importance of livestock in the Senegalese economy

Livestock is valued at USD 293 million in 2011 at current prices, corresponding to 4.3% of GDP (ANSD 2012). The value of livestock has increased by 48% since 2006 although the primary sector relative contribution to GDP has declined in recent years, from 35% in 2002 to 28% in 2011. Livestock appears as an essential sector of the Senegalese economy. It contributes to poverty alleviation and provides sustenance to vulnerable people, especially to those living in fragile ecosystems where it is one of the few viable economic activities. Its importance to the overall economy is not reflected in the Senegalese government investment priorities as it receives only 0.74% of global public investment and 7.3% of investment in the primary sector (BCI 2011). However, there is an increasing awareness of the sector’s economic potential and as a result, the government has initiated a National Program for Livestock Development (PNDE) that seeks to reach self-sufficiency in animal products and increase economic
vitality of stakeholders by 2026. In order to achieve these objectives, four options are proposed in this plan: (1) improving productivity and competitiveness of the livestock sector, (2) the creation of a favourable environment for the development of farming systems, (3) improving marketing of animal products and (4) the strengthening of the institutional framework for action. Livestock have been selected among the priority sectors which development would significantly impact on the achievement of the Millennium Development Goals through National Artificial Insemination Program (PNIA).

### 3.2 Dairy industry in Senegal

#### Dairy production systems

The cattle population in Senegal amounts to 3.3 million heads (FAO 2011). The dairy herd is composed of indigenous and exotic cattle breeds and their crosses. The Zebu Gobra is mostly present in the Sahelian part (north and centre of the country) and the taurine N’Dama in south and east (Sahelo-Sudanean zone), because of its trypanotolerance. In the transition zones between the natural areas of these two races, there is a genetic type resulting from the interbreeding between the Zebu Gobra and the N’Dama and taurine, the Djakoré. While local breeds have relatively good carcass dressing potential, dairy potential is low. Foreign breeds (Jersey, Montbeliard, Holstein and Gir, for the most part) have been introduced to improve milk supply for urban and suburban populations. Three production systems co-exist in Senegal: the pastoral extensive system type, the agropastoral system, and most recently, the intensive system (Figure 7).

Figure 7. Dairy production systems in Senegal.

[Source: Dieye (2006).]

#### The northern traditional pastoral system

It is an extensive farming system which uses vast pastures and in which more than 50% of gross income is from farming. Present in two areas in the north and north-central zones (Ferlo and the River Valley), this system contributes up to 38% of the national milk production (Diao 2003). It corresponds to the administrative regions of Saint Louis, Matam and Louga.

The Ferlo, or sylvopastoral zone, is a large area of plateaus located in the northern half of the country. It covers a third of the country’s land mass and is the cattle producing area par excellence, as it concentrates two-third of the total domestic ruminant in Senegal with 15% of cattle population. Water resources are limited and herders rely heavily...
on the groundwater, as the rainy season is very short and rainfall is low and erratic. The area is characterized by vulnerable vegetation dominated by annual and thorny grasses. Government policies, through the equipment of the Ferlo with deep boreholes, induced significant changes in production systems with a tendency of farmers to settle down around boreholes. That also favoured diversifying the activities (agriculture), namely the development of crops by Wolof. This led some authors to characterize the current system as agroforestry (Broutin and Diokhané 2000).

The river area is also an important extensive breeding zone (15% of cattle) characterized by a pendulum movement of livestock between Diéri (inland Ferlo) and Walo (flooded area). This movement has, however, decreased since the onset of boreholes. The area is considered the primary milk surplus zone (thus justifying the installation, between 1992 and 2003, of milk collection network by Nestlé Senegal). However, the volumes of milk produced and marketed remain low. The surplus production is mainly related to the size of the herd and the weakness of the local market (almost all families have livestock and do not buy milk). Moreover, urban centres are small and opportunities are limited to the city of Saint Louis and nearby hotels.

The agropastoral system in centre and south

The semi-intensive grazing system, in which 10–50% of gross income comes from farming, lies more in mixed-use areas where the expansion of cultivated land ousted the extensive livestock production system, including the centre of the groundnut basin (administrative regions of Diourbel, Louga, Kaolack, Thiès and Fatick) with a tendency to extend to the north and the south. Nearly 25% of the cattle are in this area (Infoconseil 2006). Land pressure induces a phenomenon of intensification, but declining natural resources requires the use of supplements that explains why production costs are higher than in the Ferlo. The north is the preferred area of the Gobra zebu whereas the mixed breed Djakoré (Gobra Zebu × N’Dama taurine) is mostly found in the south.

AI made its appearance in the groundnut basin in 1994 with the PAPEL (Projet d’Appui à l’Élevage, Livestock Support Project). The project sought to create dairy areas around the central cities (Kaolack and Fatick) and tested the most recent establishment of small local milk chains (generalizing the improvement of the feeding of cows in production with concentrates, organizing a milk collection network and implementing milk processing small units (Diao 2003).

The south of the country (administrative regions of Kolda, Ziguinchor and Tambacounda) which host nearly 45% of cattle (taurine N’Dama because of its trypanotolerance) is also an important semi-intensive breeding area. This area is characterized by much larger volumes of rainfall (over 1000 mm of water/year), a more abundant natural vegetation and therefore higher milk potential. Crop residues are fed to animals (peanut vines, rice straw, cotton seed and sesame cake). This area, as the groundnut basin, would be self-sufficient in dairy products. However, its potential is stronger than the groundnut basin due to lower land pressure and thus the existence of significant pastures and the possibility of combining the use of natural resources to intensification with the stabling of animals (lower production costs) (Broutin and Diokhané 2000).

The manure stables, installed around the cities of Kolda, Tambacounda and Vélingara, are initiatives from the cotton company, SODEFITEX (Société de Développement des Fibres Textiles) and the Senegalese Institute of Agricultural Research (ISRA). They are based on the partial stall of milking cows during the dry season to improve their performance in draught, milk, manure, reproduction and growth. Consumption is secondary in this paradigm and milk is a source of cash income for the operator. The various technological inputs advocated (complementation based on cottonseed or sesame oil cake, health monitoring and milking hygiene) have ensured milk production during the dry season and promoted the establishment of processing micro-enterprises with the support of institutions such as the French non-governmental organization (NGO) Veterinarians Without Borders and the French Agency for International Development (AFDI) (Dieye et al. 2005).

The intensive system

Although developing manure stables in the centre and south of the country could be perceived as a step towards intensifying production, intensive dairy systems are still rare in Senegal and are mainly located in the Dakar region.
They were created mostly by private operators (manufacturers, politicians, executives) with the support of public institutions (research). Their existence is dictated by the desire to meet the strong demand for milk and dairy products in urban areas, especially the Dakar region. These modern farms have become the preferred test site of crossbreeding local and exotic stocks in association with research centres or using livestock specialists (private veterinarians). In the Niayes there are various herds of dairy breeds (Jersey, Holstein and Montbeliard, amongst others), distributed in three large farms (ferme de Niacoulrab, ferme de Wayembam, ferme de Pout) and a dozen of medium-scale farms. For instance, the Niacoulrab farm located 30 km from Dakar was installed in 1990. The farm owns between 700 and 750 animals (Crossbreeds, Holstein, Jersey and Montbeliard), including 300 dairy cows. Raw milk is marketed through a network of kiosks in Dakar. A second farm has been installed in the same site and is said to produce up to 1000 litres/day (Broutin 2005).

The Wayembam farm, the largest in the area, is located at the Rose Lake, an area of 30 ha. It is an intensive dairy operation with 875 heads, including 350 lactating cows that were producing 3000 litres of milk per day in 2005. A milk processing unit that produces 14,000 litres per day was set up to produce curds and sterilized milk (Infoconseil 2006).

In addition to these large farms, there is a network of smaller farms around Dakar and Thiès region. These smaller operations are the initiative of businessmen who for the most part do not have much connection with livestock or who have benefited from projects set up by the state to import exotic breeds (Broutin and Diokhané 2000).

Dairy production and consumption

Total milk production amounted to 190,031 t in 2011. Milk in Senegal is primarily from cattle (the main source of marketed milk), goats and sheep, which contribute 85.9, 7.6 and 6.4%, respectively (FAO 2013).

<table>
<thead>
<tr>
<th>Species</th>
<th>Estimated number</th>
<th>Estimated production (t)</th>
<th>Milk production (% contribution)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>3,345,540</td>
<td>163,342</td>
<td>85.9</td>
</tr>
<tr>
<td>Goats</td>
<td>4,886,630</td>
<td>14,416</td>
<td>7.6</td>
</tr>
<tr>
<td>Sheep</td>
<td>5,515,600</td>
<td>12,273</td>
<td>6.4</td>
</tr>
</tbody>
</table>


Milk production has increased steadily in recent years, with a progression of nearly 70% during the 1998–2011 period (FAO 2013).

In contrast, imports of dairy products have undergone a downward trend in recent years after reaching a peak of 272,888 t in 2006. The decreasing trend observed for seven years coincides with the increase in production of large
suburban farms and the installation of new collection and processing units. The latter are modern (Laiterie du Berger) or traditional (owned by farmers’ associations). However, the dairy imports still constitute a significant burden in the country’s trade balance and amounted to USD 121 million in 2012 (CFA franc [XOF] 158 billion) (FAO 2013).

Figure 9. Trends of per capita consumption of dairy products in Senegal.


The per capita intake was 26 kg in 2011, approximately the same level as in 1998, despite an improvement noted between 2005 and 2010. This is far below world and even African averages (106.1 and 49.8 kg, respectively). It is also far below the stated goals of 40 litres and 50 litres set for the years 2000 and 2010, respectively, when the Pan-African Rinderpest Campaign (PARC) and the Livestock Support Project—Projet d’Appui à l’Elevage (PAPEL) projects were being started in 1992 (Keita 2005).

In Senegal, milk production has always been insufficient and unable to cover the consumption needs of a growing population whose dietary habits are based on fresh milk and curd. Despite external supply sources of dairy products, an expensive option by most accounts, a wide gap remains between the Senegalese government’s stated goal in terms of per capita consumption and the current consumption level. Milk production from the indigenous cattle is very low, ranging from one to three litres per day (Diao 2005). As a result, domestic production covers only one-third of national needs. Dairy imports are an annual currency loss estimated at XOF 58 billion (USD 121 million). Therefore, dairy policy strives to find an important place in the economic policies of the country.

Industries and processing systems

Typology separates the companies that transform natural milk and those using imported milk powder. Industrial and commercial projects for transforming natural milk started to emerge in the 1990s. However, many of them have abdicated, due to the difficulties associated with strong seasonal variations and weak quantities of milk collected.

Processing of natural milk

- ‘Traditional’ micro-enterprises
  These mini companies are mainly in the hands of women farmers and urban processors. A large part of the local production passes through this system of individual transformation in urban and rural areas to produce curd (fermented milk), butter and ‘butter oil’. In the northern part of Senegal, there is a nascent small-scale dairy industry promoted by farmers’ associations (FBAJ in Linguère; ADID in Dahra; ADENA in Namare). These associations have processing and packaging facilities (raw milk or curd), delivery vehicles and a network of sales outlets.

- Small enterprises of pasteurization (mini dairies)
  These units are characterized by their spatial location near the production areas and higher volumes processed,

1. On 22 April 2016, USD 1 = XOF 581.324.
even if they are modest (from 20 to 400 litre/day to up to 700 litre/day). The equipment level is very simple (stainless steel pots, gas stove, bags, cooler and refrigerator). Many of these units operate below capacity and have to suspend their operation during the year because of low and irregular production.

- In Senegal, there is no tradition of processing milk into cheese. Cheese production is still underdeveloped in the country. There are some important and well-structured production niches in Thiès for goat cheese and in Kolda for cattle cheese (Dieye 2004). However, most of the existing production units can be characterized as small-scale.

**Processing of milk powder**

- Low-tech micro-enterprises
  These are individual curd production activities, usually performed by men. The majority of processors are supplied with milk powder from importers and wholesalers. Some processors are members of dairy cooperatives that directly import milk powder for reconstitution.

