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# Genetic evaluation of some economic traits in Sahiwal cattle

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## Abstract

The breeding data of 145 Sahiwal cattle spread over a period of 30 years (1987-2016) maintained at IDF, Nagla of GBPUA&T, Pantnagar (Uttarakhand). The study was conducted on least squares means, genetic and phenotypic parameters and genetic and phenotypic trends of first lactation production and reproduction traits. In Sahiwal, the estimates of genetic trends for FL305DMY, FLMY, FLL, AFC, FCI, FDP, FSP, FLMY/FLL and FLMY/FCI were 6.26±8.56 kg, 2.02±9.29 kg, -1.53±0.76 days, -3.24±3.36 days, 1.08±2.00 days, 2.57±1.90 days, 0.16±1.99 days, 0.02±0.02 kg and -0.009±0.02 kg, respectively. The estimates of phenotypic trends for these traits were 7.92±8.46 kg, 4.64±9.05 kg, -1.35±0.71 days, -2.20±2.00 days, -0.22±3.54 days, 1.14±2.03 days, -1.17±2.03 days, 0.04±0.02 kg and 0.01±0.002 kg, respectively. The genetic trends of first lactation 305 days milk yield were estimated to be 6.26 ± 8.56 kg/year. The genetic trends were found positive and statistically non-significant. The phenotypic trends were found as 7.92 ± 8.46 kg/year in Sahiwal. The phenotypic trend was found positive but statistically non significant. The environmental trends were found as 1.67 ± 1.40 kg/year. The environmental trend was found positive but statistically non-significant. For overall improvement in production, emphasis should be given to some reproductive traits like AFC and SP along with lactation milk yield while planning selection strategies.

## INTRODUCTION

Animal breeders are primarily concerned with the genetic improvement of the animal by making suitable selection and breeding policies and their implementation. The ultimate goal in animal breeding is to rank the animals according to their genetic merit for the desired characters and to use them efficiently in breeding programmes. The average genetic gain per unit time due to selection for milk production can be predicted with the help of an estimate of the heritability and selection differential of the characters. But the predicted gain may not be actually realized because selection scheme which may not be applicable in an actual practice, the managemental and feeding conditions are likely to change over period of time, and inaccurate information of the genetic status. Even when data are adjusted for yearly changes, the genetic changes still intermingled with environmental changes. Therefore, it is imperative to separate the genetic change from the environment ones, as accurately as possible. Several methods are being developed to measure the genetic change in the animal population. The genetic evaluation of animals is, therefore a key issue. For a breeding programme, it is pre-requisite to know about the changes occurring in a given population over the years to maximize genetic gain. The change or variation in average performance of a herd per unit of time is an indicator of the phenotypic trend and does not indicate the improvement in genetic potential of the animals. Genetic trend is the change in performance per unit time due to the change in mean breeding value (Harville and Henderson 1967). Hence, present study was undertaken to estimate the genetic, phenotypic and environmental trends in various traits in Sahiwal cattle, so as to generate information that will be helpful in developing selection programmes for genetic improvement of the breed.

## MATERIALS AND METHODS

A total of 145 performance records belonging to Sahiwal cows in at least three lactations or more spread over a period of thirty years (1987-2016) were utilized to estimate the trends in various traits maintained at Instructional Dairy Farm, Nagla of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttarakhand). The geographical location of Farm is situated between 28° 52′ to 28° 25′ North latitude and 78° 58′ to 79° 42′ East longitude. The minimum temperature during winter drops down to about 3°C and maximum temperature during summer increases to about 40°C. The climate at the farm is subtropical type and the cattle maintained at this farm are exposed to extreme climate conditions. The study was conducted on least squares means, genetic and phenotypic parameters and genetic and phenotypic trends of first lactation production and reproduction traits. The estimation of the genetic trend helps to monitor the efficiency of the breeding program implemented since it corresponds to the changes observed in the average values of reproduction of the animals studied for the traits involved during the selection process.

The effect of genetic and non- genetic factors on production and reproduction traits as well as heritability was studied by using "Mixed Model Least Squares and Maximum Likelihood (LSML) Computer Program PC-2" version Harvey (1990).

