Scientific Papers. Series D. Animal Science. Vol. LXVI, No. 2, 2023
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

DISTRIBUTION AND PRODUCTIVE CHARACTERISTICS OF NORMANDE CATTLE BREED WORLDWIDE, IN EUROPE AND BULGARIA- REVIEW

Tatyana IVANOVA[1], Tsvetan MARKOV[2], Lora MONDESHKA[2], Miroslav HRISTOV[2]

[1]Agricultural Institute - Shumen, 3 S. Veliki Blvd, Shumen, Bulgaria
[2]Research Institute of Mountain Stockbreeding and Agriculture, 281 Vasil Levski Str., 5600, Troyan, Bulgaria

Corresponding email: tania_6677@abv.bg

Abstract

The Normande breed originated from cattle brought to Normandy by Viking conquerors in the 9th and 10th centuries. For more than a thousand years, these cattle have become a dual-purpose breed to meet the milk and meat needs of the people of northwestern France. Normande cows have been exported around the world. The average height of bulls is about 152 cm and cows about 140 cm. The average body weight of male animals is about 1100 kg, and females about 700 kg. Normande cattle are an enduring French breed selected for the production of high-fat, high-protein milk, sought after for high-quality production of butter, cream and cheese and for their attractive meat properties. The Normande carry the Kappa Casein gene. The Normande breed is the only dairy breed sold as `first class` meat. The carcass weight for young bulls is 355 kg with a meat yield of 55%, for castrates - 391 kg with a 55% yield, and for slaughtered cows the carcass weight is 340 kg with a meat yield of 53%.

Key words: *fats, meat, milk, protein, Normande breed.*

INTRODUCTION

The Normande breed originated from cattle brought to Normandy by Viking conquerors in the 9th and 10th centuries. For more than a thousand years, these cattle have become a dual-purpose breed to meet the milk and meat needs of the people of northwestern France. The current book about the herd in France begins in 1883. Although the breed was destroyed by the Allied invasion of Normandy during World War II, there are currently 3 million Normande cows in France. Their current role in France is to provide rich milk for the production of various types of cheese - Camembert, Pon-Leveque and Livaro while maintaining excellent carcasses.

Normande cows are exported around the world, but received their greatest recognition in South America, where they were imported in the 1890 s. Cattle thrive there as one of the best dual-purpose breeds in the world. The total number there already exceeds 4 million purebred animals plus countless Normande crosses. There are 1.6 million purebreds in Colombia alone, and the rest mainly in Brazil (animals are crossed with zebu), Ecuador, Paraguay and Uruguay, Peru, Chile, Argentina. It is also a successful breed in Africa, Asia and Oceania. The resistance to sunlight associated with the pigmentation of the mucous membranes and the color of the coat and the health of the eyes thanks to the "glasses" makes it a major breed in the tropics and equatorial zones. Distributed in Madagascar, USA, Mexico, Belgium, Switzerland, Great Britain, Spain, the Netherlands, Bosnia and Herzegovina, Croatia, Germany and Ireland. They are also found in some countries of Eastern Europe - the Czech Republic, Lithuania, Poland, Romania, and now in Bulgaria (Figure 1). It is a highly adaptable and hardy breed. The Normande cow with its strong legs and hooves can travel long distances on uneven terrain to economically convert local roughage (North American Normande Association).

In Ireland, the breed makes the most of the grass, which is the basis of the diet and provides fertility insurance.

In Italy, it can increase cheese production by 15% for Parmesan production with a good level of milk production.

In Mexico, the breed has adapted to extreme conditions of drought and sunshine. Durability and performance have been proven to be two compatible qualities (Lanormande.com).

MATERIALS AND METHODS

The study is based on the analysis of current bibliographic sources with the subject in relation to factors that influence the productive (quantitative and qualitative composition of milk) and reproductive (calving interval, age at first calving, number of inseminations) traits of the Normande breed.

