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# Association of Birth Type and Pregnancy Type with Lactation Performance and Lactation Curve in Holstein Dairy Cows in Iran

Research Article

H. Atashi[1*], M. Dadpasand[1], M.J. Zamiri[1] and A. Asaadi[2]

[1] Department of Animal Science, Shiraz University, Shiraz, Iran
[2] Department of Clinical Science, School of Veterinary Medicine, Shiraz University, Shiraz, Iran

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*Correspondence E-mail: atashi@shirazu.ac.ir

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## ABSTRACT

The association of birth type (single *vs*. double) and pregnancy type (single *vs*. double) with lactation performance and lactation curve was investigated in Holstein cows in Iran. Data of 243298 lactations on 138021 cows in 261 herds collected during January 2000 to December 2012 were used. The average twinning rate was 3.64% and ranged from 1.44% (primiparous) to 5.41% (multiparous). Factors associated with twining were calving season, calving year, herd, and parity. The rate of twinning increased from 2.49% in 2000 to 3.42% in 2012. The probability of twinning was higher in multiparous cows than that in primiparous [Odds ratio (OR) (95% confidence interval (CI))= 3.64 (3.44-3.84) for multiparous *vs*. primiparous cows]. The probability of twin pregnancy was higher in cows previously delivering twins than that in those delivering singles [OR (95% CI)= 3.17 (3.02-3.34) for cows delivering twins *vs*. cows delivering singles]. The lactation curve for cows delivering singles in previous gestation and pregnant with twins in subsequent gestation tended to be lower and flatter. The incidence of twin pregnancy was increased as the cow reached its peak yield earlier, and produced more milk at peak lactation. Primiparous cows delivering singletons in their previous gestation and having twins in their subsequent gestation produced more 100-d, 200-d and 305-d milk than those pregnant with singletons. Multiparous cows that delivered singleton in previous gestation and were pregnant with twin in the subsequent gestation, produced more milk during the first 100-d and 200-d of lactation than those pregnant with singles.

KEY WORDS Holstein cow, incomplete gamma function, lactation curve, twining.

## INTRODUCTION

Intensive genetic selection for increased milk production during the last few decades has been associated with an increase in the incidence of twin births in dairy cows (Kinsel *et al*. 1998; Wiltbank *et al*. 2000; Silva del Rio *et al*. 2007). Twin birth is an undesirable trait in dairy cows because of the high incidence of freemartinism in the heifers amongst the fraternal twins, and the lowered reproductive efficiency (Kinsel *et al*. 1998; Fricke and Wiltbank, 1999; Bell and Roberts, 2007). Cows delivering twins have a longer average days open, need more services per calf born, show higher risks of dystocia, stillbirth, ketosis, and displaced abomasum, and experience a greater rate of culling than those delivering a single calf (Bell and Roberts, 2007). Neonatal mortality and reduced birth weight are also greater among twins compared with singleton calves (Silva del Rio *et al*. 2007). The risk factors for twinning, as a complex and multifactorial trait, include multiple ovulation rate, age of dam, breeding season, level of milk production, herd management, parity and genetics (Kinsel *et al*. 1998; Fricke and Wiltbank, 1999; Bell and Roberts, 2007; Silva del Rio *et al*. 2007). There are very few comprehensive studies on the association of pregnancy type (single *vs*. twin) with lactation performance and lactation curve characteristics in Holstein dairy cows. Additionally, although there are many reports on the association between birth type (single *vs*. double) and milk production, the data are contradictory (Bell and Roberts, 2007). The use of mathematical models describing the lactation curve may enable researchers to determine the association patterns of birth type and pregnancy type with lactation performance more accurately and with more detail. The objective of this study was to investigate the association of birth type and pregnancy type with lactation performance and lactation curve in Holstein cows in Iran.

## MATERIALS AND METHODS

Data used in this study were records on Holstein cows collected during January 2000 to December 2012 by the Animal Breeding Center of Iran (Karaj, Iran). The evaluated herds were purebred Holsteins and were under official performance and pedigree recording. Monthly milk yield was recorded by trained technicians of the Animal Breeding Center of Iran, according to the guidelines of the International Committee for Animal Recording (ICAR, 2011).

