Performance of Pabna Cattle Under Subsistence Farming System in The Northern Districts of Bangladesh

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A Production Report Submitted as per approved styles and Contents

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List of Abbreviation

ADMY	-	Average daily milk yield
AFC	-	Age at first conception
AFS	-	Age at first service
AP	-	Age at Puberty
BQ	-	Black quarter
CDC	-	Crossbred dairy cattle
CI	-	Calving interval
CK	-	Clinical ketosis
CVASU	-	Chattogram Veterinary and Animal Sciences University
DMRT	-	Duncan’s New Multiple Range Test
DO	-	Days open
DP	-	Dry period
et. al	-	And others
FMD	-	Foot and mouth disease
GL	-	Gestation length
GLM	-	Generalized linear model
GP	-	Gestation period
HF	-	Holstein Friesian
HS	-	Hemorrhagic septicemia
i.e.	-	That is
JS	-	Jersey
LL	-	Lactation length
LSD	-	Lumpy skin disease
LY	-	Lactation yield
PC	-	Pabna cattle
PPP	-	Post-partum period
SCHC	-	Sub-clinical hypocalcemia
SL	-	Sahiwal
SN	-	Sindhi
SNF	-	Solids not fat
SPC	-	Service per conception
TS	-	Total solid
USA	-	United States of America

Acknowledgement

In order to thank God—the universe's creator and supreme ruler—for enabling me to complete this task successfully, I would want to convey my sincere appreciation and compliments to him.

The author would also like to thank honorable Professor Dr. Mohammad Alamgir Hossain, Dean of the Faculty of Veterinary Medicine at Chattogram Veterinary and Animal Sciences University, and Professor Dr. A.K.M. Saifuddin, Director of External Affairs at Chattogram Veterinary and Animal Sciences University, for providing this sort of research work as a mandatory element of this internship program.

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Finally, I'd want to thank everyone who helped with the course and apologize for not being able to thank you all individually.

Performance of Pabna cattle under subsistence farming system in the northern districts of Bangladesh

Abstract

A cross-sectional survey was conducted during June 2021 to July 2022 in Bhangura upazila, Pabna, Bangladesh to explore the performance of eight different sub-types of Pabna cattle (PC). Results indicated that the mean birth weight, live weight, lactation length (LL), lactation yield (LY), average daily milk yield (ADMY), age at puberty (AP), age at first service (AFS), age at first conception (AFC) and dry period (DP) differed significantly ($p<0.01$) among the PC sub-types. Mean live weight of the highest milk yielding PC×$JS_{75\%}$ was 1.32 times higher than the PC. The LL of PC×$JS_{75\%}$ was 305±1.6 d which was 1.16 times higher than PC. The highest LY was recorded in PC×$JS_{75\%}$ which was 2.22 times higher than PC. Increased live weight and increased roughage supply through increased fodder area substantially increased milk yield. However, increased dry period, post-partum period and calving interval substantially reduced milk yield. Calving interval, days open and age at 1st conception constituted highest eigenvectors controlling maximum variability in the milk yield. The earliest and most delay AP was recorded for PC×SN and PC×SL genotypes, respectively. The minimum and maximum DP was recorded for PC×$JS_{75\%}$ and PC genotypes, respectively. The highest ADMY was recorded in PC×$JS_{75\%}$ genotype, which was 1.89 times higher than the PC. Comparatively more milk was produced in parity 2 compared with parity 1 irrespective of genotype. Overall, increased body weight of the sub-types of PC with increased milk yield had the increased probability of lumpy skin disease. However, increased roughage and concentrate supply substantially reduced probability of foot and mouth disease. It was concluded that the PC×$JS_{75\%}$ was the best PC sub-type.

Keywords: Birth weight, body weight, Pabna cattle, milk yield, age at puberty, calving interval

Introduction

Bangladesh is one of the most densely populated nations of the world with an economy centered on agricultural development where agriculture employs around two-thirds of the labor force (Uddin et al., 2010). Pabna, Shahzadpur, and Sirajgong are the areas known as the largest cooperative milk pocket in Bangladesh because of the largest milk shed area commonly known as 'bathan' area (Hossen et al., 2013). Before India was divided, the residents of these regions had a long history of raising high-yielding dairy cows. For the purpose of upgrading the local cows of these areas, in 1936, Lord Linlithgo, a British Viceroy at that time imported several Red Sindhi, Sahiwal, Hariana and some other proven Multani dairy bulls from the northern region of India for natural breeding (Udo et al., 1990). Thus, the cattle of these regions gradually developed by naturally mating with local cattle over many generations into a famous dairy type known as 'Pabna cattle' (PC).