- Small-scale units
  They are processing units of reconstituted milk into curds. Transformation remains traditional and is close to that of individual craftsmen. These units have a facility for processing, sale and packaging. Hygiene is an issue in these transformation units, which compromise the quality of their products.

- Small and medium dairy industries
  The number of small units reconstituting milk powder has been increasing in Dakar in the last few years with increased production volume and investment in modern processors. Hence the products put in the market are becoming more diversified with better packaging that rivals what is being used in the industry. The products are also being trademarked and the distribution channels increasingly formalized leading to major outlets, such as supermarkets and convenience stores.

- Industrial processing and repackaging units
  In addition to the small- and medium-scale dairy units, several factories are involved in processing and distributing dairy products in Senegal. Some of these industrial units are involved in reconditioning milk powder, while some produce ice cream albeit with a very low production level.
4. Germplasm supply chain in Senegal

Animal genetic improvements based on genetic amelioration and dissemination of animals, have advanced rapidly, with the development of new phenotypic, genotypic and reproductive technologies. Among the technologies of reproduction, AI and multiple ovulations followed by embryo transfer had major impact on livestock improvement programs in developed countries. These technologies accelerate genetic progress, reduce the risk of disease transmission and increase the number of progeny from superior parents (Thibier and Wagner 2002). The field of molecular genetics is also rapidly developing. Genetic characterization based on markers and molecular marker-assisted selection offer new possibilities in the management of animal genetic resources (FAO 2004). This section is, however, focused on AI, considering embryo transfer and molecular genetics techniques are almost inexistent in Senegal.

4.1 World statistics for AI in cattle

This section is a summary of a study conducted by Thibier and Wagner (2002). A world survey of the AI industry was carried out in 1999 based on country data from 1998. A summary of the responses indicates that worldwide there were 648 registered semen collection centres (SCC) and 1635 semen banks. More than 41,084 bulls were housed in these SCCs and 264 million doses of semen were produced (95% deep-frozen with 50% in Europe, 27% in the Far East and 16% in North America).

The types of breeds involved and their distribution were difficult to establish; however, it could be stated that approximately 75% of the semen doses originated from Bos taurus dairy breeds. International movements of semen were rather important with close to 20 million doses exported in 1998. A total of 110.4 million first inseminations were reported which corresponded to about 20% of the total number of breedable females recorded in the overall FAO database for the responding countries. More than 50% of the inseminations were performed in the Far East and Oceania, 34% in Europe and 10% in North America. Compared to a previous survey, there was a considerable growth in the number of doses prepared, as well as females inseminated. This may be due to an increased number of inseminations performed, but may also be related, at least partly, to more efficient data collection. In conclusion, the AI industry seems to be very active. A large number of doses are being processed (2.5 times more than inseminated). Intense international exchanges are observed. Approximately one-fifth of the breedable female population of dairy cattle in the world are now artificially sired.

4.2 AI of cattle in developing countries

The remarkable improvement of livestock production in many industrialized countries is due to the integrated effect of rapid developments in several fields of the industry (Bane and Hultnäs 1977). Increased feed production, improved animal health, better husbandry techniques and availability of breeds with the genetic potential for improved performance are the most important factors inducing these developments. In developing countries, however, parallel improvements in livestock production have generally been inadequate, primarily due to the lack of genetically improved animals.
There are different ways of increasing the number of genetically improved animals. Selection within existing local populations may be practised, but this method is characterized by low rates of genetic gain, and thus the requirement for long-term breeding efforts. It is perceived by geneticists to be less effective and, hence, is often ruled out as a viable alternative. The importation of live animals, often genetically improved for developed country production systems, is too costly to be adopted on a large-scale. Further, these high-yielding cattle are known to face an adaptability problem when transferred from temperate to tropical and subtropical environments. Crossing local females with exotic imported sires is another method adopted at different periods by many developing countries. The advent of AI has rendered the principle of crossbreeding more effective as it could be implemented on a large-scale and at comparatively low cost.

4.3 Principal factors to be considered in developing countries

AI is a sophisticated method of animal husbandry. Its impact on cattle development is closely linked to the simultaneous introduction of reasonable standards of animal nutrition, disease control, animal husbandry and infrastructure. However, this has not always been recognized, and in some cases, AI has been adopted purely as a technical method of getting calves. The aim of cattle improvement—increased production and better feed conversion leading to a more productive cattle production system—has generally failed in such cases. It is, therefore, necessary to emphasize that any AI scheme aimed at large-scale improvement of national herd should be supported by programs for the improvement of the closely allied sectors of animal husbandry and health.

The paradigm consisting of connecting AI techniques and other sectors of animal production in industrialized countries does not necessarily apply to developing countries because of multiple constraining factors specific to the developing countries, which call for specific solutions (Bane and Hultnäs 1977; Shehu et al. 2010).

Incentives for farmers

In developed countries, the large-scale application of AI has played a key role in livestock improvement, particularly with respect to dairy cattle. This was largely driven by the promise of economic advantage that the technique could offer.

It would thus be reasonable to assume that a basic prerequisite for a successful introduction or extension of AI services in developing countries would be to economically incentivize livestock producers to seek improved animals through crossbreeding and other means and AI service providers to continue to make the technique available to livestock producers (Shehu et al. 2010). Hence, factors such as market prospects, feed availability and animal health conditions are to be considered when selecting areas for breeding services using AI. With regard to dairy cattle, preference should be given to areas that have the basic infrastructure, such as the presence of an organized milk collection scheme, and satisfactory outlets for milk and milk products.

There are also certain basic technical requirements for an AI service. Once an AI scheme is introduced it should be available on a continuous basis. It should not be allowed to collapse because of inadequate resources or conflicts among representatives of various disciplines of genetics, veterinary sciences, animal husbandry and economics, whose close cooperation is essential for a successful program. It is also important to ensure that the service is reliable and that it results in acceptable conception rates. Introducing AI by over-enthusiastic individuals who underestimate the resource requirements of such a service can do more harm than good. Indeed, once farmers lose confidence in AI, which is inevitable in such circumstances, it would be difficult to retain them in such a program or have their full cooperation (Bane and Hultnäs 1977).
Staffing an AI service

Executing an AI breeding service requires specialized staff at various levels. The importance of well-trained inseminators is sometimes overlooked. The success of an AI scheme is dependent on its reliability and on its technical results, which are to a large extent governed by the link that the service provider, namely the inseminator, has with the farmers. Insenimators must therefore be well trained and must undertake their job as a full-time responsibility. Sometimes, AI is performed by a veterinary assistant as part of his or her duties. By experience, this kind of dual-purpose technician generally leads to a less reliable AI service.

The best way of producing efficient inseminators is to select young men or women with agricultural backgrounds, and give them a course in general animal husbandry followed by a specialized course in AI techniques (Mwangi et al. 2004). During the first months of practical work, supervision should be exercised by a senior inseminator and the work should be carried out by the trainees on a full-time basis. It should be borne in mind that some people will never become good inseminators because they do not have the necessary practical talent, and therefore in the training of inseminators provision should be made for drop-outs. Good performance could be ensured through motivation whereby individual inseminators are given a suitable monetary award for good performance. This, however, would require changes in the AI recording systems to make possible the evaluation of performance.

The organisation of field services

In addition to reliability and good technical results, the successful extension of an AI breeding service is dependent on whether it is readily available to farmers. The model developed in industrialized countries, where a central office receives orders by telephone for insemination and inseminators move from one farm to another by car, is usually not applicable in developing countries. Different systems have been tried to resolve local difficulties.

In Asia, AI subcentres where farmers bring their cows in heat are used extensively. This system works well in densely populated areas, and has the advantage of enabling groups of farmers to be brought together for demonstrations of milking techniques, feeding and care of newborn calves, and so on, by other extension personnel. Audiovisual aids have been found to be extremely valuable in these demonstrations. The drawback of this system, however, is that it does not bring the technical staff into direct contact with the problems of the farms.

An extension of this system is the use of roadside facilities, which are simple wooden constructions erected along a given route, for AI operations. This method has been practised extensively in East Africa as a service to smallholders. The roadside facilities are visited by the inseminator on a fixed schedule. Transport from one facility to another may be by bicycle, motorcycle or car, depending on the density of the cattle population and on road conditions in the area. With motorized transport this system works efficiently, enabling inseminators to perform 10–20 inseminations per day, and the farmers themselves do not need to walk their cattle more than about 3 km each way. A variant of the system exists whereby the inseminators check regularly at certain points where farmers can place a call for a visit; the inseminators then go to the farm to perform the insemination.

In Kenya, AI facilities are also used for the provision of routine field veterinary services. This system offers the advantage of availing the services essential for the development of livestock production at the same location. This is a promising system that could be tested further, and applied in countries with relatively low cattle densities and reasonably good road transport links. Based on our experience this would fit the Senegalese context relatively well.

The implementation of AI program on cattle reared under extensive system has always been challenging. However, promising systems such as the use of AI camps have been developed to overcome these difficulties. Animals suitable for AI such as cows with calves on foot are selected from the herds and moved to the camp. This is essentially an area that is fenced to exclude bulls. The cows are kept at the camps for about three months, during which they are observed for symptoms of heat, inseminated and then examined for pregnancy. At the time of the introduction to the camp, the animals are given extra feed if necessary, supplemented with minerals and vitamins to stimulate their reproductive functions and to overcome any periods of anoestrus, and where indicated they are also treated for infertility.
Schemes of this type have been successfully adopted with beef cattle in some African countries as a means of introducing improved genetic material into indigenous cattle populations (FAO 2004).

Heat detection

Heat detection has been reported to be one of the major management problems in developing countries in connection with AI (Settergren 1969; Hakou Tchamda 2006). Zebu cattle have been known for their discrete symptoms of heat and shorter oestrus period than temperate breeds (Anderson 1944). Also, high temperature has a direct effect on the reproductive functions of both temperate and tropical cattle. Gangwar et al. (1965) found a higher incidence of clinical anoestrus among Holstein heifers under hot controlled climatic conditions; the oestrous cycle was prolonged, but duration and intensity of oestrus were decreased. Other experiments in the USA (Bond and McDowell 1972) have also indicated that severe heat stress will cause true anoestrus, but that beef heifers can become acclimatized and re-establish their oestrous cycles.

It is not easy to assess the extent to which the difficulty in oestrus detection in the tropics, in connection with AI is due to lack of heat symptoms. In a study of three central African cattle breeds in Zambia, kept under a 24-hour continuous observation and checked by a vasectomized teaser bull, Rakha et al. (1970) found the length of the oestrous cycle to be similar to that of temperate breeds.

Certainly, the difficulties in recording oestrus depend to a great extent on the interaction between the accuracy of the procedures for heat detection and the intensity of oestrus symptoms shown by the animals. Increased frequency of oestrus observation increases the number of heat periods detected. It is interesting to note in this connection that Rakha et al. (1970) observed a bimodal distribution of the onset of oestrus for the central African breeds: the maximum occurred around sunrise and another around sunset.

From this and other studies (Hall et al. 1959), it appears that in addition to the usual practice of observing heat in the mornings and during the day, including observations very early in the morning and late at night, would be beneficial. However, practical experience indicates that the signs of heat in tropical cattle are obvious enough to be detected with ease, and that the time interval between onset of heat and ovulation is long enough to provide for satisfactory conception rates even if the AI service is available only once every 24 hours. What is important is the necessary motivation on the part of farmers to detect heat.

The role of teaser bull in helping ease the detection of oestrus is widely discussed, despite some limitations known to this method. One of which is the heightened risk of spreading venereal diseases. Hence, the method should be precluded from areas where vibriosis and trichomoniasis are known to exist. The use of bulls with surgically deviated penises is safer. But such bulls perform their task for only a limited period and must then be replaced. Hence, it is a relatively costly procedure.

Recording

An efficient information system is a necessary component of an AI breeding service. First, records of actual conception rates per bull, per inseminator and per area have to be kept. Complete information on the number and performance of inseminated animals in various areas is also essential. It has been frequently observed that while the detailed primary data on AI may be well recorded, they are seldom processed and used in future planning and implementation of the service. There is a real danger that the primary collection of data can be made so ambitious that the processing becomes too difficult. It is, therefore, important to limit records to those which are really necessary, and to establish a system for the regular processing of up-to-date information from the operations (FAO 2004).

