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Feasibility of Artificial Insemination Network for Egyptian Buffalo Development: A Literature Reviews

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ABSTRACT

Literature reviews confirmed that Egypt has a comparative advantage in milk production rather than red meat production, particularly from buffalo. Furthermore, water resources are becoming increasingly scarce, limiting horizontal expansion in fodder acreage. Furthermore, there is fierce competition between food and feed demand on available agricultural land resources. As a result, horizontal expansion in dairy buffalo stock would be impossible. As a result, the only option for buffalo development in Egypt is vertical expansion through increased milk yield to meet the current deficit in domestic milk production. The Egyptian consumer prefers buffalo milk for its color taste and high content of total solids, particularly fat. Buffalo milk is more expensive than cow milk, and its production is increasing faster than cow milk production. The proposed genetic improvement of buffalo milk yield is being accelerated using an artificial insemination (AI) network. A recent study [1], provided evidence that the return of genetic investment in dairy buffalo would be feasible, (IRR = 19.71%) However, according to official statistics, Egypt has only two AI-centers for buffalo selected buffalo sires, serving four AI-units. As a result, the goal of this study was to assess the feasibility of establishing an AI-network in Egypt by estimating (NPV, IRR, and payback period) and its sensitivity to unfavorable changes that the proposed program may face. The study used a field survey data collected from an AI-unit of the buffaloes' semen and an AI-Center for raising buffalo sires in Nile Delta. The findings showed that, while the Egyptian economy's average discount rate was 17.5 %, the estimated IRR for one AI-unit was around 35 % under the most likely scenario. A 10% decrease in semen price and a 10% increase in insemination costs would result in IRRs of approximately 28% and 31%, respectively. Under the most likely conditions, the estimated IRR for the AI-center was around 31%. 10% Decrease in Semen Price, and 10% increase in feed costs or in Sire's price would result in 26%, 30% or 28% respectively. The lowest sale price of semen dose is thus the most effective variable on the IRR. Unfavorable changes, on the other hand, would keep investments with high incentives in establishing a feasible AI-Network for rapidly increasing the dairy buffalo milk yield.

Keywords: Buffalo; AI; NPV; IRR.

1. INTRODUCTION

The content analysis was carried out using the systematic review method. As a result, the review of literature was divided into the following categories: the lack of a sufficient artificial insemination (AI) network in Egypt, the importance of AI in accelerating genetic improvement in livestock populations, the constrains of agricultural resources that imply vertical development via raising productivity, the comparative advantage of Egypt in milk rather than meat production from dairy buffalo and the consumer preference of buffalo milk rather than cattle milk. Buffalo farming has made remarkable progress in productivity mainly because of controlled breeding with artificial insemination (AI) that has proved its worth in breed improvement and breeding managements across the livestock species. AI is more difficult in buffalo compared with cattle due to variable estrous cycles, reduced estrous behavior, and reproductive seasonality [2-5].

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2. AI-NETWORK TREND IN EGYPT

The adoption of artificial insemination technology (AI) in Egypt started in the forties of the last century in the form of studies and experiments in research centers till these efforts moved to the field in 1958 at the "Bahteim" animal production station in Qaliobia governorate. The obtained results had the great impact on establishment of the first AI-Center for real life field application at the Veterinary Training Center in "Sirs-Lyn" in 1960, followed by establishment two AI-Centers in lower Egypt and one in upper Egypt in 1961 and then another one in eastern Nile Delta in 1962. By the end of sixties, the expansion in AI-centers reached 161 spread in 18 governorates, which provided the veterinary units with fresh semen which, were decreased to only 38, in order to shrike the budget and due to the lack of enough numbers of selected bulls. However, Egypt decided in seventies of the last century to benefit from the experience of developed countries in using frozen semen. Therefore, a project has been implemented at three phases. In the first phase, a field sample survey was applied on Egyptian cattle holdings in three governorates of Nile Delta region, with the training of the largest number of veterinarians on the work of the reproductive and artificial insemination. The practical application of the use of frozen semen and the provision of incoming equipment for the project has begun in the 2nd phase. The last phase ended with processing of frozen prepared semen for both Buffalo Stallions and Frisian sires starting in January 1977 [6].

