

## Assessment of Demand and Supply of Biotechnology of Reproduction for Cattle Breeding in the Northern Regions of Cameroon

Justin Kouamo<sup>\*)</sup>, Paul Pa-ana, Andre Pagnah Zoli

School of Veterinary Medicine and Sciences. The University of Ngaoundere. PO BOX 454, Ngaoundere, Cameroon.

Email: [justinkouamo@yahoo.fr](mailto:justinkouamo@yahoo.fr) . Phone: (+237)675376954

### Abstract

The present study was conducted in pre-selected cattle farms on genetic improvement programs through artificial insemination (AI) in the northern regions of Cameroon. The main objective was to assess the demand and supply of biotechnology for cattle breeding. It was carried out on the basis of a survey of 54 breeders and six (06) service providers of reproductive biotechnologies. It consisted of interviews with each operating manager and service provider, while collecting information on the basis of a questionnaire. From this study, it appears that farmers opted for the improvement of dairy genes (79.6%) and chose AI (50%) as a tool to achieve this goal rather than natural mating (48.1%). The low success rate and the prohibitive cost of this technique were the main constraints discouraging farmers from adopting it. The subvention and the zoo-sanitary follow-up were the accompanying measures desired by the breeders. As for the supply, AI on induced estrus was the only technique offered and only one provider (veterinary doctor) has been trained in a specialized institution. The main constraints identified by reproductive biotechnology service providers were semen conservation (100%), breeders' neglect (100%) and unavailability of semen (50%). Four support measures were desired by the service providers, namely a training center in biotechnology of reproduction (100%), grants (83.3%), establishment of a quality control laboratory for semen (50%) and the creation of a semen collection center (33.3%).

**Keywords:** cattle, demand, supply, biotechnology of reproduction, Cameroon

### Introduction

In Cameroon, the livestock sector is dominated by ruminants, including cattle estimated at 5.8 million head (MINEPIA, 2015), which are largely concentrated in the northern regions, accounting for 83% of the national herd (Bouba, 2005). However, despite this size, Cameroon is unable to meet the growing needs of its population in animal proteins (milk and meat); hence a situation of extreme dependence on importation to supply milk and/or meat demand. For dairy products alone, imports in 2007 amounted to 10 921 tons of milk and milk products for a total value of almost 30 billion CFA Francs (MINEPIA, 2009). This

dependence on importation is due to low milk production and low carcass yield of local breeds encouraged largely by the adverse effects of rearing conditions, sanitary coverage, feed constraints and, above all, by low genetic potential of local breeds (Ebangi *et al.*, 2011). Thus, to face the low productivity of local breeds and the currency leakage due to importation, the Cameroonian government has undertaken genetic improvement programs based on selection and especially the improvement of crossbreeding through reproductive technologies, specifically artificial insemination with imported frozen semen. Half-blood products obtained with good

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<sup>\*)</sup>Corresponding author:

Email: [justinkouamo@yahoo.fr](mailto:justinkouamo@yahoo.fr)

production and reproduction performances have aroused great interest among farmers (Kouamo and Paana, 2017). Thus, genetic improvement strategies proposed to breeders have implicitly postulated a uniform demand for gene enhancers, assuming that beneficiaries will accept the genotypes or phenotypes offered as well as the technologies. But, there is a weak adoption of innovations improving livestock production (estrus synchronization, AI and embryo transfer) by breeders who are more skeptical (MINEPIA, 2009). So, given that the geographical location of the farms, the farming methods (transhumant / sedentary), the overall environment of the farmer can influence his genetic and technological choices; it makes sense to ask what is the position of the farmers in the face of this technology offer, because if it is not identified in time, constraints to adoption may arise from this assumption. In view of the different farming methods existing in the northern regions of Cameroon and the cattle breeding needs felt by farmers, this study set a general objective of assessing the demand and supply of biotechnology of cattle breeding in this part of Cameroon in order to know the position of breeders vis-à-vis these reproductive technologies and to identify available offers, constraints related to demand and supply and accompanying measures.