Supply of semen

The long-term preservation of semen by deep-freezing allows for considerable flexibility in the arrangements for the supply of semen. In the initial phase of an AI program, the semen can often be imported and domestic semen
production postponed to a later phase. Another important implication of the use of frozen semen is that the semen production unit can be geographically independent of the actual AI field work. Freezing also permits a more efficient use of the semen: 10,000–20,000 doses can be used per AI bull per year, whereas if the semen is used in liquid form the actual number of doses used is reduced to around 5000.

Whether semen should be produced domestically or imported could be determined in the context of both the breeding program and the costs involved. Thus, where the breeding policy dictates that exotic blood should be maintained at somewhere between 50 and 75% in the breeding animals, it may be necessary to produce semen from domestic crossbred bulls, and this would call for the establishment of a national semen production unit at the time when the F1 and/or the first backcross generations are ready for insemination. Similarly, when the number of semen doses are of the order of hundreds of thousands per year, it may be economically justified to produce the semen locally even if the bulls have to be imported. There may also be instances where domestic production may have to be supplemented by imported semen from, say, progeny-tested bulls.

Costs

The costs of an AI breeding service vary widely among countries, and depend mainly on cattle density and the number of cows served. In the initial stages, with a small number of animals being inseminated, the cost per cow is high. There is an approximate relation between the variable costs per inseminated cow and the total number of animals served. The costs expressed in litres of milk at producer prices can be used for comparison between countries. In industrialized countries AI costs per cow vary between the equivalent of 40 and 75 litres of milk, depending on cattle density, the intensity of the selection of sires, the costs of progeny testing and other evaluation activities. The major expenses of an AI breeding service are represented by the wages of the personnel, which in many instances amount to over 80% of the total variable costs. The foreign currency cost in developing countries is relatively small, compared with the alternative costs of acquiring a corresponding number of genetically improved cows, or bulls for sire service. However, a government subsidy is usually provided in the initial stages of an AI scheme, as it would not be possible for the farmer to pay a fee corresponding to the full cost of the service.

The technical problems mentioned above are a major concern in the developing world, particularly in Africa. Reaching the expected gains in milk production through AI in Senegal will require addressing the following issues:

- incentivizing producers and training them on feed production, feeding, heat detection, and body condition requirements for good conception rates;
- training inseminators;
- organizing field services;
- establishing effective recording systems; and
- securing regular supply of semen, and sustainably funding for an AI program.

An enabling policy environment is therefore a prerequisite to the success of AI operations.

4.4 History and development of AI in Senegal

Bovine AI was introduced in 1964 at the Centre for Zootechnical Research (CRZ) of Dahra-Djoloff and was solely targeting the Senegalese Fulani Zebu, known as Zebu Gobra. The insemination of cows has always occurred after the synchronization of oestrus, except in 1979 and 2007, when parallel attempts on natural oestrus were performed (Mbaindingatolou 1982; Sawadogo 2007). Private operators and development projects started getting involved in 1990s through the import and use of semen of temperate dairy cattle to produce crossbred cattle (Diop 2001).
The promotion of large-scale milk production through AI really started in the Niayes in the 1990s with the installation of modern farms (Niacoulrab and Wayembam). The strategy rests on using crossbreds and organizing small farmers into cooperatives. Key informants told us that such option was favoured following the difficulties experienced by the intensive systems that used exotic purebreds. They cited Ferme SOCA, which was disadvantaged by the high cost of feeding its Jersey cows combined with high maintenance costs due to the low adaptation of purebred Jersey cows to climatic and sanitary environment in the Niayes region, which ultimately lead to the failure of this enterprise.

4.5 Structure of the activities of AI

Semen production and AI technicians

The National Centre for Genetic Improvement (CNAG) is the only structure involved in bovine semen production. Currently, the centre has one Normand, two Holstein and three Montbeliard bulls, all imported from France. The bulls were selected according to ancestry, semen biological quality, presentation of a birth certificate, health status and breed.

The centre includes a bull stud that can accommodate eight bulls, a semen collection room, a laboratory for production and preservation of bovine semen, a food store, a unit of liquid nitrogen production and an administrative area. The staff consist of a veterinarian, supported by a livestock technician, an administrative agent, two herdsmen, a custodian and two housekeepers.

Except for CNAG which owns a semen production structure, the semen used in the various programs and AI campaigns were imported primarily from France and Brazil and stored in liquid nitrogen canisters to preserve their quality. The germplasm imported consists primarily of unsexed semen, followed by sexed semen, live animals and embryos.

The main genetic types are Holstein, Montbeliard, Normand, Limousine, Guzera, Gir, Nelor, Jersey, Charolaise, Brune des Alpes, Blonde d’Aquitaine, Girolando and Abondance (Ministry of Livestock 2013). The acquisition and distribution of semen and live animals from exotic breeds are now fully privatized. However, there seems to be a high barrier to entry (perhaps because of high cost of operation), which may pose problem for sustainable success as the quasi-monopoly under which these suppliers of the local market operate may limit competition that could bring domestic prices further down and to further widen the use of AI as sought by the state (see subsection 3.4). This highlights the necessity to design a legal framework to match the interests of the private companies with the objectives of the state for the benefit of dairy enterprises.

The AI technicians are trained in various ways. For instance, with the support of EISMV (veterinary school) and three vocational agricultural schools, the project PAPEL has trained 30 private AI technicians in its 2003 campaign (PAPEL 2004). Since then, dozens of AI technicians have been trained by CNAG, the Special Program for Artificial Insemination (Programme Special d’Insémination Artificielle, or PSIA) and the Project for the Development of Livestock in Eastern Senegal and Casamance (Projet de Développement de l’Élevage au Sénégal Oriental et en Haute Casamance, or PDESOC). The training in AI appears to be outside an organized framework. It was reserved at first to people with backgrounds in animal science (veterinarians, livestock technicians). But recently, it has been extended to ordinary people, including farmers. The exact number of people who have participated in these training events is not known because of the lack of clear monitoring scheme.

Distribution of AI services

The Enterprise for the Promotion and Development of Livestock (SOPRODEL), a company with an international dimension based in Dakar, specializes in the sale of veterinary products and service delivery. It is generally in the field of veterinary services, although its principal focus was originally on animal biotechnology, including AI and embryo transfer. Currently, the company sells veterinary pharmaceuticals (drug and vaccines), equipment and hormones for
many species. It is also involved in the marketing of genetics such as bovine and caprine semen and bovine embryos. These services are provided to farmers and producers in Senegal, the West African sub-region and central Africa.

In addition to the above mentioned activities, and according to the company’s website, they are also active in the training of resource persons and often hold sessions on AI and embryo transfer nationally and internationally.

In Senegal, the Ministry of Livestock is in fact a strategic partner responsible for carrying out some of its programs, such as the PSIA, expected to be extended over several years.

In this framework the SOPRODEL performed the 2010–2011 PSIA programs in the regions of Senegal with an overall pregnancy rate score of 43% (Ministry of Livestock 2013), which is a normal performance in the case of AI campaign in a real environment.

To meet the expectations of customers and partners, SOPRODEL established a Liquid Nitrogen Plan system, which enables it to supply nitrogen to insemination as well as poultry farmers who have concerns for the conservation of certain types of vaccines. Also in the same vein, an autonomy plan for electricity is set up to safeguard the safety of vaccines it offers to its customers. Other AI providers in Senegal are AFRIVET and Groupement d’Intérêt Économique (GIE) Cap-Vert. AFRIVET is a veterinary clinic located in Diamniadio (Dakar) which develops its activities on cattle AI (importing and distributing bulls and semen and participating in AI state programs), pharmacy and veterinary clinic. The organization known as GIE Cap-Vert, which was a pioneer in distributing germplasm, has become less active over the years and its relative contribution is now minor as compared to SOPRODEL and AFRIVET.

It is difficult to assess the market share of AI providers, as well as the criteria for selecting the germplasm they import. Apart from the state programs, these companies conduct private AI operations about which they are unwilling to disclose information.

Density of exotic cattle breeds in Senegal

Proper data on the population of exotic cattle breeds and crosses is unavailable. Livestock are not systematically recorded in Senegal. The first attempts at physical livestock inventory were held in 2013 and were to be combined with the census of the human population. Regarding crossbreds, another difficulty lies in the fact that the current AI activities take place largely outside official state channels: in addition to the main private operators, a multitude of trained people carry out AI upon request from farmers.

However, it is possible to rank the different regions according to the density of exotic cattle breeds (purebreds and crosses), by cross-checking personal observations, interviews with AI services providers and locations of state AI programs (Figure 10).

Figure 10. Relative density of exotic cattle breeds in Senegal.
The areas with largest population of exotic cattle breeds are Niayes, Groundnut basin and Sylvopastoral zone. The relatively mild climate of the Niayes makes it the favourite area of large modern farms, while the Groundnut basin and Sylvopastoral zone have benefited from state AI programs and projects (PAPEL, PNIA and PSIA).
5. Dairy policy framework in Senegal

5.1 Historical perspective

In general, livestock has long been overlooked in the formulation of agricultural policies in Senegal. This reflects the fact that during the colonial period and the first post-independence years, the focus was on groundnut. The introduction of this crop, which dates from the nineteenth century, has marginalized other agricultural activities.

Indeed, this utilitarian and productivity approach of the rural economy has generated a rise of groundnut trade. Meanwhile, livestock was considered a subsistence activity and enjoyed little attention from the colonial authorities, although there was some infrastructure built in the Sylvopastoral zone for livestock development. This resulted in decisions that still impact on breeding activities in Senegal. Thus, the main livestock rearing area (Ferlo) was not a priority in the eyes of the colonizers because of unfavourable weather conditions for groundnut cultivation. This explains to a large extent the lack of infrastructure in the region and its isolation, making the flow of livestock products to areas of consumption more difficult. Despite the railway reaching Linguere during colonial times, specifically for that purpose, it was poorly maintained afterwards. In contrast, groundnut production areas were equipped with infrastructure (roads, railways ports) to facilitate the flow of the crop to France (Dia 2009).

The priority given to agriculture at the expense of farming was reflected in the organization of services for rural development, since the veterinary service was attached to agriculture service until 1908, the year in which the livestock and epizooties’ service was detached from the agricultural inspection (Dia 2009). The livestock and epizooties’ service, which later became the department of animal husbandry and industry, was initially created to address the successive outbreaks of Rinderpest that decimated the cattle population of French West Africa, namely Chad, French Sudan (known today as Mali), Niger and Senegal (Gallais 1972, cited by Dia 2009). Apart from the livestock protection measures, the French West African animal husbandry department was created between 1920 and 1940 to promote genetic improvement through the erection of experimental stations and the importing and breeding of high quality bulls and rams to improve the local herds (Landais 1990, cited by Dia 2009).

With respect to milk production, the authorities at that time had rapidly concluded that this activity did not deserve substantial investment. According to Doutressouille (1947), the increase in milk production can only be achieved very slowly by selection and improving the maintenance conditions, but the author of the report was also clear that there was no hope of making French West Africa a dairy area. The low productivity of dairy cattle was considered insurmountable and a few initiatives, regarding genetic improvement and fodder crops, were undertaken half-heartedly. Thus, it took until the early post-independence years to see a draft dairy policy with the establishment by presidential decree of a ‘National Dairy committee’ in 1968 (Ministry of Livestock 2005).

That decree was the first attempt to create a formal framework for various initiatives that were taken to promote milk production. Thus, in 1963, a flock of exotic cows from Pakistan (Red Sindhi and Sahiwal) were raised in Dahra then Sangalkam (ISRA research stations), which also housed Montbeliard cows starting from 1976. The aim was to investigate the suitability of these breeds for use in intensive farms located near consumption centres (Diao 1991). Introducing exotic breeds has been followed by attempts to organize milk collection centres. However, they have
mostly been unsuccessful for various reasons (Bakhoum 2006): mismanagement (Union des Coopératives Laitières/UCOLAIT, from 1968 to 1972); lack of competitiveness with imported milk (Groupement d’Intérêt Economique (GIE) Coplait in the 1980s); strong seasonal variability; and low quantities of milk collected (NESTLE Sénégal).