2.1 Importance of Artificial Insemination in Cattle Breeding

Ojomo [7] showed via empirical field work that a viable AI program must include: (1) high performance bulls with quality semen, (2) skilled, dependable AI technicians, (3) healthy cows, (4) functional communication and transportation resources, and (5) cooperative and informed farmers. If any of these linked essential elements were lacking, the entire AI program fails. The data obtained in that study failed to establish the five essential elements in operation for the target area of the research of Nigeria. The community were nomadic people bounded by tradition and culture. Therefore, they could not effectively carryon an AI program.

The region in "central Madagascar" is one of the country's focal points for the development of the dairy industry, where milk production is a significant part of the regional economy. An artificial insemination program was applied as a cooperative project between Madagascar's and French government and it was successfully helping to increase production and introduce superior genetics to the area. The initiative has been happily received by farmers in the region, who have either already gained or who hope for a more profitable dairy business though AI use. Most farmers believe that using AI will become an important part of Malagasy culture as it ameliorates the indigenous zebu breed and makes traditional livelihoods more profitable. Despite the successes of the artificial insemination program thus far, even though, the facilities in which most cows were kept inhibit proper estrus detection; farmers cannot observe estrus signs. It was recommended that farmers would be able to more successfully identify and inseminate cows in estrus, thereby leading to a potentially shorter calving interval, if cows were kept together in a single large pen and also should not be tied up for long periods of time. Such practice was not applicable with small herd per holding. Estrus synchronization, as a series of hormonal injections to synchronize the estrus cycles of the cows in a given herd, if done properly, would cause cows to come into heat at the same time, and then eliminating the need for estrus detection. However, it proved too expensive to be continued long-term. It was most effective and most lucrative when used with large herd [8].

The productivity of the carabao subsector is influenced by several constraints such as social, technical, economic and policy factors. The need to enhance the local production of carabaos will help local farmers to increase their income. Thus, producing thorough breeds of carabaos and improving it genetically is the best response to these constraints. The study of Arlinda II, et al. [9] was conducted to present the feasibility study of establishing an Artificial Insemination (AI) Center and its planned area of operation in in Philippines. The market, production, organizational and financial viability of operating the business were also be evaluated. It provided insights in establishing an AI-Center, Including the identification of anticipated problems that could affect the business and recommendation of specific courses of action to counteract these possible problems. Primary data were obtained through interviews with key informants from the Philippine Carabao Center (PCC) and interviews with the technicians of PCC and private farms to get additional information. Secondary data were acquired from various literatures and from the target region's Municipal Office. The proposed area would be 1,500 square meters that would be allotted for the laboratory and bullpen. The total initial investment of EGP 3,825,417.39 was estimated for establishing the AI-Center. Financial projection showed an IRR of 30% and a payback period of 3.97 years. Based on all the market, technical, organizational, financial factors, projections and data analysis, it was concluded that that business endeavor would be viable and feasible.

Artificial insemination programs intend to increase the productive and economic efficiency of livestock holdings. The most important benefit of the application of the AI program is to achieve fast and efficient genetic improvement of cattle population in an economy. The economic concept of the genetic improvement is allocation of the present investment which is expected to yield income in the future at successive intervals. The investment spending after a gestation period the revenue stream begins to accompany the operation expenditure, which is the main reasons behind calling genetic improvement the genetic investment in livestock husbandry. The use of AI helps to speed up the rates of net present value (NPV) per either 1-unit of output or 1-technical Unit (1- head) and multiply the volume of production in a specified period. This one Domain of a new technoeconomic model via a creative cooperation between the animal breeding and agricultural economic scientists over the last four decades [10].

It should be mentioned that the common service method of the dairy buffalo insemination in Egypt is still the natural service at EGP75/service. However, field studies showed that an average of 3.5 services are required for conception and the detection of gestation is done via rectal palpation at the third month of pregnancy, where the village specialist would be able to touch the new embryo in a uterus horn [11-14]. Therefore, AI-network would not only speed up genetic improvements of offspring, but it would also improve the reproductive performances of the buffalo population in Egypt.

