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Review on estrous synchronization in Ethiopia dairy cattle, its principles, methods and purpose

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Abstract
Assisted reproductive technologies particularly estrus synchronization and artificial insemination (AI) are operated to enhance the genetic improvement of cattle. Estrus synchronization is one of the potential tools for the reproductive improvement of livestock. It is the manipulation of the estrus cycle or induction of estrus to bring a large percentage of groups of females into estrus at a short and predetermined time period. Estrus synchronization of fertile cows can be accomplished with various hormones; such as, progesterone, prostaglandin, gonadotropin releasing hormone (GnRH), follicle stimulating hormone (FSH) and luteinizing hormone (LH). These tools remain the most useful and widely applicable reproductive biotechnologies available for dairy cow operations. It is obvious that the AI service in Ethiopia has not been successful to improve reproductive performance of dairy industry. Artificial insemination service in Ethiopia has been given little or no emphasis at the federal and regional levels for long time though it is a widely practiced animal biotechnology all over the world. The most important constraints associated to estrous synchronization in Ethiopia are: inadequate resource in terms of inputs and facilities; absence of incentives and rewards to motivate technicians; lack awareness of this technology by animal producers; shortage of feed resources, synthetic hormones; and lack of adequate transportation facilities. In general, incorporating a good management practice and selecting cows that have good body condition are the two most essential requirements for successful estrous synchronization and AI. Hence, the objective of this review is to assess the status of estrus synchronization and artificial insemination; its constraints of estrous synchronization in Ethiopia.

Keywords: artificial insemination, cattle, dairy, estrus synchronization, Ethiopia

Introduction
Background: - In Ethiopia, livestock production accounts for approximately 35 to 49% of the total agricultural GDP and 16 to 17% of foreign currency earnings. From the total cattle population, 98.95% are local breeds of cattle and the remaining are hybrid and exotic breeds. Ethiopia needs to work hard on improving the work of productive and reproductive performance improvements of cattle through appropriate breeding and related activities [1]

Ethiopia has the biggest livestock number that estimated 65.35 million cattle, 39.8 million sheep, 50.5 million goats, 9.9 million donkeys, 2.1 million horses, 0.35 million mules, 7 million camels, 48.9 million chicken and 6.9 million beehives Among the cattle population 36.53 Million are Females and within this 12.57 million(19%) are Milking cows [1]

But, most of these livestock populations are native breeds/ecotypes (98.59 % cattle, 99.85 % sheep, 99.96 % goa, 94.33 chickens). Nevertheless, the productivities of these native livestock are low due to their genetic makeup, low level of inputs, and traditional management practice besides environmental stress [2]. In order to improve these local cattle, selection of the most promising breeds and cross breeding of these local breeds with highly productive exotic cattle has been a practical solution. Assisted reproductive technologies particularly artificial insemination and estrus synchronization are operated to enhance genetic improvement of cattle. Even though, some authors [3] have evaluated the efficiency of assisted reproductive technologies in different production systems of Ethiopia, well thought-out information is not lacking.

In Ethiopia, the productivity of livestock particularly milk and meat remains low due to poor management program, poor genetic potential, inadequate animal health service, location and breed differences and others [4].

Selection of the most promising breeds and crossbreeding of local breeds with highly productive exotic cattle has been considered a practical solution to improve the low productivity of local cattle [5]. It is obvious that the AI service in the country has not been successful to improve reproductive performance of dairy industry. According to some previous studies, it has been that AI service is weak and even declining due to inconsistent service in the smallholder livestock production systems of the country in general. The problem is more aggravated by lack of recording scheme, wrong selection procedures, and poor management of AI bulls associated with poor motivations and skills of inseminators [5].

Significance of the review: As mentioned above, Ethiopia has huge number of Livestock population; despite the huge numbers of livestock resource and great potential for increased livestock production, productivity and commercialization of livestock is low due to numerous constraints [5]. The major constraint for livestock production in Ethiopia is poor genetic improvement and breed selection. Other factors are due to constraints of disease, poor management, inadequate animal health services, and poor performance of indigenous breeds. Among livestock production system dairy production is one of the prevalent production systems in Ethiopia [6]. Ethiopia holds large potential for dairy development mainly due to suitable environment. The reproductive performance of the breeding female is probably the single most important factor influencing herd/flock productivity [6].

