Review on Major Factors Affecting the Successful Conception Rates on Biotechnological Application (AI) in Cattle

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Abstract

Cows become fail to conceive with various factors including management failures, nutritional status, postpartum reproductive health, semen quality and other miscellaneous factor and hence reduce efficiency of AI service. Mainly heat detection skill by farmers and timing of insemination are the major factors that determine the success and failure of AI programme. Am/Pm rule is the way which helps to determine relative insemination times achieved in practice, since maximum fertility to artificial insemination occurs when cows are bred near the end of "standing heat". Ovulation occurs about 12 hours after the end of standing heat. Management limitations also synergize other factors like delivery problems which prone the AI service to have inefficient and poor result. Conservative stocking rate, a sensible year round feeding and herd health plan and adequate AI service are important to improve reproductive efficiency, and hence, economically benefit from the crossbreeding activities. Skill of inseminator is an important element in the success of the artificial insemination program and regular practice at inseminating time is required to maintain high conception rates. Besides to that site of semen deposition has an important role in achieving conception of AI in cattle. So that the deposition of semen in the uterine body resulting in higher non-return rate than cervical deposition. Cows are inseminated just into the short uterine body.

Index terms — heat detection, artificial insemination, inseminator, conception rate.

1 I. Introduction

he role of livestock in general and cattle in particular in the national economy is more significant than what the official production figures would suggest when their contributions for farm traction, farm fertilization and fuel (through manure) are considered (Hassen et al., 2007). Ethiopian cattle population is ranked first in Africa as cited by Hassen et al. (2007) and estimated about 43.12 million (Demeke, 2010) of which 55.41% are females. Out of the total female cattle population, only 151,344 (0.35%) and 19,263 (0.04%) heads are hybrid and exotic breeds, respectively (Demeke, 2010). Cattle production is an integral part of almost all farming systems in the highlands, and the major occupation in the lowlands.

The arid, semi-arid and sub-humid zones are homes for 14% of the cattle population each while 6% and 52% of the cattle population inhabit the humid zones and the highlands of the country, respectively. The majority of the cattle population is found in the highlands of Ethiopia where 43.6% of the human agricultural population is residing which indicates that cattle have a very important role in the Ethiopian economy (Belihu, 2002).

Artificial insemination (AI) is the manual placement of semen in the reproductive tract of the female by a method other than natural mating and it is one of a group of technologies commonly known as "assisted reproduction technologies" (ART), whereby offspring are generated by facilitating the meeting of gametes (spermatozoa and oocytes). ART may also involve the transfer of the products of conception to a female, for instance if fertilization has taken place in vitro or in another female. AI has been used in the majority of domestic species, including bees, and it revolutionizing the animal breeding industry during the 20th century (Milad, 2011).

As reported by Katherine and Maxwell (2006), the first successful attempt at artificial insemination (AI) was conducted in 1776 by Italian physiologist Spallanzani who inseminated a bitch producing three pupies. The first lamb born in Australia from AI was in 1936. Both the puppies and lamb were born from AI with fresh semen; since these early attempts there has been considerable effort in the development of semen preservation and AI technology. At present, fresh, chilled and frozen-thawed semen is used extensively for AI in animal breeding and production throughout the world. It was not until around 1900 that serious attempts were made to develop the technique in farm animals. The work was carried out by Ivanov and colleagues in Russia, and by 1930 they had achieved success with cattle and sheep. Within the next ten years AI was in commercial use for cattle in the USA and the UK (Ball and Peters, 2004).

As livestock genetic improvement, AI has become one of the most important and successful reproductive biotechnology ever devised for the genetic improvement of farm animals which enable to use bulls of high genetic merit available to all (Mukassa-Mugerwa, 1989; Webb, 1992). As mentioned by Webb (1992) T

2 II. Major Factors Affecting Success of ai Delivery

The successful outcome of artificial insemination (AI) in cattle depends on a number of intrinsic and extrinsic factors which have deleterious effect. An understanding of the impact of such factors on the probability of success when performing AI is of basic importance to established correction measures (Haugan et al., 2005). Reproductive efficiency is poor in most cattle production systems, mainly cows fail to become pregnant with various factors including management failures, nutritional status, postpartum reproductive health, semen quality and other miscellaneous factors. So that the extension service must ensure that farmers get adequate information on the input required to benefit from crossbreed dairy cows and from those of higher genetic merit (Mekonene, 2010).