RESULTS AND DISCUSSIONS

Normande cattle are medium to large animals. The combination of three ancient dairy breeds imported from England (Ageronne, Sauchoise, Cotentine already extinct) with animals of the Durham breed (later Shorthorn) leads to a unique tricolor coat. They are usually red and white with occasional brown areas of brown fur. Brown chestnut usually has the appearance of tiger stripes or is dotted with red spots. Their eyes have dark "glasses" and dark pigmented hair around the eyes. Sun damage to the eyes is avoided by their darkly pigmented area around the eyes. They have a white head, and sometimes there are several spotted brown spots on the face. The average height of the bulls is about 152 cm, and of the cows about 140 cm. The average body weight of male animals is about 1100 kg, and females about 700 kg (https://www.roysfarm.com normande).
The Normande breed is developed on the pastures of northwestern France in the province of Normandy. More than 90% of Normans carry the Kappa Casein gene. It is known that the levels of casein beta and kappa in milk improve the quality of curdling of milk for cheese production (http://www.evolution-int.com/en/catalog/56/isu). They also show an excellent ratio of phosphorus to calcium in their milk, which is also an important aspect for the production of quality cheese (Peychevski & Chomakov, 1988).

Normandy beef is also characterized by excellent marbling, which contributes to the tenderness and taste of the meat. They have a high ratio of meat to bones, which provides a good percentage of meat at slaughter.

According to Le Guillou et al., (2019) Holstein and Normandy cows have significantly different milk production. The average Holstein milk production varies from 22.3 kg/day for first lactating cows to 24.1 kg/day for second lactating cows.

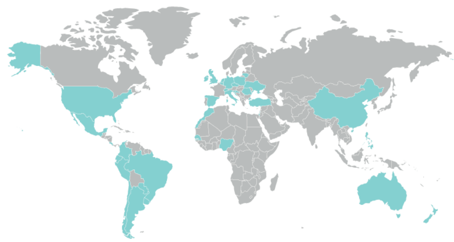

Figure 1. Distribution of Normande cattle in the world (https://www.lanormande.com/race_normande_internationale.html)

The average milk production of Normandy varies from 14.3 kg/day for cows in the first to 21.2 kg/day for cows in the second lactation. In addition, the milk protein content is higher in Normande cows than in Holstein cows - for example 35.4 g/kg compared to 30.6 g/kg, respectively, but does not differ between breeds in Normandy cows second lactation. Normande milk is rich in fat. The fat content did not differ significantly between breeds, ranging from 33 g/kg in the milk of second lactating cows in the Holstein breed to 43 g/kg in the milk of first lactating cows in Normandy. No difference in lactose, urea and acetone content was observed between breeds regardless of the age of the animal. The number of somatic cells ranged from 45.200 cells/ml to 150.600 cells/ml, with no significant differences between breeds ($p < 0.05$).
Dillon et al. (2003) conducted a study comparing Dutch Holstein-Frisian (HF), improved Irish Holstein-Frisian (CL), French Montbeliarde (MB) and French Normande (NR) dairy cows in a system based on spring calving fed with grass. HF cows give the highest milk yield; NR produce the lowest, while CL and MB are intermediate. NR produces the highest content of milk fats, proteins and lactose. The milk protein content in MB is higher than HF and CL, while the fat content in HF is higher than MB and CL.

In a study by Heins et al. (2006) milk productivity, fat content and cow protein in pure Holstein were compared with Normande/ Holstein, Montbeliarde/Holstein crosses and Scandinavian red/Holstein crosses for 305-day first lactation, calved from June 2002 to January 2005. Pure Holstein cows have significantly higher milk (9757 kg) and protein (305 kg) production than all crossbred groups, but they produce 346 kg of butter and do not differ significantly from Scandinavian red/Holstein (340 kg) crosses for fat production. Fat plus protein production was used to measure the overall productivity of pure Holsteins against crosses. Scandinavian red/Holstein (637 kg) crosses do not differ significantly from pure Holstein (651 kg) for fat plus protein production; however, the Normande/Holstein (596 kg) and Montbeliarde/Holstein (627 kg) crosses had significantly lower fat and protein production than pure Holsteins.

The interaction between the breed and the feeding system is not significant for total milk production according to Walsh et al. (2007; 2008). The breed of dairy cows has affected all variables in milk production, except for the percentage of protein. Compared to the Montbeliarde (5604 kg) and Normande (5464 kg) breeds, the Holstein-Friesian breed has the highest milk productivity (5925 kg). Holstein-Friesian cows produce more fat (226 kg), protein (202 kg) and lactose (279 kg) during lactation than Montbeliarde cows (207, 193, 266 kg, respectively) and Normandy cows breed (204, 188, 260 kg, respectively). Compared to Holstein (3.83%), the percentage of fat is similar to Normandy (3.80%), higher than that of Montbeliarde (3.71%). The percentage of lactose in Montbeliarde (4.76%) and Normandy (4.78%) is higher than in the Holstein breed.