However, the reproductive performance does not usually refer to a single trait, but to a combination of many traits. Many authors indicate that the main indicators that would be considered in evaluating reproductive performance are age at first service, age at first calving, calving interval, days open and number of services per conception [6]. So, based on the above basic facts this paper is intended to review estrus synchronization and its principle in dairy cattle breed.

Objective: To review on Estrous Synchronization and artificial insemination it's Principles, Methods, constraints and Status in Ethiopia

Literature review

Cattle Breeding Practices: A precise definition of the breeding objective is the first and probably most important step to be taken. Without it, the programme could result in genetic change, but in the wrong direction. Improving the wrong traits is equivalent or even worse than no improvement at all [7]. The breeding objective in any livestock species is to increase profit by improving production efficiency [8].

In most of the countries in the tropics, both AI and natural service are practiced as methods of breeding. Access to AI services within a country depends heavily on geographical location, being more widely available near cities or 'milk pockets' and being less available in areas with low farm density. When selection of a stud bull is possible, it's mostly by phenotypic selection on the performance of the bull. When pedigree is accounted for, the bull's dam is given more consideration than the sire. However, from the point of view of the farmer, the convenience in the availability of the bull or AI service is usually more important than the genetic makeup of the animal. This is a logical decision, especially in the short term, as increased calving intervals are associated with decreased income through longer dry periods and fewer calves over a lifetime [9]. The replacement females for the cattle herd are usually from the heifers bred within the same herd regardless of the size of the farm, but this rule is especially true for small holders.

Larger herds will have a higher percentage of replacement heifers purchased from 'outside' sources, but also sell more females. The reason for this is tied directly to size. First, larger herds are often in phases of expansion, and thus need more females than could have been produced by the existing herd of cows. Second, the larger farms are usually more market oriented and will have more available cash flow. Finally, large farms may choose to specialize and direct their attention to milking adult cows and may thus sell off young female calves to be raised by others.

In addition, pedigree and performance recording systems are essentially non-existent, so there is usually nothing concrete beyond phenotypic appearance upon which to base the payment of a premium for a higher quality animal. Breeding structures provide systems for gathering information about assessment of animals in the production system and conditions that allow selection of parents (males and females) of future progeny, and the mating of these animals in a desired manner [7]. A breeding programme must consider and address how superior animals will disseminate their genes quickly throughout the whole population.

In addition, the best young males (dairy) are often sold for beef due to lack of means to identify best animals. Farmers often have a relatively low level of formal education and may have variable knowledge of husbandry to help overcome the problems in managing improved genetic material, as their indigenous knowledge was most applicable to the raising of local breeds. Finally, when farms are far from these urban centers, formal market access, poor transportation, and communication difficulties in many parts of the countries contribute to unprofitable dairying by decreasing the motivation to increase productivity [10]. Reproductive efficiency: - Reproductive performance is a trait of outstanding importance in dairy cattle enterprises. The size of the calf crop is all-important for herd replacement and the production of milk depends heavily on reproductive activity. Possible genetic improvement in virtually all traits of economic importance is closely tied to reproductive rate [11].

The improvement of livestock production in developed countries is due to the integrated effect of rapid development in several fields of the sector. Increased feed production, improved animal health, better husbandry, and the breeding of animals with the necessary genetic potential for improved performance are the most important of this development. In developing countries, however, parallel improvements in livestock production have generally been inadequate, and one of the limiting factors has been the lack of genetically improved animals. The importation of superior breeding stock is too costly to be adopted on a large scale. Problems of adaptability also arise when high-yielding cattle are transferred from temperate tropical and sub-tropical environments. Crossing local females with superior improved sires is another method adopted at different period by many developing countries. With the advent of artificial insemination, the product of cross breeding was given a new technique for implementation on large scale and at comparatively low cost [12].

