



T.C.
NİĞDE ÖMER HALISDEMİR UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF ANIMAL PRODUCTION AND TECHNOLOGY

ESTIMATION OF GENETIC PARAMETERS OF THE PRODUCTIVE AND
REPRODUCTIVE TRAITS IN HOLSTIEN FRIESIAN CATTLES RAISED ON X-
FARM OF TURKEY

SADAF QADIR

JULY 2020

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SADAF QADIR

Master Thesis

Supervisor

Professor Dr. ZAFER ULUTAŞ

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Sadaf Qadir tarafından **Prof. Dr. Zafer ULUTAŞ** danışmanlığında hazırlanan “**Türkiye'nin x-çiftliğinde yükselen tatil filmi kedilerinde üretici ve üreme ticaretlerinin genetik parametrelerinin tahmini.**” adlı bu çalışma jürimiz tarafından Niğde Ömer Halisdemir Üniversitesi Fen Bilimleri Enstitüsü Hayvansal Üretim ve Teknolojisi Anabilim Dalı’nda Yüksek Lisans tezi olarak kabul edilmiştir.

(The study titled “**Estimation of genetic parameters of productive and reproductive traits in Holstein Friesian cattle raised on X- Farm of Turkey**” and presented by **Sadaf Qadir** under the supervision of **Prof. Dr. Zafer ULUTAŞ**, has been recognised as Master thesis by the jury at the Department of Animal Production and Technology of Niğde Ömer Halisdemir University Graduate School of Natural and Applied Sciences.)

Başkan: Prof. Dr. Zafer ULUTAŞ, Niğde Ömer Halisdemir Üniv. Tarım Bil. Ve Tek. Fak. Hayvansal Üret. Ve Tek. Bölümü-Niğde

İmza (Signature)

Üye: Prof. Dr. Mehmet Ulaş ÇINAR, Kayseri Erciyes Üni. Seyrani Ziraat Fak. Zootekni Böl. Kayseri

İmza (Signature)

Üye: Prof. Dr. Ayhan CEYHAN, Niğde Ömer Halisdemir Üniv. Tarım Bil. Ve Tek. Fak. Hayvansal Üret. Ve Tek. Bölümü-Niğde

İmza (Signature)

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THESIS CERTIFICATION

I certify that this thesis has been duly written by me, to the best of my knowledge. All the necessary information provided in the thesis is scientific and in accordance with the academic rules. All the help received in conducting the research and all other sources used have been duly acknowledged.

Sadaf Qadir



SUMMARY

ESTIMATION OF GENETIC PARAMETERS OF PRODUCTIVE AND REPRODUCTIVE TRAITS IN HOLSTEIN FRIESIAN CATTLE RAISED ON X- FARM OF TURKEY

QADIR, Sadaf

Niğde Ömer Halisdemir University

Graduate School of Natural and Applied Sciences

Department of Animal Production and Technology

Supervisor : Prof. Dr. Zafer ULUTAŞ

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This study was conducted to estimate variance components and genetic parameters for milk and reproductive traits of Holstein Friesian cattle in Turkey. Data of 765 dairy animals was taken Cattle breeder of from Turkish association farm. Cows who calved between 2013 to 2018 were used. The productive traits studied were 305 days milk yield (305d MY), dry period (DP), lactation length (LL) and reproductive traits studied were calving interval (CI) and service period (SP) of Holstein Friesian cattle. Genetic parameters were obtained by Average Information Restricted Maximum Likelihood (AIREMLf90) using animal model. In the model calving year, calving season, parity, dry period, lactation length and age at first calving were included as fixed effects for the studied traits. AFC was found significant for all traits except 305d MY and LL, CY was significant only to LL and CI while DP and parity was significant to 305dMy and LL, respectively. Heritability estimates for productive and reproductive traits were 0.1 (305d MY), 0.03 (DP), 0.1 (LL), 0.09 (CI) and 0.1 (SP). Estimation of low heritability for productive and reproductive traits indicates that improvement can be done through better environmental, climatic, and nutritional conditions followed by a good breeding program.

Keywords: Holstein Friesian cattle, milk yield, dry period, calving interval, service period, heritability.

ÖZET

TÜRKİYE'NİN X-ÇİFTLİĞİNDE YÜKSELEN TATİL FİLMİ KEDİLERİNDE ÜRETİCİ VE ÜREME TİCARETLERİNİN GENETİK PARAMETRELERİNİN TAHMİNİ

QADIR, Sadaf

Niğde Ömer Halisdemir Üniversitesi

Fen Bilimleri Enstitüsü

Hayvansal Üretim ve Teknoloji

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Bu çalışma, Türkiye'de siyah alaca sığırların süt ve üreme özelliklerine ilişkin varyans bileşenleri ve genetik parametreleri hesaplamak amacıyla yapılmıştır. Türkiye Damızlık Sığır Yetiştiricileri Merkez Birliğinden temin edilen ve 2013-2018 yılları arasında buzağılayan 765 süt sığına ait veriler kullanılmıştır. İncelenen süt verim özellikleri ve üreme özellikleri sırası ile 305 günlük süt verimi, kuru dönem, laktasyon süresi buzağılama aralığı ve servis periyodudur. Genetik parametrelerin hesap edilmesinde hayvan AIREMLf90 paket programı kullanılmıştır. Bu modelde buzağılama yılı, buzağılama sezonu, laktasyon numarası, kuru dönem, laktasyon süresi ve ilkinde buzağılamadaki yaş incelenen karakterler için sabit faktörler olarak modele dahil edilmiştir. AFC, 305d MY ve LL haricindeki bütün özelliklerde önemli bulunmuştur, DP ve laktasyon sırası 305dMY ve LL için önemliken CY sadece LL ve CI için önemli bulunmuştur. Süt ve üreme özellikleri için kalıtım derecesi sırasıyla 0.1 305d MY), 0.03 (DP), 0.1 (LL), 0.09 (CI) ve 0.1 (SP) bulunmuştur. Süt ve üreme özellikleri için düşük kalıtım derecesi tahmini, iyi bir ıslah programını takip edilerek daha iyi çevresel, iklimsel ve besleme uygulanarak artırılabilir.

Anahtar Kelimeler: Holstein be sığır, süt verimi, kuru dönem, buzağılama aralığı, servis süresi, kalıtım

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SYMBOLS AND ABBREVIATIONS

Symbols	Description
%	Percentage
°C	Degree celsius
h^2	Heritability
σ_g^2	Additive genetic variance
σ_r^2	Residual variance
σ_p^2	Phenotypic variance

Abbreviations	Description
305d MY	305 Days Milk Yield
DP	Dry Period
LL	Lactation Length
CI	Calving Interval
SP	Service Period
DO	Days Open
AFC	Age at First Calving
CS	Calving Season
CY	Calving Year
P	Parity
LN	Lactation Number
FCM	Fat Corrected Milk
N	Number of Animals
S.E	Standard Error
Kg	Kilogram
d	Days
S.D	Standard Deviation
NEB	Negative Energy Balance

CHAPTER I

INTRODUCTION

Holstein Friesians breed originated from the Dutch province of Holland and Friesland and Schleswig-Holstein in Northern Germany. It was believed that about 2000 years ago these breeds were selected for dairy qualities which with passage of time due to further genetic improvements become famous all over the world for high milk production.

Milk is one of the basic nutritive elements for humans. Humans diet majorly consist of dairy and dairy products like cheese, butter, yogurt etc. In livestock sectors milk and milk production are of great importance as it has economics impact too and represents one of major sources of income in dairy enterprises. Customarily, all traits types, production, reproduction, morphological as well as economic traits, which includes milk yield, calving interval, bone size, withers height, fleece weight, meat quality and others, they are controlled by genetic factors, but environmental factor have also influence on the economic traits. Some of environmental factors which influences these traits are calving season, calving year, AFC, and parity (Pirzada, 2011). These kinds of environmental factor have influence on the productive trait (305d MY, DP and LL) and reproductive traits (CI and SP) by effecting its true genetic ability by suppressing it therefore such traits must take into account to avoid biasness and estimate genetic factors in milk yield (Djemali and Berger, 1992).

In the past few decade milk production has become one of the major criteria for selection which leads to unwanted combinations between the traits like increase in milk production results in reduction in reproduction efficiency and functional traits. Reproductive performance for many years were not included in genetic improvement programs worldwide as majorly milk yield was considered one of the important factors for selection of dairy animals. Now high production of milk yield without focusing and considering the dairy cattle fertility performance is an issue as it resulted in reduction in dairy cattle reproductive efficacy over the time (Pryce et al., 2004 and Melendez and Pinedo, 2007). As fertility traits also effects dairy cattle breeding economics and thus must be considered important. Fertility traits usually have very low heritability close to

0.1 which make the selection difficult for the traits that should be included and evaluated for genetic estimation of fertility traits (Thaller, 1998 and Jamrozik et al., 2005). Although, improvement has been seen in breeding programs over the last decade and dairy cattle reproductive traits selection indices started including and evaluating the dairy cattle fertility traits in different countries showing the importance of considering and evaluating the reproduction trait in breeding programs of dairy cattle. Scandinavia is one of those countries where selection was primarily done not only on production trait but also on health and fertility traits (Miglior et al., 2005).

Good fertility performance is an indicator of efficient reproductive performance and is responsible for genetic progress in dairy cattle selections and crossbreeding programs. Good reproductive performance is essential for milk production along with the better genetic progress and ultimately performance for which many countries started involving and performing fertility traits genetic evaluations and estimations (Abe et al., 2009). Parameters that are considered essential for calculating and determining cattle fertility efficiency are age at first calving, number of services per conception, day's open, calving interval, days to first service, non-return rate, and conception rates. Poor reproductive performance leads to fertility problems like decreased milk yield, prolonged CI, a smaller number of calves per cow per year, increased culling rate and shorter fertile lifetime which resulted in economic losses (Abe et al., 2009; Gonzalez-Recio and Alenda, 2005).