Animals raised with a high concentrate diet achieved higher milk yield (5.840 kg), fat (220 kg), protein (200 kg), lactose (276 kg) and a percentage of lactose (4.74%) compared to those grown with a low concentrate food system (5,614; 211, 193, 265 kg; and 4.72%, respectively). The percentages of fat and protein do not differ between feeding systems. The feeding system and breed affect both average lactation and live weight (Backley et al., 1995).

Milk production for HF, MB, NM and NRF in the present study is lower than previously reported by their country of origin (Sigwald & Dervishi, 2002; Heins et al., 2006, Østerås et al., 2007). This is primarily the result of pasture-based feeding systems used in the study. However, Horan et al. (2005) demonstrate that cows with high genetic qualities have a greater milk reaction when concentrate is added within a grazing system, leading to a genotype × environment interaction for milk production. The present study did not identify genotype × environment interactions for milk production. The difference in the addition of concentrate between the feeding systems imposed by Horan et al. (2005) is greater than for the present study (approximately 1100 vs. 500 kg, respectively). Therefore, the differences between the feeding systems tested in the present study may not have been sufficient to induce genotype × environment interactions.

According to Le Guillou et al. (2019) Holstein and Normande cattle are two dairy breeds with different characteristics for milk production. Holstein is the first dairy breed in the world with higher production in terms of quantity. Normande cattle are a hardy French breed, selected for the production of high-fat and protein milk, sought after for high-quality production of butter, cream and cheese and because of their attractive meat properties. The Normande breed has lower milk production than Holstein, but higher fat and protein content and higher adaptability to durable conditions according to Ducroco (1994).

In France, most dairy cows are purebreds. Therefore, the non-additive genetic effects expressed by heterosis, loss of recombination, and depression in inbreeding have not received much attention to date (Dezetter et al., 2015). French genetic assessments are currently looking at data from different breeds separately, excluding information from crossbreds. Although crossbreeding has remained marginal until recently, it has developed over the last 10 years. Indeed, crossbred cows may be more profitable than cows of parent purebred breeds (McAllister, 2002; Heins & Hansen, 2012).

Dairy farming systems in Western Europe are based on a simple feeding system consisting of grazing and canned grass, corn silage and concentrates in varying proportions. However, there is a wide variety of feeding strategies between dairy farms (Delaby et al., 2009). Five year study by Delaby et al. (2009) examined the direct and delayed effects of four feeding strategies on lactation and the reproductive characteristics of Holstein and Normandy dairy cows. The four dietary strategies labeled Hh (high protein, high fat), Hl (high protein, low fat), Lh (low protein, high fat) and Ll (low protein, low fat) correspond to two common mixed rations in winter (corn silage with 30% concentrate or grass silage with 15% concentrate), which were subsequently crossed with two levels of concentrate supplement when grazing for up to 210 days. Each year, 72 dairy cows managed in a group winter calving were allocated to the four strategies. The four strategies led to significant variations in nutrient intake and in particular in differences in concentrate consumption, with values. Total milk production (7567, 7015, 6720 and 6238 kg per cow for treatment Hh, Lh, Hl and Ll, respectively), milk fat content (39.0, 37.1, 40.3 and 38.5 g/kg), milk protein content (33.0, 31.8, 33.1 and 31.6 g/kg, respectively), and the nature of the lactation curves and body condition are highly sensitive to the applied strategies. Holstein cows respond more dramatically to any change in diet at any time than Normande cows. Winter feeding does not affect the production of milk on the pasture, while on the pasture the milk from highly fed cows in winter has a higher content of milk fat and protein. Reproductive efficiency is not affected by the feeding strategy. Holstein cows, well fed and producing the most milk (Hh and Hl), have the lowest success rate in the first artificial inseminations (21.5%). Normande dual-purpose cows had a pregnancy rate 10 points higher than that of Holstein cows. This comparison of highly contrasting feeding strategies confirms the immediate reactivity of dairy cows (in terms of milk yield and body condition) to dietary variations during lactation, with little transfer effect from feeding levels at the beginning of lactation.