Estrus Synchronization: Synchronization of the estrous cycle has the potential to shorten the calving season, increase calf uniformity, and enhance the possibilities for utilizing AI [13]. Synchronization of estrus contributes to optimizing the use of time, labor, and financial resources by shortening the calving season, in addition to increasing the uniformity of the calf crop. The major limitation of estrus-synchronization programs is their inability to induce a potentially fertile estrus and ovulation in non-cycling cattle (i.e., pre-pubertal heifers and anestrous suckling cattle). Because initial estrus-synchronization programs were not designed for successful treatment of non-cycling cattle, their use in cow-calf operations generally has not produced results that would encourage greater A.I use for cattle [12]

The major factor limiting optimum reproductive performance on many farms is failure to detect estrus in a timely and accurate manner [14]. Cows come into estrus at all times of the day and remain in heat for only 12-18 hours making it difficult to observe estrus especially in hot weather. Keeping cows in groups of three to five with two to three visual observations per day for heat will increase the chances of detecting cycling animals. The use of synchronization and heat-detection aids can greatly shorten the time spent observing heat but will not benefit non-cycling cows or Anestrous Cows - a condition where the cow does not cycle due to insufficient natural hormonal stimuli [15]. Conception rate to first service was significantly higher in Insemination at detected estrus than in Ovarian Synchronization (45.1 vs. 34.5%) [16].

In the existing AI One AI technician is expected to inseminate on average about 300 cows per year, and in practice ranges from 50 to 1000. Pregnancy rate to 1st insemination is 27% in the existing AI system [17], whereas using estrus synchronization Results showed that number of animals responded to Prostaglandin are 100% and pregnancy rate after first insemination can be improved from 27 % to about 60% mainly as a result of timely availability of well-trained AI technicians at the time of planned heat period [6].

Physiology of Estrus Cycle:-The estrous cycle of the cow is generally about 21 days long, but it can range from 17 to 24 days in duration. Each cycle consists of a long luteal phase (days 1-17) where the cycle is under the influence of progesterone and a shorter follicular phase (days 18-21) where the cycle is under the influence of estrogen. The cycle begins with standing heat, or estrus. This time of peak estrogen secretion can last from 6 to 24 hours, with ovulation occurring 24 to 32 hours after the beginning of estrus [18]. Ovulation marks the beginning of the luteal phase, and is the culmination of a process called oogenesis, in which germ cells mature under the proper conditions. Germ cells are contained in thousands of tiny structures called follicles that contain receptors for FSH, which in turn stimulates the growth and maturation of responsive follicles. Most follicles develop in patterns referred to as follicular waves [12].

Ovarian follicular growth in cows occurs in waves. A wave of follicular growth involves the synchronous development of a group of follicles, one of which become dominant and achieves the greatest diameter suppressing the growth of the subordinate smaller follicles [19].

Endocrinology of Estrous Cycle: Estrous cycles give females repeated opportunities to become pregnant throughout their productive lifetime. The cycle is regulated by the hypothalamic-pituitary-gonadal axis, which produces hormones that dictate reproductive events. The reproductive axis is composed of the hypothalamus, pituitary, and the ovary [12].

The hypothalamus is a specialized portion of the central brain. Its primary function is to produce gonadotropin-releasing hormone (GnRH) in response to circulating estrogen, or to cease GnRH production in response to progesterone. The anterior pituitary is located directly beneath the hypothalamus in a small depression of the sphenoid bone. It produces the gonadotropin follicle-stimulating hormone (FSH) and luteinizing hormone (LH) in response to GnRH and estrogen. FSH and LH production is inhibited by progesterone. The third portion of the reproductive axis consists of the ovaries, located in the pelvic cavity of the cow. Follicles are structures on the ovarian surface that contain ova (egg) and produce estrogen. Follicles range in size and maturity at different stages of the cycle, but usually only one is selected to ovulate. A corpus luteum (CL) is a structure that forms from the previous cycle's ovulation point. The Corpus luteum is responsible for progesterone production. Both estrogen and progesterone are produced following FSH and LH stimulation of the ovary. The uterus is also found in the pelvic cavity. It likewise contributes to reproductive control, as it produces prostaglandin F2α (PGF2α) [18].

Purposes of estrus synchronization: Realistic economic benefits of improved reproductive performance are not simple to estimate. When reproductive performance improves, all changes in cash flows that result from the improvement must be accounted for. So for a good analysis, we need at least realistic estimates of lactation curves, feed intake, the risk of involuntary culling, and prices such as for milk, feed, labor, semen, fertility drugs, calves, replacement heifers and cull cows [20]

The objective of a synchronization program is to breed a high percentage of the females in a given group of heifers or cows in a short period of time, using either artificial insemination (A.I.) or natural service (bulls) [21]. Through effective implementation we accomplish the following: Concentration of the breeding season, Concentration of the calving season (focuses the workload), More uniform calf crop, typically improves returns (increases value of calf crop) and Facilitates the use of A. I. by concentrating estrus detection requirements [22].