From the last few decade world has been focusing for fulfilling the increasing milk and milk products demands. As the population increases the demands of the people also increases which requires the stable supply of dairy products to fulfill the needs of the world for which some obstacles need to be overcome one of which is the antagonist relation of production and fertility trait and their adverse impact on the genetic improvement breeding programs. Global efficiency and profitability of milk production systems are greatly influenced by the fertility efficiency of the cattle as this trait is responsible for improving the herd profitability and thus is of great interest for the breeders. Although there are several studies are done which reported an antagonist relation between the production and reproduction traits where decline in fertility performance of dairy cattle was observed with high production values. As maximum

milk production levels are nearly achieved for which reason the consideration of this inverse relation between the two traits becoming more important.

To avoid all these problems and to get maximum production breeding programs are redesigned. The main goal of animal breeding is not only to produce loftier animals but also to cause the enhancement in herd and this can be done by selecting genetically higher-level animals, sires, and dams, as parents for the next generations. In animal husbandry there is large implementation of quantitative genetics and for that to develop, an effective breeding program, genetic inheritance of those certain characters to know is important (Bugeac et al., 2013). Estimation of genetic parameters is one of vital steps for developing and initiating a breeding program. After the estimation, the results can be applying in the breeding programs which are developed for the reproduction and production traits of the dairy cattle. That is why the correct estimation of genetic parameters is very essential as these results are responsible for predicting the near to accurate genetic values for the individuals present in the herd. As the genetic improvement of a trait depends on how much genetic variation is present in the herd as they have direct relation greater the genetic difference greater will be the chances of greater variation. Heritability estimation of the traits is one of the efficient ways to find out the trend for the genetic variations present in a herd under environmental conditions (Goshu et al., 2014). Heritability involves the genetic evaluations calculations, prediction of selection response, and to help producers decide which is the most efficient way in the improvement of trait whether through management or through selection. Considering the importance of fertility traits for dairy cattle many countries started including and considering these traits in their breeding programs and goals (Miglior et al., 2005)

The objectives in this study includes, estimation of genetic parameters for productive traits (305d MY, LL, DP) and reproductive traits (CI and SP) which contains estimation of co variances and heritability.

CHAPTER II

LITERATURE REVIEW

2.1 Origin of Holstein Friesian

With the passage of time the as the population grows demands of the people increases and to fulfill those demands level of supply increased. To maintain that demand and supply chain such breeds are developed that can produce much milk and meet over the time. One of those such breed is Holstein Friesian cattle which can produce high milk yields among other breeds of dairy cattle. These animals are bred solely for one purpose, milk production, and breed again and again until they reach age where no more calving can take place and such animals have two fate in the end either they are replaced by fresh animals or culled.

Holstein Friesian cattle which is one of the highest producing dairy cattle breeds originated from the Holland and Friesland. In the world this breed of dairy cattle is also known as the highest production dairy animal. The breeders of Dutch and German bred wanted to develop a breed of dairy cattle having main objective to make maximum utilization of the grasses and the various abundant resources which in turn resulted in the development of breed over the centuries that could produce high amount of milk. In the Europe and major regions this breed is used for the milk purposes.

Based on colors two varieties can be seen which are black and white and other one is red and white. The expression of red color replacing the black in Holsteins is a function of a recessive gene. For instance, if the allele 'B' stands for the dominant black and 'b' for the recessive red, cattle with the paired genes 'BB', 'Bb', or 'bB' would be black and white, while 'bb' cattle would be red and white.



Figure 2.1. Black and white Holstein



Figure 2.2. Red and white Holstein

2.2 Turkish Dairy Sector Overview

Dairy can be defined as universal agricultural production where people milk dairy animals in almost every country across the world, and up to one billion people daily hood living depends on dairy farms as it is one of the major and important part of the global food system. In addition to this rural area maintenance and survival majorly depends on the dairy industry. It is a well-known fact that dairy industry has a major influence on a country's economics.

Turkey with milk production greater than 22 million tons makes it the Europe's 3 largest and world's 8th largest milk producer. (Figure 2.3). The Turkish food and

agricultural sector have 24,000 enterprises and dairy industry contributes 18% (4,320 enterprises) in it.

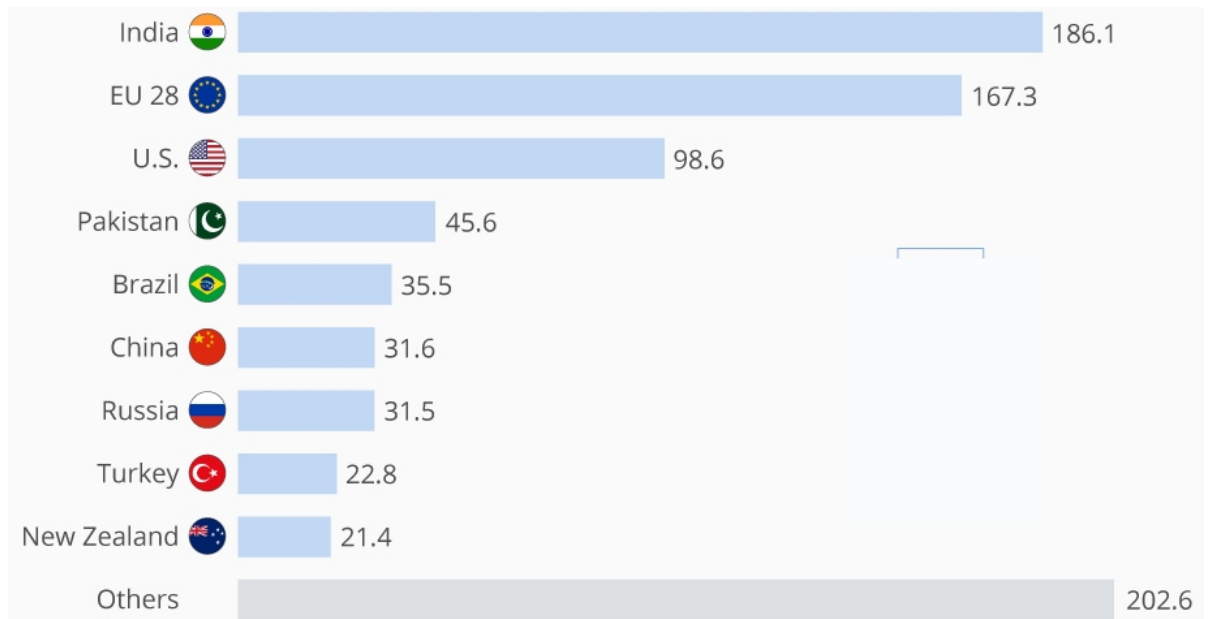


Figure 2.3. Countries by amount of their milk productions in 2018 in million tons (Katharina, 2019)

Turkey has shown a significant development in terms of milk production. In Turkey, the most milk producing provinces are Izmir, Aydin, Çanakkale, Konya, Denizli and Burdur, Balikesir. Turkey is one of those countries where milk and milk products like ayran, yogurt and lots of special kinds of cheeses consumption is high. Due to increasing milk consumption demands and to maintain that supply there is significant growth seen in liquid milk production.

In animal production sector dairy industry is one of the major and important parts which holds considerable potential and have a vital role in the Turkey economy. In the EU, the share of dairy production held by large-size enterprises. From this, it is clearly seen that the share of the dairy farming in Turkey is very small. For the improvement of this sector, an expansion of economy of scale is required. On farms the milk is used as raw milk while majority of milk goes to traditional dairies and modern processing plants remaining milk is sold on the streets. Over the past few years, the milk processing plants numbers has increased in Turkey. Many high-tech investments are done for dairy

industries, particularly in the last decade resulted an increase in the amount of milk produced, processing firm numbers, and the quantity of milk processed.

2.2.1 Milk production in Turkey

Total amount of milk produced in Turkey and it is significant development over the past years. from all species in the past years is shown in figure 2.4. With thee exceptions in 2015 and 2016 which shows slight increase in the amount of total milk production, total milk production has increased from all species and is doubled over the growing years.

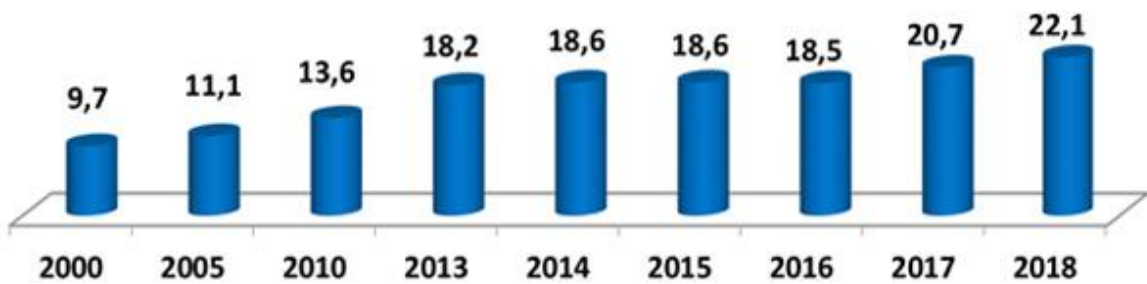


Figure 2.4. Milk production growth of all species in million tons (IDF, 2019)

2.2.2 Cow milk deliveries in Turkey

Whereas there are some other data which shows the amount of the cow's milk deliveries that has increased from 2011 to 2018 (Figure 2.5). Majority of the total amount of milk is delivered to processors the rest is marketed via informal markets, household consumption, used in feeding etc.

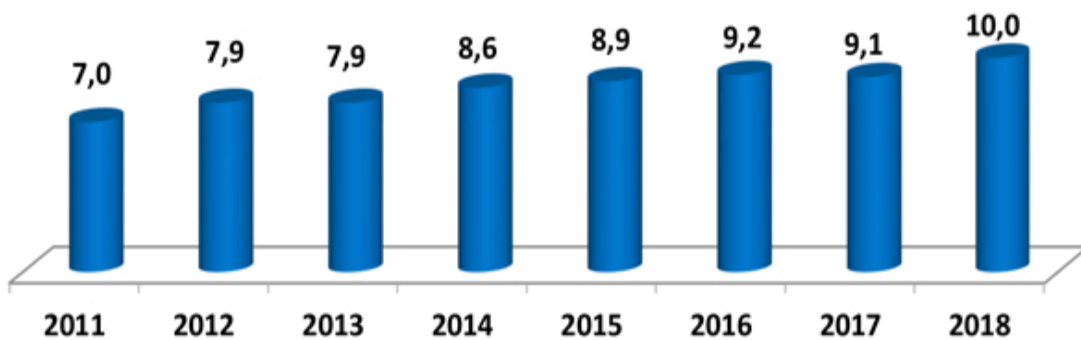


Figure 2.5. Cow's milk deliveries in million tons (IDF, 2019).