First calving ages was calculated as the difference between the birth and first calving dates and was restricted to the range of 540 to 1200 d. Test-day records before 6 d or after 320 d of calving were excluded, and cows were required to have a minimum of five test-day records per lactation. The final data set used to describe the lactation curve consisted of 2516906 test-day records from 274927 lactations on 150442 cows distributed in 261 herds.

To describe the lactation curve and associated production characteristics, the incomplete gamma function proposed by Wood (1967) was used. The function was as follows:

$$y_t = at^b e^{-ct}$$

Where:

$y_t$: daily milk yield in days in milk (DIM) *t*, the variable *t* represents the length of time since calving.

*e*: Neper number.

*a*: parameter to represent yield at the beginning of lactation.

*b* and *c*: factors associated with the upward and downward slopes of the curve, respectively.

In this study, the incomplete gamma function was transformed logarithmically into a linear form as: $\ln(y_t) = \ln(a) + b \ln(t) - ct$ and fitted to monthly lactation yield records using a simple program written in Visual Basic (Microsoft Corp., Redmond, WA).

The DIM at peak production ($T_{max}$) was defined as: $T_{max}$= (b/c) expected maximum yield ($y_{max}$) was calculated as: $y_{max} = a(b/c)^b e^{-b}$ persistency was calculated as: s= -(b+1) ln(c) and total yield from the calving up to 100, 200 and 305 DIM was calculated as:

$$y = a \int_1^n t^b e^{-ct} dt$$

Where:

n= 100, 200 and 305, respectively.

Typical lactation curves have positive *a*, *b*, and *c*, and curves with negative *a*, *b*, or *c* were considered atypical. In this study, of 274927 lactations, 31629 lactation curves were atypical and excluded. Therefore, 2247238 test-day milk records corresponding to 243298 lactations on 138021 cows in 261 herds were used to determine the association of birth type and pregnancy type with lactation performance and lactation curve, partial and 305-d lactation performance. Data on parity number were classified into two categories: primiparous (n=108916) and multiparous (n=134382). Data on birth type (single *vs*. double) and pregnancy type (single *vs*. double) were categorized into the following four classes. Cows giving birth to a single calf previously and pregnant with single in subsequent gestation (SS), cows delivering single in previous gestation and pregnant with double in subsequent gestation (SD), cows delivering double previously and pregnant with single in subsequent gestation (DS), cows giving double previously and pregnant with double in subsequent gestation (DD). The association of birth type (single vs. double) and pregnancy type (single *vs*. double) with the parameters describing the lactation curve, and partial and 305-d lactation performance was determined using multiple regression mixed models in PROC MIXED (SAS, 1999). The factors of birth type and pregnancy type were included in the models as a 3-way interaction with parity (primiparous and multiparous), along with the effect of HYS (herd-calving year-calving season combination), covariate effect of age at first calving, and random effect of dam's sire.

## RESULTS AND DISCUSSION

In this study, 11.50 % of all lactations (31629 of 274927 lactations) were atypical and excluded from the analysis. The average (±SE) squared multiple correlation coefficient ($R^2$) of the log-transformed gamma function varied from 59.77 (±0.07) for the primiparous to 76.12 (±0.07) for multiparous cows. Primiparous cows showed the lowest peak and lactation yields, highest persistency, reached their peak production later and tended to have flatter lactation curves than multiparous cows. Descriptive statistics of birth type (single *vs*. double) and twin pregnancy (single *vs*. double) by parity (primiparous *vs*. multiparous) are presented in Table 1. The average twin birth was 3.64% and ranged from 1.44% (primiparous) to 5.41% (multiparous). Factors associated with birth type (single vs. double) were calving season, calving year, herd, and parity (P<0.05). The rate of twinning increased from 2.49% in 2000 to 3.42% in 2012. The probability of twin birth was higher in multiparous cows than that in primiparous cows [OR (95% CI)= 3.64 (3.44-3.84) for multiparous cows *vs*. primiparous cows].