In compliance with the strongly stressed initiative of the then-Government for establishing a milk pocket zone of the country, Bangladesh Milk Producers Co-operative Union Limited (BMPCUL) was founded in 1973 in a cooperative structure. The Australian Friesian Sahiwal (AFS), Sahiwal (SL), Friesian (HF), and Jersey (JR) breeds were crossed with local cattle as part of BMPCUL's ongoing work to develop PC since 1987. Frozen semen was used in these crosses. The United States, Pakistan, Australia, India, and New Zealand governments contributed to the importation of frozen semen. As a result, the cattle in these regions now exhibit higher amounts of temperate dairy inheritance (Hossen et al., 2013). Eight of the subgroups of the PC genotype were identified in the current study, e.g., PC, PC×SN, PC×SL, $PC\times HF_{50\%}$, $PC\times JS_{50\%}$, $PC\times JS\times HF_{50\%}$, $PC\times HF_{75\%}$, $PC\times JS_{75\%}$. For the last few decades, it has been a hot debated issue regarding which exotic combination of PC will be optimal under field conditions for those areas. The objective of this study was to explore the production efficiency and to figure out which particular genotype of PC is most resilient under prevailing management system.

Materials and methods

Study design, animals and housing

A cross-sectional survey was conducted during June 2021 to July 2022 in Bhangura upazila, Pabna, Bangladesh. The coordinates of Bhangura are between 24°09' and 24°21' north latitudes and between 89°20' and 89°28' east longitudes. It is bordered on the north by Tarash Upazila, south by Faridpur (Pabna), east by Ullapara and west by Chatmohar Upazila. Two rivers called the Baral and the Gumani cross the Upazila. The maximum average temperature in April is 36°C and the lowest is 22°C. The average rainfall of Bhangura is 1872 mm and humidity is 64%. Eight different sub-types, i.e., Pabna cattle (PC), Pabna×Sindhi (PC×SN), Pabna×Sahiwal (PC×SL), Pabna×Holstein Friesian$_{50\%}$ (PC×HF$_{50\%}$), Pabna×Jersey$_{50\%}$ (PC×JS$_{50\%}$), Pabna×Jersey×Holstein Friesian$_{50\%}$ (PC×JS×HF$_{50\%}$), Pabna×Holstein Friesian$_{75\%}$ (PC×HF$_{75\%}$) and Pabna×Jersey$_{75\%}$ (PC×JS$_{75\%}$) of Pabna cattle were used in the study. Animals were reared in loose house and stanchion barn.

Preparation of questionnaire

A structured questionnaire was prepared to get the required information as per objectives of the study. The questionnaire contained both open and close ended questions. Data related to the farm type, breed, genotype, housing system, parity, feeding systems, milking system, service per conception, age, weight, lactation period, average daily milk yield, age at puberty, age at first calving, postpartum period and dry period were prepared in the questionnaire. The questionnaire was pretested for pilot testing and then finalized.

Farm selection

Total 47 farms were chosen at random from ten villages in the Bhangura sub-district. The farms were chosen using a simple random sampling process. Farms with at least ten years of farming expertise and a lactating cow completing three parities were recruited for the study.

Farmer's interview

The interviewer received training in surveying, interviewing, and contacting farmers, as well as how to fill out a questionnaire form for the research, all of which were taught at CVASU. To be thorough, the interviewer only interviewed four farms every day. Face-to-face questions were asked to fill out the pre-tested questionnaire. The interviews with the farm owners and labours who worked on the same farm took around one and a half hour for interviewing. Between the two consecutive interviews, a thirty to forty minutes break was taken.

Data collection

Data were collected directly from the farm record and also by visiting the selected farm in the study area and by interviewing the officer and staff. The staff and officers were interviewed face to face. Verbal consent of the staff was taken before interview. A total of 359 cattle were found initially during the study period from which 170 milch cows were selected purposively as per requirement of the study.

Statistical analysis

Raw data were compiled into Microsoft excel professional 2020 (Microsoft corporation, USA). Outliers and multi-collinearity in the data set were tested by inter quartile range test and variance inflation factors. Normality of the response variable was checked by Shapiro Wilk test. The data were analysed by generalized linear model (GLM). Heatmap of multiple orthogonal contrasts were produced to check the dimensionality and strengths of the co-variates. Kaiser-Meyer-Olkin measures of sampling adequacy and Bartlett's test of sphericity were applied to test the suitability of the data set for the principal component analysis. The linear regression and response surface models were fitted using SAS 16.2 (SAS Institute Inc., USA). When statistical effects were deemed significant (P<0.05), the Duncan's New Multiple Range Test (DMRT) was used to compare the means. All statistical tests were performed by using Stata 14.1 SE (Stata Corp LP, College Station, Texas, USA). The following model was used to estimate the effects of the predictors on dependent variables:

$$Y_{ijkln} = \mu_{0} + \alpha_{ij} + \beta_{ik} + \gamma_{il} + \ldots\ldots \omega_{in} + \varepsilon_{ijlkn}$$

Where,

Y_{ijkln} = The observed effect of the trait 'i' at the 'jth' level of the predictor 'α', the ‘k^{th}’ level of the predictor ‘β’, ‘l^{th}’ level of the predictor ‘γ’……and the ‘n^{th}’ level of the predictor ‘ω’;

μ_0 = The intercept of the regression model;

α_{ij} = The slope of the regression model for the trait ‘i’ at ‘j^{th}’ level of the predictor ‘α’ observed on Y_{ijkln};

β_{ik} = The slope of the regression model for the trait ‘i’ at ‘k^{th}’ level of the predictor ‘β’ observed on Y_{ijkln};

γ_{il} = The slope of the regression model for the trait ‘i’ at ‘l^{th}’ level of the predictor ‘γ’ observed on Y_{ijkln};

ω_{in} = The slope of the regression model for the trait ‘i’ at ‘n^{th}’ level of the predictor ‘ω’ observed on Y_{ijkln};

ε_{ijkln} = The random sampling error of the trait ‘i’ at the ‘j^{th}’ level of the predictor ‘α’, the ‘k^{th}’ level of the predictor ‘β’, ‘l^{th}’ of the predictor ‘γ’……the ‘n^{th}’ level of the predictor ‘ω’ which is distributed as $\varepsilon_i \sim$ NID $(0, \sigma^2)$.