2.2.3 Milk consumption in Turkey

Milk consumption has increased over the time as Turkey is a country where milk and dairy products are definite part of its culture. Dairy products like ayran, cheese, yogurt and butter are much used in Turkey. The milk consumption of milk in Turkey has increased over the time (Figure 2.6). From the past few years, the milk consumption in Turkey has increased therefore importance is given to its production to maintain demand supply chain.

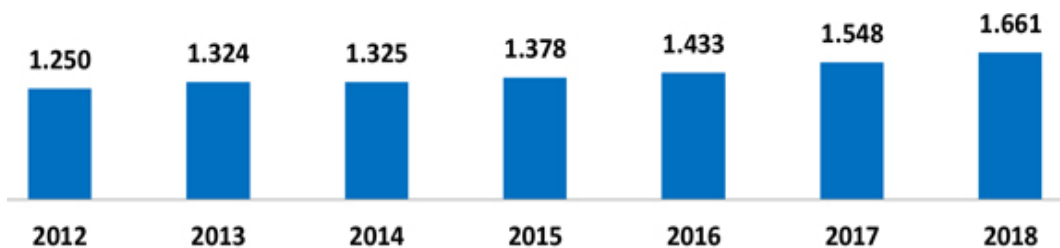


Figure 2.6. Amount of drinking milk production in million tons (IDF, 2019).

2.2.4 Dairy products utilization in Turkey

One of the major dairy products that are of extreme importance and are thus used in breakfast is cheese. According to the statistical analysis cheese is one of the major and leading products in terms of the domestic market as well as the foreign trades. Yogurt among all other dairy products is on the second number in terms of production. After the yogurt, the liquid milk has the more production. Ayran and yogurt are much consumed in different parts of Turkey.

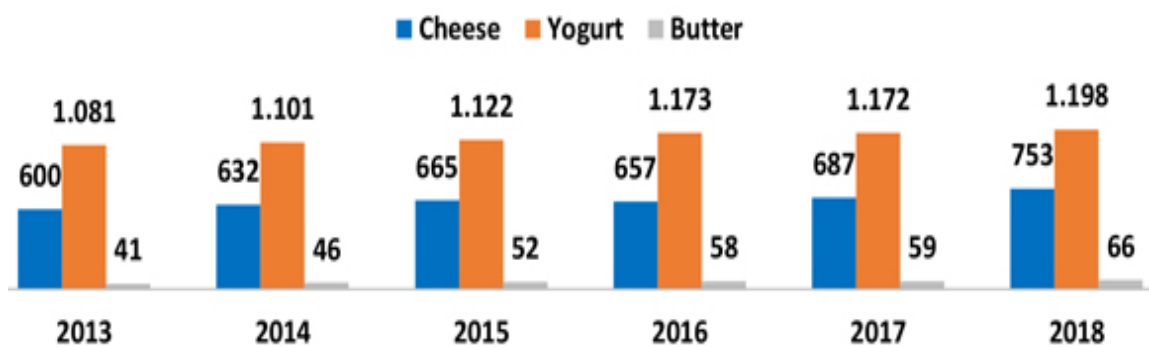


Figure 2.7. Production of cheese, yogurt, and butter in different years in Turkey (IDF, 2019).

2.3 Productive and Reproductive Traits

Several methods are being used for calculating productive and reproductive indices as well as for assessing these traits efficiency in dairy cows. Some of merits which are used for measuring the productive traits efficacy of the animal herds are milk production, total milk yield levels, lactation length, lactation numbers and dry period length while for reproductive efficiency preferred standards which are used include number of services per conception, calving interval, non-return rate, calving to conception interval and reproductive culling rate for infertility. The productive and reproductive traits which we are analyzing along with brief descriptions are defined as follow:

2.3.1 Milk yield

Milk yield is one of the major traits that are used for determining the productive efficiency of the cows. The dairy animals solely bred for one major purpose and that is to get more milk within limited time to fulfill the need of the animals. 305d MY is the minimum standard sets for getting milk for the animals to keep the herd going without effecting the reproduction. Getting milk for 305 d and then give rest or dry period to animal for 60 d minimum and maintain cycle of getting milk over the whole year. To get maximum milk yield animals should be keep away from all kind of stress and diseases like heat stress and mastitis which may adversely affects the milk production capacity of the animal ultimately reducing the milk production.

2.3.2 Dry period (DP)

Dry period is basically the time which is given to the animals to the animals after getting milk from udders. Dry period of 69 to 90 days is considered ideal for getting enough milk and maintaining calf per year strategy. Dry period is necessary to give as udder which is the milk factory keep working and epithelial cells and secretory cells (alveoli) of the udder get damage for which rest time period is required to regenerate the new epithelial cells and replace them with the damage cells. Decreasing dry period in terms for getting more milk does not result in more milk production rather it decreases the production in subsequent milking.

2.3.3 Lactation length (LL)

Lactation length or lactation period is basically the time or length of duration when animal is in milking state. The more persistent the lactation length or curve the more milk will be produced. The peak milk production occurs during the stating 60 days of lactation and then the lactation curve become persistent and then stats declining according to the conditions given to the animals.

The normal lactation curve is shown in figure 2.8 which indicates that once peak lactation is achieved the milk production remains constant for some time and then starts declining.

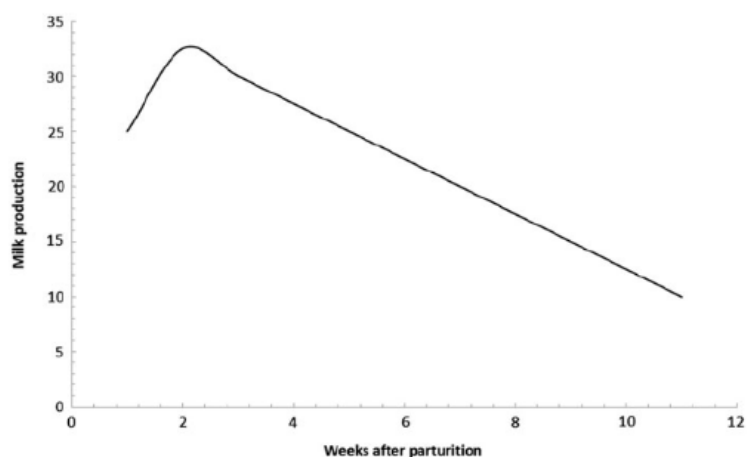


Figure 2.8. Normal lactation curve in dairy cow weeks after parturition (Martinez, 2019)

2.3.4 Calving interval (CI)

According to Dematawewa and Berger, (1998) there are several factors by which cow's fertility efficiency in terms of performance can be measured those factors include days open, calving interval, number of services per conception and age at first calving (AFC). CI is one of those traits and is defined as a period from one calving to another calving. To maintain calf per year concept the CI of 365 days should be maintained and should not be more than 365 days. This can be achieved when service period or days open of 60 to 80 days are given and then breeding is done followed by 9 months of gestation. This can be explained by figure 2.9 shows that maximum 83 days of open days will be

led to achieve calf per year concept. If days open (DO) for any reason increases the CI will increase.

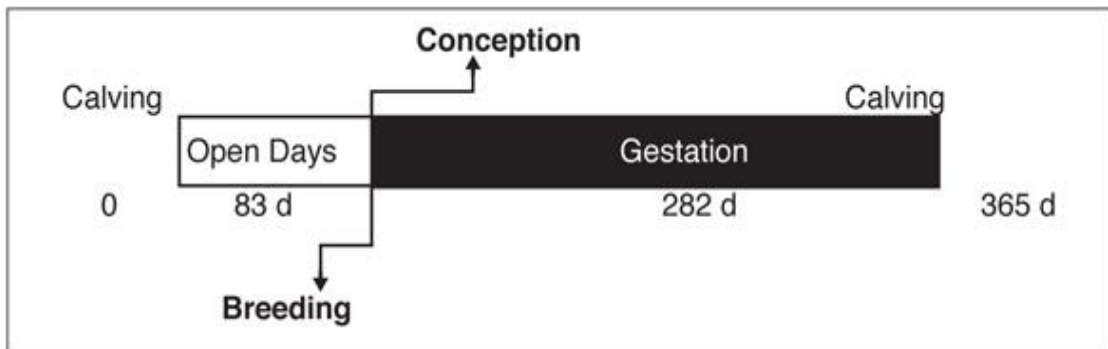


Figure 2.9. Normal dairy herd year of 365 days (Hagevoort and Garcia, 2000)

When CI increases from 365 days due to environmental, herd management or other reproductive problems the number of calves born per year decreases and after certain time the milk production also decreases which eventually finishes to avoid all these problems and maintain a persistent milk production CI should be maintained. Figure 2.10 shows if DO increased due to lack of estrous detection the CI increases.

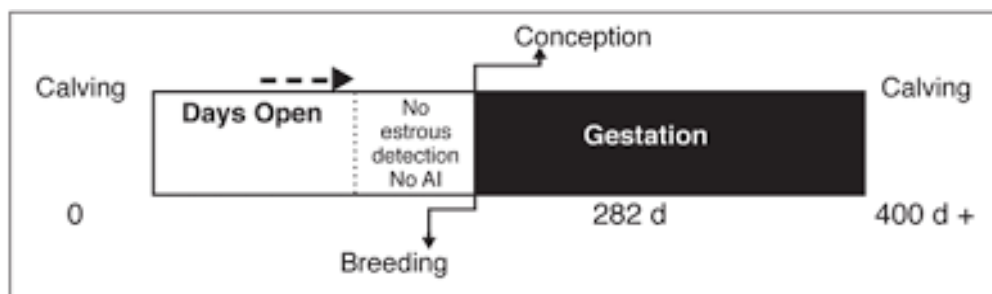


Figure 2.10. Herd year of animal with increased CI 400+ days (Hagevoort and Garcia, 2000)

2.3.5 Service period (SP)

Service period or days open is defined as the time from calving to first fruitful conception. Service period is one of the major fertility traits which are used for measuring the fertility level of any herd. Service period plays an important role in maintaining the CI between the two calving. It shares a direct relation with CI which means that the more the SP the more will be the CI and vice versa. Therefore, it is

necessary to maintain an ideal SP of range 60 to 90 days. SP greater than this will lead to increase in CI (Figure 2.11).

