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Reproductive Biotechinoloy: It's Application and Constraints in Livestock Production in Ethiopia

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Abstract

Livestock production is an important economical and traditional activity in Ethiopia. Although animals are kept for multipurpose agricultural out puts such as milk, meat, egg, wool and traction power their productivity is very low there for livestock holders become unable to meet their own need as well as consumers demand for animal products which contributes to food scarcity and insecurity. Hence, the need for supply of increased animal products requires improvement in animal production more over livestock production is becoming important to economic growth and production system are facing towards. Intensification therefore alteration of some natural reproductive processes for the benefit of livestock holders and consumers becomes an important concern. The use of biotechnologies such as estrus synchronization, Artificial insemination and embryo transfer can solve problems associated with traditional and in efficient production systems improving animal production and productivity, even though there is some constraints on to use this technologies.

Keywords

Livestock • Biotechinologies • Improved Production

Introduction

Livestock is becoming increasingly important in the growth of agriculture in developing economies. The contributions made by livestock to both agriculture and gross domestic product have risen (FAO, 2000), at a time when the contribution of agriculture to has fallen. The demand for livestock products is a function of income, and sustained growth in per capita income, rising urban populations and changes in diet and lifestyle are fuelling growth in livestock production. Livestock production contributes to socioeconomic development in many ways, by augmenting income and employment and reducing the incidence of rural poverty [1].

Biotechnology is one of the frontier area of the scientific development in the world today. Advanced in the fields of biotechnology catered to wide science vize, agriculture, animal sciences, environmental science, medicine etc. in order to improve the overall living standards of the human being. This sphere of science is increasingly becoming sustainable means of improving livestock production by influencing animal health, reproduction genetic and breeding. Animal reproduction plays a pivotal role in the multiplication of desirable animal for production purpose and in genetic improvement programs. A great deal of progress has been made through better management of the natural reproductive process. However livestock managers and researchers have recognized that certain natural reproductive processes can be altered to the advantage of management. Using reproductive biotechnologies to support livestock production is an integral part of viable agriculture in multi enterprise systems. The ranges of biotechnological tools in animal reproduction currently under practice and with direct relevance to developing countries include Artificial Insemination (AI), super ovulation and Embryo Transfer (ET), ova and embryos these techniques are not equally successfully practical on all species of domestic animals, which are limited ruminants, the knowledge base is also not wide among practitioners [2] .The improvements in production and productivity could be achieved through

Identification and utilization of animal with higher genetic potential for milk, meat, wool and other desirable traits such as disease tolerance and draught resistance. Therefore, the objectives of this paper are:

- To indicate reproductive biotechnology options for improvement in livestock production.
- To assess the potential of reproductive biotechnologies to improve livestock production.

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Literature Review

2. The application of reproductive biotechnology in animal production

Biotechnology is defined as the use of living organisms to improve, modify, or produce industrially important products or processes. In animal reproduction it plays an important role in genetic improvement programs of desirable production traits. Biotechnology (Biotech) is increasingly becoming a sustainable means of improving livestock production by directly influencing animal health, reproduction, breeding and genetics. The inherent ability of animals to reproduce, the number of young born at a time, and the generation interval limit the rapid improvements and using biotechnologies can enhance these. Though there are available biotechnological tools in animal production, in this review more emphasis is given to Oestrous Synchronization, ET, and AI for their frequent application in domestic animals.AI is the most commonly used technique in developing countries [3].

During the last few years ET has reached practical application and the procedures will contribute match to the rate of genetic progress in the future. *In vitro* capacitations of sperm and invitro fertilization have been accomplished. Some other promising researchare as frequently refer to as biotechnology procedures are control sex, embryo splitting, cloning, nuclear exchange and gene transfer.

2.1. Oestrus Synchronization

Estrous synchronization is the process of targeting female mammals to come to heat within a short time frame (36 to 96 hours). This is achieved through the use of one or more hormones. GnRH and Prostaglandin F2 are two hormones used in the "Synch" protocols during oestrus Synchronization (http://animalscience.ag.utk.edu//EstrousSynchronization,2015) [4].