Results

Herd management

Hand mixed concentrate was preferred by the farmer mostly. In the concentrate wheat bran and coconut meal was commonly used. Most of the cattle fed with hand mixed concentrate and got highest number of milk production from most of the cattle (Figure 2). Most of the farmers around 84% did not use commercial concentrate. They made their own hand mixed concentrate for their cattle. Some farmers around 16% also used commercial concentrate for cattle. Most of the farmers around 84% did not use commercial concentrate. They made their own hand mixed concentrate for their cattle. Some farmers around 16% also used commercial concentrate for cattle.

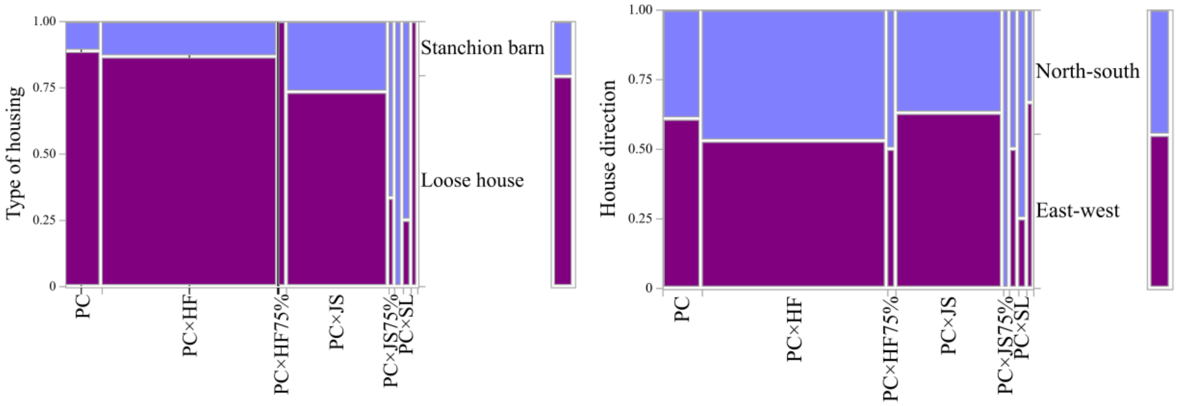

Figure 1. Mosaic plot showing the type and direction of the housing systems used for different sub-type of Pabna cattle at Bhangura, Pabna, Bangladesh (N=170)

