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INDUCED TWINNING IN CATTLE – BOON OR BANE?

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Cattle generally ovulates single ova (monotocous) under most circumstances, with a successful pregnancy producing only one offspring per pregnancy. Occasionally, the reproductive process in cattle results in twin birth as with many other monotocous species. As twinning is increasing over the time, dairy industry must be prepared to cope up with the negative effects of twinning (Guerra-Martinez *et al*., 1990). Lack of basic and applied scientific data on twinning in dairy cattle made the dairy industries less prepared to make better management decisions to mitigate these negative effects. Better understanding of physiologic mechanisms associated with twinning will encourage adaptations of sound managemental practices which can minimize/mitigate the negative effects of twinning.
Key words: Cattle, monotocous, twinning

Physiological Mechanisms of Twinning

Regulation of follicular growth

The ovarian functions are controlled by cyclic pituitary gonadotropic hormones, which are stimulated by gonadotropin releasing hormone (GnRH) from the hypothalamus. Patterns of follicular growth are closely associated with a surge in the circulating gonadotropin hormones (Adams *et al.,* 1992). Especially a high level of FSH is essential for the first and second follicular waves. Moreover the selection of dominant follicles depends upon a drop in FSH levels. Two surges of FSH occur during each estrous cycle and in which the first one encourages the surges of GnRH and LH which in turn play important role in ovulation. Selected dominant follicle is activated to grow by increasing LH concentration and eventually ovulates. A second surge in FSH level is the trigger for the arising of the first wave (Ozden, 2011). Increasing circulating levels of IGF-1 is closely related to a naturally occurring incidence of twinning in cattle. Development of more than one follicle at the same time in twin-bearing cows is possibly due to the prevented regression of the dominant follicle caused by increased levels of IGF-1 (Echternkamp *et al*., 1990a). Therefore IGF-1 play very important role not only in folliculogenesis but also in the genetic basis of multiple ovulations in cattle.

Incidence of double ovulation and twinning

Selection of a single dominant follicle capable of ovulating in each follicular wave is a hormonally controlled phenomenon. Occasionally, two follicles are selected to continue to grow from the group of recruited follicles in a follicular wave and they emerge simultaneously to become dominant among the several follicles in the follicular wave ultimately leading to release of two oocytes from the co-dominant follicles at the end of estrous cycle. If the eggs from the double ovulation are successfully fertilized by two separate spermatozoa it results in twinning. Hence the twins or triplets in rare situations will be a reality if all the subsequent events proceed normally (Wiltbank *et al*., 2000).

Types of twinning

Monozygous twinning

Ovulation of a single dormant follicle also can, on rare occasions, result in twins when a single fertilized egg split into two after fertilization. Twins resulting from ovulation and fertilization of single ocyte is called monozygous twins/identical twins. Monozygous twins are genetically and phenotypically identical and are therefore always of same sex. Though mathematical estimates of monozygous twinning rates are

high (7.4% to 13.6% of all twin births), the monozygous twinning occurs infrequently in dairy cattle population (Fricke and Wiltbank. 1999).

Dizygous twinning

Dizygous twinning accounts for most number of twin births in dairy cattle. They are also called as dizygotic twins / fraternal twins. Dizygous twins are not identical genetically or phenotypically as monozygous twins and are not necessarily the same sex as opposed to monozygous twins (Fricke *et al.,* 1998).

Methods to Induce Twinning

Hormonal induction of twinning

Induction of twinning with the usage of exogenous hormones was started thirty years ago when cattle were given with single injection of pregnant mare serum gonadotropin (PMSG) during follicular phase of the estrous cycle. Off late use of highly purified ovine FSH was evaluated for induction of twinning. Ovine FSH can be injected @ 8-10 mg as 8 injections over 4 days beginning on day 8-10 of synchronized cycle with luteolysis induced by prostaglandin injection on the morning of the third day. Which could yield ovulation rate of desired range of 2-4 (Bindon and Hillard, 1987).

Twinning by inhibin vaccine

A new approach to induced twinning is to develop a vaccine against the protein hormone inhibin, a natural ovarian peptide that inhibits FSH synthesis. Preliminary studies have confirmed that immunization against native ovine inhibin causes increased ovulation rate. Immunogens based on synthetic fragments of alpha-inhibin chain are successful in ewes but not in cows (Bindon and Piper, 1989). Recent studies have evaluated the efficacy of recombinant inhibin immunogens to induce multiple ovulations. A prototype vaccine for twinning is now ready for field evaluation.

Twinning by embryo transfer

- *Estrus Synchronization*: Using prostaglandins or intravaginal progesterone releasing devices plus prostaglandins both donor and recipient are estrus synchronized.
- *Artificial insemination*: Three days after the injection donor and recipient cows in estrus are artificially inseminated or allowed for natural mating by the proven bull.
- *Checking for the transfer suitability*: On day 7 of post mating or post-AI, the cows are examined to determine the side of ovulation and suitability for transfer
- *Embryo flushing*: Having reached initial stages of development after one week of artificial insemination, embryo was flushed out from donor cow.
- *Embryo transfer*: Non-surgical transfer of embryo to the contra-lateral uterine horn of the recipient cow previously bred by artificial insemination.
- *Conformation of twin pregnancy*: Forty five days after the embryo transfer, the left and right uterine horns of the recipient cow were examined for twin pregnancies (Guerra-Martinez *et al*., 1990).

