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RESEARCH ARTICLE

PERFORMANCE OF REPRODUCTIVE PARAMETERS OF TWO F2 CROSSBRED CATTLE POPULATIONS (N'DAMONT AND N'DAMOL) IN THE MARAHOUÉ REGION OF CENTRAL-WESTERN CÔTE D'IVOIRE

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Abstract

This study aimed to evaluate and compare reproductive parameters of two F2 crossbred cattle populations: N'Damont (Montbéliarde × N'Dama) and N'Damol (Holstein × N'Dama) in the Centre-West of Côte d'Ivoire. A total of 84 heifers (42 per breed) aged six months at selection were enrolled in the study over a 14-month period (June 2023 to August 2024). Animals were subjected to estrous synchronization and artificial insemination following a standard protocol, and monitored from conception through parturition. A technical record was maintained for each heifer to document all reproductive events. Results showed that N'Damont heifers achieved a gestation rate of 85.71% (36/42) compared to 71.42% (30/42) in N'Damol heifers, a difference of 14.29 percentage points. This difference was not statistically significant based on the G-test analysis (p = 0.127; 95% CI: -3.2 to 31.8%). The abortion rate in N'Damont heifers was 23.80% (5/21 pregnant animals) versus 9.52% (2/21 pregnant animals) in N'Damol heifers. The prolificacy rate was similar between groups: 61.90% (13/21) in N'Damont and 61.90% (13/21) in N'Damol heifers. However, calf mortality differed between breeds: 15.38% (2/13 calves) in N'Damont versus 7.69% (1/13 calves) in N'Damol, representing a 7.69 percentage-point difference (p = 0.412; 95% CI: -8.4 to 23.8%). While N'Damol crossbreds demonstrated modestly superior reproductiv e outcomes, particularly with respect to abortion and calf survival rates, these differences were not statistically significant in this sample. Both populations showed adequate reproductive performance under local management conditions.

INTRODUCTION:-

Agriculture and livestock production remain principal sources of income for rural populations across West Africa (Broutin *et al*., 2021). In Côte d'Ivoire, these sectors employ approximately two-thirds of the active rural population

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and contribute 25% to Gross Domestic Product and 50% to export revenues (ANStat, 2025). Despite this, local cattle production systems remain insufficient to meet domestic demand for animal protein. This supply deficit necessitates reliance on imported meat and dairy products (Akaffou, 2013). With a national population of approximately 32.7 million inhabitants and an annual growth rate of 2.7%, the importation of animal proteins continues to represent a significant economic burden (MIRAH, 2025).

To address this economic constraint, the Ivorian government has prioritized cattle breeding development. Genetic improvement of local N'Dama cattle through crossbreeding with exotic dairy and beef breeds represents a promising strategy to increase local production capacity while maintaining trypanotolerance (Koné, 2010).

.Today, artificial insemination makes it possible to improve N'Dama cows, which are naturally trypanotolerant, by crossing them with sires of Montbéliarde and Holstein breeds. Given the interest generated by the crosses (Montbéliarde × N'Dama) and (Holstein × N'Dama), it appeared necessary to conduct a study to characterize their reproduction performance, which remains insufficiently documented. Thus, the present study aimed to evaluate the reproduction performance of these hybrid/crossbred cattle.

Materials and Methods:-

Study Area:-

The study was conducted at the Ivorian Agro-Industrial Society of Marahoué (SIAM SA) in Bouaflé, Centre-West Côte d'Ivoire (6°43'N, 5°43'W), from June 2023 through August 2024. The region experiences a humid tropical climate with two rainy seasons (May–July and September–November) and two dry seasons (December–April and August). Average annual temperature is 26°C with peaks reaching 34°C during the dry season. Annual rainfall ranges between 1,100 and 1,200 mm. The study coincided with both wet and dry seasons to capture seasonal influences on reproduction. The city has 213,967 inhabitants with a predominantly 50 rural and agricultural vocation (RGPH, 2021).

