World Academy of Science, Engineering and Technology
International Journal of Animal and Veterinary Sciences
Vol:8, No:7, 2014

Effect of Calving Season on the Economic and Production Efficiency of Dairy Production Breeds

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Abstract**—**The objective of this study was to evaluate the effects of calving season on the production and economic efficiency of dairy farms in Egypt. Our study was performed at dairy production farms in the Alexandria, Behera, and Kafr El-Sheikh provinces of Egypt from summer 2010 to winter 2013. The randomly selected dairy farms had herds consisting of Baladi, Holstein-Friesian, or cross-bred (Baladi × Holstein-Friesian) cows. The data were collected from production records and responses to a structured questionnaire. The average total return differed significantly ($P < 0.05$) between the different cattle breeds and calving seasons. The average total return was highest for the Holstein- Friesian cows that calved in the winter (29106.42 EGP/cow/year), and it was lowest for Baladi cows that calved in the summer (12489.79 EGP/cow/year). Differences in total returns between the cows that calved in the winter or summer or between the foreign and native breeds, as well as variations in calf prices, might have contributed to the differences in milk yield. The average net profit per cow differed significantly ($P < 0.05$) between the cattle breeds and calving seasons. The average net profit values for the Baladi cows that calved in the winter or summer were 2413 and 2994.96 EGP/cow/year, respectively, and those for the Holstein-Friesian cows were 10744.17 and 7860.56 EGP/cow/year, respectively, whereas those for the cross-bred cows were 10174.86 and 7571.33 EGP/cow/year, respectively. The variations in net profit might have resulted from variation in the availability or price of feed materials, milk prices, or sales volumes. Our results show that the breed and calving season of dairy cows significantly affected the economic efficiency of dairy farms in Egypt. The cows that calved in the winter produced more milk than those that calved in the summer, which may have been the result of seasonal influences, such as temperature, humidity, management practices, and the type of feed or green fodder available.

Keywords**—**Calving season, economic, production, efficiency, dairy.

I. INTRODUCTION

DAIRY farming is widespread in Egypt for a number of reasons. The most important reasons included a source of high-quality milk, manure for fertilizer, and a good business opportunity for small-scale farmers. Although milk is the primary product produced by dairy farms, Egyptian dairies supply only 76.8% of the 59.5 kg of milk that is consumed per individual per year in Egypt [11].

Productivity in dairy cows is defined as the ratio of the milk yield to the nutritional costs associated with maintenance, milk synthesis, and the loss of body weight during lactation [8]. High production efficiency can be achieved when production is maximized at the lowest cost possible, and when the average cost is at the lowest point on the average cost curve, such that the least amount of resources are used to produce a high volume of products [21].

Calving season is influenced by the lactation length and milk yield. Summer calvers have a lactation length of 251.0 ± 1.81 days, whereas winter calvers have an average lactation length of 243.8 ± 1.70 days. However, milk yield tends to exhibit an inverse trend, compared with lactation length. Reference [6] reported that summer calvers produced 184 kg less milk than winter calvers (1361 vs. 1545 kg, respectively). Even after the adjustment for lactation length, the milk yield for winter calvers remained higher than that of summer calvers (1797 vs. 1694, respectively).

The high milk yield in winter and spring calvers might be the result of the availability of high-quality green fodder during late-winter and early-spring months. Summer conditions have been shown to have adverse consequences on the productivity of buffalo, primarily through increased ambient temperature and the scarcity of green fodder, which is usually most acute during the May to July period [3], [15]. A previous study, however, showed that cows which calved in the winter had the highest average milk yield (1661 ± 19.20 kg), whereas those which calved in the summer had the lowest milk yield (1418 ± 23.87) [14]. Another study showed that milk production was lowest for cows that calved in the early spring and highest for cows that calved in the fall [9]. Reference [13] found a significantly lower number of services per conception (NSC) in the winter ($P < 0.05$). However, [4] reported the absence of seasonal effects on NSC.

Dairy farm production systems are predominantly based on seasonal calving to maximize grazing resources. Reference [4] found that the calving season had a significant influence on milk yield ($P < 0.01$). They found that milk yield was highest (3659.48 kg) among the cows that calved during the fall, and was lowest (3249.36 kg) among those that calved in the hot, humid months. In addition, [7] reported that cows calving in the summer had the greatest number of days open, whereas those calving in the winter (January to March) had the fewest days open. Reference [7] also found that the difference in days open between herds was related to differences in management-related factors, such as nutrition, health, and the ability of farmers to detect heat signs after calving.

