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Some Managemental and Reproductive Aspects in Relation to Subsequent Fertility in Transitional Cows

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Abstract: The transition from a pregnant to non pregnant state in farm animals is associated with numerous physiological challenges and stressors. Some managemental factors during this critical period may influence subsequent fertility and even contribute in the prolongation of the interval to the next parturition and predispose to great economic losses.The present article threw light on some managemental and reproductive aspects in relation to subsequent fertility in transitional cows. Manegemental aspects include the effect of nutrition, mainly how to overcome the the effect of negative energy balance (NEB) associated with the increased nutrient demands of the growing fetus, parturition and the onset of lactation to avoid periparturient disorders. Nano food can be tried to improve the quality, safety and nutritional value of food, more effective delivery of nutrients such as protein, vitamins, minerals and antioxidants by adding nanosupplements Diseases control includes vaccination against prevailing diseases using nanoparticle based veterinary vaccines. Reproductive aspects include application of ultrasonography for early pregnancy diagnosis and decreasing the interval between successive artificial inseminations and following up fetal health and diagnosis of pregnancy disorders It can be concluded that the peripartum period is a very critical factor which determines the actual benefit from breeding of farm animals. Nutrition of parturient animals must not neglected and efforts should focus on reducing or eliminating NEB. Special care should be paid to health status; particularly for the udder, proper vaccination program and de-worming.

Key words: Peripartum Period · Management · Nutrition · Fertility · Health Status

INTRODUCTION

The proposal of an offspring per year doesn't occur whenever feeding and management conditions are not proper, especially during the last few weeks of pregnancy to correlate with the rapid growth rate of the fetus and high milk energy output in early lactating cows [1]. In the same time, culling and replacement policy is a prominent criterion in dairy enterprise depending on the herd fertility. The later is a major factor affecting the production and economic efficiency of the dairy industry [2].

The interval from calving to resumption of estrous cycles, estrous detection and conception rate following service are the major determinants of farm fertility considered by breeders. Postpartum NEB, dry matter intake and health status, all have major influences on calf crop. More favorable breeding strategies incorporating genomic technologies, modern application of nanotechnology in food science with greater emphasis on fertility and health traits should be utilized by producers. This review threw light on the pillars of fertility performance with special references to impact of some managemental and reproductive aspects on subsequent fertility in transitional cows.

Manegemental Aspects

Nutrition: Negative energy balance in late gestation predispose to many transition cow disorders and systemic inflammation such as displaced abomasum, retained placenta, dystocia, mastitis, metritis, fatty liver, ketosis, reduced feed intake after calving and immuno-suppression [2]. A part from restriction in feed availability, the trough space, limited water availability and quality, poor grouping strategy, slippery floors, excess time standing in holding areas will all limit feed intake.

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To alleviate the NEB and deficits in key nutrients in early postpartum, large amounts of concentrates must be fed, often at the expense of fiber-rich forages, which cause major dietary imbalances with critical importance for rumen health whereas the disturbed rumen microbial balance is accompanied with health disorders and systemic inflammation [3]. The rumen microbial ecosystem converts the complex dietary carbohydrates that cannot be digested by mammalian enzymes into short-chain fatty acids which is considered as the main energy source for the host [4]. Besides generating energy, proper functioning of the rumen is critical for the synthesis of microbial protein and vitamins, most importantly B-vitamins which are crucial in energy metabolism [5].

The use of total mixed ration facilitates the use of palatable feedstuffs such as molasses, which have been shown to improve energy balance in transition cows [6]. A high-protein diet, balanced calcium and phorphrous ratio and administration of selenium, vitamin A and β-carotene intra-muscularly in prepartum period are required to lower incidence rates for retained placenta in pregnant cows [7]. The concept of dietary cation / anion balance has focused attention on the level of potassium that is contained in the feed of precalving dairy cattle [8]. Also, administration of vitamin AD3E and selenium during the last month of gestation in native Egyptian cows improved their postpartum reproductive performance as calf birth weight, uterine involution and ovarian rebound and conception rate [9].

