Ultrasonography in the Cattle Reproduction

Prof M Subhan Qureshi, University of Agriculture Peshawar/Dairy Science Park, drmsqureshi@gmail.com

Understanding reproductive organs

- Ultrasonography contributed to facilitate the reproductive management of cattle (Bravo et al, 2023).
- Cows have two or three waves of follicular development during an estrous cycle.
- Monitoring individual follicles during their development and determining follicular development patterns.
- Diagnosis of gestation as well as fetal sex, diagnosis of reproductive organs and postpartum follow-up.
- Pathologies such as ovarian cysts to which is added doppler ultrasonography for blood flow among other functions.
- B-mode and real-time transrectal ultrasonography was initially used as a means of diagnosing the estrous cycle, and currently has great application in management, diagnosis and treatment in both specialized reproductive processes and reproductive biotechnology programs.

Ultrasonography and Reprod Efficiency

- Ultrasonography has great impact on reproductive efficiency.
- A corpus luteum (CL) is detectable by transrectal ultrasonography from two days after ovulation until day 21 of the subsequent cycle.
- {rogesterone (P4) concentrations only rise from day six to day 16 of the cycle, so ultrasonography may be a better indicator of reproductive status than P4 measurement.
- Since the 1990s, ultrasonography has become a diagnostic method used worldwide as a result of advances in its development: smaller size, high level of autonomy, high image quality and affordable prices.
- It improves the identification of the different stages of the estrous cycle and in the diagnosis of ovarian and uterine pathologies and pregnancy diagnosis.
- It's possible alterations (embryonic mortality, fetal malformations, among others) and helps to determine fetal sex from day 55 of bovine gestation.
- Technological advances have led to the availability of affordable ultrasound equipment that is highly functional, portable, and inexpensive, which has greatly increased its use in the reproductive management of cattle.

Transrectal Ultrasonography (TU)

- TU has been available for reproductive management decisions since the mid-1980s.
- It provides a wide range of morphologic information without invading or altering tissues.
- Examinations can be performed repeatedly over many days, or a dynamic event such as ovulation can be monitored in its entirety by continuous observation for 30 minutes or more.
- The inclusion of ultrasonic examinations in experimental protocols provides the opportunity to associate changing morphology with hormonal and other functional changes.
- Real-time B-mode US improved ovarian function assessment and pregnancy diagnosis in cattle, fetal sex in early gestation and verification of embryo viability.
- Early reproductive diagnosis helps in the separation of groups of pregnant and empty females to implement reproductive strategies.
- Clinical researchers have taken advantage of technological developments such as solid-state circuitry, real-time imaging, color and power Doppler, transrectal and transvaginal ultrasonography, and 3D imaging to improve research and diagnosis in very diverse areas.

Follicular Dynamics

- The wave-like follicular growth theory is based on visual and histological observations, that the growth of ovarian follicles develops in the form of waves and that during an estrous cycle two follicular waves propagate.
- This theory was confirmed in cattle thanks to the use of ultrasonography in the 1980s.
- Radioimmunoassay allowed the development of progesterone profiles in cow's milk samples collected twice a week, which made possible the selection of cows with abnormal progesterone patterns, and this allowed the study of some treatments of subfertile cows.
- The monitoring of follicular dynamics by means of US in cattle allowed observing that there can be two or three follicular waves in a cycle.
- US assisted in the study of changes in follicular and luteal structures and measurement of estradiol and progesterone in lactating Hereford x Angus cows during postpartum anestrus, monitoring follicular size, ovulation and corpus luteum formation and regression, the interval from calving to first ovulation was 82 days.

Estrous cycle and ovulation

- US confirmed that follicles grow, regress and are replaced by other large follicles continuously throughout the cycle.
- That estradiol concentrations increase in preovulatory follicles until the preovulatory LH peak and then decrease rapidly.
- That gonadotropin controls follicular steroidogenesis, and that high estradiol concentrations suppress progesterone production before the LH peak.
- US provides high sensitivity and specificity to detect ovarian follicles, corpora lutea or cystic structures, useful to determine the stage of a cow's estrous cycle or diagnose ovarian pathologies such as subclinical endometritis and ovarian cysts.
- The opportunity to monitor the estrous cycle and the ovaries can be performed daily by ultrasonography, also the gestation diagnosis can be performed from 32 days after artificial insemination.
- The effect of hormonal treatments such as gonadotropin-releasing hormone (GnRH) and Prostaglandin F2α on the ovaries may be observed.
- Poor estrous detection remains a limitation to achieving high reproductive performance in herds due to decreased estrous expression in high producing cows. Ovulation may be induced through GnRH injection 5-7 days of estrus cycle, of a dominant first wave follicle and form a corpus luteum, studied using ultrasonography.