The factors associated with pregnancy type (single *vs*. double) were calving season, calving year, herd, parity, birth type in previous gestation, milk yield at the beginning of lactation, the upward slope of lactation curve, milk production at peak time, and milk production in the first 100-d of lactation (P<0.05). The probability of twin pregnancy was higher in multiparous cows than in primiparous cows [OR (95% CI)= 1.18 (1.15-1.22) for multiparous cows *vs*. primiparous cows]. The probability of twin pregnancy was associated with previous birth type where twin pregnancy incidence was higher in cows previously giving twins than in cows previously giving single calves [OR (95% CI)= 3.17 (3.02-3.34) for cows delivering double *vs*. cows delivering single]. A significant interaction was found among birth type (single *vs*. double), pregnancy type (single *vs*. double), and parity for the lactation performance and the lactation curve parameters (Tables 2 and 3). The shape of lactation curve for cows (especially multiparous cows) in the SD class (cows giving singles previously and pregnant with twins in the subsequent gestation) tended to be lower and flatter (Figures 1 and 2). The cows delivering singles had higher milk yield at the beginning of lactation than those gave birth to twins (P<0.05). For cows giving birth to a single calf, the lower yield at the beginning of lactation was associated with higher incidence of twin pregnancy in next gestation (Table 2). The upward slope of the lactation curve was lower for cows delivering singles than in those delivering twins (P<0.05). For cows delivering a single calf, the lower upward slope of the lactation curve was associated with a higher incidence of twin pregnancies in the subsequent gestation (Table 2). The downward slope of lactation curve was higher in cows pregnant with twins than that in those pregnant with singletons (P<0.05). The results revealed a higher downward slope of lactation curve for cows in the SD class. Primiparous cows pregnant with twins had a lower lactation persistency than the primiparous cows carrying singles (P<0.05). Likewise, multiparous DD cows had a lower lactation persistency, and the DS cows had the highest lactation persistency (Table 2). The incidence of twin pregnancy tended to increase as cows reached their peak daily yields earlier and produced more milk at their peak (P<0.05). Primiparous SD cows produced more 100-d, 200-d, and 305-d milk than did primiparous SS cows; however, no significant difference was found for 305-d fat and protein production or 201-305-d milk production.

The primiparous DD cows, produced more 100-d milk, than the primiparous DS cows did (P<0.05). The multiparous SD cows produced more milk during the first 100-d and 200-d of lactation than multiparous SS cows. Similar pattern was found for multiparous cows delivering twins, whereas multiparous DD cows produced more milk during the first 100-d and 200-d of lactation than multiparous DS cows (Table 3). Multiparous cows delivering singles produced more 305-d milk, fat, and protein compared with those giving birth to twin calves (P<0.05).

In this study, 11.50% of 274927 lactations were atypical (*a*, *b* or *c* with negative values), characterized by the absence of a lactation peak. Rekik *et al*. (2003) reported 15% to 42% atypical curves in Tunisian dairy herds. The percent of atypical lactation curve in Holstein dairy cows in turkey ranged from 26.3 to 31.2% (Tekerli *et al*. 2000; Yilmaz and Kaygisiz, 2000). Kaygisiz (1999) reported 42% atypical lactation curve in Yellow and White cows. Atashi *et al.* (2013) reported 13.12% (of 85816 lactations) atypical curves in Holstein dairy cows of Iran. Macciotta *et al.* (2006) considered the time from calving to the first recorded test as the most important factor affecting the incidence of atypical lactation curves. The average (±SE) squared multiple correlation coefficients ($R^2$) of the log-transformed gamma function varied from 59.77% (±0.07) for the primiparous to 76.12% (±0.07) for multiparous cows which is in agreement with previous studies (Shanks *et al.* 1981; Tekerli *et al*. 2000).

The lowest peak and lactation yield but the highest lactation persistency was found during the first lactation. First parity cows also reached their peak of production later and tended to have flatter lactation curve than multiparous cows. Similar findings were reported earlier (Rao and Sundaresan, 1979; Keown *et al*. 1986; Tekerli *et al*. 2000). Rao and Sundaresan (1979) reported that the milk secretory tissue in primiparous animals takes longer to reach its peak activity than in multiparous animals. The average twinning rate of 3.64%, ranging from 1.44 (primiparous) to 5.41 (multiparous), was comparable to the values reported by other researchers (Fricke and Wiltbank, 1999; Silva del Rio *et al*. 2007).