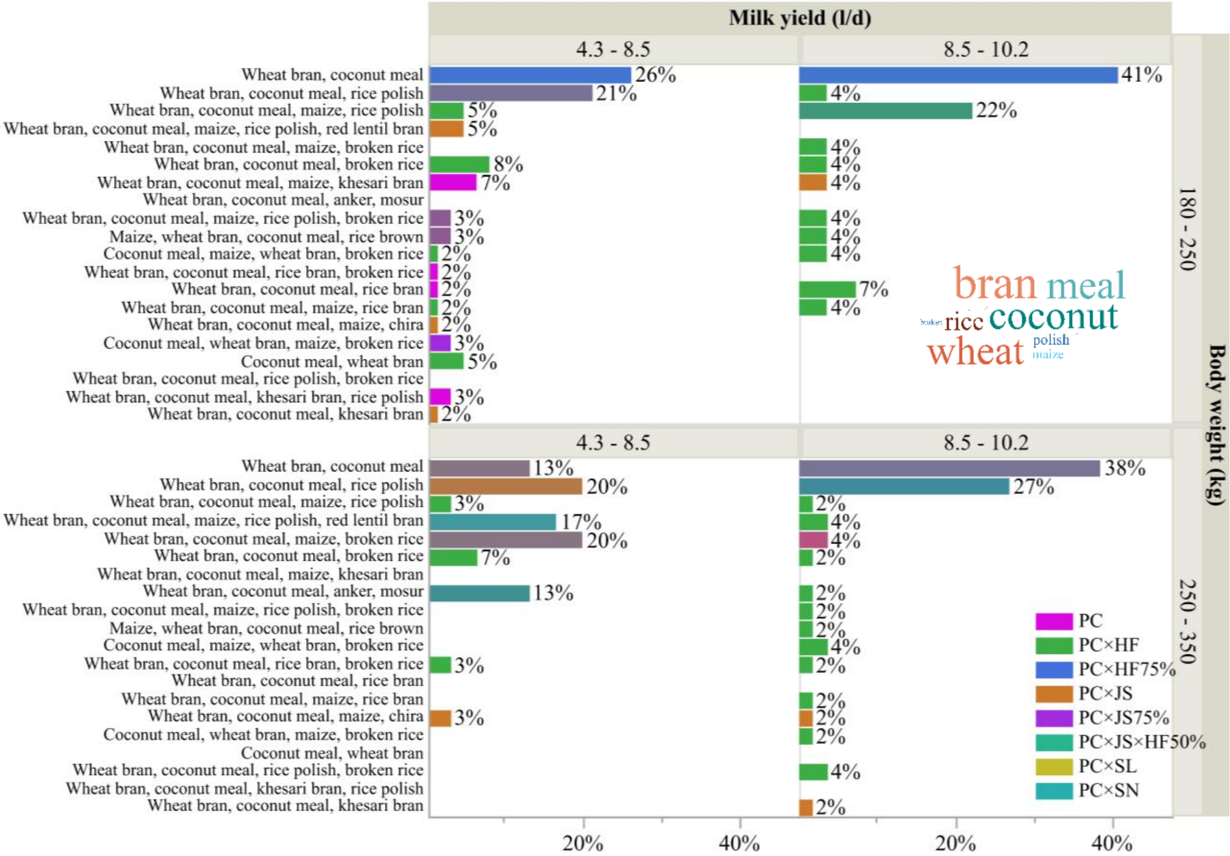

Figure 2. Feeding systems used for different sub-type of Pabna cattle at Bhangura, Pabna, Bangladesh (N=170)

Around 85% farmer used artificial inseimation to bred their cattle and around 15% farmer used bulls for natural breeding to bred their cattle. Most of the cattle was vaccinated with foot and mouth disease vaccine. Around 3% cattle were not FMD vaccinated. In case of lumpy skin disease vaccine around 35% cattle were vaccinated and other were not vaccinated (Figure 3).

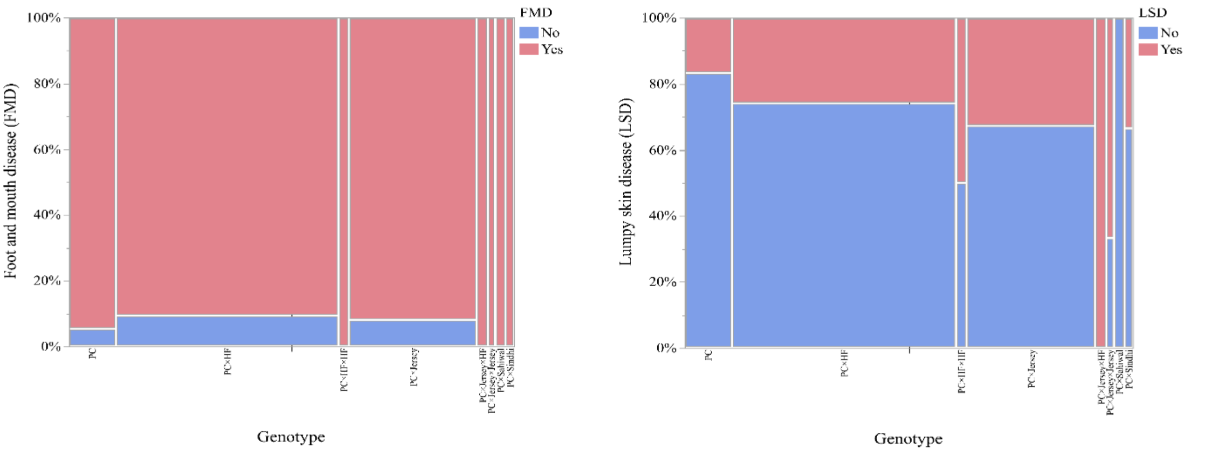

Figure 3. Status of vaccination for different sub-type of Pabna cattle at Bhangura, Pabna, Bangladesh (N=170)

Productive performance

Birth weight

The mean birth weight differed significantly ($p<0.01$) among Pabna cattle (PC) sub-types. The minimum (19.2 kg) and maximum (33.3 kg) birth weights were recorded for the PC and PC×SL genotypes, respectively.

Table 1. General summary statistics of the different sub-types of Pabna cattle at Bhangura, Pabna, Bangladesh (N=170)