The effect of genetic and non-genetic factors (period & season of birth) was analyzed using the following mixed model for AFC:

$$Y_{ijkl} = \mu + P_i + S_j + M_k + e_{ijkl}$$

Where,

$Y_{ijkl}$ is observation on the $l^{th}$ progeny in $k^{th}$ season $j^{th}$ sire and $i^{th}$ period of birth

$\mu$= Over all mean

$P_i$ = Fixed effect of $i^{th}$ period

$S_j$= Random effect of $j^{th}$ sire

$M_k$= Fixed effect of $k^{th}$ season

$e_{ijkl}$= Random error which is NID (0, $\sigma_e^2$)

The effect of genetic and non-genetic factors was analyzed using the following mixed model for other traits.

$$Y_{ijklm} = \mu + P_i + S_j + M_k + A_l + e_{ijklm}$$

Where,

$Y_{ijklm}$ is observation on the $m^{th}$ progeny in the $i^{th}$ period of $j^{th}$ sire in $k^{th}$ season and $l^{th}$ age group

$\mu$= Overall mean

$P_i$ = Effect of $i^{th}$ period

$S_j$= Random effect of $j^{th}$ sire

$M_k$= Effect of $k^{th}$ season

$A_l$ = Effect of $l^{th}$ age group

$e_{ijkl}$= Random error which is NID (0, $\sigma_e^2$)

## RESULTS AND DISCUSSION

The genetic, phenotypic and environmental trends estimated for various first lactation production and reproduction traits have been summarized in table 1. The estimation of the genetic trend helps to monitor the efficiency of the breeding program implemented since it corresponds to the changes observed in the average values of reproduction of the animals studied for the traits involved during the selection process. **Hudson and Kennedy (1995)** suggested that the monitoring and interpretation of genetic trend estimates allow to monitor the efficiency of improvement strategies and to ensure that selection pressure is directed towards traits of economic importance.

**Table 1 Genetic, phenotypic and environmental trends of production and reproduction traits in Sahiwal cattle**

| TRAITS | GENETIC TRENDS | PHENOTYPIC TRENDS | ENVIRONMENTAL TRENDS |
|---|---|---|---|
| FL305DMY(Kg) | 6.26 ± 8.56 | 7.92 ± 8.46 | 1.67 ± 1.40 |
| FLMY(kg) | 2.02 ± 9.29 | 4.64 ± 9.05 | 2.56 ± 1.90 |
| FLL(days) | -1.53 ± 0.76 | -1.35 ± 0.71 | 0.18 ± 0.22 |
| AFC(days) | -3.24 ± 3.36 | -2.20 ± 2.00 | 1.05 ± 1.16 |
| FCI(days) | 1.08 ± 2.00 | -0.22 ± 3.54 | -1.29 ± 0.24** |
| FDP(days) | 2.57 ± 1.90 | 1.14 ± 2.03 | -1.430 ± 0.47** |
| FSP(days) | 0.16 ± 1.99 | -1.17 ± 2.03 | -1.33 ± 0.21** |
| FLMY/FLL | 0.02 ± 0.02 | 0.04 ± 0.02 | 0.01 ± 0.002** |
| FLMY/FCI | -0.009 ± 0.02 | 0.01 ± 0.002 | 0.02 ± 0.03** |

** Significant at $P \leq 0.01$ * Significant at $P \leq 0.05$

**First lactation 305 days milk yield**

The genetic trends of first lactation 305 days milk yield were estimated to be 6.26 ± 8.56 kg/year (Table 1) and were found positive and statistically. The phenotypic trends were found as 7.92 ± 8.46 kg/year. The phenotypic trend was found positive but statistically non-significant. The environmental trends were found as 1.67 ± 1.40 kg/year and were found positive but statistically non-significant.