Factors affecting twinning frequency

Breed differences

Twinning indicates the reproductive capacity of an animal. However, uniparous animals like cattle rarely give birth to multiple young ones. Considerable variation in the frequency of twinning is observed in different breeds of cattle. Some of these differences in the frequencies of twinning are attributed to real breed differences as well as some environmental factors. HF display highest twinning frequency (4.75 %) and Jersey exhibit lowest twinning rate (1.83 %) among exotic dairy cattle (Ozden, 2011).

Parity and age of the dam

Normally an increase in twinning rate is observed between first and second parity in heifers. Twin pregnancy continues to show increase trend with subsequent parities but to a lesser degree. It seems that monozygotic twin rate does not depend on parity. On the other hand the parity effect on twinning rate is most likely due increase fraternal (dizygotic) twin frequency and enhanced double ovulation rates. The effect of parity on incidence of twinning could be possibly due to the fact that older dams have more chance of double ovulation physiologically and have more ability to support development of twin calves (Rutledge, 1975).

Season of the year

Peak twinning rate is observed in cows conceived in the fall season and lowest frequency is observed in cows conceived in spring season. A high peak frequency is observed in June and lower peak on December and January. Reduced percentage of twin births during winter could be due to reduced photoperiod and an improved feeding in fall season (Johansson *et al*., 1974).

Is twinning in cattle desirable or undesirable?

Twin birth is an unavoidable issue in dairy production systems since several factors such as breed, genetics, parity, and some other environmental factors greatly influence the twinning rates in cattle. Thus twin calving cause to lessen overall reproductive efficiency, productivity, and thus the profitability.

Breeding efficiency

Multiple births reduce the reproductive efficiency of cows by increasing the difficulties during the pregnancy and calving periods. Twin calving also negatively affects the number of days between one calving to the next and subsequent calving to conception. Twin calving increase the calving by two to three weeks compared to single calving. Additionally twinning also causes reduced number of available heifers for use as replacements in dairy herds (Nielen *et al*., 1989).

Retained placenta

Increased occurrence of retained placenta, chronic genital organ disease and subsequent lower conception rates in multiple pregnancies is recorded in cow giving twin birth (Johansson *et al*., 1974). Gestation period which tends to be shorter in twin bearing cows could be the possible risk factor for retained placenta which will also lead to delayed uterine recovery (Foote, 1981).

Incidence of dystocia

Incidence of dystocia remains high in cows bearing twin pregnancy when compared to normal single pregnancy even though the causes of it are different between twin bearing and single bearing cows. As a result mortality rate is also higher in multiple pregnancies. In one of the study mortality rate was four times higher in twin born calves due to an increased dystocia and reduced gestation length (Guerra-Martinez *et al*., 1990).

Milk production

A positive correlation between twinning and milk production is recorded in dairy cattle for first lactation and second lactation. Though the association between twinning and double ovulation are not clearly understood, increased incidence of double ovulation observed more often in high yielding cows than the low producing counterparts (Bar-Anan and Bowman, 1974).

Calf survival

Neonatal calf mortality and stillbirth are common detrimental effects of twin calving due to decreased gestation period and increased of dystocia among the cows bearing twins. Premature births are main reason for many stillborns and limited capacity of uterus due to weight and size of the twin pairs is also the other factor affecting it (Ozden, 2010).

Reproductive ability

Main reason for reduced reproductive ability in twin bearing calves is freemartinism, a syndrome observed in heifer calves born co-twin to bull calves, where in the female is infertile. Freemartinism is the result of fusion of placental blood vascular system of two fetuses during early gestation, which allows the interchange of primordial cells and endocrine hormones (Anti-Mullerian hormone) that causes sexual differentiation between twin calves (Jost *et al*., 1973).

Management of twin pregnancy

Despite of lack of information, several management strategies could be considered when a dairy is experiencing significant levels of twinning.

Early identification of twin bearing cows

Trans-rectal ultrasonography can be sued for early identification of twins at 40-55 day post-AI. Palpation per rectum 50 to 70 day post-AI also results in acceptable degree of accuracy. But majority of the twin pregnancies are detected during routine per rectal examination for early-pregnancy diagnosis. Systemic identification of cows carrying twin fetuses allows for differential management of these cows later during

gestation, especially during dry and transition periods (Day *et al*., 1995).

Elective abortion and culling of twin bearing cows

Continued management of cows carrying twin pregnancies could be avoided either by culling the cow or by aborting the pregnancy during first trimester of gestation, through administration of prostaglandin $F_{2\alpha}$. Several factors could be considered before electing to abort a twin pregnancy with intent of rebreeding the cow. First the estimated average lactation length would approach 500 days. Secondly the risk of twin pregnancy during the subsequent gestation is increased because the cows calving twins are at greater risk for subsequent twinning. Third is the establishment of pregnancy in lactating dairy cattle. Finally the cows carrying twins experience greater rates of early embryonic loss than cows carrying singletons (Fricke, 2001).

CONCLUSION

Detailed understanding of the complex follicular growth pattern during estrous cycle and oocytes development will certainly improve the knowledge to maximize and control the reproductive efficiency in dairy cattle, especially the existence of dizygotic twinning since fertilization of more than one ocyte after ovulation will be main reason of multiple births. Though the twin bearing impose many negative effects on the overall reproductive performance of the cattle, an economic gain from the twinning could be maximized with the adaptation of better nutrition program and managemental practice.

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