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A Present Vision for Artificial Insemination of Certain Farm Animals in Egypt

ABSTRACT

It is well known that one of the major limitations in the development of farm animals in Egypt is the extremely low reproductive efficiency. As a result, horizontal expansion would be impossible for dairy animals in Egypt. Therefore, such as in developing countries, artificial insemination (AI) programs are one of the most important options for fast development and genetic improvement in animal breeding studies in Egypt. Meanwhile, the proposed genetic improvement of buffalo milk production is being accelerated using an AI network. According to official statistics, Egypt has only two AI centers for selected buffalo sires, serving four AI units. Based on the current status of AI studies of farm animals in Egypt, this review spots light on recent progresses in the breeding of farm animals such as buffalo, camel, sheep, and goat, based on a comprehensive scientific experience of more than a decade to get a better food security in Egypt.

Keywords: Artificial insemination, farm animals, genetic improvement, Egypt

Mısır'da Bazı Çiftlik Hayvanlarında Suni Tohumlamaya Güncel Bir Bakış

ÖZ

Mısır'da çiftlik hayvanlarının geliştirilmesindeki en büyük sınırlamalardan birinin aşırı düşük üreme verimliliği olduğu iyi bilinmektedir. Bunun bir sonucu olarak Mısır'da süt hayvanı varlığında yatay genişleme imkânsızdır. Bu nedenle, hayvancılığı gelişmiş ülkelerde olduğu gibi, Mısır'da da hayvan yetiştirme çalışmalarında hızlı bir gelişme ve genetik ilerleme için suni tohumlama (ST) programları en önemli seçeneklerden biridir. Halihazırda sütçü mandalar için istenen genetik ilerleme etkili bir ST ağı kullanılarak hızlandırılmaktadır. Resmi istatistiklere göre Mısır, seçilmiş manda boğaları için sadece iki ST merkezine sahip olup bunlar dört ST birimine hizmet vermektedir. Bu derleme, Mısır'da çiftlik hayvanlarında ST çalışmalarının mevcut durumuna dayalı olarak, on yılı aşkın bir süredir manda, deve, koyun ve keçi gibi memeli çiftlik hayvanlarının üreme ve ıslahında kapsamlı bir bilimsel deneyime dayanarak Mısır'da daha iyi bir gıda güvenliği elde etmek için yapılan ve süregelen çalışmalarda kaydedilen ilerleme ile gelecekte yapılacak ya da yapılması gereken ıslah çalışmalarına ışık tutmaktadır.

Anahtar Kelimeler: Suni tohumlama, çiftlik hayvanları, genetik ilerleme, Mısır

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INTRODUCTION

Egypt is one of the top 15 most populous countries in the world with a population of about 100 million (World Population Review, 2018). Egypt is located at the northeastern corner of Africa and the southwest corner of Asia. According to the World Bank (2018a), the gross national income (GNI) per person was $3010, and the GNI index, which measures the wealth distribution within a nation, was 31.8 (World Bank, 2018b). Based on factors including average population education levels and life expectancy at birth, Egypt ranks 115th out of 189 countries in 2017 human development index (United Nations Development Programme, 2018). Economy in Egypt heavily depends on agriculture; it produces over 14.5% of the country's gross domestic product and accounts for 28% of all occupations (United States Agency for International Development, 2018). Despite the importance of agriculture, Egypt struggles with food insecurity. In Upper Egypt food insecurity is more severe, where 38.7% of the population lacks adequate food access (World Food Programme, 2018). As a result, recommendations including improvement in reproductive efficiency of farm animals are required to get better food security in Egypt (Soliman, 2018).

To improve the reproductive efficiency of farm animals in Egypt, artificial insemination (AI) is one of many techniques with significant potential. AI can be used to enhance hereditary characteristics like the ability to produce milk, meat, wool, and racing prowess (Vishwanath, 2003). The success of AI, which in turn depends on the quality of semen produced and its capability for dilution and storage with minimal loss of fertilizing power, is one of the important factors in achievement of the high reproductive activity (Mostafa et al., 2014).