**First lactation milk yield**

The genetic trends of FLMY were found as 2.02 ± 9.29 kg/year. The genetic trends were found positive but statistically non-significant. A positive genetic trend indicated that the selection strategies emphasized more on milk yield. The overall increasing genetic trends were observed for FLMY in Sahiwal (Fig 1). The phenotypic trends were found as 4.64 ± 9.05 kg/year and positive and non-significant phenotypic trend was found. The overall increasing phenotypic trends were observed for FLMY (Fig. 2). The environmental trends were found as 2.56 ± 1.90 and were found positive but statistically non-significant. **Nehara (2012)** also observed a positive environmental trend for this trait. The genetic trends of FLL were found as -1.53 ± 0.76 days/year. A negative and non-significant genetic trend was observed. A similar negative genetic trend in FLL as the present study was observed by **Mukherjee (2005)** and **Raja (2004)**. However, the positive genetic trend in FLL was observed by **Chaudhary *et al*. (2014)** and **Nehara (2012).**

**First lactation Length**

The phenotypic trends of FLL were found as -1.35 ± 0.71 days/ year. A negative and non-significant phenotypic trend was observed . A similar negative phenotypic trend in FLL as the present study was observed by **Rehman *et al.* (2008), and Mukherjee (2005)**. However, positive phenotypic trend was observed by **Chaudhary *et al*. (2014)** and **Nehara (2012)**. The environmental trends were observed as 0.18 ± 0.22 days/year and were statistically non-significant but in positive direction**. Nehara (2012)** also observed a positive environmental trend for this trait.

**Age at first calving**

The genetic trends were estimated to be -3.24 ± 3.36 days/year and was statistically non-significant. Overall, a decreasing genetic trend was observed (Fig.1). Negative genetic trends in AFC were also observed by **Ambhore *et al.* (2017), Nehara (2012), and Mukherjee (2005)** whereas**, Chaudhary *et al.* (2014)** found positive genetic trends in AFC. The phenotypic trends of AFC were found as -2.20 ± 2.00 days/ year and. a negative and non-significant phenotypic trend was observed. The similar negative phenotypic trend in AFC was also observed by **Chaudhary *et al.* (2014)**.

**First Calving Interval**

The genetic trends of FCI were found as 1.08 ± 2.00 days/ year. The genetic trends were found positive and statistically non-significant. **Ambhore *et al.* (2017)** and **Rehman *et al.* (2008)** also found positive genetic trends, while **Chaudhary *et al.* (2014)**, **Nehara (2012)** and **Mukherjee (2005)** observed negative genetic trend in FCI**.** The overall increasing genetic trends were observed for FCI in Sahiwal (Fig 1). The phenotypic trends of FCI were found as -0.22 ± 3.54 days/ year with negative and non-significant phenotypic trend was observed. A negative phenotypic trend in FCI was observed by **Mukherjee (2005)** and **Gaur (2003).** However, positive phenotypic trend was reported by **Ambhore *et al.* (2017), Chaudhary *et al.* (2014)** and **Nehara (2012).** Overall a decreasing phenotypic trend of FCI was observed (Fig 2). The environmental trends were found as -1.29 ± 0.24 and were found statistically highly significant ($P \leq 0.01$) **Nehara (2012)** and **Chaudhary *et al.* (2014)** also reported positive environmental trend for this trait.

**First Dry Period**

The genetic trends of FDP were found as 2.57 ± 1.90 and were found positive whereas negative and statistically non-significant in crossbred cattle. **Chaudhary *et al.* (2014)** and **Mukherjee (2005)** also reported negative genetic trend for FDP. However, **Rehman *et al.* (2008)** and **Rehman and Khan (2012)** found a positive genetic trend for FDP. Overall an increasing genetic trend of FDP was observed. The phenotypic trends of FDP were found as 1.14 ± 2.03 days/ year in Sahiwal and positive and non-significant phenotypic trend was observed. A positive phenotypic trend in FDP was observed by **Chaudhary *et al.* (2014), Rehman and Khan (2012), Rehman *et al.* (2008)** and **Mukherjee (2005).** The environmental trends were found as -1.430 ± 0.47 and 0.67 ± 0.24 days/year in Sahiwal and crossbred cattle, respectively. Environmental trends were found statistically highly significant ($P \leq 0.01$) in Sahiwal as well as in crossbred cattle. **Chaudhary *et al.* (2014)** also reported positive environmental trend for this trait.