3 a) Effect of AI Delivery System

Absence of appropriate collaboration and communication between the NAIC, regional agriculture bureaus and other stakeholders, absence of recording system, lack of clearly defined share of responsibilities among stakeholders, poor integration of AI service with livestock health and feed packages, poor motivations and skills of inseminators due to of lack of on job training, lack of support and readily available inputs such as liquid nitrogen. All these factors make the delivery service poor and some of the farmers move their cows for long distance in search of AI service. This is happening in many areas and the reason is AI technicians are unable to get transport facilities like motor bicycles and fuel.but insemination is time dependent job, in which during this long journey/waiting time, heat period is passed away before the service have been given (Lemma, 2010).

4 b) Factors related to heat detection

Compared with other factors accuracy of heat (estrus detection) is one of the major factor that determine AI program. Heat detection in cows carried out by experienced herd persons/inseminator who can able to identify those animals which would be in heat stand while being mounted/ridden by other female cows or vasectomized bulls, since the period is the shortest period between two successive oestrus cycles (Iftikhar et al., 2009 **??** Arthur,2001). As shown in the table (1) below, those animals manifest behavioral symptoms like frequent urination, bellowing raised tail, restlessness and licking of external genitalia besides to different visible external changes like vulvular edema and absence of wrinkles on vulvular lips, vaginal hyperemia, wetness and mucus discharge also observed. Roelofs et al. (2006) mentioned that expression of estrus can be influenced by many factors such as heritability, number of days postpartum, lactation number, milk production, artificial insemination (AI) plays an important role in the development of the dairy industry; however, follow-up of cows that have been inseminated and assessing success of AI by regular pregnancy diagnosis is a problem. The usual method is by rectal palpation, which can be performed only 2-3 months following AI and requires an experienced inseminator or veterinarian (FAO/IAEA, 2007). These limitations result in long waiting periods before non-pregnant cows are detected, leading to long calving intervals and economic losses to the farmers. Therefore, a technique for early detection of non-pregnancy is required to shorten the interval between an unsuccessful insemination and the subsequent breeding (NAIC, 1995; FAO/IAEA, 2007). Selective breeding is a highly effective and sustainable approach for increasing animal productivity in the longterm. Reproductive technologies such as artificial insemination (AI) allow single animals to have multiple progeny, reducing the number of parent animals required and allowing for significant increases in the intensity of selection, and proportional increases in genetic improvement of production (FAO/IAEA, 2007).

According to NAIC (1995), AI has been introduced to Ethiopia in the early 1930's, however, it was interrupted because of World war II and in 1981 National Artificial Insemination Center (NAIC) has been established to coordinate the overall AI activities throughout the country, even though a cross breeding program has been introduced to Ethiopia at a wider scope in late 1960 ' s (Brannang et al, 1980).

An achievement in an increasing milk and meat production by improving the genetic merit of indigenous cattle has been one of the primary livestock development objectives of Ethiopia (Heinonen, 1989). Improvement in livestock resources have been achieved through the implementation of an efficient and reliable AI service, in parallel with proper feeding, health care and management of livestock ??Meles and Henonen,1991). Hence to cope up with effective AI service trained man power, facility, follow up and linkage with those involved animal management and breeding while a lack in one of these have been resulted in a failure of the service or in its effect ??Shiferaw et al., 2002). In Ethiopia even though AI program has been started and continued for several decades, the genetic improvement achieved throughout the country is still unsatisfactory due to several factors. Very few studies in limited part of the country have been conducted to evaluate the success rate of AI.

Therefore, the objectives of this literature review are to provide some insights on: types of major factors that hinder the achievement of pregnancy post insemination and effects of these limiting factors on efficiency of AI. and health are known to influence estrus expression. Environmental factors like nutrition, season, housing, herd size, etc. also play a role in estrus expression.