Parameter	Genotype[1]										
	PC	PC×SN	PC×SL	PC×JS	PC×HF$_{50\%}$	PC×JS×HF$_{50\%}$	PC×HF$_{75\%}$	PC×JS$_{75\%}$	Overall mean	SEM	P-value
Stanchion height (ft)	11.2^{cd}	11.3^{abcd}	14.3^{a}	12.6^{ab}	13.5^{ab}	12.1^{bc}	10.0^{d}	12.0^{abcd}	12.2	0.2	0.026
Standing platform (sft/cow)	25.0		22.0	23.5	24.5	23.4		24.0	23.5	0.2	0.140
Concentrate supply (kg/d)	3.0	2.7	3.0	3.3	3.5	3.4	3.5	3.3	3.3	0.1	0.550
Fodder area (acre)	3.1^{b}	2.7^{b}	3.6^{b}	2.8^{b}	4.0^{b}	3.3^{b}	9.0^{a}	3.0^{b}	3.3	0.2	0.003
Roughage supply (kg/d)	40.8	35.0	36.3	39.3	40.0	43.1	50.0	46.7	41.6	0.8	0.177
Body weight (kg)	202.8^{b}	270.0^{ab}	312.5^{a}	246.1^{b}	267.5^{b}	256.0^{b}	255.0^{b}	266.7^{ab}	249.5	2.8	<0.00
Birth weight (kg)	19.2^{d}	29.0^{abc}	33.3^{a}	25.6^{c}	26.3^{bc}	27.4^{b}	24.5^{bc}	27.0^{bc}	26.1	0.3	<0.00
Age at puberty (m)	22.4^{a}	17.3^{b}	23.3^{a}	19.8^{b}	19.3^{b}	19.1^{b}	18.0^{b}	19.3^{ab}	19.7	0.2	<0.00
Age at first service (m)	23.5^{a}	19.0^{bc}	24.3^{a}	20.8^{b}	20.3^{bc}	19.8^{c}	19.0^{bc}	20.3^{bc}	20.6	0.2	<0.00
Age at first conception (m)	26.4^{ab}	22.0^{c}	27.3^{a}	23.8^{c}	24.3^{abc}	22.9^{c}	22.0^{c}	23.3^{bc}	23.6	0.2	<0.00
Service per conception (n)	1.5	1.7	1.0	1.6	1.8	1.6	1.0	2.0	1.6	0.0	0.170
Gestation period (d)	284.4	280.0	277.5	279.3	276.3	279.6	280.0	278.3	279.9	0.5	0.083
Post-partum period (d)	58.3	63.3	77.5	69.9	65.0	66.8	48.8	70.0	66.6	1.8	0.472
Days open (d)	85.6	88.3	102.5	96.1	90.0	92.5	73.8	95.0	92.5	1.8	0.550
Calving interval (d)	370.0	368.3	380.0	375.4	366.3	372.1	353.8	373.3	372.4	1.9	0.794
Dry period (d)	102.5^{a}	80.0^{abc}	90.0^{ab}	77.4^{bc}	60.0^{c}	93.9^{a}	90.0^{ab}	60.0^{c}	88.2	1.6	<0.00
Lactation length (d)	262.5^{c}	285.0^{abc}	275.0^{bc}	287.6^{ab}	305.0^{a}	271.2^{c}	275.0^{bc}	305.0^{a}	276.8	1.6	<0.00
Milk yield (l/d)	4.8^{d}	5.6^{d}	6.8^{c}	8.2^{b}	8.5^{ab}	8.6^{a}	9.0^{a}	9.1^{a}	8.0	0.1	<0.00
Milking frequency (n)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0	-
Lactation yield (l)	1255.6^{d}	1583.3^{cd}	1875.0^{c}	2361.0^{b}	2575.0^{ab}	2348.2^{b}	2480.0^{ab}	2783.3^{a}	2227.7	34.7	<0.00
Weaning age (m)	6.2	7.0	7.0	6.5	7.0	6.3	6.0	6.7	6.4	0.1	0.176
House cleaning frequency (n)	2.1^{bc}	2.0^{c}	3.0^{a}	2.4^{b}	2.0^{c}	2.3^{b}	2.0^{c}	2.0^{c}	2.3	0.0	0.026
Drain cleaning frequency (n)	2.0^{c}	2.0^{c}	2.8^{a}	2.2^{b}	2.0^{c}	2.1^{bc}	2.0^{c}	2.0^{c}	2.2	0.0	0.003

[1]PC = Pabna cattle; PC×HF = Pabna cattle×Holstein Friesian; PC×JS = Pabna cattle×Jersey; PC×SL = Pabna cattle×Sahiwal; PC×SN = Pabna cattle×Sindhi

Body weight

Similar to birth weight, the mean live weight differed significantly ($p<0.01$) among the PC sub-types. Mean live weight of the highest milk yielding PC×$JS_{75\%}$ was 1.3 times higher than the PC, 1.04 times PC×JS×$HF_{50\%}$, 1.04 times PC×$HF_{75\%}$, 1.08 times PC×JS but 1.003 times lower than the PC×$HF_{50\%}$, 1.17 times PC×SL and 1.01 times PC×SN genotype (Table 1).

Lactation length

The mean lactation length (LL) differed significantly ($p<0.01$) among the PC sub-types. The LL of PC×$JS_{75\%}$ was 305±1.6 d which was 1.16 times higher than PC, 1.11 times higher than PC×$HF_{75\%}$, 1.06 times higher than PC×JS, 1.11 times higher than PC×SL, 1.07 times higher than PC×SN genotype and the same as PC×$HF_{50\%}$ (Table 1).

Lactation yield

The mean lactation yield (LY) differed significantly ($p<0.01$) among the PC sub-types. The highest LY was recorded in PC×$JS_{75\%}$ which was 2.22 times higher than PC, 1.08 times higher than PC×$_{HF50\%}$, 1.12 times higher than PC×$HF_{75\%}$, 1.18 times higher than PC×JS, 1.19 times higher than PC×JS×$HF_{50\%}$, 1.48 times higher than PC×SL, and 1.76 times higher than PC×SN genotype (Table 1).