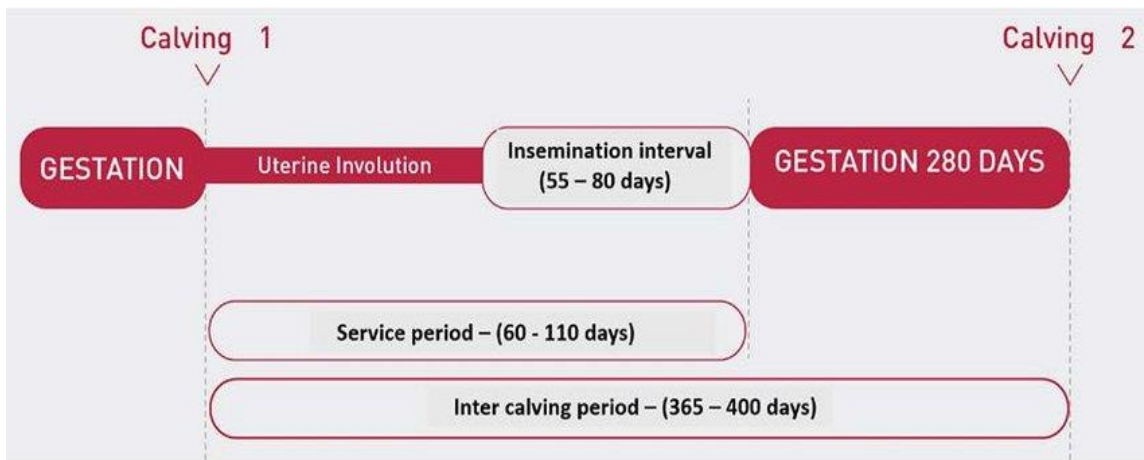


Figure 2.11. Length of service period and CI between two calving (Zigo et al., 2019)

2.4 Factors Affecting Performance Traits

The yield of the animals in terms of both production and reproduction performance is because of the combine effect of genetics and environmental effects. Maximum performance levels in terms of high production and good fertility performance can be achieved through proper maintenance and improvements in the environmental conditions and genetic structure of the animals. Climatic conditions, feeding practices, calving year, calving season, genetic background and diseases effects the production traits like lactation length, milk yield and dry period (Msanga et al., 2000 and Epaphras et al., 2004) For this it is important to determine the factors which are responsible and effecting these traits. Environmental factors include like calving age, calving year, calving season, milking frequencies etc. These effects can be measured and can be used in the farm management and maintenance (Çilek and Tekin, 2006).

2.4.1 Calving season

Calving season is defined as the month (season) in which the animal gave birth. Seasons have effect and influence on the performance trait of the animals. This is because performed best according to good environmental and seasonal conditions. During winter and spring seasons fresh fodder and pastures grazing are available in the most of places

which allows animals to have fresh fodder and pasture grazing availability causing animals to feed ad libitum and fulfill its nutrition requirements according to the body needs having positive effect on the udder health and milk production.

Pasture grazing helps the cows in providing more natural environment which helps animals to behave and work more efficiently. In addition to this, pasture grazing was allowed provided animals with environments effecting performance of animals in more normal manners. Pasture based feeding is done customarily it is characterized by maintaining cows grazing in the fresh pastures outdoors when weather is suitable enough like the summer months and when winter seasons came in they are dried off and are kept indoors commencing spring calving period.

Cows that are allowed to graze on pasture based systems have more good reproductive efficacy as they will calve in spring every year and after parturition are allowed to do outdoor pasture feeding resulting in improve relationship between pasture availability and feed requirements. As spring season have more fresh availability of pastures and are have nutritious value according to need of animals. When calving of such milk producing animal is done which have high genetic merit then each cow each year could produce up to 7000 kg of milk (Buckley et al., 2000). Similar results were reported by Theron et al., (2002) that winter calved Holstein dairy animals produce 186 kg more milk than summer cows. Other than fresh availability of pasture in winter and spring another major reason that vast effect on differences in milk production of summer and winter calving animals is heat stress.

Heat stress happens when animals are exposed to hot temperature and are unable to maintain the normal thermoregulation of body as a result normal physiology of udder and hormonal levels got disturb which eventually effects the milk production (Figure 2.12). When the environmental temperature rises then animal intake of feed decreases which results in low milk production. In addition to low feed intake it effects rumen functioning and udder health. Figure describes how heat stress effects in dairy cattle with low milk production. Thornton et al., (2015) reported that 10-30°C is the temperature where usually livestock species work efficiently when temperature rises above this the productive performance of dairy cattle got effected. Rejeb et al., (2012) studied heat stress effect on milk yield of Holstein cattle and observed that milk yield

decreases in summer compared to spring ascribe it with metabolic and physiological changes which lowers the feed intake. Majority of decrease in milk production is because of heat stress as compared to less feed intake (Rhodas et al., 2009). In addition to that heats stress also effects the rumen function, absorption of nutrients and imbalance of hormonal levels (Bernabucci et al., 2010)

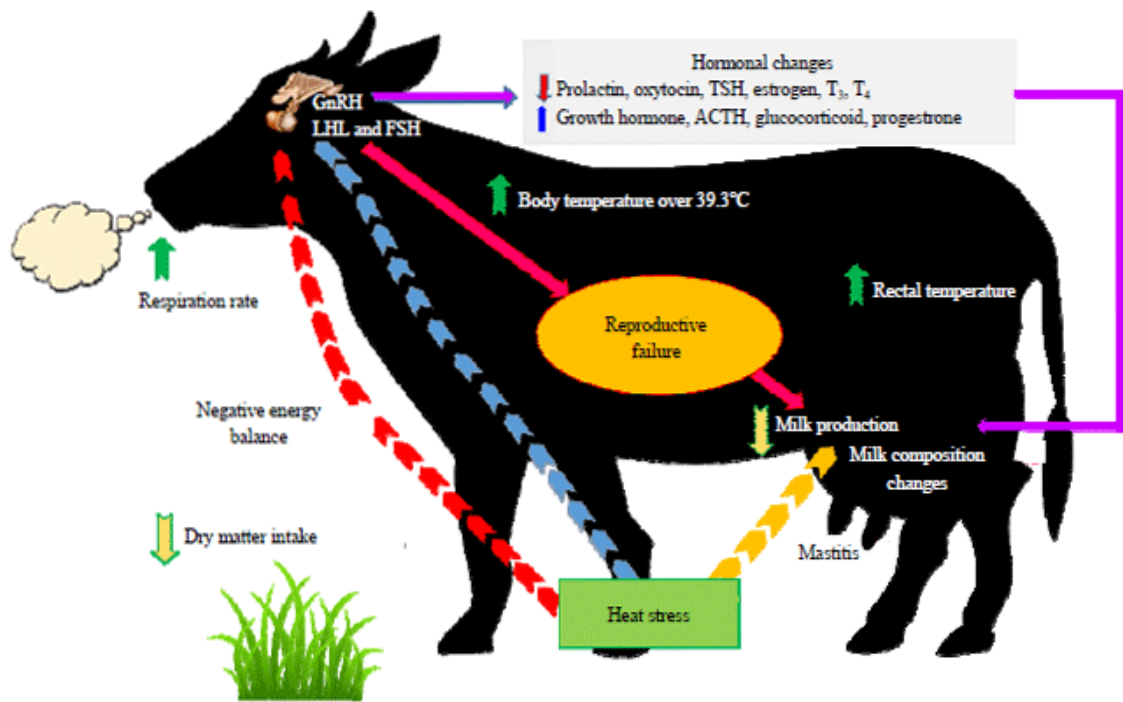


Figure 2.12. Representation of heat stress effect on dairy cow production (Pragna et al., 2017)

Holstein Frisian cattle are more effected by heat stress than the Jersey cattle (Bajagai, 2011). The animals who are high yielder are more effected by heat stress than the low yielders because high yielders have high feed intake which ultimately produce more metabolic heat in result of rumen degradation of feed as a result the overall heat level in high yielder increases both from outside (environment heat) and inside (metabolic heat) and are thus adversely effected followed by less milk production. This is very much like the results by Brown et al., (2015) who reported that heat stress outcomes are more harmful to high yielder dairy cattle that are already under metabolic stress. Dikmen et al., (2015) noticed that cows who calved in summer season followed by heat stress reported decreased milk production then those dairy animals who calved in winters. As a result, it shows that calving season has a significant effect on the amount of milk

produced as summer calvers had lower values for 305-days milk production than did winter and spring calvers.

2.4.2 Age at first calving (AFC)

Age at first calving (AFC) is defined as the age when animal give birth to its first calf. AFC is an important factor and have effect on both productive and reproductive performance of the animals. Generally, it is recommended that animal achieved puberty when 65% of the adult weight is gained by the individual animal and then get an early AFC of less than 20 months and thus start giving milk early with long time milk production and good fertility. This is done because as the age of animal increases the fertility and life span of the animal decreases. As animal gets older animal may suffer from diseases and other health issues which shortens the life span followed by reproductive tract disorders. Animal may get obese with the progressing age and fat deposition occurs on the ovaries which make the animals difficult to get cyclic. Noncyclic animals unable to show heat and hence reproduction efficiency starts decreasing having effects on production performance of the animals. Early AFC is attained through proper feeding, proper growth rate, health maintenance and fulfill nutrition requirements during the rearing period.