## **Material and Method**

### **Area of study**

This work was conducted from January to June in the northern regions of Cameroon (Far North, North and Adamawa). The choice of these regions comes from the fact that, they represent 83% of the national cattle population (Bouba, 2005) and reproductive biotechnologies are being popularized by the Cameroonian government. The Far North region extending between 10th and 13th North latitude and 13th and 15th East longitude covers an area of 34.262 km<sup>2</sup>. It is characterized by a Sudano-Sahelian climate with two seasons: a short rainy season from June to September and a long dry season from October to May. The mean rainfall is between 400 and 1100 mm per year and the maximum temperatures of 40°C in Maroua and 41 °C in Kousseri are recorded between March and April and the minimums of 16-18°C between December and February, respectively. The North region, extending between the 7th and 10th meridian East, the 12th and 16th parallel North covers an area of 66.090 km<sup>2</sup>. The tropical climate of the Sudanian type with two seasons: a rainy season (May to September) and a dry season (October to April) characterizes the North region. Average annual rainfall is between 100 mm and 1300 mm per year and the minimum and maximum temperatures are respectively 14 °C in December and 40 °C in April. The Adamawa region, located between the 6th and 8th degree of North

latitude and between the 11th and 15th degree of Longitude East extends over an area of 72000 Km<sup>2</sup>. It is characterized by a Sudano-Guinean climate with two seasons, a rainy and dry season. Sometimes up to 7 months of rainfall is recorded per year and rainfall can exceed 1500 mm. The minimum and maximum recorded temperatures are 15.2°C and 29°C, respectively.

### **Data collection**

The questionnaires were developed from personal interviews with some breeders. The designed questions were entered using Sphinx Plus2 version 4.0 software. The survey sheets, tested before, served as a guide for the interview. The interview was done in *fulfuldé* (language spoken widely in the northern regions of Cameroon) directly with breeders. The surveys were carried out among 54 breeders randomly (14, 10 and 30 in the Far North, North and Adamawa regions, respectively) and six (06) service providers (3 in the North and 3 in the Adamawa regions). The breeders were those retained in the Agricultural Productivity Improvement Program (APIP) / Support to Development of the Dairy Sector (SDDS) co-financed by the European Union and the government of Cameroon. One of the objectives of the project was to improve local dairy production through the use of AI, to train, equip and structure the actors of the dairy sector, to secure their incomes and better livelihood.

### **Characterization of Demand and Supply in Reproductive Technology**

It consisted of interviews with each operating manager and service provider, while collecting information on the basis of a questionnaire. For the demand for bovine reproductive technologies, information was collected on known and preferred technologies, preferred animal strategies, speculations and breeds, the reasons for these preferences, and the intended goals. As for the supply, it was characterized on the basis of the following information: the different reproductive technologies offered, effectiveness or not of quality control of the semen, AI on natural or induced estrus and the specialization for the provider.

### **Identification of demand and supply constraints and accompanying measures**

The information collected included the following items: success rate, cost of technology, sex ratio and phenotype and support measures. With regard to supply, the following items were considered: cost of materials, estrus detection, availability of semen, quality of semen, conservation of semen and negligence of farmers with regard to constraints and accompanying measures.

### **Statistical analysis**

For the descriptive analysis, the Sphinx Plus 2 Version 4.0 software was used. This analysis allows to obtain the different proportions, the frequencies, the

averages, the standard deviations. The results were represented in the form of tables. The Chi2 test was used to compare the proportions at the significance level of 5%.

## Results

### Characterization of the demand in biotechnology of reproduction

Each region, according to its geographical specificity, its endowment of resources and its breeding system, has developed a demand for its own reproduction. Reproductive strategies, known technologies, preferred technologies, reasons for preferences and goals are presented in Table 1.