Milk yield

The average daily milk yield (ADMY) differed significantly ($p<0.01$) among the PC sub-types (Table 1). Increased live weight and increased roughage supply through increased fodder area substantially increased milk yield (Figure 4). However, increased dry period, post-partum period and calving interval substantially reduced milk yield. Calving interval, days open and age at 1st conception constituted highest eigenvectors controlling maximum variability in the milk yield (Figure 5).

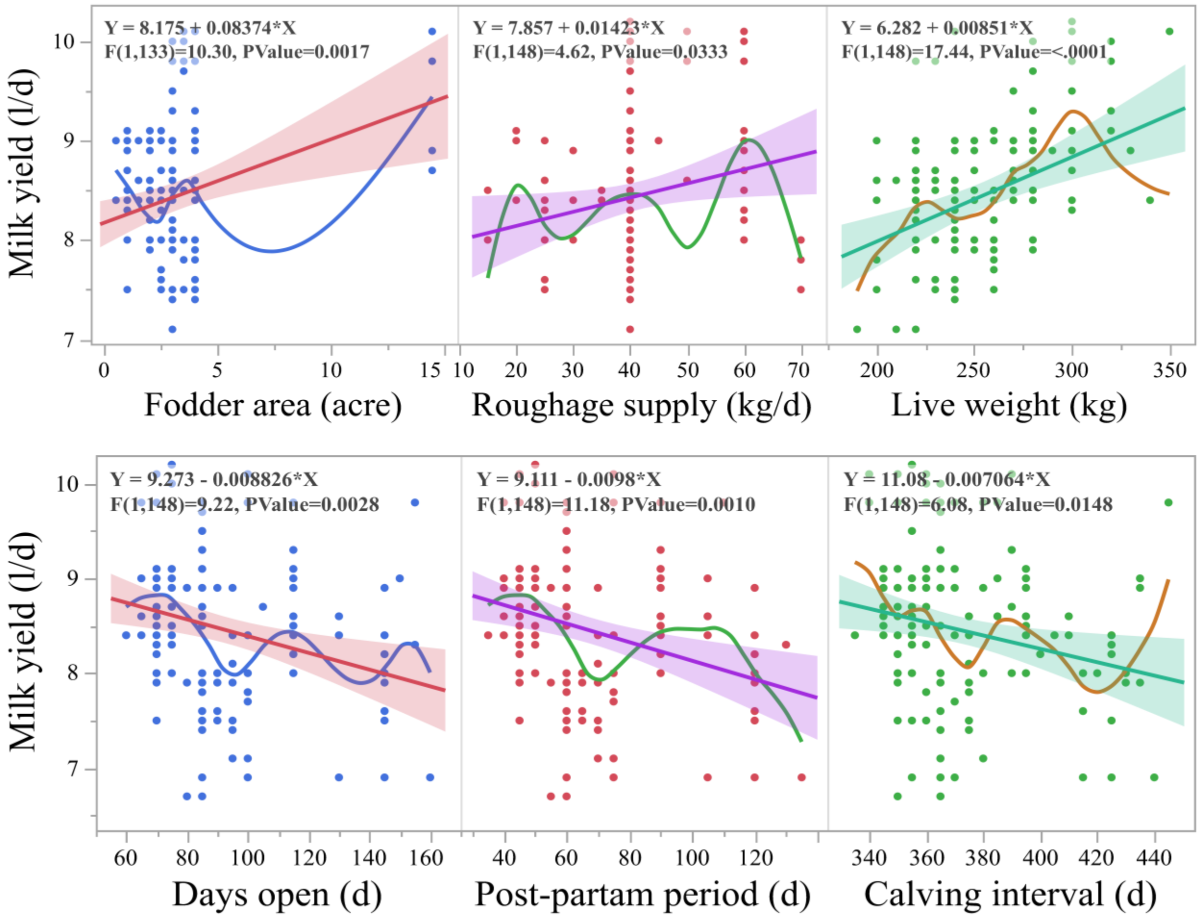

Figure 4. Bivariate linear regression showing effects of fodder area (acre), roughage supply (kg/d), live weight (kg), dry period (d), post-partum period (d) and calving interval (d) on average daily milk yield of the different sub-types of Pabna cattle (N=170)