For example, Silva del Rio *et al.* (2007) reported that mean twinning rate was 4.2%, and ranged from 1.2% to 5.8% in primiparous and multiparous cows, respectively. The probability of twin pregnancy was higher in cows previously delivered twins than that in those delivered singles; in a close agreement with previous studies (Nielen *et al.* 1989; Silva del Rio *et al*. 2007).

**Table 1** Descriptive statistics of twin birth and twin pregnancy by parity for 243298 lactations of 138021 Holstein cows calving between 2000 and 2012 in Iran*

| Parity | Number | Birth type | Number | Single pregnancy | Double pregnancy |
|---|---|---|---|---|---|
| Primiparous | 108916 | Single | 107344 (98.56) | 102952 (94.52) | 4392 (4.03) |
| | | Double | 1572 (1.44) | 1049 (0.96) | 523 (0.48) |
| Multiparous | 134382 | Single | 127110 (94.59) | 120103 (89.37) | 7007 (5.21) |
| | | Double | 7272 (5.41) | 6311 (4.70) | 961 (0.72) |

* Numbers in parentheses are percentages.

**Table 2** Association of twin birth and twin pregnancy with the parameters of lactation curve[1] in primiparous and multiparous Holstein cows (n=243298)

| Parity | Birth type (single *vs*. double) and pregnancy type (single *vs*. double)[2] | ln(a)[3] | b[4] | c[5] | s[6] | Peak yield (kg)[7] | Peak time (day)[8] |
|---|---|---|---|---|---|---|---|
| Primiparous | SS | 2.61 (0.003)$^{a}$ | 0.260 (0.0009)$^{c}$ | 0.002969 (0.000015)$^{b}$ | 7.49 (0.0028)$^{b}$ | 34.50 (0.04)$^{b}$ | 91.80 (0.16)$^{b}$ |
| | SD | 2.59 (0.011)$^{b}$ | 0.272 (0.0030)$^{b}$ | 0.003188 (0.000039)$^{a}$ | 7.46 (0.0092)$^{c}$ | 35.02 (0.09)$^{a}$ | 89.38 (0.48)$^{c}$ |
| | DS | 2.49 (0.022)$^{c}$ | 0.287 (0.0061)$^{a}$ | 0.003079 (0.000079)$^{ab}$ | 7.60 (0.190)$^{a}$ | 34.46 (0.18)$^{b}$ | 97.90 (0.98)$^{a}$ |
| | DD | 2.53 (0.041)$^{bc}$ | 0.290 (0.0115)$^{ab}$ | 0.003305 (0.000153)$^{a}$ | 7.50 (0.350)$^{bc}$ | 35.25 (0.35)$^{a}$ | 90.23 (1.83)$^{bc}$ |
| Multiparous | SS | 2.79 (0.003)$^{a}$ | 0.295 (0.0009)$^{c}$ | 0.004957 (0.000015)$^{c}$ | 6.98 (0.0029)$^{c}$ | 42.27 (0.04)$^{c}$ | 58.70 (0.16)$^{b}$ |
| | SD | 2.75 (0.009)$^{b}$ | 0.320 (0.0024)$^{b}$ | 0.005395 (0.000033)$^{a}$ | 6.98 (0.0075)$^{c}$ | 43.19 (0.08)$^{a}$ | 57.66 (0.39)$^{c}$ |
| | DS | 2.63 (0.009)$^{c}$ | 0.333 (0.0026)$^{a}$ | 0.005157 (0.000034)$^{b}$ | 7.12 (0.0081)$^{a}$ | 41.47 (0.8)$^{c}$ | 63.67 (0.42)$^{a}$ |
| | DD | 2.66 (0.022)$^{c}$ | 0.338 (0.0063)$^{a}$ | 0.005523 (0.000081)$^{a}$ | 7.04 (0.0195)$^{b}$ | 42.99 (0.19)$^{b}$ | 59.95 (1.00)$^{b}$ |

The means within the same column with at least one common letter, do not have significant difference (P>0.05).

