



Effect of genetic and non-genetic factors on some productive and reproductive traits of Holstein cows in the middle of Iraq

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ABSTRACT

This study was conducted at the Al-Salam cows' station for milk production located in Al-Latifiya sub- district - Al-Mahmudiyah district (25 km south of Baghdad governorate) on a sample of (180) Holstein cows imported from Germany by Taj Al-Nahrain company, to study the effect of the parity, season and calving year on total Milk Production (TMP), the lactation period (LP), calving interval (C.I), Services per conception (SPC) and to estimate the heritability of the studied traits. The results showed that the overall means of TMP and LP were 3172.53 kg and 237.09 days respectively. The parity effect on TMP in Holstein cows was highly significant. Total Milk production increased with the advance of parity and mostly reached its maximum value in the 4th and 3rd parity being 3305.87 kg and 3286.35 kg per day, respectively. Season of calving has a highly significant effect on (TMP). Cows calved in spring had a higher milk production than those calved in other seasons. Season of calving had highly significant on services per conception. The result of the study showed the heritability value for TMP, LP, SPC and CL were 0.21 ,0.08 ,0.08 and 0.07 respectively.

1. Introduction

The cow is a dairy animal that plays a large role in milk production all over the world [13]. Cattle are the predominant dairy species worldwide, they produce 83% of all milk, comprising more than 90% in Europe and North America but only 75% and 60% in Africa and Asia

respectively [11]. The reproductive activity of cows in dairy operations is an important factor in milk production. In dairy breeding, selection for milk production has been mostly based of 305-days milk production [4]. Holstein cows breed is preferred by breeders, because of

their high milk production, good fattening ability, less difficulty in environmental adaptation and good breed selection can be achieved through proper record keeping [17]. Milk production and reproductive traits are the most important economic traits as sources of income for dairy farmers where high producing and fertile cows are usually profitable. Heritability is the key genetic parameter that determines the possible genetic progress for selected traits [21] Milk production of cows has a major impact on the profitability of dairy farming. Both genetic and non-genetic factors affect the milk production of cows. Non-genetic factors include feeding (nutrition), and calving year, season, number of lactations, number of pregnancies and milking frequency and duration. [2] Genetic factors are inherited individually from the parents and possessed from birth, while the environment is the influence of non-genetic factors [18] The genetic effect referees to differences in milk production and composition among breeds or genotypes and individuals within each breed.

The objective of this investigation was to determine the effects of some non - genetic factors (parity, season of calving and year of calving) on total milk production, lactation period, services per conception and calving interval with heritability estimated of these traits in Holstein cows in the middle of Iraq.

2. Material and Methods

This study was conducted at the Al-Salam cows' station for milk production located in Al-Latifiya sub-district of Al-Mahmudiyah district (25 km south of

Baghdad governorate) on a sample of (180) Holstein cows imported from Germany by the Taj Al-Nahrain Company.

2.1. Management:

Feeding at the station varies from season to season and from year to year depending on the availability of fodder and its different types, taking into account the cost of its components. Green fodder is relied on for feeding. In winter and spring, mixtures of alfalfa, barley and alfalfa are provided. Hay and silage are also provided when the green fodder crops are not possible as a result of rain, as well as in the case of transition from summer to winter, as during this period there is a shortage of green fodder. In the summer, yellow and white corn white corn are provided, and green fodder is provided at a rate of 2% of the body weight. As for the concentrated feed (12-14% crude protein and energy 10-12 mega joules / kg), it is provided at a rate of 1 kg for every 2-2.5 kg of milk / head. The components of the concentrated diet vary depending on the availability of the raw materials involved in its manufacture, and it usually contains bran, barley, wheat, cottonseed meal, sunflower meal, rice crumb, limestone and table salt.

