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Reproductive performance of crossbred dairy cows under smallholder production system in Kurdistan province of Iran

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The sustainability and improving of milk production and the profitability of smallholder dairy units require integrated assessment of reproductive performance. The purpose of this study is to identify reproductive performance, and genetic and non-genetic factors affecting the performance of Kurdi crosses with Holstein and Brown Swiss, developed in recent years, under rural smallholder management. The cross breeding data were related to 210 herds, 885 cows and 970 calving intervals from two calving periods of 1998–2001 and 2004–2007. The traits of interest were age at first calving (AFC), days open (DO), gestation length (GL) and calving interval (CI). The means of AFC, DO, GL and CI were 28 months and 113, 277 and 390 days for crossbreds. In contrast to the sire breed, exotic gene percentage significantly influenced all traits ($p < 0.01$). DO, GL and CI were tested and no significant differences were found for the regions and calving periods. Season of calving significantly influenced next DO ($p < 0.05$) and GL ($p < 0.01$). Parity number had significant effect on next DO, GL and CI ($p < 0.01$). DO and CI have relatively desirable values in $<75\%$ crosses; on the contrary, $\geq 75\%$ crossbreds have unacceptable means for these traits. For upgrading to $\geq 75\%$, the appropriate management practices (housing, nutrition and reproduction) must be considered to reduce postpartum anoestrus and service periods. Moreover, some research to determine more effective factors on DO must be conducted.

Keywords: crossbred cows; Iranian Kurdi cows; reproductive traits; rural condition; smallholder

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1. Introduction

Increasing the milk production is one of the major policies of the Ministry of Agriculture in Iran. According to the noticeable population of indigenous cattle (6,783,000 heads in 1994), cross breeding projects of dairy cows have been developed in recent two decades in the country. In Kurdistan province, the national and provincial projects have been started since 1993 and 2000, respectively. Accordingly, crossbred dairy cattle population of the province has been increased from 12,000 heads in 1994 to more than 36,000 heads in 2007 (Agricultural Jihad Organization of Kurdistan 2008). Artificial inseminations using Holstein and Brown Swiss sperms and subsequently natural mating among crossbreds and Kurdi cattle have produced crossbred cattle with different exotic gene percentages.

Reproductive efficiency has an important role in breeding efficacy and milk production of cows. Genetic progress is dependent on having enough heifers for replacing old cows. For optimised calving rate and highest profitability, the annual producing of a live healthy calf is necessary by any matter (Peters and Ball 1995). Having more than 365 days calving interval (CI) will be followed by the remarkable economic losses (Esslemont et al. 2000; Kafi et al. 2007). To achieve 365 days CI, average days between calving to pregnancy (days open (DO)) must be 80–85 days (Peters and Ball 1995). Reproductive performance depends partly on milk production. Several studies suggest that the effects of milk production can only be observed in high-producing dairy cows (Lucy 2001). Other factors affecting the reproductive performance have been reported as production system, disease, calving season, parity, calving year, exotic gene and its percentage in crossbred cows (Silva et al. 1992; Shiferaw et al. 2003; Lobago et al. 2006; Asimwe and Kifaro 2007; Abraha et al. 2009). The reduction in reproductive performance by increasing the percent of exotic gene has been reported in a few researches (Roy et al. 1993; Naji 1996; Teodoro and Madalena 2003; Asimwe and Kifaro 2007).

So far, only a few studies have been conducted to determine production and reproductive performance of crossbred cows under rural conditions in Iran. Production and reproductive performance of crossbred Golpaiegani cows (Naji 1996) and production performance of crossbred Kurdi cows (Rashidi et al. 2002) under rural smallholder dairying have been investigated. Based on the results of later

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research, lactation milk yield of Brown Swiss × Kurdi and Holstein × Kurdi cows were 1792 and 1989 Kg that compared with Kurdi milk production were increased by 23.92% and 37.51%, respectively.