Feed availability, quality of fodder, and incidence of disease might contribute to the influence of calving season on milk yield and reproductive performance [1]. Reference [17]

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reported that the most important factors affecting economic and production efficiency were calving interval, days open, days dry, and calving season. Reference [14] also observed that Sahiwal cows which calved in the winter had the highest milk yield (1661 ± 19.20 kg), whereas those that calved during the hot, humid months had the lowest milk yield (1418 ± 23.87 kg).

The aim of our current study was to examine the effect of calving season on the production and economic efficiencies of dairy farms in Egypt.

II. Material and Methods

A. Study Location and Animals

Our study was performed at dairy production farms in the Alexandria, Behera, and Kafr El-Sheikh provinces of Egypt from summer 2010 to winter 2013. The randomly selected dairy farms had herds that consisted of Baladi (local), Holstein-Friesian (imported), or cross-bred (Baladi × Holstein-Friesian) cows. The cattle were fed a total mixed ration, based on a dry matter intake of 60% concentrate and 40% forage. The Holstein-Friesian herds tended to be larger than those of the Baladi and cross-bred farms.

B. Data Collection

The data were collected using field surveys. During the data collection, the researcher was in intimate contact with the dairy holders and managers. The dairy farms were visited two or more times, with at least one visit in the summer and another in the winter [12]. The data were collected from the production records available at the farms and from the responses to a structured questionnaire that was administered to the dairy holders and managers, as previously described [19], [16]. The data from milk production and reproduction records were analyzed to evaluate the economic and production efficiency of the various dairy herds [2]. The data were grouped into the production and management, reproduction, economic data and fixed costs, variable costs, and returns of dairy production datasets, and analyzed as described below.

C. Production, Economic, and Management Data

The production and management data included herd size, breed, parity, lactation number (1, 2, 3, and so on), calving season (summer or winter), daily milk yield per kilogram, annual milk yield per ton, daily lactation period, type of feed (berseem clover, silage, concentrates, tibn, or bran), dry matter intake, and feed consumption per year.

D. Reproduction Data

Various data were collected regarding reproductive performance, such as calving season, calving interval, days open, dry period, date of calving, date of insemination, dry off date, and type of insemination (artificial or natural) .

E. Economic Data (Costs of Dairy Production) and Fixed Costs

The costs of dairy production included the depreciation of buildings, animals, equipment, and the dairy parlor. The depreciation rates were calculated for the building and dairy parlor by dividing the estimated sale price of the building by 25 or 15 years, respectively. The animal depreciation was calculated by subtracting the value of the animal as meat from the purchase value and dividing by 13, which represented the estimated production lifetime of the animal in years, according to fixed line method [19], [10].

F. Variable Costs

The variable costs included the costs in Egyptian pounds (EGP) for drugs, vaccines, disinfectants, veterinary care, labor costs, utilities (electricity and water) costs, and feed costs. Feed costs included the cost of berseem clover (feddan and ton per animal), tibn (heml per animal), silage (ton per animal), concentrates (ton per animal), dry matter (kg/day), and any other feed-related materials [16].

G. Returns of Dairy Production

The returns of dairy production included the returns in EGP from milk sales, heifer and calf sales, the value of calves added to the herd, and manure sales. The total return from milk sales was calculated by multiplying the total volume of milk produced (corrected for 305 days of milk production) per year by the average price during the three-year study period [16].

H. Statistical Analyses Methods and Economical Analysis

The data were analyzed using the general linear model based on an analysis of variance. Duncan's multiple range test was used to test the significance of the differences between the mean values of the parameters related to production, reproduction, costs, and returns, as previously described [5], [20].

III. Results and Discussion

A. Productive Parameters

As presented in Table I, the Baladi cows that calved in the winter produced more milk (4740 kg) than those that calved in the summer (4590 kg; $P < 0.05$), and the lactation lengths for the seasonal Baladi calving groups were 237.08 and 229.54 days, respectively. The cross-bred cows that calved in the winter produced more milk than those that calved in the summer (8253.4 vs. 7493.4 kg, respectively), and their lactation lengths were 241.78 and 249.78 days, respectively. The Holstein-Friesian cows that calved in the winter produced more milk (8663.2 kg) than those that calved in the summer (7037.7 kg; $P < 0.05$).