Estrus in cattle is commonly referred to as heat which occurs every 18 to 24 days in sexually mature, open (non pregnant) female cattle when they are receptive to mounting activity by bulls or other cows or heifers. According to Jane et al. (2009) standing heat can occur any time in a 24-hour period (table ??). However, the most likely time for a cow or heifer to show heat signs is at night but the season of the year can influence this, with more cows showing heat at night in hot weather and more showing heat during the day in cold weather. Hot weather, high production, crowded conditions, and high stress environments may reduce mounting activity. Observers must distinguish among cattle coming in to heat, in standing heat, and going out of heat. Females that are in standing heat, were in standing heat yesterday, or will be in standing heat tomorrow are the most likely herd mates to mount other cows or heifers in heat. Observe cows away from the feed bunk so feeding behavior does not interfere with heat detection. Cattle need nonslip footing and ample room to interact freely. Dirt footing increases mounting and standing activity (Jane et al., 2009). The optimal time at which insemination should take place relative to ovulation (insemination-ovulation interval = IOI) depends mainly on the fertile lifespan of spermatozoa and on the viable lifespan of the oocyte in the female genital tract (Roelofs et al., 2006). For conception to occur, insemination must take place at the correct stage of the cow's estrus cycle since ova remains viable for about 12-18 hrs after ovulation (Bekana, 1991;Rodriguez-Martinez, 2000).

Successful fertilization highly depends on the time interval from insemination to ovulation meaning that insemination takes place too early, the sperm is aged and by the time ovulation occurs it cannot fertilize the ovum and if insemination takes place too late, the egg is aged and fertilization and formation of a viable embryo is not likely. Indications exist that, in practice, an enormous variability exists in the timing of insemination relative to ovulation (Roelofs et al., 2005).

Oestrus is short in the cow, with ovulation occurring 10-12 hours after the end of oestrus (Arthur, 2001). During the next 6 hours the oocyte travels about a third of the way down the uterine tube, during which time fertilisation occurs, about 30 hours after the onset of oestrus. The best conception rates occur if insemination is carried out in the middle to the end of standing oestrus, i.e. 13-18 hours before ovulation. Cows may conceive if they are inseminated at the beginning of oestrus or even 36 hours after the end of oestrus but conception rates are reduced (Arthur, 2001).

There are various reports that indicate low rates of service in artificially inseminated cattle, mainly due to problems in the detection of estrus. While few cows are detected in heat losses occur in significant herd reproductive efficiency. This is higher in Bos indicus cattle (Galina, 1996) since have special breeding features -heat of short duration with a high percentage of expression during the night and also depend on social cues. The secretion of estrogen, a manifestation of oestrus LH surge and ovulation are closely related and well known. With follicular growth, the amount of estrogen secreted increases to a peak serum concentration, triggering a preovulatory LH surge, follicular maturation and ovulation, lasting 27 hours. The goal of increased concentrations of estrogen is triggering hormonal cascade of events that includes the LH surge and a series of changes that promote follicular ovulation, and sexual behaviors associated with acceptance of mounts. The main characteristic of estrus is the posture of immobility assumed by acceptance of the cows and ride. High milk producing cows manifest estrus of shorter duration than cows with lower production. Females of childbearing age are pregnant or in the luteal phase of the cycle (under the domain of progesterone) are less likely to mount other females in estrus. Almost 86% of females who ride other females are in estrus and proestrous (under the domain of the estrogen) (Milad, 2011;Arthur, 2001).

When natural service is used there are no problems, since a cow will only stand for the bull when she is in oestrus, and under free-range conditions a cow may be served several times at each oestrus. Several literatures review (O'Connor, 1993; Milad, 2011; Arthur, 2001; Jane et al 2009; ??afez,1993) on the correct timing of artificial insemination which is a dependent upon true, accurate and early identification of oestrus, the accurate identification of the individual animal and informing the inseminator at the correct time. A cow that is first seen in oestrus in the morning is usually inseminated in the afternoon of the same day, whilst a cow that is first seen in oestrus in the afternoon is inseminated early the next day (Arthur, 2001). Frequently, where large numbers of cows are inseminated at the incorrect time, the oestrus detection rate is poor, thus generally reflecting a poor standard of herd management. In such circumstances, some of the methods described above should be used to improve the oestrus detection rate in the herd (Arthur, 2001;Hafez, 1993).