2.2 Egypt Comparative Advantage in Dairy Production

Soliman and Mashhour [15] showed that Egypt has a comparative advantage in dairy production, particularly from dairy buffalo, but not in the production of red meat. The results of that study indicated that the net income of the farm and the return on investment and the return on the use of the feed unit were for the benefit of dairy production, particularly the dairy buffalo. However, Egypt has a limited feed resources due to the scarcity of arable land and water resources, which would not allow for horizontal expansion in livestock population or raising specialized breeds. Therefore, the feasible approach would be maximizing the output of milk from 1-additional unit of feed [16]. This implies that the vertical expansion is the appropriate option to increase milk production in Egypt. A recent study has shown a high feasible return to investment (IRR ≈ 20%) generating from the genetic improvement of the Egyptian buffalo [1]. The effective genetic improvement requires a network of AI-Centers and AI-Units. However, the Egyptian infrastructure is lacking sufficient numbers of AI-Centers. The official statistics [17], showed that there are only two AI-Centers for raising selected buffalo sires, one in Cairo and the other in Beni-Suef of Upper-Egypt.

2.3 Egyptian Dairy Market Performance

Up to 2010 there was a fast Increase in Egyptian Population associated with higher nutrition awareness and changes in food consumption pattern with improvement in per capita income level that led to a significant increase in the demand for dairy products due to high income elasticity of demand, compared to other animal Protein food commodities [18].

The average annual per capita consumption of dairy products was low around 60kg and far below the international recommended standard [19]. Due to the slow domestic milk production, the share of imports in total consumption increased over time which, Increased the burden on the trade balance and therefore balance of payments [20]. Therefore, the demand for dairy has increased, resulted in high Continuous increase in dairy product Prices which surpassed the per capita income growth [21]. Recent empirical evidences for the dairy market performances were derived from the time series (2007- 2016). Results showed that there was a decreasing rate in the annual per capita dairy consumption averaging 2.69 kilograms per year, equivalent to about 3.67%. Total domestic production of milk decreased by -1.6% which was a main reason in the significant decrease in per capita consumption, in spite of the increase in imports at annual rate of 3.7%. Thereof, there was an annual increase in milk price of about 7%. This was due to high income elasticity of demand for milk in Egyptian market where 10% increase in income would increase the per capita quantity of milk demanded by 20% [22].

2.4 Importance of Dairy Buffalo in Egyptian Market

While buffalo milk production did not show a significant change in its total volume over the period (2007-2016), the cow milk production decreased significantly at annual rate of 2%, accordingly, the share of buffalo milk production in total domestic supply increased from 45% in 2007 to 47% in 2016 at the expenses of cow milk share [22]. The Egyptian consumer prefers buffalo milk for white color, sugary taste and higher total solids than cow milk. Therefore, the buffalo milk price is around 35% higher than cow milk. The buffalo milk price reached EGP5790/ton in 2016 while cow milk in the same year was EGP4330/ton. The annual rate of increase in buffalo milk price reflected the high demand and high preference of buffalo milk in Egyptian market which, averaging 7% a year while cow milk price increased by only 5% a year over the period (2007-2016) [22].

Abdul Kareem [23], provided a unique recent field survey study on dairy marketing system in Egyptian village, where more than 80% of milk production and more than 78% of livestock holdings. That study showed the disposal pattern of farm milk produced. While the farm households kept about one fourth of milk produced for home processing they kept only one-eighth of cow milk for home processing. This was due to the much higher value added from selling processed buffalo milk than cow milk. Several village whole-sale traders intended to mix both types of milk to get benefits from much higher fat content of buffalo milk than cow milk by selling such mix at high price as buffalo milk. The same attitude was conducted by the dairy processing plants as noticed by the researcher. While the farm gate price was EGP4.5/Kg for buffalo milk it was only EGP3.25/Kg for cow milk. Sale of raw milk achieved a profit of about 66%, 72% of the farm gate price. from cow and buffalo milk, respectively.