The development of AI technology in Egypt began in the 1940s with experiments carried out in research centers. In 1958, these efforts were transferred to the field at "Bahteim" station in the governorate of Qaliobia. The obtained results had a significant influence on creation of the first AI center for practical field application at a veterinary training center in "Sirs-Lyn" in 1960. This was followed by opening three AI centers, the first in Upper Egypt, the second in Lower Egypt, as well as another one in the eastern Nile Delta in 1962. By the end of the 1960s, there were 161 AI centers spread throughout 18 governorates, but they were reduced to 38 because of budget constraints and a shortage of suitable bulls. Subsequently, a project has been completed in three phases. A sample study was conducted on cattle in the Nile Delta during the first phase, where the high qualified veterinarians were trained in reproductive and AI procedures. The second phase of the project has started with the real implementation of the use of frozen semen and the provision of incoming tools. In January 1977, the final phase concluded with the preparation of frozen semen for both buffalo and Friesian sires (Allam, 2011). In this way, this review focuses on the current progresses in AI of buffalo, camel, sheep, and goat breeding in Egypt.

Artificial Insemination in Buffalo Breeding

According to FAOSTAT (2018), Egypt has 3.37 million head of buffaloes. AI of buffaloes in Egypt was hardly ever used, where only 0.3% of Egyptian buffaloes were a part of AI operations (Borghese, 2010). A good AI program must have high-performance sires with superior semen, dependable and skilled AI technologists, healthy cows, functional communication and transportation networks, and cooperative and competent farmers. The whole AI program fails if even one of these interconnected fundamental components is missing. It should be noted that the natural service, which costs EGP (Egyptian Pound) 75 per service, is still the most popular technique of insemination for dairy buffalo in Egypt. However, it is revealed that on average, 3.5 services are needed for conception, and the specialist may feel the new embryo in the uterus horn by detecting gestation at the third month of pregnancy using a rectal palpation (Soliman, 2008). As a result, AI networks would not only increase genetic improvement in progeny but also enhance the reproductive capabilities of the Egyptian buffalo herds (Soliman and Mashhour, 2019).

Egypt has a competitive advantage in the production of milk from dairy buffalo, but not in the production of red meat (Soliman and Mashhour, 2003). The farm's net income, return on investment, and utilization of the feed unit all benefited dairy production in general and the dairy buffalo in particular. As a result of limited amount of water resources and fertile lands in Egypt, cultivating specialty breeds or expanding the livestock population horizontally is not an option. Therefore, getting the most milk production possible from one additional unit of feed would be a viable work. This showed that the best option for increasing milk production in Egypt is the vertical growth. Internal rate of return (IRR) of 20% or higher has been demonstrated by a recent study resulting from the genetic enhancement of the Egyptian buffalo (Soliman, 2017). An interconnected system of AI centers and AI units is necessary for effective genetic progress however; there aren't enough AI centers in Egypt's infrastructure. According to Central Agency for Public Mobilization and Statistics (CAPMS) 2000, only two AI centers for raising specific buffalo sires are known to exist, one of them in Cairo and the other in Beni-Suef in Upper Egypt.

Table 1. The required regional spread of Lower Egypt's AI-buffalo network
Tablo 1. Aşağı Mısır'da Mandalarda Suni Tohumlama İçin Gerekli Ağın Bölgesel Dağılımı

Governorate	Buffalo Population (H)	Required Sires (H)	Required AI-centers	Required AI-units
Bahira	466,021	31	3	165
Dakahleya	196,873	13	1	69
Gharbia	227,315	15	2	80
Kafr El-Sheikh	254,628	17	2	89
Monofia	369,684	25	2	132
Qaliobia	161,364	11	1	56
Sharkia	298,048	20	2	104
Total	1,973,933	132	13	695

Source: Central Agency for Public Mobilization and Statistics (CAPMAS), 2016.

A genetic enhancement program utilizing AI would significantly increase milk production in Egyptian buffalo (Soliman and Mashhour, 2019). This is due to the fact that AI would result in about 10 thousand to 20 thousand inseminated females per buffalo sire, but no more than 60 females inseminated per buffalo sire for natural insemination results. Additionally, the buffalo sires raised at AI centers are chosen based on offspring test criteria in addition to phenotypic traits. According to the density of buffalo in each governorate in Lower Egypt, the number of buffalo sires required for the AI network was determined using the rate of buffalo that were inseminated. To guarantee the effectiveness, a management constraint was implemented. Therefore, no more than 100 buffalo sires should be housed in each AI center. As a result, roughly 13 centers for AI were listed (Soliman and Mashhour, 2019). Additionally, according to Table 1, there would be around 695 connected AI-Units in Lower Egypt, as shown geographically in Figure 1. The total number of inseminated buffalos in Egypt was 42,000 with a positive number of 16,000 (Ministry of Agriculture and Land Reclamation, 2015).

