UNIVERSITY OF ILORIN

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"THERIOGENOLOGIST'S ACCOUNT: INSIGHTS INTO GENDER EFFECTS IN VETERINARY REPRODUCTION"

By

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My Lords, Spiritual and Temporal,
Distinguished Invited Guests,
Esteemed Invited Guests and Friends,
Gentlemen of the Press,
Students of the Faculty of Veterinary Medicine and other Students here present,
Great Students of the University of Ilorin,
Distinguished Ladies and Gentlemen.

Preamble

In the name of Allah, the Most Gracious, the Most Merciful. I begin this lecture with humility and gratitude to Him the Creator and Sustainer of the Universe. The One who guided me as a spermatozoon running, charging forward progressively while competing with other several hundreds of millions spermatozoa from the same ejaculate of my father, in a race for life, to fertilise the ovum of my darling mother; develop to an embryo, go through the gestational period of nine months to become the very me presenting before you all today, with similar embryological background. I cannot appreciate enough this purposefully orchestrated divine phenomenon just described, being one of the very core aspects of my routine activities as a

Theriogenologist that observes under the microscope, the activities of sperm cells from various species and breed's ejaculates (some of which are even much greater in volume than that of human). All praise is due to Allah, who shaped me in form, in faith, and in intellect, who planted in me the seed of curiosity and watered it with tests, mentors, and moments of reflections.

Mr. Vice-Chancellor, Professor Wahab Olasupo Egbewole, I thank you for approving today's inaugural lecture. Today is a historical feat, because this is the first inaugural lecture from the Department of Theriogenology and Production and only the fourth from the Faculty of Veterinary Medicine. The first was delivered by the immediate past Deputy Vice-Chancellor Management Services Prof. Suleiman Folorunsho Ambali of the Department of Veterinary Pharmacology and Toxicology, the second was by the present Dean of the Faculty Prof. Oyebisi Mistura Azeez, while the third was by Prof. Nusirat Elelu. I do not take this privilege lightly.

Vice-Chancellor Sir, permit me to briefly give some insights into some other keywords of today's inaugural lecture. For those who might be wondering why it is only my department, Theriogenology and Production in the Faculty of Veterinary Medicine that does not begin with "Veterinary", it is simply because Theriogenology simply means "Veterinary Reproduction". So saying "Veterinary Theriogenology" is a tautology. Being a Theriogenologist, I have managed to be "gender sensitive". My research focus on "Gender effects in Veterinary Reproduction" emphasizes the male-effect while underscoring the indispensable role of the female-effect, captured in the phrase, "The male effect is the main effect, but no effect without the female effect".

In its most literal sense, the "male-effect" refers to a reproductive phenomenon observed in Veterinary Science, wherein the mere presence of a male stimulates oestrus and ovulation in a previously anestrous female especially in small ruminants (Rodrigo *et al.,* 2023). It is a hormonal awakening, triggered not by copulation, but by scent, sight, and biology. This effect, well-documented in literature, is the basis of several controlled breeding programs across the globe. Yet, the "main

effect" is a philosophical and social interrogation. Is maleness synonymous with centrality? Is the male always the initiator and the sustainer? And what happens when society and science ignore the agency of the female? The phrase "no effect without the female-effect" is both a scientific truth and a societal reminder: reproduction, whether in livestock or legacy, is never unilateral. It is, by nature and necessity, collaborative. Today's lecture, therefore, is my rebellion against reductionism. It is my contribution to a broader conversation: that in every spermatozoon and every ovum lies a story, and no story is complete without the other.

My Academic Journey into the Realm of Theriogenology

Mr. Vice-Chancellor, every academic journey is seeded in mystery but grown through memory. Mine began in "Mushin", Lagos, a place of intensity, resilience, and rhythm. It was here that I learned the values of grit, adaptability, and the sacredness of discipline. My earliest education, both secular and spiritual, was administered by my father, a man whose life was a curriculum in itself, and whose devotion to shaping minds was both austere and affectionate. It was he who introduced me to the power of letters and the dignity of purpose. My mother, though not formally schooled, remains my eternal professor of endurance and prayerful conviction. My formal educational journey took root in the 80s at Lagos in four different primary schools including Islamic Model Primary School (Primary 1 and 2), Daleko Primary School (Primary 3), Igbo-Owu Primary School (Primary 4) and Oye Primary School (Primary 5 and 6). My secondary education was at Archbishop Aggey Memorial Secondary School, Mushin between 1989 and 1994, where I cultivated foundational knowledge and a thirst for biology. I had also studied Building Technology from 1995 to 1997 at YABATECH, where I concluded my National Diploma. Thereafter, I proceeded to study Veterinary Medicine in 1997, courtesy of Professor Popoola, the immediate past Vice-Chancellor of Osun State University.

This dual identity of builder and healer has, perhaps, shaped how I approach both animals and institutions as structures requiring vision and care. As a matter of fact, he

encouraged me to accept the offer of Veterinary Medicine given to me, when I could not meet up with the cut-off mark for Medicine (MBBS). Today, I never regret accepting the offer and I will do same, again and again. Today, I make bold to say that during my lecturing career while at the Michael Okpara University of Agriculture, Umudike (MOUAU), Abia State, before moving to this great citadel of learning, University of Ilorin "Better by Far", I have met, trained, graduated and still training students who had initially graduated in other highly esteemed fields such as Animal Science, Human Anatomy and even Engineering, but came back into the University system to Study Veterinary Medicine. Also, during my nine years in private practice before my lecturing career began, I had met and consulted for clients in other similar highly placed fields. I earned my Doctor of Veterinary Medicine (DVM) in 2004, but the thirst for knowledge, once awakened, does not go away; it demands more.

I returned to the University of Ibadan for my postgraduate studies and earned my MVSc. and Ph.D. in Theriogenology in 2011 and 2017, respectively. These years were not just academic they were spiritual crucibles and intellectual battlegrounds. I learned not only from textbooks, but from testicles, semen analyses, uteruses, hormonal profiles and ultrasonography. I handled cows with prolapse, treated ewes with dystocia, and measured follicles with trembling fingers and increasing confidence. A critical turning point came when I joined Michael Okpara University of Agriculture, Umudike, where I began my lecturing career in earnest. The experience, though brief, was foundational. I taught courses in veterinary andrology, obstetrics, and gynecology, and saw the impact that mentorship, if properly applied, could have on students who, like me, were once unsure. In 2014, I joined the University of Ilorin, and this was where roots became trees. I rose from Lecturer I to Professor and invested my entire academic passion into research, teaching, and administration. I taught undergraduate and postgraduate courses including Advanced Veterinary Andrology, Theriogenology Clinics, Artificial Insemination, Biomedical Research Communication, and Reproductive Physiology.

I supervised projects, corrected theses, and mentored students who now carry the torch further. This journey is dotted with over 40 peer-reviewed publications, conference presentations across Africa and Europe, and book chapters that distill years of inquiry into pages of public good. Each study on semen quality, hormonal cycles, reproductive toxins, and indigenous breeds, a chapter in the story of a Nigerian Theriogenologist determined to elevate both livestock productivity and human dignity. To walk this path has not been without sacrifice, missed family moments, long hours under the sun scanning testes, nights spent formatting figures, and weekends explaining the difference between corpus luteum and follicular cyst during rectal palpation to wide-eyed students. But if I were to walk it again, I would choose no other field.

I am a product of faith, family, fortitude, and faculties that believed in me.

Let us now journey through biology and metaphor, through science and society into the world of reproductive truth and academic reflection.

Introduction

Mr. Vice-Chancellor, Theriogenology, an imposing word to some, but to those who work with it daily, a discipline of immeasurable elegance and indispensable utility. It is derived from two Greek roots: *therio*, meaning beast, and *geno*, meaning offspring or lineage. In its simplest form, Theriogenology is the science of animal reproduction, but in its fullest sense, it is a symphony of biological insight, technological intervention, and philosophical inquiry into the very nature of continuity in animal life. To understand Theriogenology is to appreciate the seamless interplay between anatomy and purpose, between hormones and heritage, between instinct and intervention. It is not simply the delivery of calves, foals, kids, and piglets; it is the conscious orchestration of reproductive health, breeding soundness, fertility control, and technological advancement in both domestic and, increasingly, wild animal populations and ultimately human well-being and survival.

The field encompasses three major pillars: Veterinary Andrology which deals with the diagnosis, treatment and prevention of the diseases, disorders and injuries of the reproductive tracts of the male animals; Veterinary Gynecology, which is concerned with the diagnosis, treatment and prevention of the diseases, disorders and injuries of the reproductive tract of the female animals; and Veterinary Obstetrics, which deals with medical, manipulations and surgical care of the female animals during breeding, gestation, labor, purperium and neonatal periods, involving also udder health and care (see Fig. 1). Together, they form the scientific and clinical backbone of animal production industries across the world.

Historical Background and Core Concepts of Theriogenology

Theriogenology has evolved over time. In ancient societies, livestock reproduction was governed by myth and observation. The Greeks and Egyptians held symbolic interpretations of fertility, often tied to deities. Yet, they were astute empirical observers. By the Middle Ages, animal breeders began recognising patterns in heat cycles and fertility windows, passing down oral traditions that still influence pastoral practices today. Modern Theriogenology, however, stands on the shoulders of laboratory science. From the first artificial insemination of a dog by Lazzaro Spallanzani in the 18th century, to the landmark developments in embryo transfer, cryopreservation, and in-vitro fertilization, the field has become a central nerve of veterinary innovation (Howe, 2010). Today, it interfaces with genetics, endocrinology, immunology, nutrition, and increasingly, environmental science.

