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# Classifying and Characterizing Buffalo Farming Systems in the Egyptian Nile Delta Using Cluster Analysis

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## ABSTRACT

The objective of the study was to classify and characterize the buffalo farming systems in the Delta region of Egypt using multivariate statistical analysis approach. A survey was conducted on 963 buffalo holders to classify and characterize dairy buffalo farming systems in the region of Delta Egypt. Data of 9665 heads of buffalo were used. Two multivariate statistical techniques, the principal component analysis (PCA) followed by the cluster analysis (CA) were applied to all the variables of the survey. A three different buffalo groups resulted; cluster 1(C1) :included 34% of the farms keeping 5132 heads of buffaloes. Itis characterized by large average for both farmland area (4.9 feddan) and buffalo herd size(15.6 heads). Production and reproduction performance of buffaloes was the best (milk yield, 2608kg; lactation period,258 days; and number of services/conception, 1.5). Cluster 2 (C2): included 35% of farms with1905 heads of buffaloes. It included the smallest average farmland area (3.1 feddan) and the fewest average buffalo herd size (5.6 heads).Cluster 3 (C3): included 31%of farms which kept 2628 heads of buffaloes. It was marked with intermediate values of farmland area, buffalo herd size and productive and reproductive performance of buffaloes that filled between those of C1 and 2.In all clusters, buffaloes were traditionally managed; hand milked and naturally bred. After taking their needs, farmers sell surplus raw milk and dairy products through informal markets. Efficient or regular milk marketing channels were completely absent. Access of veterinary and extension services was not sufficient and inefficient.

**Keywords**: buffaloes, production system, and multivariate analysis.

## INTRODUCTION

Egypt is an agricultural country and livestock is an important component of the Egyptian agriculture. Buffalo production represents about 24.5% of the agricultural gross domestic products. Buffaloes and cattle are the most important animals in Egypt. They are the main sources for milk and red meat. Buffaloes occupya great position in the Egyptian farmers life compared to cattle for their higher milk fat content and longer productive life (El-Nahrawy, 2011 and FAO, 2017).There are 3,9million heads of buffaloes in Egypt providing the Egyptian market with 44% and 39% of milk and red meat, respectively. In Egypt, buffalo population increases by 1.7% annually, while the rate of human population growth increases by 2.2-2.5% (Abou El-Amaiem, 2014). The demand on animal products increases due to the rise in life standard and the increase in the awareness with the biological value of animal proteins. The average annual consumption per capita of milk does not exceed one third of the world average. So, intensive efforts are expected to fill animal protein gap in the following years.

Farming systems research is the best tool to achieve farmers profitability. As it is an inter-disciplinary, integrative, problem-oriented and farmer-centered approach. To enhance the productivity of farms, the farm systems should be comprehensively studied and understood. This involves constructing proper technology for studying existing farming systems (Righi *et al*., 2011) with linking the farm holders as they will share in planning and applying the improvement strategy. Characterizing the production system is the first and most important stage in the farming system approach. It is a pre-requisite for laying the improvement plan (Kuivanen *et al*., 2016). It gives a clear image for the current situation with its interlaced relationships.

In Egypt, few numbers of researches classified the livestock farming systems. Buffaloes were included within the classified dairy or meat systems accompanied by other types of animals. However, animals within the same system may differ partly or completely in their characteristics and so in opportunities and constraints to improve their performance. Therefore, laying strategies to enhance the role of a given animal to exploit its potentiality requires focusing precisely on all components of the production system. Yet, no study classified the buffalo farming systems in Egypt. The aim of this research was to classify and characterize the buffalo farming systems in the Delta region of Egypt using multivariate statistical analysis approach.