[1] Modeled as: $\ln(y_t) = \ln(a) + b\ln(t) - ct$

Where:

*y*: daily milk yield in DIM *t*, the variable *t* represents the length of time since calving.

*e*: Neper number.

*a*: parameter to represent yield at the beginning of lactation.

*b* and *c*: factors associated with the upward and downward slopes of the curve, respectively.

[2] Data on birth type (single *vs*. double) and pregnancy type (single *vs*. double) were categorized into four classes: cows giving birth to a single calf previously and pregnant with single in subsequent gestation (SS); cows delivering single in previous gestation and pregnant with double in subsequent gestation (SD); cows delivering double previously and pregnant with single in subsequent gestation (DS) and cows giving double previously and pregnant with double in subsequent gestation (DD).

[3] Parameter to represent yield at the beginning of lactation.

[4] Parameter associated with the inclining slope of the lactation curve.

[5] Factors associated with the declining slopes of the lactation curve.

[6] Persistency, calculated as: $s = -(b+1)\ln(t)$.

[7] Days in milk (DIM) at peak yield, calculated as: (b/c).

[8] Peak yield calculated as: $a(b/c)^b e^{-b}$.

**Table 3** Association of twin birth and twin pregnancy with partial and 305-d milk yield, 305-d milk fat and 305-d protein yield in primiparous and multiparous Holstein cows (n=243298)

| Parity | Birth type (single *vs*. double) and pregnancy type (single *vs*. double)[1] | 100-d milk (kg)[2] | 200-d milk (kg)[3] | 305-d milk (kg)[4] | 101-200-d milk (kg)[5] | 201-305-d milk (kg)[6] | 305-d fat (kg) | 305-d protein (kg) |
|---|---|---|---|---|---|---|---|---|
| Primiparous | SS | 3105 (3.4)$^{b}$ | 6342 (7.1)$^{b}$ | 9263 (11.6)$^{b}$ | 3238 (4.1)$^{b}$ | 2922 (5.2)$^{a}$ | 257.8 (0.37)$^{ab}$ | 244.9 (0.35)$^{a}$ |
| | SD | 3148 (8.9)$^{a}$ | 6411 (16.7)$^{a}$ | 9312 (25.7)$^{a}$ | 3264 (9.1)$^{a}$ | 2902 (11.1)$^{a}$ | 259.2 (0.90)$^{a}$ | 246.1 (0.81)$^{a}$ |
| | DS | 3056 (17.8)$^{c}$ | 6305 (32.8)$^{b}$ | 9238 (50.1)$^{ab}$ | 3251 (17.1)$^{ab}$ | 2935 (21.6)$^{a}$ | 254.5 (1.75)$^{b}$ | 245.1 (1.67)$^{a}$ |
| | DD | 3145 (33.2)$^{ab}$ | 6434 (61.2)$^{ab}$ | 9340 (93.1)$^{ab}$ | 3290 (33.1)$^{ab}$ | 2908 (40.0)$^{a}$ | 255.9 (4.72)$^{ab}$ | 242.0 (4.37)$^{a}$ |
| Multiparous | SS | 3868 (3.5)$^{b}$ | 7353 (7.2)$^{b}$ | 10023 (11.8)$^{a}$ | 3486 (4.1)$^{a}$ | 2971 (5.3)$^{a}$ | 288.9 (0.370)$^{a}$ | 275.4 (0.35)$^{a}$ |
| | SD | 3933 (7.3)$^{a}$ | 7429 (13.8)$^{a}$ | 10021 (21.5)$^{a}$ | 3498 (7.6)$^{a}$ | 2592 (9.3)$^{c}$ | 288.8 (0.74)$^{a}$ | 275.6 (0.65)$^{ab}$ |
| | DS | 3751 (7.8)$^{c}$ | 7212 (14.7)$^{c}$ | 9856 (22.8)$^{b}$ | 3463 (8.1)$^{b}$ | 2645 (9.9)$^{b}$ | 282.5 (0.80)$^{b}$ | 274.0 (0.70)$^{b}$ |
| | DD | 3865 (18.3)$^{b}$ | 7331 (33.7)$^{b}$ | 9883 (51.4)$^{b}$ | 3467 (18.3)$^{ab}$ | 2553 (22.1)$^{c}$ | 281.0 (1.86)$^{b}$ | 274.5 (1.62)$^{ab}$ |

The means within the same column with at least one common letter, do not have significant difference (P>0.05).

