Interactions of Breeding Systems and Productive Status of Females with the Month and Year of Breeding and their Effects on Conception Rate and Services per Conception in Holstein Cows

S. S. Khalaf[*] and N. N. AL-Anbari[**]
[*]Dep. of Animal Resources- College of Agriculture/ University of Anbar.
[**]Dep. of Animal Resources- College of Agriculture/University of Baghdad.

Abstract

Breeding records totaling 68844 inseminations at AL-Nasir dairy farm (50 Km South-East of Baghdad) were analyzed to study the interactions between breeding systems and productive status of females with the month and year of breeding and their effects on conception rate (CR) and services per conception (SPC). Data were collected for 10 years from January 1, 1997 to December 31, 2006. Total number of services for lactating (M), dry (D) and virgin heifers (H) and overall means of CR and SPC were 52236, 4503, 12105, 41.65% and 2.61 respectively. In general, CR were not affected significantly ($P < 0.01$) by the interactions of the month x breeding system except for the month of November and December which differed significantly ($P < 0.01$) than artificial insemination (AI) of June and September and both AI and natural service (NS) for August. Highest values of CR for AI and NS were in December and November and lowest values were in August, but CR of AI in August (14.85%) differed significantly ($P < 0.01$) than CR of NS (34.25%) in the same month which indicate a choice of breeding for the hot months of the year. Interactions of productive status of female x month of the year showed that hot months had pronounced effects on CR of M cows but lesser and no effects on CR of D and H respectively. Calculated average CR of hot months (June to September) for M, D, and H were 21.09%, 30.17%, and 56.38%, respectively. Interactions of breeding system x year of breeding revealed overall improvements of CR with successive years for both AI and NS. However, this appeared to be related to improvements in CR of M and D but not in CR of H due to increasing rate of culling of multiparous females. Interactions of breeding system x year of breeding and their effects on SPC indicated general improvements with successive years for both AI and NS. Additionally, interactions of productive status x year of breeding also showed improvement in SPC of M and D but not in SPC of H which again confirm that increasing culling rate of older cows with lower reproductive efficiency led to improvements in SPC with successive years.

التداخلات بين نظام التلقيح والحالة الإنتاجية للإناث مع شهر وسنة التلقيح وتأثيراتها على نسبة الإخصاب وعدد التلقيحات اللازمة للإخصاب في أبقار الهولشتاين

سعدي شعلان خلف[*] ونصر نوري الانباري[**]