Reproductive efficiency has declined in recent decades in many dairy systems. This study by Cutullic et al. (2011) aims to compare the effects of high and low feeding on the reproductive stages (cyclicity, estrus and fertility) of Holstein and Normande cows bred on pasture. Highly fed cows received a total mixed ration consisting of 55% corn silage, 15% dehydrated alfalfa pellets, 30% concentrate in winter and 4 kg/day concentrate for grazing. Low-fed cows received only 50% grass silage and 50% haylage in winter and no grazing concentrate. Low-fat cows produce less milk but lose more body condition than high-fat cows. Normande cows produce less milk and lose less fitness than Holstein. Postpartum ovarian activity is weakly affected by the level of nutrition. In both breeds, the detection rate of ovulation is higher in low-fed cows. In both breeds, the rate of re-calving after the first and second inseminations was not significantly affected by the feeding level, although less cases of infertility or early embryonic mortality were observed in low-fed cows. For the Holstein breed, this was clearly explained by later embryonic mortality in highly fed cows. Dual-purpose cows (Normande breed) had a higher pregnancy rate by the end of the breeding period than Holstein dairy cows due to better ovarian activity and a higher rate of re-calving after insemination.

Poor udder health can be a source of economic loss for both dairy farmers and processors. This can lead to reduced milk yield and milk quality (Bartlett et al., 1991), changes in milk composition (Auldist et al., 1995), increased involuntary destruction (Berry et al., 2005), and the cost of veterinary treatment (Berry & Amer, 2005). In addition, in Ireland, the pricing of milk is differentiated on the basis of sanctions imposed on milk with a high somatic cell count. In France, an average of € 35 less costs are made for veterinary medicine per cow.

The results of this study highlight the differences between dairy breeds cattle, somatic cell count and milking characteristics. They are probably related to the differences in the breeding purposes from which these breeds are made, namely the intensity of milk selection and the inclusion of traits aimed at maintaining or improving udder health.

For beef producers, the Normandy became famous for its high-quality carcasses and delicious meat. The average 570 kg Normande castrated animal has a quality class of 90%, 347 kg weight of hot carcass, 34.3 cm fat in the ribs, 0.64 cm fat on the back, 2% total fat found in the body cavity of the carcass, in particular in the kidney, pelvic, and heart regions and 2.2 yieldgrade (https://www.normandeassociation.com/what-is-a-normande). The carcases of Normande cattle are heavy and have an excellent yield; the meat is well marbled and extremely fragrant; best value of beef both quantity and quality among dairy breeds.

The average age for slaughtering cows is 6.4 years, young bulls 21 months and castrates 36 months. The carcass weight for young bulls is 355 kg with a meat yield of 55%, for castrates it is 391 kg with a 55% yield, and for slaughtered cows the carcass weight is 340 kg with a meat yield of 53%. The meat yield of Holstein cows is 48%, and of crosses between Normande and Holstein breeds is 50%. In the young castrated animals of the Holstein breed the meat yield is 51%, in the Normande breed it is 55%, and in the crossbreeds it is 53%. The Normande breed is the only dairy breed sold as "first class" meat (supermarket Carrefour - Flunch restaurants) (Internacional Evalution).

The milk produced by the Normande cow breed is naturally rich in calcium. It has the highest content, followed by the milk produced by the Montbeyard breed and the Holstein cow's milk has the lowest calcium content (Gaignon et al., 2018).

The minimum amount of calcium in milk needed to make cheese is 1.2 g/l. If the amount is <1.1 g/l, then between 15 and 22 ml should be added. The calcium content in milk is according to the diet of the cows (grass, mineral, fodder, legumes). The calcium in Normandy milk is> 1.1g/l, so no calcium addition is required.

The data in Table 1 show that the production of one kilogram of cheese and butter requires less milk from the Normandy breed than from the Holstein cows.

Data from Table 2a obtained from Minnesota farms in 2012 on 245 F1 crosses between Normande x Holstein for 305 days of lactation show that the amount of milk increased until the third lactation and then begins to decrease.