When the bulls reach a weight of 350 kg, the bulls are released to benefit them, as well as the bulls are released with cows that were vaccinated by artificial insemination more than four times and did not become pregnant. Artificial insemination relies on insemination of cows with frozen semen, as for detecting the teller, it is done by three means: scout bulls, doctors, and agricultural engineers, as well as by knowing the cows that were

born 60 days ago and did not show signs of estrus to know the problem they are exposed to. The process of artificial insemination takes place and the cows are isolated. The estrus is in a barn, then the vaccinator examines the cow first by palpation through the rectum. If he notices that she is a newborn (no more than 45 days have passed since her birth) or sick (the appearance of the telltale fluid in a cloudy color or the presence of blood or pus with it), then it is not vaccinated, but rather treated. As for the insemination process, it takes place after liquefying the frozen semen content of the reed in a water bath (37-38 °C) for 15 seconds. Cows are vaccinated twice, the first 10-12 hours after the onset of estrus and the second. Cows are isolated two months before giving birth in special pens for childbirth and dried. Three weeks before giving birth, pregnant cows are treated as dairy cows in terms of nutrition. Immediately after birth, the calves are isolated from their mothers, the cows are milked to artificially feed the newborns on colostrum, and the cows are dried 60 days before the expected date of calving or when the cow's productivity drops to 3-4 kg/day. Animals are vaccinated annually against infectious diseases prevalent in the area (rinderpest, anthrax, communicable abortion, sepsis hemorrhagic, accidental anthrax and foot and mouth disease). Spraying animals with pesticides to eliminate external parasites from May to September.

2.2. Data:

In this study, the breeding and production records of 180 Holstein cows were used for the productive seasons 2020, 2021

and 2022. The parity, season and year of calving were recorded, then total milk production, lactation period, calving interval and services per conception.

2.3. Statistical analysis

Used SAS [19] in the statistical analysis according to the following mathematical model:

$$Y_{ijklm} = \mu + P_i + S_j + R_k + L_m + e_{ijklm}$$

μ : the overall mean

P_i : effect of the i th parity = i (first, second, third and fourth).

S_j : effect of the j th season of calving = (j : 1= winter, 2= spring, 3= autumn and 4= summer).

R_k : effect of the k th calving year = (k : 2020, 2021 and 2022).

L_m : effect of the l th sire = (m : 13).

e_{ijklm} : is the error term associated with the observations.

Assumptions where error term is independently, identically and normally distributed with zero mean and constant variance, NID (0, $\sigma^2 e$).

[7] multiple range test was used to determine the significance of differences between means at ($p \leq 0.05$).

The sire components of variance as well as covariance from multivariate analyses were used to estimate genetic variables using the given formula:

Heritability (h^2) = VA / VP = additive genetic variance / total phenotypic variance

or 4* sire variance / phenotypic variance
 (half-sib)

$$h^2 = 4 \sigma^2 d / \sigma^2 d + \sigma^2 e$$

Where:

$\sigma^2 d$ is the sire component of variance

$\sigma^2 e$ is the environmental component of variance.

Table (1): Experimental diets and its chemical analysis

Feed	R1%	R2%	R3%	R4%	R5%	R6%	R7%
Crushed barley	50	50	50	50	50	49	48
Bran	35.5	34.5	33.3	31.4	28.5	26.5	24.6
Soybean meal	5	3	1	--	--	--	--
Crushed fenugreek	--	3	6	9	12	15	18
Hay	8	8	8	8	8	8	8
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.3
Urea	0.5	0.5	0.7	0.6	0.5	0.5	0.4
Limestone	0.5	0.5	0.5	0.5	0.5	0.5	0.45
Chemical composition							
Dry matter%	92.55	92.50	92.60	92.75	92.75	92.80	92.40
Organic matter%	88.80	87.58	88.19	88.03	87.22	88.39	88.10
Ether Extract	4.28	4.25	5.07	4.65	4.21	5.05	4.77
Crude protein%	14.17	13.85	13.90	13.86	13.84	13.94	14.14
Crude fiber%	11.08	10.84	10.57	10.28	10.79	10.66	10.61
Metabolism Energy Mcal/kg))	2.41	2.41	2.44	2.43	2.45	2.46	2.48

Rams were divided into three groups, each containing 5 animals. Because the number of animals is limited, they were used alternately and as shown in (Table 2). At the beginning of the experiment, the first group was introduced and included 5 animals as they were introduced into individual wooden cages and fed on the first ration (R1) for a period of 10 days as an introductory period. The animals took at a rate of 1.5 kg \ day in two periods in the morning and evening, then

transferred to the digestion cages on the tenth day of each trial period for the purpose of collecting waste for a period of 5 consecutive days. Waste is collected every morning and before feeding the fodder for the morning meal. It is weighed and a sample of 25% of the weight is taken. It is placed in polyethylene bags and kept in the refrigerator until the collection process is completed. The samples were collected on the last day of the collection process and mixed well,

then a sample representing 25% of sample weight was taken. of the total weight, then dried at 60 °C until the weight is stable and kept until chemical analyzes are performed. Blood samples

were taken from the jugular vein [9]. 5 days after introducing the first group, the second group was introduced to the individual cages and fed on the second diet (R2).