Despite these inconclusive experiences, new projects of milk collection continued to emerge in the different agro-ecological areas of Senegal, namely: Sylvopastoral zone (Linguère and Dahra) and the Senegal River Valley (Saint Louis); Niayes (Dakar); Eastern Senegal (Tambacounda) and Upper Casamance (Kolda and Velingara) and the Groundnut basin (Kaolack).

5.2 Review of policies and regulations relevant to dairy development

The livestock sector, while making up 35% of agricultural GDP, receives only 3% of public investment devoted to agriculture (BCI 2011). This lack of attention obviously affects the dairy subsector. Strictly speaking, there has never been a structured dairy policy in Senegal. The existing legislation with respect to dairy originates from two main sources: laws, decrees, orders and circulars made since independence and the texts prior to independence that have not been abrogated.

‘Dairy policy’ in Senegal is a set of legal and regulatory texts that are characterized by their transversality, whereby the legislative texts that are impacting the livestock sector are not developed under the sole responsibility of the Ministry of Livestock and Animal Resources. They are also initiated by other ministerial departments such as the ministries of agriculture, trade, economy, education and professional training etc. Most of these texts did not have as primary objective the development of the dairy sector in Senegal. However, they benefit the dairy sector indirectly through induced effects on the main determinants of the industry. This body of legislation can be divided into five subsets (Figure 11):

- Livestock development policies
- Natural resources access and use
- Structuring policies
- Fiscal and trade policies
- Macro-economic and national investment policies

Figure 11. Categorizing legislative provisions affecting milk production in Senegal.

With respect to this study, the emphasis is on institutional context, animal health, genetic improvement and germplasm development issues. These are the component of livestock development policies that have direct impact on the dairy sector. The remaining policy aspects, e.g. the points related to natural resource access and use, structuring policies, fiscal and trade policies, macro-economic and national investment policies are discussed briefly to provide some context.

Institutional framework

Framework law on agroforestry and pastoralism—Loi d’Orientation Agro Sylvo Pastorale (LOASP)

- Implementation and operation (Ministry of Livestock 2005)
  Political and agricultural strategies in Senegal in the past decades (withdrawal of the state, privatization and/or restructuring of state enterprises, empowerment of producers, liberalization of prices and markets, decentralization, incentives for private investment) failed to reduce poverty in rural areas.

The lessons learned from this lack of success and the orientation given by the context of regionalized agricultural policy environment under West African Economic and Monetary Union (WAEMU) and Economic Community of West African States (ECOWAS) and the new international policy and international context (AGOA, World Trade Organization, New Partnership on Africa’s Development, European Union/Africa, Caribbean and Pacific countries agreements etc.) prompted the government to initiate LOASP. This law (no. 2004-16, 16 June 2004) articulated a long-term vision (20 years) and constituted the basis for development and implementation of operational programs such as the PNDE.

The law was founded on the following guiding principles: economic efficiency, social equity, sustainability, economic liberalization, decentralization, subsidiarity and solidarity, subregional competition, the common agricultural market within WAEMU and ECOWAS. These principles resulted from the political, economic and social objectives of the government included in the Strategic Document for Poverty Reduction (DRSP). The LOASP was organized around five structures:

- **Title 1** referred to as ‘General Provisions’ contains two chapters related to objectives, priorities and axes of the act.

- **Title 2** referred to as ‘agricultural professions, organizations and farms’, comprises three chapters dealing with formally recognizing careers in agriculture, agricultural professional organizations, socially protecting persons in the farming profession and the legal status of farms.

- **Title 3** focused on ‘agroforestry—pastoral strategies of development’ and comprises eight chapters dealing with land reform, diversification, value chain development and markets regulation, water management, development of infrastructure and public services in rural communities, promotion of social equity, protection against natural disasters and risks associated with agricultural activities.

- **Title 4** deals with ‘supporting measures’ and addresses agricultural information, education and training to agricultural professions and empowerment of farmer’s organizations.

- **Title 5** deals with ‘Miscellaneous and final provisions’: The act enshrines creating the High Council dealing with agricultural, pastoral and forestry issues.

The act was part of an iterative process involving all stakeholders and was supposed to be gradually complemented by other laws and regulations.

- **Main results**
  The strategic axes of the law such as a formal recognition of careers in agriculture and agricultural organizations, social protection of farmers, land reform, legal status of farmers, infrastructure and service development in rural areas, empowering agricultural professional organizations, developing agroforestry—pastoral research, and funding of agroforestry—pastoral development enacted in the LOASP are expected to have major impact in livestock development in Senegal.
New Sectoral Initiative for Livestock Development (NISDEL)

- Implementation and operation (Ministry of Livestock 2005)

NISDEL is an action plan designed in 2004 with the overall objective of accelerating the development of animal husbandry to benefit from the opportunities the subsector could present for the socio-economic development of Senegal. Its aims are, among other things:

- securing livestock asset, accelerating the modernization and diversification of sustainable production systems;
- ensuring the quality and traceability of animal products;
- strengthening internal markets;
- developing a new dynamic for external market access; and
- reducing poverty and malnutrition by increasing incomes.

The action plan was built around three major strategic pillars:

- The securing of livestock asset;
- The program for the consolidation of the production environment (strengthening food safety and animal health protection by medical prophylaxis of livestock); and
- The implementation of a production intensification program through the creation of modern private farms, the establishment of a support fund for animal sheds (FONSTAB) and Centres for Modernization of Livestock (CIMELs).

Main results

The FONSTAB was created by Decree no. 2007—1353 of 6 November 2007. It is the operational arm of NISDEL designed to facilitate the financing of all farming activities legally recognized in Senegal. The year 2009 was marked by the effective starting of operations and completion of financial and institutional structure of the FONSTAB. To date, 179 projects have been funded for a total of USD 1.8 million (XOF 865 million) (Ministry of Livestock 2013).

National Program for Livestock Development (PNDE)

- Implementation and operation (Ministry of Livestock 2005)

As part of the implementation of the LOASP, the Ministry of Livestock led the development of the PNDE as a framework for the implementation of the proposed interventions in the livestock sector. The general approach follows the strategic guidelines defined in the policy document for economic and social development. The challenges are defined in four strategic axes:

- Axis 1 ‘Improving the productivity and competitiveness of the livestock sector’, aims specifically to improve health and zootechnical condition of the livestock population, through the following action lines: (i) preserving and improving animal health, (ii) improving breeding lines in different agro-ecological zones, (iii) improving the genetic potential of livestock, (iv) developing and disseminating innovative techniques and technologies, (v) strengthening the technical capacity of stakeholders in the various sectors and (vi) increasing the organizational and management capacity of actors.

- Axis 2 ‘Creating an environment conducive to developing breeding systems environment’ emphasizes the following lines: (i) jointly managing pastoral resources, (ii) improving food availability for livestock, (iii) strengthening the facilities, infrastructure and equipment, (iv) opening of the high-potential areas of animal production, (v) supporting the professionalization of farmers and (vi) upgrading the suburban farming.

- Axis 3 ‘Improving the marketing of animal products’ for which the overall objective is to ensure the quality of animal products and protect public health by eliminating the risk of infection to people (zoonoses and food-borne illnesses). Specifically, it will (i) ensure the marketing of quality products, (ii) meet the requirements of domestic and foreign demand, in its diversity and in its entirety and (iii) enhance the safety of foodstuffs of animal origin.
• Axis 4 ‘Strengthening institutional framework’ that aims at improving the management of the livestock sector, acting on the actors (farmers, agropastoralists, other livestock professionals, private practitioners and the Ministry of Livestock) and institutions (technical services of the Ministry of Livestock).

• Main results
  The PNDE has just become operational (early 2013) and there has not been enough time to assess its effects. There is a lot to be seen how this program will impact livestock.

Senegalese Dairy Board (SDB)

• Implementation and operation
  The SDB was established by ministerial decree in 1997 and linked to the Animal Industry Division within the Department of Livestock with following missions:

• Participate, among others, in dairy development policies, programs and projects; the definition of genetics policy, monitoring and supporting their implementation in relation to the CNAG; the definition of objectives in the sector in collaboration with the relevant departments; techno-economic studies to all interested operators to make technological choices adapted from profitable dairy processing models;

• Facilitate consultation and coordination between public and private operators and farmers to improve the provision of services for the production, such as technical advice, credit, supply of inputs, marketing etc.;

• Disseminate technical and economic information to farmers, processors and their industrial and commercial partners in collaboration with specialized public institutions and farmers organizations;

• Monitor and advise producers and dairy processing units;

• Promote the development of techniques for processing and storage of milk and milk products;

• Assess the needs and opportunities to promote the collection, preservation, processing and packaging dairy products;

• Establish database on feasible projects in the field of production and dairy processing at national and regional levels; and

• Inform producers on trade opportunities at subregional, regional and international levels.

• Main results
  Since its inception, the SDB has been involved in training in good hygiene practices and dairy quality, training in milk processing, and participating in the conception of dairy projects (PRODELAIT, PSIA).

Relevance of the institutional framework to dairy development

LOASP: The strategic pillars previously mentioned are expected to have an impact on livestock and dairy development. More specifically, the PNDE is articulated around topics relevant to dairy: adequate animal health; improved breeding lines across agro-ecological zones; higher genetic potential for livestock; developing and disseminating innovative techniques and technologies for adequate animal health.

The total volume of milk consumed in Senegal was 250 million litres at the launch of the NISDEL in 2004, of which half came from imports. Imports held constant, the NISDEL aimed to target a domestic milk production of 309 million litres by 2015, to raise the per capita consumption from 27 to 40 litres. For that, the following measures were planned:

• Putting 230,000 in animal stalls with the support of FONSTAB

• Establishing Centres for the Modernization of Livestock (CIMELs). Seven centres were included in the program, three of which had functions in relation to milk production. The CIMEL of Dahra (264 km from Dakar, in the
Sylvopastoral zone) will host the centre of AI; the CIMEL of Mbakhana (18 km northeast of Saint Louis, River valley) will be the centre for multiplying heifers, in charge of distributing heifers to dairy farms and disseminating semen for animal breeding; the CIMEL of Niayes (Sangalkam, in Dakar region) will be in charge of disseminating purebreds and multiplying crosses. These CIMELs will also provide support for the collection and processing of milk (mini and modern dairies) and promote the development of food rations to enhance animal fattening and dairy production (MAH 2004).

- Creating Modern Private Farms (MPFs). Establishing modern private farms was based on the extension and use of modern farming techniques previously experienced in the CIMELs. Units of bovine milk production (UBMP) were settled to develop milk production by exploiting crossbred cows from crossing indigenous breeds with exotic dairy breeds. The expected milk yield was around 10 litres/day per cow. The UBMP identified were located in the following regions: Dakar, Thiès, Saint Louis, Tamba, Kolda, Kaolack and Fatick. Nevertheless, this device is not yet fully operational.

Assessing the institutional framework

At the institutional level, LOASP provides a framework and a vision for the future of agriculture, including livestock, over a period of 20 years. It also provides a vision and strategic guidance to the PNDE for developing the livestock sector, with the objective of increasing livestock production, including milk.

Despite its multiple prerogatives, the dairy board is in fact an ‘empty shell’. It is inadequately staffed with a single veterinarian. It also lacks the adequate logistical means to monitor field activities (farms and dairies), efficient hardware, and capacity building of field agents in the dairy industry requirements, which makes it difficult to monitor and advise the mini-dairies, and to collect and send feedback information from field level to management. Moreover, the SDB has no independent budget and its activities are funded by the DIREL (Livestock Directorate).

A restructuring of the institutional architecture to establish an authority responsible for the conception, coordination and control of dairy policies would be an excellent starting point. The SDB could play this role, provided that its structure, funding and functions are redefined and strengthened.