In Nigeria and sub-Saharan Africa, Theriogenology is not merely an academic curiosity, it is a national imperative. Our country faces rising food insecurity, rural poverty, and livestock diseases that hinder economic resilience. The science of reproduction offers solutions: optimizing herd productivity, ensuring species conservation, and empowering smallholder farmers especially women, who are often the primary caretakers of animals in many rural settings. Furthermore, Theriogenology is a moral and ethical arena. It interrogates how humans should intervene in natural processes, how far science should go in

manipulating fertility, and what it means to balance efficiency with compassion. Whether in the controlled atmosphere of a Veterinary Teaching Hospital or the unpredictable realities of a Fulani cattle camp, the reproductive choices we make are not just biological they are ecological, economic, and existential.

Vice-Chancellor Sir, at the University of Ilorin, my department, Theriogenology and Production, has embraced this complexity. We do not merely teach techniques; we teach context. Our students learn how to approach a dystocia case not just as an obstetrical challenge, but as a moment of life-and-death decision-making that can impact family livelihoods. We explore semen analysis not just to report motility, but to understand what it reveals about nutrition, climate stress, and systemic disease. Thus, Theriogenology is not just about animals reproducing. It is about societies reproducing their values through animals. It is about scientific stewardship in the face of tradition, modernity, and uncertainty. Hence, Theriogenologists are not just veterinarians specialised in animal reproduction, we are guardians of fertility, translators of instinct, and custodians of continuity. To navigate Theriogenology with clarity and competence, one must grasp the foundational concepts that frame the science of reproduction. These are not merely abstract terms confined to textbooks; they are the living vocabulary of clinical encounters, breeding strategies, and research inquiries. In this lecture, I shall walk you through the core ideas that structure our discipline: biological, technological, ecological, and philosophical; and my humble research contributions in the wonderful field of Theriogenology.

At the heart of Theriogenology lies a deep understanding of Reproductive Physiology. Hormones such as Gonadotropin-Releasing Hormone (GnRH), Luteinizing Hormone (LH), Follicle Stimulating Hormone (FSH), progesterone, estrogen, oxytocin, and prostaglandins form an intricate link between the hypothalamus, pituitary, gonads, uterus and testis. This endocrine interplay governs spermatogenesis, estrous cycle, conception, gestation, parturition, and postpartum recovery (Greene, 2024). Each species has its unique cycle and reproductive habits, monoestrous, polyestrous, monotocus, polytocus, seasonal polyestrus, freemartins, seasonal breeders,

repeat breeders, regular and irregular estrus, silent estrus, early ovulators, late ovulators, spontaneous ovulators, induced ovulators, primiparous, multiparous, nullyparous, among many others, requiring Theriogenologists to calibrate their knowledge accordingly, to understand and translate the "spoken" and "unspoken" words and feelings of these precious animals.

A cow with silent heat, an ewe exposed to photoperiod changes, or a buck with low libido each presents a diagnostic puzzle whose solution begins with hormonal literacy. It is also common in clinical practice and research to influence these cycles and reproductive habits for maximum reproduction purposes. This is where the concept of estrus synchronization comes in where groups of female domestic animals are made to come on estrus at the same time, such that the dates of their deliveries and nursing will be similar. The advantage of this act is that fostering, production and sales of milk and other dairy products could be planned for, especially in dairy industry, which is a multi-million-dollar business in the developed world. Similarly, fertility rates are influenced using natural products and hormones to treat and/or increase semen production.

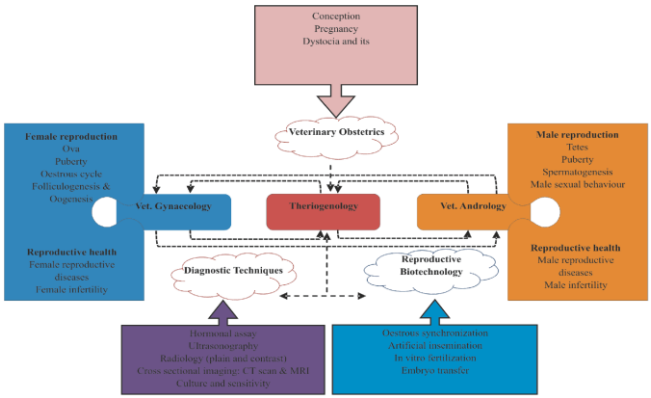

Fig. 1: Branches of Theriogenology

In reproductive science, it is required both in males and females to know the normal structure or architecture of cells, tissues and organs in order to distinguish them from their

pathological conditions when they are affected by disease conditions. The male reproductive system, comprising the testes, epididymides, accessory sex glands, penis, and associated musculature, plays roles beyond ejaculation; it contributes to endocrine signaling, thermoregulation, and behavioral modulation. Similarly, the female system ovaries, oviducts, uterus, cervix, vagina, and vulva are not merely passive recipients, but active selectors, nourishers and aiders in the delivery of lives (Raheem *et al.*, 2017). I study these organs not in isolation but in function and dysfunction: testicular degeneration, uterine torsion, ovarian cysts, vaginal prolapse. These are not just pathological states; they are windows into environmental stress, nutritional deficiencies, and systemic diseases. In reproductive medicine, fertility is not binary, it is a spectrum defined by time, success rates, and context. Infertility may be absolute (sterility) or temporary (subfertility), and its etiology spans infections (brucellosis, trichomoniasis), nutritional deficits (vitamin A, selenium), anatomical defects (segmental aplasia), and human management errors (poor heat detection, overuse of sires). Theriogenologists must therefore think in networks, where an infertile bull may represent a failure in mineral nutrition, or a barren cow may reflect underlying herd stress, social dynamics, or endocrine disruption.

A cornerstone of modern Theriogenology, Artificial Insemination (AI) allows controlled, disease-minimised, and genetically enhanced breeding. Yet, it is not as simple as 'depositing semen'. It requires semen collection (using artificial vagina, electro-ejaculation, rectal, digital, cloacal massage), evaluation (mass activity, motility, concentration, morphology), dilution with extenders while maintaining its fertilising capability (skimmed milk, egg yolk citrate, paw-paw juice, goat milk, cow milk), packaging and preservation of semen, cooling, freezing and thawing of extended and stored semen, sexing of semen (to determine sex of offspring with about 90% accuracy using flow cytometer, flourescent dyes amongst other techniques) and timely insemination synchronised with ovulation (Nara, 2024). Semen extenders are more than diluents. They are biochemical shields against oxidative stress, thermal shock, and microbial invasion. Beyond AI lies the realm of embryo transfer

(ET), in vitro fertilization (IVF), cryopreservation, and cloning. Though still emerging in Nigeria, these technologies hold promise for endangered species preservation, genetic advancement, and rapid herd multiplication. However, they demand ethical caution and technical precision. Theriogenologists must understand follicular dynamics, superovulation protocols, oocyte retrieval techniques, culture media formulation, and the logistics of embryo storage and transfer. This is where science meets engineering, and where precision becomes prophetic.

Real-time ultrasonography has revolutionised reproductive medicine. It allows us to see what the stethoscope cannot: testicular architecture, estimation of invaluable reproductive parameters and indices (such as testicular volume and follicular development), uterine involution, early pregnancy, fetal viability, and reproductive pathology. Combined with hormonal assays and clinical signs, it forms a triad of diagnostic confidence. However, the tool is only as wise as the user. Misinterpretation can lead to mismanagement. Hence, image literacy is now a non-negotiable skill in our training programs. Reproductive intervention raises ethical questions: Should we inseminate a heifer repeatedly despite poor welfare? Should we abort in cases of fetal abnormalities? Should religious communities be engaged in discussions on artificial breeding? In predominantly Muslim settings, the handling of semen, uterine intervention, and cross-species technology must align with Sharia-compliant principles. Theriogenologist must not only be a scientist but a cultural diplomat, ensuring that knowledge does not conflict with belief.

Insights into Gender effects in Theriogenology: My Humble Contributions

The Male-effect

Raji *et al*. (2024) evaluated some reproductive indices of the White Fulani Indigenous cattle bulls in Ilorin, Kwara State, Nigeria. Results suggested that the average age of puberty in the indigenous white Fulani bulls is three years. Veterinarians and farmers can leverage on these reproductive indices (scrotal circumference, scrotal length, chest girth, and body weight) to

select bulls with superior breeding potential, ultimately improving herd health and productivity.

In practical terms, the research contributes to the formulation of reproductive management policies tailored towards increasing indigenous livestock, enhancing the productivity of herds without relying solely on exotic or crossbred sires' indices. It also adds value to the conservation of native genetic resources by establishing their reproductive viability, reinforcing the male-effect as a critical component of herd fertility that must be studied in context. Ultimately, the study strengthens local capacity for evidence-based livestock improvement programmes.

Raji *et al.* (2024) investigated the effects of *Peste des Petits Ruminants* (PPR) vaccine on the semen characteristics of West African Dwarf (WAD) goat bucks. The PPR vaccine is the major strategy adopted for prevention and control of *Peste des Petits Ruminants* which is one of the economically significant diseases of small ruminants. Findings suggested that PRR vaccination as used in this study did not significantly alter the semen characteristics of the WAD goat bucks. This reaffirms the male-effect as not just being biologically sensitive but also immunologically compliant. The findings highlight the importance of investigating the effects health interventions on fertility. Even when we are trying to prevent or treat disease conditions affecting other non-reproductive systems, we need to ensure reproductive health is not compromised. The PPR vaccination is essential for herd immunity but while doing so, herd continuity should not be jeopardised. This study has been able to give closure that such immunological stimuli did not suppress semen quality or breeding which is the backbone of continuous livestock production. The work reinforces the interconnectedness of health and fertility and the importance of reconciling vaccination and treatment programmes with reproductive health.