[*]قسم الثروة الحيوانية– كلية الزراعة/ جامعة الانبار

[**]قسم الثروة الحيوانية– كلية الزراعة/ جامعة بغداد

الخلاصة

تم تحليل سجلات التناسل المتضمنة 68844 تلقيحة العائدة إلى محطة أبقار النصر (50 كم جنوب شرق بغداد) لدراسة التداخل بين نظام التلقيح (اصطناعي أو طبيعي) والحالة الإنتاجية للإناث (حلوب، جافة أو بكر) مع شهر وسنة التلقيح وتأثيراتها على نسبة الإخصاب وعدد التلقيحات اللازمة للإخصاب في أبقار الهولشتاين للفترة من الأول من كانون الثاني 1997 إلى الواحد والثلاثون من كانون الأول 2006. بلغ مجموع التلقيحات في ألأبقار الحلوب والجافة والأباكير والمعدل العام لنسبة الإخصاب وعدد التلقيحات اللازمة للإخصاب 52236، 4503، 12105، 41.65% و2.61 على التوالي. بشكل عام فان نسبة الإخصاب لم تتأثر معنويا ($P < 0.01$) من التداخل بين شهر التلقيح x نظام التلقيح ماعدا شهري تشرين الثاني وكانون الأول التي اختلفت معنويا ($P < 0.01$) قياسا إلى التلقيح الاصطناعي لشهر حزيران وأيلول وكلا التلقيح الاصطناعي والطبيعي لشهر آب. إن أعلى قيم لنسبة الإخصاب من التلقيح الاصطناعي والطبيعي كانت في شهري كانون الأول وتشرينلثاني وا ن أوطأ القيم كانت في شهر آب، لكن نسبة الإخصاب من التلقيح الاصطناعي لشهر آب (14.85%) اختلفت معنويا ($P< 0.01$) عن نسبة الإخصاب من التلقيح الطبيعي (34.25%)لنفس الشهر مما يدلل على وجود خيار أفضل للتلقيح في اشهر السنة الحارة. التداخل بين الحالة الإنتاجية للإناث x اشهر التلقيح أشارت إلى أن الأشهر الحارة كان لها تأثيرات واضحة على نسبة الإخصاب في الأبقار الحلوب ولكن بدرجة أقل أو بعدم وجود تأثير على كل من الأبقار الجافة والاباكير على التوالي. عند حساب معدل نسبة الإخصاب للأشهر الحارة (حزيران إلى أيلول) للأبقار الحلوب والجافة والاباكير فقد كانت 21.09%، 30.17% و56.38% على التوالي. التداخل بين نظام التلقيح x سنة التلقيح أظهر تحسنا عاما في نسبة الإخصاب مع تقدم سنين التلقيح لكلا نوعي التلقيح، إلا أ ن ذلك يبدو أن له علاقة بالتحسن في نسبة الإخصاب للأبقار الحلوب والجافة وليس للأباكير وهذا يعزى إلى زيادة نسبة الاستبعاد في الإناث الوالدة سابقا. التداخل بين نظام التلقيح x سنة التلقيح وتأثيراته على عدد التلقيحات اللازمة للإخصاب أشار إلى وجود تحسينات عامة مع تقدم سنين التلقيح لكلا نظامي التلقيح. إضافة لذلك فإن التداخل بين الحالة الإنتاجية x سنة التلقيح أظهر أيضا تحسنا في عدد التلقيحات اللازمة للإخصاب للأبقار الحلوب والجافة ولكن ليس في الاباكير مما يعزز مرة أخرى زيادة نسبة الاستبعاد في الأبقار الكبيرة ذات الكفاءة التناسلية المنخفضة أد د إلى التحسن في عدد التلقيحات اللازمة للإخصاب مع تقدم سنين التلقيح.

Introduction

Reproduction has a very important role in the management of dairy cattle especially large dairy herds. Conception rate and services per conception in hot climate have been studied extensively (1,2, 3, 4, 5, 6). In Iraq especially in the middle and the south regions, the hot season start during May until September. During July and August ambient temperatures may reach over 45ºC (1). These high temperatures have carry-over effects on fertility until the months of September and October (7). The cold season is very short and may start as late as the middle of December until the middle of February. In most of the cold days the temperatures are within the normal range for *Bos taurus* breeds of dairy cattle. One of the major obstacle limiting dairy production in Iraq is high environmental temperature and its effects on production and reproduction. Investigations conducted in tropical and subtropical areas indicated lower conception rate and higher services per conception (2, 3, 4, 5, 6). Studies in this country also showed lower conception rate and higher services per conception with increasing environmental temperatures during the hot months of the year (1, 8, 9). In previous report (7) effects of breeding system, year, month of the year and productive status of females on conception rate and services per conception were studied. In this report an attempt was made to further analyze the interactions of breeding systems and productive status of females with the month and year of breeding and their effects on conception rate and services per conception.

Materials and Methods

This study was conducted on data collected from AL-Nasir dairy farm, a privately owned by AL-Bunnia Co. The dairy farm is located 50 Km southeast of Baghdad and its one of the large dairies remaining in this country after the invasion in 2003. The dairy had over 7000 heads of Holstein cattle. Animals are housed in open sheds and offered free choice of green chopped forages and fresh water. Forages consist of sorghum-sudan grass in the summer and clover (*Trifolium alexandrium*) in the winter. Green alfalfa were also fed especially for close-up and newly freshened cows and small female calves. Roughages are fed *ad libitum* based on 1.5 – 2% of body weight as dry matter. Concentrate mixtures also offered according to level of production for lactating cows and other growing criteria for the rest of the herd. Close-up cows are offered about 6 Kg of concentrate mixture 3 weeks precalving. Post-calving, cows are housed in a separate barn for about a week to check their reproductive health status, then they leave to the milking herd. For about the first 60 days in milk all cows are fed high amount of grain mix to replenish their body weights. Thereafter, they will be grouped according to their level of production. Cows are milked twice daily in 2 x 20 x 2 Bou Matic parallel milking parlors. Estrus detection are conducted by trained personnel during day and night times. Artificial inseminations (AI) are performed by experienced inseminators. The dairy also use natural breeding (NS) especially with repeat breeders and when semen is not available because of the conditions of the war. It is worth mentioning that the center of AI in Abu-Ghraib was entirely looted in 2003 and production of frozen semen was completely ceased, so all dairies had to rely on natural insemination until recently. Young bulls used for NS are sons of high producing cows from the same herd and they are checked frequently for their reproductive performance. Lactating cows (M) are inseminated after no less than 45 days postcalving. Virgin heifers (H) are bred naturally or artificially when they weigh 375 Kg of body weight. Dry cows (D) are lactating cows which have long days in milk and dried off as a result of lower milk production, abortion or reproductive failure or aborted pregnant dry cows which are kept for their excellent previous performances. Conception was based on pregnancy diagnosis per rectal palpation at 45 to 60 days post insemination. Data are collected and