Principles of synchronization: Synchronization of estrus in cows is feasible by either curtailing or extending the length of estrus cycle, which can be maintained based on two principles; one is using of in-situ luteolytic agent (prostaglandin) that induces luteolysis of corpus luteum (CL) and exogenous administration of such agents mimics premature luteolysis and hence results in to shortening of left over diestrus phase of estrus cycle; and the second principles is lengthening of diestrus phase through maintenance of Corpus luteum in terms of progesterone production which determines the length of diestrus phase. Hence, with the administration of progesterone hormone, the diestrus phase can be extended [23].

Estrus Synchronization Protocols: Different estrous synchronization protocols are available globally. Some commonly used estrous/ovulation synchronization protocols in dairy cattle includes use of prostaglandin (one shot method and two-shot method) and progestin and GnRH (Ovsynch and Cosynch). Advantages of GnRH use in Ovulation Synchronization allow for synchronized follicular growth and ovulation, not just the synchronization of estrus, induces ovulation and estrous cycles in non-cycling cows. These systems allow producers to artificially inseminate cows with little or no heat detection; eliminating the risk of injury for cattle that are mounting or displaying other estrus behavior [5].

Factors affecting estrus synchronization: - High priority needs to be placed on transferring these current reproductive management tools and technology to producers, veterinarians and industry personnel to ensure they are adopted at the producer level and to provide the necessary technical support to achieve optimum results. Because current management, breed, economic, location, and marketing options are producer specific, it is essential to ensure that transfer of this technology is not presented in blanket recommendations [23].

Cattle must be in good body condition or on a gaining plane of nutrition. This involves adequate levels of dry matter in general but specifically protein, energy minerals and vitamins. Cattle must be cycling, prevention and treatment of diseases, control of parasites is important. Time and labor available for product administration, heat detection and breeding especially with A.I, if natural service is to be used bull to cow ratio has to be considered. Recent studies suggest that one bull can service 25 synchronized females. The bull(s) need to be 2 years or older, experienced and in good condition [22]. For a synchronization program to work the way it should, several issues must be considered, some of them are listed below [23].

Cow factor: Cattle must be in good body condition or on a gaining plane of nutrition. This involves adequate levels of dry matter in general but specifically protein, energy minerals and vitamins. Any of the synchronization protocols are recommended for mature cows with a body condition score of 5 or greater that is 50 days or more since calving at the time of AI. Young, thin, and late calving cows are all less likely to have resumed their estrous cycles at the beginning of the breeding season [22]. Cattle must be cycling, prevention and treatment of diseases, control of parasites is important [24].

Cost factor: If labor is available or can be hired, protocols using heat detection are generally lower cost than fixed timed AI. Treatments, semen and number of handlings will contribute to cash costs of synchronization. Estimated savings from fewer bulls needed for natural service and increased returns from age and weight of AI sired calves should be considered [25].

Capacity building: Multi-disciplinary stakeholders composed of animal production experts, breeders, feeds and nutrition experts, veterinarians, and AI technicians are needed for the success of the technology. Moreover, to improve effectiveness of the technology, skilled and experienced technicians as well as capacity building of farmers in heat detection and husbandry practices are of major concerns [25].

Other factors: Time and labor available for product administration, heat detection and breeding especially with A.I, if natural service is to be used bull to cow ratio has to be considered. Recent studies suggest that one bull can service 25 synchronized females. The bull(s) need to be 2 years or older, experienced and in good condition [22]. Length of the protocol, number of times handled, and the ability to successfully deliver treatments is other factors that must be considered when choosing a synchronization protocol. Management system, feed resource flexibility, and facilities will play a role in which protocol works best in each particular environment. Success of any protocol is dependent on the proper administration and timing of treatments [24].

Status of Estrous Synchronization in Ethiopia: - The history of estrous cycle synchronization and the use of artificial insemination in cattle are a testament to how discoveries in basic science can be applies to advance the techniques used for livestock breeding and management. Synchronization of estrus involves controlling the estrous cycle of the females, so that they can be breed at approximately the same time [5].