**First Service Period**

The genetic trends of FSP were found as 0.16 ± 1.99 and were found positive and statistically non-significant. **Dash *et al*. (2016), Rehman *et al.* (2008)** and **Mukherjee (2005)** also reported positive genetic trend for FSP whereas **Ambhore *et al*. (2017)** and **Chaudhary *et al.* (2014)** are ported negative genetic trend. Overall, an increasing genetic trend was observed in present study. The phenotypic trends of FSP were found as -1.17 ± 2.03 days/ year and was observed in Sahiwal cattle whereas the positive. A negative phenotypic trend in FSP was also observed by **Ambhore *et al*. (2017).** However**, Chaudhary *et al.* (2014), Rehman *et al.* (2008)** and **Mukherjee (2005)** observed positive phenotypic trend. The environmental trends were found as -1.33 ± 0.21 and were found statistically highly significant (P≤ 0.01). **Chaudhary *et al.* (2014)** also reported positive environmental trend for this trait.

**First lactation milk yield/ First lactation Length (FLMY/FLL)**

The genetic trends of FLMY/FLL were found as 0.02 ± 0.02 and 0.22 ± 0.02 kg/year in Sahiwal and crossbred cattle, respectively. The genetic trends were found positive but statistically non-significant in Sahiwal cattle, while highly significant (P≤ 0.01) in crossbred cattle. **Nehara (2012)** and **Chaudhary *et al.* (2014)** also reported positive genetic trend for this trait. Overall, an increasing genetic trend was observed in Sahiwal (Fig 1) as well as in crossbred animal (Fig 2). The phenotypic trends of FLMY/FLL were found as 0.04 ± 0.02 were found positive but statistically non-significant. The environmental trends of FLMY/FLL were found as 0.01 ± 0.002 and were found statistically highly significant (P≤ 0.01). **Chaudhary *et al.* (2014)** also reported negative environmental trend for this trait.

**First lactation milk yield/ First Calving Interval (FLMY/FCI)**

The genetic trends of FLMY/FCI were found as -0.009 ± 0.02 and were found statistically non-significant. Overall, increasing trends were observed for FLMY/FCI (Fig. 1). **Nehara (2012)** and **Chaudhary *et al.* (2014)** also reported positive genetic trend for this trait. However, **Murdia (1989)** reported negative genetic trend for this trait.

Overall, an increasing phenotypic trend was observed in Sahiwal (Fig. 2). **Nehara (2012)** also reported positive phenotypic trend for this trait. However, **Chaudhary *et al.* (2014)** reported negative phenotypic trend.

The environmental trends of FLMY/FCI were found as 0.02 ± 0.03 and were found positive but statistically highly significant (P≤ 0.01) **Chaudhary *et al.* (2014)** also reported negative environmental trend for this trait.

Based on the results obtained in the present study, the positive and significant genetic and phenotypic correlation among production traits viz. FL305DMY, FLMY and FLL revealed that these traits are influenced by the same genes and improvement for one trait simultaneously leads to the improvement in other traits. The negative and non-significant genetic correlation between FLL and FDP indicate that selection on the basis of one trait could be done up to a desirable limit after that selection process can be relaxed. The overall increasing genetic and phenotypic trends for FL305DMY, FLMY, FLL, FCI, FSP, FLMY/FLL and FLMY/FCI in dictated that the selection strategies emphasized more on milk yield which is quite obvious as in dairy animals milk production takes precedence over other production traits. The AFC showed the negative trends over the years indicating the improvement in reproductive management of the cows.

