Review On Reproductive Biotechnology And Its Role In Dairy Cattle Production And Health

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Abstract: Biotechnology is a key technology in the generation of an adequate food supply for the ever growing human population. The main objectives of using this biotechnology in dairy cattle are to increase production, reproductive efficiency and rates of genetic improvement. To achieve this goal, reproductive biotechnologies like: - artificial insemination (AI), synchronization, Embryo transfer (ET), in-vitro fertilization (IVF) cloning, and newly emerging reproductive biotechnologies. Artificial insemination, the oldest and most powerful among the reproductive technologies because it is easy to perform, cost-effective, and highly successful and synchronization are the most applicable technology almost all over the world. It does not mean that it is morally acceptable or friendly welfare. It can prevent venereal transmission of sexually transmitted diseases; increases milk production and also reproduce disease resistant offspring. However, improper use of this technology can affect the production and the health of animal. Reproductive biotechnology have also drawbacks like high cost, need instruments & materials, patience, longtime, skilled man power and animal welfare consideration. Most of these biotechnologies (cloning (nuclear transfer), embryo transfer and in-vitro fertilization) are not comfortable to apply for commercial purpose unlike AI. In Ethiopia, most of these technologies are not widely used due to different constraints. Hence, there should be a means to apply most of the technologies in extensive animal production system across the globe to improve dairy production and health.
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1. Introduction

Biotechnology is a key technology in the generation of an adequate food supply for the ever growing human population. Genetics and reproduction as fundamental functional prerequisites for successful livestock production have been important subjects of biotechnological research in animal science for many decades. Biotechnological procedures developed so far are to be applied for increasing breeding efficiency in farm animals, for the preservation of animal genetic resources, for the improvement of product quality or for new production strategies and novel animal products (Smidt and Niemann, 1999).

Various biotechnological tools for reproduction in cattle are artificial insemination (AI), super ovulation and embryo transfer (SOET), in vitro handling of oocytes and production of embryos, reproductive cloning and emerging technologies. The application of these technologies for cattle breeding is has been discussed in relation to their impact in the improvement of the efficiency of dairy, which ultimately rule the possibilities of a competitive and sound production of food for human consumption, especially milk production (Heriberto, 2012).

The skillful application of these technologies has an immediate effect on contemporary animal production efficiency and a permanent effect on future generations through alteration of selection differentials and generation length (Shelton, 1990). Combinations of these technologies with information systems and data analysis will provide even more significant changes in the next decade. Various techniques have been developed to obtain a large number of offspring from genetically superior animals or obtain offspring from infertile (or sub fertile) animals (Naqvi *et al.,* 2002; Blackburn, 2004). To take full advantage of the benefits of assisted reproductive technologies, one must understand the basic physiology of the female and male reproductive systems as well as various methods to synchronize reproductive cycles (Paterson *et al.,* 2003).

Commercialization of animal biotechnologies, including those related to reproduction (also known as Assisted Reproductive Techniques, ARTS) is an

increasing reality in developing countries, following the enormous flow of information around us and the increasing global commercial interests in areas where cattle production has its major assets (Heriberto, 2012).

The present paper is aimed at reviewing on reproductive biotechnologies applied in livestock, with an emphasis on their role in dairy cattle production and health.

2. Review On Reproductive Biotechnology

Reproductive biotechnologies intend to be used routinely to shorten generational intervals and to propagate genetic material among breeding animal populations. To achieve this goal, reproductive biotechnologies have been developed in generations over the years, namely artificial insemination (AI), embryo transfer (ET), manipulation of fertilization and embryo production in vitro (IVF) and multiplication techniques (cloning) for the application of transgenesis (Morrell & Rodriguez, 2009; 2010).

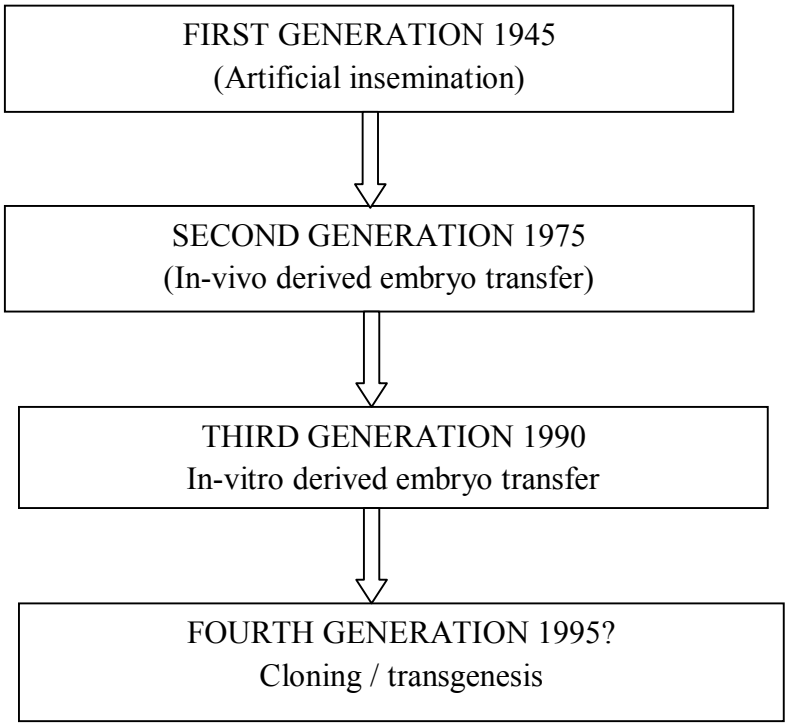

Fig. The various generations of animal reproductive biotechnologies (Source: Thibier, 1990).

Despite the remarkable progress made and the punctual importance of some of the above mentioned technologies, AI remains the most important assisted reproductive technology (ART) in developing countries. Any attempt to gain widespread of any other ART under the predominant economical conditions in developing countries ought to match the simplicity and the success of AI as a breeding tool (Heriberto, 2012).