tabulated at the farm using Dairy Base™ computer program from Bou Matic. Informations regarding different aspects and activities of the farm are provided by the farm staff and collected by the senior author since 1997. Breeding records which included number of services, conception rates (CR) and services per conception (SPC) are collected on a monthly basis using separate computer programs. Inseminations included in this analysis totaled 68844 from January, 1, 1997 until December, 31, 2006. Analysis of variance for CR and SPC were computed by method of least square means using general linear model procedures of the Statistical Analysis System, SAS, 2001(10).

Results and Discussion

Conception Rates (CR):

Table (1) shows the interaction of breeding system x month of breeding. Overall average CR for months and both types of breeding was 41.63%. This result is lower than that reported by Washburn et al., (11) who found CR of 49.5% for Holstein cows from data collected from 1995 to 1998. However, our observation and those of Washburn et al., (11) are much higher than those of Washburn et al., (12) who reported an average CR of 32% for Holstein during 1997 to 1999. Using the same records (7) average CR for AI (38.46%) was significantly ($P< 0.01$) lower than NS (43.99%). To avoid difficulties related to estrus detection and reducing the cost of inseminators and frozen semen, many dairy farms use natural breeding either immediately after voluntary waiting period (VWP) or after unsuccessful AI period. It may be assumed that pregnancy rates (PR) can be improved when NS is practiced where more cows will be detected in estrus and inseminated. Use of NS as a component of the breeding system in dairy herds varied from 55 to 74% (13, 14). Several studies compared reproductive performance of AI and NS (14, 15, 16, 17). Pregnancy rates obtained from dairy herd records of cows bred by AI or NS were not different (16, 17). Using DHI records, actual calving interval was shorter (an indicator of higher CR) in herds that used NS bulls (14), however overall reproductive efficiency as measured by the percentage of cows in milk and herd milk production was greater for AI herds and declined as the percentage of NS system increased.

A trend of reducing CR with the hot months of the year was reported earlier (7) which was in agreement with others (3, 5, 6, 15). Generally, no significant ($P< 0.01$) effects of the month on the type of breeding were found except for the month of November and December which differed significantly ($P< 0.01$) than AI of June and September and both AI and NS of August. Highest value of CR from AI was observed in November and the lowest value was seen in August. Highest value of CR from NS was found in December and the lowest value was noted in August also. However, CR from NS in August was significantly ($P< 0.01$) higher than CR from AI during the same month. In August CR of NS (34.25%) increased by 131% compared to AI (14.85%). This may indicate that application of NS breeding could be a better alternative for breeding during the hot months of the year. During winter de Vries et al., (15) found that PR were twice as high as those during summer, but the use of NS system resulted in no difference in PR compared to herds that use mainly AI. Selection of the type of breeding system used in dairy herds should be based on the ability of that system to maximize reproductive performance (15). In table (1) CR from NS generally had higher values compared to AI during all months except for July in which no explanation was found for this discrepancy. Heat stress usually affect both AI and NS by reducing duration of estrus and CR (3). In addition, during periods of heat stress natural service

bulls may experience reduced libido, sperm motility and increase numbers of abnormal sperms (18). Ingraham, et al., (5) reported that CR to AI may range from 55% during month of low temperatures and humidity to only 10% during months of high temperatures and humidity. In our study highest and lowest CR for AI and NS were 49.89, 14.85, 50.99 and 34.25, respectively. Increase heat loads at estrus or following insemination increase body temperature which may affect conception (4). Other reports related variations of CR to solar radiation, atmospheric pressure and day length (4, 19, 2). Fertility of dairy cattle was also affected by breed, age, service number and inseminator (4, 21, 22). Contrary to our results, de Vries et al., (15) reported no clear interaction of season x breeding system on pregnancy rate. During winter (November–April) PR for AI herds was 17.9% which did not differ from that of mixed herds (17.8%) and NS herds (18.0%). During summer (May-October) , PR for AI herds was 8.1% which was slightly lower than that of mixed herds (9.3%) and NS herds (9.8%). However, differences in upper and lower ambient temperatures and humidities between the two locations of the studies must be taken into consideration.