2.1.1. Follicular dynamics

The pre ovulatory follicle grows at an average rate of approximately 3mm per day during estrus in mare and Jennies and 1.5to 2.5mper day in cattle. Ovarian follicular development in cows and ewes is a progressive and recurring process with two or three waves of follicular growth occurring in each cycle. During each wave a group of follicles will be recruited and start to grow among which one follicle will attain dominance and the remaining subordinate follicles will become atretic. The last wave of cycle, the dominant follicle is the ovulatory follicle. Although the first wave is an ovulatotory in normal cycles the dominant follicle of this wave become ovulatory after ingestion of PGF 2α in early diestrus as in synchronization of oestrus [5].

2.1.2. Hormonal control of oestrus cycle

Regulation of oestrus cycle involves a reciprocal interaction between reproductive hormones of hypothalamus, anterior pituitary and ovaries. An interaction between the uterus and ovaries is also important. Progesterone has a dominant role in regulating the oestrus cycle during diestrus. With a functional Corpus Luteum (CL), high concentration of progesterone inhibit release of follicle stimulating hormone (FSH) and Luteinizing Hormone (LH) through its negative feedback control of the hypothalamus and anterior pituitary. Progesterone also inhibits behavioral oestrus. The drop in progesterone removes hypothalamus from its negative feedback inhibition with removal of this inhibition; pulses of GnRH, FSH and LH are released with increasing frequency and amplitude. That increased release of FSH stimulates the rapid follicle growth. Two to three days after the drop in progesterone, oestradiol, reaches the threshold concentration that stimulates the preovulatory surge of FSH, Gonadotrophin Releasing Hormone (GnRH) and LH. The preovulatory surge of FSH stimulates more rapid growth follicle and greater secretion of oestradiol that is necessary for the female to exhibit behavioral sign of oestrus.Through knowledge the circulating concentration of hormones of oestrus cycle along with the understanding of the mechanism of their release, how their receptors are regulated and their physiological actions, a reasonable logical sequence for hormonal regulation of the oestrus cycle set forth [6].

Artificial manipulation to get the fall in peripheral progesterone concentration can be achieved in three ways: first by artificial indication of premature luteolysis using luteolyting agent like PGF 2α; secondly, by attempting to modify the timing of normal ovarian events through combination of trophic hormones and luteolytic agents and thirdly, by simulation of CL function through the administration of progesterone or one of its synthetic derivatives for a number of days followed by abrupt withdrawal.

2.1.3. The role of oestrus synchronization in animal production

Several advantages have been recognized in having a number of female animals in oestrus during a very short period of time. It will permit the manager to schedule livestock handling and breeding to fit into a work schedule and is in most cases an essential part of super ovulation and ET procedures. It is also a useful part of AI program because checking heat and breeding animals under extensive management conditions is time consuming and expensive. Economic losses from longer calving result from reduced milk produced per day of herd life greater involuntary culling and birth of few replacement heifers can be reduced. Another economic aspect is that parturition season can be shifted to better coincide with the most favorable marketing patterns [7].

2.1.4. The effect of oestrus synchronization on reproductive performance

Oestrus Detection Efficiency (ODF) has the greatest correlation with calving interval and the greatest impact on reproductive performance. Synchronization may relieve the problem somewhat especially in cows, doe, and sows and it shortens the time needed for intensive observation of oestrus. The breeding season can be shortened because more females become pregnant during the first week of breeding, it also shortens calving interval as compared to programs that do not control the onset of oestrus. In one study by expert showed that the administration of PGF2α based on fixed treatment schedule without prior identification of existing CL and at ODE of 75% and 35% respectively for the first and second week had reduced days open by 31.6 days ,days at first service by 14.6 days, reproductive replacement rate by 11.5 over the base line of 35% ODE . Based on retrospective analysis of data from 17 published trials concluded that PGF2α treatment combined with AI at observed oestrus improved conception rate over control by an average of 7% in cow [8].