If AFC is too early like 11 or 13 months there are chances of dystocia or still birth as animal body has not fully developed properly to carry out pregnancy as fetal to mother ratio is not proper and smaller animals get matted with larger body sires and female yet does not have achieved the required body size to carry out pregnancy with fetal maternal disproportion. Similarly, Martinez et al., (1983) also reported that animals whose AFC is very low they suffer from dystocia. Dystocia is defined as difficulty in parturition. When high yielding animals suffer from dystocia their body comes in stress which releases such hormones like corticosteroids that have negative effect on milk production and causes drop in milk production levels. Dystocia has direct effect on decrease milk production (Dematawewa and Berger, 1997).

Negative energy balance (NEB) is another reason which occurs when animals are allowed to calve at a younger age then required resulting in less milk production because the body and udder is not fully developed yet to produce sufficient milk as

body is still in growing process and the energy and feed which animal utilizes is used by body for growth and development. Milk yield is related to the development of the mammary glands, most of which happen before first calving. Therefore, a lower AFC can affect milk yield in the first lactation due to the insufficient development of mammary tissue. Negative energy balance affects the reproductive efficiency in terms of ovarian cycle where normal oestrous cycle does not carry out in animals as NEB effects the oocyte quality and size (Kendrick et al., 1999). In addition to this the reactivation of reproductive cycle in animals who calved at early age is also effected and compromised by NEB as these animals are still in small age and majority of the food they consume is utilized for growth, thermoregulation, milk production and other physiological activities as compared to older AFC group animals.

Similar work was indicated Fox et al., (1999) where it was showed that animals who calved early in age produce less milk in first lactation then the mature sized cows because they still using the energy and feed for growth to attain the required size. AFC is also associated with CI of animals. Animals who reach puberty early, get pregnant early and give calves in younger age have less CI between two lactations as the reproductive tract of primiparous cows is free from different diseases as compared to multiparous cows which develop different reproductive disease over the time.

Therefore, AFC less than 15 months should be avoided to remove chances of the negative effects on the health, production, and reproduction trait of the animals.

2.4.3 Dry period (DP)

Dry period is the time when no milking is done in the animals. Dry period of minimum 60 to maximum 90 is generally seen to get a calf per year. DP is an important time and must be given to animal for increase milk production. Dry period has significance effect on milk production. During the milking time the animal keep on producing milk and the udder are in continuous working phase for udder to rest and overcome the damage tissue during the lactation period. Dry period is advised so animal can make up the damage tissue and replaced it with the new tissues and cells for better performances in upcoming lactations. Capuco et al., (1997) stated that dry period resulted in new mammary tissue ultimately giving more milk.

Figure 2.13 represents the pictorial explanation of normal epithelial cells. During DP, these cells renewal is necessary to get good quality and quantity milk as these secretory cells responsible for milk production.

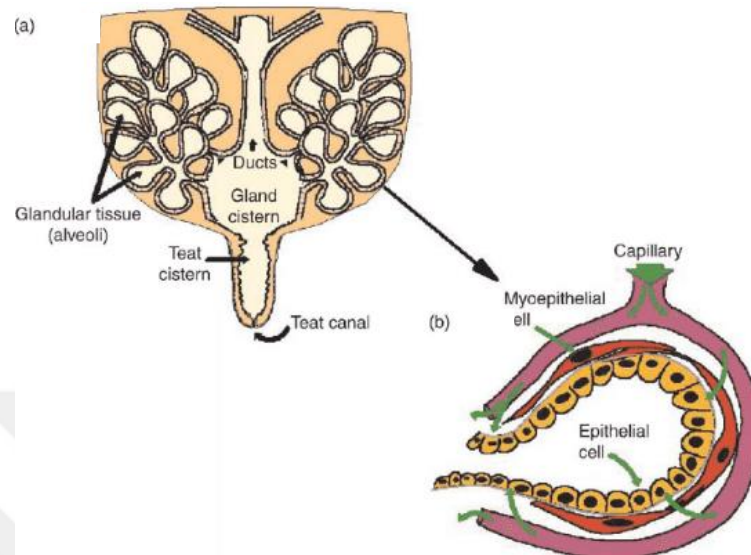


Figure 2.13. Normal udder epithelial cells (Nickerson and Akers, 2011)

When animal starts milking then epithelial cells starts secreting the milk and keep on producing until dry period is given. During that lactation time epithelial cells number decreases over the time due to damage and regression in epithelial cells and for their renewal dry period is given. In figure 2.14 illustration of lactation curve along with epithelial cells fate in a lactation period is given. The milk yield production of a day in a lactation is represented by the curve which reaches its peak production value at around days 40-50. The udder systems are highly developed before the lactation starts and even until peak production reaches whereas in later lactation period the epithelial cells and alveolar cells starts regressing until the lactations ends.

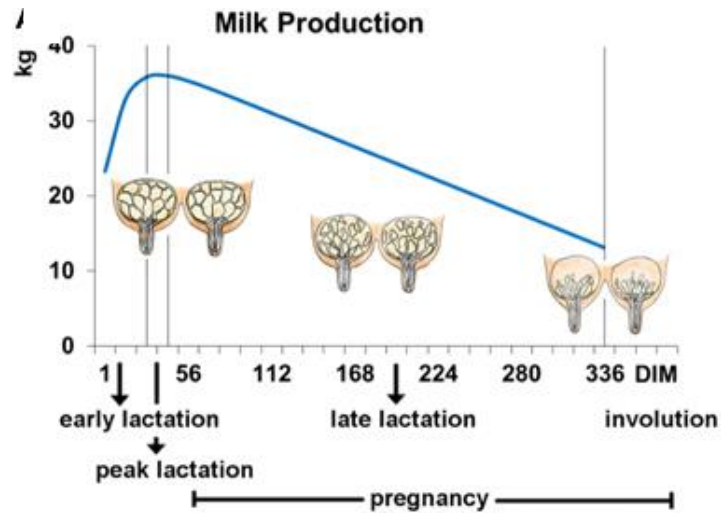


Figure 2.14. Lactation curve and udder health in a lactation (Strucken et al., 2015)

Dry period is essential for getting milk having good quality and quantity. Usually farmers are more into getting high milk yield levels and therefore continuously milk the animals with less or no DP. Therefore, many studies have been performed on the length of dry period given to animals to see how it effects the milk production and composition levels.

During the dry period, the animal energy balance shifts from negative towards positive energy balance as the feed which was previously utilized for the milk production is now using for growth, development, and udder recovery by the animal. In a study by Sorensen and Enevoldsen, (1991) studied the effect of 4,7 and 10 weeks of dry period on milk production and reported that when you increased the dry period from 4 to 10-week milk production increases. Thus, indicates the necessity of DP for good and persistent milk production and ideal DP of 60-90 days is recommended.

2.5 Heritability

2.5.1 General meaning of heritability

Heritability can be defined as the measure of the extent to which the performance of the offspring produced is like their parents for that particular trait. Heritability is an important term which describes the properties of inheritance of quantitative traits. Heritability value ranges between 0 to 1. If the value of heritability for a trait is higher it

means that high performance animals can produce offspring that have high performance as well and animals with low performance will then produce offspring with low performance. Contrary to this if trait have low heritability value and is not much heritable then the progeny performance is less revealed by parents performance.

There are two types of heritability that are used in researches these are broad sense and narrow sense heritability. Broad sense heritability ($H^2 = V_G/V_P$) can be defined as the ratio between variation due to genotype to variation due to genetic values whereas narrow-sense heritability, ($h^2 = V_A/V_P$) can be defined as ratio between additive genetic variations due to phenotypic variations (Wray and Visscher, 2008). In animals and plants selection programs narrow sense heritability is used mostly because the selection response (artificial or natural) depends on the additive genetic variance as resemblance present between the relatives majorly directed by additive genetic variance (Hill et al., 2008)

2.5.2 Importance of heritability

Heritability helps in the selection of those animals that can produce offspring with good performance. Selection objective is to choose those individuals that have enough good breeding values to be parents of next generation. As heritability defines the extent of relationship that is present between phenotype (performance) and genotype (breeding values) thus the contribution of heritability in selection is obvious (Cassell, 2009). Heritability estimates below or around 0.1 are regarded as low while between 0.1 and 0.3 is considered medium and between 0.3 and 0.4 is relatively high and above 0.4 is considered very high. Reproductive traits usually have low heritability whereas the production traits usually have moderate or high heritability. Heritability of some traits that are important for dairy animals are shown in table 2.1.

Heritability indicates the expected differences in the breeding value (genotype) of the animal for each unit of difference in animal phenotype (performance) for that particular trait. It indicates the amount of differences present in animal performance for a particular trait are estimated by genetic factors as compared to non-genetic factors. The goal of the breeding program is to get significant changes and improvements in animal performances as progeny are produced over the time for this the breeders tend to select

for high heritable traits which can cause genetic changes. As milk yield have high heritability then the CI that is why breeders selection is done on the basis of milk production performance of the animals not on the fertility traits which ultimately resulted developing high heritability trait in productions as compared to reproduction and an antagonist relationship exist between them.

Table 2.1. Estimation of heritability for some traits in Holstein cattle (Cassell, 2009).

Traits	Heritability values
Mature equivalent milk yield	0.30
Lifetime actual milk yields	0.15
Days of productive life	0.13
Persistency of milk yield	0.11
Lactose percent	0.43
Protein percent	0.51
Fat percent	0.58
Age at first calving	0.14
Calving interval	0.05
Days to first breeding	0.04
Number of inseminations	0.02
Body condition score	0.25
Energy balance	0.20

2.5.3 Heritability in breeding programs

Heritability helps the breeders to determine the amount of confidence to be placed in phenotypic performance of animal when choosing for next generation. Traits which have high heritability that is the value exceeds 0.4 then for such animals their phenotype values is an efficient standard to estimate their genetic performance while for low heritable traits where value is less than 0.15 animals phenotypic values is not much helpful in estimating the genes that are responsible for that traits.

The dairy sector is much keener about the genetic improvements done in fertility, production, health management and livability rate. Milk production have high heritability as compared to these traits. Over the last 30 years there is significant genetic gain in milk production of these animals. Progeny testing programs and multiple records collections for individual animals in the herds are some of the selection methods that can be used and are helpful for the traits that have low heritability. Heritability of such

traits can be improved through proper environment conditions as it removes the differences due to environment present between animals. Some of good environmental practices includes better nutrition, good milking practices, skilled and well managed hygiene practices.