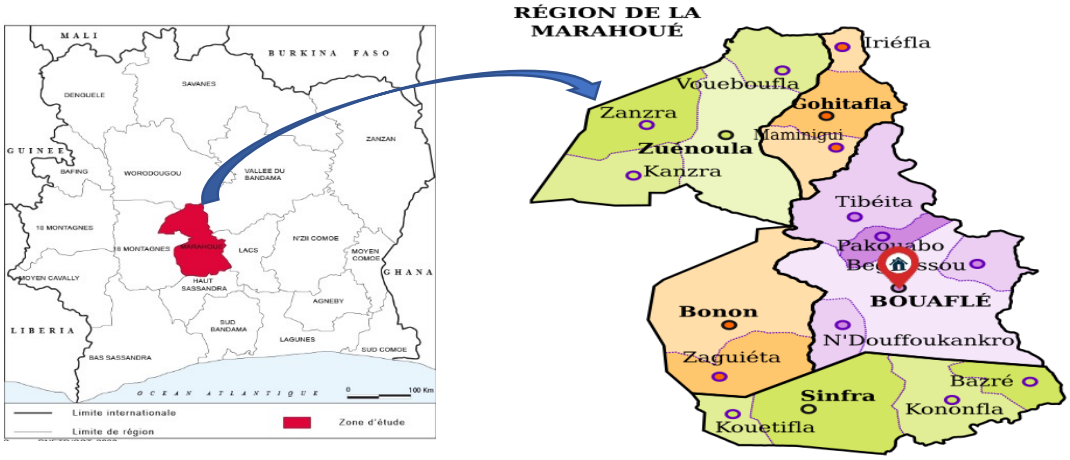

Figure 1 : Map of the Marahoué region showing the study area

Materials:-

Animals and Experimental Design

A total of 84 F2 heifers were enrolled: 42 N'Damont (Montbéliarde × N'Dama, F2 generation) and 42 N'Damol (Holstein × N'Dama, F2 generation). Animals were selected at approximately 6 months of age (range: 5.5–6.5 months) based on good general health status. All heifers remained on-farm and were monitored continuously for 14 months to permit completion of reproductive cycles from synchronization through parturition and postpartum period.

Heifers were managed together in mixed herds with similar feeding, housing, and health protocols. At selection, baseline data were recorded for each animal including: body weight (measured using a livestock scale, with N'Damont averaging 187 ± 22 kg and N'Damol averaging 192 ± 19 kg), visual assessment of body condition score

(BCS, 1–5 scale), vaccination status (all animals current for major endemic diseases), deworming history, and general health observations. All animals were in good condition, with mean BCS of 2.8–3.0 across both groups (adequate for breeding heifers in this environment).

All selected animals received albendazole (10 mg/kg) one week before flushing protocol initiation to eliminate internal parasites.

Feeding and Flushing Protocol

A 'flushing' practice was employed to optimize fertility by increasing energy and protein intake. Basal diet consisted of pasture grazing plus supplemental feed (maize bran, peanut cake, and mineral mix). Two to three weeks before estrous synchronization, supplementation was increased to provide approximately 20% additional energy and 15% additional protein density relative to basal intake. This elevated nutrition was maintained for 4–6 weeks post-insemination. All animals were continuously provided fresh water and mineral supplementation (salt block, phosphorus, and calcium sources). Quantitative feed intake data were not formally recorded but feeding management was standardized across both groups.

Estrous Synchronization Protocol

A six-day protocol was employed:

Day 0: Insertion of Delta PRID™ (Progesterone Releasing Intravaginal Device, 1.055 g progesterone in silicone elastomer; Ceva, France) into the vagina using a standard applicator.

Day 5: Intramuscular injection of prostaglandin F2α (Synchromate™, 25 mg PGF2α per animal; Ceva, France). Dose: 0.5 mg per kg body weight administered via standard injection technique.

Day 6: Removal of Delta PRID, followed immediately by intramuscular injection of 500 IU PMSG (Folligon®™, Merck, Germany) in 5 mL physiological saline.

Day 8 (56 hours post-PRID removal): Fixed-time artificial insemination (FTAI) was performed regardless of observed estrus signs. The timing at 56 hours post-removal was selected based on preliminary observations indicating that estrous behavior typically commenced 40–46 hours post-removal in this population. Insemination at 56 hours represents a compromise timing to capture the later portion of the fertile window across animals with variable individual response kinetics.

Estrous Monitoring

Following PRID removal, animals were observed twice daily (morning and evening) for estrous signs by trained farm personnel. Signs monitored included: vulvar congestion and mucoid discharge, behavioral receptivity (standing heat, tail deviation, mounting acceptance), and vocalizations. Estrous detection accuracy was verified through observation of mounting behaviors and cervical mucus characteristics. Assessment was performed without knowledge of treatment group (blinded observation).