2.2.5. Methods of oestrus synchronization

Synchronization using progestins and progestin containing compounds.Exogenous progestin work by preventing the release of GNRH, which in turn results in ,reduced release of gonadotrophin so that oestrus and ovulation are prevented until progestin is withdrawn or its effect declines. When the source of progestin is withdrawn there will be a return to cyclic activity. Synthetic progestin can be administered in feed, drinking water, as subcutaneous implants, as topical application or as vaginal pessaries. About 80-90% of cows were synchronized to oestrus 2 days after the injection of progestin for16 days. An implant containing progestin along with ostradiol valerate and progestin injection resulted in synchronization oestrus 2 to 3 days after removing the implant on the ninth day of treatment .This combination treatment also causes many none cycling heifers to show heat however conception rates are low. Administration of progestin as vaginal pessary for 7 days along with the ingestion of PGF2α on day 6, 82% of treated cows exhibited oestrus within 17 hours and 100%in 32 hours. Research has been conducted into different ways farmers can perform estrous synchronization such as progesterone injections or a Progesterone Releasing Intra-vaginal Device (PRID). The PRID is a sponge that is inserted into the vagina of a cow to stop the natural estrous cycle (for it acts as a corpus luteum), because progesterone is the hormone that signals the body to stop the cycle because fertilization has occurred. When the sponge is removed the cycle restarts. This apparatus is useful in manipulating the cycle so that multiple cows can be ovulated around the same time [9].

In doe good synchrony and good conception rate have been obtained after administration of vaginal sponges containing FGA (Flurogestone Acetate) for 17-22 days followed by injection of PMSG (Pregnant Mare Serum Gonadotropin) during sponge removal. In mare progestin is administered for 14 days so that approved synchronization of oestrus occurs within 2 to 4 days and ovulation occurring 6-7 days after withdrawal [10].

PGF2α AND PGF2α containing compounds

The mechanism of action of PGF2α is through causing regression of CL thus eliminating the source of progesterone, which prevents expression of heat and ovulation. PGF2α is more effective with the presence of fuctional CL. In cows that were correctly diagnosed as having CL and treated with PGF2α 90% of them ovulated within the next 7 days. MGA (Melengestron Acetate) and PGF2α have been used in combination in highly successful oestrus synchronization programs in a 30 day breeding program more than 80% of heifers usually conceive under excellent management and good environmental condition. An injection of GnRH followed by PGF2α 7 days later and a second injection of GnRH will synchronize ovulation in addition to the oestrus. In ewes which have been injected PGF2α 12 days apart and treated with PMSG together with the second PGF2α oestrus was manifested in 75% of them in less than 72 hours, and good fertility have been achieved. In mare PGF2α is commonly given in tow doses 14 or 15 days apart. Using this regime 75-90% of mares have oestrus within 6 days of the second PGF2α administration unfortunately the variable follicular phase result in a significant variation in the day of ovulation such that the regime is not particularly use full [11].

2.2. Artificial insemination (AI)

2.2.1. Principle and history of AI

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. Sub-optimal fertility leads to aggravating productivity losses which can be directly translated into economic loss of great magnitude, and it is also the major reason for involuntary culling of dairy cows. In spite of major advance in other biotechnologies in recent years, AI remains the most practical and cost effective method for up grading of cattle production [12].

AI in cattle developed in the 1940's and has since then come to be used and developed by the dairy industry in great parts of the world. Every year about 100 million cattle are inseminated, which are about one fifth of the female reproductive cattle population. AI being simple, economic and successful is the most important assisted reproductive technology in developing countries.

2.2.2. Advantages of AI

There are many advantages of using AI instead of using a bull for breeding; one example is faster genetically improvement. There are reports of up to four times faster genetic progress with AI compared to natural mating. [13] Other advantages with AI are: lessens the risk of spreading disease between animals, makes it possible to overcome the geographical and temporal distances between males and females, lessens the risk for injuries on the male and female, safer working environment for staff, more effective use of good males when one ejaculate can be used to many females and allows progeny testing of AI-bulls. It is economically advantageous not to have to pay for feed and management for a bull. Also increased production and decreased spread of diseases result in healthy animals that produce more which is economically good for the farmers.

2.2.3. Disadvantages of AI

AI has many advantages but also some disadvantages. A well functional AI-breeding system requires a thorough and well-functioning heat detection of females. To accomplish this, education, training and breeding management is needed.

Artificial insemination can, if not managed in a correct way, causes wide spreading of diseases and genetic defects. Before insemination, the female animal has to be separated from the herd and restrained which requires some kind of crush. The insemination process also requires well trained and technically skilled personnel, using relevant equipment. Essential for a well operated AI-breeding is a thorough recording system. [14] This is to avoid inbreeding, to calculate birth dates, know when to expect repeat breeders.