Table (1) Interaction of breeding system x month of breeding

Month	Breeding System			
	Total Number of Services = 68844 ; **Average CR** = 41.63%			
	AI		NS	
	Number of Services	CR (%)	Number of Services	CR (%)
January	3203	39.65 abcde	2143	47.03 abc
February	2824	36.86 bcde	1843	46.00 abcd
March	2957	37.58 bcde	2319	47.33 abc
April	2855	37.70 abcde	2145	46.68 abc
May	3214	43.15 abcde	2671	44.52 abcde
June	2406	32.10 de	2310	40.32 abcde
July	2017	42.40 abcde	3059	37.86 abcde
August	2138	14.85 f	3229	34.25 cde
September	3907	30.69 e	3025	38.86 abcde
October	4660	37.82 abcde	2902	45.16 abcd
November	3811	51.90 a	3213	48.84 ab
December	2934	49.89 ab	3059	50.99 ab

- **Means with different letters in columns and rows are significantly (P< 0.01) different.**

Table (2) indicate the interactions of month of breeding x productive status of females. For all months of breeding virgin heifers had highest values of CR and were mostly significantly (P< 0.01) different than CR of M and D cows. Reduced fertility in older cows was related probably to lactational stress and subsequent problems associated with calving in multiparous females (3). In addition, the hot months of the year (June to September) had no pronounced effects on CR of H. Conversely, CR of M were significantly affected during the hot months of the year. Highest values of CR for M cows were seen in December (45.69%) and January (45.35%) but the lowest values appeared during August (13.46%) and July (19.32%). Reduction of CR of lactating cows during the hot season may reflect the added stress of higher environmental temperatures on these females coupled with the stress generated with lactation. In an experiment conducted in subtropical climate, Badinga et al., (3) found sharp decrease in CR of lactating cows when air temperatures on day after insemination exceeded 30º C. Conversely, CR of heifers did not decline until 35º C. Nulliparous heifers had higher CR (50%) than lactating cows (34%) and suffered only slight depression of fertility during summer months. Furthermore, high producing cows such as Holstein are more thermal sensitive (23), thus lactating cows have much lower CR. With respect to dry

cows (D), the hot season also affected their CR but not to the extent of M cows. This fact was apparent during the month of July to September when comparing M with D cows. Although D cows are nonlactating multiparous females and do not suffer from additional lactational stress, their CR did not attain that of virgin heifers. Dry nonpregnant cows are usually repeat breeders and suffer from reproductive failures which may offset having the advantage of not lactating. A gradual decline of CR was observed with increasing service number (3). Average CR for the first service was 56% compared to only 31% for greater than five services. Lower fertility was observed with advancing services that accumulate as cows presented for successive services (24). Further analysis of CR in table (2) for the hot months (June – September) showed a pronounced difference among females. Average CR during the hot months for M, D and H were 21.09, 30.17 and 56.38%. The difference between CR of H and M was 167% whereas, between H and D was 87% and between D and M was only 43%. This further indicates that the hot season has less effects on non-lactating compared to lactating multiparous cows. For virgin heifers, the average CR of the hot months (56.38%) and other months of the year (56.16%) indicated no effect of heat stress on CR compared to parous cows. Lactation represents a significant thermal load on dairy cows (3). Lowered fertility following exposure of females to high environmental temperatures may be associated with detrimental effects of ambient heat on developing embryos (25).