Animal health policies

Animal health accreditation mandate

- Implementation and operation (Ministry of Livestock 2005)
  The Animal Health Accreditation Mandate (AHAM) was implanted in two steps: the first was a presidential decree (no. 95–645, 6 July 1995) and the second a ministerial order (no. 11047, 4 December 1995) which set out the practical arrangements.

Prior to that, mandatory prophylactic measures against animal diseases were under the exclusive prerogative of state veterinary services. However, due to poor performance in the mid-1980s, which could be attributed, among other reasons, to the declining number of civil servant veterinarians as a consequence of the privatization of this function, entrusting the execution of prophylactic campaigns against the noticeable bovine diseases (Rinderpest and CBPP) to private veterinarians. However, control of compliance was the responsibility of public veterinary services which ensured that the technical requirements of the program were being met by private veterinarians using random serological tests.

- Main results
  The results were mixed. While Senegal was declared free of Rinderpest (ME 2005) and CBPP has been under control for many years, vaccination coverage for other diseases remains relatively low.

Animal health policy

- Implementation and operation (Ministry of Livestock 2005)
  A new animal health policy was established by presidential decree (no. 2002-1094, 4 November 2002) repealing and replacing that of 5 July 1962.
Updating the 40 years old policy was necessary in light of the many changes that occurred in animal health context in Senegal in recent years and to better reflect the developments in trade of products of animal origin. Furthermore, new guidelines in the livestock subsector, namely liberalizing veterinary medicine, privatizing input delivery, increasing producer empowerment and withdrawing the state from commercial activities required a new legal framework.

The globalization of trade, in the aftermath of the GATT (General Agreement on Tariffs and Trade), and the need to comply with the health standards of World Organisation for Animal Health (OIE), imposed an overhaul of the legislation in order to eventually export products of animal origin. Thus, updating the decree 62-0528 of 5 July 1962 has been proposed to bring suitable innovations to promote the modernization of farming and support its sustainable development.

That is how the list of notifiable infectious diseases was revised to fit the new epizootic context and the liberalized international trading system. In addition to the CBPP and Rinderpest, other bovine diseases of economic and public health importance were included in the list of reportable diseases in the updated decree: Lumpy Skin disease (LSD), hemorrhagic septicemia, Heartwater, Anthrax, bovine spongiform encephalopathy (BSE) and Foot and Mouth disease (FMD).

This decree was a major paradigm shift because livestock health was seen as a major factor of production that farmers should bear mainly with the paid-support of private veterinarians. It also moves the focus not only on diseases with high morbidity and mortality potential, but to include those which are less dramatic yet which cause considerable economic loss, such as FMD and LSD.

- Main results
  The main result of the Animal Health Policy is the inclusion of LSD, hemorrhagic septicemia, anthrax and FMD in the public vaccination programs.

National program against trypanosomosis (NPFTTS)

- Implementation and operation (Ministry of Livestock 2005)
  The National program against Trypanosomosis was established through a ministerial decree in 2004. The general objective was the fight against poverty by means of sustainable development of the livestock sector. The specific objective was eradicating tsetse flies across the country.

The NPFTTS included a ‘development’ and a ‘research’ component. The latter was assigned to ISRA.

The tasks assigned to the program were: making an inventory of areas infested by tsetse flies; developing and implementing control plan against tsetse flies and trypanosomes; training of all the technicians involved in the control plan; ensuring regular monitoring and evaluation; assessing the impact of the presence of tsetse flies on animal health; and publishing information on the level of advancement of results. A steering committee that included all relevant stakeholders (ministries of livestock, scientific research, ISRA, EISMV, IRD etc.) was formed to monitor the program.

- Main results
  The data collection and the distribution maps of tsetse and trypanosomosis are finalized (Ministry of Livestock 2013). Technicians have been trained in entomological and parasitological monitoring. The national laboratory for veterinary research (LNERV) is equipped with a modern insectarium. Tests of sterile males to be used for biocontrol purposes have begun.

National Epidemiological Surveillance System of animal diseases (NESSAD)

NESSAD was established by ministerial decree (no. 005917, 25 February 2005) and mandated to adapt the existing animal disease control to the new context of globalization of trade and risk related to the exchange of animals and animal products according to the standards set by the OIE. NESSAD has the following objectives: (1) to detect and place under surveillance any recurrence and/or reintroduction of animal disease eradicated in Senegal; (2) to detect
the introduction of new diseases; (3) to determine the importance of diseases by studying their prevalence and their economic impact; (4) to evaluate interventions against animal diseases; and (5) to provide epidemiological information to assist in the decision-making regarding disease mitigation strategies.

Its tasks were to: conduct investigations in cases of outbreaks; organize the collection, processing, analysis and publication of any epidemiological information; design effective intervention strategies against animal diseases; conduct public awareness campaigns regarding intervention against disease outbreaks; implement early warning and rapid reaction systems regarding outbreaks; and provide training to all relevant stakeholders.

NESSAD included a steering committee, a technical coordination committee and epidemiological surveillance networks for animal diseases. It was operated by the directorate of livestock production.

- Main results
  NESSAD takes into account 13 priority animal diseases and allows for early warning for rapid response. In the specific case of cattle, it may be emphasized: 1.3 million were vaccinated against LSD in 2010 vs. 110,400 in 2009; 54,400 against FMD; 151,000 against haemorrhagic septicaemia; 96,600 against botulism; 50,000 against Blackleg; and 12,500 against anthrax (Ministry of Livestock 2011).

Control of imported products in the bovine sector

The program on the control of imported products in the bovine sector had its origins in a technical note from the director of livestock to his staff (no. 1558/MAE/DIREL). This note was taken in the wake of the news related to BSE. Senegal lacks the technical means for definitive diagnostics, such as specialized equipment and highly trained technicians. A definitive diagnostics based on clinical signs alone is nearly impossible. Hence a precautionary approach was adopted. It was justified by the impossibility to establish a traceability system and the inability to manage the risks on importing bovine, ova and embryos, as well as meat and derivatives. Thus, the decision was made to deny a certificate of safety to meat, ova, embryos and bone meal from countries where cases of BSE have been confirmed.

Regarding countries where BSE has not been detected, the import of ova and embryos were allowed only under the following conditions: requirement of an international veterinary certificate attesting that animals had not eaten food containing meat meals and/or bone meals for six years, there was a tracking system to locate the farm of origin of the cattle, and to ascertain that cattle were not born from females suspected to have the disease.

- Main results
  Since then, importing germplasm from countries that are not certified free from BSE (‘BSE free country’) is prohibited in Senegal.

Relevance of animal health policies to dairy development

Animal health policy in Senegal is essentially based on four pillars (animal health accreditation mandate, animal health policy, NPFTTS and NESSAD), aimed at ensuring good health conditions for cattle, the first input for a proper milk production.

The introduction of health mandates has indirect effects on dairy development. But they are not less tangible since the mass vaccination against CBPP and Rinderpest has significantly contributed to increase the size of the dairy herd by reducing the morbidity and mortality associated with these diseases.

African animal trypanosomosis (AAT) is one of the main constraints to the development of more effective cattle production systems. The main areas of prevalence of the disease are the regions of Kolda and Tambacounda. Other areas infested by tsetse flies are les Niayes and la Petite Côte. An epidemiological survey conducted at the bovine herd level in these areas revealed a serological prevalence of 28.7%, 4.4% and 0.3% for *Trypanosoma vivax*, *T. congolense* and *T. brucei*, respectively (Seck et al. 2010).
These areas have particular meteorological and ecological characteristics that provide great potential for animal production, but are still infested by the tsetse species. Whereas Kolda and Tambacounda contain 42% of the Senegalese cattle population (Dia 2009), almost all systems of intensive dairy production are concentrated in les Niayes and la Petite Côte: that highlights the relevance of the NPFTTS in the development of the dairy sector in Senegal.

Germplasm importation and distribution, including AI using semen from exotic dairy breeds, constitutes a cornerstone of the dairy policy in Senegal. Thus, the assurance that imported bovine products (semen, ova and embryos) meet the requirements of biosafety is essential to success.

Animal health policies provide a framework to fight against major diseases affecting cattle in Senegal with some degree of success. As a result, the country is relatively free of major epidemics that could affect dairy herd.

Germplasm development policies

Genetic improvement policies are an important component of the economic and agricultural development strategy in Senegal. Indeed, the daily production of indigenous cattle breeds is very low, ranging from 1 to 3 litres, depending on the season and the availability of fodder. Initiatives undertaken in recent decades consisted of the introduction of exotic breeds recognized for high milk production, as well as the practice of AI to produce crossbreds that have milk yields higher than the local breeds, while being better adapted to the tropical environment than the introduced exotic breeds.

National Committee for Genetic Improvement (NCGI)

- Implementation and operation (Ministry of Livestock 2005)
  NCGI was established by ministerial decree (no. 1764 MDRA-CT2, 7 February 1989). It was tasked to make propositions on any issue related to the genetic improvement of domestic animals. The specific objectives were:
  - Coordinating all organizations involved in genetic improvement;
  - Establishing all the recommendations necessary to develop sectoral breeding policies in conjunction with the competent authorities;
  - Examining development projects and research programs involving animal genetic improvement and making recommendations thereon; and
  - Studying and proposing measures likely to favour the promotion, selection and dissemination of genetic material, according to the needs of the livestock sector.

NCGI members were selected by the Minister based on a proposal from the authorities to which they belong. The director of animal husbandry and the director of ISRA were responsible for executing the order.

- Main results
  Since its inception, NCGI has been involved in producing frozen bovine semen and liquid nitrogen, training AI technicians, providing technical support for AI technicians for executing the AI national campaign, and overseeing the implementation of AI programs under the Millennium Villages project.

Genetic Improvement Act (GIA)

- Implementation and operation (Ministry of Livestock 2005)
  The long-term and potentially irreversible consequences that genetic manipulation can have on livestock require a precautionary approach in disseminating improved breeds. The local breeds though less productive than their exotic counterparts are well-adapted to the local environmental conditions. So any program that could lead to
changing or diluting the genetic make-up of indigenous breeds requires a thorough and rigorous process. Hence the Genetic Improvement Act (GIA) (no. 2002-24, 26 November 2002) was proposed to secure, moralize and organize the use of genetic material for the improvement of local domestic breeds (mainly cattle, sheep, goats, equines and pigs). It defines genetic improvement and public breeding; specifies the scope of genetic improvement; and defines the conditions of production, importation and distribution of germplasm.

Under this act, both within-breed selection (e.g. process of accumulating favourable genes in a given population) and crossbreeding between two or more breeds (e.g. process of combining within a new population favourable traits from two or more breeds) are considered as genetic improvement. The law accompanying the decree in its application regulates the standards for the selection, introduction and dissemination of breeders and guarantees the genetic and sanitary requirements for the importation and export of breeders, semen, and embryos, and regulates the exchange of such materials at national level.

The dissemination of breeders, embryos and semen were subject to a prior approval by the Ministry of Livestock. Only authorized structures accredited by the Ministry of Livestock are allowed to produce, import, store, and distribute semen and embryos for which some restrictions exist under the state AI programs. The law provides sanction for any violation of the act. For instance, a prison sentence between six months to two years and fines up to XOF 10 million were foreseen for any person found guilty of:

- Deception or attempted deception on assessing any attributes that determine the value of a stock, including the health status of the animal offered for sale, sold or used for natural breeding or AI, or the value and health status of semen and embryos.
- Fraudulent practices related to the sale or attempted sale, use or attempted use of semen and embryos not meeting, because of their origin or conditioning, the alleged standards.

Application decree of the law on genetic improvement of livestock species

- Implementation and operation (Ministry of Livestock 2005)

A competitive livestock sector requires, among other actions, some genetic enhancement of the indigenous stock to increase their productivity and better enable the livestock sector to play its strategic role in poverty alleviation. This justified the establishment of program of genetic improvement to be carried out over the long run with well-defined objectives and the required means for its adequate implementation.

Thus, the decree 2007-544 was the application decree of the above mentioned act (2002-24) on genetic improvement of livestock species. It specifies the conditions for implementation of measures enacted in the Genetic Improvement Act.