Table (2): Plan of using animals in the digestible experiment

Groups	Times								
	5 Days	10 Days	15 Days	20 Days	25 Days	35 Days	40 Days	45 Days	50 Days
T1	Wooden cages		Digestive cages						
T2		Wooden cages		Digestive cages					
T3			Wooden cages		Digestive cages				
T4				Wooden cages		Digestive cages			
T5					Wooden cages		Digestive cages		
T6						Wooden cages		Digestive cages	
T7							Wooden cages		Digestive cages

3. Results and Discussions

The results in Table 3 that the dry matter digestibility of the experimental rations did not differ significantly between the treatments except for the second treatment (6% fenugreek seeds), as a significant decrease ($P \leq 0.05$) was observed in the dry matter digestibility compared with the rest of the rations. The percentages of the digestibility of the dry matter for the experimental diets were 75.78 , 76.99 , 72.62 , 76.61 , 74.02 , 73.54 and 75.36% for each of the control group and the rest of the treatments. So it is with regard to the digestion coefficient of

organic matter, as the values of the digestibility were 76.71 , 77.64 , 72.76 , 77.34 , 75.24 , 74.79 , and 77.04%, respectively.

The digestion of the dry and organic matter for any diet may varies in any group depending on factors such as type of animal, type of diet in terms of its components, and the ability of microorganisms to decompose and digest them . As for the decrease in the digestibility of dry and organic matter in the second diet (6% fenugreek seeds), its cause is not clear. In this field, and in a study conducted by [6] on sheep, in which

fenugreek seeds were used at rates of 0 , 5 , 10 , and 15% in experimental diets, results similar to the results of this study were obtained, as no significant effect was observed for the different levels of fenugreek seeds in dry and organic matter digestibility . Similar results obtained by [8] in their study on buffaloes showed that the addition of fenugreek seeds to the rations led to a significant decrease ($P \leq 0.05$) in the digestibility of dry matter digestibility of the ration to which fenugreek seeds were added compared to the control ration. In a previous study by [8], they showed that adding 200 gm of fenugreek seeds to buffalo diets led to an improvement in the coefficient of dry matter digestibility . In studies on goats, an improvement was observed in the coefficient of digestion of both dry and organic matter in goat groups whose diets contained a proportion 5 , 10 , and 15% as fenugreek seeds, a result that contradicts what was found in [7] .

The results in Table [3] indicated that there was an improvement in the digestibility of the ether extract in all treatments that contained fenugreek seeds compared to the control groups, but the differences were significant ($P \leq 0.05$) only between the second group (85.85%) and the fourth group (93.47%) compared to the control group (82.63%). And the sixth transaction (82.63%). In a similar study conducted by [6], a significant decrease was found in the digestibility of ether extract in groups of sheep that ate diets containing different fenugreek seeds proportion compared to the control group, which is a result contrary to what was found in this study. Whereas, [8] when adding 200 gm of fenugreek seeds

to buffalo diets noticed a significant improvement in the digestibility coefficient of ether extract, a result similar to what was found in this study. The reason for this difference in the results of studies on the effect of fenugreek seeds on the digestibility of ether extract may be that the presence of these seeds is effective in affecting the absorption of fats from the small intestine [11].

Table (3) indicates that there are some significant effects of fenugreek seeds on the protein digestibility. It was observed a significant decrease ($P < 0.05$) in the protein digestibility of the second diet (72.62%) compared to the control diet (75.96%), the first treatment (76.99%) and the sixth treatment (75.36%), while it did not differ significantly with the fourth and fifth treatments, which amounted to 74.02 and 73.54%, respectively. The degradability of protein within the rumen by microorganisms and the ability of these organisms to benefit from the degradable of nitrogen is one of the important factors that affect the coefficient of protein digestion. In this study, the proportion of protein in the experimental diets was different in the percentage of fenugreek seeds, as it appears from the results of this study that fenugreek seeds did not have a clear effect on the protein digestion coefficient, and this is what [6] indicated in his study on sheep. No significant effect was observed for the percentage of fenugreek seeds on the protein digestibility. However, in the study conducted by the researcher [10] when adding 200 gm/day of fenugreek seeds to the diets given to buffaloes, it caused a significant increase ($P \leq 0.01$) in the protein digestibility. This difference