2.6 Estimation of Variance Components and Heritability

The goal of the world is to fulfill the and maintain the demand and supply chain and for that purpose main objective is to get maximum production in limited time. Over the time this objective leads to selection and development of the things which have good genetics that can undergo such challenges and perform the best. Selection of individuals which have good genetics and can be parents for next generation this involves estimation of genetic parameters is done which shows which trait have enough heritability to be passed on to next generation. For heritability variance components estimation is much important which helps understanding the breeding mechanism as well as development of breeding program.

2.6.1 Estimation of heritability

The symbol of heritability is always h^2 . Heritability (h^2) can be measured in a lot of ways as it has many definitions and types according to which the estimating formula changes. Heritability can be calculated and define in many ways. Some of the ways by which can be define and calculated are as follow:

- a) The ratio of the additive genetic variance (V_A) to that of the total phenotypic variance (V_p):

$$h^2 = V_A/V_p \quad (2.1)$$

- b) The change in breeding value (BV) expected per unit change in phenotypic value (P). heritability is the regression of breeding value (BV) on phenotypic value (P):

$$h^2 = b_{BV.P} \quad (2.2)$$

- c) The ratio of genetic progress (G_{PROG}) because of selection to selection differential (S_{DIFF})
- $$h^2 = G_{PROG} / S_{DIFF} \quad (2.3)$$

2.6.2 Variance components

In natural populations the variations in most characters are taken in the form of continuous phenotypic range rather than the discrete phenotypic classes. The genetic and environmental variance estimations are specific to the one population and their environment in which the estimation was done.

The genetics of a metric character centers round the study of its variation. The variations based on causes can be divided into different components. The variance is basically the amount of variation that is measured. The phenotypic variance (V_P) can be divided into the environmental (V_E) and genetic variance (V_G) as shown below:

$$V_P = V_G + V_E \quad (2.4)$$

Table 2.2. Components of variance and their symbols

Variance components	Symbols
Phenotypic variance	σ_p^2
Additive genetic variance	σ_g^2
Residual variance	σ_r^2

2.7 Computer Programs to Estimate Genetic Parameters

In animal breeding programs the computing problems are becoming very difficult and complex with the passage of time which enabling to create new computer programs. REML has emerged and become as the method of choice in estimating covariance matrices in animal breeding. Its common views have only become possible with increasing computer power and the availability of free software packages. Several computer programs are currently available to a large extent this has been caused by the requirement for package and by the availability of computer networks.

2.7.1 REML

The main feature of Restricted Maximum Likelihood was described by Graser, (1987). In any livestock population with enough pedigree records it is possible to estimate the heritability from information record on related animals which includes the sibs, sire, dam, and grandparents. It is advantageous to use all the data to estimate variance components and genetic parameters. In short it calculates the variance components that would give likelihood of getting the observed phenotypic values of all individuals in dataset.

REML methods usually used for co variance components estimation under an animal model a model in which the additive genetic effect of the individual is fitted as a random effect.

2.7.2 MTDFREML

The program was an independent development and rewrite of DFREML. MTDFREML is more general in terms of models and is flexible with regards to data file structure.

2.7.3 ASREML

ASREML is a program designed to fit the general linear model to large data set using complex variance models. The program can be run in ODS, Windows 95 and UNIX systems and is a general program that can be applied to livestock data.

2.7.4 AIREMLF90

A modification of REMLF90 for estimating variances with the Average-Information algorithm. AIREMLF90 uses a second derivative REML algorithm with extra heuristics. In the first round, the algorithm produces new values based on the initial values. In a subsequent round, the new values come from the previous values. With several iterations, the values are expected to be close enough to the estimates of variance components.

CHAPTER III

MATERIAL AND METHODS

3.1 Animal Data

Data of 765 dairy animals was taken Cattle breeder of from Turkish association farm. Cattles who calved between 2013 to 2018 were used. Record of 765 animals which was used in analysis were born to 498 dams and 37 sires.

3.2 Preparation of Data for The Analyses

The production traits considered in present study were 305d MY, DP and LL where, 305d MY and LL were considered in kg while dry period was considered in days. Before the analysis, calving season considered from 1 to 12 months. Calving months were grouped in four seasons, December to February were termed as winter, from March to May were termed spring, June to August as summers and September to November as autumn. Age at first calving (AFC) were classified into 3 levels. AFC less than 20 months were considered as 1, 20-25 months as level 2, more than 25 months as level 3. DP from less than 100 days were considered as level 1, 100 to 150 days as level 2 and above 150 days as level 3. Animals with up to 4 parities were considered in final analysis. Animals LL were adjusted in such a way that LL less than 400 d was considered 1, 400 to 530 d as 2 and above 530 d as 3. Data of animals whose DP, CI, SP were unknown and those who have AFC less than 16 months are removed. Production traits studied were 305d MY, LL and DP and reproduction traits studied were CI and SP.

Table 3.1. Structure of the data used in analysis

Data	Total
Cattles	765
Sires	37
Dams	498
Years (2013-2018)	5
Seasons	4
305d MY	753
CI	419
DP	419
SP	416

305d MY= 305 days milk yield, DP = dry period, CI = calving interval, SP = service period.

3.3 Statistical Analysis

Minitab statistical program was used to identify the environmental factors effects (AFC, CS, CY, DP, LL, and parity) on traits (305d MY, LL, DP, CI, and SP). The significance and non-significance effects of the data with the target trait is checked using General Linear Model GLM of (Minitab Version-14) only significant effects were including in analysis. AFC was significant for all traits except the 305d MY and LL. Whereas CY was significant with CI and LL while CS was significant for 305d MY.

Following model was used in Minitab to identify the effects of environmental factors.

3.3.1 Model

$$y_{ijklmo} = \mu + AFC_i + CS_j + DP_k + P_l + CY_m + LL_n + e_{ijklmo} \quad (3.1)$$

Where,

y_{ijklmo} = observation value for the productive and reproductive traits

μ = overall mean

AFC_i = fixed effect of i^{th} value of AFC

CS_j = fixed effect of j^{th} value of CS

DP_k = fixed effect of k^{th} value of DP

P_l = fixed effect of l^{th} value of Parity

CY_m = fixed effect of m^{th} value of CY

LL_n = fixed effect of n^{th} value of LL

$e_{ijklmno}$ = random residual effect

For variance components and ultimately estimated genetic parameters estimation the AIREMLF90 software is used.

3.3.2 AIREMLF90

REML (restricted/residual maximum likelihood) is a popular method to estimate variance components in animal breeding. AIREMLF90 supports the average information (AI) algorithm. The AI algorithm (AI REML) is an iterative method which needs initial values of variance components. In the first round, the algorithm produces new values based on the initial values. In a subsequent round, the new values come from the previous values. With several iterations, the values are expected to be close enough to the estimates of variance components. To estimate variance components single trait animal model is used for traits which are 305d MY, DP, LL, CI, and SP. In preliminary analysis which check the significance of the factors which are used as fixed factors in the model to estimate the genetic parameters. The purpose of this analysis is to estimate the additive genetic variance (σ_u^2) and residual variance (σ_e^2).

The description of model to estimate the genetic parameters for traits in-matrix notations is written as:

3.3.2.1 Model for 305d MY

$$y_{ijk} = CS_i + DP_j + u_k + e_{ijk} \quad (3.2)$$

Where,

y_{ijk} = observed values; 305d MY

CS_i = fixed effect of i^{th} season of calving

DP_j = fixed effect of j^{th} dry period

u_k = additive genetic effect
 e_{ijk} = random residual effect, respectively.

3.3.2.2 Model for DP

$$y_{ij} = AFC_i + u_j + e_{ijk} \quad (3.3)$$

Where,

y_{ijk} = observed values, DP
 AFC_i = fixed effect of i^{th} age at first calving
 u_j = additive genetic effect
 e_{ijk} = random residual effect, respectively.

3.3.2.3 Model for LL

$$y_{ij} = CY_i + u_j + e_{ij} \quad (3.4)$$

Where,

y_{ij} = observed values, LL
 CY_i = fixed effect of i^{th} year of calving
 u_j = additive genetic effect
 e_{ij} = random residual effect, respectively.

3.3.2.4 Model for CI

$$y_{ijk} = AFC_i + CY_j + u_k + e_{ijk} \quad (3.5)$$

Where,

y_{ijk} = observed values, CI
 AFC_i = fixed effect of i^{th} age at first calving

CY_j = fixed effect of j^{th} calving year

u_k = additive genetic effect

e_{ijk} = random residual effect, respectively.

3.3.2.5 Model for SP

$$y_{ij} = AFC_i + u_j + e_{ij} \quad (3.6)$$

Where,

y_{ij} = Observed values, SP

AFC_i = fixed effect of i^{th} age at first calving

u_j = additive genetic effect

e_{ij} = random residual effect, respectively



CHAPTER IV

RESULTS AND DISCUSSION

The result has two parts the first part covers the results for the statistical analysis for the productive trait (305d MY, DP, LL) and reproductive trait (CI, SP) while the second part covers the estimation of heritability for productive and reproductive traits in Holstein Friesian cattle.

4.1 Descriptive Statistics

The display descriptive stats of the production and reproduction traits includes means, standard error (S.E), minimum and maximum of traits and are presented in Table 4.1. Mean of 305d MY, DP, LL, CI, and SP were $11799 \text{ kg} \pm 72.6$, $76\text{d} \pm 3.70$, $371\text{d} \pm 3.44$, $435\text{d} \pm 6$, and 155 ± 6.10 , respectively.