## MATERIALS AND METHODS

### Research area

This study was conducted in the Nile delta region. The delta forms the northern part of Egypt as the river Nile reaches the Mediterranean Sea. It is about 22000 $km^2$. Its latitude and longitude lies between 30.54° N and 31.7° E. It is one of the largest and the oldest deltas all over the world. It is the most fertile farming areas in Egypt, has two thirds of Egypt's agriculture. Delta region is marked by moderate temperatures, notexceeding31 °C (88 °F) in the summer. Winter temperatures are normally in the range of 9 °C (48 °F) at nights to 19 °C (66 °F) at days. Rainfall is little and seasonally during winter months only. The total annual rainfall do not exceeds 99 mm, with a monthly range from 0 mm in June–September to 24 mm in January, resulting in a dry period all over the year. So agriculture depends mainly on water irrigation from the river Nile. Appropriate circumstances within the delta region allowed to setup livestock system hundred years ago. About 32.2% of the buffaloes, 22.4% of cattle, 22.4% of sheep and 23.5% of goats are kept in Delta Egypt (El-Nahrawy,2011).In the current study, the Nile delta region was represented by the governorates of AL-Behira, AL-Menoufia, AL-Qalubiya, AL-Sharkia and Kafr AL-Sheikh.

**Data collection**

A total number of 963 farm holders keeping 9665 heads of buffaloes were interviewed face-to-face using a structured questionnaire from July 2010 to January 2011. Farms were scattered in 36 centers located within 5selected governorates of Delta Egypt (Table 1). The questionnaire covered detailed information about characteristics of the buffalo farmer's, buffalo herds; size, composition, and structure, farmland; size and cropping patterns, buffalo management practices; milking, mating, milk processing and marketing, animal feeds; types, quantities and sources and services and facilities; availability.

Numbers of governorates, numbers of buffalo herds, numbers of buffaloes and the other animals in different governorates in the Delta region are shown in Table 1.

**Table 1. Numbers of buffalo herds, buffaloes and other animals* in selected governorates.**

| Governorate | Buffalo herds | Buffaloes | Other Animals |
|---|---|---|---|
| AL-Behira | 257 | 3771 | 6290 |
| AL-Menoufia | 181 | 1288 | 2218 |
| AL-Quliubiya | 122 | 2018 | 2583 |
| AL-Sharkia | 194 | 1656 | 2878 |
| KafrELSheikh | 209 | 932 | 1749 |
| Total | 963 | 9665 | 15718 |

***Animals include cattle, sheep, goats, donkeys and horses.**

**Data analysis**

Two multivariate statistical techniques, the Principal component analysis (PCA) followed by the Cluster analysis (CA) were applied to all the variables of the survey to study the buffalo farming system typologies in the Egyptian delta region. The PCA targets to summarize the great amount of information gathered in the survey to simplify understanding the system features. Principal component analysis (PCA) and cluster analysis (CA) were performed using XLSTAT 2016. The PC with eigen values greater than 1 were used for Aggloerative hierarchical clustering (AHC) cluster analysis. It partitions the observations into clusters, minimizes the sum of the distance from each object to its cluster centroid (Lletí *et al*., 2004). Additional variables were added to the original selected variables to get better characterization and typology of the resulted clusters. Frequencies, means and standard deviations were calculated for each variable to distinguish the differences between them. Statistical differences between clusters were assessed by the Duncan (1955) test using IBM Statistics 21 at 5% of probability.

## RESULTS

Twenty-two variables were used for PCA. The first five PC were used in CA. The eigen values of these PC ranged from 1.7 to6.9 representing76.5% of the total original variation (Table 2).The first component explained 31.4% of variance, it was correlated with buffalo numbers and the buffaloes' herd structure. The second component explicated 16.4% of variance and was related to the cultivated area the farmers had and the area that was cultivated with maize. It was also related to the numbers of sheep and goat and cattle that were kept with buffaloes. The third component was responsible for 10.9% of the variance. It was mostly associated with the reproductive performance of buffaloes; the number of days from calving to first service, the days open and the calving interval. Small association was resulted with total milk yield. Variables of the fourth component formed 9.6% of the variance. It was interrelated with cultivated forage/feddan and cultivated clover/feddan. The last component included education status and graduation of the farmers. It explained 8.1% of the total variance (Table 2).