may be due to the different type of animal on the one hand and the environment of the rumen on the other hand. The results of the statistical analysis indicate that there is a significant decrease ($P \leq 0.01$) in the fiber digestibility in the second, fourth and fifth treatments, as the percentage of the fiber digestibility was 58.45 , 56.65 and 56.55 , respectively, compared to the control group and the first, third and sixth treatments, as the proportion of the digestibility reached 66.25 , 65.68 , 66.46 , and 63.68%, respectively. The reason for this difference is not completely clear, but the pH of the rumen fluid may have a fundamental role in this difference, as it is known that when the pH of the rumen fluid decreases, the activity of fiber-decomposing bacteria decreases [12], and this is what was observed in this study.

Although there is a variation in the effect of fenugreek seeds on the fiber digestibility coefficient, these results are in line with what was found by [8] in their study on buffaloes, where they indicated a significant increase ($P \leq 0.01$) for the fiber digestibility coefficient of The group added to its diet was 200 gm/day per head, reaching 74% compared to the control group, which amounted to 63.5%. It was observed a significant decrease ($P \leq 0.05$) in the protein digestion coefficient of the second diet (72.62%) compared to the control diet (75.96%), the first treatment (76.99%) and the sixth treatment (75.36%), while it did not differ significantly with the fourth and fifth treatments, which amounted to 74.02. and 73.54%, respectively.

Table (3). Means $\pm$ S E for Digestibility in rams

Digestibility	Control	T1 3%	T2 6%	T3 12%	T4 15%	T5 15%	T6 18%
Dry matter%	75.78 $\pm$ 1.25 a	76.99 $\pm$ 0.54 a	72.62 $\pm$ 0.45 b	76.61 $\pm$ 1.13 a	74.02 $\pm$ 0.52 a	73.54 $\pm$ 1.28 a	75.36 $\pm$ 0.55 a
Organic matter%	76.71 $\pm$ 1.18 a	77.64 $\pm$ 0.57 a	72.76 $\pm$ 0.81 b	77.34 $\pm$ 1.16 a	75.24 $\pm$ 0.66 a	74.79 $\pm$ 1.34 a	77.04 $\pm$ 0.55 a
Ether Extract	81.50 $\pm$ 1.60 b	85.85 $\pm$ 0.74 a	83.71 $\pm$ 1.59 ab	85.18 $\pm$ 1.12 ab	93.47 $\pm$ 0.30 a	85.35 $\pm$ 1.39 ba	82.63 $\pm$ 1.71 b
Crude protein%	75.96 $\pm$ 1.24 a	76.99 $\pm$ 0.54 a	72.62 $\pm$ 0.45 b	76.61 $\pm$ 1.13 a	74.02 $\pm$ 0.52 ab	73.54 $\pm$ 1.28 ab	75.36 $\pm$ 0.55 a
Crude fiber%	66.25 $\pm$ 2.14 a	65.68 $\pm$ 1.36 a	58.45 $\pm$ 1.50 b	66.46 $\pm$ 2.41 a	56.65 $\pm$ 1.01 b	56.55 $\pm$ 1.77 b	63.68 $\pm$ 1.16 a

Note : Similar letters within the same row refer that there are no significant differences

3.1 Blood Parameters

Table (4) indicates that there is a significant effect ($P \leq 0.05$) of fenugreek seeds on the level of blood glucose, where a high level is observed with a significant increase in glucose values in the fifth treatment 75.47 and sixth 77.90 mg\100 ml compared to the rest of the treatments

whose values ranged Between 45.42 to 56.24 mg\100 ml. A previous study by [13], there was a significant increase ($P \leq 0.05$) in the level of glucose for groups of Awassi lambs fed on diets containing different percentages of fenugreek seeds, which are similar results to what was found in this study. The researchers attributed the reason for the high level of

glucose in the blood to a decrease in the decomposition of starch in rumen, and thus an increase in the amount of starch passing into the small intestine, which is decomposed by starch-digesting enzymes in the intestine, which results in glucose, which is absorbed and thus increases its concentration in the blood.