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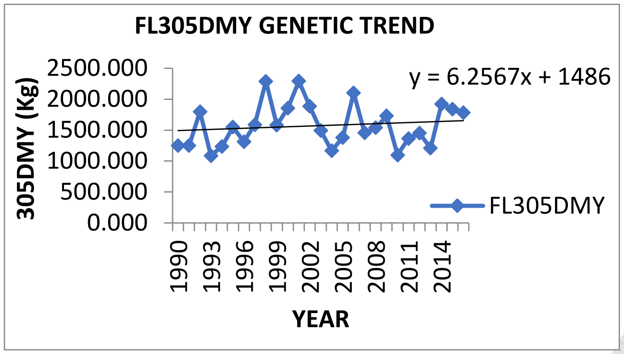
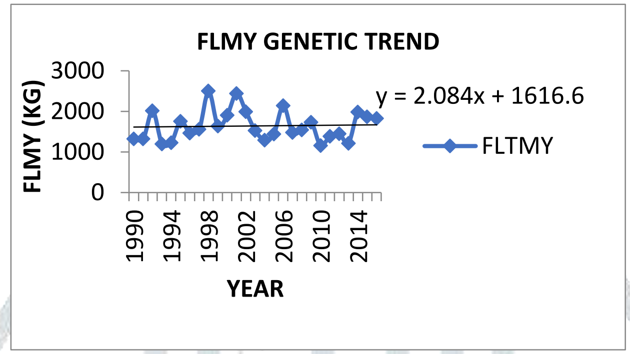
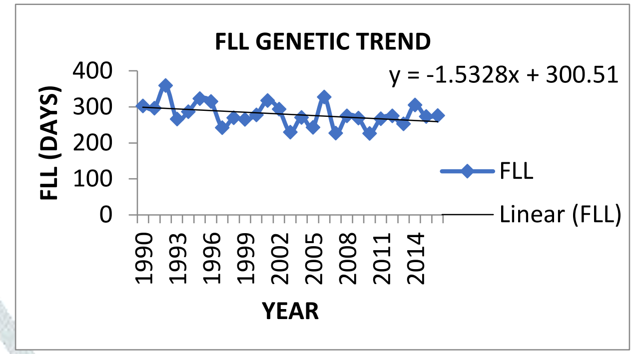
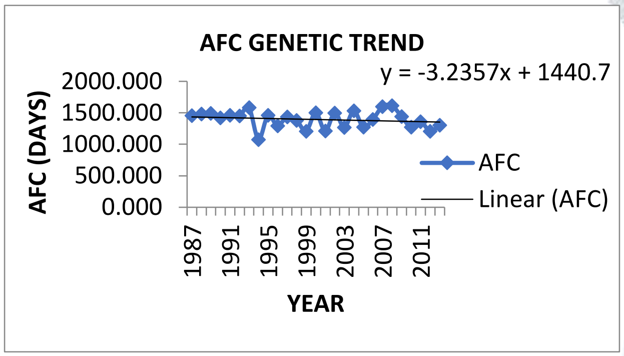
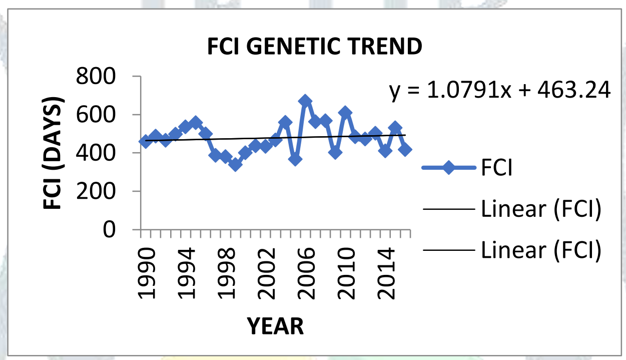
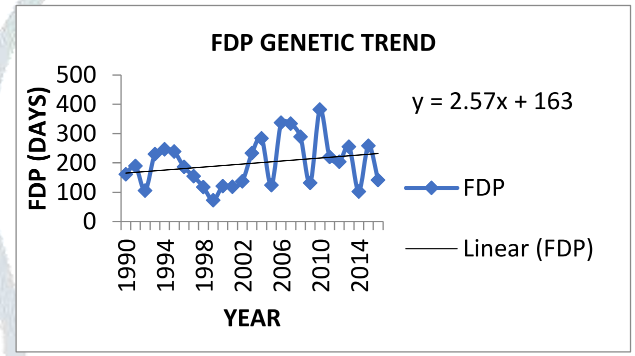

FL305DMY GENETIC TREND
y = 6.2567x + 1486
305DMY (Kg)
2500.000
2000.000
1500.000
1000.000
500.000
0.000
1990 1993 1996 1999 2002 2005 2008 2011 2014
YEAR
FL305DMY


FLMY GENETIC TREND
y = 2.084x + 1616.6
FLMY (KG)
3000
2000
1000
0
1990 1994 1998 2002 2006 2010 2014
YEAR
FLTMY


FLL GENETIC TREND
y = -1.5328x + 300.51
FLL (DAYS)
400
300
200
100
0
1990 1993 1996 1999 2002 2005 2008 2011 2014
YEAR
FLL
Linear (FLL)