2.1. Artificial Insemination

Artificial insemination (AI) is the technique of transferring semen collected from a male animal and manually (artificially) placing the spermatozoa in the reproductive tract of a female animal (insemination) in order to get the female impregnated. Artificial insemination is widely used for livestock breeding around the world, and a necessary tool in sustainable farm animal breeding (Gamborg and Sandoe, 2005). This technology has been used in cattle for over 65 years (Betteridge, 2003). Artificial insemination is the oldest and most powerful among the reproductive technologies because it is easy to perform, cost-effective, and highly successful (Vishwanath, 2003).

Genetic progress in cattle can be increased up to 50% through the application of AI, the first generation biotechnology, using either extended semen that has been preserved in liquid form (fresh, or cooled to 5ºC), or deep-frozen (Vishwanath, 2003). Some diseases can be transmitted via semen and a hygienic and safe semen handling including control of the semen for contagious diseases is important. The fresh semen is also evaluated in terms of motility and

quality. The spermatozoa in the collected semen are sensitive and must be handled with care. After collection the semen is cooled, frozen, and stored in liquid nitrogen (LN2) in -196°C until it is time for thawing and insemination. It is important to avoid sudden temperature changes and cooling and thawing of the semen shall be made according to certain recommended approved regimes. Post thaw motility should be at least 40 %. It is important to regularly check levels of LN2 in storage containers (Galloway and Perera, 2003).

A successful AI program must include efficient and accurate heat detection and timely AI relative to ovulation. The failure to detect heat is the most common and costly problem of AI programs and the major limiting factor of reproductive performance on many dairies (Nebel and Jobst, 1998). 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. Extensive training of inseminators has been one of the most significant contributions to the successful commercial application of AI in dairy cattle breeding (Foote, 1996).

During mating, the bull deposits several billions of spermatozoa into the anterior vagina. However, because the cervix is a major obstacle for sperm transport, the number of spermatozoa that finally reach the uterine body usually does not exceed 1% (Harper, 1982). In artificial insemination, semen is generally deposited directly into the uterine body, thus bypassing the cervix and permitting the use of a considerably reduced number of sperm (López-Gatius, 2000).

2.2. In-Vitro Fertilization

In case other artificial reproductive techniques fail due to difficulties such as blocked reproductive systems, non -responsive ovaries in the females, marginal semen quality and quantity in the male, and presence of disease, in vitro fertilization (IVF) is used. The fertilization of the sperm and the egg is conducted in vitro (outside the animal's body) at specific environmental and biochemical conditions. With IVF, a technician removes unfertilized eggs (oocytes) from the donor cow's ovaries, usually recovering 6-8 useable oocytes. The oocytes mature in an incubator and are fertilized with sperm. The resulting zygotes incubate and develop in the laboratory before being placed into the recipient cow. IVF facilitates recovery of a large number of embryos from a single female at a reduced cost thus making ET techniques economically feasible on a larger scale (Cowan, 2010).

2.3. Embryo Transfer

Embryo transfer is a process by which an embryo is collected from a donor female and then transferred into a recipient female where the embryo completes its development (Sauvé, 2002). The bovine embryo transfer industry as it is known today arose in North America in the early 1970s (Betteridge, 1981 and 2003). The International Embryo Transfer Society (IETS) was founded in 1974, with 82 Charter Members, representing researchers, academics and veterinary practitioners (Thibier, 1998).

As a method, ET basically requires synchronization of the donor and the recipient females so that the embryos are recovered and transferred in synchrony in order to warrant a proper embryo elongation and the recognition of pregnancy by the recipient cow (Rodriguez *et al*., 1999).

The quality control of the whole process is now necessary for a given team and regular testing in the media collected and stored for assay should be a standard procedure. This could involve search for a putative contamination by various viruses that might originate from the collected donor of from some serum used in the media, and the status for pathogenic and also for saprophytic micro flora. This should contribute in the mid-term to establish and verify the effectiveness of the quality assured production process procedure. Adding antibiotics to the media is also always of good practice as it contributes to remove permanent or opportunistic pathogenic agents or saprophytic microorganisms inadvertently introduced at the collection point or at the time of fertilization from semen that can never be sterile (Guerin *et al.,* 2000).

2.4. Hormone Use (Synchronization)

Synchronization of estrus implies manipulation of the estrous cycle or induction of estrus to bring a large percentage of a group of females into estrus at a short, predetermined time (Odde, 1990). The most pronounced sign of estrus is standing immobile when being mounted. Although it is difficult to compare studies because of many different estrus detection strategies, it is clear that many cows do not display standing heat at all during estrus (Eerdenburg *et al.,* 1996; Roelofs *et al*., 2005; Roelofs *et al*., 2008).

2.4.1. Prostaglandin treatment

One of the oldest ways to synchronize estrus is by using a luteolytic agent such as Prostaglandin F2a, or an analogue, which causes the regression of the corpus luteum (Lauderdale, 1972; Louis *et al.,* 1972; Rowson *et al.,* 1972; King and Robertson, 1974; Roche, 1977). In order to improve the estrus detection rate, estrus synchronization programs using prostaglandin F2alpha (PGF2α) or progestogens that focus on controlling the lifespan of the corpus luteum have been implemented (Lucy *et al*., 1986). Pregnancy Prostaglandin F2a is only effective if administered between days 8 to 17 of the estrous cycle

when functional corpus luteum is available in one of the ovaries (King *et al.,* 1982).

2.4.2. Progesterone treatment

Synchronization of estrus with progesterone (Nellore and Cole, 1956) maintains high levels of progesterone in the female's system, even after the regression of the corpus luteum. Synchrony of estrus occurs 2 to 5 days following progestin removal. Commercial products that fall into this category are melengesterol acetate (oral feeding), Syncro-Mate-B (Ear Implant) and Intra-vaginal device. Estrus was synchronized in only 48% of the cows treated on day 3, but the synchronization was 100% when treatment began on day 9 of the estrous cycle (Pratt *et al.,* 1991).