Insulin is required for synthesis of insulin-like growth factor-I (IGF-1) in the hepatocytes in response to the higher level of growth hormone (Somatotropin) resulting in production of estradiol in higher amounts from dominant follicles, more LH receptors for ovulation and development and growth of corpus luteum [10]. The intentions of nano food are to improve the quality, safety and nutritional value of food, more effective delivery of nutrients such as protein, vitamins, minerals and antioxidants by adding nanosupplements [11]. Nanoencapsulation can control the release of certain active ingredients such as proteins, vitamins, minerals, enzymes and preservatives. It can mask undesirable odours and flavours such as fish oils, enhance the shelf-life and stability of the ingredient and the finished food product and also improve the uptake of encapsulated nutrients and supplements [12-14].

The Importance of Rumen Health for Fertility: A large body of evidences indicates that poor rumen health results insystemic inflammation [3] and greater risk of developing other disorders and diseases such as mastitis, metritis, laminitis, abomasal displacement, bloat, off-feed and ketosis [15]. The mechanisms of the activation of this type of inflammation seem to be identical with other common inflammatory processes in cattle which start with stimulation of Toll-like receptor (TLR)-4 cascade, activation of the transcriptional pathways and the subsequentrelease of pro-inflammatory cytokines [16,17] such as interferon (INF)-β which decrease the secretion of LH [18] and resulted in suboptimal luteal function, absence of ovulation and compromised follicle and oocyte development [19]. Furthermore, cytokines have direct adverse effects on the ovary. For example, interleukin (IL)-6 inhibits the estradiol secretion and consequently reduces LH secretion [20]. Other cytokines like tumor-necrosis factor (TNF)-α and INF-δ caused cytotoxicity in the corpus luteum and reduced the progesterone secretion [21, 22]. Moreover, TNF-α was found to be a key factor inhibiting the process of oocyte maturation.

Disturbed rumen function often result in incomplete degradation of nutrients and diarrhea like condition causing suboptimal nutrient supply and reduced feed efficiency [23]. Also, the risk of mycotoxin contaminations to impair rumen microbiota and thus the risk of mycotoxin transfer from feed-to-milk increases [24].

Recently, antimicrobial additives, detoxifying nanomaterials were added to animal feed such as mycotoxin binders, nanoclay, to protect animals against mycotoxicosis [11].

At present, there are some examples of commercially available nanobiosensors used for early diagnosis of animal disease. Also, there are products incorporating nanosized particles comprising of a polystyrene base, polyethylene glycol linker and mannose targeting biomolecule, that adhere to pathogens in the gastrointestinal tracts of livestock [25].

The Possibility of Postpartum Reduced Concentrate Feeding Beside Good Quality Roughage and its Impact on Milk Yield and Health: After parturition concentrates are usually fed to increase food intake and milk production by increasing the passage rate and digestibility of the diet, by increasing the energy content and by balancing the energy to protein ratio of the ration [26, 27]. On the other hand, cows are ruminants and are anatomically and physiologically specialized for digesting roughage feed. High amounts of concentrates lead to low pH values in the rumen and to metabolic disorders specially if it is fed separately from roughage [26, 28] and higher milk acetone levels were recorded, indicating ketosis, in different levels

according to breed. Therefore, too low as well as too high amounts of concentrates can be, but are not necessarily, connected to health risks and fertility impairments, depending on farm conditions like roughage quality or breed.

Ivemeyer *et al*. [29] noticed that when the concentrate feeding is reduced from 363 kg/ cow / year to 276 kg/cow/year there was no significant effect on milk yield. Also, milk yield and veterinary service incidences were higher and calving intervals were longer when more concentrates were fed. The reduction in concentrate feeding showed no association with somatic cell score. Within breeds, However, Reist *et al*. [30] found only a slight reduction in milk yield in cows fed lower concentrate amounts (30%) compared to a higher level (50%) despite higher body losses and higher negative energy balances in the 30% concentrate group. It was concluded that reduced concentrate level could be compensated by good quality roughage and better herd and feeding management.

Diseases Control: Vaccination against prevailing diseases such as foot and mouth disease (FMD), hemorrhagic septicemia (HS) and other diseases as a vaccination program in the dairy region must be carried out. Traditionally, inactivated microorganisms provided the antigen, but recently there has been a shift towards the use of safer synthetic peptides and recombinant proteins [31]. Alone, these new vaccine candidates were poorly immunogenic until the advent of nanotechnology a plethora of novel antigen in nanoparticle-based adjuvants were available and can be engineered for reduced dosage, frequency and easier administration whereas large number of animals can be treated at once in a commercial unit [32]. The nanoparticle adjuvants can control the residence time, location and dose of antigen released so as to maintain immunity levels and enhance translocationof antigen to lymph nodes. Also, they act as a depot to provide prolonged delivery of antigens. Finally, nanoparticles can be engineered to produce virus like particles that have similar morphologyto virus capsid and stimulate immune responses without the infectious genetic material that is responsible for host infection [31].