[1] Data on birth type (single *vs*. double) and pregnancy type (single *vs*. double) were categorized into four classes: cows giving birth to a single calf previously and pregnant with single in subsequent gestation (SS); cows delivering single in previous gestation and pregnant with double in subsequent gestation (SD); cows delivering double previously and pregnant with single in subsequent gestation (DS) and cows giving double previously and pregnant with double in subsequent gestation (DD).

[2] Total yield from calving up to days in milk (DIM) of 100 calculated as: $y = a\int_1^{100} t^b e^{-ct} dt$.

[3] Total yield from calving up to DIM of 200 calculated as: $y = a\int_1^{200} t^b e^{-ct} dt$.

[4] Total yield from calving up to DIM of 305 calculated as: $y = a\int_1^{305} t^b e^{-ct} dt$.

[5] Total yield from DIM of 101 up to DIM of 200 calculated as: $y = a\int_{101}^{200} t^b e^{-ct} dt$.

[6] Total yield from DIM of 201 up to DIM of 305 calculated as: $y = a\int_{201}^{305} t^b e^{-ct} dt$.

The rate of twinning increased from 2.49% in 2000 to 3.42% in 2012, being in close agreement with previously reported values (Kinsel *et al*. 1998; Wiltbank *et al*. 2000; Silva del Rio *et al*. 2007). It has been reported that twinning was related to the level of milk production, therefore increased twinning rate is not unexpected considering the annual increases in milk production per cow that have occurred over this time (Ron *et al*. 1990; Fricke and Wiltbank, 1999; Wiltbank *et al*. 2000; Atashi *et al*. 2012). Multiparous cows delivering single produced more 305-d milk than those delivering twins. In contrast, Bell and Roberts (2007) reported that there were no significant differences between twin and single delivering cow's daily milk yield, total milk yield and milk fat and protein composition during early, mid and late lactation.

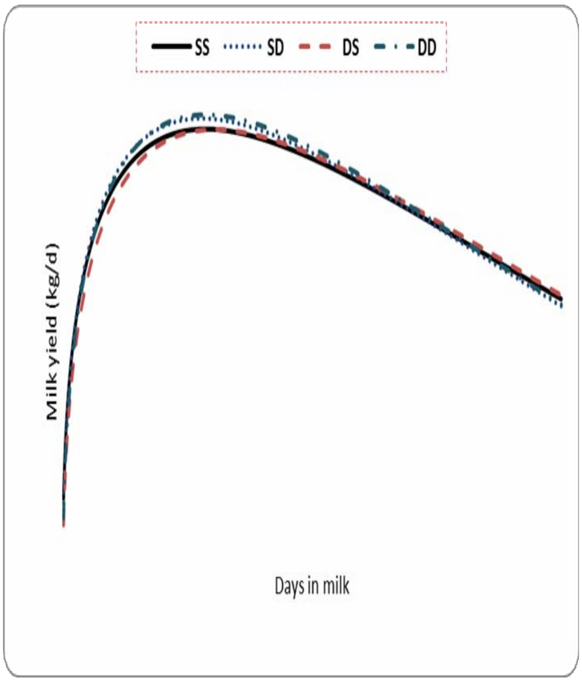


**Figure 1** Lactation curves of primiparous cows in different classes of birth type and pregnancy type
Data on birth type (single *vs*. double) and pregnancy type (single *vs*. double) were categorized into four classes: cows giving birth to a single calf previously and pregnant with single in subsequent gestation (SS), cows delivering single in previous gestation and pregnant with double in subsequent gestation (SD), cows delivering double previously and pregnant with single in subsequent gestation (DS) and cows giving double previously and pregnant with double in subsequent gestation (DD)

The factor associated with the downward slope of the lactation curve was higher in cows pregnant with twins than that in those pregnant with singles. Lactating primiparous cows pregnant with twins had lower lactation persistency than primiparous cows pregnant with singles. The results showed that the incidence of twin pregnancy tended to increase as cows reached their peak daily yields earlier, and produced more milk at peak lactation.