2.4.3. GnRH – based synchronization system

Administration of GnRH during the bovine estrous cycle causes regression or ovulation of the dominant follicle and initiates the emergence of a new wave of follicular growth an average of 2.5 days following treatment. The first GnRH injection alters follicular growth by inducing ovulation of the largest follicle (dominant follicle) in the ovaries after the GnRH injection to form a new or additional CL (Pursley *et al*., 1995a).

2.5. Genetic Engineering (Cloning, And Newly Emerging Reproductive Biotechnologies)

2.5.1. Cloning

Cloning of potential practical value occurs when copying a genetically outstanding animal. This usually is done by taking a very small biopsy of skin from the animal to be cloned, growing some of the skin cells in plastic dishes in an incubator, and using nuclei of those cells as the genetic material for the clones. Other body cells also can be used, such as roots of hair, somatic cells in milk or semen, etc. Usually the donor cells are frozen in liquid nitrogen, and thawed when the cloning step is done. This method of cloning is often termed somatic cell nuclear transfer (SCNT) because somatic (body) cells are used instead of germ line cells, such as sperm, eggs, and early embryos (George and Seidel, 2009).

The nuclear transfer is done starting with removing the chromosomes from an oocyte (egg) ready to be fertilized, and fusing it to a somatic cell using an electric current. Causing the very large oocyte to fuse with the very small somatic cell is very similar to what occurs with normal fertilization, in which the sperm fuses with the oocyte. Therefore, SCNT could thought of as fertilizing an oocyte with a somatic cell rather than a sperm. Somatic cells are diploid (means 2 or double) in their genetic make-up, with half the chromosomes (which contain the genetic material, DNA) derived from the sperm, and half from the fertilized oocyte. The sperm and oocyte are normally both haploid. Because the chromosomes are removed from the oocyte when cloning, it is zeroploid; combining it with a diploid somatic cell results in a 1-cell embryo with the normal diploid genetic make-up (George and Seidel, 2009).

The production of a large number of clones from high quality animals (i.e. from within the nucleus herd) which will allow overall genetic improvement of the herd (Woolliams, 1999). Sheep was the first mammal to be cloned from an adult somatic cell and some other sheep and innumerable calves (above 4,000 reported) followed, using variants of the original technique (Vajta and Gjerris, 2006).

2.5.2. Newly emerging reproductive biotechnologies

Several new reproductive technologies are foreseen developing further in a near future, with obvious advantages for breeding. One of them is sexing spermatozoa for directed production of offspring of a desirable sex by use of modified flow cytometric cell sorting of fluorescent dye- loaded living spermatozoa. Cattle present about 3.8% differences in DNA contents between their X- and Y-chromosome-bearing spermatozoa, a difference large enough to allow successful sorting (Garner and Seidel, 2008). Predetermination of the sex of offspring would provide a greater number of males or females, which will help in selection of individuals with top genetic makeup for improvement in next generation (Plummer and Beckett, 2006).

2.6. Drawbacks And Challenges In Reproductive Biotechnology

2.6.1. Issues related with management

One extremely important consideration in developing reproductive technologies is the likely cost to the farmer; to a great extent, cost is likely to be determined by the scale of operations and by the experience of the organization that brings them to the farm. It might also be mentioned that there is likely to be a close correlation between management expertise in a cattle enterprise and the successful adoption of a new procedure (Gordon, 2004).

Artificial insemination can, if not managed in a correct way, causes wide spreading of diseases and genetic defects. However, in a healthy male, the ejaculate itself does not contain microorganisms, but contamination occurs at semen collection from the prepuce and foreskin, the male´s abdomen and the environment (Althouse, 2007). The failure to detect heat is the most common and costly problem of AI programs and the major limiting factor of reproductive performance on many dairies (Nebel and Jobst, 1998).

However, Periods of stress due to inadequate nutrition or high milk yield reduce the intensity of estrous signs by affecting the endocrinology of behavior and ovarian function and jeopardize the

outcome of artificial insemination or embryo transfer (Rodriguez *et al.,* 2008).

2.6.2. The issue of animal welfare and reproductive biotechnology

It might be speculated that, because of a considerable increase of the size of the ovaries, multiple ovulation induction in cattle is associated with pain, especially during manual palpation. Although the needle puncture through the vaginal wall of the oocyte donor is invasive, repeated puncture for OPU was not accompanied by adhesions or any pathological changes in the tissue (Kruip *et al*., 1994). The procedure of obtaining sperm in AI subjects the bull to what humans might call indignity, but which to the bull is more likely frustration. "Current recommendations for preparation of dairy bulls are one false mount, two minutes of restraint and two additional false mounts before ejaculation" (Charoweth, 1983).

Most cattle embryo transfers are non-surgical; nevertheless, embryo removal risks piercing the uterine horn, or rupturing the lining of the womb. Embryo implantation takes place when the cow's cervix is closed; it is clearly difficult and potentially painful to pass the required equipment through the cow's closed cervix. Epidural anaesthetic is required, but this does not have to be administered by a veterinary surgeon. A badly administered epidural anaesthetic can result in paralysis. And of course, prior to any embryo transfer, the donor animal must be 'super ovulated' by the administration of repeated hormone injections, and hormone-impregnated sponges inserted directly in the animal's reproductive tract. Embryo transfer in cattle is being used to implant beef-breed embryos into dairy cows, and also to induce twinning. Both of these techniques place physical and physiological burdens on the cow, which the cow would not have to endure if it was allowed to mate naturally (Joyce and Peter, 1995).