- Main results
  The aim of the decree was to make the GIA operational. However, this objective remains theoretical because it lacks guidelines to implement the principles.

Creation and organization of the National Centre for Genetic Improvement (NCGI)

The NCGI was established by ministerial decree (no. 006137/MEL/DIREL, 9 November 2005). Its general objective was to contribute to self-sufficiency in meat and milk and fight poverty. The specific objectives were:

- Contributing to a genetic improvement policy to increase in potentials for producing meat and milk; producing and disseminating animal semen for AI;
- Promoting embryo transfer;
- Training technicians and producers in animal biotechnology; and
- Keeping the pedigrees used for the semen production up-to-date.
The NCGI was managed by a director appointed by ministerial decree. A steering committee was formed to assist the director to coordinate, control and monitor the activities of the NCGI. The steering committee included all relevant stakeholders: public authorities; associations of dairy producers; AI technicians; CIMEL; ANCAR (National Agency for Rural and Agricultural Counsel); directorate of biotechnology and ISRA, to name a few.

Funding of the NCGI was provided by proceeds from the sale of semen and embryos, service provision, allocation of state and various other contributions.

The director of livestock production and the director of PAPEL were responsible for executing the ministerial order.

Assessing germplasm development policies

The legislative system governing the breeding operations is available, namely the Genetic Improvement Act and the subsequent application decree, which deals with the conditions for implementing the following issues: disseminating broodstock; introducing methods of exotic germplasm; establishing a national breeding centre; creating centres for producing and depositing semen. The presence of CNAG, responsible for leading all initiatives related to animal biotechnology will provide a better coordination and more visibility. The ongoing implementation of CSAGs is enabling decentralization and better services of AI programs. The CIMELs are expected to have major impact on dairy development, through their functions such as: hosting the centre for genetic improvement; multiplying and disseminating heifers; disseminating semen for AI; disseminating purebreds and crosses; supporting collection and processing of milk; and demonstrating and disseminating research results related to dairy development.

However, this system has gaps symbolized by the deficiencies of the National Centre for Genetic improvement. The AI program is not paired with a clearly defined goal and planning, at least from a conception stand point. Hence, there has never been any performance testing or genetic evaluation made since the early date of the implementation of AI program, dating back to 1994, and no guidelines have been established on how to conduct formal performance monitoring. Initiatives to improve local breeds are taken by farmers in a rather informal way without the support of technical structures, such as CNAG. Importation of breeding animals, seeds and embryos are supervised by the Directorate of Veterinary Services, without the involvement of CNAG. Border control is only documentary: there is no verification of the quality of the germplasm imported.

CNAG infrastructures are inadequate; laboratory seed production stopped operating properly for three years ago. There has not been any maintenance done on equipment since their establishment in 2006. The capacity of production and storage of liquid nitrogen is very weak. These failures are not without consequences, perhaps explaining why the Ministry of Livestock has never used the semen and liquid nitrogen produced by CNAG, including when the centre was operational. The ministry of livestock has always contracted out suppliers who procure their products through importation.

Livestock development projects including genetic improvement programs

The Livestock Support Project (PAPEL)

• Implementation and operation
  The Livestock Support Project (PAPEL) was established in 1992 with funding from the government of Senegal and with the support of the African Development Bank (ADB). The aim of the project, which ended in 2009, was to increase the production of meat and milk in the Senegal Groundnut basin and SylvoPastoral zone.

• Main results
  The results presented are based on project operation between 1995 and 2005. The figures stated are from various sources summarized by Kouamo et al. (2009a). Nearly 5000 cows, located in the Groundnut basin and SylvoPastoral zone were inseminated during these phases. PAPEL was the first project in Senegal to initiate a regional campaign of this magnitude in rural areas, and this was not without consequences on organizing operations and the results
obtained.

- **Pregnancy rate**
  The overall pregnancy rate for the years 1995–1998 was 43.4%. The highest pregnancy rate was obtained in 1996 with 73.6%, and the lowest rate was 37.8% in 1997, probably due to a forage deficit that year. The bad results of 1997 and 1998 could be explained by the inexperience of the newly trained insemination technicians which have been trained by the PAPEL project. They can also be explained by the change in experimental protocol between the years 1995–1996 and 1997–1998. The first two years, AIs were performed after observing heat, while in 1997–1998 the inseminations were performed indiscriminately, 48 hours after removal of the hormonal implant to induce ovulation.

The data (pregnancy and calving rates) presented by the PAPEL project from 2003 to 2005 derived from private insemination providers, to which the AI operations were subcontracted. The overall pregnancy rate for the years 2003–2005 was 51.9% with a non-significant difference between the two campaigns. The pregnancy rate was considered quite satisfactory as it approached the fertility rate to natural service in the Gobra zebu, namely 50–60% (Laminou 1999).

- **Calving rate**
  Referring to the census in January and February 2001, the PROCORDEL (Cooperative Research and Development Breeding Program in West Africa), a regional research network for livestock development in West Africa, there were only 425 calves for 1373 cows inseminated, during the four years of insemination campaigns, which was quite disappointing. Data on the calving rate are lacking for the years 2003–2004 and 2004–2005 because no birth monitoring was implemented (Kouamo et al. 2009b).

**Agricultural Development Project of Matam (PRODAM)**

- **Implementation and operation**
  PRODAM is an initiative born following the 1989 conflict between Senegal and Mauritania. It was initiated in 1995 on behalf of the victims and displaced persons to improve the quality of life of farmers and ranchers in the Matam region. Since 1996, the project included a component AI for improving milk production.

- **Main results (Kouamo et al. 2009b)**
  The wide area covered by the project combined with an extremely difficult terrain led to logistical difficulties that impeded the project activities and their monitoring. Only 384 Gobra cows were inseminated over four years (1996–1999). The recorded data shows low pregnancy and calving rates (35.9 and 26.5%, respectively).

**PDESOC**

- **Implementation and operation**
  PDESOC, for a period of four years and a total cost of USD 18.3 million (XOF 9.7 billion) is funded by the Islamic Development Bank (56%), the Arab Bank for Economic Development in Africa (34%) and the government of Senegal (10%). The project covers areas in the departments of Bakel, Tambacounda, Kolda, Velingara and Kédougou. The overall objective of the project is to help reduce poverty and improve food security through sustainable management of natural resources and livestock development (Ministry of Livestock 2011).

- **Main results**
  The project activities started in 2011 and not in 2008 when it was launched. The project conducted the training of 20 AI technicians and installed secondary centre of genetic improvement (CSAG) in Kolda.
AI programs

National Artificial Insemination Program in Senegal (PNIA)

• Implementation and operation

As part of its development policy of the national milk production, the Senegalese government, through AI, implemented breeding campaigns to improve the productivity of the local dairy cows, based on crosses with seeds of foreign stock, mainly temperate breeds. Three campaigns were conducted in 1999, 2001 and 2004 mainly by private firms using protocols defined on the basis of the specifications of agro-ecological zones. In fact, all the regions in Senegal have, to some extent, benefited from this program. There was no follow-up beyond 2004 due to lack of funding.

• Main results

The results reported are a summary of studies undertaken by Gueye (2003) and Ministry of Agriculture and Livestock. The average success rate has increased from 31% in 1999 to 42% in 2001 (MAE 2002a; MAE 2002b; MAE 2002c; Gueye 2003). Despite the increase in successful cases between the two periods, the same observations were made as in the case of PAPEL pertaining mainly to the lack of experience of AI technicians, geographic dispersion of activities and feeding problems. In addition, other factors such as unsuitable periods when the campaigns were conducted, which led to higher number of failures in areas such as Saint Louis and Louga during the first phase of AI in 1999.

The synchronization methods were not uniform, as both implant-based methods and spirals were used and sometimes within the same region. One of the problems at this level is the high frequency of loss of spirals. For 2004, only the pregnancy rate of cows in the Groundnut basin (Fatick and Kaolack) is available; that amounted to 62% for 2900 cows inseminated. Calving rates are available only for the Groundnut basin (Fatick and Kaolack) for the years 1999 (15.6%). The calving rate was lower than that obtained by the PAPEL project in 1995–1998 in the same region (28%).

All cows inseminated did not undergo pregnancy diagnosis for PNIA project: 63% of the animals were diagnosed in 1999 and 74% in 2001 (Kouamo et al. 2009b). As for the PAPEL project, pregnancy rates presented could then be overestimated.

Special Programme for Artificial Insemination (PSIA)

• Implementation and operation (Ministry of Livestock 2005)

Under the breeding component of the GOANA (Grande Offensive Agricole pour la Nourriture et l’Abondance/ Agricultural Leap for Food and Abundance), it was chosen to boost livestock production through the implementation of the National Program for the Development of the Local Dairy Sector (PRODELAIT). The first step of this program has been the massification of AI, with the objective of obtaining 100,000 crossbred cows by 2012.

The strategy was to inseminate 500,000 cows by 2012 with the expectation that additional milk production of up to 400 million litres would meet a large portion of the domestic demand for milk and dairy products, hence limiting the importation of milk which is weighing heavily on the country’s treasury.

• Main results

The goal of the 2010–2011 programs to inseminate 20,000 cows out of 37,339 registered cows. As of March 2011, 21,112 cows were dewormed, 105% of the targeted population; 20,228 were synchronized and 19,209 inseminated, 96% of the targeted population.

The cumulative number of inseminated cows since 2008 amounted to 100,000 cows, about 20% of the original target of 500,000 cows. The low achievement was attributed to a lack of financial resources to carry out the project, as only about 11% of the necessary funding was mobilized.
National Fund for Agricultural and Agrifood Research (FNRAA)-EISMV project

• Implementation and operation
  The project was funded by the Fonds National de Recherche Agricole et Agro-alimentaire (FNRAA, National Fund for Agricultural and Agrifood Research) and carried out by EISMV, ISRA, ANCAR and the Directorate for women in livestock (DIRFEL). It was a research and development project, which had general objective ‘to confirm and transfer the technique of bovine AI on natural heat in the Senegal Groundnut basin’ (Asseu 2010). To achieve this goal, the project worked to:
  • Strengthen the capacity of farmers for detecting natural heat and cow management (housing and food);
  • Improve cattle genetic through the use of AI on natural heat;
  • Implement food, housing and health monitoring strategies; and
  • Evaluate financially the AI on natural heat and the strategies for food supplementation, stabling and health monitoring.

• Main results
  In 2006, 108 cows were inseminated for an overall success rate (pregnancy diagnosis) of 33.3% (Sawadogo 2007). In 2009, pregnancy diagnosis was 40.5%, but only 37 of the 48 cows inseminated were diagnosed (Habimana 2012).

  The low pregnancy rates were the result of poor maintenance of cows inseminated; very few have been dewormed and received a nutritional supplement, which is essential for the onset of oestrus. The insemination on natural heat requires a strict timetable, and success lies in the prompt observation and reporting by the farmer at the beginning of heat, which is often fleeting in indigenous cows. Therefore, a prerequisite for obtaining good results is careful monitoring (Miguiri 2011).

Relevance of germplasm development programs to dairy development

Since the 1990s, Senegal has opted to promote cattle genetic improvement by means of inclusion and extension of AI in livestock development projects (PAPEL, PRODAM, PDESOC). This option was accompanied by establishing specific AI programs (PNIA, PSIA and FNRAA-EISMV). The direct link between milk production increase per cow and the use of AI in dairy herds have been established long ago (Settergren 1969), although the quality of bulls used is also an important factor.

One of the major advantages of AI is the reduction of the costs and risk associated with maintaining a bull on the farm. The use of AI has cumulative beneficial effects on a dairy herd because of the opportunity of choosing sires that are proven to transmit superior genetic traits. The risk of spreading sexually transmitted diseases or genetic defects is also minimized when AI is used by a dairy farm. The dairy industry has benefited greatly from the use of AI because of the very rigorous selection of the bulls that are used before they are allowed into the AI line-up. Testing of the bulls prior to being used as semen donors is the foundation upon which the success of AI in milk production rests. Testing of the bulls prior to being used as semen donors is the foundation upon which the success of AI in milk production rests. Bull studs can almost guarantee an improvement in body type and milk yield in female offspring sired by elite AI bulls.