The sustainability and improving of milk production and the profitability of smallholder dairy units require integrated assessment of reproductive performance and the factors affecting it. The purpose of this study is to identify reproductive performance, and genetic and non-genetic factors affecting the performance in Kurdi crossbreds with specific gene contents under rural condition.

2. Materials and mathods

2.1. Study area

This study was carried out in Kurdistan province in the western of Iran. Kurdistan lies between 45°33′11″ and 51°13′7″ eastern longitude and between 34°24′16″ and 37°52′12″ northern latitude. The province contains two separable, plain and mountain, regions. Plain region is covered in view of the extent with agricultural lands and pasture area. Dry and irrigated farming of forage and grain are performed in agricultural lands, and pasture area is mostly covered by Astragalus-Agropyron type, respectively (Management and Planning Organization of Kurdistan (MPOK) 1996; Ghasryani 1999). In view of land type, the region includes piedmont plains and plateaus and upper terraces (MPOK 1996). The prevailing climate is cold semi-arid (Mohammadi et al. 2008). In contrast, mountain region is mostly covered with pasture area including Astragalus – psathyrotachys and Ferula-prangos types, and dry-farming of grains is often performed in agricultural lands (MPOK 1996; Ghasryani 1999). Its land type is mountains and hills (MPOK 1996), and the prevailing climate is cold semi-humid (Mohammadi et al. 2008). Priority of mountain region is animal husbandry in contrast to farming in another region.

2.2. Animals and their management

Kurdi cattle are native to the Kurdistan provinces of Iran and Iraq. This breed is small in size with a short horn and has no hump. Its body is black and brown with bright spots on the belly area, feet and face. Low milk production (1446 kg) is reported during their lactation period. In two recent decades, cross breeding has been developed, and crossbred cows with different exotic gene percentages have been distributed overall the province. They are kept in the average number of 3–4 heads in small units under rural conditions. In both regions, cattle are grazed about 7–8 months on pastures and post-harvest agricultural lands, and receive supplementary feed in cold months. Their hygienic and nutritional condition is unsuitable. However, some improvements in housing and feeding are observed in units that have crossbreds (Rashidi et al. 2002; Kakakhani et al. 2004).

2.3. Data collection

The data were related to Kurdi crosses with Holstein and Brown Swiss breeds. Reproduction data of crossbred cows with known gene percentage were chosen using the information from the registration, insemination and calving forms of the cross breeding project conducted by Agricultural Jihad Organization of Kurdistan. The cross-breeding data were related to 210 herds, 885 cows and 970 CIs from two calving periods of 1998–2001 and 2004–2007. In cross breeding project, herds were randomly selected for data collection. The following informations were derived from the data: age at first calving (AFC) as the number of months from birth date to first calving date, DO as the interval in days between calving and conception, gestation length (GL) as the interval in days between conception and next calving and CI as the interval in days between two consecutive calving.

2.4. Data analysis

The levels of fixed effects were determined for statistical analysis. Two sire breeds of Holstein and Brown Swiss and five exotic gene percentages of 25%, 37.5%, 50%, 62.5% and $\geq$75% were identified. Only a few cows had above 75% exotic gene added to the latest group. The province divided into two plain and mountain regions. The years of calving were grouped into two periods of calving, that is, 1998–2001 and 2004–2007. Calving was distributed in four seasons of spring, summer, autumn and winter. Further, all parturition numbers were classified into four groups of 1, 2, 3 and $\geq$4. All parities above four were pooled together in parity four because only a few cows that had completed more than five lactations.

Statistical analysis of data was performed by SPSS software (SPSS version 16, 2007). The General Linear Models procedure was used to assess the fixed effects on the dependent variables. Primary model to analyse DO, GL and CI was a variance model with fixed effects of sire breed, exotic gene percentage, region, calving period, season and parity number, and primary model to analyse AFC was a variance model with fixed effects of sire breed, exotic gene percentage, region and calving period. Owing to the advantage of Scheffe method for comprising levels with unequal

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records (Winer 1971), least square means from significant effects were compared by this method.