**Table 1: Characteristics of reproduction demand by region**

Variables	Modalities	Adamawa (%)	North (%)	Far-north (%)	Total (%)
Why reproductive biotechnology?	To ameliorate the breed	20 (37.0)	2 (3.7)	7 (13.0)	29 (53.7)
	To increase the productivity	20 (37.0)	10 (18.5)	12 (22.2)	42 (77.8)
	To modernize the farm	12 (22.2)	2 (3.7)	2 (3.7)	16 (29.6)
Favourite speculation	Milk	24 (44.4)	7 (13.0)	11 (20.4)	42 (77.8)
	Meat	3 (5.6)*	0 (0.0) *	0 (0.0)*	3 (5.6)
	Milk and meat	3 (5.6)	3 (5.6)	3 (5.6)	9 (16.7)
Known Technologies	AI	30 (55.6)	10 (18.5)	14 (25.9)	54 (100)
	ET	9 (16.7)	2 (3.7)	5 (9.3)	16 (29.6)
	IE	28 (51.9)	8 (14.8)	12 (22.2)	48 (88.9)
	NE	2 (3.7)	2 (3.7)	2 (3.7)	6 (11.1)
Favorite technology	AI	20 (37)*	4 (7.4)*	3 (5.6)*	27 (50.0)
	ET	0 (0.0)*	0 (0.0)*	1 (1.9)*	1 (1.9)
	Sire	10 (18.5)*	6 (11.1)*	10 (18.5)*	26 (48.1)
Reasons of the choice of technology	AI : SDAMP	37 (67.3)	7 (38.9)	5 (20.8)	50 (50.5)
	ET : IR	0 (0.0)	0 (0.0)	1 (4.2)	1 (1.9)
	Sire: SLR	18 (32.7)	11 (61.1)	18 (75.0)	48 (48.5)
	IE: HW	30 (55.6)	10 (18.5)	14 (25.9)	54 (100)
Favourite breed	Milk	18 (33.3)	8 (14.8)	6 (11.1)	32 (59.3)
	Meat	3 (5.6)*	0 (0.0)*	0 (0.0)*	3 (5.6)
	Milk and meat	9 (16.7)	2 (3.7)	8 (14.8)	19 (35.2)
Relation between technology-speculation	Yes	17 (31.5)*	2 (3.7)*	2 (3.7)*	21 (38.9)
	No	13 (24.1)	(8) (14.8)	12 (22.2)	33 (61.1)
TOTAL		30 (55.6)	10 (18.5)	14 (25.9)	54 (100)

\*= Significant difference. ET: Embryo transfer. IE: Induced estrus. NE: Natural estrus. SDAMP: Saving of difficulties of acquisition and maintenance of parent; IR: Immediate results. SLR: Safe and less restrictive. HW: Harmonize the work.

### **Case of the Adamawa region**

Breeders consider that a breeding strategy is aimed at genetic improvement (37.0%) and increased productivity (37.0%) of their local breeds. For them, genetic improvement and increased productivity seem to be linked. The real goal of reproductive technologies is to improve milk production (44.4%). Breeders surveyed prefer the dairy breed (33.3%) followed by the mixed breed (16.7%) than the beef breed (5.6%). Producing more milk for sale (dairy breed) and ensuring food security (mixed breeds) are the reasons for these preferences. Breeding technologies most known by farmers in the Adamawa region are artificial insemination (55.6%). The most preferred technology by breeders in this region remains significantly ( $P < 0.05$ ) artificial insemination (37%) but, they do not give any interest for the embryo transfer (0%). In addition, 51.9% of the breeders surveyed remain convinced that reproductive technologies, in particular artificial insemination, are practiced only on induced estrus compared to 3.7%, which know their use on natural and induced estrus. Breeders who have chosen artificial insemination find that it saves the acquisition and maintenance of a parent (67.3%) while those who choose the Sire find that it is safe and less binding (32.7%). Significantly ( $P < 0.05$ ), farmers in the Adamawa region (31.5%) link the technological choice to speculation for the simple reason that

reproductive technologies harmonize work and allow predictive production even though 24.1% of them do not make any connections. Breeders of the region are convinced of the relevance of the objectives sought for by reproduction biotechnologies in relation to their local context. Thus, they argue that, given the limited potential of local breeds, reproductive technologies remain the tools to help improve the intrinsic qualities of their local breeds.