Raji *et al.* (2023) evaluated the effect of Vitamin C on the reproductive parameters of rabbit bucks experimentally exposed to metronidazole. Results revealed significant decreases in the sperm motility, sperm concentration, percentage sperm livability and percentage normal sperm cells. The gonadal and

epididymal sperm reserve of rabbit bucks exposed to metronidazole also decreased. These decreases were reversed following the administration of vitamin C. This study affirms the male-effect's sensitivity to pharmaceutical insult and highlights the protective antioxidant role of vitamin C. By restoring the semen characteristics of the bucks to normal level, vitamin C has shown it is a potent agent of countermeasure against oxidative reproductive damage. This underscores the need for integrative reproductive management strategies that consider pharmaceutical side effects and antioxidant supplementation in breeding males.

Yusuf, **Raji** *et al*. (2023) highlighted the pertinence of Theriogenology in the farming of aquatic organisms. In aquaculture, the most important aspect to consider is ensuring the development of valuable offspring by using high-quality gametes from fish broodstock. The research compared the biochemical constituents of seminal plasma in both wild and cultured *Clarias gariepinus* broodstock. Results indicated that environmental stressors, nutrition, and stocking density in aquaculture settings can alter seminal fluid biochemistry and, by extension, sperm function. These biochemical disparities impact fertilization success, particularly in artificial breeding programs. By revealing the dynamic interaction between environment and male reproductive health, the study underscores the environmental modulation of the male-effect in aquatic systems. The implications are significant for hatchery operations and aquaculture policy. Optimizing culture conditions to mimic wild environmental parameters may enhance male fertility and ensure reliable seed production. This reinforces the concept that the male-effect is not static but shaped by ecological context, management practices, and husbandry protocols.

Raji *et al*. (2022) evaluated the efficacy of whole and skimmed cow milk as extenders for the semen of West African Dwarf (WAD) goat bucks. Findings suggest that WAD bucks can be extended with whole cow milk for 30 minutes at 37℃ successfully and not with skimmed milk. This study supports the use of cow milk as a viable alternative to commercial semen extenders, particularly in low-resource settings. The practical implication is profound: it empowers smallholder livestock

keepers with an affordable method to extend semen shelf life, improve AI outcomes, and harness the male-effect through biotechnological innovation. By bridging the gap between traditional livestock practices and modern reproductive technology, the study reaffirms that semen preservation is central to optimizing the male-effect. It calls for further research into nutritional and microbial profiles of milk extenders to standardize and expand their utility across species.

Olatunji, **Raji** *et al*. (2022) examined the effect of daflon-500®, a flavonoid compound on sub-chronic chlorpyriphos (CP)-evoked changes in antioxidant and biochemical parameters in the hypophysis and testes of adult male rats. Alteration of redox status is one of the molecular pathways commonly associated with pesticide toxicity. Antioxidants, including those obtained from plant phenolics, have been shown to mitigate pesticide-induced cellular injury. Results demonstrated that pre-treatment with Daflon-500® mitigated CP-induced alterations in oxidative and biochemical parameters apparently due to the antioxidant effect of the flavonoid compound. These findings underscore the critical need to address environmental and agricultural toxicants that compromise male reproductive capacity-a central element of the male-effect. Dafon-500® offers a promising therapeutic avenue due to its antioxidant potency, and its protective effects suggest it could be integrated into preventative reproductive health protocols for populations exposed to agrochemicals. This study expands our understanding of reproductive toxicology and confirms that maintaining the male-effect requires not just monitoring breeding soundness, but also counteracting environmental hazards that subtly erode reproductive integrity over time.

Raji *et al*. (2021) focused on developing practical and adoptable formulae for estimating testicular volume in Red Sokoto Goat (RSG) bucks using ultrasonographic measurements. Given that testicular size is a key indicator of sperm production and overall reproductive fitness in males, the intention was to create standardised, non-invasive methods that can aid in breeding soundness evaluations. Results revealed that by ultrasound biometrics, Prolate Ellipsoid Formula (PEF), Prolate

Spheroid Formula (PSF) and Lambert Formula (LF) were suitable for estimating TV for post pubertal RSG bucks; however, PEF was not suitable for pubertal RSG bucks. This work makes a critical contribution to the operationalisation of the male-effect in livestock management. It enables field-based practitioners to make accurate reproductive assessments using affordable, portable and non-invasive diagnostic tools. Beyond diagnostics, these formulae can support breeding selection, fertility forecasting, and the design of genetic improvement programs. By transforming testicular evaluation from subjective palpation to precise biometric calculation, this study helps bridge the gap between clinical theriogenology and field practice. It enhances the visibility and quantifiability of the male-effect, especially in developing regions where access to high-tech laboratories is limited.

Biobaku, **Raji** *et al.* (2021) carried out a comprehensive pharmacological and toxicological study investigated the systemic and reproductive effects of 30-day oral administration of *Aframomum melegueta* (grains of paradise) extract in adult male Wistar rats. Known traditionally for its analgesic and aphrodisiac properties, the plant contains bioactive flavonoids and essential oils. The extract showed analgesic, antioxidant and anti-inflammatory potential with possible adverse effects consistent with testicular and prostate cancers, cardiovascular complication, hepatic congestion and cholestasis. In the broader context of theriogenology, this study highlights the intersection between ethnobotany and reproductive toxicology, and underscores the importance of safeguarding the male-effect in any medicinal use context.

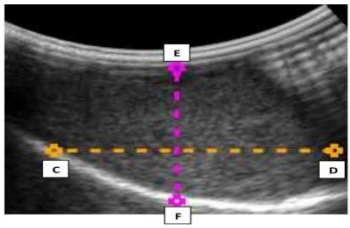

Fig. 2: Sonogram showing the length (C–D) and height (E–F) of RSB testis on longitudinal plane

Raji *et al*. (2020) investigated the effects of danazol, a synthetic steroid, on the male reproductive system of WAD goat bucks. While danazol is widely used in human medicine for managing endometriosis and other hormone-related conditions, its reproductive implications in male livestock remained poorly understood. This study evaluated whether danazol administration could modulate semen characteristics, endocrine function, and testicular histology in bucks. Results showed that danazol significantly decreased semen characteristics and hormonal profiles. Importantly, the effects were found to be reversible upon withdrawal of the drug, with gradual normalization of hormone levels and spermatogenesis. This reversibility indicates that danazol can be considered a potential pharmacological regulator of male fertility, provided treatment duration and dosage are carefully controlled. The study contributes to the broader understanding of the male-effect by demonstrating how endocrine-active compounds can temporarily suppress or modulate male fertility in livestock. It also offers insight into potential avenues for reproductive management, including temporary contraception or manipulation of breeding cycles in male animals.

Adam, **Raji** *et al.* (2020) explored the reproductive consequences of chronic lead toxicity in red sokoto bucks and investigated whether dietary supplementation with *Cyperus esculentus* (tiger nut) could mitigate the harmful effects. Results revealed that methanol extract of tiger nut contained antioxidant properties that significantly influence a protective role in ameliorating the pathological effect of lead poisoning in male reproductive pathology in Red Sokoto goat. This study provides compelling evidence that lead exerts deleterious effects on male reproductive health by inducing oxidative damage and hormonal dysregulation. It also validates tiger nut as a functional food with promising protective benefits. In the context of the male-effect, this study underscores the vulnerability of male fertility to environmental pollutants and the potentials of dietary strategies to preserve reproductive integrity in exposed livestock populations.

Akorede, **Raji** *et al*. (2020) investigated the reproductive toxicity induced by carbamazepine, a widely used antiepileptic

drug and the ameliorative effects of methanolic extract of *Moringa oleifera* leaves in adult male Wistar rats. Carbamazepine is an effective chemotherapeutic agent used to manage individuals with epilepsy and trigeminal neuralgia. Chronic use of carbamazepine has been incriminated to cause reproductive disorders. This study revealed that chronic carbamazepine administration evokes oxidative stress, partly involved in the alterations of concentration of sex hormones, sperm characteristics and histoarchitecture of pituitary gland and testes. Treatment with leaf extract of M. oleifera protects against the adverse reproductive consequences of long-termexposure to CBZ, due to its antioxidant property.

This study underscores the dual threats posed by pharmaceutical toxicity and the therapeutic promise of botanical interventions. Carbamazepine clearly disrupts the male-effect by impairing spermatogenesis and hormonal balance. Yet, *Moringa oleifera* demonstrated strong cytoprotective potential, likely due to its rich flavonoid and polyphenol content. The implications are substantial for reproductive pharmacology and veterinary therapeutics. *Moringa oleifera* may serve as an accessible, natural protective agent for safeguarding male reproductive health in animals exposed to oxidative insults or chronic medications. The study also advocates for preclinical screening of common drugs for reproductive side effects, especially in food-producing animals or breeding stock.

Raji (2017) in chapter two of the book titled *Introduction to Theriogenology* by Raheem, **Raji** *et al*. (2017) presented a foundational exposition on the anatomy, physiology, and pathophysiology of the male reproductive system, serving as a vital educational resource in the field of Theriogenology. It bridges basic biological principles with clinical applications relevant to veterinary and animal reproductive health. Structured thematically, it covers the male reproductive organs, the hypothalamic-pituitary-gonadal axis, spermatogenesis, hormonal regulation, libido, and conditions affecting male fertility across common domestic species. One of the key contributions of the chapter is its clarification of the structure-function relationship in male reproductive organs. For example, it highlights how the morphology of the scrotum, testes, and accessory glands in

ruminants is adapted to optimise thermoregulation and spermatogenesis.