It was noted from Table (4) a decrease in the level of cholesterol in the blood of rams with an increase in the level of fenugreek seeds in a diets provided to the groups of rams, but a significant decrease was observed ($P \leq 0.05$) and a clear decrease in the level of cholesterol in the blood of the fifth (61.64) and sixth treatment (59.02) mg/100 ml. This compared to its level in the rest groups, which amounted to 72.13, 69.51, 66.23, 64.26 and 65.25 mg/ml blood level for the control, first, second, third and fourth groups, respectively. The researchers ascribe the reason for possible association of fenugreek saponin with bile salts, and since saponin are indigestible in the rumen, this association hinders or reduces the re-absorption of cholesterol and bile salts from the lining of the intestine, and this is reflected in an increase in the conversion of Cholesterol in the liver turns into new bile salts, and leads to a decrease in the level of cholesterol returned to the hepatic circulation, and thus to a decrease in the level of cholesterol in the blood. Or that saponin have ability to stick with bile salts and neutral fats in the intestine and inhibits their absorption and then lower the level of cholesterol, and this stimulates the liver to convert cholesterol into bile acids and thus leads to a decrease in the level of cholesterol in the

blood. Some researchers have explained the reason for the effect of fenugreek seeds in lowering blood cholesterol, because they contain fibers that affect the speed of passage of cholesterol and bile acids in the intestine, and then reduce their absorption rate, which leads to an increase in their excretion with waste [14], [16], [18]. As for the researcher [17], they explained the ability of fenugreek seeds to lower cholesterol through the association of bile salts with fiber and saponin, which reduces their re-absorption from the intestine, and this leads to an increase in the conversion of cholesterol in the liver into new bile salts, and thus its level decreases. Another reason for the decrease in the concentration of cholesterol in the blood plasma is that fenugreek seeds contain some compounds that reduce the synthesis of cholesterol by inhibiting the activity of (HMG Co A) Hydroxy Methyl Glutaryl Co A, which raises the rate of excretion of cholesterol and bile acids with waste products [19]. The results of this study agreed with [18] in their study on sheep that ate diets containing fenugreek seeds in different proportions, while [6] did not find any effect of fenugreek seeds on the level of cholesterol in the blood of Kurdish ewes when they used fenugreek seeds at 0,5,10 and 15%.

As for the level of triglycerides in the blood, it began to rise with the increase in the proportion of fenugreek seeds in the diets, and the increases reached a significant level ($P \leq 0.05$) in the third, fourth, fifth and sixth treatments compared to the rest of the treatments. These levels reached 63.21, 61.55, 68.19,

80.83, 80.05, 75.85 and 75.65 mg/100 ml of blood for the seven treatments, respectively. The results of this study are different with those that indicated that adding fenugreek seeds to diets can lead to a decrease in the level of triglycerides in the blood because fenugreek seeds contain fiber and pectin that can reduce the level of absorption of this substance in the gastrointestinal tract [21]. In this study, there was a clear decrease in the control group and the first and second treatments. In other studies for sheep, the researcher [6] and [13] did not find any significant effect of the proportion of fenugreek seeds on the concentration of serum triglycerides in sheep. A variation was observed in the effect of fenugreek seeds on the level of total protein in the blood. A significant decrease ($P \leq 0.01$) was observed for the second (6.13), the third (6.17) and the fifth (6.51 mg/100 ml blood) treatments, compared to 7.62, 7.27, 7.48 and 7.55 mg/100 ml blood for each of the control group and the first, fourth and sixth treatments, respectively. The reason for this difference is not clear, and it may be related to what happens to the protein inside the rumen on the one hand, and the availability of digested and absorbable protein on the other hand. Similar results were previously obtained by [13] and [20] in their study on sheep

fed on diets containing different percentages of fenugreek seeds. In other studies, on sheep [6] and Shami goats [18] and [23], fenugreek seeds had no significant effect on the concentration of protein in the blood. The level of albumin in the blood was 3.48, 3.25, 2.94, 3.08, 3.25, 3.06 and 3.48 mg/100 ml blood for each of the control group and the first, second, third, fourth, fifth and sixth treatments, respectively, and the differences did not reach the level of significance. Similar results were reached by [18] and [6] when using fenugreek seeds in the diets in different proportions in sheep diets, as they did not notice any significant differences in the concentration of albumin. Other studies on goats, [22] and [23] also indicated that fenugreek seeds had no effect on albumin concentration. Fenugreek seeds had no clear effect on blood urea (Table 4), but a significant decrease ($P \leq 0.05$) was observed in the first group compared with the rest of the others, as its concentrations were 57.83, 51.65, 62.61, 61.57, 62.91, 63.46 and 60.94 mg/100ml blood. The results of this study were different with 24 in their study on Awassi ewes, and 5 in their study on cows, who found that the addition of fenugreek powder led to a significant decrease ($P \leq 0.05$) in blood urea.