Among the management problems, poor heat detection skill by farmers and timing of insemination are the major factors that determine the success and failure of AI programme (Mukasa-Mugerewa, 1989). Reproductive efficiency is thus poor in most cattle production systems, mainly because cows either fail to become pregnant and require high number of services per conception. Among the varous problems, poor heat detection skill by farmers and timing of insemination are the major factors that determine the success and failure of AI programme (Mukasa-Mugerewa, 1989; Mekonen et al., 2010).

As Richard J. (1998) stated that when AI was being developed and validated, there were several studies that were designed to determine the optimal time of AI in relation to estrus. The data suggested that optimal pregnancy rate per AI (PR/AI) would be achieved from midestrus until a few hours after the end of estrus. Since then, the recommended practice has been AI 12 h after the first observed estrus (a.m.-p.m. breeding) (Arthur, 2001, Galina, 1996).

However, because of the variability of interval between the onset and the observation of estrus, it is difficult to define the ideal time of AI in relation to ovulation. A protocol has been developed using GnRH and PGF2a that synchronizes the time of ovulation within an 8-h period (24 to 32 h after the second injection of GnRH) with PR/AI similar to a.m.-p.m. breeding. This precise synchrony of ovulation allows for an effective test to determine the optimal time of AI in relation to ovulation ??Richard, 1998).

NAAB (2011) reported that embryonic quality and accessory sperm numbers can be effected by time of insemination. Using varying quality and quantities of semen, the number of accessory sperm was highest when insemination occurred 24 hours after onset of estrus. The quality was the best when insemination occurred at heat onset, but fertilization rates are lower at this time. The optimum insemination time to maximize pregnancy rates is approximately 12 hours after onset of heat. Therefore, AI timing should be performed at 12 hours after estrus detection for maximized pregnancy rates. Loss of pregnancy rate to early inseminations is due to fertilization failure (but embryo quality is high). Whereas, loss to late insemination is due to embryonic failure (but fertilization rate is high). Thus optimum insemination time appears to be a compromise (NAAB, 2011).

5 c) Intrinsic Factors related to the cow i. Reproductive health

Cows with uterine infection in the early postpartum period generally have lower conception rates at subsequent breeding. Studies confirm that even mild uterine infections adversely affect conception rates (O'Connor, 1993). As Smith (1982) on his finding in the following table described that health and reproductive disorders to post-calving seriously affect conception rate. Calving and post-calving reproductive disorders seriously affect conception rates as illustrated by the following table (Table 1). Thus, the key to maximizing conception rates must lie in the prevention of disorders, not treatment after they have occurred. Some evidences indicate cows suffering from metabolic disorders, like milk fever, may have a higher incidence of reproductive disorders and lower conception rates. Smith (1982) reported that first service conception rate was lower (38%) in cows treated for milk fever than in cows not suffering from this disorder (47%). Besides to that a higher incidence of cystic ovaries (20%) in cows treated for milk fever than in cows that were not (4%).

6 Table (2) Effect of calving and post calving disorders on conception rate

High reproductive efficiency is dependent on obtaining normal uterine involution, early resumption of ovulation, high efficiency of oestrous detection and high conception rates per service as shown in the following table(3) (James, 2006). Early Embryonic Loses Reduced conception rates could due to early embryonic mortality which contributes to reproductive inefficiency in lactating dairy cows because fertility assessed at any point during pregnancy is a function of both conception rate and pregnancy loss. Conception rates at 28 to 32 days post-AI in lactating dairy cows according to James (2006) ranged from 40 to 47%, whereas conception rates in dairy heifers nearly 75% where as 50-55% around day 42(Jonathan, 2009). The fertilization rate after AI in beef cows is 90%, whereas embryonic survival rate is 93% by Day 8 and only 56% by Day 12 post AI. In dairy cattle, only 48% of embryos were classified as normal on Day 7 after AI. Thus, substantial pregnancy loss probably occurs within two weeks post AI (Grimard et al., 2006).