The chapter discusses the critical importance of maintaining testicular temperature 2-4°C below core body temperature, emphasizing the role of the pampiniform plexus and *tunica dartos* in heat exchange physiological features essential for sperm viability. It highlighted the journey of the sperm cells through the seminiferous tubules, rete testis, efferent ducts, caput epididymis, corpus epididymis, caudal epididymis, vas deference, ampula, pelvic urethra, penile urethra into the female reproductive tract. It also discussed male sexual activities involving the pre-copulatory (libido, courtship, erection and mounting), copulatory (probing, intromission and ejaculation) and post copulatory stages (withdrawal, dismounting, refraction and memory. A good memory of mating will always make a male animal coming for more and be more cooperative during semen collection irrespective of the method used.

The chapter highlights the concept of the "male-effect" both as a biological driver of fertility and as a determinant of herd productivity. It discusses coital lock and its importance in ensuring semen is deposited into the uterus of the female for subsequent fertilization; flehmen's reaction in ruminants and horse which signals sexual preparation, it is a unique phenomenon characterised by elevation of the head, closing of the nostrils and curling of the upper lip to expose the teeth. By consolidating current understanding and aligning it with practical veterinary applications, this chapter forms a scientific backbone for training students and professionals in reproductive management. It elevates the visibility of the male-effect beyond just sperm delivery, emphasizing its physiological, endocrine, and behavioral dimensions.

Raji *et al*. (2016) explored the utility of ultrasonography as a non-invasive diagnostic and biometric tool in WAD goat bucks. Traditionally, testicular palpation and visual appraisal have guided breeding soundness evaluations in small ruminants, but these methods can be subjective and imprecise. Twelve bucks of proven breeding capability were selected for this purpose. Scrotal circumferences of these animals were measured using a flexible tape. Testicular ultrasound was carried out on the

transverse and longitudinal planes on the right and left testes. The electronic caliper on the ultrasound machine was used to measure the testicular length, height and width from which the testicular volume was calculated using the PEF, PSF and LF. These were compared with the true testicular volumes obtained by the Water Displacement Method (WDM).

Testicular ultrasound was found to be valuable as a diagnostic and biometric tool in measuring the important biometric parameters such as testicular volume; of which the prolate spheroid formula was found to be the preferred formula in WAD goat bucks. This work is pivotal in shifting reproductive diagnostics from subjective estimates to objective, quantifiable assessments. By introducing ultrasonography as a cost-effective and portable diagnostic option, the study enhances the visibility and operationalisation of the male-effect in small ruminants. It also provides baseline ultrasonographic references for indigenous goat breeds, addressing a critical gap in theriogenological literature. In broader terms, it advocates for the integration of imaging technologies in routine herd health management, particularly for breeding selection, fertility monitoring, and screening for subclinical testicular disorders. Such innovations strengthen the infrastructure for sustainable animal breeding and in improving the precision of reproductive management in resource-limited settings.

Raji *et al*. (2015a) carried out an anatomical study that investigated the gross and histo-morphology (Fig. 3) and morphometry of the epididymis in WAD goat bucks, providing valuable insights into male reproductive biology by detailing the structure responsible for sperm maturation, transport, and storage. Measurements of captured images were taken and analysed using the Motic Images Plus (MIPlus). The measurements taken included Epididymal Ductal Diameter (EDD), Epididymal Luminal Diameter (ELD) and Epididymal Epithelial Height (EEH). Ten measurements were taken per section for each parameter. Morphologically, the epididymis was found to be elongated, well-coiled, and closely opposed to the dorsal border of the testis. The cauda also had the largest diameter and weight, aligning with its functional role in

concentrating and preserving spermatozoa prior to ejaculation. Histologically, the epididymal duct showed pseudo-stratified columnar epithelium with stereocilia, characteristic of absorptive and secretory functions. The cauda segment displayed dense luminal spermatozoa presence and broader ductal diameters, which corresponded to greater sperm reserve.

The study emphasized that the anatomical and cellular features of the WAD epididymis were functionally adapted to support fertility and could influence sperm quality parameters such as motility and viability. There were no significant differences in the mean of EDD, ELD and EEH of the right compared with left head of the epididymis, body of the epididymis and tail of the epididymis, respectively. Also, when these parameters were compared between the head and body of the right epididymis and the left epididymis. However, the mean EDD and ELD of the tail region were significantly higher than those of the body region for the right epididymis, and left epididymis, respectively). The mean EEH of the tail was significantly lower than that of the body for the right and left epididymis, respectively.

These findings contribute significantly to the understanding of the male-effect by anchoring it to the structural and histological maturity of the epididymis. It also provides crucial baseline data for fertility evaluation and artificial insemination protocols in indigenous goat breeds. Knowing the functional histoanatomy of this region enhances the interpretation of semen characteristics and supports the design of interventions to improve male reproductive performance. Furthermore, this work supports the standardisation of breed-specific reproductive parameters and highlights the need for morphometric and histological evaluation in breeding soundness examinations. By shedding light on the physical basis of male reproductive function, this study reinforces the critical role of the epididymis in expressing and sustaining the male-effect.

Raji and Ajala (2015b) sought to establish the predictive value of Scrotal Circumference (SC) as a simple, non-invasive indicator of sexual maturity and breeding readiness in WAD goat bucks. Semen was collected from 10 randomly selected bucks in each group and analysed (Fig 4). The study concluded that a

threshold SC of 18 ±0.4 cm may be used as a reliable cutoff for selecting breeding-ready WAD bucks under extensive and semi-intensive systems. This practical, field-friendly metric makes it easier for farmers and veterinarians to select fertile males without costly reproductive evaluation tools. In context, this study reinforces the male-effect by linking external physical traits to internal reproductive capacity. It affirms that SC can serve as a functional marker of reproductive fitness, aiding herd improvement programs, reducing unproductive mating cycles, and accelerating genetic progress in indigenous goat populations. The operationalisation of SC as a diagnostic tool also democratises access to breeding soundness evaluation, especially in rural and resource-constrained environments.

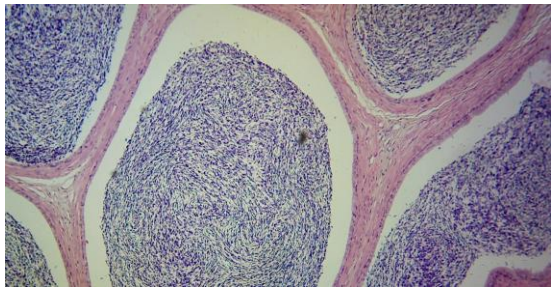

Fig. 3: A section of cauda epididymis. H & E stain (X 100), showing Connective tissue, and Lumen filled with spermatozoa

Raji and Ajala (2015c) carried out an anatomical study which provided foundational baseline data on testicular structure in WAD goat bucks, using ex-situ morphometric techniques to quantify dimensions, weight, and histological features of the testes. The research is particularly significant in the context of indigenous breed improvement, as it offered empirical insights into the physical correlates of male fertility. Gross morphologic results revealed that WAD testis was ellipsoidal in shape with 2 borders (free and attached), margins (medial and lateral) and similar surfaces (ventral and dorsal). The surfaces were covered by an outer tunica vaginalis and a deep tunica albuginea. Histomorphology showed the testis comprised mostly of rounded and some irregularly shaped seminiferous tubules (ST). Each ST

was lined by a basement membrane and a layer of germinal epithelium with lumen filled with spermatozoa surrounded by an adluminal space. Histomorphometric results revealed no significant differences in the seminiferous tubular diameter, seminiferous luminal diameter and germinal epithelia height of the right and left testes, respectively. The morphological and morphometric data highlighted in this study would be useful in comparative regional anatomy and research on the testis of these valuable breeds of goats.

The study significantly contributes to the male-effect literature by quantifying the structural basis of male fertility. It provides crucial anatomical references for reproductive health assessment and artificial insemination protocols tailored to WAD goats. Importantly, it also supports comparative anatomical research by situating indigenous testicular metrics within global livestock standards. In the broader context of breeding management, these findings reinforce the need to include testicular morphometry in routine evaluation of bucks selected for reproduction. The testis is the primary organ of fertility in the male, and its dimensions are reflective of endocrine and exocrine functions central to sperm production. By linking physical dimensions to potential sperm output, the study reaffirms that effective expression of the male-effect is rooted in anatomy as much as behavior or hormones.

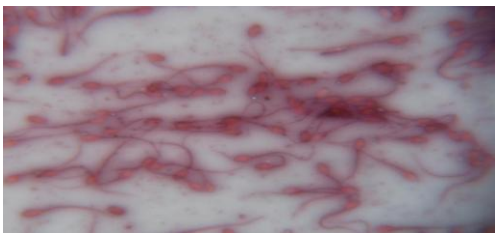

Fig. 4: WAD goat buck semen sample stained with eosin-nigrosin stain

Ajala, **Raji** *et al*. (2009) tested the efficacy of using pawpaw juice to replace egg yolk citrate as semen extender for artificial insemination (AI) in WAD does. While the focus was on female conception outcomes, the study indirectly assessed semen viability, quality, and handling, thus illuminating the

male-effect in the context of AI success. The experiment aimed to provide a cost-effective, natural alternative to commercial extenders, especially for smallholder systems where affordability and accessibility are critical. Fresh semen was collected from clinically healthy WAD bucks and extended using freshly extracted pawpaw juice. The extended semen was used for AI in synchronized does (n=15), and conception was confirmed using the non-return to estrus method at day 30 post-insemination. The conception rate observed was 100%, a promising result considering the minimal technological inputs and use of non-conventional extender media.

This study demonstrates that male reproductive inputs including semen quality, extender composition, and handling techniques are central to female conception outcomes. It reinforces the male-effect in the broader reproductive chain, not only as a donor of genetic material but also as a contributor to the biological and biochemical quality of that material. Moreover, the integration of indigenous resources (pawpaw) into AI technologies marks a pivotal step toward localised reproductive solutions that reflect ecological and economic realities. The findings open new directions for future studies on phytochemical-based extenders, sustainable AI strategies, and fertility preservation in low-resource settings. By improving semen handling and delivery, even in the absence of high-end lab equipment, this study affirms that optimising male reproductive contributions can translate into tangible fertility outcomes.