B. Reproductive Parameters

The results of our analysis of the effect of the calving season on the reproduction efficiency of dairy cattle are presented in Table I. The calving interval of the Baladi cows was affected by the calving season. Cows that calved in the winter had a significantly longer calving interval (373.14 days) than those that calved in the summer (355.57 days; $P < 0.05$). A similar trend was observed in the number of days open and the calving season. The calving interval and the number of days open (394.11 and 108.77 days, respectively) for the cross-bred cows that calved in the winter were significantly longer ($P < 0.05$) than those for the cross-bred cows that calved in the summer (383.79 and 99.13 days, respectively). However, no significant differences in the calving interval and number of days open were observed between the Holstein cows that calved in the winter and those that calved in the summer.

TABLE I
REPRODUCTIVE AND PRODUCTIVE PARAMETERS AMONG DIFFERENT BREEDS OF DAIRY CATTLE WITHIN DIFFERENT SEASONS

Breed	Calving season	No of records	Calving interval	Days open	305-milk yield	Days in milk
Balady	winter	108	373.14±7.02a	87.28±5.09a	4740.06 ±85.13a	237.08±9.69a
	summer	109	355.57±5.06b	69.71±4.14b	4590.8± 90.27b	229.54±9.74a
crossbred	winter	332	394.11±5.15a	108.97±3.19a	8253.4±60.61a	241.78±5.54a
	summer	329	383.79±3.17b	99.13±3.21b	7493.4±69.03b	249.78±5.56a
Holstein Frisian	winter	912	463.37±3.12a	193.21±3.14a	8663.2±85.09a	247.52±3.35a
	summer	1191	464.40±2.73a	193.22±2.75a	7037.7±74.43b	234.59±2.93b

Means within the same column among winter and summer seasons carrying different are significantly different (P<0.05).

TABLE II
COSTS PARAMETERS OF DIFFERENT DAIRY CATTLE BREEDS WITHIN DIFFERENT SEASONS

Breed	Calving season	Depreciation of buildings	Depreciation of animals	Depreciation of parlour	Total fixed costs
Balady	winter	59.63±8.49a	259.66±16.60a		319.29±16.60a
	summer	64.35±7.55a	243.32±16.68a		307.67±16.68a
crossbred	winter	192.16±19.86a	325.71±39.51a	12.04±1.51a	529.91±33.10a
	summer	166.62±10.03a	309.75±29.56a	11.36±1.40a	487.73±27.20a
Holstein Frisian	winter	185.25±24.08a	1251.0±25.02a	419.16±34.97a	1855.41±26.10a
	summer	213.61±34.66a	1274.0±35.74a	479.68±35.65a	1967.29±35.50a

Means within the same column among winter and summer seasons carrying different are significantly different (P<0.05).

C. Fixed Costs Components

The results of our analysis of fixed costs are presented in Table II. Non significant differences ($P > 0.05$) in the fixed costs were observed between the cattle breeds and calving seasons. As shown in Table IV, the building depreciation cost ranged from 59.63 EGP for the Egyptian Baladi cows that calved in the winter to 64.35 EGP for those that calved in the summer. The equipment depreciation ranged from 259.66 to 243.32 EGP, and the variation between the different breeds and calving seasons was not significant. The building and equipment depreciation costs were 192.16 and 325.71 EGP, respectively, for the cross-bred cows that calved in the winter, whereas these costs were 166.62 to 309.75 EGP, respectively, for those that calved in the summer. The building and equipment depreciation costs were 185.25 and 213.61 EGP, respectively, for the Holstein-Friesian cows that calved in the winter, whereas these costs were 213.61 and 1274 EGP, respectively, for those that calved in the summer.

D. Veterinary-Care Costs

The results of our analysis of costs related to veterinary care are presented in Table III. Significant differences ($P < 0.05$) in the drug, vaccine, disinfectant, veterinary-care, and total veterinary management costs were observed between the different calving seasons and cattle breeds. The average drug cost was highest for the Holstein-Friesian cows that calved in the winter (117.46 EGP/cow/year), and it was lowest for Baladi cows that calved in the winter (72.98 EGP/cow/year). The vaccine cost was highest for the Holstein-Friesian cows that calved in the winter (95.95 EGP/cow/year), and it was lowest for the Baladi cows that calved in the winter (7.18 EGP/cow/year). The disinfectant cost was highest for the Holstein-Friesian cows that calved in the summer (129.02 EGP/cow/year), and it was lowest for the cross-bred cows that calved in the winter (15.44 EGP/cow/year).