2.5 Study Objectives

The study aims to conduct a feasibility study of establishment a network of Artificial insemination centers and Units for serving the Egyptian Buffalo, associated with a Sensitivity analysis to investigate the impact of the major factors that affect the value of the estimated most probable return to investment.

2.6 Data Sources

To achieve its objectives, the study relied on two types of data, the first was published secondary data from the central Agency for public mobilization and statistics in Egypt (CAPMAS), and the second from a field data survey of the components of an artificial insemination unit at the Buffalo Research Station in "Gharbia" Governorate, and the center of AI in " Kafr El-Sheikh Governorate. Therefrom, the study built up two models for the feasibility study. 1. A model of Artificial Insemination Unit (AI-Unit) which provides the services for the buffalo holdings in the villages. There are two types of services. To sell the semen doses to the buffalo holders at 10 EGP per dose including the insemination service at the farms by the inseminators. The AI-unit keeps two types of frozen semen's containers. Large ones of 12- liters for storing in the AI-unit and small ones of 3 liters for providing the service on farms. The unit is equipped with the tools for AI services and motorcycles for farm visits by the inseminators. 2. A model of Artificial insemination Center (AI-Center) which select and raise the required buffalo bulls and prepare the semen doses and store them using liquid nitrogen. The center major components are a liquid nitrogen processing unit, a stall for the husbandry of selected bulls, storage for feeds, laboratory for testing the semen viability, a warehouse for storing the frozen semen stock and an office building.

3. METHODOLOGY AND ANALYTICAL PROCEDURES

The study assessed the feasibility of the two major components of a network for artificial insemination, i.e., the AI-Unit and the AI-Center via three analytical procedures: (1) profitability per unit of output (semen's dose), (2) Estimation of the net present value (NPV), internal rate of return (IRR) and the capital payback period (CPP), at the most probable techno-economic conditions and (3) Iteration of some scenarios of unfavorite conditions to test the resistance of the project feasibility (sensitivity analysis) of under these scenarios.

3.1 Profitability Measure

The profitability measure was estimated as a percent margin of the sale price/1-semen dose, as shown by (Eq. 1),

Profit / Dosage of semen = [(Sale price/1-dosege– Average total cost)/1-dosge)] / (Sale price/1- dosage) x 100 Eq. 1

Where, the average total cost per one dosage of semen was derived from (Eq. 2)

Total cost/1-semen dose = (variable costs + fixed costs) / (total produced semen doses) Eq. 2

The cost statement composed from the data of the field sample survey as presented in Tables 1 and 2 for the AI-Unit and AI-Center, respectively. However, it should be mentioned that although the livestock assets are fixed capital, but their annual costs have not been managed via a depreciation schedule because livestock value changes along the productive life. Thereof, livestock as assets are treated on base of the concept of the inventory change (Eq. 3) [12]. If the net value was positive it would be imputed profit and if negative it would be considered as loss imputed loss.

Bulls' Inventory change = [(Bulls value at End of yea-bulls value at Onset of Year) / (productive life) Eq. 3

It should be mentioned, that the annual income statement used for calculating the profitability included either direct expenses or imputed values (indirect items). The later included net inventory change and interest on capital, even though the enterprises have not gotten loans, but it was imputed to include an average value of the opportunity cost of capital invested. Finally, the cost items were classified into variable and fixed costs.

3.2 Return to Investment

The study designed an investment analysis statement which composed of the cash flow statement to drive the net present value (NPV) using discounting technique. The study derived from the same statement the discount rate that would result in achieving a zero value of the cumulative NPV, along the life span of the Project (Eq. 4). Such discount rate represented the average return on investment, which is called the most probable annual return per EGP, i.e. internal rate of return (IRR), (Eq. 5). The reciprocal of the IRR estimates the capital payback period (Eq. 6), i.e. the number of years required to recover an investment EGP [24]. These three criteria (NPV, IRR and payback period) were applied for both enterprises (the AI-Unit and the AI-Center).

$$NPV = \sum_{n=0}^{N} \frac{C_n}{(1+r)^n} = 0 \qquad \text{Eq. 4}$$

Where:

C_n = net cash flow in the year n
r = the discount rate
N = Project lifespan = the number of time periods

$$IRR = NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - Co = 0 \qquad \text{Eq. 5}$$

Payback period = 1/ (IRR) Eq. 6

Where:
C_t = net cash inflow during the period t
C_o = total initial investment costs
r = the discount rate, and
t = the number of time period
IRR = Internal rate of return

$$CRR = \frac{1}{IRR} \qquad (6)$$

Where:
CRR = Cash Reserve Ratio.
IRR = Internal rate of return.