3. Results

3.1. Reproductive performance

The least square means of AFC, DO, GL and CI for crossbred cows were 27.9 ± 5.4 months and 113.16 ± 47.3, 277.02 ± 6.9 and 390.19 ± 47.1 days, respectively.

3.2. Factors affecting reproductive performance of crossbred cows

There was no significant difference ($p > 0.05$) in view of reproductive performance between crossbred cows with Holstein and Brown Swiss bloods. Exotic gene percentage significantly ($p < 0.01$) influenced all traits. Increase of exotic gene percentage resulted in decreasing AFC and in increasing DO and CI. The maximum AFC was related to 25% and 50% exotic gene groups, whereas the minimum value was related to $\geq 75\%$ group. Crossbreds with $\geq 75\%$ exotic gene had significantly more DO and CI than the other groups ($p < 0.01$). The lowest GL was related to 25% group, whereas the highest value was related to 50% and $\geq 75\%$ groups. Different regions had no effect on DO, GL and CI, but AFC was significantly higher ($p < 0.01$) in plain region than mountain region. All traits were tested and no significant differences were found for the calving periods ($p > 0.05$). The season of calving significantly influenced next DO ($p < 0.05$) and GL ($p < 0.01$). The CI consistent with DO was changed, but it was not significant. The maximum and minimum values for DO were related to the summer and winter times, respectively. Whereas, the maximum and minimum values for GL were belong to the winter and summer seasons, respectively. Parity number had significant effect on next DO, GL and CI ($p < 0.01$). The lowest DO and CI were related to ≥ 4 parity group (Table 1).

4. Discussion

The mean value for AFC estimated in this study (28 months) for crossbred cows was similar to the value reported by Ansari-Lari et al. (2009) for Iranian Holstein cows in Fars Province. However, it was higher than 26 months reported by Naji (1996) for Golpayegani crosses by Brown Swiss and Holstein, and was lower than the ones (from 35 to 47 months) reported by Shiferaw et al. (2003), Asimwe and Kifaro (2007) and Abraha et al. (2009) for Bos Taurus/Bos Indicus crosses in tropical climates.

There are different findings for the effect of increasing exotic gene percentage on AFC. Increase of Holstein gene percentage in Golpayegani crosses had no effect on AFC, but the trait extended with increasing Brown Swiss gene level in the crosses (Naji 1996). Contradictory to previous report, AFC extended with increasing Holstein Friesian gene percentage in crossbred cows (Asimwe and Kifaro 2007). Similar to the results of current study, AFC reduced by increasing exotic gene percentage in crossbred cows (Taneja and Bhat 1974). Presumably, this reduction was due to more attention to high-grade crossbred heifers that would expect to exhibit faster growth rate and attain higher weights at relatively younger ages in appropriate condition. Unsuitable nutrition of heifers has been found to be the reason for delaying the onset of puberty and consequently to extend AFC in dairy cattle (Schillo 1992). Furthermore, more attention to heifers in mountain region, owing to priority of animal husbandry, probably caused reduction of AFC in this region.

Increasing farmers' experience and knowledge can improve reproductive performance of dairy cows over time through reducing AFC, DO and CI (Asimwe and Kifaro 2007; Ansari-Lari et al. 2009). However, there were no significant differences between different calving periods for reproductive traits in this work.

The average value of 113 days for DO found in this study for crossbred cows was higher than reported by Naji (1996) of 77 days for Golpayegani crosses and the reports of Larsson et al. (1984) and Esslemont and Peeler (1993) of 93–102 and 99 days for improved pure breeds in European countries, respectively. This value is close to reported by Adeli et al. (2009) of 115 days for Iranian Holstein cows and a few reports (Gogoi and Goswmi 1993) for Bos Indicus/Bos Taurus Crosses (123 days). On the other hand, in most reports (Roy et al. 1993; Shiferaw et al. 2003; Lobago et al. 2006; Asimwe and Kifaro 2007), averages (from 185 to 224) for Bos Indicus/Bos Taurus Crosses were higher than our result.