Figure 1. Distribution of AI centers concerning the population of buffalo.
Şekil 1. Manda Popülasyonuna Göre Suni Tohumlama Merkezlerinin Dağılımı

Artificial Insemination in Camel Breeding

According to FAOSTAT (2018), Egypt has 85 thousand head of camels (Dromedary Camels). About 75% of the dromedary camel's population is raised in arid and semi-arid regions, making it the strategic stockpile of food security in the Arabian world. Due to its special adaptive traits, it is regarded as an animal that can survive and produce under such difficult environmental conditions. However, a variety of intricate ecological limitations negatively impact the dromedary camel's ability to reproduce. This is demonstrated by the species' low reproductive efficiency. In order to increase the ability of male or female dromedary camels to reproduce, various studies have been done in Egypt since the establishment of a modern, well-equipped laboratory in 1998.

According to El-Hassanein (2003), to collect semen, modified methods often utilized for other domestic species were created as a result of the unique behavior of camel males (position of sitting, and duration of mating). It featured the use of a female camel dummy whose form and position were quite close to those of the female during mating. At the base of the dummy, there was an artificial vagina. An operator was positioned under the dummy in a position that was more comfortable than the natural mating to collect the semen. The typical issues with natural service, such as female injury and male restlessness, are overcome by this position. Additionally, it increases the operator's safety. Rutting, or male camel breeding season, is confined to a few months of the year under the Egyptian environment (from mid-December to late February).

For AI in camel, high viscosity, poor freezing ability and limited post-thawed motility are the major limitations. Pellets and 0.5 mL French straws were two ways that were used to improve semen cryopreservation. After centrifuging the seminal plasma, a tris-lactose extender with 3% glycerol content was utilized to reduce viscosity. Viscosity in camel semen must be removed to create a homogeneous dilution and enhance the evaluation of the material's basic physical qualities. To get around this problem, El-Bahrawy and El-Hassanein (2009) investigated the effects of α-chymotrypsin (0.5%), α-amylase (25%), sodium hydroxide (0.1 N), trypsin (25%), and bromohexine hydrochloride (0.2%) on the viscosity and physical properties of semen, in which α-amylase eliminated semen viscosity and significantly improved sperm motility. However, acrosomal integrity was negatively affected by these mucolytic agents after equilibration.

Contrarily, developing and perfecting a dependable protocol for collection of semen is now crucial for use in AI facilities for camels. El-Bahrawy et al. (2011) investigated the effects of extender, frequency of collection, and temperature of thawing on cryopreserved semen and found that semen extension with tris-lactose extender combined with α-amylase is the best collection program for providing high-quality insemination doses. The physiology of reproduction and AI in such animals have been low focus of research done on the origins of this phenomena, despite the fact that recent studies in the management of camel herds have uncovered the occurrence of unexplained sub-fertility in males. Low libido and short breeding season are thought to be the main causes of low fertility in males, along with their limited breeding opportunities (El-Hassanein, 2003). El-Bhrawy (2005) reported that the intensity and frequency of sexual activity indicators differed across rutting months and between individual bulls. In most species that demonstrate seasonality in reproduction, environmental and physiological factors control when the breeding season begins and how long it lasts.

The term "induced ovulators" refers to female camels, in whom coitus is currently thought to be the main trigger for ovulation. To find the best procedure for synchronizing estrus, inducing ovulation, AI, and early pregnancy detection, numerous studies have been carried out. In line with this development, El- Hassanein et al. (2010) examined three alternative approaches as follow natural mating, intramuscular injection of GnRH, and seminal plasma intrauterine deposition for induction of ovulation in she-camels. El- Hassanein et al. (2010) concluded that synchronization of estrus and induction of ovulation techniques reduced the rate of conception to 83.3% whereas spontaneously mating animals had a 100% pregnancy rate throughout the breeding season. Additionally, no pregnancies were produced following seminal plasma intrauterine deposition for induction of ovulation.