3.3 The Sensitivity Analysis

The sensitivity analysis model would simulate the impact of some probable unfavorite conditions in the market that may face the project, leading to a decrease in the annual internal rate of return. Such model would test the resistance of the project in facing such conditions. If the IRR would not decrease to the extent below the average of the announced discount coefficient of the central Bank of Egypt, it would have shown the viability of the feasibility of the proposed program. The study had chosen to test three scenarios on the estimated IRR. Either 10% increase in the variable costs or 10% increase in the selected sire's price or 10% decrease in price per one dosage of semen [1].

4. RESULTS AND DISCUSSION

4.1 Profitability Per Dosage of Semen

The total annual costs of the AI-center amounted to about 536,190 EGP of which the variable costs contribution was only about 31.42%, the rest was fixed costs. i.e., about 68.58% (Tables 1 and 2) the total annual costs of the AI-unit amounted to about 224,045EGP, of which the variable costs contribution was only about 31.57% and the share of the fixed costs was 68.43%. Such high technology projects the fixed costs supposed to be the major component in the costs structure.

The AI- center raises four selected Buffalo sires and 6 selected cattle bulls. Therefrom, the total production of the center of semen doses per year is estimated at about 192,000 doses, of which about 50,000 doses from Buffalo sires, representing about 26.1%, the remainder is about 73.9% from cattle sires. Application of (Equation 2), resulted in a cost per dose of semen produced in the center of about 2.79 EGP. With respect to the AI-Unit, the total inventory of semen doses of the AI-unit per year was about 96 thousand, Using (Equation 2). the average cost per dose produced from semen reached about 2.33 pounds, i.e., 80% of the average cost per semen dose produced by the AI-Center. This because of the high absolute costs of the fixed costs at the AI-Centre due to the existence of a unit for production, packaging, and storage of liquid nitrogen for storing the frozen semen packages until be distributed to AI-Units in addition to the fixed costs of buffalo sires.

The Sources of revenue of the AI-Center are three, The first was from the sale of semen doses at a price per dosage of 10 EGP which generated about 1.860 million EGP from selling of 186 thousand doses of semen, The second source was from the sale of liquid nitrogen packages not only for artificial insemination units, but also for hospitals and medical centers, which reached about 40,000

EGP. The third source was from imputed income of net Inventory change in the value of Buffalo sires at ten thousand pounds a year, (Equation 3). The total income of the AI-unit stems from the sale of semen doses. It reached 965 thousand EGP, at a price of 10 pounds for the dose to the farmers including the providing the service to their dairy buffalo holdings.

Table 1. Annual costs structure of an AI-Center in Egyptian Pounds (EGP)

Cost Item	Unit	Value/Unit EGP	Quantity	Value EGP	Share in Total Costs
Feeding Sires in Winter:					
Concentrate feed mix	Kg	4,25	14400	61200	11.41%
Green Fodder	Kg	0,30	36000	10800	2.01%
Rice Straw	Kg	0,15	21600	3240	0.60%
Feeding Sires in Summer:					
Concentrate feed mix	Kg	4,25	10800	45900	8.56%
Green Fodder	Kg	0,20	27000	5400	1.01%
Rice Straw	Kg	0,15	21600	3240	0.60%
Semen Residual	EGP			6000	1,12
Syringes	EGP			3000	0,56
Slides	EGP			2000	0,37
Veterinary Care	EGP				
Drugs, Vaccines, serums	EGP			2500	0,47%
Electricity	EGP			24000	4,48%
Water	EGP			1200	0,22%
Total Variable Costs	EGP			168480	31,42%
Depreciation	EGP			88350	16%
Manager	Number	5000	1	60000	11%
Assistant Manager	Number	3500	1	42000	8%
Other Labor	Number	1000	3	36000	7%
Interest Costs	EGP			141360	26%
Total Fixed Costs	EGP			367710	69%
Total Costs	EGP			536190	100%