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On the other hand conception rate to first service is the combined consequence of fertilization, early embryonic, late embryonic and foetal development, and each of these steps in establishing pregnancy may be affected. Grimard et al. (2006) cited that fertilization failure and early embryonic loss, late embryonic/foetal loss and late abortion represent 20-45%, 8-17.5% and 1-4% of pregnancy failure, respectively. Jonathan (2009) at the following table shows the condition of pregnancy rate after fertilization. Most investigations conducted on effect of nutrition at the later part of gestation (Smith, 1982) because of the limited nutrient requirements of the fetus because of the limited nutrient requirements of the fetus for growth and development during the first one-half of gestation. But according to Smith (1982) and Anzar (2003) energy status is generally considered to be major nutritional factor that influence reproductive performance. Also total dietary intake can affect fertility, both at the level of the oocyte and embryo, which means it is important to differentiate between optimum conditions for follicle growth (both in terms of number and follicles and paracrine environment) and optimum conditions for embryo survival. So that nutrition has effect on quality of follicle, oocyte and embryo (Maurice, 2003). Maurice (2003) briefly described the blastocyst Volume XV Issue III Version I

8 Table (4) : Frequency of embryonic mortality at different stages of pregnancy

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formation is as a key developmental process in the growth of an embryo and the blastocoels cavity forms as a consequence of fluid transport across the trophectoderm. This process is partially facilitated by Na/K-ATPase. Messenger RNA for this enzyme has been identified in day-7 bovine embryos. Dietary intake and diet type can alter the expression of transcripts of genes involved in early embryo development, such as Na/K-ATpase. and CU/Zn SOD. A decreased in invitro secretion of interferon-tau in day-15 embryo from undernourished ewes and an increase in the invitro secretion by endometrial tissue of PGF 2? was evident in the same animals. Thus, nutrient requirements for optimum follicle growth and embryo development may be quite different. Based on this, he indicates that the importance of diet around the time of mating and in particular the significance of extreme underfeeding post mating in regulating pregnancy rate.

As Xu et al. (2010) reported that the peak of embryo death occurs during the first month of pregnancy, and controlled feed intake is important to reduce mortality of embryos. He has demonstrated that a diet consumed before mating has a major impact on embryo survival and litter uniformity in blastocyst size in pigs. Manipulation of feed intake before mating may affect embryo survival through changes in follicular development by altering oocyte quality (Smith, 1982) and also there are increasing evidences that the feed intake after mating plays a major role on embryo survival. As a result of steroid dependent changes in the uterine environment, embryo survival is affected by different feed intake levels after mating (Maurice, Global Journal of Medical Research ( ) G be expressed which enable to identify estrous cow easly. Especially on cattle housed in tie-stall or stanchion barns must be turned out in order for this behavior to be expressed. L ' Oconor (1993) reported under research conducted on high-producing Holstein cows to what extent slippery footing surface could have been affect expression of estrus. The result showed that mounting activity occurs more frequently when cows are on soil rather than concrete. When five estrous cows were individually presented with an opportunity to spend time on soil or on concrete in the presence of a tied cow which was either an estrous cow or a cow not in heat, the test cow spent an average 70 % of the time on ground reported by L ' Oconor (1993) and 73% by Milad (2011). The test estrous cow mounted more frequently when a tied estrous cow was on soil rather than on concrete.

2003

9 e) Factors related to semen quality

As Saacke (2008) considering the economic investment in semen and other inputs, success must be judged on the basis of pregnancy rate to the first AI. Also, a good first service pregnancy rate response usually signifies good conditions for second service.

Additional key factors to be considered as impacting pregnancy rate to first service are semen quality (primarily dependent on choice of bulls). In most breeding strategies, whether estrous synchronization is employed or not, semen quality is one of a critical point to a successful pregnancy. The nature of sub fertility due to the male is proving as complex as that due to the female. Saacke (2008) emphasized that the importance of semen handling and placement to achieve threshold or above threshold number of sperms to the ovum (i.e., approach 10 sperms/ovum) necessary to maximize both fertilization rate and embryo quality for a general population of bulls. Based upon the median number of 2.4 accessory sperms per ovum/ embryo and the threshold requirement of nearly 10 sperms per ovum/embryo to optimize embryo quality, efforts to raise accessory sperm number have been undertaken. While morphological defects are minimum since this will checked before processing.