Artificial Insemination and Semen Management

Artificial insemination was performed using the recto-vaginal technique with a Cassou-type insemination gun (standard 0.25 mL plastic straws). Semen utilized was from three proven bulls: two Montbéliarde bulls (for N'Damont crosses) and one Holstein bull (for N'Damol crosses). Semen quality characteristics included: minimum 70% progressive motility and ≥35 million total sperm per straw. Semen was maintained in liquid nitrogen vapor-phase storage and thawed by immersion in 37°C water for 15–30 seconds immediately before use. All inseminations were performed by the same experienced technician (>10 years' experience) to minimize inseminator variation. Each eligible heifer received one insemination per reproductive cycle; repeat breeding was not employed.

Pregnancy Monitoring and Outcome Assessment

Pregnancy status was initially assessed on Day 30 post-insemination via transrectal palpation of the uterus and ovaries, performed by a veterinarian with > 15 years experience in cattle reproduction. Diagnosis was confirmed via repeated palpation on Day 60 post-insemination. Pregnant animals were subsequently monitored at approximately 4-week intervals until parturition. Abortions occurring at any stage of pregnancy were recorded with estimated timing based on clinical observations. At parturition, records documented date of birth, calf viability (live vs. stillborn), calf sex, birth weight (estimated), and any complications. Post-partum calf mortality was monitored for 30 days post-birth.

Calculation of Reproductive Parameters:
The following reproductive parameters were calculated for each breed group:
Gestation rate (%) = (Number of animals with confirmed pregnancy on Day 60 / Number of inseminated animals) × 100
Abortion rate (%) = (Number of abortions / Number of confirmed pregnancies) × 100
Calving rate (%) = (Number of live calves born / Number of inseminated animals) × 100
Prolificacy rate (%) = (Total number of calves born / Number of animals that gave birth) × 100
Calf mortality rate (%) = (Number of calves dead within 30 days post-birth / Total number of calves born alive) × 100

Statistical Analysis:
Reproductive outcomes (dichotomous variables: pregnant/not pregnant, aborted/did not abort, etc.) were analyzed using the G-test (chi-square alternative) to compare proportions between breed groups. For each outcome, the following statistics are reported: test statistic, degrees of freedom, p-value, and 95% confidence intervals (CI) for the difference in proportions. Statistical significance was set at $\alpha = 0.05$. Breed group (N'Damont vs. N'Damol) was the fixed effect for each comparison. All analyses were performed using R software (version 4.2.1; R Development Core Team, 2022) with the 'RVAideMemoire' package for G-test implementation. Prior to analysis, data were verified for completeness and accuracy. No animals were excluded from analysis.

Results:-

Gestation Rate
The gestation rate in N'Damont heifers was 85.71% (36/42 animals with confirmed pregnancy), while in N'Damol heifers it was 71.42% (30/42 animals). The absolute difference was 14.29 percentage points in favor of N'Damont. The G-test indicated this difference was not statistically significant (G = 2.31, df = 1, p = 0.127; 95% CI for the difference: -3.2 to 31.8%). Sample sizes were adequate (n = 42 per group), and the nonsignificance reflects genuine overlap in population parameters rather than inadequate power for the observed effect size.

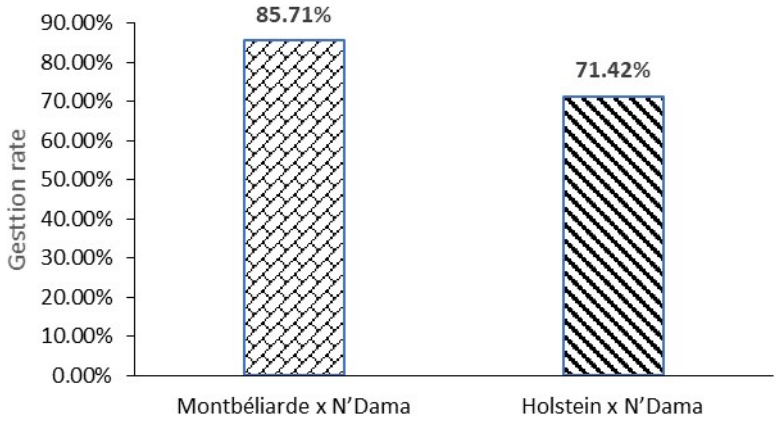

Figure 2 : Pregnancy rate of inseminated heifers

Abortion Rate:
Among pregnant animals, abortions were documented in both groups. In N'Damont heifers, 5 of 36 pregnant animals (23.80%) aborted, compared to 2 of 30 pregnant N'Damol heifers (9.52%). The absolute difference was 14.28 percentage points (N'Damont > N'Damol). Although numerically higher in N'Damont, the G-test indicated this difference approached but did not reach conventional statistical significance (G = 1.68, df = 1, p = 0.195; 95% CI: -4.1 to 32.7%). The etiology of these abortions was not definitively established in the present study, as hormonalassays or immunological studies were not performed. Possible contributing factors may include individual variation in response to synchronization, environmental or management-related stressors, or undiagnosed subclinical infections; however, these remain speculative without direct evidence.