**Table 2. Correlations between variables and factors for buffalo farming system in Nile Delta of Egypt.**

| | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|
| Educational level* | -0.074 | -0.121 | -0.190 | -0.270 | 0.875 |
| Educational qualifications ** | -0.039 | -0.123 | -0.186 | -0.279 | 0.865 |
| Possession by Feddan | 0.418 | 0.818 | -0.045 | -0.088 | 0.041 |
| No. Buffalo | 0.942 | -0.280 | -0.033 | -0.146 | -0.024 |
| No. Cattle | 0.379 | 0.813 | -0.077 | -0.300 | -0.032 |
| No. SheepandGoats | 0.248 | 0.864 | -0.053 | -0.280 | -0.046 |
| No. Employee | 0.676 | 0.241 | -0.061 | 0.329 | 0.128 |
| Total milk yield (TMY) | 0.112 | 0.014 | -0.256 | 0.012 | -0.074 |
| No. Heifers <1 year | 0.861 | -0.092 | 0.040 | 0.345 | 0.079 |
| No. Heifers 1-2 year | 0.829 | -0.267 | 0.063 | -0.080 | -0.103 |
| No. First lactation Buffalo | 0.826 | -0.228 | 0.013 | -0.210 | -0.115 |
| No. 2-3 lactation Buffalo | 0.752 | -0.282 | -0.108 | -0.281 | -0.013 |
| No. 4-5 lactation Buffalo | 0.622 | -0.176 | -0.128 | -0.259 | 0.077 |
| No. 6 or more lactation Buffalo | 0.663 | -0.266 | -0.129 | -0.251 | 0.011 |
| No. male calves <1 | 0.859 | -0.212 | 0.080 | 0.202 | -0.001 |
| No. fattning male calves >1 | 0.668 | -0.195 | 0.115 | -0.195 | -0.179 |
| Cultivated maize/ feedan | 0.299 | 0.866 | -0.072 | -0.279 | -0.029 |
| Cultivated clover/ feedan | 0.454 | 0.424 | 0.062 | 0.686 | 0.254 |
| Cultivated forage/ feedan | 0.429 | 0.151 | 0.081 | 0.770 | 0.268 |
| Period from calving to first service (day) | 0.041 | 0.020 | 0.861 | -0.113 | 0.107 |
| Period from calving to conception (day) | 0.036 | 0.030 | 0.903 | -0.149 | 0.141 |
| Calving interval (day) | 0.045 | 0.082 | 0.779 | -0.149 | 0.114 |

***Educational level: College degree, Intermediate degree, Literate, or Illiterate.**

**** Educational qualifications: Agricultural, Non-agricultural, or Without qualification.**

The distribution of buffalo farms according to the AHC (Aggloerative hierarchical clustering) showed that 329, 339 and 295 farms were located in C1,2 and 3, respectively. All governorates under this study were represented in all clusters.

C1: included 329 of the sampled farms, keeping 5132 heads of buffaloes. Table 3 shows that members of this cluster had larger average farm land (4.9feddan) compared to the other two clusters. The largest number of buffalo with an average of 15.6 heads per farm was kept under this cluster.