2.2.4. Factors affecting reproduction and pregnancy results at AI

Some general factors that can influence reproduction negatively in dairy cows are: Heat stress location of the farm urban or rural heard size, increased incidence of clinical mastitis and other diseases, season at calving, high production, no dietary supplementation, loss of body condition, lameness, subclinical mastitis and intensive suckling.Farmers must be skilled in heat detection and keep proper records of fertility and reproduction in the herd. Farmers should look for heat in their herd for at least three times per day, in times other than during milking and feeding. Standing to be mounted is the primary sign of estrus, other signs of heat can be: swelling of vulva, mucus discharge, mounts other animals and frequent vocalization [15].

To gain genetic improvement it is necessary with record phenotypic traits regarding health, fertility and production in excess of recording insemination and their results. Without phenotypic recording it is impossible to select the best animals for breeding or making the right combinations of dam and sire. 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 [16].

The AI-technicians must be well trained and have fresh knowledge in AI-technique, hygiene routines, reproduction, heat detection, pregnancy checking, dairy cow nutrition and herd management. Correct AI-work includes some minimum of equipment: A small portable LN2 container, insemination gun, water thermos with hot water for thawing, thermometer, scissors, tweezers, disposable gloves, disposable plastic sheets for the insemination gun, paper/paper towels, lubricant, recording files or record books, protective clothing, easily cleaned foot were and soap [17]. AI semen doses are sensitive to temperature changes and must be kept in adequate levels of LN2 during storing to prevent damages on the spermatozoa. It is therefore essential that the AI-technicians always have easy access to LN2 so they can store the straws in LN2 in a correct way. An organization responsible for the AI-work performed and supervision and control of the AI-technicians in their work facilitates the goal to provide a good AI-service. Hence, there is a guarantee of quality of the service of the AI-technicians and the farmers know what to expect of the AI-service. Many factors can affect the conception results when using AI for breeding. As mentioned earlier right insemination time is of great significance. Other factors that affect the outcome are sperm quality and number of sperms in the insemination dose and handling of semen. The preferable place to deposit the semen is in the body of uterus [18]. Some propounds deeper intra corneal insemination as a better place for semen deposition but according to Hunter (2003) the insemination technique potentially could cause damage to the endometrium and in the worst cases cause perforation of the uterine wall. Furthermore, palpation and manipulation of the ovaries, to determine where ovulation is expected to occur in the deep insemination, increase the risk of premature ovulation and a poor fertility result.

2.2.5. Practical Techniques of AI

The technique in itself is easy to perfom, cheap and applied worldwide rather uniformly by technicians and veterinarians . Successful AI depends on the proper placement of high quality semen in the part of the reproductive tract that will give the best chance for conception. High conception rate using AI is also dependant on the female cycling and ovulating, proper heat detection, and avoiding extremes in stress to the animal being inseminated. The insemination technique is different for each of the farm animal species. This is due to the size of the females and the difference in the anatomy of their reproductive system. The recto vaginal method is a method of choice for cows because of its superior conception rate than vaginal and cervical inseminations with the best time being 12 hours the onset of oestrus. In ewe and doe it is necessary to use either vaginal or cervical inseminations because of their size. In ewes, insemination is done best during middle to late oestrus. whereas in doe best to do a few hours after the end of oestrus .cervical insemination is a method of choice in sows so that the inseminated tube is easily directed in to the cervix without the aid of sight or cervical fixation [19].

2.3. Embryo Transfer

2.3.1 Principle of embryo transfer

Embryo Transfer (ET) refers to the collection of embryo from a donor animal and its placement in to the oviduct or uterus of a recipient. The procedure involves the host of technologies including oestrus synchronization, super ovulation, embryo recovery, *in vitro* storage and culture as well as the actual transfer techniques themselves. The potential ova contained in the ovary of the female have not been utilized effectively. However, with the help of super ovulation an average of 12 ovulations can be expected from ewes, cow and doe so that after fertilization and sufficient development embryos can be transferred to other female to get increased number of progeny from genetically superior female animals or banking of frozen embryos to accommodate seasonal breeding or long term breeding strategies. The advent of efficient non-surgical techniques for recovery of embryos and effective methods for preserving embryos in liquid nitrogen demand for ET service increased dramatically in both beef and dairy industries. The commercial application of ET has been much more restricted to some domestic animal species for economic factors and need for surgery that has limited the wide spread use in pigs, goats and sheep. The major application includes increased annual reproduction of elite females, to increase the population of endangered breeds of species, the import export of embryos. ET is also used as a method of continuing breeding from animals unable to do so naturally. ET and associated techniques are undergoing continual refinement recent developments include refinement of super ovulation, embryo splitting, cryopreservation, IVM/IVF (*in vitro* maturation/ *in vitro* fertilization) , embryo sexing cloning and gene transfer [20].