2.7. Reproductive Biotechnology In Ethiopia

In Ethiopia, genetic improvement through crossbreeding has been introduced through development and research projects during the last four decades. The distribution of crossbred heifers, the provision of artificial insemination service and setting up of bull service stations were major components of the development projects. As indicated by (Ahmed *et al.*, 2003) through the effort of these projects, Ethiopia has built up a herd of more than 120 thousand cattle with exotic inheritance. However, since cattle breeding are mostly uncontrolled in Ethiopia, appropriate bull selection criteria have not been established applied and controlled which makes genetic improvement difficult (Gebremedhin, 2008).

The most commonly used reproductive biotechnology tool in Ethiopia for over four decades is artificial insemination. The National Artificial Insemination Center (NAIC) established in Kaliti in 1981 is a national center for the production, preservation and distribution of cattle semen mainly from selected exotic (Holstein Friesian) sires (NAIC, 1995). To a limited extent, it also produces semen from selected sires of indigenous breeds and their crossbreeds with Holsteinn Freisians. It has an average capacity of producing 170 thousand doses of semen per year. The manipulation of animal reproductive biology by embryo transfer is targeted as an area of focus in biotechnology in Ethiopia. The International Livestock Research Institute initiated embryo transfer program at Debre Zeit Research Station in 1990, primarily on zebu cattle and the first calf was born in 1991 (Tegegne, 1991).

On the other hand, artificial insemination (AI), the most commonly used and valuable biotechnology (Webb, 2003) has been in operation in Ethiopia for over 30 years. Refinement of super ovulatory regimes for Boran cattle has been undertaken and eight pairs of identical twins calves were produced using embryo-splitting technique (Tegegne *et al*., 1994). Nevertheless, the efficiency and impact of the AI operation has not been well-documented (Engidawork, 2012).

For a dairy cow to produce the most offspring during her life in a herd, she should calve first at two years of age and again every 12 months until she is culled. This pattern will also optimize the milk production per day of her life. Unfortunately this seldom occurs because the interval from calving to subsequent conception is prolonged (Etherington et al., 1984). In this regard, one of the most effective ways to improve both the reproductive performance as well as genetic performance is utilizing of superior sires through artificial insemination (AI) combined with estrus synchronization (Million *et al.,* 2011).

The goal with sexed semen is to produce a calf of a specific sex. Sexed semen is widely available now and many dairy producers are using it to obtain more (and better) heifer calves. Because of its higher cost per dose of semen, combined with a reduced conception risk, sexed semen is primarily recommended for use in virgin heifers. The use of sexed semen varies widely among dairy producers. Some producers do not use it at all while others use it on heifers only, and some use it on both heifers and cows. With heifers (and cows), sexed semen is usually used for first and perhaps second breedings, but typically not for later breedings. The economic benefits of the use of sexed semen are different for every dairy farm (Anonymous, 2008).

Generally, in the developing countries like Ethiopia, AI is the most common technology used. A probable reason is that AI has the most favorable cost-

benefit ratio of the reproductive biotechnologies and also requires comparatively less technical skill and equipment (Thibier *et al.,* 2004).

Constraints to the development and utilization of reproductive biotechnologies in general include a lack of financial, human and technical resources. Moreover, the provision of services such as AI often has to overcome difficulties relating to access, affordability, farmer awareness and knowledge, and the need to tailor services to the needs of livestock keepers within diverse local production systems. In the case of more complex technologies such as ET the constraints are magnified to an even greater extent (Pilling, 2007). Due to these, unfortunately, reproductive biotechnologies have not been systematically transferred to the national agricultural research and extension system. However, in same extent AI can be. Efforts are currently underway to apply multiple ovulation and embryo transfer technology using indigenous breeds at the Ethiopian institutes of agricultural resource (Adane, 2009).

2.8. Application Of Reproductive Biotechnology In Dairy Cattle

The main objectives of using reproductive biotechnologies in livestock are to increase production, reproductive efficiency and rates of genetic improvement. Over the years, many options have become available for managing the reproduction of the major large and small ruminants. Artificial insemination (AI) and preservation of semen are the main technologies that are used extensively. Assessing the fertilization capacity of sperms, sexing sperms, synchronization and fixed-time insemination, super ovulation, embryo transfer (ET) and in vitro embryo production (IVEP) are additional techniques that can improve reproductive efficiency and pregnancy rates. Reproductive technologies can also be used to control reproductive diseases if procedures and protocols are accurately followed (Madan, 2002).

AI reduces transmission of venereal disease, lessens the need of farms to maintain breeding males, facilitates more accurate recording of pedigrees, and minimizes the cost of introducing improved genetics (Wilmu *et al*., 1997; ISAAA, 2012). Progress in semen collection, dilution and cryopreservation now enables a single bull to be used simultaneously in several countries for up to 100, 000 inseminations a year (Gibson and Smith, 1989). The high intensity and accuracy of selection arising from AI can lead to a four-fold increase in the rate of genetic improvement in dairy cattle relative to that from natural mating (Vleck, 1981). AI and MOET speed up genetic progress reduce the risk of disease transmission and expand the number of animals that can be bred from a superior parent (FAO, 2004).

In urban and peri-urban farming environment in Uganda, dairy farmers are faced with hardship of feeding their cattle and cannot afford the luxury of keeping a bull simply to breed one or two cows they keep for milk production. For these farmers it would be advantageous to use a well functioning AI-service to avoid the costs of feeding and management for a bull. Import of exotic milking cattle breeds and artificial insemination service started in the 1960s in Uganda (Nakimbugwe, 2004).

Animal cloning ensures the sustainability of the desirable phenotype allowing them for better production of high quality and safe food products. At present the main reason to clone farm animals is to preserve the breeding capacity of genetically elite animals (proven through progeny testing), particularly males and to insure against loss of valuable genetic and characteristic features (Sejian *et al*., 2010). Clones allow farmers to upgrade the overall quality of their herds by providing more copies of the best animals in the herd (FDA, 2014).