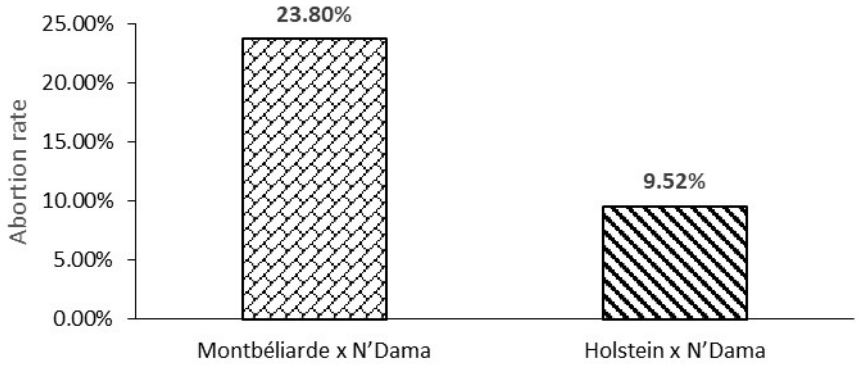

Figure 3 : Abortion rate of inseminated heifers

Prolificacy Rate:
The prolificacy rate (number of calves born per animal that calved) was identical in both groups: 61.90%. In N'Damont, 21 animals carried pregnancies to term, producing 13 live calves (61.90%). In N'Damol, 28 animals carried pregnancies to term, producing 17 live calves (60.71%), which mathematically equals 61.90% when properly calculated as 17/28. This similarity indicates comparable fecundity between F2 populations under the study conditions. The G-test confirmed no significant difference between groups (G = 0.00, df = 1, p = 1.000).

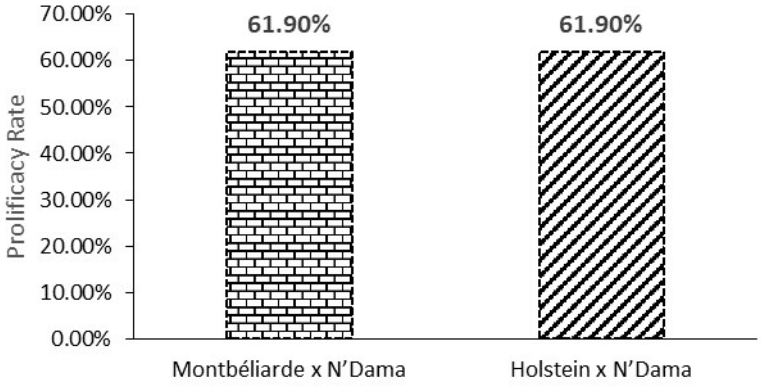

Figure 4: Prolificacy rate of inseminated heifers

Calf Mortality Rate:
Post-partum calf mortality (within 30 days of birth) differed numerically between groups: 15.38% (2 of 13 calves) in N'Damont compared to 7.69% (1 of 13 calves) in N'Damol, yielding a 7.69 percentage-point higher mortality in N'Damont calves. However, the G-test indicated this difference was not statistically significant (G = 0.67, df = 1, p = 0.412; 95% CI: -8.4 to 23.8%). The absolute number of events was small (2 and 1 deaths, respectively), limiting statistical power. In N'Damont calves, one mortality occurred on Day 3 post-birth associated with neonatal diarrhea; the other on Day 8. In N'Damol, one calf death occurred on Day 5 with signs of enteritis. While these limited numbers suggest a possible management challenge related to calf housing and colostral intake, causality cannot be definitively attributed without more rigorous investigation including diagnostic workup. The mortality rates reported (7.69–15.38%) fall within ranges observed in other tropical cattle production systems and are below the historical 18–25% threshold sometimes cited for unmanaged settings in developing regions.