2.3.2. Genetic improvement gained through ET

The rate of genetic improvement with in a breed depends on four variables, amount of genetic variation for traits under question, the accuracy with which the parents of the next generation can be selected, the selection intensity and the generation interval .ET can be used to influence all four variables and improve rate of progress. Multiple Ovulation Embryo Transfer (MOVET) schemes based on this system have been applied in practice in cattle and sheep and allow a dramatic reduction in the generation interval and consequently allow the opportunity for more rapid genetic improvement that can be achieved with the application of a traditional progeny testing system [21].

2.3.3. Import and export of embryo

International transport of embryo minimizes the risk to disease transportation, is the cheaper means of transporting germ- plasm, and provides the opportunities of receiving both maternal and environmental conditions necessary for the young to develop in place where it is destined to survive and produce. International transport of transport of embryo also provides increased diversity for marketing herd genetics [22].

2.3.4. Application of embryo transfer in disease control

ET employing in vivo produced embryos is already a valuable tool for the maintenance and improvement of the health status of livestock populations. Transmission of pathogens can be avoided by employing strict hygienic protocols the intact zona pellucida acts as a very efficient barrier against pathogenic infection. Sufficient transfer have been conducted with embryos from bovine leucosis, infectious bovine rhinotracheatis, blue tongue, brucella aborts, FMD (Foot And Mouth Disease) infected cattle and pseudo-rabies infected pig donor to determine that these microorganisms will not be transmitted via embryos provided that they are washed properly. None of the infectious diseases studied in the bovine species have been transmitted by *in vivo*-produced embryos, providing embryo handling procedures were done correctly. Several large studies have now shown that the zona-intact, washed, bovine embryo will not transmit infectious diseases. Consequently, it has been suggested that embryo transfer be used to salvage genetics in the face of a disease outbreak. For example, this may be a useful alternative in the establishing herds that are free of Bovine Leukosis, as this virus was not transmitted with embryos. Breeders are now using embryo transfer techniques to establish disease free herds to be used strictly for export purposes [23].

2.3.5. Practical transfer of the embryo

The ET procedure to the recipient is the same for frozen or fresh embryo. The surgical procedure of ET involves laparatomy to expose the reproductive tract. The normal embryo depending on the stage of development is placed either in the oviduct or uterus adjacent to the ovary, which contain CL with small syringe fitted with a 21 gauge needle .Two non-surgical procedures have been used in the cow and mare. In the first procedure along hypodermic needle is inserted in to the vagina to bypass the cervix and puncture the uterine horn so that the embryo can be deposited in to the lumen of uterus. For the second procedure a 0.25 ml straw is placed in the stainless steel ET gun that is passed through the cervix to deposit the embryo in the uterus [24].

Results and Discussion

Application of reproductive biotechnologies in ethiopia

Ethiopia owns siginificant proportion of livestock resource eventhuogh data on the number and characteristics of all livestock breeds livestock product such as meat, milk, egg, and hides accountsto 25% of total agricultural production. Furthermore the value of animal traction and manure for fertilizer and fuel was estimated to one half of combined value of meat ,milk and eggs In Ethiopia biotechnological developments have been achieved more rapidly than was generally predicated this technologies offer immense opportunities for conserving and improving animal production as well as productivity one area of biotechnology that has been applied in Ethiopia for over four decades is AI [25].

AI was first introduced to Ethiopia in 1938 by Italians primarily for breeding horse. Since then AI has been playing a significant role in animal production mainly of the dairy industry. Today there is only one AI center, the National Artificial Insemination Center (NAIC) at Kality which was established in 1981 with a national mandate of production and distribution of semen and liquid nitrogen ,training of AL technicians and dairy milk recording [26-30].