Embryo transfer procedures have been useful in the diagnosis, treatment and salvage of reproductive function in so-called infertile cows (Gordon & Lu, 1990; Gray *et al.,* 1991; Goodhand *et al*., 1999). The Import/Export Committee of the international embryo transfer service, now referred to as the Health and Safety Advisory Committee, has been instrumental in gathering and disseminating scientific information on the potential for disease control through the use of bovine embryo transfer (Thibier, 1998).

2.8.1. In reproduction

Reproduction practices on dairy operations are crucial to maintaining consistent milk production and creating replacement heifers. The goals of a reproduction program should be to have heifers at a proper weight and height for the breed and calve at about 22 to 24 months of age (age at first calving) with healthy calves (USDA, 2007). The principal benefit of embryo transfer is the possibility to produce several progeny from the female, just as AI produces many offspring from one male animal (Rege, 1991). The Intercontinental transport of alive animal may cost $1,000 or more; where as an entire herd can be transported, in the form of frozen embryos, for less than the price of a single plane fare (Mapletoft, 1985).

2.8.2. Milk production

Reproductive biotechnology like Cloning animals will be beneficial to the agricultural industry by copying a highly valued selected individual several times, such as a dairy cow with excellent milk production, or an outstanding bull with highly desired traits (Clintock, 1998). The improvement of livestock growth or survivability through the modification of milk composition involves production of transgenic animals that: 1) produce a greater quantity of milk; 2)

produce milk of higher nutrient content; or 3) produce milk that contains a beneficial "nutriceutical" protein. The major nutrients in milk are protein, fat and lactose (Matthew *et al*., 2010). Cloning could allow breeders to select those cattle that can produce high quality milk and thrive in extreme climates and use them to breed more cattle to be used for food production (FDA, 2014).

Workers in New Zealand have shown that it is feasible to substantially alter a major component of milk in high-producing dairy cows by a transgenic approach, thereby improving the functional properties of dairy milk. They introduced additional copies of the genes encoding bovine b- and k-casein into bovine fibroblasts and used nuclear transfer to produce transgenic calves; when they started milking, nine transgenic cows produced milk with 8–20% more b-casein and a twofold increase in k-casein. The control of milk composition by genetic engineering could improve the processing characteristics in milk and have profound effects on the milk-processing industry. The authors also suggested that it will take about 4 years to introduce the transgenes which they produced into the dairy cattle population on a large scale. Once a highly expressing founder line has been identified, it becomes possible to expand the number of homozygous animals within a year by way of conventional reproductive technologies (Brophy *et al*., 2003).

2.8.3. In animal health

Infectious diseases in the bovine species seem unlikely to be transmitted by the embryo (Singh and Hare, 1985). Consequently, it has been suggested that embryo transfer be used to salvage genetics in the face of a disease outbreak (Eaglesome *et al.,* 1980). AI reduces transmission of venereal disease (ISAAA, 2012). Since spermatozoa may function as vectors for viruses, further work is required to investigate how closely different viral particles are associated with the sperm membrane with putative carry-over during processing. The double method of processing has also been successful in removing virus from an infected animal (Morrell and Geraghty, 2006).

The risks of transmitting infectious diseases by embryo transfer are very low, and many thousands of embryos have been transferred within and between countries without consequent outbreaks of disease. While embryo transfer progeny have, in a few instances, been found to be congenitally infected with *bovine viral diarrhea virus* (BVDV) (Howard *et al.,* 1990; Kirkland *et al.,* 1990), a strong possibility exist that infected transfer media, or infection of the recipients after embryo transfer, were the cause (Hare, 1986).

If proper procedures are followed, the risk of transmitting infectious diseases via embryo transfer is lower than with natural mating (FAO, 2014). For example, the major venereal diseases of cattle are Vibriosis and Trichomoniasis, which are caused by bacteria and protozoa, respectively. The effects these diseases are virtually identical. These organisms "hide" in the crypts of the bull's penis and cause no outward sign of disease. Once introduced into the cow, a severe inflammatory disease is initiated with the resultant death of the embryo. Reproductive failure may also be due to severe damage to the lining of the uterus resulting in pyometra (pus in the uterus) or endometritis in natural mating. However, in reproductive biotechnology like AI or cloning it can be avoided (Vasquez *et al.,* 1983; BonDurant, 1997).

3. Conclusion And Recommendation

Reproductive biotechnology is very important in developing country like Ethiopia. Most of these biotechnologies (cloning (nuclear transfer), embryo transfer and in-vitro fertilization) are not comfortable to apply for commercial purpose unlike AI due to high cost, need skilled man power, need instruments & materials etc. However, all reproductive biotechnologies can be used in research institutions. The AI industry has developed dramatically in most domestic species in the last few decades and its use is now widespread in intensive animal production. Proper use of reproductive biotechnology (especially synchronization and AI) in dairy cattle have great role in production, health and is also easy for management of the animal. As compared to other reproductive biotechnologies, AI is widely applied in Ethiopia.

Based on the above conclusion the following points are forwarded as recommendation**:**

- There should be a means to apply most of the reproductive biotechnologies in extensive animal production system across the globe to improve dairy production and health.
- Stakeholders should work in collaborations to optimize the service delivery & outputs; maintain appropriate implementation strategies and have comprehensive data on the achievements of reproductive biotechnologies.
- In Ethiopia focus should be given to launch reproductive biotechnologies other than AI.

Competing Interest:

The authors declare that they have no competing interest.