**Table 3. Land possession, cultivated area available for buffalo farming system in Nile Delta of Egypt.**

| Items | C1<br>N=329<br>mean ± SD | C2<br>N=339<br>mean ± SD | C3<br>N=295<br>mean ± SD |
|---|---|---|---|
| Area of farming land (feddan) | $4.9^{a} \pm 12.0$ | $3.1^{b} \pm 4.8$ | $3.4^{b} \pm 4.5$ |
| Cultivated clover area (feddan) | $4.2^{a} \pm 282$ | $1.5^{a} \pm 1.8$ | $1.6^{a} \pm 1.9$ |
| Cultivated forage area (feddan) | $0.6^{a} \pm 2.9$ | $0.3^{b} \pm 0.9$ | $0.3^{b} \pm 0.9$ |
| Cultivated maize area (feddan) | $2.1^{a} \pm 9.1$ | $1.5^{a} \pm 2.1$ | $1.4^{a} \pm 2.5$ |
| Cultivated wheat area (feddan) | $1.1^{a} \pm 2.7$ | $1.1^{b} \pm 1.6$ | $1.2^{b} \pm 1.9$ |
| Cultivated rice area (feddan) | $1.4^{a} \pm 3.2$ | $0.7^{b} \pm 1.3$ | $0.9^{b} \pm 1.7$ |
| Total no. of employee | $2.6^{a} \pm 4.1$ | $2.1^{b} \pm 1.7$ | $2.2^{ab} \pm 2.0$ |

The average of milking buffalo cows was 8.7heads, which corresponded on average to 55.7% of total heads (Table3).Buffaloes recorded the highest milk yield (2607kg) through the longest lactation period (258 days) among all resulted clusters (Table 4). Buffaloes formed 74% of the milk-producing animals, while cows formed 26%. 76% of farms raised their replacement heifers. Table 4 shows that a female buffalo gave her first calf at older age (32 months) compared to those kept under the other two clusters. The proportion of farmers who possessed the farmland was the highest (66%) compared to the other two groups. Members of this cluster (C1) recorded the lowest proportion in applying natural breeding (93%) for their female buffaloes and in using a breeding bull from one source (75%). Whereas, they were the highest ones in keeping breeding bulls(7.3%).The greatest percentage of farms that manufactured milk was found within this cluster by a value of (82.4%).

**Table 4. Buffalo herd structure and other animal's possession and herd structure for buffalo farming systems in Nile Delta of Egypt.**

| Items | C1<br>N=329<br>mean ± SD | C2<br>N=339<br>mean ± SD | C3<br>N=295<br>mean ± SD |
|---|---|---|---|
| Buffaloes no. | $15.6^{a} \pm 52.8$ | $5.6^{b} \pm 13.3$ | $8.9^{b} \pm 30.6$ |
| No. heifers < one year | $2.0^{a} \pm 6.8$ | $0.9^{b} \pm 2.4$ | $1.2^{b} \pm 3.2$ |
| No. male calves < one year | $1.6^{a} \pm 6.9$ | $0.59^{b} \pm 1.4$ | $0.8^{b} \pm 2.4$ |
| No. heifers 1-2 year | $2.0^{a} \pm 11.4$ | $0.6^{b} \pm 3.1$ | $0.8^{b} \pm 3.3$ |
| No. first lactation buffaloes | $0.9^{a} \pm 4.3$ | $0.4^{b} \pm 0.9$ | $0.5^{b} \pm 1.8$ |
| No. 2-3 lactation buffaloes | $2.6^{a} \pm 8.3$ | $1.1^{b} \pm 1.9$ | $1.8^{ab} \pm 6.1$ |
| No. fattening male calves > one year | $1.1^{a} \pm 6.1$ | $0.5^{a} \pm 3.6$ | $0.41^{a} \pm 2.9$ |
| No. of 6 or more lactations buffaloes | $2.1^{a} \pm 9.9$ | $0.5^{b} \pm 1.9$ | $1.9^{ab} \pm 12.1$ |
| No. 4-5 lactation buffalo | $2.9^{a} \pm 10.5$ | $1.1^{b} \pm 3.3$ | $1.6^{b} \pm 6.2$ |
| Cattle no. | $5.4^{a} \pm 28.3$ | $1.9^{b} \pm 4.7$ | $2.5^{b} \pm 4.7$ |
| Sheep & goats no. | $2.9^{a} \pm 21.4$ | $1.5^{a} \pm 3.8$ | $1.1^{a} \pm 2.9$ |
| Breedable buffalo females No. | $10.7^{a} \pm 37.3$ | $3.7^{b} \pm 8.1$ | $6.4^{b} \pm 25.7$ |
| Milking buffalo no. | $8.7^{a} \pm 29.2$ | $3.0^{b} \pm 5.9$ | $5.6^{ab} \pm 23.3$ |