Source: Compiled and calculated from the sample survey data in 2017

Table 2. Annual costs structure of an AI-Unit in Egyptian Pounds (EGP)

Item	Unit	Value/Unit	Quantity	Value (EGP)	Relative importance (%)
Chemicals: Semen Residuals	Package	10	200	2700	1.21%
Liquid Nitrogen	Liter	40	6	2000	0.89%
Syringes	Package	50	8	240	0.11%
Slides	Package			400	0.18%
Drugs, Vaccines, serums	EGP			1000	0.45%
Electricity	EGP			1200	0.54%
Water	EGP			360	0.16%
Insemination Service Costs	EGP			62820	28.04%
Total Variable Costs	EGP			70720	31.57%
Depreciation	EGP			1745	0.78%
Technicians	Number	5000	2	120000	53.56%
Labor	Number	1000	2	24000	10.71%
Interest	EGP			7580	3.38%
Total Fixed Costs	EGP			153325	68.43%
Total annual Costs	EGP			224045	100

Source: Compiled and calculated from the sample survey data in 2017

Therefore, the application of (Equation 3) resulted in estimating, a profit per 1-semen dose as 71.3% of the sale price of the AI-Center and 76.8% of the sale price of the AI-Unit.

4.2 Estimation of the Investment Efficiency Criteria

The analysis of the investment statement (the cash flow statement) was applied to estimate the NPV, the most probable IRR and payback period of both components of the AI- network (the AI-Center and AI Unit). The lifespan assumption of AI-Unit and AI-Center was 20 years and the assumption of the gestation period of investment, i.e. the period before the recognition of the first revenue was 4 years, according to the conducted panel survey with the responsible fellows and according to the types of assets. The residual value of the assets was estimated using the straight-line model, according to the useful life of each type of assets, but the buffalo sires. The later was estimated according to the marketing value of the bull at sale, when it sold as beef animal (Eq. 4). NPV (EGP) 1,582,398 5,530,290 IRR (%) 35% 31% payback period (Years) 2.49 3.06 B/C Ratio 2.2 3.81 While Tables 3 and 4, present the total investments in the two components of the AI-network, Table 5 presents the most probable NPV, IRR and payback period in years, derived from the analysis of the cash flow statement of the two components of the AI network. The Estimated value of NPV, IRR and Payback period were EGP1,582,398, 35% and 2.49 years, respectively for the AI-Unit and such criteria were EGP5,530,290, 31% and 3.06 years, respectively for the AI-Center. Both estimates of IRR were much higher than the market discount announced rate by the Central bank of Egypt in 2017 of 17.5%. Therefore, both components of the AI-Network showed feasible investment criteria. In addition, such proposed program has other positive externalities which are acceleration of genetic improvement of dairy buffalo with expansion in milk production, providing thousands of employment opportunities for both skilled labor (agriculturists and veterinarians) and unskilled labor, and raising the agricultural household income. The number of years required to payback 1-EGP invested was 2.49 years and 3.06 years of the AI-Unit and AI-Center, respectively.

Table 3. Investment costs of AI-Center in EGP

Asset	Asset value	Residual value
Buildings	200000	12000
Nitrogen processing Set 1	1000000	60000
Nitrogen processing Set 2	500000	30000
Microscope	150000	9000
Autoclave	25000	1500
Large Container for Semen	40000	2400
Small Container for Semen	25000	1500
sensitive balance	4000	240
Refrigerator	3000	300
Artificial Vagina	3000	300
Buffalo Sires	250000	350000*
Total Investments	1838000	463340