Table (2) Interactions of month of the year x productive status of female

Month	Productive Status of Female					
	M		D		H	
	Number Of Services	CR (%)	Number Of Services	CR (%)	Number Of Services	CR (%)
January	4405	45.35 cdefg	460	32.87 fghij	481	55.55 abc
February	3759	43.03 cdefghi	414	36.06 efghi	494	49.51 bcde
March	4013	42.99 cdefghi	450	41.14 cdefghi	813	45.18 cdefgl
April	3635	42.24 cdefghi	408	30.68 ghijk	957	55.22 abc
May	3708	38.38 efghi	420	29.68 hijk	1757	62.38 ab
June	3716	30.01 hijk	300	29.18 ijk	1240	53.04 abcd
July	3324	19.32 kl	329	39.69 defghi	1423	63.99 a
August	3752	13.4 l	309	19.22 kl	1306	53.53 abcd
September	5437	21.5 jkl	299	32.60 fghijk	1196	54.95 abc
October	6348	34.41 fghij	296	38.14 efghi	918	53.36 abcd
November	5900	44.43 cdefgh	399	42.79 cdefghi	725	63.97 a
December	4779	45.69 cdef	419	42.95 cdefghi	795	64.14 a

- **Means with different letters in columns and rows are significantly (P< 0.01).**

Table (3) Interaction of breeding system x year of breeding

Year	Breeding System			
	AI		NS	
	Number of Services	CR (%)	Number of Services	CR (%)
1997	4336	38.21 bcdefg	1801	36.13 bcdefg
1998	3420	32.27 fg	3564	37.05 defg
1999	3728	32.84 fg	3090	35.90 defg
2000	4996	30.47 g	7723	38.69 abcdefg
2001	5361	34.81 efg	2248	46.91 abcde
2002	4948	37.67 cdefg	2605	45.08 abcdef
2003	1922	50.82 ab	5547	47.51 abcde
2004	2725	48.22 abcd	4933	51.54 a
2005	2049	48.77 abcd	3147	50.80 ab
2006	3441	43.55 abcdef	2256	50.25 abc

- **Means with different letters in columns and rows are significantly (P < 0.01) different.**

Table (3) shows the interaction of year x breeding system. Previous study (7) indicated the presence of a general trend of improvement in CR with successive years from 1997 until 2006 for both type of breeding and for different productive status of females. It was also suggested that this trend may reflect improvement in the reproductive management of the farm over the year. It would be assumed that the previous analysis might be true for AI but not for NS breeding. Contrarily, table (3) revealed increasing trend in CR with successive years for both AI and NS. This might be due to a management decision to increase percentage of culling rate of cows with reproductive problems especially from 2001 to 2006 because of the increase in the total number of the herd over the capacity of the farm. So this prcess led to a reduction in total number of cows with lower fertilities which presumably led to some improvement in reproductive efficiency or overall CR of the herd. This analysis can be confirmed in table (4) which indicates that the improvements in CR with successive years were of lactating and dry cows but not of virgin heifers since these females were less subject to culling decisions.

Table (4) Interaction of productive status of female x year of breeding

Year	productive status of female					
	M		D		H	
	Number of Services	CR (%)	Number of Services	CR (%)	Number of Services	CR (%)
1997	4374	31.52 ij	849	25.20 j	953	54.79 bcde
1998	5875	25.74 j	529	26.84 ij	580	57.48 abcd
1999	5057	28.76 ij	670	25.39 j	1091	56.55 abcde
2000	6263	28.36 ij	533	23.81 j	927	66.64 a
2001	6131	31.99 hij	348	45.50 defg	1130	46.56 cdefg
2002	5698	37.22 ghij	454	34.90 hij	1401	53.31 bcde
2003	5717	46.57 cdefg	507	47.28 cdefg	1245	52.14 cdef
2004	5937	42.99 fgh	283	45.59 cdefg	1438	61.53 ab
2005	3606	44.00 efgh	151	46.44 cdefg	1439	59.25 abc
2006	3617	38.95 ghi	179	44.09 defgh	1901	58.53 abc

- Means with different letters in columns and rows are significantly (P< 0.01) different.

Services Per Conception (SPC):

Table (5) shows the interaction of breeding system x year of breeding and their effects on SPC.

No significant differences (P< 0.01) were found between AI and NS breeding from 1997 to 2006.

Table (5) Interaction of Breeding System x Year of Breeding

Year	Breeding System			
	AI		NS	
	Number of Services	SPC	Number of Services	SPC
1997	4336	3.11 a	1801	3.27 a
1998	3420	2.66 a	3564	3.72 a
1999	3728	3.11 a	3090	3.04 a
2000	4996	3.09 a	7728	2.94 a
2001	5361	2.98 a	2248	2.35 a
2002	4948	2.46 a	2605	2.28 a
2003	1922	2.22 a	5547	2.15 a
2004	2725	2.13 a	4933	2.01 a
2005	2049	2.03 a	3147	2.00 a
2006	3441	2.33 a	2256	2.03 a

- Means with the same letters in columns and rows are significantly (P < 0.01) not different.