Ameen, **Raji** *et al*. (2015) explored the influence of Aloe vera, a widely utilised ethnoveterinary remedy, on the serum mineral profile of RSB a breed prized for its meat quality and economic relevance in Nigeria. This study aimed to scientifically validate the traditional use of Aloe vera in livestock systems, particularly for enhancing vitality and possibly supporting reproductive health via micronutrient modulation. While Aloe vera is often used empirically in animal care by pastoralists, its biochemical impact on systemic mineral homeostasis had not been fully elucidated in indigenous small ruminants. From a theriogenological perspective, the study revealed Aloe vera as a potential adjunct in reproductive management, especially in

mineral-deficient zones or during breeding seasons requiring enhanced fertility performance. Calcium and phosphorus are not only vital for testicular steroidogenesis and sperm membrane integrity but also for muscle contractility and neuromuscular coordination factors influencing mating efficacy.

The findings also have implications for ethnoveterinary integration into mainstream reproductive management. Given the affordability and accessibility of Aloe vera, its validated impact on mineral status makes it a candidate for inclusion in nutritional supplementation protocols for bucks during semen collection or breeding campaigns. Moreover, this study contributes to the emerging discourse on evidence-based ethnoveterinary medicine. It calls for further research into dose optimization, long-term effects, interactions with reproductive hormones, and combined effects with other phytotherapeutics. There should be collaboration between traditional livestock keepers and veterinary scientists to create standardised, safe, and effective herbal interventions that can be scaled across agro-ecological zones. Ultimately, this paper reinforces the importance of micronutrient monitoring in buck fertility and illustrates how traditional knowledge, when subjected to scientific scrutiny, can yield viable solutions for enhancing the male-effect. It provides a foundation for mineral-focused reproductive biochemistry studies and reaffirms the value of indigenous knowledge in sustainable livestock development.

Iliyasu, **Raji** *et al*. (2017) explored the anatomical and morphometric parameters of reproductive organs in male dromedary camels presented for slaughter at the Maiduguri abattoir. Given the limited body of knowledge on camel theriogenology in Nigeria, particularly in the semi-arid northeast region, the study contributes valuable anatomical benchmarks for both researchers and pastoralists. Findings emphasized the need for standardised morphometric assessment tools in camel breeding programs. The data obtained could be utilised in breeding soundness evaluations, semen collection protocols, and reproductive health monitoring. It also reinforces the role of anatomical profiling in preserving and enhancing the male-effect in less-studied species such as camels, where visual appraisal is often the only tool used by traditional herders. It is

recommended that reproductive organ assessment be institutionalised in camel abattoirs nationwide as part of a national surveillance programme. Such measures would support herd fertility profiling, identify genetic outliers, and guide selection for artificial insemination or controlled natural breeding. Additionally, these benchmarks provide a foundation for reproductive toxicology investigations, as deviations may reflect environmental or management-induced reproductive insults. In conclusion, morphometric assessment of reproductive organs is not merely anatomical documentation but a strategic component of reproductive planning. By generating quantitative benchmarks in local camel populations, this research enhances the precision and relevance of breeding programmes, sustains genetic quality, and affirms the male-effect as a determinant of camel herd productivity.

Raji *et al*. (2017) explored the effects of honey supplementation on semen quality and reproductive fitness in WAD goat bucks. Honey, a natural compound with known antioxidant, antimicrobial, and energy-enhancing properties, was evaluated for its potential to serve as a fertility booster. The research targeted a key challenge in small ruminant reproduction suboptimal semen quality often linked to oxidative stress, malnutrition, and environmental constraints. The study demonstrated that honey supplementation led to improved spermatogenesis and semen characteristics, likely through a combination of nutritional and oxidative stress-mitigating pathways. This supports the inclusion of honey as a bio-enhancer in buck management, particularly in settings where commercial semen extenders or antioxidants are inaccessible or expensive. Furthermore, the results hold translational potential for the development of honey-based semen extenders, especially for use in AI programmes in goats.

Given the cost-effectiveness and cultural acceptance of honey in rural communities, this intervention could be scaled to enhance the reproductive capacity of indigenous goat breeds and support genetic improvement programs. Beyond its physiological benefits, the study contributes to ethnoveterinary validation, bridging traditional livestock practices with empirical science. It promotes honey as a scientifically endorsed adjunct

for reproductive enhancement in male goats. The findings also call for further investigation into dosage optimisation, long-term effects on fertility, and potential combinatory use with other natural antioxidants. In conclusion, the administration of honey enhanced semen characteristics in WAD bucks, reinforcing the male-effect in reproductive efficiency. The intervention is both affordable and adaptable, providing a pragmatic tool to support fertility in local goat production systems.

Raji *et al*. (2019) examined testicular pathology experimentally induced in WAD bucks, with a focus on correlating ultrasonographic, hormonal, and morphological changes. The objective was to improve the diagnosis of male infertility by triangulating physical, biochemical, and imaging data, thereby refining the application of the male-effect in breeding soundness evaluations. The study found strong correlations between hormonal suppression and sonographic testicular patterns, suggesting that non-invasive imaging can predict underlying pathological changes. Importantly, the study demonstrated that testicular degeneration may not be apparent on external palpation alone and that hormonal and ultrasonographic evaluations provide complementary tools for early detection.

These findings support integrating imaging and biochemical screening into field reproductive diagnostics, especially in breeding programs that rely on phenotypic assessments. The implications are twofold: first, male infertility can be diagnosed earlier and more accurately using accessible technologies and second, therapeutic interventions can be better targeted when the underlying cause whether hormonal or structural is clarified. The study adds practical value to veterinary reproductive medicine by strengthening the diagnostic dimension of the male-effect.

The Female-effect: No-effect without her Readiness

Raji *et al*. (2018) documented a rare instance of fetal arthrogryposis (Fig. 5) in a two-year-old ewe from North-central, Nigeria, attributed to intrauterine infection with *Babesia ovis*. Although the direct subject was a female, the findings underscore how maternal health and infection status are critical determinants of reproductive outcomes, and how female susceptibility can override male reproductive input, reinforcing

the concept of "no-effect without the female-effect."The ewe had exhibited prolonged labor and unresolvable dystocia. Clinical and post-mortem examination revealed a malformed fetus with rigid joints and underdeveloped musculature consistent with arthrogryposis. Laboratory analysis of maternal blood and fetal tissues confirmed *Babesia ovis* infection. The report found that maternal infections can result in intrauterine pathologies that are incompatible with life, regardless of the quality of inseminating semen or sire genetics.

Thus, the reproductive success of the male-effect is fundamentally contingent on female physiological integrity. Even where fertilisation is achieved, gestational disruptions mediated by maternal infections, immunological compromise, or metabolic disorders can negate conception outcomes. From a One Health perspective, this case reflects the interconnectedness of animal health, disease ecology, and reproductive efficiency. It also speaks to the need for robust prenatal care, disease surveillance, and veterinary obstetric interventions to support the female-effect. In livestock systems where veterinary access is limited, such undiagnosed reproductive pathologies may silently contribute to poor conception rates and unexplained perinatal losses. There is the need for increased attention to female reproductive resilience, including pre-breeding health assessments, vector control, and nutritional support. In the broader framework of fertility, it affirms that even the most optimal male reproductive contribution can be rendered futile in the face of maternal pathology solidifying the foundational truth of "no-effect without the female-effect."

Fig. 5: Fetal Arthrogryposis in sheep, case was handled at the Veterinary Teaching Hospital, University of Ilorin

Leigh, **Raji** and Diakodue (2013) carried out vaginal cytology studies to detect standing heat in adult bitches. The results showed that the predominating superficial cells observed were Large Intermediate Epithelial Cells (LIEC) and Giant Anucleated Cells (GAC) at 38.0 ± 21, 6 hours before and at standing heats. Findings indicated that vaginal cytology is a useful tool in detecting standing heat in bitches. The ultimate female-effect in bitches is heat detection; based on my years of experience in clinical practice and teaching, vaginal cytology remains arguably one of the best methods of heat detection in bitches.

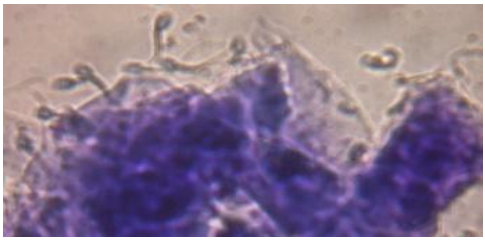

Fig. 6: Numerous sperm cells, clumped giant anucleated and large intermediate superficial cells indicating oestrus.

Raji *et al*. (2012) examined the influence of aqueous garlic extract on some aspects of reproduction in the female reproductive of Wistar albino rats. *Allium sativum* (Garlic) is one of the plants used as a therapeutic agent in many cultures. The current study was to investigate the effect of its extract on some aspects of reproduction in the female albino rat (Wistar strain). Findings suggest that aqueous garlic extracts have no deleterious effect on the reproductive performance of female rat. This consolidates the adaptability of the female-effect to ethnoveterinary reproduction.

Raheem, **Raji** *et al*. (2019) focused on the evaluation of how Trans-Rectal Palpation (TRP), a core diagnostic technique in bovine reproductive management, is taught across several veterinary schools in southern Nigeria. This procedure is critical in assessing reproductive status, diagnosing pregnancy, identifying uterine abnormalities, and monitoring ovarian function in cows. Despite its centrality in bovine theriogenology,

there has been limited appraisal of its pedagogical depth and practical accessibility in veterinary training institutions across the country. Results showed that more male students (65%) than female (35%) responded to the survey. Most respondents (43%) were within age group 25-30 years compared to <25 and >30 years age groups. The students demonstrated good knowledge of anatomy and physiology of the reproductive tract of cow with 72% having high scores (≥ 75%).