Table 1. The amount of milk as a raw material required for the production of 1 kg of butter and 1 kg of cheese (https://infortambo.cl/es/contenidos/normando-en-chile-2)

Breed	Liters of milk per 1kg butter	Liters of milk per 1kg cheese
Holstein	23	7.25
Normande	18	5.10

Table 2a. Milk productivity in F1 stock crossbreeds Normande x Holstein cattle (Hansen & Brad, 2010)

Stock crosses	milk yield (kg)
First lactation in F_1 Normande x Holstein	8602
Second lactation in F_1 Normande x Holstein	10080
Third lactation in F_1 Normande x Holstein	10634
Fourth lactation in F_1 Normande x Holstein	10611
3rd and 4th lactation in Holstein	12332

In pure Holstein cows, the milk yield for the third and fourth lactations does not differ significantly from the milk obtained from the crosses. There is a significant difference in the percentage of fat and protein for purebred Holstein cows and F1 crosses between Normande x Holstein (Table 2b).

Table 2b. Protein and milk fat content of F1 stock crosses of Normande x Holstein cattle (Hansen & Brad, 2010)

Breed	Protein (%)	Fat (%)
Holstein	3.60	3.09
F_1 Normande x Holstein	3.72	3.22

The data in Table 3 for 305 days of lactation for 416 Holstein heifers and cows and 254 F1 Normande x Holstein heifers and cows bred in the state of Minnesota show that crossbred and purebred milk yields increased as lactations progressed. The percentage of protein in purebred animals increases, and in crossbreds it remains at the same level. Fat percentage decreased as lactation progressed in both groups of animals. There is a large increase in the amount of protein and fat per kg as lactation progresses.

The studies carried out (Table 4a), with 16 purebred Holstein cows and 13 Normandy cattle cows, in the first lactation show that the differences in chemical composition and somatic cells are observed in favor of the Normandy cattle representatives (Guajardo et al., 2020).

Table 3. Milk yield and physicochemical composition of milk from Holstein heifers and cows and F1 Normande x Holstein crosses (Hansen & Brad, 2010)

Breed	Lactations	Days	Milk (kg)	Protein, %	Protein, kg	Fats, %	Fats, kg	Protein + Fats, kg
Holstein	1	305	9,899	3.10	307	3.56	352	659
F_1 Normande x Holstein	1	305	8,603	3.23	278	3.79	326	604
Holstein	2	305	11.976	3.11	373	3.57	428	801
F_1 Normande x Holstein	2	305	10.081	3.24	327	3.73	376	749

Table 4a. Milk yield and physicochemical composition of milk from heifers and cows Holstein and Normande (Guajardo et al., 2020)

Breed	Number of cows	Number of lactations	Fats (%)	Protein (%)	Lactose (%)	Density (g mL-1)	pH	Somatic cells (cell mL-1)
Holstein	16	1	3.35	2.87	4.58	1026	6.59	163 000
Normande	13	1	3.35	3.16	4.74	1028	6.65	115 000

Table 4b. Time between first and second calving of Holstein cows and crosses F1 Normandy cattle x Holstein (Heins & Hansen, 2012)

Breed	Number of cows	Time between first and second calving, days
Holstein	3845	420.9
F_1 Normande x Holstein	276	396.5

Table 4c. Age at 1st calving, months (Heins & Hansen, 2012)

Breed	Number of cows	First calving (months)
Holstein	5574	28.3
F_1 Normande x Holstein	518	27.56

A study in Chile with purebred Holstein cows and crosses of Normande with Holstein cows found a time between first and second calving in purebred animals 420.9 days and in crosses 396.5 days, and the age of first calving was 28.3 and 27.56 months, respectively (Heins & Hansen, 2012), (Tables 4b and 4c).

The data in Figure 2 show that the fertility rate after 1st insemination in Normande cows was 8% higher than in Holstein cows. Fertility after the first insemination of the Jersey breed is the same as the cows of the Normande breed. There were no significant differences in heifers.

The Figure 3 shows that the highest number of inseminations is in cows of the Holstein breed (2.08), the lowest number is in cows of the Montbeliarde breed (1.74). 1.85 inseminations are required for Normandy cows. In heifers of the presented breeds on the chart there is no significant difference. The number of inseminations is the lowest in Normande heifers, the highest in Jersey heifers (1.69), and in Montbeliarde and Holstein heifers this number is the same (1.67).