Controlled Intravaginal Drug Releaser (CIDR) and GnRH injection could be used to regulate and induce ovarian activity in she-camels during the anestrus season (Monaco et al., 2012). Ovarian activity is stimulated by this medication during the summer. The mean follicular diameter is reduced with CIDR treatment. According to Monaco et al. (2012), by combining CIDR treatment with PMSG technique before the mating season (September), the synchronization activity is present at day 13 after treatment in both primiparous and multiparous camels. However, in primiparous camels the treatment response was higher. As a result, female camels that have lost a calf can be synchronized for ovulation and artificially inseminated as soon as 37 to 44 days following calving (El-Bahrawy et al., 2011).

Artificial Insemination in Sheep Breeding

Sheep are the most prevalent animal bred for food in Egypt (apart from avian species) (FAOSTAT, 2018). Sheep are a crucial part of agriculture, where its production generates around 30% of all agricultural income in the country. To increase human daily dietary protein intake, sheep breeding is encouraged. Therefore, sheep are a crucial part of the food security strategy in Egypt. About 72,296 tons of red meat was produced by 2.34 million of sheep in 2017, which was about 7.4% of total production of red meat in Egypt (FAOSTAT, 2018). In total, 99,322 tons of sheep milk were produced. Sheep are the most sophisticated livestock in Egypt due to their adaptability to many agricultural circumstances, particularly in reclaimed lands and desert regions. Sheep are very effective in producing meat, milk, and wool from sparse pastures. One of the most urgent issues facing the nation is the lack of protein in the average person's diet. Sheep meat and milk can considerably help with this goal. Therefore, when compared to large ruminants, sheep has the ability to produce both milk and meat without ingesting significant amounts of feed concentrates.

According to FAOSTAT (2018), Egypt has 5.69 million head of sheep, which is more than cattle (5.06 million), buffaloes (3.37 million) and goats (4.35 million). Over the previous two decades, both the number of sheep and cattle has increased, but the number of buffaloes has dropped over the same period. While increasing the number of cattle as they use more feeds to produce milk, the number of sheep has climbed since they can graze more easily and require less concentrate. Figure 2 shows sheep breeds that are commonly raised in Egypt.

Figure 2. Geographic distribution of local Egyptian sheep breeds.
Şekil 2. Mısır'da Yerli Koyun Irklarının Coğrafi Dağılımı

The Egyptian-Finnsheep breeding project was a crossbreeding initiative conducted by Ministry of Agriculture in Egypt with a goal of increasing the production of Rahmani and Ossimi sheep breeds by mating them with the highly productive Finnsheep. According to the project's findings, breeding local breeds of sheep with Finnsheep resulted in a genotype that is 1/4 Finn, 3/4 local (Elshennawy, 1995). However, crossbreeding should not be disregarded as a crucial strategy to increase sheep output in Egypt. To capture breed complementarity and hybrid vigor (heterosis), Egyptian researchers advised commercial flocks to crossbreed the three local fat-tailed breeds (Rahmani, Ossimi, and Barki). Additionally, they recommended crossbreeding with other breeds but only if the exotic variety is suitable for the desert. Egyptian native breeds should be crossed with enhanced breeds that have a moderate level of productive or reproductive efficiency; these exotic breeds should have developed in conditions resembling those of the native breeds (Marai et al., 2009). It is feasible that productive breeds that are not acclimated to desert environments could make a significant contribution in semi-intensive production systems where sheep are fed gathered feeds rather than relying on grazing.

Egypt currently lacks a national, comprehensive sheep breeding program. Although creating a nationwide program for improvement of sheep genetics would be a difficult and impossible task, research institutions and colleges can take the lead in such an endeavor. It may be possible to conduct genetic analyses and subsequently identify genetically superior rams and ewes if sheep farms administered by research institutions and universities adopt a consistent record-keeping system. An essential step in restructuring of sheep sector in Egypt would be the incorporation of AI and embryo transfer (ET) into the programs of sheep breeding at research institutions and universities. Although Egypt already possesses some of the technical expertise to integrate AI and ET into sheep breeding operations, more money will probably be required to fund technical education and equipment acquisitions to increase the process of these technologies which become more widely used.