Semen is collected from exotic, zebu and cross breed (50%and 75%) bull maintain at kaliti. However some of the reports suggested that AI activities have been unsatisfactory in the country in that its activity is limited to the capital and a few major cities due to a number of technical, financial, infrastructure and managerial constraints.[31-33] According to the information released from the national artificial center the average AI annual application for the year from 1984 to 1995 was 20.6 thousand, which is below the average value for Africa (30.6 thousand). Moreover the cost of production of semen in the NAIC is about 14 birr per straw, which is very high as compared to price per service (2 birr for rural areas and 5 birr in the urban areas (NAIC, 1995) [34].

Constraints on application of reproductive biotechnology

The major constraints on applying biotechnologies have been enumerated by and include: the absence of an accurate and complete database on livestock and animal owners so that programmers can be implemented, the biodiversity present within species and breeds in agro-ecological systems, The fact that models of biotechnological [35-38] intervention differ distinctly between developed and developing economies, the fact that many animal species and breeds are unique to the developing world; each has its own distinct Developmental, production, disease resistance and nutrient utilization characteristics, the lack of trained scientists, technicians and fieldworkers to develop and apply the technologies, both in the government and in the private sectors, The absence of an interface between industry, universities and institutions, which is necessary to translate technologies into products, the inability to access technologies from the developed world at an affordable price in order to make a rightful, positive and sustainable contribution to livestock production and the economic welfare of farmers, the high cost of technological inputs such as materials, biological and equipment, the failure to address issues of biosafety and to conduct risk analyses of new biological, gene products, transgenes and modified food items, and the negligible investment in animal biotechnology. The critical issues affecting livestock productivity have recently been re-examined. [39] Research that aims to enhance productivity and sustainability should focus on improving livestock feeds and nutrition, improving animal health, managing natural resources relating to the livestock sector, assessing the impact of technological interventions, and strengthening the capacity of the national agricultural research systems of developing countries FAO/IAEA, 2004. Furthermore, the potential production capacity and contribution of livestock to the economy are still not being achieved in developing countries because the transfer, adaptation and adoption of technology is hampered by the lack of a clear policy for livestock development that is conducive to the introduction of new proven technology and by the lack of information flow from and to decision makers. [40-42] In developing countries, there is a wealth gap between urban and rural areas, which persists and may even be widening; the rural-urban divide also tends to be reflected in education and health indicators FAO, 2004. In addition, women in rural (and urban) areas who are predominantly involved in animal husbandry have higher illiteracy rates than men [29].

Conclusion

Reproductive biotechnologies have contributed significantly towards increasing the livestock production in varies developed countries .To maximize the reproductive and productivity potential of animals of economic importance has been exploited .These technological developments have helped these countries immensely to achieve self sufficiency in animal products such as milk ,meat and other by products and also in creating surpluses that bring revenues through exports .Considering the fact that much of the promise of animal biotechnology is applicable equally in the developed and developing countries ,coherent national understanding and hopefully plan for the possible for the application of biotechnological tools to improve animal production in Ethiopia is an essential concern. Since developed countries have almost optimized the genetic potential of specialized breed of animals in relatively conductive environmental conditions, the potential impact of reproductive biotechnologies in animal production could be more pronounced in developing countries like Ethiopia that owns a significant proportion of livestock genetic resource with high degree of heat tolerance, disease resistance, and the ability to survive long period of feed and water shortage. Moreover the relatively low production level of animal offers a great opportunity to demonstrate the impact of biotechnological tools in improving in animal production as well as the consequence improvements in the lively hood of many millions of poor and toiling people.

Therefore based on the above conclusions the following points are recommended:

- Develop a breeding program or breeding recommendations that has the potential to meet with the prevailing conditions.
- Detailed studies should be undertaken to make general assessment of the status, limitation and potential of reproductive biotechnologies in animal production in Ethiopia.
- Sufficient man power, infrastructure, research, favorable government policy and long term commitment and support are essential to benefit from the advantage of reproductive biotechnologies.
- The available biotechnological tools have to be refined to fit the local requirements and need to be livestock holders who are resource poor small-scale operators.
- Proper identification and characterization of the genetic merits of indigenous livestock on the basis of productivity, adaptation traits and disease tolerance is to improvement strategies

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