Source: Compiled and calculated from the sample survey data in 2017

Table 4. Investment costs of AI-Unit

Asset	Asset value	Residual value
Buildings	175000	8750
Large Container for Semen	7000	420
Small Container for Semen	4000	240
Microscope	4000	240
Artificial Vagina	3000	300
Insemination Gun	200	20
Water Cooler	50	5
Total Investment	193250	9975

Source: Compiled and calculated from the sample survey data in 2017

Table 5. Estimated investment efficiency Criteria of AI- Network components

Most Probable Feasibility Criteria	AI-Unit	AI-Center
NPV (EGP)	1,582,398	5,530,290
IRR (%)	35%	31%
payback period (Years)	2.49	3.06
B/C Ratio	2.2	3.81

Source: Compiled and Calculated from the Sample Survey data in 2017

4.3 Sensitivity Analysis

To test the validity of the feasible investment when the program face unfavorite economic conditions, the study estimated the IRR of both components of the project under some probable scenarios. With respect to the AI-Center, probable 10% increase in feed prices and buffalo sire price, or 10% decrease in 1-dosage of semen price would result in IRR value of 30%, 28% or 26%. It shows that the most effective variable is the frozen semen price. Even though, the expected IRR would still be significant above the market discount rate of 17.5%, (Table 6). As the AI-Unit does not raise buffalo-sires, the only test scenarios were the possible decrease in frozen semen price by 10% and an increase in insemination service costs by 10%. Under lower semen price by 10% the IRR of the investment in an AI-Unit would decrease to 28%, which would stay feasible and under the scenario of probable higher costs of insemination services costs of 10%, due to proposed phasing out the fuel price subsidy and/or floating of the Egyptian currency, the IRR would decrease to 30%, (Table 6).

To assure that the feasibility of establishing an AI Unit and AI-Center both are valid even under the probability of occurrence simultaneously of all unfavorite economic scenarios, the IRR was estimated, the resulted IRR would be 26%, and 27, % i.e., the project would still be feasible.

Table 6. Sensitivity analysis at alternative scenarios of unfavorite conditions of investment

Unfavorite Scenarios	AI-Unit	AI-Center
The Mos Probable IRR	35%	31%
10% Decrease in Semen Price	28%	26%
10% increase in Insemination Costs	31%	NA
10% increase in feed costs	NA	30%
10% increase in Sire's price	NA	28%

4.4 Geographical Distribution of the Proposed AI-Network

The proposed program of establishing an artificial insemination network would be in the Lower Egypt which hold 57% of the total Egyptian buffalo population, rather than the Upper Egypt (Southern Nile Valley), [25]. This because a recent socio-economic study has shown the low consumer demand for milk in the Upper Egypt, as a community dietary tradition, , in comparison to the Lower Egypt and Big Cities in Egypt [26].

5. POLICY IMPLICATION AND CONCLUSION

The program of genetic improvement using artificial insemination would rapidly raise the milk yield of the Egyptian Buffalo population. This because AI would increase the number of inseminated females to about (10-20 thousands) per buffalo sire, while the number of inseminated females is not more than 60 females per buffalo bull by natural insemination [27]. Also, the buffalo sires raised in the AI-centers are selected according not only the phenotype but also according to progeny tests criteria. The rate of inseminated buffalo number/buffalo sire was used to estimate the number of buffalo sires required for the AI-network and according to the buffalo population density in each governorate in Lower Egypt. A management constrain was applied to assure the efficiency. Thereof, the number of buffalo sires in each AI- center should not exceed 100. Therefore, the Study estimated the number of artificial insemination centers of about 13. In addition, the number of associated AI-Units would reach about

695 units in the Lower Egypt, (Table 7) which geographically were demonstrated by the illustrative map in (Fig. 1).

The veterinary units in the Egyptian countryside's villages would grant the right to issue the licenses for establishment of the AI-network components and would also practice surveillance the performance of the AI-Units, which would locate in their circles. The private sector should get the opportunity to invest in such network establishment. The graduated veterinarians and animal science fellows should be given periostitis in such employment opportunities. A credit line should be established by the Egyptian Agricultural Bank to finance such program with credit facilities.