Position of semen more closely to fertilization site during laparoscopic insemination, is more favorable. For this reason, Laparoscopic Artificial Insemination (LAI) is beneficial in both sheep (Wulster-Radcliffe et al., 2004) and goats (Anakkul et al., 2013) in case of low sperm quantities or low sperm quality. In Egypt, LAI is typically the only way to improve Barki ewe progeny (Elshazly and Youngs, 2019). The technique of standing position artificial insemination (SPAI), which uses advanced research and carefully chosen frozen sperm, can be used to increase the genetic potential of high-quality sheep without putting undue stress on the animals (Elsayad et al., 2014).

Artificial Insemination in Goat Breeding

Goat breeding plays a significant role in Egyptian agriculture. Due to their strong tolerance for heat stress and hard environments, goats play a key role. Goats, unlike other ruminants, can quickly transform scarce crops and forages into milk and meat (Tekin, 2019). Depending on the choice for semen deposition, there are various AI approaches for small ruminants. According to Faigl et al. (2012), fresh semen deposited vaginally (pericervical deposition of semen), cervically (intracervical deposition of semen), or intrauterinally (laparoscopic technique) resulted in satisfactory pregnancy rates (50-70%). The only way to achieve acceptable pregnancy rates when using frozen sperm is through laparoscopic or transcervical intrauterine insemination procedures because, after cervical AI, cryopreservation renders spermatozoa functionally compromised and with disturbed semen transport through the reproductive tract.

During laparoscopic insemination, semen is positioned more closely to the site of fertilization, which is favorable. When sperm quantities are low or sperm quality is poor, deep uterine insemination is beneficial in both sheep (Wulster-Radcliffe et al., 2004) and goats (Anakkul et al., 2013). Insufficient sperm counts have typically resulted in lower pregnancy rates when utilized for AI (Scenna et al., 2005). To achieve the maximum pregnancy rates in goats, it is necessary to determine the ideal number of spermatozoa. Frozen-thawed goat spermatozoa have reported insemination dosages ranging from 5×106 to 200×106 sperm, and these doses mostly rely on the AI procedure used (Anakkul et al., 2014).

Amal Leil (2020) found that the rate of pregnancy following intrauterine insemination (IUI) with 20×106 Zaraiby spermatozoa was the greatest ($P<0.05$) with 71%, while the rate of pregnancy following IUI with 10×106 Boer spermatozoa was the highest ($P<0.05$) with 60%. The lowest ($P<0.05$) pregnancy rate was obtained when 40×106 spermatozoa from Zaraiby or Boer bucks were used (from 0 to 14.29%). When either 10×106 or 20×106 spermatozoa were inseminated laparoscopically by the semen of two breeds, no appreciable changes in the number of kids per goat were found (Amal Leil, 2020). On average, goats inseminated with the spermatozoa of the Boer buck at the aforementioned doses had greater multiple birth rates than goats inseminated with the spermatozoa of the Zaraiby buck (66.67 to 100% vs. 25 to 40%, respectively).

To achieve satisfactory pregnancy results in goats and sheep, Kulaksız and Arı (2016) indicated that cervical or vaginal AI should contain at least 200×106 sperm cells. Ejaculate from bucks or rams may only artificially inseminate 10-15 females due to the large dosage utilized in cervical or vaginal AI. Contrarily, LAI, which uses low doses (10 to 20×106) of frozen-thawed semen, guarantees a greater pregnancy rate (Anakkul et al., 2014; Kulaksız and Arı, 2016). In this case, LAI offers a widespread and more effective mechanism for AI to use semen from a superior buck or ram. Although the semen quality can affect this rate, other factors influencing the pregnancy rate include the body condition of the female, lactation status, the inseminator's skill, the number of prior pregnancies, the time between kidding and AI, seasonality of reproductive, farm and fertility of farm and buck, as well as the technique of semen cryopreservation (Gibbons et al., 2019).

According to Anakkul et al. (2014), using 60×106 or 120×106 spermatozoa in LAI in Saanen goats, there were no significant changes in kidding rates (50.33% vs. 60%, respectively). These variations could be explained by sperm quality elements such as viability, motility, and longevity. According to Bonato et al. (2019), similar kidding rates were observed in various goat breeds. However, some experiments found less impressive findings, occasionally peaking at 85% (Toni et al., 2012).

Finding the ideal quantity of spermatozoa is typical of great importance to increase goat pregnancy rates. LAI is an easy and practical way to increase fertilization rates and promote cross-breeding in goats. It is suggested that the minimal doses of motile spermatozoa for LAI could be 10×106 and 20×106 in Boer and Zaraiby bucks, respectively (Amal Leil, 2020).