The present mean of DP was like estimate reported by Abd-El- Bary et al., (1992) (75d) and Sanad, (2016) (78.5d). Mean of LL was 371 days. The present mean was similar and closer to those estimated by Yadav et al., (1995); Javed et al., (2000) and Khan et al., (2012) as the estimated values were 372d, 348d and 312d, respectively. While, the present mean of LL was higher than that estimated by Zafar et al., (2008) and Rehman and Khan, (2012) as the estimated values were 262 and 235d, respectively. Higher LL of 532d was reported by Yadav et al., (1995) in Hariana breed of cattle in India which is higher than present study. The mean of CI is 435d. The mean is like Yadav et al., (1995) (431d), Zafar et al., (2008) (437d), and Rehman and Khan, (2012) (438d). These values are lower than reported by Rehman et al., (2008) (464d) and Javed et al., (2000) (468d). The mean of DO 155 was like estimate reported by Zafar et al., (2008) (159d); Rehman and Khan, (2012) (151d) and Raja, (2010) (149d). While, lower than those reported by Javed et al., (2000) (186d) and Kathiravan et al., (2009) (229d).

Table 4.1. Display descriptive stats of the reproductive and productive traits

Traits	N	Mean	Minimum	Maximum	S. E
305d MY	753	11799	5776	17874	72.6
DP	416	76.04	2	594	3.70
LL	764	371.05	220	818	3.44
CI	419	434.93	283	963	6.00
SP	419	155.42	3	799	6.10

N= number of animals, S. E= standard mean, 305d MY= 305 d milk yield, DP= dry period, LL=lactation length, CI=calving interval, SP=service period.

4.2 Factors Effecting Production and Reproduction Traits

Different standards are available to measure the lactating and fertility performance of the dairy cattle some of which for milk production are total milk yield of individual cattle in a year within single lactation, average milk production, lactation period, and lactation persistency while for fertility traits are age at first calving, calving interval, days open, and number of services per conception. The present analysis includes 305d MY, DP and LL as production traits while CI and SP as fertility traits. The result of effects (AFC, CS, CY, DP, and parity) on productive traits and reproductive traits along with the p-values were shown in Table 4.2.

Table 4.2. Factors effecting the productive and reproduction traits and their p-values

Productive Traits	Factors	Factors level	n	Mean ± S. D	P values
305d MY	CS	Winter	103	12203 ± 1602	0.005**
		Spring	138	12076 ± 1860	
		Summer	270	11783 ± 1948	
		Autumn	241	11489 ± 2213	
	DP	<100	726	11754 ± 1993	0.003**
		100-150	19	12817 ± 1612	
		>150	8	13520 ± 1214	
	AFC (months)	<20	462	11868 ± 1682	0.4NS
		20-25	30	11573 ± 1471	
		>25	261	11704 ± 2488	
DP	AFC (months)	<20	218	62.55 ± 31.14	0.001**
		20-25	62	89.73 ± 94.26	
		>25	136	91.43 ± 106.50	
	CS	Winter	52	93.23 ± 111.84	0.1NS
		Spring	83	84.37 ± 82.54	
		Summer	144	71.83 ± 73.32	
		Autumn	137	68.91 ± 52.24	

LL	CY	2013	55	354.91 ± 90.75	0.007**
		2014	50	355.80 ± 106.51	
		2015	70	370.70 ± 107.39	
		2016	166	380.47 ± 104.71	
		2017	222	386.48 ± 99.04	
		2018	207	355.30 ± 70.64	
	Parity	1	265	365.90 ± 91.51	0.5NS
		2	247	369.79 ± 91.43	
		3	137	377.47 ± 95.84	
		4	115	377.97 ± 108.61	
Reproductive Traits	Factors	Level	N	Mean ± S.D	P values
CI	AFC (months)	<20	221	418.9 ± 88.9	0.01*
		20-25	62	444.4 ± 144.3	
		>25	137	456.3 ± 152.8	
	CY	2013	4	315.0 ± 8.5	0.004**
		2014	42	390.0 ± 79.0	
		2015	50	408.5 ± 168.2	
		2016	68	419.4 ± 112.3	
		2017	120	437.0 ± 131.2	
		2018	135	442.3 ± 105.9	
	LL (days)	<400	214	434.2 ± 133.9	0.1NS
		400-530	122	422.5 ± 96.2	
		<530	83	455.1 ± 126.4	
SP	AFC (months)	<20	220	139.9 ± 94.6	0.02*
		20-25	62	164.4 ± 144.3	
		>25	137	176.3 ± 152.8	
	Parity	1	217	152.9 ± 127.2	0.1NS
		2	113	150.3 ± 105.8	
		3	57	186.3 ± 166.4	
		4	32	134.9 ± 69.9	

* = significant, **= very significant, NS = not significant. 305d MY= 305 days milk yield, AFC=age at first calving, LL=lactation length, CY=calving year, CS=calving season, DP=dry period, CI= calving interval, SP=service period.

4.2.1 Effect of CS

The present analysis revealed that CS was only significant with 305d MY while season of calving showed non-significant variation for DP (Table 4.2). Çilek and Tekin, (2005); Zafar et al., (2008); Özkan and Güneş, (2011) and Bolacali and Öztürk, (2018) also reported non-significant effect of CS on DP. While Bormann et al., (2003) and Çilek and Tekin, (2005) reported significant effect of CS on milk yield and was higher in winter season calving cows.

The present study results show that milk yield is sensitive to seasonal variation and an increased trend is seen from winters to autumn. Milk yield was high in winter (12203 ± 1602 kg) and spring (12076 ± 1860 kg) while lower values were present in autumn (11489 ± 2213 kg) and summers (11783 ± 1948 kg). With the highest production in

winters and lowest production value in autumn the animals calved in autumn produced 714 kg less milk than the winter calvers (12203 kg Vs. 11489 kg). Theron et al., (2002) also reported that winter calved Holstein dairy animals produce 186 kg more milk than summer cows. Similarly, McDowell et al., (1969) reported that cows with winter freshening dates had highest 305-d FCM (fat corrected milk), whereas cows calving in fall had intermediate 305 d FCM. These data indicated a carry-over of heat stress effects into the fall and summer months. High milk production in winters is due to the fact that animals have fresh and good pasture available for feeding which eventually increases the feeding levels while animals who calved in summer and autumn seasons have not fresh available pasture and face heat stress which further reduces the feed intake of animals resulting in negative energy balance ultimately reducing the milk production. Rhodas et al., (2009); Rejeb et al., (2012); Brown et al., (2015) and Dikmen et al., (2015) reported the effect of heat stress on milk production whereas Bajagai, (2011) results indicated that Holstein Friesian cattle are more sensitive to heat stress than the Jersey cattle.

CS was found non-significant with DP in present study showing decreasing trend in DP over the seasons from winter to autumn (Table 4.2) with the maximum DP was found in winters (93.23 ± 111.84) and minimum was found in summers (68.91 ± 52.24).

4.2.2 Effect of DP

Dry period was found significant only with the 305 d MY as per shown in table 4.2. Dry period significance for 305d MY indicates that it is one of important factor to get good milk production. In present analysis the value of 305d MY shows an increase trend with an increase in DP length. The minimum 305d MY (11754 ± 1993) is seen when DP length is less than 100 days and maximum 305d MY (13520 ± 1214) is shown when DP length is more than 150 days (Table. 4.2)

The result is like Sorensen and Enevoldsen, (1991) who studied the effect of increasing dry period length on milk production and reported that when you increased the dry period from 4 to 10 weeks milk production increases. Dry period plays an important role in the amount of milk produced. During the dry period, the renewal of udder tissues takes place and the damaged epithelial cells are replaced to make the udder healthy for

next milking. Capuco et al., (1997) stated that dry period resulted in new mammary tissue ultimately giving more milk.

4.2.3 Effect of CY

The effect of CY on the LL and CI was statistically significant ($p < 0.05$). Several other literatures where CY was found significant with LL were (Çilek and Tekin, 2005; Rehman et al., 2006; Zafar et al., 2008; Kathiravan et al., 2010; Rehman and Khan, 2012 and Bolacali and Öztürk, 2018).

The lowest LL yield ($355d \pm 90.75$) was seen in 2013 year, the highest LL ($386d \pm 99.04$) was seen in 2017. In LL, an increase in values was seen from 2013 to 2017 which then decreases in 2018. This decline in 2018 may be due differences in the feeding and management practices maintenance, less availability of forages and changes in environmental conditions.

For CI also an increasing trend over the year was seen with minimum CI ($315d \pm 8.5$) in 2013 and maximum CI ($443.9 d \pm 113.4$) in 2018. CI was between 315 to 443.9 days in this study (Table 4.2). This variation in CI over the years could be attributed to the increase in age of animal, herd management strategies and reproductive diseases of animals all of which make ultimately make it difficult for the animals to conceive resulting in increased CI.

According to present analysis the variation in milk yield from one year to other (Table 4.2) could be attributed to changes in herd size, use of animals with good genetics, age of the animals and good management and feeding practices introduced from year to another.

4.2.4 Effect of AFC

The age at calving significantly affect DP, CI, and SP with an increasing trend seen in dry period, CI, and SP which means that all three of them increases with increases in age at first calving (Table 4.2). The lowest DP, CI and SP (62.55 ± 31.14 , 418 ± 98.5 , $139.9 d \pm 94.6$) was found in animals with less than 20 months AFC and highest DP, CI

and SP (91.43 ± 106.50 , 456 ± 152.8 , $176.3d \pm 152.8$) in animals with AFC more than 25 months..

This may be because as the age of animal increases the milk production increases followed by udder growth and development and thus for highly well develop udder dry period length requirement in days also increases. Moreover, animals in older ages may also suffer from disease and udder problems like mastitis such conditions may also responsible for increase in length of the dry period. Animals with either AFC very low like less than 15 months or very high AFC like more than 30 months usually shows more CI this is because when AFC is very low then body is not developed enough to carry out pregnancy and cause problems for subsequent pregnancy resulting in increased CI and when AFC is very high then fat deposition in body is too much which causes problems during normal cyclicity of animals resulting increase the CI. In a study by Eastham et al., (2018) reported that on examining fertility performance animals CI increases as AFC increases. In another study by Pirlo et al., (2000) indicated that when AFC decreased it resulted in decrease in CI which ultimately showed a positive effect on genetic progress. Hutchison et al., (2017) reported that earlier AFC groups had improved effects for cow conception rate (CCR), heifer conception rate (HCR), daughter pregnancy rate (DPR), and calving ease which resulted in less still births rates suggesting that early AFC heifers have good conception rate and were able to get pregnant faster which decreases the CI and have high fertility. Gonzalez-Recio et al., (2004) also reported decreasing ages at first calving for dairy populations in Spain.