Stress factors related to environmental conditions or local farming practices during the summer period, such as higher temperatures, greater numbers of insect pests, and more frequent vaccinations, might have contributed to the differences in the various veterinary-care-related costs. Because the European Holstein-Friesian breed is not adapted to the environmental conditions in Egypt, it is also possible that differences between the management practices used for the Holstein-Friesian and native Baladi breeds also contributed to the differences in veterinary-care-related costs [18], [1]. The total veterinary management cost was highest for the Holstein-Friesian cows that calved in the winter (610.37 EGP/cow/year), and it was lowest for the cross-bred cows that calved in the summer (288.63 EGP/cow/year).

E. Effect of Calving Season on Production Costs

The results of our analysis of the effect of calving season on production costs are presented in Table IV. The total feed cost differed significantly ($P < 0.05$) between the cattle breeds and calving seasons. The average feed cost was highest for the Holstein-Friesian cows that calved in the winter (15220 EGP/cow/year), and it was lowest for the Baladi cows that calved in the summer (8582 EGP/cow/year). The total feed cost for the cross-bred cows that calved in the winter was 15168 EGP/cow/year, and it was 14394 EGP/cow/year for those that calved in the summer.

The higher feed cost for the Holstein-Friesian and cross-bred cows may have resulted from higher feed prices during feed shortages, during which farmers searched for high-quality feed to sustain a high level of milk production. The lower feed cost for Baladi summer calvers might have caused low milk production, which resulted from feed shortages in the summer, during which farmers spent less money on concentrates. These results are consistent with those of a previous study by [1], who found that the feeds required for high-level milk production generally cost more, especially during the summer months**.** In addition, [18] previously reported that the average cost of feed was significantly different (*P* < 0.05) between the native, cross-bred, and Holstein-Friesian breeds.

TABLE III
VETERINARY MANAGEMENT COSTS OF DIFFERENT DAIRY CATTLE BREEDS WITHIN DIFFERENT SEASONS

Breed	Calving season	Drug cost	Vaccine cost	Disinfectant cost	Veterinary supervision cost	TVM cost
Balady	winter	72.98±4.47a	7.18±0.17b	18.40±3.83a	190.07±10.79a	288.63±50.50a
	summer	78.15±3.50a	24.86±1.20a	18.19±2.54a	185.35±11.45a	306.55±42.57a
crossbred	winter	89.68±3.71a	12.08±1.17b	15.44±2.05b	243.57±8.02a	360.77±45.31b
	summer	97.41±5.72a	28.61±0.19a	20.85±1.05a	254.09±11.03a	400.96±32.35a
Holstein Frisian	winter	117.46±10.96a	95.95±12.17a	127.42±24.55a	269.54±12.54a	610.37±54.39a
	summer	91.53±11.24b	67.36±11.48b	129.02±20.63a	266.83±13..62a	554.74±45.01b

Means within the same column among winter and summer seasons carrying different are significantly different (P<0.05).

TABLE IV
VARIABLE COSTS PARAMETERS OF DIFFERENT DAIRY CATTLE BREEDS WITHIN DIFFERENT SEASONS

Breed	Calving season	Total feed cost	Labor	Electricity	TVM cost	Total variable costs
Balady	winter	9569±94.50a	261.47±44.33a	35.78±4.04b	288.63±50.50a	10155.21±89.14a
	summer	8582±85.29b	252.78±35.44a	45.83±4.06a	306.55±42.57a	9187.16±100.78b
crossbred	winter	15186±100.64a	579.25±48.94a	40.30±2.32b	360.77±45.31b	15166.32±100.40b
	summer	14394±113.72b	588.03±40.0a	75.26±2.33a	400.96±32.35a	15458.25±105.90a
Holstein Frisian	winter	15220±116.24a	650.96±37.36a	25.51±1.22a	610.37±54.39a	16506.84±120.45a
	summer	13190±120.07b	638.02±38.41a	25.14±1.40a	554.74±45.01b	14407.9±143.036b

Means within the same column among winter and summer seasons carrying different are significantly different (P<0.05).