CONCLUSION

Artificial insemination has become of great importance in livestock breeding in Egypt. Due to restricted amount of water resources and reclaimed lands in Egypt, spreading the livestock horizontally is not a choice. Therefore, the AI of livestock would be a viable work. Meanwhile, this review represents a current vision for applying the AI of livestock to get a better food security in Egypt.

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REFERENCES

Allam M. 2011. Artificial insemination - a present and future vision, International Information Network, Forum of Veterinarians. (http://vet-kfr.yoo7.com/t497-topic).

Amal Leil 2020. Clinical application of intrauterine laparoscopic insemination in Zaraiby goats using different concentrations of Zaraiby and Boer bucks' frozen semen. Journal of Applied Veterinary Sciences, 5 (4): 61-67.

Anakkul N, Suwimonteerabutr J, Tharasanit T, Panyaboriban S, Khunmanee S, Thanomsuksinchai N, Techakumphu M. 2013. Production of black goat using laparoscopic artificial insemination and embryo transfer. The Thai Journal of Veterinary Medicine, 43 (2): 259-263.

Anakkul N, Suwimonteerabutr J, Tharasanit T, Khunmanee S, Diloksumpan P, Debra K, Techakumphu M. 2014. Sperm distribution and fertilization after unilateral and bilateral laparoscopic artificial insemination with frozen-thawed goat semen. Theriogenology, 82 (8): 1137-1144.

Bonato GC, Maia A, Cortes LR, Oliveira TA, Arrais AM, Figueira LM, Oliveira MEF, Souzafabjan JMG, Fonseca JF. 2019. Effects of dcloprostenol administrations with 7.5 and 11.5-day intervals between administrations on pregnancy rates after artificial insemination in estrous cyclic dairy goats. Animal Reproduction Science, 209: 106-172.

Borghese A. 2010. Development and perspective of buffalo and buffalo market in Europe and Near East. Revista Veterinaria, 12.

Central Agency for Public Mobilization and Statistics (CAPMAS) 2016. Livestock Statistics Bulletin.

Central Agency for Public Mobilization and Statistics (CAPMS) 2000. Publications of Animal and Poultry Disease & Artificial Insemination, Nassr City, Cairo, Egypt.

El-Bahrawy KA, El-Hassanein EE. 2009. Effect of different mucolytic agents on viscosity and physical characteristics of dromedary camel semen. Alexandria Journal of Agricultural Research, 54 (3): 1-6.

El-Bahrawy KA, Salama O, Rateb SA, Zagloul AA. 2011. Aspects of reproduction and hormones pattern in post-partum dromedary she-camels (Camelus dromedarius) in the North-West coast of Egypt. 9th Scientific Conference of the Society of Physiological Sciences and Their Applications, Hurgada 24-27 Nov.

El-Bhrawy KA. 2005. Reproductive studies on desert animals: Sexual behaviour and semen characteristics and freezability of male dromedary camels. PhD Thesis, Faculty of Agriculture, Alexandria University, Egypt.

El-Hassanein 2003. An invention for easy semen collection from Dromedary camels, El-Hassanein camel dummy. In: Recent Advances in Camelid Reproduction, L. Skidmore and G.P. Adams (Eds.) Publisher: International Veterinary Information Service (www.ivis.org), Ithaca, New York, USA.

El-Hassanein EE, El-Bahrawy KA, Zagloul AA. 2010. Artificial insemination and ovulation induction in dromedary she-camel. Nature Science Journal, 8 (9): 203-208.

Elsayad A, Amal leil, Moustafa A, Seleim M. 2014. Surgical laparoscopic artificial insemination in standing position in Barki ewes in Egypt. Kafrelsheikh Vet. Med. J., 12 (2): 387-396.

Elshazly AG, Youngs CR. 2019. Feasibility of utilizing advanced reproductive technologies for sheep breeding in Egypt. Part 1. Genetic and nutritional resources. Egyptian Journal of Sheep and Goat Sciences, 14 (1): 39-52.

Elshennawy M. 1995. Sheep development program in Egypt. In: Strategies for Sheep and Goat Breeding. (Gabiña D., Ed.). Zaragoza: CIHEAM, 1995. p. 27-32. (Cahiers Options Méditerranéennes; n. 11). Meeting of the joint FAO/CIHEAM Network on Sheep and Goats, Subnetwork on Animal Resources, 1995/03/26-28, Sidi-Thabet (Tunisia).