To date, more than 40 diseases of animal species including FMD and BVD virus and *Toxoplasma gondii* inruminants have nanoparticle vaccine delivery systems that are either successfullydeveloped or under development [32,33]. A detailed review of nanoparticlebased veterinary vaccines is provided by Scheerlinck and Greenwood [34].

Heifers must be checked for mastitis before calving. Recently, extensive research has been performed to develop nanoparticle systems to enable sub-clinical disease diagnosis via detection of small aggregates of atypical cells and detection of biomarkers and pathogens.

There are a multitude of nanoparticle based detection systems successfully validated for the detection of viral, parasitic and bacterial pathogens in the veterinary field [35,36].

Imaging, as a tool of diagnosis, can be macroscopic or at a molecular level where nanoparticles passively extravagate due to the increased permeability at these sites or the nanoparticles are conjugated to various ligands (e.g. monoclonal antibodies, peptides, polysaccharides or aptamers) to direct them to a certain cell type or pathway [37]. Some nanoparticles, such as quantum dots, gold nanoparticles and perfluorocarbon nanoparticles, have innate imaging properties, whereas others (Such as radiolabelled liposomes) have the ability to detect pathological tissues or septic foci in large animals [38].

In dairy heifers, control and prevention of mastitis is currently based on avoidance of inter-sucking among young stock, fly control, optimal nutrition and implementation of hygiene control and comfort measures, especially around calving. Moreover, prepartum intramammary treatment with antibiotics has been proposed as a simple and effective way of controlling heifer mastitis, but positive long-lasting effects on somatic cell count and milk yield do not always occur, ruling out universal recommendation of this practice. The use of antibiotics for treatment of heifers mastitis in this manner is off-label and results in an increased risk of antibiotic residues in milk. Prepartum treatment can be implemented only as a short-term measure to assist in the control of a significant heifer mastitis problem under supervision of the herd veterinarian [39].

In a recent study, Ametaj *et al*. [40] demonstrated that intravaginal administration of probiotics in periparturient cows lowered systemic inflammation and enhanced both performance and fertility in dairy cows.

De-worming for external and internal parasites should be carried out [41].

One of the most important factors in management of pregnant cows is the determination of pregnancy status with regard to single vs twin pregnancies. Cows gestating twins need to be provided with a higher plane of nutrition and increased obstetrical care before and after calving. Elective termination of pregnancy near completion of gestation is largely used as a management tool in cattle when required in some critical cases such as hydrocephalus, fetal oversize, etc… [42].

The owner needs to prepare the calving area which should be clean, dry, non slippery, quiet and isolated to keep the prepartum cow close for the owner to notice and provide help if the cow shows signs of difficulty during the birth [43].

Reproductive Aspect: The application of real-time ultrasonography often provides information that was previously only available through exploratory laparotomy. Ultrasound is used in identifying pregnancy and foetal number determination [44]. It also permits fetal sexing [45]. It is accurate and rapid and the outcome of the test is known immediately at the time the test is conducted. The rate of embryonic mortality and the efficacy of strategies to rebreed cows at various stages post breeding also play a role in determining the advantages and disadvantages of the timing of pregnancy diagnosis and resynchronisation [46]. Transrectal ultrasonography is a reliable method for studying follicular dynamics. It shows the antral follicles of various sizes as non-echogenic structures, which can be distinguished from blood vessels in cross-section by the elongated appearance of the latter [47]. The CL is identified ultrasonically from the third day after ovulation. A developing CL appears on the ultra-sound image as a poorly defined, irregular, greyish-black structure with echogenic spots all within the ovary; a mid-cycle CL is a well defined granular, greyish echogenic structure with a demar- cation line visible between it and the ovarian stroma; in a regressing CL the demarcation line is faint, owing to the slight difference in echogenicity between the tissues [48].