The mean DO value of 113 days compared with the optimum recommended (80–85 days) to achieve the target in 365 days of CI (Peters and Ball 1995) is an unfavourable estimate. Prolongation of postpartum anoestrous interval and service period extends DO. In rural condition of Kurdistan, poor hygienic condition increases the likelihood of occurrence of reproductive abnormalities during parturition. Practice of suckling calves is prolonged, and weaning age of calves is often high. Because of financial circumstances most cows are milked continuously, only being dried off as a result of too little milk production. Therefore, in some cases, cows are dried off even 1 day before parturition (Kakakhani et al. 2004). As a

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Table 1. Least squares mean (± SE) for reproductive traits of Kurdi crossbred cows under smallholder production system in Kurdistan, Iran.

Variables	Number of records	Age at first calving (months)	Number of records	Days open	Gestation length (days)	Calving interval (days)
Breed of sire		NS		NS	NS	NS
Holstein	732	27.9±0.2	785	114±1.7	276.9±0.2	391±1.7
Brown Swiss	153	28±0.4	185	109.5±3.3	277.2±0.5	386.7±3.3
Exotic gene percentage		**		**	**	**
25%	119	29.5±0.5a	127	104.8±3.6b	274.4±0.8b	379.5±3.6bc
37.5%	171	27.3±0.4b	178	106.4±3.5b	276.9±0.6ab	383.3±3.5bc
50%	281	29.4±0.3a	330	112.1±2.7b	277.7±0.3a	389.8±2.7b
62.5%	132	27.7±0.4b	143	97.4±3.1b	276.7±0.6ab	374.2±3.1c
≥75%	182	25.2±0.3c	192	138.5±3.3a	277.7±0.4a	416.2±3.2a
Region		**		NS	NS	NS
Plain	96	30±0.6a	153	110.1±4.4	277.9±0.5	388±4.4
Mountain	789	27.6±0.2b	817	113.7± 1.6	276.8±.2	390.6±1.6
Calving period		NS		NS	NS	NS
1998–2001	675	27.9±0.2	703	112.4±1.8	276.8±0.3	389.2±1.7
2004–2007	210	28±0.2	267	115.2±2.9	277.7±0.4	392.8±2.9
Season of calving				*	**	NS
Spring	–	–	264	111.2±3ab	277.7±0.4ab	388.9±3
Summer	–	–	220	121.1±3.3a	275.8±0.5c	396.9± 3.3
Autumn	–	–	207	113.6±3.3ab	276.1±0.5bc	389.7±3.2
Winter	–	–	279	108.5±2.7b	278±0.4a	386.5±2.6
Parity				**	**	**
1	–	–	305	112±2.6a	277.9±0.4ab	389.9±2.6a
2	–	–	282	119±3a	275.7±0.4c	394.7±3a
3	–	–	198	116.3±3.3a	278.4±0.4a	394.7±3.2a
≥4	–	–	185	102.9±3.3b	276.2±0.5bc	379±3.3b

Note: Least squares means within the same column and category with different letters differ significantly.SE, standard error; NS, not significant.
*Significant at $p < 0.05$, **significant at $p < 0.01$.

result, there is no opportunity to rest and recovery of body resources, and cows may encounter with negative energy balance in early lactation. In spite of access to variable feedstuff, for financial reasons and unawareness of farmers, balanced diets are not used in different practices of animal husbandry (Bahmani et al. 2005). Several reports indicated that postpartum uterine infections and retention of fetal membranes can result in deleterious effects on the subsequent fertility of the cows (Swai et al. 2005). In addition, practice of suckling calves, inadequate nutrition, poor body condition of the cow, or the cow being in negative energy balance could impair the release of luteinising hormone, interfere with the resumption of ovarian activity and subsequently extend anoestrous interval (Lobago et al. 2006; Bishop and Pfeiffer 2008). Moreover, in rural condition of Kurdistan a number of socioeconomic, organisational, technical and biological factors make the service more difficult to provide. The above factors could affect DO and extend its period. Wide range of DO indicates reproductive problems in the investigated farm units. To identify more effective factors on DO, more research must be conducted in the future.