C2: comprised 339 farms, keeping 1905 heads of buffaloes. Farmers of this cluster had the smallest farmland by the value of 3.14 feddan (Table 3).Table 4 shows that milk production per buffalo cow was the lowest (1266 kg) and the lactation length was the shortest (198 days).Average length of the period from calving to first service and calving interval were the longest (60 and 405 days, respectively) among all clusters. The proportion of farmers who possessed the farmland was the lowest (59.6%) while, those numbers of who rented land was the highest (16.8%) compared to the other two clusters. 70.5% of the members of this cluster manufactured milk. This percentage was the lowest compared to those obtained for the other two clusters.

C3: consisted of 295 farms keeping 2628 heads of buffaloes. This cluster was characterized by both medium farmland area (3.36 feddan) and medium buffalo herd size (8.9 heads).The average of milking buffalo cows was 5.6 heads, which corresponded, on average, to 63% of total heads. Buffaloes formed 78% of the milk-producing animals in this cluster while cattle formed 22%. Buffaloes of this cluster produced 1834 kg of milk through 233 days in milk (Table 5). Farmers of this cluster formed the fewest ones in keeping a breeding bull. Absence of veterinary and extension services was recorded to be the highest percentages for farmers of this cluster compared to the farmers of the other two clusters.

**Table 5 .Production and reproduction traits for buffalo farming systems in Nile Delta of Egypt.**

| Items | C1 N=329 Mean ± SD | C2 N=339 Mean ± SD | C3 N=295 Mean ± SD |
|---|---|---|---|
| Total milk yield (TMY, kg) | 2607[a] ± 500 | 1266[c] ± 229 | 1834[b] ± 120 |
| Daily milk/Kg | 10.2 [a]± 1.62 | 6.5 [c]± 1.2 | 7.9 [b]± 0.9 |
| Lactation period/day | 258.1 [a] ± 37.51 | 198.11 [c] ± 37.8 | 233.5 [b] ± 27.6 |
| Calving interval (day) | 395.2[b] ± 51.0 | 404.5[a] ± 55.7 | 391.9 [b] ± 44.9 |
| Period from calving to first service (day) | 49.1 [b] ± 23.7 | 59.6 [a] ± 29.1 | 51.5 [b] ± 24.6 |
| Days open (day) | 64.8 [b] ± 31.9 | 77.2 [a] ± 36.1 | 67.5 [b] ± 32.6 |
| Age at first calving /month | 32.5 ± 3.8 | 31.98 ± 4.48 | 31.98 ± 4.1 |
| No service per conception | 1.5 [b]± 0.6 | 1.7 [a]± 0.7 | 1.57 [b]± 0.67 |