### **Case of the North Region**

For breeders in the North Region, the importance of a breeding and genetic improvement strategy lies primarily in the fact that it makes it possible to rapidly increase the productivity of the breed (18.5%). In this region the goal is milk production (13%) followed by mixed production (5.6%). Breeders are not interested in meat speculation (0%). The logic supporting these racial preferences is on the one hand, the strict dairy specialization and on the other hand, the diversification of the sources of income. 18.5% of breeders surveyed in this region are aware of artificial insemination as the only existing cattle breeding technology compared to 3.7% of breeders who, in addition to this, know of the existence of embryo transfer like another technology. 14.8% of producers know that reproductive technologies, in particular AI, are only possible on induced estrus, while 3.7% of

them know that it is also possible on natural heat. But, addressing the issue of technological preference, the majority of respondents (11.1%) opted significantly ( $P < 0.05$ ) for natural breeding compared to AI. No breeder (0%) preferred the embryo transfer. The sire is safe and less restrictive (61.1%), the AI saves difficulties of acquisition and maintenance of a parent (38.9%), are the reasons put forward by farmers to justify their technological preferences. 14.8% of the breeders surveyed do not link the speculation to the preferred technology ( $P < 0.05$ ). Breeders in their entirety are convinced of the relevance of the objectives sought for by reproduction biotechnologies in relation to their local context characterized by low genetic potential of local breeds, degradation and rarefaction of pastures.

### **Case of the Far North Region**

Considering that the productivity of the breeds that they own is poor, breeders in the Far North region (22.2%) have chosen the biotechnology of reproduction to increase productivity. When choosing a breed of preference to improve productivity, 14.8% of respondents prefer the mixed breed (which produces milk and meat) without any one being able to choose on the beef breed (0%). The reasons for these choices come from the fact that, with the mixed breed, in addition to its hardiness, they take advantage of both speculations (milk and meat). 25.9% and 9.3% of

breeders surveyed know of the existence of AI and embryo transfer as reproductive technologies respectively. 22.2% of them say that AI is only possible on induced estrus while 3.7% of them know its use on natural heat. When it comes to displaying their preference for a reproduction technology, a significant difference is observed ( $P < 0.05$ ). 18.5% of these breeders have a preference for natural breeding compared to 5.6% for AI and 1.9% for embryo transfer. The logic underlying these choices is that the parent is safe and less restrictive (75.0%), the AI saves difficulties of acquisition and maintenance of a parent (20.8%) and the transfer embryo gives an immediate result (4.2%). When asked to assess the relevance of such a strategy in their local context, the breeders all agree on its relevance due to the degradation and rarefaction of pasture on the one hand and low genetic potential of local breeds on the other hand. In the Far North of Cameroon, the majority of breeders (22.2%) do not establish a link between speculation and the preferred technology even if 3.7% of respondents manage to make this link.

### **Constraints related to the adoption of reproductive biotechnology and accompanying measures desired by farmers**

The main constraint in all three regions remains the low success rate (81%) followed by the prohibitive cost (79%). They also raise the problem of sex ratio (50%).

However, we notice that some breeders, particularly those in the Far North region, still attached to the phenotypic characters and preferred particularly white animals with horns. Whatever the preferred speculation, the constraint most cited by the farmers surveyed was the prohibitive cost of production (90.7%). These breeders are also faced with the difficult problem of marketing their produce, especially those in the North and Far North regions. Some of the

breeders consider that it takes too long for the product from crossbreeding to begin its first production (milk). As support measures, the subsidy remains the most sought-after support measure by the farmers surveyed (96.3%). However, some of them, faced with the recurring problems of the pathologies, want the zoo-sanitary assistance to palliate these animal health problems which hinder the productivity and the production of their flock (Table 2).