Majority of the students (90%) were able to use live animals for TRP exercise, out of which only 25 (28%) had performed palpation on a live cow (≥ 3×). There was a strong ($p > 0.05$) association between frequency of palpation and the confidence displayed by respondents to use the method post-graduation. It was recommended that students should be taught TRP with live animals possibly by being involved in ante-mortem inspection of cattle meant for slaughter at the abattoir. The implications of these findings are profound. Trans-rectal palpation remains a foundational tool for bovine reproductive diagnostics, yet its teaching remains inconsistent and, in some settings, under-prioritised. This gap undermines the clinical readiness of graduates and weakens national capacity for livestock fertility services. Without properly trained veterinarians capable of evaluating estrus cycles, diagnosing early pregnancy, or detecting reproductive tract pathologies, both productivity and animal welfare suffer.

Jimoh, **Raji** and Raheem (2022) conducted a conceptual review on the physiological processes of luteolysis and luteostasis and their pivotal roles in determining reproductive outcomes in mammals. The corpus luteum (CL), a transient endocrine structure formed post-ovulation, serves as a progesterone factory critical for the establishment and maintenance of pregnancy. The study aimed to dissect the molecular and endocrine mechanisms that govern CL survival (luteostasis) or regression (luteolysis), illustrating the delicate hormonal balance that determines reproductive success or failure the essence of the female-effect. Luteolysis, the functional and structural demise of the CL, is often triggered by prostaglandin F2α (PGF2α), especially in non-pregnant females. This regression halts progesterone production, paving the way for

estrous cycle renewal. In contrast, luteostasis, sustained by luteotropic signals like LH and chorionic gonadotropins, maintains the CL and progesterone output essential for early pregnancy. The review synthesized evidence from multiple species, including ruminants and primates, detailing how hormonal signaling pathways, immune mediators, and oxidative stress interact to influence CL fate.

One of the key messages was the role of progesterone as the 'hormonal glue' for uterine quiescence, embryo implantation, and maternal recognition of pregnancy. Insufficient progesterone secretion due to premature luteolysis could lead to infertility, early embryonic loss, or pregnancy failure. In describing the 'tripod model' of luteal fate, the paper presented three interdependent pillars: endocrine support, immune modulation, and oxidative balance. Disruption in any of these domains can tilt the scale towards CL regression and reproductive failure. Conversely, therapeutic maintenance of these systems through luteal support agents, anti-inflammatory therapies, or antioxidant supplementation can prolong luteal function and improve conception rates. The review also highlighted the implications of this physiology in veterinary reproductive management. Synchronization protocols, fixed-time AI, and embryo transfer programs rely heavily on precise control of luteal dynamics.

Understanding when and how to manipulate luteolysis pharmacologically (with PGF2α analogs) or support luteostasis (with progesterone supplementation) is key to maximizing conception rates in both individual animals and commercial herds. Ultimately, this study reinforces the indispensable role of the corpus luteum in reproductive biology. It also reiterates that the female reproductive system is not simply passive but actively engages in a complex hormonal choreography to sustain or terminate gestation. Any disruption in luteal function reflects a breakdown in this coordination and underscores the biological truth of the female-effect: that reproductive success is hinged on the dynamic competence of female endocrine regulation.

Aremu, **Raji** *et al*. (2019) evaluated the hematological effects of propofol administration in pregnant Red Sokoto goats (does). Propofol (Diprivan®) is now a mainstay drug during anaesthesia in human and small animal surgeries and this is as a

result of its good quality anaesthesia, rapid onset, and short duration of action with rapid recoveries. There is paucity of information in Nigeria as per the use of general anaesthesia to carry out procedures in pregnant red Sokoto Does. This study laid credence to the fact that propofol anaesthesia is suitable and safe anaesthetic agents for induction and maintenance of general anaesthesia in pregnant red Sokoto does. Importantly, this study advocates for species- and condition-specific risk assessments before anesthetic application in pregnant livestock. It also calls for incorporating reproductive status in pharmacovigilance protocols within veterinary surgical practice. The data support a cautious, well-monitored use of propofol and similar agents during pregnancy, particularly in field conditions where laboratory diagnostics may be limited. In reinforcing the female-effect, this work shows that reproductive outcomes are not merely a function of fertility hormones or uterine health, but also of systemic integrity during gestation. Even minor interventions can ripple through maternal physiology with implications for fetal well-being. Veterinary care in pregnancy must thus adopt a holistic lens supporting not just reproductive structures, but the entire maternal system that sustains them.

Wahab, **Raji** *et al*. (2019) documented the clinical diagnosis and successful surgical management of vaginal prolapse in a pregnant ewe, highlighting the delicate interplay between obstetrical emergencies and maternal-fetal survival the core of the female-effect in veterinary reproduction. Vaginal prolapse, particularly in late gestation, is a life-threatening condition in small ruminants due to the risk of fetal loss, infection, and compromised maternal health. The prolapse was noticed some days following an abrupt change in feed. On physical examination, the sheep was depressed and recumbent with intermittent straining. Epidural anaesthesia was achieved via administration of lidocaine into the first intercoccygeal space. The swollen and edematous prolapse was cleaned and decontaminated using mild potassium permanganate, after which the prolapse was repositioned and purse string suture was appliedon the vulva for retention purpose. The animal was placed on antibiotics for 5 consecutive days to prevent secondary bacterial infection and the suture material was removed on the

8th day with no signs of recurrence. The sheep delivered precisely a week after the suture was removed with no complications. In conclusion, this report has shown detail of a successful correction of vaginal prolapse in a pregnant ewe. This case reiterates that surgical skill must be coupled with reproductive insight when managing gestational complications.

The decision to preserve pregnancy instead of opting for emergency parturition highlighted a balance between maternal well-being and fetal viability, a hallmark of effective female-focused veterinary intervention. From a broader perspective, the case adds to the clinical evidence base supporting early detection and standardized protocols for vaginal prolapse management in small ruminants. It also supports the need for field veterinarians to be trained in reproductive emergencies that disproportionately affect female livestock, with cascading effects on productivity, animal welfare, and farmer livelihoods. In reinforcing the female-effect, this case affirms that timely and context-specific interventions can restore reproductive health and preserve future fertility. Pregnancy-associated pathologies such as prolapse are not just mechanical failures but signal the need for holistic management encompassing nutrition, endocrine balance, anatomical support, and skilled veterinary care.

Akorede, **Raji** *et al*. (2024) assessed the reproductive and neurological consequences of two commonly encountered neurotoxicants carbamazepine (CBZ) and pentylenetetrazol (PTZ) in pregnant Wistar rats, and evaluated the protective potential of Vitamin C supplementation. Although the toxins were primarily seizure-inducing agents, their systemic effects extended to reproductive viability, with a focus on pre-implantation losses. The research aligns strongly with the female-effect by demonstrating how maternal systemic balance determines embryonic retention or loss. Epilepsy is a complex neurological disorder affecting millions worldwide and is the most common major neurological complication during pregnancy. Carbamazepine, a widely used antiepileptic drug, has been associated with oxidative damage. Vitamin C, a powerful antioxidant has shown potential in controlling seizures and improving fertility. Results revealed that antioxidant properties of vitamin C at gestation contribute to its protective effects

against seizures and carbamazepine-induced alterations in reproductive parameters. The findings may have implications for human exposure to antiepileptics during pregnancy.

Jaji, **Raji** *et al*. (2022) conducted anatomical study to understand the normal morphometry of the development of female reproductive organs of the dromedary (Camelus dromedarius). Reproductive organs of apparently normal fetuses (n = 24) were collected from Maiduguri metropolitan abattoir after the slaughter of pregnant dromedary cows. The fetus was aged and grouped into 2-4 months, 4-7 months, 7-10 months, and 10-13 months, representing quarters of pregnancy. The reproductive systems were dissected out of the fetus, and all the organs were measured by using standard measurement techniques. All the parameters measured increased chronologically. In the fourth quarter, the left and right horn measured 7.50 ± 1.86 cm and 5.80 ± 0.79 cm, respectively, the uterine body, cervix, vagina, and vestibule measured 4.28 ± 0.17 cm, 4.69 ± 0.09 cm, 6.75 ± 0.21 cm, and 3.68 ± 0.19 cm, respectively, whereas the whole reproductive tract measured 57.73 ± 1.04 cm. The uterine body and uterine horn had the longest and shortest lengths. The developmental pattern of the female reproductive organs in the dromedary camel reported in this study is the first of its kind. The knowledge of the developmental pattern of the reproductive structures will aid in understanding reproductive cycles, congenital anomalies, and their etiology so that the anomalies can be treated.

The Male-effect and the Female-effect

Raji *et al*. (2024) conducted a comprehensive retrospective study on theriogenology cases managed over a seven-year period (2016-2023) at the Veterinary Teaching Hospital (VTH), University of Ilorin, Nigeria. Data was obtained from the records in the Theriogenology Clinic of the VTH University of Ilorin, and was subjected to descriptive statistics using GraphPad Prism version 5.0.3, and presented in frequencies and percentages using tables. Records of a total of 84 theriogenology cases were examined. Majority (63) representing 75% of the animals presented in the Theriogenology clinic were canine species, 11 (13.0%) were caprine, 5 (6.0%)

were ovine, 2 (2.4%) were pisces, while the bovine, feline and equine each had 1 (1.2%) case. Seventeen out of the 84 (20.2%) were cases of dystocia, 18 (21.4%) were presented for semen analysis, 41 (48.8%) were presented for vaginal cytology, 2 (2.4%) cases each for mastitis and pregnancy diagnosis, while there was 1 (1.2%) case each for testicular atrophy, abortion, vaginal prolapse and pyometra. Sixty-seven (79.8%) of the cases presented were females, while 17(20.2%) were males. The highest number of cases (22) representing 26.2% was recorded in 2021, while the least 3 (3.6%) was recorded in 2016. It was concluded that majority of theriogenology cases presented at the Theriogenology Clinic, VTH University of Ilorin, were canine species, and predominantly females, with vaginal cytology being the commonest procedure handled.