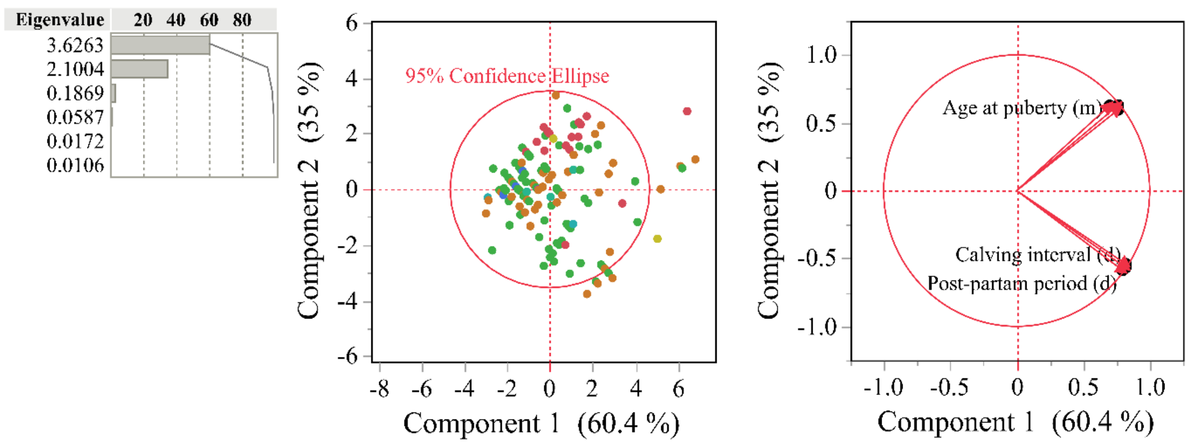

Figure 5. Principal component analysis showing dimensionally and latent trends of the components exhibiting variability of milk yield plotted on ‘x’ as component 1 (60.4%) and ‘y’ as component 2 (35%) of the different sub-types of Pabna cattle (N=170)

Reproductive performance

Age at puberty

The mean age at puberty (AP) differed significantly ($p<0.01$) among the PC sub-types. The earliest and most delay AP was recorded for PC×SN and PC×SL genotypes, respectively. There was a strong relationship between age at puberty, age at first service and age at first conception (Figure 6).

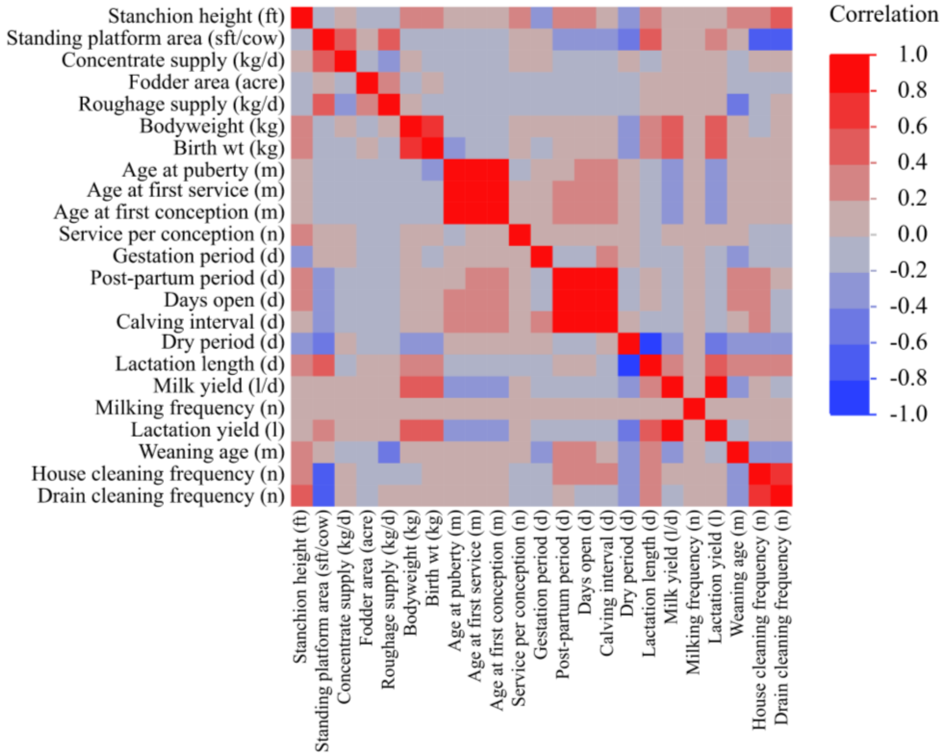

Figure 6. Color map showing multiple correlation coefficient matrix of the productive and reproductive parameters of the different sub-types of Pabna cattle at Bhangura, Pabna, Bangladesh (N=170)

Age at first service

The mean age at first service (AFS) differed significantly ($p<0.01$) among the PC sub-types. The earliest and most delay AP was recorded for PC×SN and PC genotypes, respectively.

Age at first conception

The mean age at first service (AFC) differed significantly ($p<0.01$) among the PC sub-types. The earliest and most delay AP was recorded for PC×SN and PC×SL genotypes, respectively.

Service per conception

The mean service per conception (SPC) did not differ ($p>0.01$) among the PC sub-types.

Gestation period

The mean gestation period (GP) did not differ ($p>0.01$) among the PC sub-types.

Dry period

The mean dry period (DP) differed significantly ($p<0.01$) among the PC sub-types. The minimum and maximum DP was recorded for PC×$JS_{75\%}$ and PC genotypes, respectively.

Post-partum period

The mean post-partum period (PPP) did not differ ($p>0.01$) among different Pabna cattle sub-types.

Days open

The mean days open (DO) did not differ ($p>0.01$) among the PC sub-types.

Calving interval

The mean calving interval (CI) did not differ ($p>0.01$) among the PC sub-types.