AFC GENETIC TREND
y = -3.2357x + 1440.7
AFC (DAYS)
2000.000
1500.000
1000.000
500.000
0.000
1987 1991 1995 1999 2003 2007 2011
YEAR
AFC
Linear (AFC)


FCI GENETIC TREND
y = 1.0791x + 463.24
FCI (DAYS)
800
600
400
200
0
1990 1994 1998 2002 2006 2010 2014
YEAR
FCI
Linear (FCI)
Linear (FCI)


FDP GENETIC TREND
y = 2.57x + 163
FDP (DAYS)
500
400
300
200
100
0
1990 1994 1998 2002 2006 2010 2014
YEAR
FDP
Linear (FDP)

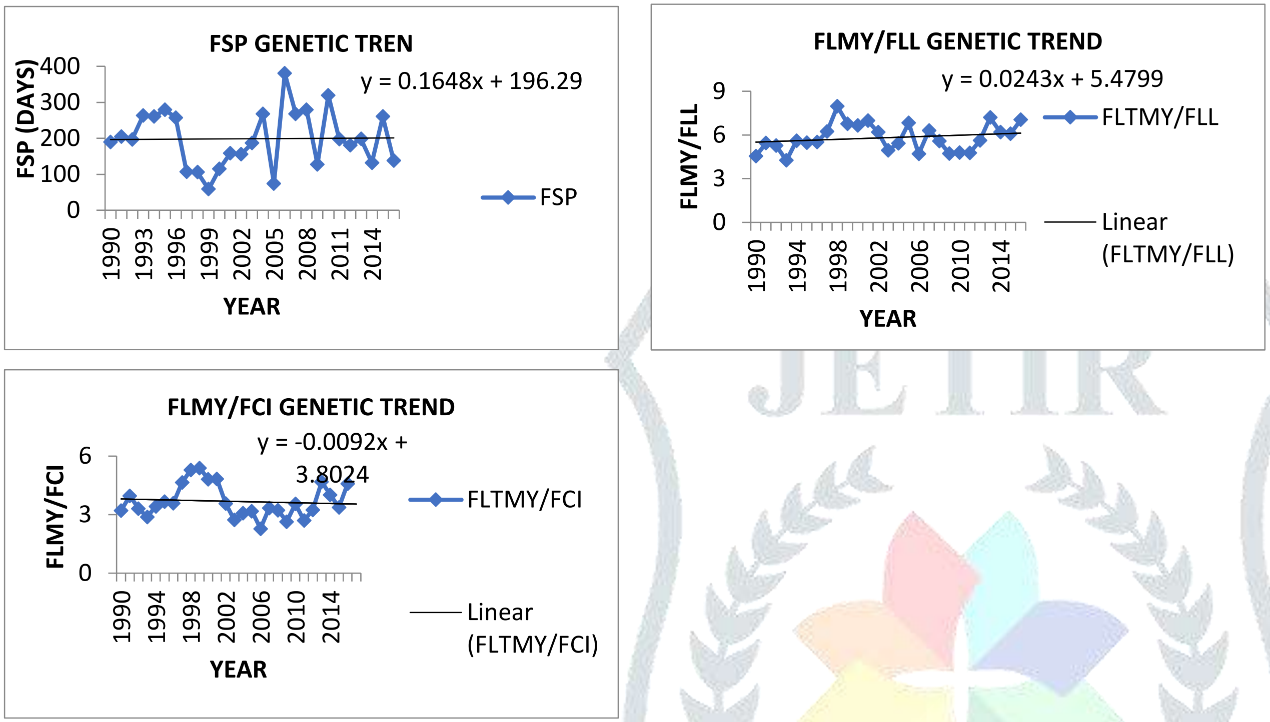
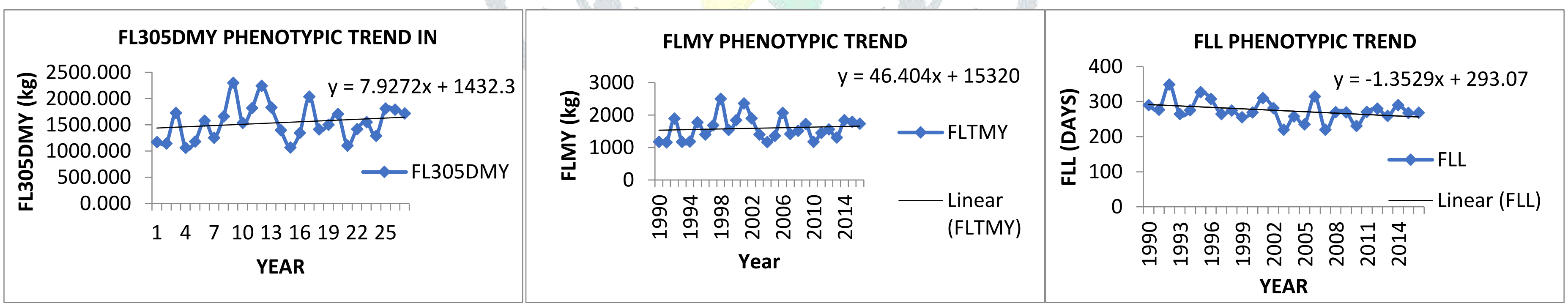