Table 2. Constraints related to the adoption of reproductive biotechnology and accompanying measures desired by farmers

Variables	Modalities	Adamawa (%)	Norht (%)	Far-north (%)	Total (%)
Constraints to adoption of proposed technologies	High cost	25 (46.3)	8 (14.8)	10 (18.5)	43 (79.6)
	Low success rate	27 (50)	8 (14.8)	10 (18.5)	45 (83.3)
	Bad Phenotype	0 (0)	0 (0)	2 (3.7)	2 (3.7)
	Sex ratio	13 (24.1)	6 (11.1)	9 (16.7)	28 (51.9)
Constraints associated to the speculation	Cost of production	29 (53.7)	9 (16.7)	11 (20.4)	49 (90.7)
	Wait delay	5 (9.3)	1 (1.9)	4 (7.4)	10 (18.5)
	Flow to product	1 (1.9)	3 (5.6)	8 (14.8)	12 (22.2)
Assistance measures wished	Subvention	30 (55.6)	10 (18.5)	12 (22.2)	52 (96.3)
	Zoo-sanitary assistance	14 (25.9)	4 (7.4)	6 (11.1)	24 (44.4)
TOTAL		30 (55.6)	10 (18.5)	14 (25.9)	54 (100)

#### Characteristics of providers offering reproductive biotechnology

Six biotechnology service providers in total are present only in the regions of Adamawa (3) and North (3). They are all male with an average age of  $37.5 \pm 8.22$  years. Regarding their level of study, there are two veterinary doctors, an agronomist, two livestock technicians and a veterinary nurse. Only one provider (veterinary doctor) has been trained in AI in a specialized institution (Nigeria and Israel) while the

remaining 05 except are trained by the APIP/SDDS project.

Artificial insemination (AI) remains the only reproductive technology offered by all service providers in the northern regions of Cameroon. 05 out of 06 surveyed do quality control of the semen they import at the Institute of Agricultural Research for Development (IARD) of Ngaoundere. All providers practice AI only on induced estrus (Table 3).

### Constraints and accompanying measures desired by providers

Three main constraints were identified by reproductive biotechnology service providers: semen conservation (100%), breeder's neglect (100%) and unavailability of semen (50%). Four support measures

were desired by the providers, namely a training center in biotechnology of reproduction (100%), the grant (83.3%), the establishment of a laboratory for quality control of the semen (50%) and the creation of a semen collection center (33.3%).

Table 3. Characteristics of the supply in biotechnology of reproduction

Variables	Modalities	Adamawa	North	Far-north	Total
Reproductive biotechnologies offered	AI	3	3	0	6
	ET	0	0	0	0
	IVF	0	0	0	0
	Other	0	0	0	0
Control of quality of semen	Yes	2	3	0	5
	No	1	0	0	1
Structure to control	IARD	2	3	0	5
Type of estrus before AI	Induced	3	3	0	6
	Natural	0	0	0	0

AI: Artificial insemination. ET: Embryo transfer. IVF : in vitro fertilization.

### Discussion

The breeders surveyed are convinced (100%) of the relevance of genetic improvement strategies given the low productivity of their livestock. Dairy production as a target (79.6%) overlaps farmers' interest in dairy speculation (77.8%) and dairy breed preference (59.3%). These results are similar with those reported by Yahimi *et al.* (2013) in Algeria and Santos *et al.* (2016) in Brazil, were respectively 63% and 67.8% of the breeders surveyed preferred dairy speculation. However, these results differ from those obtained by Sawadogo *et al.* (2009) in Senegal where 74.25% of breeders opted for mixed breeds (milk and meat). This difference could be justified by the ambition of the breeders to

satisfy the demand of the small dairy units implanted by the Cameroonian government in the northern regions, by the proximity of most of the surveyed farms of the chief towns of the departments and / or the regions where the demand for milk and dairy products (restaurants where the Pendidam "fermented milk" and the Kindirmu "local yogurt" are sold) is quite important. Milk production provides a source of monthly income, in contrast to the seasonal production of meat, they said. Thus, it allows a greater liquidity, since the owners can sell the milk and when the time comes (especially for reform), the animal in question. The majority of breeders prefer AI (50%) as breeding technology versus 48.1% for natural breeding. Kouamo (2007) in