Faigl V, Nora V, Javor A, Kulcsar M, Solti L, Georgios ND, Cseh S. 2012. Artificial insemination of small ruminants - a review. Acta Veterinaria Hungarica, 60 (1): 115-129.

FAOSTAT 2018. Live animals. Fao.org/faostat.

Gibbons AE, Fernandez Maria Macarena, Bruno-Galarraga, Maria Victoria Spinelli, Marcela ISABEL Cueto 2019. Technical recommendations for artificial insemination in sheep. Animal Reproduction, 16 (4): 803-809.

Kulaksız R., Arı UC. 2016. Correctness/incorrectness on laparoscopic artificial insemination in sheep and goats. Journal of Veterinary Science Obstet Gynecol-Special Topics, 2 (1): 38-47.

Marai IF, Daader AH, Bahgatal LB. 2009. Performance traits of purebred Ossimi and Rahmani lambs and their crosses with Finnsheep born under two accelerated mating systems. Archives Animal Breeding, 52 (5): 497-511.

Ministry of Agriculture and Land Reclamation, Egypt 2015. Economic Affairs Sector, animal production bulletin.

Monaco D, Lacalandra GM, El-Hassanein EE, Rateb S, Salama O, El-Bahrawy KA. 2012. Effect of a Controlled Intravaginal Drug Releaser (CIDR) and GnRH administration on ovarian follicular dynamics of female dromedary camel during seasonal anestrus period. 3rd Int. Conf. of the Society of Camelid Research and Development. 29th January to 1st February, Masqat, Sultanate Oman. pp. 123- 124.

Mostafa TH, Abd El-Salaam AM, Elbadry DE, Anour AM. 2014. Freezability and DNA integrity of dromedary camel spermatozoa in semen collected by artificial vagina and electro-ejaculator. Egyptian Journal of Animal Production, 51 (2): 145-155.

Scenna FN, Hockett ME, Towns TM, Saxton AM, Rohrbach NR, Wehrman ME. 2005. Influence of a prostaglandin synthesis inhibitor administered at embryo transfer on pregnancy rates of recipient cows. Prostaglandins and Other Lipid Mediators, 78 (1-4): 38-45.

Soliman I, Mashhour A. 2003. Economic Management of Livestock and Poultry Projects, first edition, Golden Star Printing and Publishing, Cairo.

Soliman I., Mashhour AF. 2019. Feasibility of artificial insemination network for Egyptian buffalo development. Journal of Buffalo Science, 1 (8): 3-12.

Soliman I. 2008. Role of dairy buffalo in Egypt food security. Buffalo Newsletters, FAO, Rome Italy; No. 23rd.

Soliman I. 2017. Genetic investment in dairy buffalo: A case study from Egypt, 4th International Conference and Industrial Exhibition on Dairy Science Park (DSP); November 1-5, Selçuk University, Konya, Turkey.

Soliman M. 2018. Food security in Egypt. Downloaded December 5, 2018 from www.njf.nu/assets/490/7-Food-security-inEgypt.pdf

Tekin K. 2019. Cervical insemination with frozen thawed semen in goats at different breeding age. Kocatepe Veterinary Journal, 12 (3): 357-362.

Toni D, Plamen T, Vladimir P, Florina P, Ljupce K, Juraj G. 2012. Laparoscopypromising tool for improvement of reproductive efficiency of small ruminants. Macedonian Veterinary Review, 35 (1): 5-11.

United Nations Development Programme, 2018. Human Development Report. UNDP, New York, p. 199.

United States Agency for International Development (USAID) 2018. Agriculture and food security.

Vishwanath R. 2003. Artificial insemination: the state of the art. Theriogenology, 59 (2): 571-584.

Word Bank 2018a. Egypt GNI per capita, Atlas method (current US$).

World Bank 2018b. GINI index (World Bank estimate).

World Food Programme 2018. WFP Egypt country brief.

World Population Review 2018. Egypt population 2018.

Wulster-Radcliffe MC, Wang S, Lewis GS. 2004. Transcervical artificial insemination in sheep: Effects of a new transcervical insemination instrument and traversing the cervix on pregnancy and lambing rates. Theriogenology, 62 (6): 990-1002.