TABLE V
RETURNS PARAMETERS OF DIFFERENT DAIRY CATTLE BREEDS WITHIN DIFFERENT SEASONS

Breed	Calving season	Milk sales	Calf sales	Litter sales	Total return	Total cost	Profit
Balady	winter	11850.30±131.78a	918.07±24.45a	119.27±23.13a	12887.64±130.84a	10474.5±156.36a	2413.00±313.83b
	summer	11477.20±125.62b	913.52±24.56a	99.07±19.15a	12489.79±125.67b	9494.83±147.15b	2994.96±224.97a
crossbred	winter	24760.2±176.60a	1034.0±34.01a	76.89±21.80a	25871.09±176.06a	15696.23±138.70b	10174.86±354.09a
	summer	22480.2±178.77b	969.21±28.07b	67.90±15.80a	23517.31±178.22b	15945.98±144.7a9	7571.33±255.38b
Holstein Frisian	winter	25989.6±251.63a	2995.0±27.40a	121.82±10.95a	29106.42±251.35a	18362.2±107.10a	10744.17±330.54a
	summer	21113.1±287.56b	3000.0±28.45a	122.65±13.08a	24235.75±287.23b	16375.19±111.71b	7860.56±269.49b

Means within the same column among winter and summer seasons carrying different are significantly different (P<0.05).

F. Labor Costs

As shown in Table IV, the labor cost didn't differ significantly (*P* > 0.05) between the cattle breeds and calving seasons. The average cost was highest for the Holstein-Friesian that calved in the winter (650.96 EGP/cow/year), and it was lowest for Baladi cows that calved in the summer (252.78 EGP/cow/year).

G.Electricity Costs

As shown in Table IV, the electricity cost differed significantly (*P* < 0.05) between the cattle breeds and calving seasons. The average electricity cost was highest for the cross-bred cows that calved in the summer (75.26 EGP/cow/year), and it was lowest for the Holstein-Friesian cows that calved in the summer (25.14 EGP/cow/year).

The total variable cost (TVC) for the Baladi cows that calved in winter (10155.21 EGP) was significantly different than that of those that calved in the summer (9187.16 EGP: *P* < 0.05). The TVC for the cross-bred cows that calved in the summer (15458.25 EGP) was greater than that of those that calved in the winter (15166.32 EGP). The greatest difference in TVC was observed between the Holstein cows that calved in the winter and those that calved in the summer (16605.84 vs. 14407.90 EGP, respectively; P < 0.05).

H.Returns and Profitability

Total returns from milk sales, heifer and calf sales, and litter sales are presented in Table V. Significant difference in the total return was observed between the Baladi cows that calved in the winter (11850.30 EGP) and those calved in the summer (11477.20 EGP). As well, the cross-bred cows that calved in the winter had a significantly greater return (24760.20 EGP) than those that calved in the summer (22480.20 EGP). The Holstein-Friesian cows that calved in the winter also had a greater total return than those that calved in the summer.

The total costs also the same trend of variable costs between breeds and calving season. The total cost (TC) for the Baladi cows that calved in winter (10474.50 EGP) was significantly different than that of those that calved in the summer (9494.83 EGP: *P* < 0.05). The TC for the cross-bred cows that calved in the summer (15945.98 EGP) was greater than that of those that calved in the winter (15696.23 EGP). The greatest difference in TC was observed between the Holstein cows that calved in the winter and those that calved in the summer (18362.25 vs. 16375.17 EGP, respectively; P < 0.05)

The net profit from the Baladi cows that calved in the summer (2994.96 EGP) was higher than that of the Baladi cows that calved in the winter (2413 EGP; $P < 0.05$). In contrast, the cross-bred and Holstein-Friesian cows that calved in the winter yielded a higher net profit than those that calved in the summer. The net profit from the cross-bred cows that calved in the winter (10174.86 EGP) was higher than that of the cross-bred cows that calved in the summer (7571.33 EGP; $P < 0.05$). Furthermore, the net profit from the Holstein-Friesian cows that calved in the winter (10744.14 EGP) was higher than that of the Holstein-Friesian cows that calved in the summer (7860.56 EGP; $P < 0.05$).

IV. Conclusion

The results of our study showed that the Baladi, cross-bred, and Holstein-Friesian cows that calved in the winter had the highest milk yield. The total returns for the Baladi, cross-bred, and Holstein-Friesian cows that calved in the winter were greater than those of the cows that calved in the summer. The net profits for the cross-bred and Holstein-Friesian cows that calved in the winter were greater than those of the cows that calved in the summer. In contrast, the net profit for the Baladi cows that calved in summer was greater than those calved in winter.

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