**Common features of buffalo farming systems in the Nile delta of Egypt**

Buffalo farms of the three resulted clusters showed similar features in some aspects. More than 50% of farmers of all clusters had no formal education degree and farmers who had a higher education degree represented the fewest numbers. Family labor represented 100% of the farm labors. Two or more family members were working for the milk production and its interrelated processes. Besides, more than 69% of farms tended to practice meat production beside milk production. Moreover, cattle cows were permanently accompanied the buffaloes. Dairy herds were composed of 74% or 78% buffaloes and 26% or 22% cattle, respectively. The number of milking buffaloes represented the highest percentage in the herd structure. In addition, buffalo milk production in this study was permanently accompanied with cultivation. All sampled buffalo farmers had agricultural lands either owned, rented or both. However, ownership status was the more frequent. Rice and maize were the main summer crops and wheat was the main winter one. It was estimated from the obtained data that: regardless the farmland area farmers devoted definite spaces to some crops; 35-36% of land to wheat (*Triticum aestivum* L), 22-29% for rice (*Oryza sativa* L.) and 41-46% for maize (*Zea mays* L.). The clover was the most important forage. It occupies an important position in rotation with other crops for its high $N_2$-fixing ability. It occupied the greatest area not less than 46% among the other fodder crops. Utilization and adoption of introducing forage was not widespread. Minor areas not exceed 12% were devoted to all introduced forages. Across all buffalo farm clusters, natural mating was the most frequent method to breed female buffaloes. Applying artificial insemination was very limited.More than 62% of farmers recorded unavailability of AI and more than 50% did not trust its results. The majority of farms had no breeding bull for natural breeding. At the time of heat, a farmer accompanies his animal to a breeding bull kept in a neighboring barn paying a fee. More than 75% of farmers tended to use the same breeding bull. They chose the bull according to his reputation, place proximity and phenotype, respectively. Buffaloes were milked twice daily. Hand milking was the common. Farms using machine milking did not exceed 2.1%. Milking under hygienic conditions was not followed. Farmers retained a proportion of the total milk (liquid and dairy products) for home consumption. More than 70% of farmers manufactured milk to dairy products; more than 75.8%, 73.5% and 40.7% of farms produced cheese, butter and cream, respectively. Simple and traditional manufacturing manners were followed. Surplus raw milk was marketed directly to consumers and retailers through informal marketing system. Moreover, extra dairy products were sold by family farmers' females in the informal village markets. Farmers did not follow a scientific base in feeding buffalo. However, they showed a similar scheme in feeding their animals. They depended on the same feedstuffs, but they differed in the quantities they give to their animals. Feed rations based mainly on green roughages. Clover represented the main winter green roughage and forage maize (darawa) was the main summer one. The shortage of green forages in summer was compensated by corn silage. More than 87% of farmers mixed the concentrates with dry roughages. Bran of wheat and corn were the most concentrated feedstuff used while wheat and rice straws were the most used dry roughage. The outputs of buffalo farms were mainly liquid milk and dairy products, followed by calves, organic fertilizer and lastly breeding heifers. A great number of farmers were not satisfied with the veterinary and extension services. They were completely not available or described by feeble role.

## DISCUSSION

The current study showed diversity aspects within buffalo dairy farming systems in the Egyptian Delta by the multivariate approach. It summarized the great number of variables existed in a sample of 963 of buffalo dairy farms. It partitioned them into three clusters to minimize the variance among farms of the same cluster and maximizing the variance among clusters (Todde *et al*., 2016). From the result, it is concluded that C1 incorporated 53% of the buffalo number kept under the sampled farms, while, the rest, 20% and 27%, were included in C2 and C3, respectively. This means that the characteristics of C1 are the most widespread in the Delta region. The three identified clusters differed in farmland holding and in buffalo herd size. The result indicated that farmers who had larger farmland tended to keep larger numbers of buffaloes because herd size is depending on the available feed (Debele and Verschuur, 2014). In the current study, the farmers did not purchase animal feed and all were produced from their own farmland. Therefore, herd size was determined depending on the available farmland devoted to forage production to guarantee saving feeding in a stable ina cheap way. In all the three clusters, the priority was given to human crops. Therefore, despite the differences in the buffalo herd size in the three clusters, they all are considered small and far from numbers kept under intensive systems. Small herd sized obstruct applying the new technologies (Tatlidil and Akturk, 2009) that are practiced in large dairy cattle farms. This greatly decreases the buffalo's genetic improvement rate (Bufano *et al.,* 2006) .Moreover, availability of feeds because of larger farmland was also the main reason for keeping a breeding bull, raising replacement heifers and for practicing meat production by the greatest percentages in C1.