Indigenous cattle breeds in Senegal (Gobra zebu, N’Dama taurine and Djakoré, a crossbred of the two) have very limited dairy potential. The acquisition of exotic dairy breeds and crossbreeding with indigenous cattle are considered the best options to significantly increase milk production. Using purebreds is generally limited to modern farms which have adequate facilities, as well as capacities to meet the nutritional and health requirements. Since the vast majority of small dairy farmers are unable to maintain such animals, the option of crosses with local breeds is the most common practice. The crossbred have the dual advantage of being less demanding than exotic breeds and much more productive than indigenous breeds in terms of lactation yield and length, as evidenced by various experiments in Africa (Table 4).
These examples illustrate the importance of AI programs for the development of dairy industry in sub-Saharan Africa. However, AI is not a panacea: while crossbreeds produce additional milk in comparison to the local breeds, there is a cost in obtaining this additional milk (e.g. housing, feed, and healthcare) and other issues to consider (e.g. environmental sustainability of feed supply).

<table>
<thead>
<tr>
<th>Breed</th>
<th>Lactation yield (kg)</th>
<th>Lactation length (days)</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malawi zebu</td>
<td>880.0</td>
<td>260.8</td>
<td>Malawi</td>
</tr>
<tr>
<td>Friesian</td>
<td>4304.4</td>
<td>325.5</td>
<td></td>
</tr>
<tr>
<td>Malawi zebu × Friesian</td>
<td>1803.5</td>
<td>289.3</td>
<td></td>
</tr>
<tr>
<td>Mpwapwa</td>
<td>1591.8</td>
<td>267.4</td>
<td>Tanzania</td>
</tr>
<tr>
<td>Mpwapwa × Friesian</td>
<td>1935.5</td>
<td>311.7</td>
<td></td>
</tr>
<tr>
<td>N’Dama</td>
<td>475.9</td>
<td></td>
<td>Gambia</td>
</tr>
<tr>
<td>Holstein × N’Dama</td>
<td>1444.8</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Jersey × N’Dama</td>
<td>1114.1</td>
<td>311.7</td>
<td>Ethiopia</td>
</tr>
<tr>
<td>Zebu</td>
<td>622.4</td>
<td>271</td>
<td></td>
</tr>
<tr>
<td>Zebu × Holstein-Freisian</td>
<td>2746.5</td>
<td>319</td>
<td></td>
</tr>
</tbody>
</table>

Sources: Developed from Mwenya (2003); Diack et al. (2005); Duguma et al. (2012).

Assessing livestock development projects and AI programs

Livestock development projects and AI programs implemented to develop the dairy sector presented several shortcomings:

- Very low targets
  The objectives targeted by livestock development programs were not ambitious enough to significantly alter the breed composition of the Senegalese livestock population, or improve dairy production and productivity. Indeed, PAPEL realized the AI of only 5000 cows in three phases, while the result was only 768 cows in two phases for PRODAM. And PSIA, which forecasted the insemination of 500,000 cows in five years, has barely realized the fifth of this objective.

By comparison, in Kenya, Uganda and Tanzania, the three East African countries used as reference, the improved dairy herd has been growing on average by 6% per year during the last decades (FAO 2011). In Kenya, the third African dairy producer, the grade cattle population (Friesian/Holstein, Ayrshire, Guernsey, Jersey and crosses) amounts to 3.5 million heads. The Zebu breed represents 70% of the total cattle population, but contributes less than 20% of total milk production from cattle (FAO 2011).

- Poor AI programs records
  The pregnancy and calving rates obtained through AI under PAPEL, PRODAM and PNIA are weak as mentioned earlier. The reasons are various:

- A lack of technical mastery of AI. This is relatively new in Senegal contrary to countries where this technique has been used for a long time. AI is a specialized field and requires training over several months (or even two to three years if the students do not have a suitable background) and sustained practice. Moreover, there are no adequate training programs to enable farmers to care for pregnant cows (once AI is performed) and crossbred animals.

- The extensive livestock production system (AI are done on-farm) combined with the wide geographic area
(groundnut basin and Sylvopastoral zone) targeted under these projects led to significant increase of operating costs through higher technical support costs of AI and serious organizational difficulties of insemination campaigns (Guèye 2003). This is exacerbated by the fact that inseminators must make repeated visits for pregnancy diagnosis or to re-inseminate in the case of negative response. Hence, while instances where AI have been successfully implemented in extensive, sparsely populated livestock areas can be documented in Senegal, these conditions have been identified as a major constraint for the successful implementation of an AI program.

- Feeding constraints led many of the farmers whose herds were selected for AI not to follow the defined protocols on food and housing management. Inseminated cows were taken to pasture, while the protocol stipulated the complete housing of animals until calving. The combined effects of undernutrition and roaming significantly increased the likelihood of abortion and embryonic mortality (Habimana 2012).

- Failures in selecting cows to be inseminated, resulting in the inclusion of animals with poor body conditions in the AI programs.

Adequate reproductive performance is one of the most costly problems facing dairy producers. Many factors influence the reproductive performance of lactating dairy cows. Management factors—such as accuracy of heat detection, use of proper inseminating techniques, proper semen handling, and appropriate herd health policies—can directly influence the reproductive performance of a dairy herd (Lobago 2007). In addition other factors beyond the immediate control of management that may impact fertility include: milk production of the cow, age of the cow and season of year (Hillers et al. 1984). A variety of environmental factors affect the onset of ovarian cycles in the postpartum period and the most important of these are suckling, milk yield, nutritional status and season (Peters 1984). Swensson et al. (1981) suggested that malnutrition, diseases, heat and inbreeding are factors that commonly result in very low fertility in unimproved breeds.

Figure 12. Calving rates in Senegal relative to benchmark.

The elements above illustrate the variety and complexity of the technical considerations when setting up AI programs. PAPEL, PRODAM and PNIA to a lesser extent have initiated AI programs whereas no legislation was available. Indeed, the first efforts to establishing a legal framework for germplasm development have in reality started in 2002, with the Genetic Improvement Act. The absence of a legal framework, and especially guidelines specifying the technical conditions of AI operations, could explain to a large extent the poor results (e.g. lack of diagnostics for pregnancy, improper synchronization methods and poor recording).

- Failures of privatization policies

This section is a summary of interviews with relevant stakeholders. Under the privatization of veterinary services, the public sector veterinary sector is no longer providing AI services, which are entirely under the responsibility of private practitioners such as SOPRODELI and AFRIVET. The privatization option is not without harmful effects. Public authorities have been virtually stripped of their supervisory functions, which has led to the following consequences:
The imports control process, conducted by the Directorate of Veterinary Service, is limited to administrative document verification at the airport, without regard to compliance with zootechnical and sanitary requirements.

There is no effective traceability scheme that could attest to the identity of the bull where the semen was sourced. The authorities rely entirely on private operators’ statements. In other words, private operators are left policing themselves on a matter that could have dire long-term consequences as eluded to earlier.

There are also structural deficiencies in the contract between state and private practitioners due to information asymmetries as the state did not provide itself with the means to confirm a posteriori the diagnosis of the private operators. Pregnancy rates and the remunerations that follow are all based on private operators’ assessments. Therefore, measures to mitigate the risks of exaggerating the rate of positive diagnosis obtained are not effective.

Beyond state campaigns, private inseminators carry out AI operations on request from farmers. In such cases, there are no restrictions on breeds imported, which are determined by mutual agreement between the contracting parties. Currently, there is no data on this AI occurring outside the various state programs.

There is a lack of clear direction in the funding of AI operations. At the beginning of state AI campaigns (PAPEL, PRODAM), the operations were subsidized and the farmer had to pay XOF 10,000 (USD 22). Then under the PSIA, the government decreed the total gratuity. However, the funding actually released were low, obliging farmers interested in AI to directly solicit private inseminators, at prices ranging from XOF 30,000 to 40,000 (USD 64 to 85).

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High AI costs
In a study conducted in Louga, Kébémer, Fatick and Kaolack in Senegal, Kouamo et al. (2009b) estimated the average cost of insemination at XOF 33,797 (USD 72) for induced heat and XOF 25,177 (USD 53) for natural heat in first insemination against XOF 62,247 (USD 130) and XOF 44,660 (USD 94) in second insemination during PNIA. According to Diao (2003), the cost of insemination on induced heat under the PAPEL project in Senegal was around XOF 50,000 (USD 105) per cow inseminated. That is within the same range as the XOF 48,143 (USD 101) for induced heat reported by Diakhounpta (2003) in the Senegal groundnut basin.

AI is, therefore, not within the reach of many farmers. The costs of AI services are relatively high in Senegal; as these figures indicate. The reason as eluded to earlier is primarily the situation of quasi-monopoly under which the importers operate and the relatively low number of service providers and inseminations. Hence, there is no competition among these actors that could bring service fees down, leading Senegal to implement a policy of subsidies to render the procedure accessible to small-scale farmers. However, because of limited budget, targeted goals are relatively modest.

Under the PSIA, the AI operations are fully borne by the government. At first glance, this option is favourable to the massification of AI operations. However, the total gratuity for the farmers was not accompanied by obligations on stabling and monitoring of inseminated cows, which has affected the overall performance of AI operations.

Unmatched dairy genotype to given environments
In the Sylvopastoral zone in particular, many farmers prefer the Guzera breed to European ones. According to their beliefs, the crosses from European breeds are too costly to maintain and poorly adapted to the harsh climate. As a consequence, many crosses from European breeds obtained through AI programs are being smuggled across borders into Mauritania, Gambia and Mali.

Under state AI programs, the farmers have no say in the choice of the breeds used, although some farmers may personally solicit private inseminators to choose a breed type. There are no studies specifying which of the crosses from different exotic breeds used in Senegal are most suited to the agro-ecological regions. However, the Jersey breed is preferred in eastern and southern Senegal due to the small size of the taurine N’Dama found in these areas.

Absence of germplasm standards
The Genetic Improvement Act, its application decree, and the decree appointing the CNAG specify the duties of this structure related to standards on: genetic selection; introduction and dissemination of breeders; quality...
standards with respect to zootechnical and sanitary requirements for the importation and export of breeders, their semen and embryos; germplasm trade at national level. However, the standards have still not been developed. There, therefore, does not exist to date a normative basis (guidelines) upon which to base the control of production, importation and distribution of germplasm.

Other related policies

Other policies that have impact on the dairy sector in Senegal, namely:

• Policies for access to resources:
  These policies are related to land access, water availability and decentralization, especially on matters related to natural resource management, access and use. A sound policy framework regarding productive capital is necessary for any successful investment, especially in dairy production. The relationship between these issues and milk production may not be obvious at first glance. However, for a country where the extensive production system predominates and provides 70% of milk production (Dia 2009), the problem of the isolated remote rural areas and subsequently road infrastructure, as well as water infrastructure, deserves attention. Thus, the National Agricultural Investment Plan (PNIA 2011–2015) involved in constructing and/or rehabilitating boreholes and access roads in forest grazing areas. This will have the dual benefit of improving livestock watering and facilitating the marketing of milk.

• Structuring policies
  These policies are related to organizing the livestock industries, developing producers’ associations and training. For instance, new and/modified laws on collective status (associations, GIE, cooperatives, federations), organizing agricultural and rural schools and establishing training centres are prime examples of such policies.

• Fiscal and trade policies
  They pertain to regulations on tariffs and trade barriers, hygiene and quality of products, internal taxes, importation and export procedures, subsidies and prices control.

• Macro-economic and national investment policies
  They are mainly monetary policy (exchange rates, interest rates) and public research programs.
6 Recommendations

6.1 Benchmark elements

Institutional framework

Policies impacting the dairy industry are diverse and crosscutting. They involve several ministries and include measures that can be considered as direct, such as breeding and animal health, but also indirect measures, such as rural infrastructure, tax policy and decentralization policy. The difficulty in managing policies emanating from multiple government agencies calls for the need to establish a structure responsible for coordinating all policies and provide better vision for all stakeholders. Some African countries experiencing significant growth in their dairy industries (Kenya, Uganda and Tanzania) have taken this path in setting up dairy boards according to the process described below (FAO 2011).