Likewise, cows pregnant with twins produced more milk during the first and second 100-d of lactation compared with those pregnant with singles.

Syrstad (1974) reported that cows pregnant with twins had a higher peak yield but less lactation persistency than those pregnant with singles.

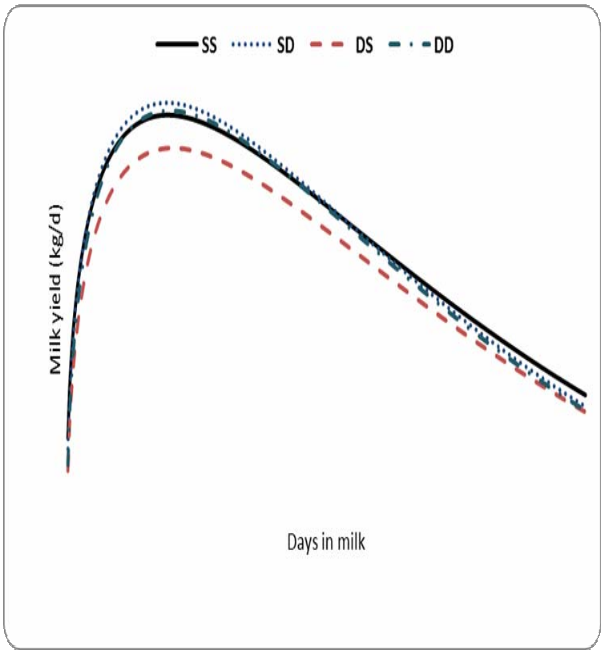


**Figure 2** Lactation curves of multiparous cows in different classes of birth type and pregnancy type
Data on birth type (single *vs*. double) and pregnancy type (single *vs*. double) were categorized into four classes: cows giving birth to a single calf previously and pregnant with single in subsequent gestation (SS), cows delivering single in previous gestation and pregnant with double in subsequent gestation (SD), cows delivering double previously and pregnant with single in subsequent gestation (DS) and cows giving double previously and pregnant with double in subsequent gestation (DD)

Nielen *et al.* (1989) found that high cumulative milk production and peak yield were strongly associated with increased likelihood of twinning. Kinsel *et al*. (1998) reported that peak yield was a major risk factor for increased twinning rates in lactating dairy cows. Fricke and Wiltbank (1999) reported that the incidence of double ovulations was higher in high milk producing herds than that in low producing herds. Lopez *et al*. (2005) reported that the level of milk production for the 14 d preceding estrus was associated with increased incidence of multiple ovulations. Although there are a strong association between milk production and twinning rate, it is the milk production in two weeks before ovulation (milk production around the peak time), not necessarily overall production throughout a given lactation that might affect the twinning rate. Peak milk production can be affected by several factors, including energy density of the diet; therefore, a possible explanation of this association is the enhancement of double ovulation caused by high-energy diets. However, Bell and Roberts (2007) investigating the effect of high-concentrate diet vs. low-concentrate diets, reported no effect of the diet on twinning rate. According to Wiltbank *et al*. (2000), high milk production is closely associated with high dry matter intake (DMI), which, in turns results in greater blood flow to the digestive system, including the liver. Increased liver blood flow would increase the catabolism of the steroids which may contribute to an increase in circulating FSH levels and formation of more dominant follicles (Wiltbank *et al*. 2000; Lopez *et al*. 2005). However, more research is needed to clarify this phenomenon.

## CONCLUSION

The overall twinning rate was 3.64% and ranged from 1.44% (primiparous) to 5.41% (multiparous). The phenotypic rate of twinning increased from 2.49% in 2000 to 3.42% in 2012. The probability of twin pregnancy was higher in cows previously delivering twins than that in those delivering singles. Birth type (single *vs*. double) affected the lactation performance as cows delivering single calves produced more 100-d and 305-d milk than those delivering twins. The most important finding of this study was that the incidence of twin pregnancy tended to increase as cows reached their peak daily yield earlier, and produced more milk at peak lactation. Likewise, the cows pregnant with twins produced more milk during their first and second 100-d of lactation compared with those bearing singletons.

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