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References

1. 2011. Estrus Performance of Boran and Boranx Holstein Fresian Crossbred.
2. Adane, A. 2009. Review Agricultural biotechnology research and development in Ethiopia. J. *Afr. Biotechnol.* 8: 7196-7204.
3. Ahmed, M.M., Emana, B., Jabbar, M.A., Tangka, F., Ehui, S. 2003. Economic and nutritional impacts of market oriented dairy production in the Ethiopian highlands. Socio-economics and Policy Research Working Paper 51. *ILRI (International Livestock Institute),* Nairobi, Kenya 27.
4. Althouse, G. 2007. Artificial Insemination, In: Schatten, H. and Constantinescu, G.M. (Eds.) Comperative Reproduction Biology. 159-169. Oxford: Blackwell Publishing Ltd.
5. Anonymous, 2008. They use sexed semen (57th Hoard's dairyman round table). Hoard's.
6. Betteridge, K.J. 1981. An historical look at embryo transfer. *J. Reprod. Fertil.*, 62:1-13.
7. Betteridge, K.J. 2003. A history of farm animal embryo transfer and some associated techniques. *Anim. Reprod. Sci.* 79:203-244.
8. Blackburn, H.D. 2004. Development of national animal genetic resource programs. *Reprod. Fertil. Dev.* 16:27-32.
9. BonDurant, R.H. 1997. Pathogenesis, Diagnosis, and Management of Trichomoniasis in Cattle. *Vet. Cl. North. Am. F. An. Pract.* 2:350.
10. Brophy, B., Smolenski, G., Wheeler, T., Wells, D., L'Huillier, P., Laible, G. 2003. Cloned transgenic cattle produce milk with higher levels of beta-casein and k-casein. *Nat. Biotechnol.* 21:157–162.
11. Cattle Synchronized with a protocol based on Estradiol benzoate or Charoweth, P.F. 1983. "Sexual Behavior of the Bull a Review". *Journal of Dairy Sci*. 16, 173-179. (Quoted by Phillips C.J.C. "Cattle Behavior" 1993. Farming Press).
12. Clintock, A.E. 1998. Impact of cloning on cattle breeding systems. *Reprod. Fertility Dev*. 10:667.
13. Cowan, T. 2010. Biotechnology in Animal Agriculture: Status and Current Issues. Analyst in Natural Resources and Rural Development. [www.crs.gov] RL32809.
14. Dairyman, January 25, p56.
15. Eaglesome, M.D., Hare, W.C.D., Singh, E.L. 1980. Embryo transfer: A discussion on its potential for infectious disease control based on a review of studies on infection of gametes and early embryos by various agents. *Can. vet. J.,* 21:106-112.
16. Eerdenburg, F.J.C.M., Loeffler, H.S.H., Van Vliet, J.H. 1996. Detection of oestrus in dairy cows: a new approach to an old problem. *Vet. Quart.* 18:52–4.
17. Engidawork, B. 2012. Evaluation of artificial insemination service efficiency and reproductive performance of crossbred dairy cows in north shewa zone, Ethiopia. M.Sc. Thesis approved by Haramaya University, Ethiopia.
18. FAO (Food and agricultural organization). 2004. The State of Food and Agriculture. Agricultural Biotechnology - meeting the needs of the poor? FAO, Rome. 2003–2004.
19. FAO,2014.Advances in Animal Biotechnology. http://www.fao.org/docrep/004/t0117e02.htm (accessed on April, 2016).
20. FDA (Food and Drug Administration), 2014. 10903 New Hampshire Avenue Silver Spring, MD 20993 1-888-INFO-FDA (1-888-463-6332).
21. Foote, R.H.F. 1996. Dairy cattle reproductive physiology research and management-past progress and future prospects. *J. Dairy. Sci*.79:980–90.
22. Galloway, D. Perera, O. 2003. Guidelines and recommendations for improving artificial breeding of cattle in Africa. *A working document of the AFRA Project* III-2(RAF/5/046).
23. Gamborg, C., Sandoe, P. 2005. Sustainability in farm animal breeding. A review. *Livestock Prod. Sci*. 92:221.
24. Garner, D.L., Seidel, G.E.Jr, 2008. History of commercializing sexed semen for cattle. *J. Theriogen.* 69:886-895.
25. Gebremedhin, D. 2008. Assessment of problems/constraints associated with artificial Insemination service in Ethiopia. M.Sc. Thesis approved by Addis Ababa University, Debre Zeit, Ethiopia.
26. George, E., Seidel, Jr. 2009. Animal Reproduction and Biotechnology Laboratory, Colorado State University Fort Collins, CO. 80:523-683.
27. Gibson, J.P., Smith, C. 1989. The incorporation of biotechnology into animal breeding strategies. In: Babiuk, L.A. Phillips, J.P. and Moo-Young, M. Animal biotechnology. comprehensive biotechnology. 1st edition. pp 203-231. Pergamon Press, Oxford.
28. Gonadotrophin Releasing Hormone.
29. Goodhand, K.L., Watt, R.G., Staines M.E., Hutchinson, J.S.M., Broadbent, P.J. 1999. In vivo ocyte recovery and in vitro embryo production from bovine donors aspirated at different frequencies or following FSH treatment. *J. Theriogen.* 51:951-961.