Table (4). Means $\pm$ S E for biochemical blood Parameters for rams (mg/100 ml)

Items	Control	T1 3%	T2 6%	T3 12%	T4 15%	T5 15%	T6 18%
Glucose	53.04 $\pm$ 2.71 bcd	45.44 $\pm$ 4.41 A d	56.24 $\pm$ 2.89A b	47.24 $\pm$ 2.36 cd	55.14 $\pm$ 3.03 bc	75.47 $\pm$ 1.89 A	77.90 $\pm$ 2.01 A
Cholesterol	72.13 $\pm$ 1.04 a	69.51 $\pm$ 6.34 ab	66.23 $\pm$ 2.41 abc	64.26 $\pm$ 3.68 abc	65.25 $\pm$ 1.31 abc	61.64 $\pm$ 1.91 Bc	59.02 $\pm$ 1.47 C
Triglycerides	63.21 $\pm$ 2.95 b b	61.55 $\pm$ 1.59b b	68.19 $\pm$ 2.73b b	80.83 $\pm$ 1.57a a	80.05 $\pm$ 2.46a a	75.85 $\pm$ 1.75a A	75.65 $\pm$ 3.468a A
Total protein	7.63 $\pm$ 0.16 a	7.27 $\pm$ 0.36 a	6.13 $\pm$ 0.05 b	6.17 $\pm$ 0.20 b	7.48 $\pm$ 0.204 a	6.51 $\pm$ 0.16 B	7.55 $\pm$ 0.28 A
Albumen	3.48 $\pm$ 0.15 a	3.25 $\pm$ 0.136 a	2.94 $\pm$ 0.25 a	3.08 $\pm$ 0.12 a	3.25 $\pm$ 0.23 a	3.06 $\pm$ 0.18 A	3.48 $\pm$ 0.11 A
Urea	57.83 $\pm$ 1.55 a	51.65 $\pm$ 2.77 b	62.61 $\pm$ 1.99 a	61.57 $\pm$ 1.88 a	62.91 $\pm$ 0.90 a	63.46 $\pm$ 1.48 A	60.94 $\pm$ 0.98 A

Note: Similar letters within the same row refer that there are no significant differences

Conclusion:

By reviewing the results of this study, the productive and medicinal importance of the fenugreek plant is evident. It can be used for improving some of digestibility traits and Blood Parameters for rams

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تأثير بعض العوامل اللاوراثية وتقدير المكافئ الوراثي لعدد من الصفات الانتاجية والتناسلية لابقار الهولشتاين وسط العراق

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الملخص

أجريت هذه الدراسة في محطة أبقار السلام لإنتاج الحليب الواقعة في ناحية اللطيفية - قضاء المحمودية (25 كم جنوب محافظة بغداد) على عينة مكونة من (180) بقرة هولشتاين مستوردة من المانيا من قبل شركة تاج النهرين ، لدراسة تأثير تسلسل وموسم وسنة الولادة على إنتاج الحليب الكلي (TMP) وفترة الادرار (LP) و المدة بين الولادتين المكافئ الوراثي للصفات المدروسة. أظهرت النتائج أن المتوسط العام لـ LP و TMP كان 3172.53 كغم و 237.09 يوم على التوالي. ارتفع إنتاج الحليب الكلي مع تقدم تسلسل الولادة ووصل في الغالب إلى قيمته القصوى في الولادة الرابعة والثالثة حيث بلغت 3305.87 كغم و 3286.35 كغم على التوالي. موسم الولادة له أهمية كبيرة على TMP إذ كانت الأبقار التي تولد في الربيع تنتج أعلى الحليب من تلك التي تولد في المواسم الأخرى. كان لموسم الولادة أهمية كبيرة في عدد التلقيحات اللازمة للأخصاب. أظهرت نتائج الدراسة أن قيمة المكافئ الوراثي كانت 0.21، 0.08، 0.08، و 0.07 لكل من CL، SPC ، LP، TMP على التوالي .

الكلمات المفتاحية: أبقار الهولشتاين ، الحليب ، المكافئ الوراثي