10 f) Factors Related to Insemination Techniques

One of the most significant contributions to the successful application of AI in cattle breeding has been made by the highly trained inseminator (Arthur, 2001).The efficiency of cow insemination depends, among other factors, on the ability of the inseminator to deliver the semen to the appropriate site in the reproductive tract at the appropriate stage of estrus. However, there has been a tendency to adopt routine insemination techniques and to ignore inseminatorrelated factors that can dramatically affect fertility. Although professional inseminators palpate the reproductive tract of numerous cows every day, most are not trained to examine the uterus and ovaries. This poses a serious practical limitation to the success of AI (López-Gatius F., 2011). Animals showing signs of true heat should inseminate using frozen semen thawed at 37 0 C for 30 seconds (Iftikhar et al., 2009;Jane et al., 2009).

Professional technicians are more successful at insemination than inexperienced ones, indicating that selection of a qualified inseminator is an important element in the success of the artificial insemination program and regular practice at inseminating is required to maintain high conception rates. Citation evidence by Gebremedhin (2008) shows that the site of semen deposition has been an important factor in the success of AI in cattle, i.e the deposition of semen in the uterine body resulted in a 10% higher non-return rate than did cervical deposition and

An increase in the conception rate has been reported when semen was deposited in the uterine horns rather than the uterine body. cows are inseminated just into the short uterine body(O ' connor, 2003). Insemination into the cervix produces a lower fertilization rate, while insemination deeper into the uterus runs the risks of either inseminating into the uterine horn contra lateral to the ovulation site, or scoring the endometrium with the tip of the insemination catheter. Reduced fertility is the consequence of both of the latter two errors (O ' connor, 2003; Arthur, 2001). In the early days of AI there was controversy among researchers about the optimum site for semen deposition. A study conducted in Canada cited by O ' connor (2003), provided evidence that fertility was highest when semen was deposited in the uterine body. Researchers currently are reexamining insemination technique to determine the proper site of semen deposition. Failure to understand the anatomical and functional relationships among the various tissues and organs of the reproductive system may lead to consistent insemination errors (O ' connor, 2003).

The ability to perform an intrauterine insemination in cattle means that a relatively low dose of sperm is required to achieve acceptable pregnancy rates. Typically, of the 20-30 million sperm that are required in each insemination dose, 6-7 million survive freezing, that is generally regarded as the minimum dose compatible with acceptable fertility (Arthur, 2001). Regarding to depth and time of insemination NAAB (2011) recommends that very deep insemination can enhance sperm delivery. However, site of insemination was found to make only small increases in sperm per egg. Deep insemination be used only when the sperm dose is below threshold, or if sexed semen is being used. Also hygien, tawing methods, temperature maintenance between thawing to insemination have also play a factor in achieving pregnancy (Milad, 2011). Rectal palpation and ultrasound examinations should be considered safe procedures when performed correctly,

11 III. Conclusions and Recommendations

Artificial insemination is still now serve as a main tool for dissemination of outstanding germplasm, control of venereal diseases and cost-effective dairy farming approach and through this method it is possible to improve conception rate and reduce number of service per conception by applying proper AI program implementation. The main problems identified are: delayed insemination; low conception rates; which leads to repeat breeding and long calving intervals and resulting overall low AI output. The major reasons for the above problems incriminated cases are: untrained AI technicians, poor heat detection, poor quality of semen, malnutrition, improper AI timing, endometrial problems and other related factors. It is possible to increase CR and decreasing embryo mortality by optimizing the insemination-ovulation interval with a high probability of fertilization. However, the insemination-ovulation interval in which this fertilized oocyte has a high probability of developing into a good embryo is shorter (24-12 h before ovulation).

Based up on the above conclusions, the following recommendations are forwarded: ? A Successful heat detection methods and subsequent proper timing of insemination should be required in increasing reproductive efficiency. Am-Pm principle should be followed as a rule of thumb approach during insemination service. ? Technique and site semen deposition is the sole of factor to achieve pregnancy, which inseminators have to given an attention, ? Through periodical trainings and workshops developing the skill of inseminators is required. ? Strengthening the extention system and awareness creation on the owners on identification and time of presentation of cattle showing oestrus sign. ? Strong veterinary intervention is required to maximize conception rates which lie in the prevention of post-calving disorders than treatment trails after they have occurred. ? To maximize the effectiveness of insemination, post breeding heat detection (detection or return heats) must be high. ? Extension service must ensure that farmers get adequate information on the input required to benefit from crossbreed dairy cows and from those of higher genetic merit. [1]