30. Gordon, I. 2004. Reproductive Technologies in Farm Animals. 1st edition. P.17. Cromwell Press. London, UK.
31. Gordon, I., Lu, K.H. 1990. Production of embryos in vitro and its impact on livestock production. *Theriogenology*, 33:77-87.
32. Gray, K.R., Bondioli, K.R., Betts, C.L. 1991. The commercial application of embryo splitting in beef cattle. *Theriogenology*. 35:37-44.
33. Guerin, B., Le, Guienne, B., Thibier, M. 2000. A secure health status associated with the production and trade of in vitro derived cattle embryos. *Livest. Prod Sci*., 62:271-285.
34. Hare, W.C.D. 1986. Bovine Viral Diseases Virus infection and embryo transfer. *Vet Ret*., 118:544.
35. Harper, M.J.K. 1982. Sperm and egg transport. In: Reproduction in Mammals: 1. Germ Cells and Fertilization. Austin CR, Short RV (Eds.), Cambridge University Press; 102–27.
36. Heriberto, R.M. 2012. Assisted Reproductive Techniques for Cattle Breeding in Developing Countries: A Critical Appraisal of Their Value and Limitations, *Reprod.dom. anim*, 47, SI, 21-26.
37. Howard, T.H., Bean, B., Hillman, R., Monke, DR. 1990. Surveillance for persistent bovine viral diarrhoea virus infection in 4 artificial insemination centres. *J.A.V.M.A*; 196: 1951-1955.
38. ISAAA (International Service for the Acquisition of Agri-biotech. Application), 2012. Pocket K No 40: Biotechnology for the Livestock Industry. http://www.isaaa.org/kc.
39. Joyce,D Peter,S. 1995.Modern breeding technologies and the welfare of farm animals. Compassion in World Farming Trust, Reg. Charity No. 295126.
40. King, G.J., Robertson, H.A. 1974. A two injection schedule with prostaglandin F2α for the regulation of the ovulatory cycle of cattle. *Theriogenology,* 1:123-128.
41. King, M. E., Kirachofe, G.H., Stevenson, J.S., Schalles, R.R. 1982: Effect of stage of the estrous cycle on interval to estrus after $PGF_{2\alpha}$ in beef cattle. *Theriogenology*, 18:191-200.
42. Kirkland, P.D., Hart, K.G., Moyle, A., Rogan, E. 1990. The impact of p&virus on an artificial breeding programme for cattle. *Aust Vet J,* 67:261-263.
43. Kruip, T.A.M., Boni, R., Wurth, Y.A., Roelofsen, M.W.M., Pieterse MC 1994. Potential use of ovum pick up for embryo production and breeding in cattle. *Theriogenology.* 42, 675-684.
44. Lauderdale, J.W. 1972. Effects of PGF2α on pregnancy and estrous cycle of cattle. *J Anim Sci*. 35: 246 (abstr).
45. López-Gatius, F. 2000. Site of semen deposition in cattle: a review. *Theriogenology;* 53:1407–14.
46. Louis, T. M., Hafs, H. D., Morrow, D. A. 1972. Dairy cattle synchronization *J. Anim. Sci.,* 35:247 (Abstr).
47. Lucy, M.C., Stevenson, J.S., Call, E.P. 1986. Controlling first service and calving interval by prostaglandin F2α, gonadotropin-releasing hormone and timed insemination. *J Dairy Sci.* 69:2186-2194.
48. Madan, M.L., 2002. Biotechnologies in animal reproduction. Key note address at international conference on animal biotechnology. Tamilnadu Vaterinary and Animal Science University, Chennai.
49. Mapletoft, 1985. Embryo transfer in the cow: general procedures. report presented at the OIE\LETSround table meeting on sanitary problems related to embryo transfers. Paris.4:843-858.
50. Matthew B., Wheeler, Elisa. Monaco, Massimo Bionaz, Tetsuya Tanaka, 2010. The Role of Existing and Emerging Biotechnologies for Livestock Production: toward holism. *Acta Scientiae Veterinariae*. 38:463-484.
51. Million Tadesse., Theingthan, J., Pinyopummin, A., Prasanpanich S. and Azage Tegegne.
52. Morrell, J.M., Geraghty, R.J. 2006. Effective removal of equine arteritis virus from stallion semen. *Equine Vet. J*. 38:224-229.
53. Morrell, J.M., Rodriguez, M. H. 2009. Biomimetic techniques for improving sperm quality in animal breeding: a review. *The Open Andrology J.* (Open access) 1:1-9.
54. Morrell, J.M., Rodriguez, M.H, 2010. Practical applications of sperm selection techniques as a tool for improving reproductive efficiency. *Vet. Med. Int.* 2011, Article ID 894767, 9pp (doi:104061/2011/894767), open access.
55. NAIC (National Artificial Insemination Center). 1995. NAIC at a Glance. Ministry of Agriculture, National Artificial Insemination Center, Addis Ababa, Ethiopia.
56. Nakimbugwe, H., Sölkner, J., Willam, A. 2004. Open Nucleus Cattle Breeding Programme in the Lake Victoria Crescent Region of Uganda. Deutscher Tropentag 2004, Berlin, October 5-7, 2004, Conference on International Agricultural Research for Development. [online] Available from: http://www.tropentag.de/2004/abstracts/full/80.pdf [2013-01-02].