Superovulation protocols and treatment

- Ultrasonography helped greatly in the development of superovulation protocols and treatments.
- Inducing superovulation in embryo transfer programs maximum number of transferable embryos observed through ultrasonography.
- Eight to 12 days after estrus would be the approximate time of appearance of the second follicular wave, and a cluster of growing follicles is present at that time.
- The day of onset of the second follicular wave has been shown to differ between two-wave cycles and three-wave cycles and between individual animals.
- Superovulatory response was optimized when treatments were initiated at the time of follicular wave onset.
- Superovulation in cows is influenced by multiple factors, which should be carefully considered when designing a protocol. Additionally, the use of ultrasonography is essential for monitoring the progress and effectiveness of these treatments.

Implantation process and early embryonic death

- Ultrasonography may be used in the diagnosis and follow-up of gestation in cows, although embryonic mortality has a substantial impact on cow fertility.
- Most embryonic losses occur during the first few days after fertilization and during the implantation process.
- Primary attention has often been given to infectious agents, but noninfectious causes probably account for 70 % or more of cases.
- Early embryonic death occurs before fetal calcification, and complete embryo resorption, mummification, maceration, or abortion is often observed.
- Dead embryos, between the time of implantation and calcification, are also resorbed.
- Generally, product losses occur during the first 42 to 50 days after mating or insemination.
- There are a variety of readily adoptable management factors that can directly increase embryonic survival or ameliorate the consequences of low embryonic survival rates.
- Ultrasound examination has no detrimental effects on the fetus, rectal palpation is also a safe procedure when performed correctly.

Pregnancy Diagnosis through Ultrasonography

- Fetal morphometry by ultrasonography is useful for evaluation of fetal development, estimation of gestational age, and prediction of calving if the mating date is unknown.
- Gestational age determination is feasible during early pregnancy in cattle and becomes more difficult in late gestation due to the size of the fetus and its position in the maternal abdomen.
- Determination of placentome size, fetal thoracic, abdominal and umbilical diameter, and heart width by ultrasound are the reliable variables for predicting gestational age.
- Examination and monitoring of gestation is very important as there are crucial periods for gestation loss during the first trimester of gestation in cows, even though it can occur at other stages and for a variety of causes, producing a negative impact on the reproductive and economic performance of herds.
- From days eight to 27 after mating, contemplates embryo elongation and the period of "maternal recognition of pregnancy" with average losses of 30 % but with a variation of 25 to 41 %, maintenance of CL by interferon-tau and changes in prostaglandin secretion, as well as failures in trophoblast elongation.
- During 2-3 months of postconcussion 60, an embryonic losses of 12 % is observed due to delays or defects in the development of chorioallantoic placentome, resulting in CL regression or embryo death.
- Gestation diagnosis is performed by transrectal ultrasonography between 30 and 47 days after insemination.

Doppler ultrasonography (DUS) in superovulation and embryo transfer

- A specialized imaging technique that uses high-frequency sound waves to visualize and measure blood flow within vessels and tissues.
- In embryo transfer its main use is in the choice of recipients, based on the quality of their *corpus luteum*, although it can also serve us to monitor the process of superovulation, embryo transfer and implantation.
- Ultrasonographic image of the corpora lutea of several heifers were analysed and it was concluded that recipients with higher quality corpora lutea will be more favorable candidates for embryo implantation.
- In recent years, transrectal DUS has proven to be a useful tool that can determine uterine blood flow during the estrous cycle, gestation and puerperium.
- Visual assessment of corpus luteum blood flow 14 days after embryo transfer is effective for the detection of non-pregnant recipients.
- Day seven ovarian assessment information and validation of visual scores for corpus luteum blood flow improved prediction accuracy.
- This methodology increased flexibility in the use of recipients, allowing resynchronization of about 79 % of non-pregnant animals between nine and 14 days earlier.