Early pregnancy diagnosis can improve reproductive performance by decreasing the interval between successive artificial insemination services and guide breeders when rapidly rebreed the animal [49]. The foetus appears as an echogenic structure inside a non-echogenic structure [50]. To compensate for embryonic mortality, cows diagnosed pregnant early post breeding must undergo one or more subsequent pregnancy examinations to identify and rebreed cows that experience embryonic mortality and to maintain the reproductive performance of the herd.

Estimation of foetal age, monitoring of foetal growth across time and diagnosis of pregnancy disorders can be performed by ultrasonographic foetometry. Biparietal diameter of the skull and length of long bones. Ultrasonographic foetometry has been shown to provide a precise estimation of gestational age and prediction of calving dates [51]. With the assertion that the accuracy and precision of the prediction of calving date are sufficient to be of benefit in the management of cows in late pregnancy and at calving.

How to Alleviate the Stress Factors Affecting Fertility: The period of postpartum anoestrus is usually longer in buffalo than in cattle under comparative management conditions [52,53].

Factors such as poor nutrition and body condition [54] suckling management [55] and climate or heat stress [56] which also influence nutrition through feed quality and availability, can delay ovarian rebound considerably. Dams raised under free grazing with abundant natural feed and their calves were allowed for suckling only once per day, resumed oestrous cyclicity sooner than those raised under harsher conditions with free suckling by the calves [55, 57].

Heat stress during the hot summer months is an important cause of anoestrus in buffalo cows and is associated with elevated blood concentrations of prolactin, which is thought to influence ovarian activity as well as cause sub-fertility and repeat breeding by decreasing progesterone secretion [58].

The first postpartum ovulation was frequently followed by one or more short oestrous cycles (<18 days). Cessation of oestrous cyclicity occur after the first or second ovulation in about 25% of buffalo cows due to ovulatory failure or prolonged luteal activity [56]. Methods that are recommended for overcoming prolonged postpartum anoestrus in cows include adequate nutrition before and after calving, restricting the suckling by calves and alleviating heat stress by permitting wallowing or use of water sprinklers [59].

Ovarian inactivity, cystic ovarian disease and infection of genital tract are some of the main causes of anestrous. Hormonal therapy, balanced energy and protein intake, feeding of macro- and micro-nutrients like cobalt, copper, iodine, manganese, phosphorus, calcium, selenium, zinc and vitamins E, A, beta carotene are the general considerations for the treatment of anestrous[57]. Therefore, plants providing above nutrients and/or having hormonal activity may be helpful in the treatment/management of such reproductive disorders.

The presence of buffalo bulls in a herd also has a biostimulatory effect, reducing irregularities in oestrous cycle patterns and advancing the time of first postpartum ovulation [60]. Ahmed *et al.* [61] mentioned that buffalo cows, having anestrous during breeding season, supplemented with mineral mixture of sodium phosphate dibasic, zinc sulphate, copper sulphate, potassium iodide,

sodium selenite, vitamine AD3E and lasalocid came in estrus nearly in the same percentage of recovery of those animals received hormone treatment, some recieved Folligon (Pregnant mare serum) and others received Reciptal (GnRH) followed by Estrumate (Prostaglandin $F_{2\alpha}$).

Some plants used in animals with delayed puberty and anestrous were generally considered to have high calorific value and therefore, heat generating. Other plants have hormonal activity such as Phoenix dactylifera [62], Linum usitatissimum [63], and seeds of Gossypium hirsutum [64]. phytoestrogens may influence sex hormones production and affect intracellular enzymes, protein synthesis and growth factor [65].

CONCLUSION

The peripartum period is a very critical factor which determines the actual benefit from breeding of farm animals both during the near and the far future. Moreover, it correlates with the reproductive and productive performances. From the current review article, multiple practical implications from what happened during this period can be extracted and should be making used of. Firstly, nutrition of parturient animals must not neglected and efforts should focus on reducing or eliminating NEB and loss of BCS, as well as ensuring that animals have fairly ideal BCS to optimize fertility. Moreover, it is possible to reduce the percent of concentrate in animal feed if the animal was provided with good quality roughage and good management without limitation in milk yield,Secondly, special care should be paid to health status; particularly for the udder, proper vaccination program and de-worming. Thirdly, owners or managers must prepare a suitable area for parturition to decrease incidence of uterine infection. Fourthlyuse of reproductive tools such as ultrasonography should be applied to follow uterine and fetal health and reduced the non productive time in animal life.

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