57. Naqvi, S.M.K., Gulyani, R.A., Joshi, G.K., Das., Mittal, J.P. 2002. Effect of dietary regimens on ovarian response and embryo production of sheep in tropics. *Small Rumin. Res.* 46: 167-171.
58. Nebel, R.L., Jobst, S.M. 1998. Evaluation of systematic breeding programs for lactating dairy cows: *A review. J. Dairy Sci.* 81:1169-1174.
59. Nellor, J.E., Cole, H.H. 1956. The hormonal control of estrus and ovulation in the beef heifer. *J Anim. Sci.* 15:650-661.
60. Odde, K. J. 1990. oocyte recovery and in vitro embryo production from bovine donors aspirated at different *J. Anim. Sci.,* 68:817-830.
61. Paterson, L., DeSousa, P., Ritchie, W., King, T., Wilmut, I. 2003. Application of reproductive biotechnology in animals: Implications and potentials applications of reproductive cloning. *Anim. Reprod. Sci.,* 79:137-143.
62. Pilling, D. Cardellino, R., Zjalic, M., Rischkowsky, B., Tempelman K.A., Hoffmann, I. 2007. The use of reproductive and molecular biotechnology in Animal Genetic Resources management a global overview. Animal Production and Health Division, FAO, V.le delle Terme di Caracalla 1, 00100 Rome, Italy 40: 1-13.
63. Plummer, W.E., Beckett, D. 2006. Development of successful sex determination method of bovine embryos utilizing embryo biopsy and pcr. California State University Agricultural Research Initiative Final Report.
64. Pratt, S. L. J. C., Spitzer, G. L., Burns, B., Plyler, B. 1991. Luteal function, estrous response, and pregnancy rate after treatment with Norgestomet and various dosages of estradiol valerate in suckled cows. *J. Anim. Sci*., 69:2721-2726.
65. Pursley, J. R., Mee, M. O., Wiltbank, M. C. 1995a. Synchronization of ovulation in dairy cows using PGF2α. and GnRH. Theriogenology 44: 915–923.
66. Rege, J.E.O. 1991. Application of biotechnology in genetic improvement, characterization and conservation of livestock. International Livestock Research Institute. P 0 Box 5689, Addis Ababa, Ethiopia.
67. Roche, J. F. 1977. Synchronization of oestrus with prostaglandins. *Vet. Res. Com.,* 1:121-129.
68. Rodriguez, M.H., Båge R., Gustafsson, H., Larsson B, 1999. The role of the female in the success of artificial insemination. Proc Int Symp Bicentenary of Lazzaro Spallanzani (Russo V, Dall´Ólio S, Fontanesi L, eds), Reggio Emilia, Italy, 1: 119-137.
69. Rodriguez-Martinez, H., Hultgren, J., Båge, R., Bergqvist, A.S., Svensson, C., Bergsten, C., Lidfors, L., Gunnarsson, S., Algers, B., Emanuelson, U., Berglund, B., Andersson, G., Håård, M., Lindhé, B., Stålhammar, H., Gustafsson, H. 2008: Reproductive performance in high-producing dairy cows: can we sustain it under current practice? In: IVIS Reviews in Veterinary Medicine, I.V.I.S. (Ed.). *International Veterinary Information Service*, Ithaca NY (www.ivis.org), last updated: 12-Dec-2008; R0108.1208 (Open Journal).
70. Roelofs, J.B., Eerdenburg, V., Soede, N.M., Kemp B. 2005. Various behavioral signs of estrus and their relationship with time of ovulation in dairy cattle. *Theriogenology*; 63: 1366-77.
71. Roelofs, J.B., Soede, N.M., Voskamp-Harkema, W., Kemp, B. 2008. The effect of fenceline bull exposure on expression of oestrus in dairy cows. *Anim Reprod Sci,* 108:226–35. J. Roelofs et al. / Theriogenology 74 327–344 339.
72. Rowson, L. E., Trevit, A. R., Brand, A. 1972: synchronization of estrus in cattle. *J. Reprod. Fertil.,* 29:145-154.
73. Sauvé, R. 2002. Embryo Transfer. Available: http://www.embryobec.com/TEang.html.(Accessed 0n April,2016).
74. Sejian, V., Meenambigai T.V., Chandirasegaran, M., Naqvi, S.M.K. 2010. Reproductive Technology in Farm Animals: New Facets and Findings: *A Review. J.Biologic. Sci.*, 10:686-700.
75. Shelton, J.N.1990. Reproductive technology in animal production. *Rev. sci. tech. Off. int. Epiz*. 9:825-845.
76. Singh, E.L., Hare, W.C.D. 1985. Embryo-pathogen interactions. In Current Therapy in Theriogenology. II. D.A. Morrow (ed.), W.B. Saunders Co., Philadelphia (in press).
77. Smidt, D., Niemann, H. 1999. Biotechnology in genetics and reproduction. *Livestock Prod. Scie.* 59:207–221.
78. Tegegne, A, Franceschini,R., Sovani, S. 1994. Superovulatory response, embryo quality and progesterone secretions in Boran (Bos indicus) cows after treatment with either Pluset or Pergovet. *Theriogenology* 41:1653-1662.
79. Tegegne, A. 1991. Embryo Transfer at ILCA: The first calf is born. *I.L.C.A* Newsletter 10:1-2.
80. Thibier, M, Nibart, M. 1987. Disease control and embryo imports. *Theriogenology*, 27:37- 47.
81. Thibier, M. 1998. Introduction to the establishment and evolution of the International Embryo Transfer Society: personal observations. In Manual of the International Embryo Transfer Society: a procedural guide and general information for the use of embryo transfer technology, emphasizing sanitary procedures (D.A. Stringfellow & S.M. Seidel, eds),3rd Ed.

International Embryo Transfer Society, Savoy, Illinois, 1-6.
82. Thibier, M., Humbolt, P., Guerin, B. 2004. Role of reproductive biotechnologies: global perspective, current methods and success rates, In G. Simm, B. Villanueva, K.D. Sinclair & S. Townsend (Eds), Farm Animal Genetic Resources. British Society for Animal Science, Publication 30, Nottingham University Press, Nottingham, United Kingdom, pp. 171-189.
83. USDA. 2007. Dairy Cattle Health and Management Practices in the United States, 2007. USDA-APHIS-VS, CEAH, Fort Collins, CO. #N480.1007.
84. Vajta, G., Gjerris, M. 2006: Science and technology of farm animal cloning: state of the art. *Animal. Reprod. Sci.* 92:211-230.
85. Vasduez, L.A., Ball, L., Bennett, B.W. 1983. Bovine Genital Campylobacteriosis (Vibriosis): Vaccination of experimentally infected bulls, *American J. of Vet. Research*. 44:1553-1557.
86. Vishwanath, R. 2003. Artificial insemination: the state of the art. *Theriogenology* 59:571-584.
87. Vleck, V. L.D. 1981. Potential genetic impact of artificial insemination, sex selection, embryo transfer, cloning and selfing in dairy cattle. In: Brackett B.G., Seidel Jr G.E. and Seidel S.M. (eds), *New Technologies in Animal Breeding*. Academic Press, New York, USA. 221-242.
88. Webb, D.W. 2003. Artificial Insemination in Cattle. University of Florida, Gainesville. IFAS Extension, DS 58:1-4.
89. Wilmut, I., Schnieke, A.E., McWhir, J., Kind, A.J., Campbell, H.S. 1997. Viable offspring derived from fetal and adult mammalian cells. Nature; 385:810–813.
90. Woolliams, J.A. Wilmut, I. 1999. Potential genetic impact of artificial insemination, sex selection, embryo transfer, cloning and selfing in dairy cattle. *J. Anim. Sci.* 68 245.

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