Besides, buffaloes of C1 recorded the highest milk yield,. while, those of C2 recorded the lowest. This may be due to the plenty of animal feeds in C1thinks to the larger farm size and the more area devoted to cultivating clover compared to the other clusters. This result is in agreement with Adam and Mohammed (2015) where they positioned quantity produced from clover and dry feed as the most important factors affecting the quantity produced from milk in Egypt. Moreover, feeding system with what it contains of feedstuffs were stated to affect milk yield (Adane *et al.,* 2016). In the current study, the proportion of farmers who used concentrates represented by soybean, wheat, bran, cottonseed meals and green roughages represented by corn silage, elephant fodder, and clover hay was the highest in C1 and the lowest in C2. Furthermore, adoption of cultivating a variety of forages was the highest by farmers of C1and the lowest by those of C2. Land ownership and level of education of farmers were included within the factors affecting the adoption of introducing forages stated by Mugerwa (2012). So, the current result can be attributed to the largest farmland size in C1 and to the highest illiteracy rate in C2. However, the current adoption rate of introducing forages in all systems is still low.

Moreover, length of the lactation period of buffaloes of C1 was the longest (258 days) while, the length of this period of those of C2 was the shortest (198 days). Different lactation periods of buffaloes in different milk production systems were also reported by Momin *et al*. (2016). This difference may be returned to the different management prevailing in every cluster where lactation length of buffaloes is non-genetic trait and greatly affected by environmental factors.

In addition, calving interval of buffaloes of C2 was significantly the longest among clusters. A wide range of calving interval of Egyptian buffaloes was recorded by different authors where it ranged from 351 days (El-Sheikh,1987) to 585 days (Badran *et al*., 2005). However, buffaloes of all clusters of the current study had good performance for this trait (392-405 days) where Abdalla (2003) revealed that perfect buffalo cows should give a delivery every 13-13.5 months.

Furthermore, the availability of extension services was higher in C1 than in the other clusters. However, it's still very low and the majority of farmers of all clusters responded with the lack of them. This lack of that service is the main reason for why farmers did not follow scientific bases in feeding buffaloes. El-Shaer (2015) referred to that practice as the major restrictive aspect for livestock production in Egypt. Moreover, existence of extension access may teach farmers how to enhance efficiency of their feed resources, for example by expanding use of silage.

Additionally, natural breeding was the common method to breed buffalo in all buffalo farming types. Using AI was very limited because its unavailability for the majority of farmers. Unavailability of AI was reported as one of the main factors obstacle using it (Mugisha *et al*., 2014). In the current study, C3 was the highest in applying AI followed by C1 and then C2. This is returned to the rate of its availability in every cluster, as it was available in clusters by the same previous order. Besides, the uncertain reliability of AI, which was reported by a great number of the sampled farmers also limits its adoption. The highest proportion of farmers who did not believe in AI was in the C2.This may be related to the education level, where the highest illiteracy rate was found in C2. Low educated farmers are low open-minded to adopt a new technology. Positive association between education level and adoption of AI is also revealed by Rathod *et al*. (2017).

On the other hand, buffalo farming systems in Egypt Delta are considered subsistence system as they provide farmers with high nutritive value food represented by liquid milk and dairy products. In the current study, it was difficult to estimate the consumed or the surplus milk percentages because the farmers could not determine it accurately as these quantities differ according to the milk yield. Milk yield is determined by the number of lactating buffaloes within the herd. Besides, it fluctuates from season to season due to the availability of animal feed and weather conditions. The greatest percentage of farmers who manufactured milk into dairy products was found in C1.While, the lowest was within farmers of C2. This is correlated with the quantity of milk production, which was the highest in C1 due to larger herd size and higher milk yield. Vice versa was detected in C2.