Table 7. Required geographic distribution of AI-Network for Buffaloes' in Lower Egypt

Governorate	Buffalo Population(000)H (*)	%	Buffalo Sires Required (H)**	No. AI-Centers Required**	No. of AI-Units Required**
Al Bahira	466.021	13.36	31	3	165
Al Monofia	369.684	10.6	25	2	132
AL Sharkia	298.048	8.55	20	2	104
Kafr el-Sheikh	254.628	7.3	17	2	89
Al Gharbia	227.315	6.52	15	2	80
AL Dakahleya	196.873	5.65	13	1	69
AL Qaliobia	161.364	4.63	11	1	56
Total Lower Egypt	1973.933	56.61	132	13	695

Source: Compiled and calculated from: (*) CAPMAS [28]. (**)The study Model

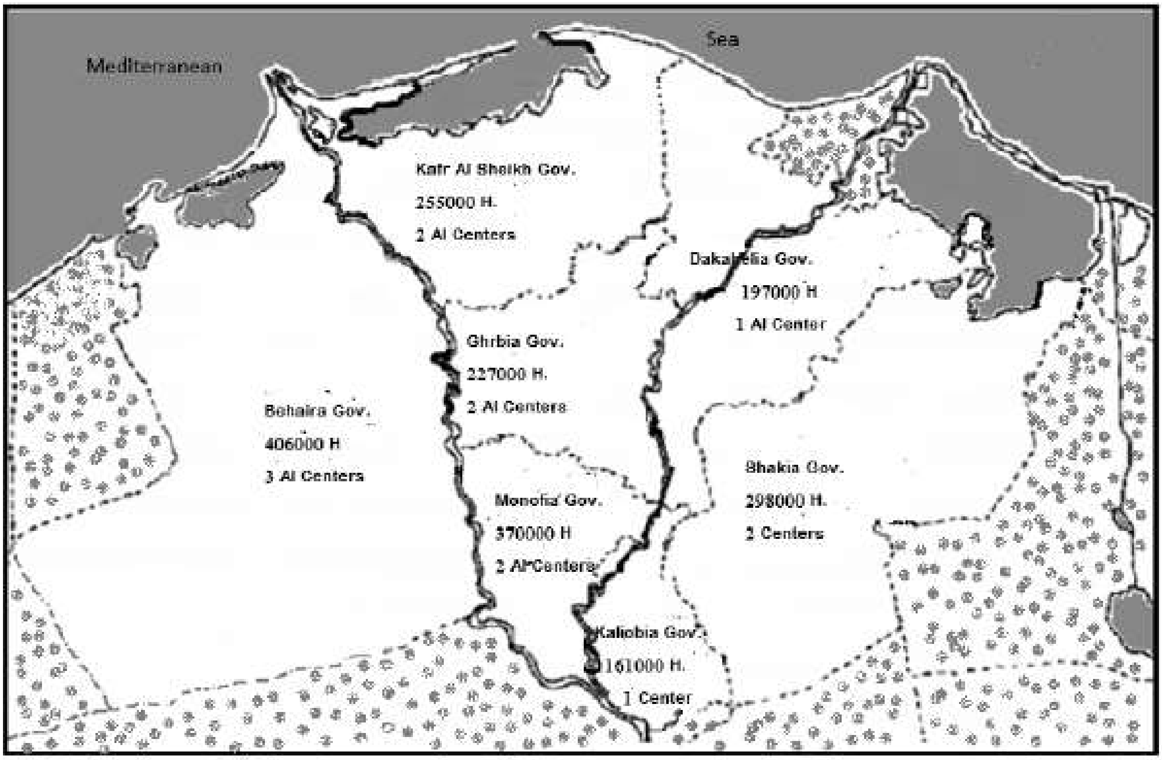

Fig. 1. Allocation of AI-Centers by Buffalo Population Distribution
Source: Derived from (Table 7)

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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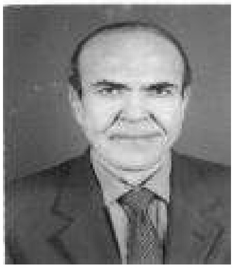

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