The findings underscored the increasing importance of integrating diagnostic tools such as ultrasound, cytology, and semen evaluation into theriogenology practice. It also highlights the intersection of male and female contributions to fertility, where success depends on synchronisation of breeding readiness, semen quality, and reproductive tract health. Notably, cases of failed conception often traced back to poor semen quality, anovulation, or misalignment in estrus timing demonstrating that neither male-effect nor female-effect operates in isolation. This positions theriogenology as a dynamic intersection of both reproductive axes. The report recommends strengthening laboratory capacity, improving farmer education on estrus detection, and increasing awareness of advanced reproductive technologies. Ultimately, the study affirms that sustainable animal reproduction requires synergistic optimization of both male and female reproductive inputs.

Ram, **Raji** *et al*. (2015) highlighted the emerging environmental and reproductive threat posed by nylon waste pollution in semi-intensive small ruminant production systems. The study was presented at the XVII International Congress on Animal Hygiene and aimed at raising awareness about the overlooked implications of plastic waste, especially nylon materials, on the productivity and fertility of livestock. It examined field-based observations of ingestion, entanglement, and exposure pathways, with specific attention to goats and

sheep reared in urban and peri-urban zones of Nigeria. It highlighted that small ruminants are particularly susceptible to ingesting plastic waste due to their scavenging behavior, especially when confined within areas littered with domestic waste. Nylon materials, unlike biodegradable forage, accumulate in the rumen, leading to ruminal impaction, chronic digestive distress, and systemic toxicity. Although the clinical manifestations often involve weight loss, bloat, and emaciation, the study emphasized the silent reproductive toll: hormonal disruptions, delayed puberty, poor libido in bucks, and increased embryonic loss in females. Furthermore, field investigations revealed histopathological changes in the testes and epididymis of bucks that had been chronically exposed to nylon-polluted environments.

These changes included testicular fibrosis, degeneration of seminiferous tubules, and reduced sperm density, pointing directly to the male-effect of environmental stressors. In female animals, field veterinarians observed irregular estrous cycles and increased incidences of abortions, underscoring the pervasive impact on the female-effect as well. The study urged policymakers, veterinarians, and farmers to view environmental hygiene as a reproductive health strategy. It called for the inclusion of waste management protocols in livestock housing designs, improved community sanitation enforcement, and active sensitization of herders and animal health workers on the dangers of environmental toxins. Ultimately, this paper positioned plastic waste not only as a threat to animal welfare and food safety but also as a direct contributor to fertility decline in small ruminants. It adds a novel environmental dimension to the understanding of reproductive health, showing that sustainable animal production must address both biological and ecological determinants. The findings reinforce that reproductive soundness is not immune to external stressors and that mitigating environmental risks is a necessary extension of the male-effect and female-effect paradigms.

Adenkola, **Raji** *et al*. (2016) managed a case of infectious coryza in a flock of peafowls kept at the University of Ilorin Zoological Garden. Although peafowls are not primary livestock species, this research holds important implications for

avian reproductive health, especially within the context of institutional breeding programmes, exotic bird conservation, and One Health surveillance frameworks. The affected flock presented with clinical signs consistent with upper respiratory tract infections, including sneezing, ocular and nasal discharge, facial swelling, and depression. Mortality was reported in some birds, prompting full necropsy and laboratory investigation. Bacteriological culture of nasal and infraorbital sinus swabs confirmed the presence of *Avibacterium paragallinarum*, the causative agent of infectious coryza. Gross pathological findings included infraorbital sinusitis, tracheitis, and conjunctivitis. Histopathological examination revealed severe lympho-plasmacytic infiltration of the sinus epithelium, mucosal erosion, and infiltration of heterophils in the respiratory tract. These changes are characteristic of chronic upper respiratory bacterial infection and highlight how rapidly such infections can compromise systemic and reproductive stability, especially under stress or immune suppression.

While reproductive consequences were not the primary focus of the study, the authors observed reduced mating behavior, egg production decline, and poor hatchability among the affected peahens. These reproductive repercussions demonstrate how even seemingly localized infections can cascade into fertility losses, especially in birds with narrow breeding seasons or high genetic value. The study emphasized the importance of routine veterinary monitoring, early microbial diagnosis, and biosecurity protocols within zoological settings and aviaries. It also suggested the inclusion of exotic avian species in broader veterinary reproductive studies, recognising that disease-induced fertility suppression is a significant threat to both conservation and commercial avian reproduction. In reinforcing the female-effect and its vulnerability to infectious stressors, this case contributes to a growing body of evidence that immune-reproductive interactions are critical in managing flock productivity. Proper housing, nutrition, quarantine measures, and targeted vaccination are essential reproductive interventions, even for non-traditional livestock species.

Socio-economic Insights into the "Gender effects"

Mr. Vice-Chancellor, Theriogenology and Veterinary Medicine in general is so demanding because we deal with several species and breeds of animals. The fact that reproductive expressions vary in various species and breeds of animals makes the work of Theriogenologists (and Veterinarians in general) much more complex but interesting. It may be surprising or even shocking to many to know that the price tags on our Nigerian West African Dwarf goat kid ranges between 300 to 900 dollars in America as of 2025, equivalent of which runs into hundreds of thousands if not millions, enough to comfortably pay the salaries of some high ranked academics. Such is the value of our domestic animal which we as Nigerians rarely value. In WAD goat production, the buck plays a very important role like any other male animal in livestock production. They can sire many does; this potential could increase, especially using affordable extenders for artificial insemination purposes like we established in my undergraduate work with my supervisor. The buck has the potential of synchronising estrus in saving huge cost of estrus synchronisation. It is the best detector of heat like any male animals. However, these potentials can only be maximised, when the buck reaches the optimum breeding age which is after puberty.

Small and large scale WAD goat farmers are encouraged to allow bucks attain an optimum breeding age of eight months to allow them to maximise their breeding potential, earlier highlighted for increased goat production purposes. This will increase the potential protein supply in terms of meat and milk of our WAD goats. Also, huge income could be generated especially in the near future, if they start looking towards standardisation of our livestock farming. Testicular Ultrasound is one of the standard non-invasive methods used in Breeding Soundness Examination (BSE) protocols. It is used to as diagnostic and biometric tool for estimating important indices such as testicular volume, which is a significant correlate of fertility in male animals. The need for more research into our indigenous livestock animals cannot be overemphasized; the reproductive indices of foreign livestock we read in textbooks

and use for teaching purposes are quite different from those our domestic animals.

These reproductive indices are invaluable particularly in the male livestock as earlier highlighted, for teaching, research and improved livestock production. Raji *et al.* (2024) related reproductive indices including scrotal circumference and semen characteristics with age to determine pubertal breeding age in indigenous white Fulani bulls. It was interesting to find out that the pubertal breeding age in these bulls was average of three years. This is in contrast with the foreign breeds of bulls that have been documented to reach pubertal age earlier.

Mr. Vice-Chancellor, dog breeding is a big business in Nigeria. The foreign breeds such as German shepherd, rottweilers, boerboel, among many others, are bred for socio-economic reasons including security, commercial and companionship. Dog breeders often seek semen analysis to know the reproductive status of their studs. This is important to ensure the studs are not having any reproductive diseases such as brucellosis which could jeopardise the reproductive lives and commercial values of these studs. Requests are often also made for heat detection in bitches because they are monoestrous animals, that is they display heat once in a year; as such, searching and targeting this period of heat is of paramount importance. I have provided adequate services successfully in these regards for many clients within and outside Ilorin through clinical and consultancy services rendered to the VTH, University of Ilorin. In responding to these clients, I taught Veterinary students the process of semen analysis and vaginal cytology which remains one of the best methods of choice for heat detection in bitches.

National and Global Relevance

Theriogenology is not an isolated scientific enclave; it is a keystone in the arch of sustainable development. As nations grapple with population growth, food insecurity, and zoonotic threats, animal reproductive science steps into global conversations about survival, equity, and innovation. In Nigeria, livestock plays a vital role in food production, economic empowerment, and rural livelihood. According to the Federal

Ministry of Agriculture and Rural Development, the livestock subsector contributes approximately 17% to the agricultural GDP and supports the livelihoods of over 30 million Nigerians. This is not a minor statistic; it is a call to action. If reproduction is the engine of livestock productivity, then theoretical engineer is its chief engineer. My research and clinical interventions respond directly to this national urgency by:

1. exploring low-cost semen extenders, we reduce dependency on imports and empower local inseminators;
2. diagnosing infertility in indigenous breeds, we protect genetic heritage while improving productivity; and
3. educating farmers on seasonal breeding cycles, we synchronise livestock production with market demand and climatic realities.

Beyond national boundaries, my work speaks to global priorities:

1. **Sustainable Development Goals**: Theriogenology intersects at least four SDGs:

- *Goal 2*: Zero Hunger-Through reproductive optimization, we increase meat and milk supply.
- *Goal 3*: Good Health and Well-being-By controlling sexually transmitted livestock diseases, we reduce zoonotic risk.
- *Goal 5*: Gender Equality-Women are primary animal handlers in rural Africa; empowering them with reproductive knowledge changes communities.
- *Goal 13*: Climate Action-Sustainable breeding reduces overgrazing, deforestation, and methane emissions.