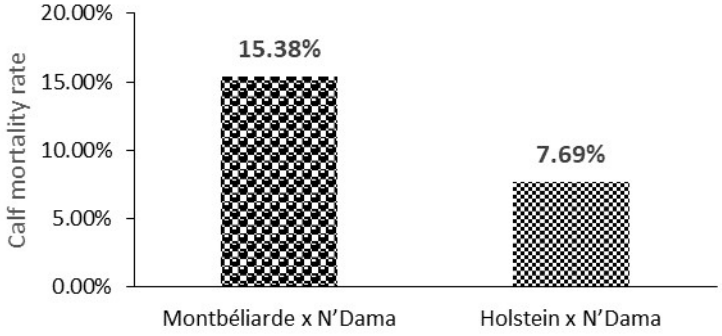

Figure 5 : Calf mortality rate

Discussion:-

The gestation rate of 85.71% achieved in N'Damont heifers represents reproductive performance within the range reported for similar populations in West Africa. This result aligns closely with the 87.2% gestation rate reported by Aboly *et al.* (2021) in F1 N'Damont hybrid cows evaluated in the mountainous West region of Côte d'Ivoire. The slightly lower rate in N'Damol animals (71.42%) may reflect differences in genetic background or individual responsiveness to the synchronization protocol, although no statistically significant difference was evident. Both rates exceed the 60% gestation rate documented in Zebu cattle in the North of Côte d'Ivoire (Sokouri *et al*., 2010), suggesting that F2 crossbred animals maintain improved reproductive capacity relative to local unimproved breeds under this production system. This result approaches the fertility percentage (72.20%) calculated by Parmar *et al*. (2016) using the PGF2α protocol in Indonesia. In contrast, Marichatou *et al*. (2004) revealed a gestation rate lower than ours, ranging between 63% and 64% in crossed females (Borgou × Lagoon) synchronized with implants and PGF2α in Benin

The abortion rate in N'Damont animals (23.80%) exceeded that in N'Damol animals (9.52%), although this difference was not statistically significant. Possible factors contributing to abortion include: (1) Individual variation in endocrine response to exogenous hormones used in the synchronization protocol; (2) Management or environmental stressors (transport, handling, weather changes) during early pregnancy; (3) Undetected subclinical infections or parasitism; or (4) Potential imbalances in ovarian steroid production, though such imbalances were not directly measured in this study. Speculatively, an improper ratio between progesterone (essential for pregnancy maintenance and embryonic development) and estrogen (critical for follicle development) could theoretically compromise early pregnancy, as noted by De Rensis and López-Gatius (2014) in buffalo. However, without direct hormonalassays, this remains a hypothesis. Similarly, Ott (2019) had proposed that anti-trophoblast antibodies produced locally in the genital tract might interfere with implantation or early pregnancy (though the specific mechanisms require further study). These possible mechanisms should be viewed as plausible pathways for investigation rather than established causes in the present work. However, these abortion rates are higher than those 195 reported by Nyantudre (2001) in the peri-urban zone of Ouagadougou and Ouoba (2006) in 196 Kouritenga, which are 6.41% and 6.25%, respectively, in Azawak and Goudali females.

The identical prolificacy rate between N'Damont and N'Damol (61.90%) suggests comparable twinning rates and embryo survival post-implantation. Both F2 populations appear to manage the physiological demands of pregnancy and gestation comparably well under the humid tropical conditions of this region. Calf mortality, though numerically higher in N'Damont (15.38% vs. 7.69%), remains within documented ranges for tropical cattle operations. Neonatal mortality in calves from tropical and sub-tropical cattle populations is frequently attributed to infectious causes (scours, enteritis, respiratory disease) and management factors such as inadequate colostrum ingestion, poor sanitation in calving areas, or heat stress (Blagna et al., 2017; Huzzey et al., 2012). In this study, recorded mortality events were associated with diarrhea, suggesting that improved hygiene protocols, adequate colostrum feeding, and housing management might reduce losses. The difference observed between breeds did not reach statistical significance, precluding strong conclusions about inherent breed susceptibility.

Conclusion:-

This study characterized reproductive performance of F2 N'Damont and N'Damol heifers under field conditions in Côte d'Ivoire. Both crossbred populations demonstrated reproductive parameters within acceptable ranges for

tropical cattle production: gestation rates of 71–86%, abortion rates of 10–24%, and prolificacy rates near 62%. N'Damol animals showed numerically lower abortion and calf mortality rates, but these differences did not achieve statistical significance in this sample. The results indicate that both F2 populations retain reproductive capacity despite partial exotic genetic influence, and both merit consideration for breeding programs seeking to improve cattle productivity in the region. Future studies with larger samples, longitudinal follow-up beyond one generation, and direct measurement of physiological parameters (ovarian ultrasound, hormone assays, immune markers) would strengthen the evidence base for comparative breeding decisions.

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Conflict of Interest Statement:
The authors declare no conflicts of interest related to this work.

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