However, SPC improved with successive years for both type of breeding. By dividing years of breeding into two durations, one from 1997 to 2001 and the other from 2002 to 2006, it was found that SPC of AI was improved by about 25% (from an average of 2.99 to 2.23). Also SPC of NS improved by about 32% (from an average of 3.06 to 2.09). This indicate that improvements in SPC for both AI and NS were mainly due to increase rate of culling of cows with reproductive failure and may not to improvement of AI techniques. However, we should also consider that inseminators usually adjust and improve their skills with time which may add to the general progress of the reproductive program of the farm.

Table (6) Interactions of productive status x year of breeding

Year	Productive Status of Female					
	M		D		H	
	Number of Services	SPC	Number of Services	SPC	Number of Services	SPC
1997	4335	3.13 abcdefg	849	4.51 a	953	1.91 fgh
1998	5875	4.14 abc	529	3.75 abcd	580	1.68 gh
1999	5057	3.30 abcdef	670	4.18 ab	1091	1.73 gh
2000	6263	3.43 abcde	533	4.31 a	927	1.32 h
2001	6131	3.09 bcdefg	348	2.18 efgh	1130	2.72 cdefgh
2002	5698	2.54 defgh	454	2.60 defgh	1401	1.97 efgh
2003	5717	2.15 efgh	507	2.05 efgh	1245	2.36 defgh
2004	5937	2.37 defgh	283	2.20 efgh	1438	1.67 h
2005	3606	2.30 defgh	151	2.03 efgh	1439	1.70 gh
2006	3617	2.65 cdefgh	179	2.00 efgh	1901	1.72 gh

- **Means with different letters in columns and rows are significantly (P < 0 .01) different.**

AL-Doori, (1) reviewed many studies which showed significant effects of year on SPC. Several authors attributed these effects to differences in management and reproductive and veterinary programs of different farms in addition to variations in feeding and environmental conditions that affect fertility of cows from year to year. However, others have found no effects of year on SPC.

Table (6) showed the interaction of productive status of female x year of breeding. In a previous report (7) it was generally indicated improvements in SPC with successive years for the different productive status of females and breeding systems. Further analysis of this parameter by also separating the years to two durations as previously described with table (5), no significant differences ($P< 0.01$) were noticed in SPC of H between the first (1.88) and the second (1.87) duration. On the contrary, SPC of M (3.42 vs. 2.40) and D (3.79 vs. 2.18) were improved by 30% and 43% respectively. These observations again confirm that culling of multiparous females were the primary factors contributing to the improvement in reproductive efficiency of the farm with successive years.

Conclusions

It was concluded from this study that higher environmental temperatures during the hot months of the year in the middle and probably in the south parts of Iraq have detrimental effects on CR and SPC as measurements of reproductive efficiency of dairy farms. These effects include both AI and NS breeding systems. However, their impacts on AI were more pronounced than NS which may offer an alternative breeding system for the hot season. In addition the effect of high temperatures was more on parous females but not on virgin heifers. Dry parous cows were less affected by higher temperatures compared to lactating cows. Improvements of CR and SPC with

successive years were noticed which were mainly due to increase of culling rate of multiparous cows with lower reproductive efficiency.

Acknowledgments

The authors wish to thank AL - Bunnia group of companies and the staff of AL-Nasir dairy farm for their help in providing the data and their effort in the discussion of the results.