2. **One Health Framework:** Reproduction and disease transmission are interlinked. Infected reproductive tracts serve as reservoirs for zoonoses such as brucellosis, leptospirosis, and Q fever. My participation in reproductive health surveillance and my contributions to NUC curriculum design integrate Theriogenology within the One Health paradigm approach that sees human, animal, and environmental health as inseparable.

3. **Climate-Responsive Breeding**: Climate change alters breeding seasons, forage availability, and disease prevalence. My studies on semen viability under thermal stress, and my advocacy for indigenous, climate-resilient breeds such as the West African Dwarf Goat and Fulani Bull, aim to future-proof Nigeria's livestock sector.
4. **Global Scientific Visibility**: Through international collaborations and publications in journals based in Turkey, Egypt, Sri Lanka, and Slovakia, I have positioned Nigerian Theriogenology research on the global stage. These contributions foster South-South cooperation and challenge the dominance of Euro-American narratives in animal science.

Indeed, every scan of a goat's testis, every microscopic evaluation of sperm, every lecture to a student in Ilorin echoes into broader arenas feeding a child in Bauchi, empowering a widow in Ekiti, or informing a policy in Addis Ababa. Theriogenology, once thought to be confined to barns and clinics, now shapes boardrooms, classrooms, and the United Nations' agenda.

My Humble University and Community Services

I served as Head of the Theriogenology Unit, coordinated postgraduate programs, and acted as Department Head. I held the position of Examination Officer, Faculty Farm Committee Chair, Faculty dress code Chair and represented the faculty on the University CBT Committee, the Open Educational Resources Committee, amongst others. I am also proudly currently serving as Head of my Department and as Financial Secretary of the Academic Staff Union of Universities (ASUU), UNILORIN Branch. I balanced academia with community leadership as Mayor of ASUU Luxury Quarters and currently still serving as Chairman of Arafat Muslim Community and Vice Chairman of The Companion (Muslim Organisation), Kwara State. My academic life has never been isolated from my social and spiritual life. This harmony is what makes the journey meaningful.

Conclusion

Together, these studies tell a story that spans species, organs, ecosystems, and laboratories. The male-effect is not merely about sperm, it is about influence, initiation, and intervention. The female-effect is not simply about ovulation it is about readiness, receptivity, and resilience. And between them lies the "main-effect": the recognition that reproduction is not just science, but a symphony where no note sounds right unless the harmony is acknowledged. Let us therefore continue this academic journey, not as observers of Biology, but as composers of a narrative that insists: in every ejaculation and every ovulation, there is legacy, lineage, and life itself. The journey I have shared with you today, though grounded in the science of Theriogenology transcends the confines of biology and clinical practice. It is the story of continuity of how one life, one lineage, one discipline, can ripple across communities, institutions, and generations.

Theriogenology is far more than an academic field; it is a testament to how life is created, nurtured, challenged, and renewed. It has taught me that fertility is not just a matter of gametes and hormone is a metaphor for hope, for resilience, and for continuity against the odds. As I have examined follicles, scanned uteri, evaluated semen, and recorded hormonal surges, I have seen reflections of society, policy, inequality, and untapped potential. From the fields of Mushin to the lecture halls of Ilorin, from the silent prayers of my mother to the bustling corridors of veterinary clinics, from dusty rural goat pens to academic boardroom, I have remained committed to this idea: that knowledge must serve, science must listen, and education must liberate.

Recommendations

Mr. Vice-Chancellor, research, no matter how groundbreaking, must ultimately speak to policy and practice. The true worth of knowledge is seen in its power to inform decisions, shape institutions, and empower communities. Drawing from years of research, clinical experience, and

institutional service, I present the following recommendations structured for stakeholders across academic, professional, and public sectors:

1. **Mainstream Theriogenology in National Livestock Policy**: Theriogenology, the science of animal reproduction should be recognised as a strategic pillar in Nigeria's livestock development agenda. Fertility optimisation is as vital as nutrition or disease control. The Federal Ministry of Agriculture and Rural Development, along with its state counterparts, must establish Reproductive Health Units within Veterinary Services Directorates. These units will be responsible for championing fertility management, artificial insemination, breeding soundness evaluation, estrus synchronisation, and genetic improvement strategies. Livestock extension programmes must prioritise reproductive efficiency as a measurable productivity indicator. Beyond administrative inclusion, policy documents such as the National Livestock Transformation Plan (NLTP) should explicitly allocate funding and operational roles for veterinary reproduction experts. This can be achieved through inter-ministerial collaboration with the Ministry of Science and Technology, aligning reproductive innovations with national food security strategies.

2. **Institutionalising Semen Technology Centers in all Geopolitical Zones**: The decentralisation of reproductive technology access is crucial. Semen collection, evaluation, and cryopreservation centers should be established in each of Nigeria's six geopolitical zones. These centers should house facilities for semen analysis, extender preparation (using locally available materials like honey or milk), cold chain storage, and distribution logistics. Each center should operate as a public-private-academic partnership, hosted within veterinary teaching hospitals, animal health institutes, or livestock training centers. Zonal centers will enhance regional autonomy in breeding programs, provide semen from climate-adapted superior sires, and reduce

overreliance on imported genetics. Importantly, these centers can also serve as training hubs for veterinarians, paravets, and livestock officers, embedding semen science into practical field applications. Community cooperatives and pastoralist groups must be engaged as both contributors and beneficiaries.

3. **Subsidised and Scaled Artificial Insemination (AI) Services**: A critical constraint to AI uptake in Nigeria is cost. To achieve scale, AI must be integrated into agricultural subsidy and extension schemes. Governments should offer subsidised AI services to rural farmers using proven extenders (honey-based, skim milk) and synchronised ovulation protocols. AI kits can be incorporated into agro-input distributions managed by ADPs. Subsidised AI not only improves calving/kidding rates but also reduces the risk of sexually transmitted diseases (trichomoniasis, brucellosis). Moreover, it allows for controlled breeding, reduces unwanted pregnancies, and conserves endangered indigenous breeds. Incentivising female-headed farms to adopt AI can multiply impact, particularly where herd management rests with women.

4. **Integrate Reproductive Health into One Health Surveillance**: Reproductive indicators such as abortion rates, dystocia frequency, semen abnormalities, and hormonal disruptions should be integrated into One Health surveillance platforms. These indicators are often early warnings of zoonotic infections, environmental toxicity (endocrine-disrupting chemicals), and climate-induced stressors. Veterinary teaching hospitals and livestock clinics should develop reproductive health dashboards aligned with national disease reporting systems like the National Animal Disease Information System (NADIS). Data harmonisation between ministries of agriculture, health, and environment will enable predictive modelling of outbreaks and reproductive crises. Sentinel farms,

managed in collaboration with academic institutions, can pilot these reproductive surveillance models.

5. **Revised Veterinary Curricula to Reflect Contemporary Reproductive Science**: Nigeria's veterinary education must evolve to meet modern reproductive science needs. Faculties of Veterinary Medicine should revise theriogenology curricula to include Reproductive ultrasonography, semen cryo-preservation and extender development, biostatistics for fertility data interpretation, gender-sensitive approaches to reproductive health and climate change impacts on fertility. Furthermore, postgraduate diplomas and certificate programs should be developed for practicing veterinarians in reproductive biotechnology, breeding herd management, and AI. Continuing Professional Development (CPD) in reproductive medicine must be made mandatory as a license renewal criterion.

6. **Bridge Gender Gaps in Livestock Reproduction Training**: In many rural Nigerian households, women and girls are the primary caregivers of small ruminants and poultry. However, they are significantly underrepresented in formal livestock training and certification programs. Government agencies, NGOs, and universities must design inclusive programmes that train, certify, and empower women as para-theriogenologists. These women can serve their communities as local inseminators, fertility scouts, and reproductive health educators. Recruitment of female trainees should prioritise pastoralist communities, widows, and female-headed households. By equipping them with knowledge and tools, livestock productivity and social equity will rise concurrently.

7. **Support Ethnoveterinary Research for Evidence-based Validation**: Pastoralists and traditional livestock keepers have used plant-based remedies for fertility modulation for centuries. Unfortunately, much of this knowledge remains anecdotal. Funding agencies and research institutions must

prioritize ethnoveterinary reproductive research through structured validation pipelines. Priority actions include-screening of herbs used for estrus induction, dystocia prevention, and libido enhancement, toxicological assessments, controlled clinical trials, dosage standardisation and mechanistic studies. Validated remedies can be incorporated into formal reproductive protocols, offering affordable and culturally acceptable alternatives. National policy frameworks must then support their regulation and integration.

8. **Institutionalising Community-based Breeding Programmes**: Universities and veterinary institutions must expand their extension roles by anchoring Community-Based Breeding Programs (CBBPs). These should integrate breeding soundness evaluations, fertility screening, AI campaigns, and reproductive health education. CBBPs offer participatory platforms where farmers define breeding goals and veterinarians offer scientific support. University-linked field stations can serve as service delivery points. Each CBBP should train local champions to carry out follow-up evaluations and encourage data recording. The outcome is sustainable livestock improvement, enhanced academic impact, and rural community development.

Vice-Chancellor Sir, these recommendations represent a synthesis of research outputs and real-world observations. They are actionable, scalable, and adaptable. What remain is political will, institutional alignment, and community mobilization. Nigeria must position theriogenology not as an academic discipline alone but as a transformative tool for food security, public health, and gender equity. Let this be our collective pledge to move knowledge from papers to paddocks, from presentations to policies, and from classrooms to communities.

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