Synchronization of the estrous cycle has the potential to shorten the calving season, increase calf uniformity and enhance the possibilities for utilizing AI. The objective of a synchronization program is to breed a high percentage of the females in a given group of heifers or cows in a short period, using either AI or natural service (bulls). The use of PGF2α for estrus control has been considered more applicable to tropical herds, possibly owning to problems with estrus detraction and irregularity of the estrus cycle [5].

Artificial Insemination Services: Provision of AI services requires active participation of and cooperation between, the Stakeholders in dairy production. This includes farmers, inseminators, AI centers and Organizations involved in milk recording, milk collection and dairy product marketing. Governments need to be proactive in supporting and organizing the administration and Infrastructure for AI. Genetic improvement depends on the accurate measurement of milk production in identified cows and the utilization of this data for bull selection. Getting cows in calf requires good semen, good heat detection and good insemination technique. An adequate infrastructure needs to be in place and maintained. Telephone services or transport systems for messages from the farmer must be reliable. Inseminators should have reliable and fast means of transport. Motor vehicles or light motor bikes are recommended. Contingency plans are needed to continue to provide services when vehicles require repairs or when the inseminator is on holiday or is sick. In each country, the policies and practices for delivery of improved genetics and related services to farmers should be formulated in relation to the distribution of cattle population, types of production systems, environmental conditions, availability of resources for livestock production, and the social and economic situation of farmers and people [12].

Timing of insemination: Correct timing of insemination is as important as correct placement of semen. Field experience has shown that the best results are obtained when the insemination is performed at or near the end of oestrus. The beginning and end of oestrus are very difficult to determine. The simplest practical method of timing inseminations is to use the a.m. - p.m. rule [26].

Conclusion: Estrous synchronization can be a useful tool in the reproductive management of a cow herd. However, if proper levels of nutrition, body condition and health are not maintained, the program is likely to fail. For synchronization program to work the way it should, several issues such as cow factor, cost factor, capacity building and other factors must be considered.

Estrus synchronization is receiving renewed attention in dairy cows gradually. Estrus Synchronization technology not only maximizes animals' productivity, but also Increased safety for animals and farmers and reduces the risks of spreading sexually transmitted diseases. In-spite of the efforts made to introduce large-scale Estrus Synchronization technology services, growth in its use has generally not been very strong and conception rate is very low. Therefore, the desired effect in terms of animal improvement has not been achieved. Poor body condition cows, provide non cycling cows, improper semen handling starting from production until insemination, poor management, time missing for insemination (cows were inseminated at fixed time 48-72 hours) and lack of follow up were the main identified problems in Ethiopia.

Recommendation: Based on the conclusion the following point is put as recommendation

- Governments have to design and implement clear policies for Estrus synchronization through alleviating the most important causes of low performance.
- For future breeding activity, the skill and knowledge based training must be given for both the farmers and implementers to enhance estrus synchronization for improvement and adoption of the technology in collaboration with concerning stakeholders.
- Economic incentives should be provided to farmers to breed improved animals for the successful introduction or extension of AI in developing countries.
- Furthermore, sound long-term breeding strategies that would improve the farmers' profits without destroying the indigenous genetic resources should be supplemented.
- However, further researches to create awareness for the society have to be conducted and forwarded.