References

1. AL-Doori, D. S. (2002). The effect of heat stress and coat color (Black & Red) on some performance traits of Holstein Friesian cows in Iraq. Ph. D.Thesis, College of Agriculture, University of Baghdad.
2. Armstrong, D. V. (1994). Heat stress interaction with shade and cooling. J. Dairy Sci., 77: 2044.
3. Badinga, L.; Collier, R. J.; Thatcher, W. W. & Wilcox, C. J. (1985). Effects of climatic and management factors on conception rate of dairy cattle in subtropical environment. J. Dairy Sci., 68: 78-85.
4. Gwazdauskas, F. C.; Wilcox, C. J. & Thatcher, W. W. (1975). Environmental and managemental factors affecting conception rate in subtropical climate. J. Dairy Sci., 58:88.
5. Ingraham, R. H.; Gillette, D. D. & Wagner, W. E. (1974). Relationship of temperature and humidity to conception rate of Holstein cows in subtropical climate. J. Dairy Sci., 57: 476.
6. Stott, G. H.; Wiersma, F. & Woods, J. M. (1972). Reproductive health program for cattle subjected to high environmental temperatures. J. Am. Vet. Med. Assoc., 161: 1340.
7. Khalaf, S. S. (2009). Effects of breeding system, year, month of the year and productive status on conception rate and services per conception in Holstein cows. Al-Anbar J. Agr. Sci., 7: 1-8.
8. Al-Obaidi, M. A. (2007). Genetic evaluation of Holstein cows depending upon some productive and reproductive traits. Ph. D. Thesis, College of Agriculture, University of Anbar.
9. Al-Timimy, A. N. (2003). Genetic evaluation of Holstein Friesian bulls at the artificial insemination center in Abu-Graib. M.Sc.Thesis, College of Agriculture, University of Baghdad.
10. SAS. (2001). SAS User Guide. Version 6.12. Institute Inc. Cary, NC. USA.
11. Washburn, K. A.; White, S. L.; Green, J. T. Jr. & Benson, G. A. (2002). Reproduction, mastitis, and body condition of seasonally calved Holstein and Jersey cows in confinement or pasture systems. J. Dairy Sci., 85: 105-111.
12. Washburn, S. P.; Silvia, W. J.; Brown, C. H.; McDaniel, B. T. & McAllister, A. J. (2002).Trends in reproductive performance in southeastern Holstein and Jersey DHI herds. J. Dairy Sci., 85: 244-251.
13. National Animal Health Monitoring System. (2002). Part 1: Reference of dairy health and management in the United States. Ctr. Epide- miol. Anim. Health, Fort Collins, CO.
14. Smith, J. W.; Ely, L. O.; Gilson, W. D. & Graves., W. M. (2004). Effects of artificial insemination vs. natural service breeding on production and reproduction parameters in dairy herds. Prof. Anim. Sci., 20: 185-190.

15. de Vries, A.; Steenholdt, C. & Risco, C. A. (2005). Pregnancy rates and milk production in natural service and artificially inseminated dairy herds in Florida and Georgia. J. Dairy Sci., 88: 948-956.
16. Niles, D.; Risco, C. A. & Thatcher, M. J. (2002). Seasonal evaluation of artificial insemination and natural service pregnancy rates in dairy herds. Compend.Contin. Educ. Prac. Vet., 24: S44- S48.
17. Williamson, N. B.; Morris, R. S. & Anderson, G. A. (1978). Pregnancy rates and nonreturn rates following artificial and natural breeding in dairy herds. Aust Vet, J., 54: 111-120.
18. Ott, R. S. (1986). Breeding soundness examination in bulls. Pages 125-136 in Current Therapy of Theriogenology. 2nd ed., D. A. Morrow, ed. W. B. Saunders Co., Philadelphia, PA.
19. Chang, M. C. & Fernandez-Cano, L. (1959). Effects of short changes of environmental temperature and low atmospheric pressure on the ovulation of rats. Am. J. Physiol., 196: 653.
20. Mercier, E. & Salisbury, G. W. (1947). Seasonal variation in hours of daylight associated with fertility level of cattle under natural breeding conditions. J. Dairy Sci., 30: 747.
21. Stevenson, J. S.; Schmidt, M. K. & Call, E. P. (1983). Estrus intensity and conception rates in Holsteins. J. Dairy Sci., 66: 275.
22. Stott, G. H. (1961). Female and breed associated with seasonal fertility variation in dairy cattle. J. Dairy Sci., 44: 1698.
23. Thatcher, W. W. & Collier, R. J. (1981). Effect of heat on animal productivity. Page 77 in Handbook of agricultural productivity. Vol.11. M. Rechcigl, ed. CRC Press, Boca Raton, FL.
24. Boyd, H. & Reed, H. C. B. (1961). Investigations into the incidence and causes of infertility in dairy cattle – fertility variations. Br. Vet. J., 117: 18.
25. Alliston, C. W.; Howarth, B. & Ulberg, L. C. (1965). Embryonic mortality following culture in vitro of one and two-cell rabbit eggs at elevated temperatures. J. Reprod. Fertil., 9:337.