**Fig 1 Genetic trends of first lactation production and reproduction traits in Sahiwal cattle**.



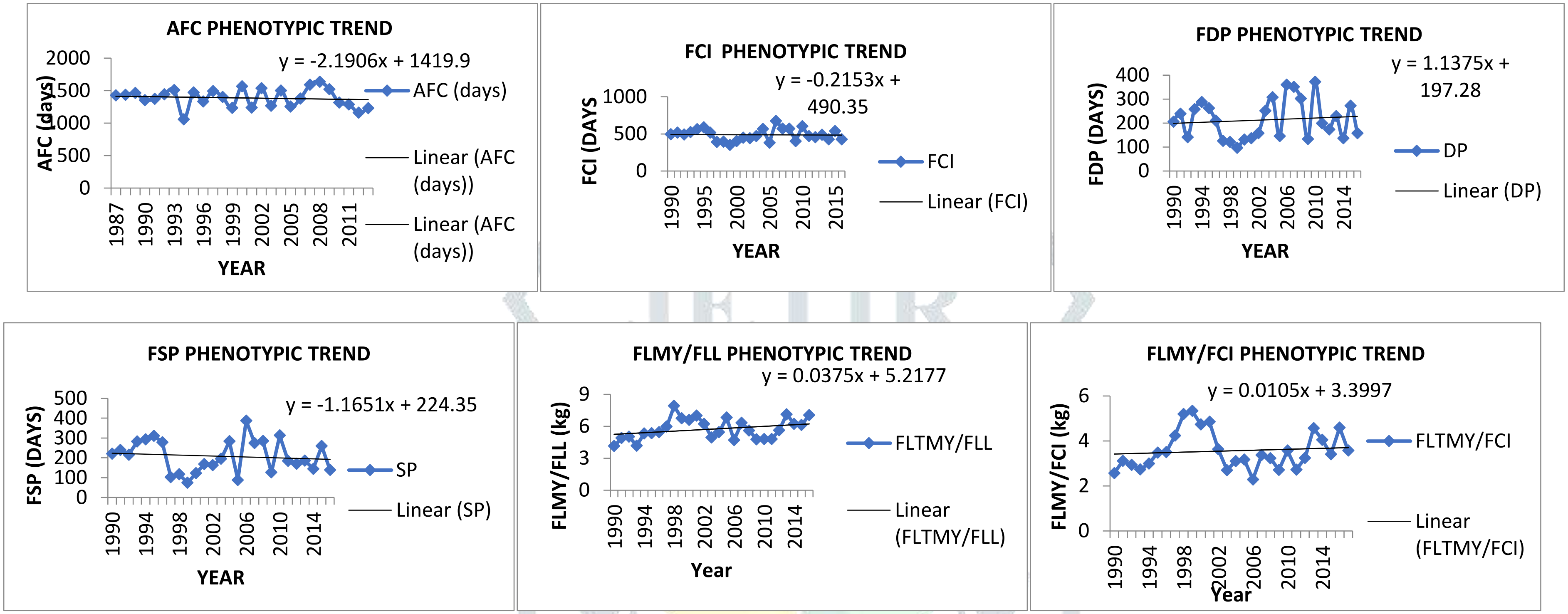



**Fig 2 Phenotypic trends of first lactation production and reproduction traits in Sahiwal cattle.**