Reference

1. CSA. Agricultural sample survey of 2012 E.C. report on livestock and livestock characteristics, volume II, Addis Ababa, Ethiopia 2019/20.
2. Tegegne A, Gebremedhin B, Hoekstra D. Livestock Input Supply and Service Provision in Ethiopia: Challenges and Opportunities for Market Oriented Development. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 20. ILRI (International Livestock Research Institute), Nairobi, Kenya 2010.
3. Ashebir G, Birhanu A, Gugsa T. Status of Artificial Insemination in Tigray Regional State, “Constraints and Acceptability under field Condition”. J Dairy Vet Anim Res 2016;3:91-95.
4. Tesfaye A, Alemayehu L, Tefera Y, Endris A. Factors affecting the reproductive performance of smallholder dairy cows in two regions of Ethiopia. Livestock Res Rur Dev 2015.
5. Mebrate Getabalew, Tewodros Alemneh Status of Artificial synchronization; its constraints and estrus synchronization in Ethiopia. Article research Gate 2019.
6. Azage Tegegn, Awet Estifanos, Asrat Tera, Dirk Hoekstra. Technological options and approaches to improve smallholder access to desirable animal genetic material for dairy development: IPMS Experience with hormonal estrus synchronization and mass insemination in Ethiopia 2013.
7. Van Der Werf J. An overview of animal breeding programs 2004. Online: http://www.genome.iastate.edu/edu/QTL/Julius_notes/01_intr.PDF. Accessed 14th July.
8. Charfeddine N. Economic aspects of defining breeding objectives in selection programmes. ciheam-iamz, Options Méditerranéennes : Série A 2000;43:9-17.
9. Bebe BO, Udo HMJ, Thorpe W. Disposal and replacement practices in Kenya’s smallholder dairy herds. Proc 3rd All Africa Conference on Animal Agriculture and 11th Conference of the Egyptian Society of Animal Production 2000.
10. Buvanendran V, Petersen PH. Genotype-environment interaction in milk production under Sri Lanka and Danish conditions. Acta Agriculture Scandinavica 1980;30:369-372.
11. Rick R, Gene D. Synchronizing Estrus in Beef Cattle. University of Nebraska–Lincoln | Lincoln, NE 68588 | 2013;402-472-7211.
12. Rick F, John B, Graham. Protocols for synchronization of estrus and ovulation. Research Gate 2010.
13. Lamb G, Cliff. Estrus Synchronization protocols for cows. North Florida Research and Education Center, Marianna, Florida. Proceedings, Applied Reproductive Strategies in Beef Cattle January 28-29 2010.
14. Graves W. Improving Reproductive Performance in Dairy Cattle. United States Department of Agriculture. National Institute of Food and Agriculture 2009.
15. Pennington A. Heat Detection in Dairy Cattle. University of Arkansas, Division of Agriculture. Web. United States Department of Agriculture National Institute of Food and Agriculture 2013. http://www.uaex.edu/Other_Areas/publications/PDF/FSA-4004.pdf.
16. Tenhagen B, Drillich M, Heuwieser W. Synchronization of lactating cows with prostaglandin F2alpha: insemination on observed oestrus versus timed artificial insemination. J Vet Med Assoc 2000;47:577-584.
17. Desalegn. Assessment of problems/constraints associated with artificial Insemination service in Ethiopia, Addis Ababa University Faculty of veterinary medicine 2008.
18. Williams SW, Stanko RL, Amstalden M, Williams GL. Comparison of three approaches for synchronization of ovulation for timed artificial insemination in Bos indicus-influenced cattle managed on the Texas gulf coast. Animal Reproduction Laboratory, Texas A&M University Agricultural Research Station, Beeville 78102-9410, USA 2002.
19. Pierson R, Ginther OJ. Follicular populations during the estrous cycle in heifers: 1. Influence of day. Anim Reporod Sci 1987;124:165-176.
20. Albert de Vries, Jessika Van Leeuwen, William W, Thatcher. Economics of improved reproductive performance in dairy cattle. University of Florida, Institute of Food and Agricultural Sciences, Cooperative Extension Service, Gainesville, 32611, 2012.
21. Noseir Wael MB. Ovarian follicular activity and hormonal profile during estrous cycle in cows: the development of 2 versus 3 waves. National Center for Biotechnology. Information, U.S. National Library of Medicine 8600 Rockville Pike, Bethesda MD, 20894 USA 2003.
22. Stephen, Blezinger. Estrous synchronization a valuable tool in management of cows and heifers. Cattle Today, Inc 2000.
23. Cliff LG. Estrus Synchronization protocols for cows. North Florida Research and Education Center, Marianna, Florida. Proceedings, Applied Reproductive Strategies in Beef Cattle 2010.
24. Alemayehu K, Getu A. The Status of Estrus Synchronization and Conception Rate in Ethiopian Cattle Breed.International Journal of Agriculture and Veterinary Sciences 2015;1:15-22.
25. Tegegn F, Zelalem A. Evaluation of oestrus synchronization and mass artificial insemination service

of dairy cattle in Mizan Aman area, Bench Maji zone, South West Ethiopia. International Journal of Livestock Production 2017;8:1-4.

26. Gaurang KP, Nilufar H, Mahesh M, Ashvin KC, Dhaval KP, Nikita B *et al*. Artificial insemination: A tool to improve livestock productivity. Journal of Pharmacognosy and Phytochemistry 2017.