Louga (Senegal) and Santos *et al.* (2016) in Brazil obtained opposite results in which respectively 58.75% and 63.9% of farmers opted for natural breeding. This difference could be explained by the fact that most of the operators surveyed in this study find that the acquisition and maintenance of a parent is very difficult in their local context. This means that by improving the success rate of AI and reducing its prohibitive cost, more farmers will adopt this technique which is crucial especially on dairy farms where the context "one year, a calf" is appropriate. Santos *et al.* (2016) in Brazil and Uddin *et al.* (2010) in Bangladesh reported that milk production remains high in AI farms compared to those using natural breeding. Indeed, 88.9% of breeders know induced estrus as the only method allowing the achievement of AI against 11.1% who know the existence of methods of AI on natural and induced estrus. These results confirm those obtained by Asseu (2010) in the Kaolack region of Senegal where 85% of breeders only know the AI method on induced estrus compared to 15% who know of the existence of two methods. The lack of knowledge of natural estrus detection before AI by most of the breeders surveyed in this study is justified by the fact that the method presented by the service providers is only AI on induced estrus.

The low success rate and the prohibitive costs of AI as major constraints discouraging breeders from adopting reproductive technologies are similar to the

results obtained by Sawadogo *et al.* (2009) in Senegal and Santos *et al.* (2016) in Brazil, where respectively 47% and 64% of farmers cited the prohibitive cost and 43% and 55% of them cited the low success rate. Whatever the preferred speculation, the main constraints most cited by farmers are the prohibitive cost of production (89%) related to the purchase of feed followed by the difficult flow of the product (20%) especially in the rainy season where there is milk flow on the market. Bayemi *et al.* (2005b) in the Northwest region of Cameroon and Odero-Waitituh (2017) in Kenya report that smallholders are constrained by the quantity and quality of feed given to animals due to high prices, inadequate rural infrastructure (highways, means of preservation and transformation of milk, electric current) and long distances from the market. Faced with the various constraints, the majority of farmers (96.3%) wanted a subsidy on hormonal products and feeds to reduce the cost of the strategy and speculation chosen. Kouamo (2006) and Sawadogo *et al.* (2009) in Senegal reported that 70% of breeders wanted the subsidy as an accompanying measure.

Characteristics of reproductive biotechnology service providers differ from those reported by Habimana (2012) in the Kaolack and Kolda regions of Senegal where, out of 07 providers, 06 were veterinary doctors and 01 livestock technicians, of whom 05 received training in AI in a specialized institution. Thus, for

qualified service providers, the School of Sciences and Veterinary Medicine of the University of Ngaoundere could be a major player in the training and recycling of inseminators in this part of Cameroon. Artificial insemination (AI) on induced estrus remains the only reproductive technology offered by all service providers in the northern regions of Cameroon. These results differ from those reported by Habimana (2012) in Senegal where AI service providers practice on natural and induced estrus. The lack of knowledge of natural estrus AI practices by most farmers in the northern regions of Cameroon would explain this difference. Semen conservation and breeders' neglect are the constraints reported (100%) by reproductive technology service providers. Kouamo *et al.* (2009) in Senegal reports that the difficult supply of liquid nitrogen (conservation liquid of semen) and its high cost make semen conservation the most cited constraint by providers. The difficulty of supplying liquid nitrogen is also reported by Santos *et al.* (2016) in Brazil. The non-compliance by farmers with the instructions given by the service providers on the one hand and the non-delivery of the right information to them on the other hand highlighted by Habimana (2012) in Senegal and Seydou *et al.* (2016) in Burkina Faso confirm the present results. The main support measure for reproductive technology service providers is the training center for biotechnology of reproduction (100%). This testifies on the one hand, the willingness of

service providers to improve in the field to meet the requirements of farmers and secondly that the demand for cattle breeding in rural areas is real.

### Conclusion

The main breeding technologies desired by herders to improve the productivity of their herds are AI and natural mating. In order to achieve this goal, government authorities must take into account the support measures proposed by both farmers and providers and create an adequate and supportive framework for the efficient implementation of AI programs.

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