4.2.5 Effect of parity

The effect of parity showed non-significant variation for the LL and SP (Table 4.2). Similarly, Zafar et al., (2008); Pantelic et al., (2011) and Bolacali and Özturk, (2018) reported non-significant effect of lactation number (parity) on LL.

Although, LL and SP showed non-significant effect the minimum LL was in first parity (365.90 ± 91.5) and maximum LL was in the fourth parity (377.97 ± 108.61) while for SP maximum was in third parity (186.3 ± 166.4) and minimum was in second parity (150.3 ± 105.8)

4.2.6 Effect of lactation length (LL)

The results in table 4.2 showed that the LL was not significant with CI ($p > 0.05$). The maximum value of the CI (455.1 ± 126.4) was recorded when LL was more than 350 days (Table 4.2)

4.3 Estimation of Heritability for Productive and Reproductive Traits

Variance components, i.e., additive genetic variance and residual variance, were estimated for reproductive traits using AIREMLF90. Heritability was calculated from the variance components of productive traits obtained through program. Heritability was calculated using formula:

$$h^2 = \frac{\sigma_g^2}{\sigma_g^2 + \sigma_r^2} \quad (4.1)$$

Table 4.3. Estimation of variance components and heritability for productive and reproductive traits through AIREMLF90

Traits	h^2	σ_g^2	σ_r^2	σ_p^2	S. E for G	S. E for R
305d MY	0.1	373743	3458100	3831843	134190	206230
DP	0.03	182.54	5791.6	5974.14	299.49	489.40
LL	0.1	985.89	7928.3	8914.19	362.70	489.41
CI	0.09	1260.3	12688.	13948.3	838.59	1121.5
SP	0.1	1866.8	13599.	15465.8	951.30	1195.4

σ_g^2 = Genetic variance; σ_r^2 = residual variance; σ_p^2 = Phenotypic variance; S.E for G= Standard error for genetic variance; S.E for R= Standard error for R.

Estimated heritability for production and reproduction traits 305d MY, DP, LL, CI, and SP were 0.1, 0.03, 0.1, 0.09 and 0.1, respectively (Table. 4.3). The heritability estimates for productive traits is low and ranged between 0.03 to 0.1 while for reproductive traits ranged from 0.09 to 0.1. Such low heritability estimates for fertility traits in dairy cow is common as reproduction trait is antagonist with productive trait. The low heritability estimates for these traits indicate that these traits were largely affected by environmental factors majorly related to the management, and feeding of the animals therefore, improving management and feeding could also improve the traits followed by good breeding program.

The heritability of the productive and reproductive traits in comparison with other literatures can be seen in the table 4.4. the table summarizes the estimated heritability with other literatures heritability.

Table 4.4. Estimation of heritability in different literatures

Traits	Estimated heritability	Literature heritability	Source
305dMY	0.1	0.1	Dahlin et al., (1998)
		0.13	Abou-Bakr et al., (2006)
		0.14	Shalaby et al., (2016)
		0.14	Salem and Hammoud, (2016)
		0.23	Ulutas et al., (1995)
DP	0.03	0.03	Almedia et al., (2017)
		0.05	Rehman et al., (2008)
		0.06	Silva et al., (2006)
		0.1	Ulmek, (1991)
		0.1	Suhail et al., (2010)
		0.0004	Pereira et al., (2000)
LL	0.1	0.1	Ulmek, (1991)
		0.09	Rehman et al, (2008)
		0.08	Pantelic et al., (2011)
		0.16	Ulutas et al., (1995)
		0.14	Atil and Khattab, (2000)
		0.04	Ali et al., (2019)
		0.27	Abdel-Glil, (1996)
		0.33	Hammoud, (1997)
		0.33	El-Shalmani, (2011)
CI	0.09	0.08	Zambrano and Echeverri, (2014).
		0.04	Ojango and Pollot et al., (2001)
		0.06	Shalaby et al., (2016)
		0.05	Uloha et al., (2016)
		0.06	Dangar and Vataliya et al., (2017)
SP	0.1	0.1	Pantelic et al., (2011)
		0.09	Abe et al., (2009)
		0.08	Zambrano and Echeverri, (2014)
		0.09	Ali et al., (2019)
		0.04	Dematawewa and Berger, (1998)
		0.05	Atagi and Hagiya, (2005)

In present analysis the 305d MY heritability is 0.1 (Table 4.3). The results are much closely in agreement with the results reported by Dahlin et al., 1998; Abou-Bakr et al.,

2006; Shalaby et al., 2016 and Salem and Hammoud, 2016 who reported heritability value of 0.1, 0.13, 0.14 and 0.14, respectively. Higher values of 0.23 were reported by Ulutas et al., (1995) in Holstein Friesian cattle in Turkey (Table 4.4).

Heritability estimates of dry period for the Holstein Friesian were 0.03. Almedia et al., (2017) reported the same heritability of 0.03 for DP in Holstein cattle in Brazil. Rehman et al., (2008) worked on Sahiwal cattle in Pakistan and reported heritability estimate of 0.05. Silva et al., (2006) worked on Mantiqueira cows in Brazil and estimated value of 0.06 which are much close in agreement to our present study. Higher finding of 0.1 heritability was reported by Ulmek, (1991) and Suhail et al., (2010). In contrast, lower results of 0.0004 were reported by Pereira et al., (2000) for same breed in Brazil (Table 4.4).

Heritability estimates for the LL is 0.1 in the present study. Estimated results in present studies were like Ulmek, (1991) who reported a value of 0.1. The present findings are more like the findings of Rehman et al., (2008) and Pantelic et al., (2011) who reported heritability estimates of 0.09 in for Sahiwal cows in Pakistan and 0.08 in Simmental cows. Slightly higher heritability was estimated by Ulutas et al., (1995) and Atil and Khattab, (2000) reported value of 0.16 and 0.14, respectively. In contrast to this lower heritability estimates of 0.04 for lactation length were recorded by Ali et al., (2019). Abdel-Glil, (1996); Hammoud, (1997) and El-Shalmani, (2011) obtained heritability estimates of 0.27, 0.33 and 0.33, respectively which is higher than present study (Table 4.4).

Results showed that the value of CI heritability is 0.09 (Table 4.3) and are within the literature estimates for the fertility traits. Present analysis heritability is much closer to 0.08 heritability estimate of Zambrano and Echeverri, (2014). Whereas Ojango and Pollot et al., (2001); Shalaby et al., (2016); Uloha et al., (2016), and Dangar and Vataliya et al., (2017) reported heritability estimates of 0.04, 0.06, 0.05, 0.06, respectively which is lower than present results. In contrast to this Ali et al., (2019) reported heritability estimate of 0.14 which is higher than present study.

The heritability of SP was estimated to be around 0.1 (Table 4.3) which is similar to Pantelic et al., (2011) estimated value of 0.1 and is pretty much closer to Abe et al., (2009); Zambrano and Echeverri, (2014) and Ali et al., (2019) who reported values of 0.09, 0.08, 0.09, respectively. In contrast some authors Dematawewa and Berger, (1998)

and Atagi and Hagiya, (2005) reported value of 0.04 and 0.05, respectively which is lower than our estimated SP value (Table 4.4).

Low heritability estimates for production and reproduction traits in this study indicated that majority of the variations is because of the environment effects as compared to the genetic variations. These results indicate that genetic have some scope for improvement in trait but management and environment factors majorly effected the traits and does have role in controlling this trait as the variation of these traits is due to environmental differences among animals in a herd and, therefore, by improving management practices like proper heat detection, insemination at the right time, hygienic practices by decreasing disease prevalence, proper nutritional feeding, climatic conditions management by decreasing heat stress effects these things could improve the traits. The difference in our study with other countries research is due to difference in climate, environment and management factors.



CHAPTER V

CONCLUSION

Season of calving, calving year, lactation number, DP, and AFC, plays great roles in dairy cattle profitability through their significant effect on productive and reproductive traits. Cattles with AFC less than 20 months with calving in winter season and shorter DP than 150 days showed the best productive performances in terms of highest milk productions while animals that calved in 2017 showed the longest LL. For reproductive performances least values for CI and SP in days were in cattle that calved at AFC less than 20 months.

Estimation of low heritability for production and reproductive traits shows that these traits are majorly affected by the climatic conditions, nutritional, management and environmental factors as compared to genetic factors. The heritability of these traits can be improved with better management practices like estrus synchronization, proper heat detection to avoid heat missing scenarios and maintain ideal CI and SP intervals, get more winter calving, reduce adverse effect of autumn and summer seasons like heat stress. Moreover, it is preferred to avoid longer DP duration and maintain enough interval to keep animals in production. In addition to this the breeders should select animals through selective breeding and animals that have high genetic values should be selected as parents for next generation.

Overall, the present study results indicate that improvements in studied productive and reproductive traits for Holstein Friesian cattle can be achieved by managing the environmental factors as compared to genetic factors. Proper management practices, nutritional strategy, effective climatic conditions maintenance followed by selecting a proper breeding program may give better results.

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CURRICULUME VITAE

SADAF QADIR was born on December 19, 1993, in Lahore, Pakistan. She completed her secondary education from The Punjab School, Lahore in 2010. She completed her higher secondary education from Punjab College, Lahore in 2013. Afterwards, she was enrolled in University of Veterinary and Animal Sciences, Lahore for her undergraduate studies. She completed her Doctor of Veterinary Medicine (DVM) from the Faculty of Veterinary Sciences, University of Veterinary and Animal Sciences, Lahore, Pakistan in 2018. She was enrolled in the Graduate School of Natural and Applied Sciences, Department of Animal Production and Technology at Niğde Ömer Halisdemir University, Niğde, Turkey in September 2018 to pursue her master's education under the supervision of Prof. Dr. Zafer ULUTAS. During her Master's thesis research, she worked on the Estimation of genetic parameters for productive and reproductive traits in Holstien Friesian cattles, Turkey. She knows English, Punjabi and Urdu languages.