- Implementation process of dairy institutions
  A strong dairy policy includes a participatory process, the determination of clear goals, agreement on how to set priorities and implement them, clear delineation of tasks and a monitoring mechanism for activities designed to improve services and information. The participatory stakeholder consultation process encourages devolution of decision-making powers to where potential contributions for sustainability are greatest. That contrasts with the imposed policies, which formulation was carried out exclusively by the government, stakeholder participation was limited, and the resulting policies tended to face some resistance at the local level and therefore did not work.

While policy formulation is a traditional purview of governments, the ministries responsible for livestock in each country have striven to formulate dairy policies with the assistance of industry professionals through a participatory approach. This has included frequent dialogue with stakeholders, experts, NGOs and the private sector. In order to achieve policy coherence and alignment with broader macro-economic government initiatives, and to ease the consultation process, ministries have tended to propose policy broadly in line with the prevailing socio-economic, political and market environments.

The stakeholders should include:

- milk producers (farmers), including their organizations;
- both formal and informal milk traders, including raw-milk traders and processed-milk distributors;
- both small- and large-scale milk processors, or those who add value to milk in other ways;
- consumers of milk and dairy products, including consumer organizations;
- input providers (animal feed, AI services and veterinary drugs companies);
• the government, particularly the ministry responsible for livestock, dairy board, the public health department, institutes responsible for dairy research, public universities and institutions offering dairy-related courses, and other government ministries making contributions to the dairy industry; and

• Structure and functions of dairy institutions

In the three countries studied, the dairy boards were established under bill enacted by their parliaments. The bills also gave the dairy boards their mandates, functions, objectives and structures. The structures of the dairy boards differ from one country to another, but the overall architecture is essentially the same: In Tanzania, the structure of the dairy board includes a board, a chief executive officer and staff in the three departments of finance and administration, regulatory services and dairy development. In Kenya, the structure of the dairy board includes a secretariat staffed by 10–12 employees, which can be expanded as the need arises. In Uganda, the dairy board is required to have a board of directors consisting of a chair and ten other members. The full board is made up of nine members representing different stakeholder groups, including: the chair, who is appointed by the minister, and representatives of farmers, veterinary association, dairy traders, dairy-processing companies, etc.

The attributions of the dairy boards also defined in the acts are to provide proper coordination and efficient implementation of all government policies designed to achieve and maintain self-sufficiency in the production of milk by promoting production and competition in the dairy industry and monitoring the market for all milk and dairy products (FAO 2011). The dairy boards are specifically charged with facilitating the dairy industry to:

• raise incomes and living standards of small-scale farmers through increasing their returns in dairy farming;

• achieve and maintain self-sufficiency in milk and dairy products and export the surplus;

• increase production in an environmentally sustainable manner (productivity rather than population of cattle); and

• establish a dairy market in dairying and enhance competition in processing and marketing.

• Funding of dairy institutions

Funding sources are varied and reflect the desire to ensure the widest possible financial autonomy to dairy boards: grants from the governments (30% of annual budget in Kenya); milk duties levied on producers; licence fees; levies on imported products; contribution from fees collected on importation of milk and milk products; counterpart funds towards donor-financed grants; any other sources of income identified by the board and legally acquired.

Annual budgets of the dairy boards of Kenya (2007–2008), Tanzania (2006–2007) and Uganda amounted to USD 3.5 million (Kenyan shilling, KES 300 million), USD 308,000 (Tanzanian shilling, TZS 500 million) and USD 85,000 (Ugandan shilling, UGX 215 million), respectively (FAO 2011).

• The legal framework and enabling legislation

In Tanzania, the functions of the dairy board complement other government agencies mandated to undertake work with its own sphere of influence. During the process of drafting the legal framework and the public hearings before it was presented to parliament, stakeholders were wary of the potential for duplicating functions between the dairy board and other government agencies. This problem was avoided by concentrating the dairy board on quality assurance down the value chain, while the Food and Drug Agency (FDA) concentrates on food safety issues during and after processing, and on the retailing of dairy products. Regulations made by the FDA are published by the Ministry of Health, while regulations made by the dairy board are implemented under the authority of the ministry responsible for livestock development.

In Kenya, many public and private institutions are relevant to the dairy industry. However, only a few are involved with dairy regulations. The most important institutions for dairy industry regulation are the two departments of

3. On 22 April 2016, USD 1 = TZS 2197.80.
Ministry of Livestock Development, Kenya Dairy Board (KDB), KEBS (Kenya Bureau of Standards), the Public Health Division of the Ministry of Health, the Weights and Measures Section of the Ministry of Trade, the Kenyan Police and local councils. KDB, KEBS and the Public Health Division are central institutions within the dairy industry regulatory framework. In addition, KEBS implements the standards for dairy products, equipment and handling in collaboration with KDB.

In Uganda, the Dairy Development Authority is the main institution responsible for developing and regulating the dairy industry. However, the Dairy Industry Act recognizes the important roles of other institutions. The 2003 dairy regulations (related to the marketing and processing of milk and dairy products) make reference to compulsory standards and technical regulations under the 1995 Ugandan National Bureau of Standards Act, the 1995 National Environmental Statute and the 1962 Public Health Act (FAO 2011).

**Germplasm production and trade**

The best practices in countries that are references in the field of animal biotechnology are based on the Terrestrial Animal Health Code of the OIE. The code encompasses all relevant fields related to zoosanitary requirements for germplasm production and trade (OIE 2013):

- Conditions applicable to cattle AI centres
- Conditions applicable to semen collection facilities
- Conditions applicable to semen laboratories
- Conditions applicable to the management of bulls
- Conditions applicable to the testing of bulls and teaser animals
- Conditions applicable to the collection of semen
- Conditions applicable to the handling of semen and the preparation of semen samples in laboratory
- Conditions applicable to the storage and the identification of frozen semen
- Requirements for germplasm imports and exports.

**6.2 Restructuring the dairy institution**

Dairy institutions have never been at the core of the design and operational implementation of dairy policies in Senegal. The Dairy National Committee, set up in 1968, went unheeded whereas the current SDB is far from fulfilling its mission to design, control and promote dairy policies. A strong dairy board should avoid duplication of efforts by providing regulatory authorities with clear operational boundaries along the dairy value chain. A restructuring of the SDB could be articulated around the following points:

- Providing human resources with different specialists in the relevant areas of the dairy industry.
- The prerogatives of SDB should be defined in the act to provide proper coordination and efficient implementation of all government policies.
- Funding of the dairy board, alternative sources to supplement the budgetary framework of the state should be explored.
• The legal framework and enabling legislation, to define and delineate the roles of the various institutions that will work collaboratively with the dairy board.

The implementation process of dairy policies should take the following steps:

Relevant stakeholders to be involved in a participatory process to formulate dairy policies and have the widest possible adherence to their operational implementation should be:

• Government/decision-makers, in particular the Ministry of Livestock
• National Centre for Genetic Improvement
• Research/training institutions: ISRA/LNERV, EISMV, Institut de Technologie Alimentaire
• Dairy industries: dairy stakeholders including producers, processors, traders, service providers and consumers from the formal and informal sectors
• Dairy farmers: large-scale (Wayembam, Niacoulrab, Ferme de Pout) medium- and small-scale
• Development partners

Figure 13. Participatory process for implementing dairy policies.


6.3 Implementing guidelines for germplasm development

The introduction of temperate dairy breeds in the country for crossbreeding indigenous cattle has been accepted for quite some time now. In pursuance of this need, private operators have been importing exotic germplasm to produce quality crossbred animals. With the extension of the breeding programs and the artificial breeding network, a surge in demand for exotic germplasm is also expected. Accordingly, the production and importation of germplasm must be from the most appropriate sires, i.e. the choice of germplasm based on suitability to agro-ecological zones and farmers’ preferences. The Genetic Improvement Act and its application decree must be made operational by setting zootecchnical and sanitary standards for germplasm development.
Eligibility of germplasm importers

Genetic and production data/information with respect to the germplasm to be imported should be submitted to the Ministry of Livestock along with application for imports (country of origin, species, breed name, donor number, producer institution, date of production, batch number and volume per package must be clearly labelled, indicating necessary information for tracing the material). Only the entities (including private companies) capable of keeping and maintaining the performance records of exotic germplasm should be permitted to import bovine germplasm (the records will include information from the date of import to the date of disposal to Ministry of Livestock). These entities will be evaluated regularly by the Ministry of Livestock for grant of permission.

The justifications for importation and the future roadmap for using imported germplasm should be supplied with other documents. The quality requirements for import should consider the standard lactation yield, milk fat, protein and somatic cell count and suitability to local conditions.

Standards for germplasm imports

All the applications for the import of germplasm should be examined by a committee within the Ministry of Livestock, specifically created for this purpose. In Senegal, the committee should include members from CNAG, veterinary services and ISRA.

For germplasm imports, the order of preference should be frozen semen and frozen embryos. The importation of live animals shall be allowed only if there is a strong justification.

Regarding health requirements, the guidelines formulated by OIE, Codex Alimentarius and IETS (International Embryo Transfer Society) should be strictly adhered to while importing the genetic material.

Regarding zootechnical requirements, each country has the flexibility to determine its own quality standards, according to its objectives and the level of development of its farming systems. However, the standards must ensure that crossbreeds allow qualitative and quantitative gains in milk production. Most countries require minimum standards for germplasm imports (semen, embryos and live germplasm). Senegal could for example rely on the standards in force in India, which are less stringent than in the industrialized countries, to develop its own (GOI 2013).
7 Conclusions

The study was undertaken to review the policies affecting the dairy sector in Senegal, with an emphasis on germplasm development. It was conducted by combining a desk review with interviews of relevant stakeholders, including director of Veterinary Services, director of Dairy Board, director of SOPRODEL and director of the CNAG, among others. Since 1960, Senegal’s regulatory environment on livestock include 101 texts divided into 25 themes as varied as health, nutrition, genetics, hygiene, trade, transport, land resources etc. One single text (creating the Dairy National Committee in 1968) was specifically dedicated to the dairy sector. This reflects the neglect the sector suffered for many years and/or the lack of a comprehensive vision.

The analysis of dairy policy, therefore, required to sort and underline the texts having an impact on the dairy sector. The most relevant, according to the objectives of the study, were legislative texts on genetic improvement and animal health.

In general, the legal framework for animal health is a positive step for the dairy sector, especially as the exotic breeds and crossbreds are more susceptible to diseases than indigenous breeds. The policy on germplasm development is mainly based on three pillars: legislation (genetic improvement act, creation of CNAG), livestock development projects with a component on genetic improvement (PAPEL, PRODAM, PDESOC) and national AI programs (PNIA, PSIA and FNRAA-EISMV project in a lesser extent).

However, these pillars are weak and do not allow an optimal growth of the dairy sector. AI operations, included in national programs or livestock development projects, are hindered by many factors. The main ones are:

- low targets due to insufficient funding;
- poor AI records (calving records are far from the benchmark);
- failures of privatization (semen quality, donor identity, pregnancy diagnostics not certified by an independent authority and all records are based on the statements of the private operator).

The genetic improvement act and the attributions of the CNAG arise in principle as a legal framework to regulate the germplasm development. In practice this device is inoperative due to the lack of national zoosanitary standards laying down the conditions of production, distribution and import of germplasm (live animals, semen, embryos). The difficulties pertain to the fact that the authorities rely on the statements provided by the private operators. The CNAG, which is better equipped to check the conformity of imported germplasm, is neglected in favour of the Director of Veterinary Services, which just checks documents for administrative purposes.

These findings led to the formulation of recommendations to implement germplasm zootechnical and health standards, based on guidelines set up by the OIE and IETS. At the institutional level, inconsistency in the decision process and the multiplicity of decision centres justify the establishment of a structure responsible for the design, coordination and monitoring of dairy policies. An SDB strengthened in its structure, funding and powers could fulfil this responsibility.
References


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Policy framework for dairy development in Senegal