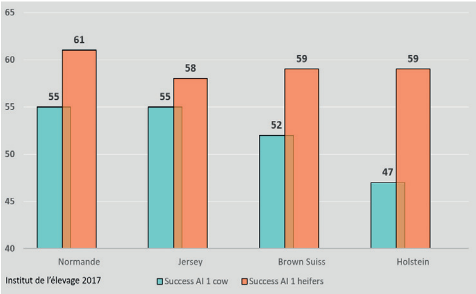

Figure 2. Level of fertility after 1st insemination in Normande, Jersey and Holstein (Evolution International, 2021)

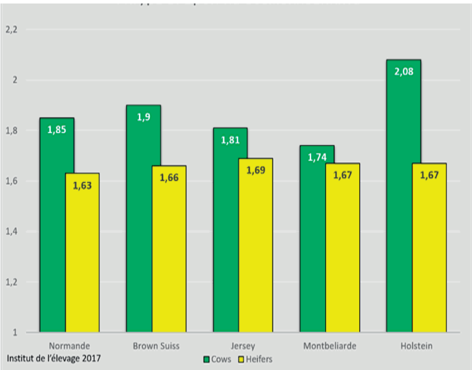

Figure 3. Number of inseminations (Evolution International, 2021)

Table 5 shows that in Normande cows there is a 96.5% ease of calving, in Holstein it is 94.6%, and in cows of the Montbeliarde breed the percentage is below 90% (84.5%). The percentage of calving without assistance is the highest among the Normande breed of cows (73.3%).

Table 5. Light calvings %, unassisted calvings % (Evolution International, 2021)

Breed	Ease of calving, %	Calving without assistance, %
Normande	96.5	73.3
Holstein	94.6	69.2
Monbeliarde	84.5	58.7

CONCLUSIONS

In conclusion, we can say that the cattle of the Normandy breed have been selected for the production of milk, rich in fat and protein for the production of butter, cream and cheese. It is naturally rich in calcium.

Meat from Normandy cattle has the best taste qualities among the bear breeds.

REFERENCES

Auldist, M. J., Coats, S., Rogers, G. L. & Mc Dowell, G. H. (1995). Changes in the composition of milk from healthy and mastitic dairy cows during lactation cycle. *Australian Journal of Experimental Agriculture, 35*(4), 427–436.

Backley, F., Walsh, S. & Dilon, P. (1995). Comparison of breed of dairy cow uder gross-based spring milk production sistems, Dairy production *Resans Centre, Fermos, „Co. Corcк“*, Ireland, 4-83.

Bartlett, P. C., Van Wijk, J., Wilson, D. J., Green, C. D., Miller, G. Y., Majewski, G. A. & Heider, L. E. (1991). Temporal patterns of lost milk production following clinical mastitis in a large Michigan Holstein herd. *Journal of Dairy Science*, *74*(5), 1561-1572.

Berry, D. P., Harris, B. L. V. D., Winkelman, A. M. & Montgomerie, W. (2005). Phenotypic associations between traits other than production and longevity in New Zealand dairy cattle. *Journal of Dairy Science*, *88*(8), 2962-2974.

Berry, D. P. & Amer P. R. (2005). Derivation of a health sub-index for the Economic Breeding Index in Ireland. *Technical report to the Irish Cattle Breeding Federation* (August).

Cattle Farming and Caring Information and Guide. (2022). *Normande Cattle Characteristics, Uses & Origin* /https://www.roysfarm.com/normande

Cutullic, E., Delaby, L., Gallard, Y. & Disenhaus, C. (2011). Dairy cows' reproductive response to feeding level differs according to the reproductive stage and the breed. *Animal*, *5*(5), 731-740.

Delaby, L., Faverdin, P., Michel, G., Disenhaus, C. & Peyraud, J. L. (2009). Effect of different feeding strategies on lactation performance of Holstein and Normande dairy cows. *Animal*, *3*(6), 891-905.