Consistent with this study, increase of Holstein Friesian gene level to more than 50% extended DO in Tanzania (Asimwe and Kifaro 2007). Despite increase of nutritional requirements for ≥75% crossbred cows, inadequate nutrition, especially in early lactation, in addition to excessive milking in previous lactation period may encounter them with problem and delay the onset of reproductive cycling. In tropical climate, wet and dry seasons through the quality and quantity of nutrition affected DO (Asimwe and Kifaro 2007; Lobago et al. 2007). In moderate climate, similar to the results of this research, the lowest and highest DO were related to cold and warm seasons, respectively (Sliva et al. 1992; Devries and Risco 2005; Adeli et al. 2009). Heat stress in warm seasons can extend DO through decreasing plasma concentrations of thyroid hormones (De

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Rensis and Scaramuzzi 2003) and increasing the incidence of retained placenta (Ahmadi and Mirzaei 2006). Decreasing of DO in fourth and upper parities similar to this work has been reported by Lobago et al. (2007) and Asimwe and Kifaro (2007). Cows with high parity number compared with others have probably less physiological stress in early lactation and more adaptability with environmental conditions. Further, this fact should be considered that young cattle are still growing and developing their mammary glands (Ciccioli et al. 2003).

The mean CI estimated in this study (390 days) for crossbred cows was higher than 362 days reported by Rashidi et al. (2002) for Kurdi crosses and reported by Naji (1996) of 357 days for Golpayegani crosses. This value was similar to the values reported by Adeli et al. (2009) and Ansari-Lari et al. (2009) for Iranian Holstein cows in Fars Province and was close to the results of Silva et al. (1992) and Refsdal (2007) for improved pure breeds in the United States and Norway (375 and 401 days) and a few reports (Gogoi and Goswami 1993) for Bos Taurus/Bos Indicus crosses (387 days). In most reports (Roy et al. 1993; Shiferaw et al. 2003; Swai et al. 2005; Lobago et al. 2007; Abraha et al. 2009; Medina et al. 2009), Bos Taurus/Bos Indicus crosses had more values for CI (438–552 days).

For economic dairy production, 365 days are usually an ideal CI (Peters and Ball 1995). Increasing CI from ideal value results in an economic loss in milk production (Safiullah 2001). The average of 390 days in this study was nearly 1 month more than desirable interval. Affecting factors on DO prolonged CI. Similar to the findings of Adeli et al. (2009), high significant correlation ($r = 0.99$) between DO and CI confirmed this conclusion. Similar to DO, the highest CI was related to $\geq 75\%$ bred group. Reduction of reproductive performance along with increasing of exotic gene percentage more than 50% has been reported in crossbred cows (Roy et al. 1993; Naji 1996; Teodoro and Madalena 2003; Asimwe and Kifaro 2007). The less fertility of high-grade crossbred cows, apart from mentioned reasons for increasing of DO, is probably due to the weakness of adaptation traits through decreasing heterozygosis and native gene content of crosses. The highest CI was related to summer calving (397 days) in contrast to winter calving (386 days). The differences among seasons were not significant, but seasonal pattern of CI and DO were alike. CI and DO in different parities had the same trend. These changes were similar to the reports of Asimwe and Kifaro (2007) and Medina et al. (2009). Reduction in CI in higher parities may be the result of improvement in reproduction management and physiological maturation of the older cows.

In conclusion, AFC and CI as indices of reproductive performance had relatively desirable values in $<75\%$ crossbred cows. Of course, owing to existing range of values, there is potential capacity to improve these traits. In view of reproductive performance, regardless of sire breeds, exotic gene level up to 62.5% showed desirable performance. In $\geq 75\%$ crossbred cows, DO and CI had unacceptable means of 138 and 416 days, respectively. If the aim is upgrading to $\geq 75\%$, the appropriate management practices (housing, nutrition and reproduction) must be considered to reduce postpartum anoestrus and service periods. Moreover, some research to determine more effective factors on DO must be conducted.

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