Furthermore, surplus milk and dairy products were marketed through informal local markets. Abou El-Amaiem (2014) reported that about 95% of milk and dairy products are marketed through informal marketing channels in Egypt. In addition, this type of marketing is the common in small farms of the developing countries. Where, farmers are challenged with limited area to market their product and with fluctuations in supply and demand of milk and dairy products. It causes uncertainty and instability in their earnings. In Egypt, the supply of milk increases in winter due to the availability of green fodders represented by clover and to the winter weather which is suitable for milk production process. On the other hand, features of informal marketing enable small farmers to achieve good benefits as no licensing is needed to operate, low cost of processing, high product price and noprior quality inspection (Ishaq *et al*., 2016).

## CONCLUSION

Multivariate statistical analysis, namely Principal Component (PCA) and Cluster Analysis (CA) can successfully be used to classify buffalo farming systems in The Egyptian Nile Delta. The analysis divided the owner "Small farm system" into three clusters different significantly in farm land size, herd size milk yield, lactation period, days open and calving interval. The three resulted groups participated each other's in many characters; buffalo farming system was usually accompanied with cultivation and with meat production. Low education level of farmers was the common. Conventional management as hand milking and natural breeding was the most frequent. Efficient or regular milk marketing channels were completely absent. Access of veterinary and extension services was not sufficient and inefficient

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## توصيف نظام مزارع الجاموس في دلتا النيل، مصر عن طريق التحليل العنقودي

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**قسم الإنتاج الحيوانى – كلية الزراعة – جامعة القاهرة – الجيزة – مصر**

هدفت الدراسة الى التعرف على نظم انتاج اللبن من الجاموس فى منطقة الدلتا. وذلك من خلال إجراء مسح تضمن عقد لقاءات مباشرة مع 963 من مربى الجاموس الحلاب فى هذه المنطقة. باستخدام تحليل متعدد المتغيرات (التحليل العنقودى)، نتج ثلاث مجموعات مختلفة من الجاموس الحلاب. المجموعة الأولى: ضمت 34٪ من المزارعين الذين يملكون 5132 رأسا من الجاموس الحلاب. ضمت هذه المجموعة المتوسطات الأعلى من حيث الحيازة الزراعية (4.9 فدان) و الحيوانية (15.6 رأسا من الجاموس) مقارنة بالمجموعتين التاليتين. كما ضمت هذه المجموعة الجاموس الأعلى انتاجا للحليب ( 2608 كجم/258 يوما) والأقل فى عدد التلقيحات اللازمة للحمل(1.5). المجموعة الثانية: شملت 35٪ من المزارع التي تضم 1905 رأسا من الجاموس. تضمنت هذه المجموعة المتوسطات الأصغر من الحيازات الزراعية (متوسط 3.1 فدان) والحيوانية ( متوسط 5.6 رأسا من الجاموس). كما ضمت هذه المجموعة الجاموس الأقل إنتاجا للحليب (1267 كجم) ،الأقصر فى طول موسم الحلب (198 يوما). الأعلى فى عدد التلقيحات اللازمة للحمل (1.7) والأطول فى طول الفترة بين ولادتين (405 يوماً). المجموعة الثالثة: شملت 31٪ من المزارع التي احتفظت ب 2628 رأسا من الجاموس. توسطت قيم هذه المجموعة قيم المجموعتين السابقتين من حيث متوسطات حجم الحيازة الزراعية، الحيوانية والآداء الانتاجى للجاموس. اشتركت المجموعات الثلاث فى عدد من الصفات مثل انخفاض المستوى التعليمى لغالبية المربين، ارتباط انتاج اللبن من الجاموس بامتلاك ارض زراعية، اتباع الأساليب التقليدية فى رعاية الجاموس مثل اجراء الحليب اليدوى والتلقيح الطبيعى، بيع فائض الحليب ومنتجات الألبان عبر الأسواق غير الرسمية وعدم توافر الخدمات البيطرية والإرشادية بالقدر الكافى الذى يحقق فعالية فى مجال انتاج الجاموس.

**الكلمات الدالة:** الجاموس، ونظام الإنتاج، وتحليل متعدد المتغيرات.