Dezetter, C., Leclerc, H., Mattalia, S., Barbat, A., Boichard, D. & Ducrocq, V. (2015). Inbreeding and crossbreeding parameters for production and fertility traits in Holstein, Montbéliarde, and Normande cows, *Journal of Dairy Science*, *98*(7), 4904-4913

Dillon, P., Buckley, F., O'Connor, P. & Hegart, D. (2003). A comparison of different dairy cow breeds on a seasonal grass-based system of milk production: 1. Milk production, live weight, body condition score and DM intake. *Livestock Production*, *83*(1), 21-33.

Ducroco, V. (1994) Statistical analisis of length of productive life for dairy cow for tihe nornande breed, *Journal of Dairy Science*, *77*(3), 855-866.

Evolution International, Dairy, beef ang goat genetics. (2021) *Catalogue Normande.* 15-28. http://www.evolution.int.com/en/catalog/56/isu

Evolution International. (2021) Presentation of the Normando breed by Sixtine Person (Cooperativa

Evolution), Normando product manager for the market. https://fb.watch/iRBz6a-biZ/

Gaignon, P., Gelé, M., Hurtaud, C. & Boudon, A. (2018). Characterization of the nongenetic causes of variation in the calcium content of bovine milk on French farms. *Journal of Dairy Science*, *101*(5), 4554-4569.

Guajardo, C., Velasco1, V., Astudillo, R., Cáceres, C., Cea, C., Campos, J., Ocampo, M. & Seminario, L. (2020) Milk quality and dairy product development of a Normande cow herd in the region of ñuble, Chile. Chilean journal of agricultural & animal sciences, *36*(3), 190-197.

Hansen, L. & Brad, H. (2010). Crossbreeding in Dairy Cattle. Retrieved from the University of Minnesota Digital Conservancy, https://hdl.handle.net/11299/57207.

Heins, B. J. & Hansen, L. B. (2012). Short communication: Fertility, somatic cell score, and production of Normande × Holstein, Montbéliarde × Holstein, and Scandinavian Red × Holstein crossbreds versus pure Holsteins during their first 5 lactations. *Journal of Dairy Science*, *95*(2), 918-924.

Heins, B. J., Hansen, L. B. & Seykora, A. J. (2006). Production of pure Holsteins versus crossbreds of Holstein with Normande, Montbeliarde, and Scandinavian Red. *Journal of Dairy Science*, *89*(7), 2799-2804.

Horan, B., Dillon, Faverdin, P., Delaby, L., Buckley, F. & Rath, M. (2005). Rath The interaction of strain of Holstein-Friesian cows and pasture-based feed systems on milk yield, body weight, and body condition score. *Journal of Dairy Science*, *88*(3), 1231-1243.

La race normande a l'international. (2022). https://www.lanormande.com/race_normande_internationale.html

McAllister, A. J. (2002) Is crossbreeding the answer to questions of dairy breed utilization. *Journal of Dairy Science*, *85*(9), 2352-2357.

Østerås, O., Solbu, H., Refsdal, A. O., Roalkvam, T., Filseth, O. & Minsaas, A. (2007). Results and evaluation of thirty years of health recordings in the Norwegian dairy cattle population. *Journal of Dairy Science, 90*(9), 4483-4497.

Peychevski, I. & Chomakov, H. (1988). Dairy. *Zemizdat*, Sofia.

Sigwald, J. P. & Dervishi, V. (2002). Resultats de controle laitier des especes bovine et caprine. CL-Resultats par races (Lactations de reference 305 jours)-Toutes lactations *Institut de L'Elevage, Department Genetique, Paris, France*.

Thiebot, C. (2019) *La Normando, raza doble propósito con plusvalía económica*. https://infortambo.cl/es/contenidos/normando-en-chile-2.

Walsh, S., Buckley, F., Berry, D. P., Rath, M., Pierce, K., Byrne, N. & Dillon, P. (2007). Effects of Breed, Feeding System, and Parity on Udder Health and Milking Characteristics. *Journal of Dairy Science*, *90*(12), 5767-5779.

Walsh, S., Buckley, F., Pierce, K., Byrne, N., Patton, J. & Dillon, P. (2008). Effects of breed and feeding system on milk production, body weight, body condition score, reproductive performance, and postpartum ovarian function. *Journal of Dairy Science*, *91*(11), 4401-4413.

What is a Normande?. North *American Normand Association, official U.S Registratio website.* https://www.normandeassociation.com/what-is-a-normande