[1] Review on Major Factors Affecting the Successful Conception Rates on Biotechnological Application (AI)in Cattle

Figure 1:

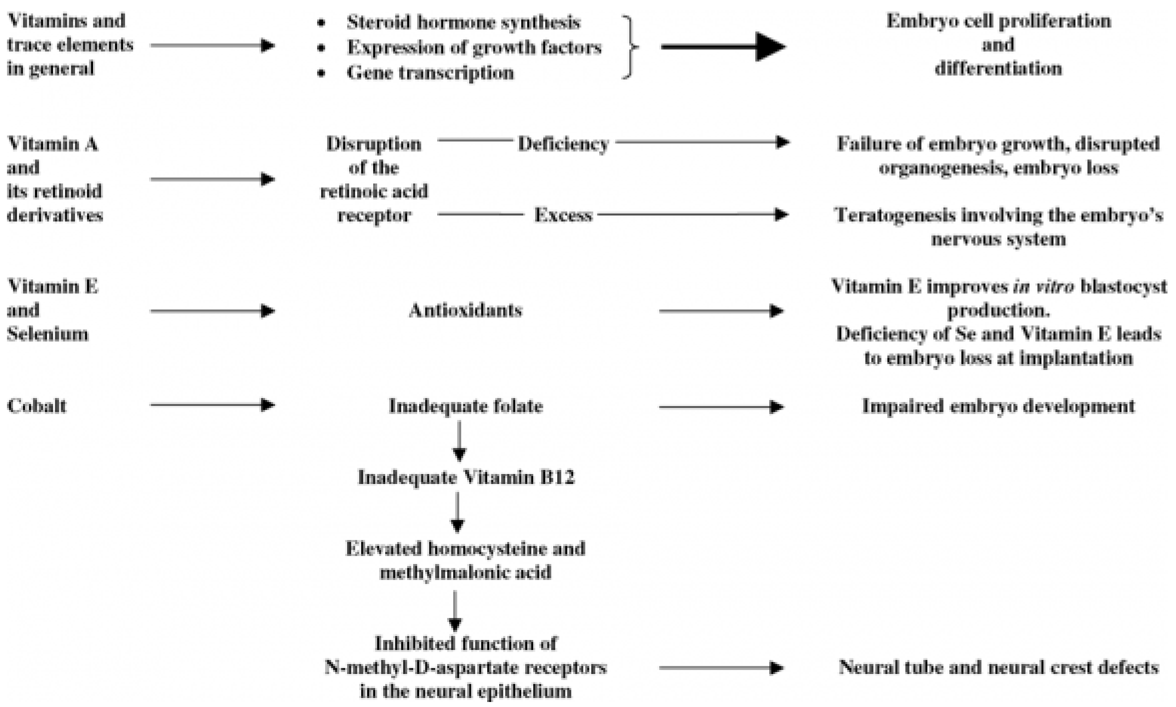

Figure 2:

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	Timeline for Heat Signs in Cattle		
	Coming into Heat (8 hours)	Standing Heat (18 hours)	Going out of Heat (14+ hours)
Heat Signs	Stands and bellows Smells other cows Headbutts other cows Attempts to ride other cows but will not stand to be mounted Red, moist, slightly swollen vulva Clear mucous discharge from vulva	Stands to be mounted Rides other cows Bellows frequently Nervous and excitable	Attempts to ride other cows but will not stand to be mounted Smells other cows Clear mucous discharge from vulva
Source:	Jane et al. (2009)		

Figure 3: Table (1

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Reproductive process	Target to be achieved	Risk factors affecting targets
Normal uterine involution	Day 50pp	Dystocia, RFM , Uterine infection
Resumption of ovulation	90% by day 42	Loss of $>$ 0.5 BSC unit, Low feed intake, Uterine health
High oestrous detection	85% per cycle	Infrequent checks, Sub-oestrus, High yield
High conception rate to AI	50% per breeding	Excess BCS loss, Prior uterine problems Low P4 days 4-7 of pregnancy
Source James (2006)		

Figure 4: Table (3

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