Effects of genotype

The highest ADMY was recorded in PC×$JS_{75\%}$ genotype, which was 1.89 times higher than the PC, 1.07 times PC×$_{HF50\%}$, 1.01 times PC×$HF_{75\%}$, 1.1 times PC×JS, 1.058 times PC×JS×$HF_{50\%}$, 1.34 times PC×SL and 1.62 times higher than the PC×SN genotype (Table 1; Figure 7).

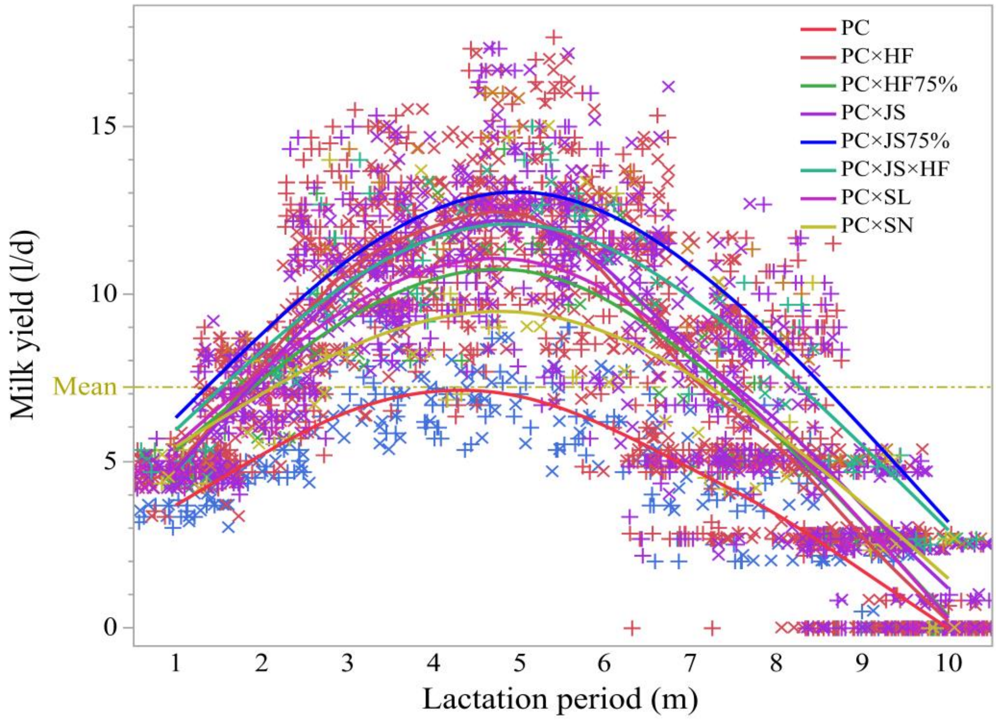

Figure 7. Effects of genotype (PC=Pabna cattle, HF=Holstein Friesian, JS=Jersey, SL=Sahiwal, SN=Sindhi) on milk yield of the different sub-types of Pabna cattle at Bhangura, Pabna, Bangladesh (N=170)

Effects of parity

Comparatively more milk was produced in parity 2 compared with parity 1 irrespective of genotype (Figure 8-9).

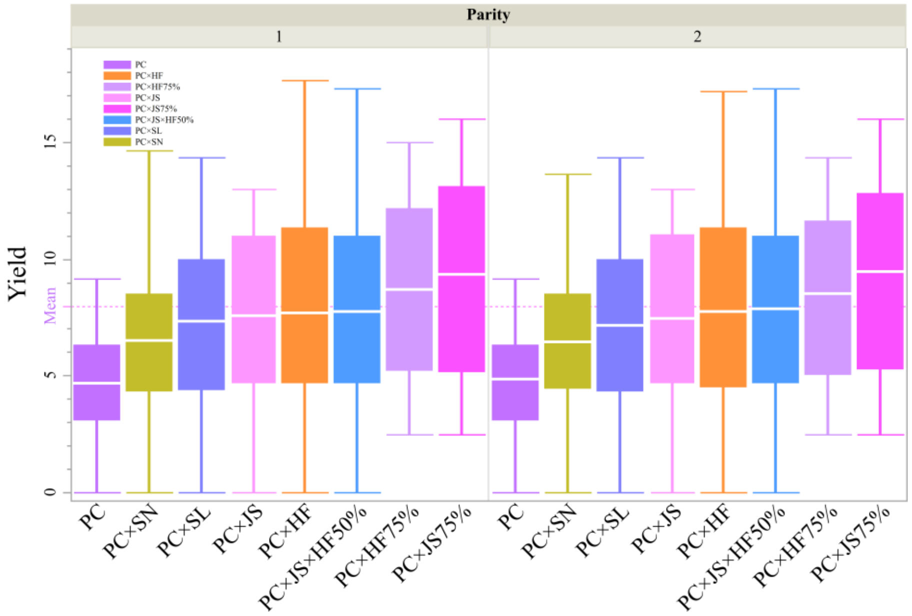

Figure 8. Effects of parity on average daily milk yield of the different sub-types of Pabna cattle at Bhangura, Pabna, Bangladesh (N=170)

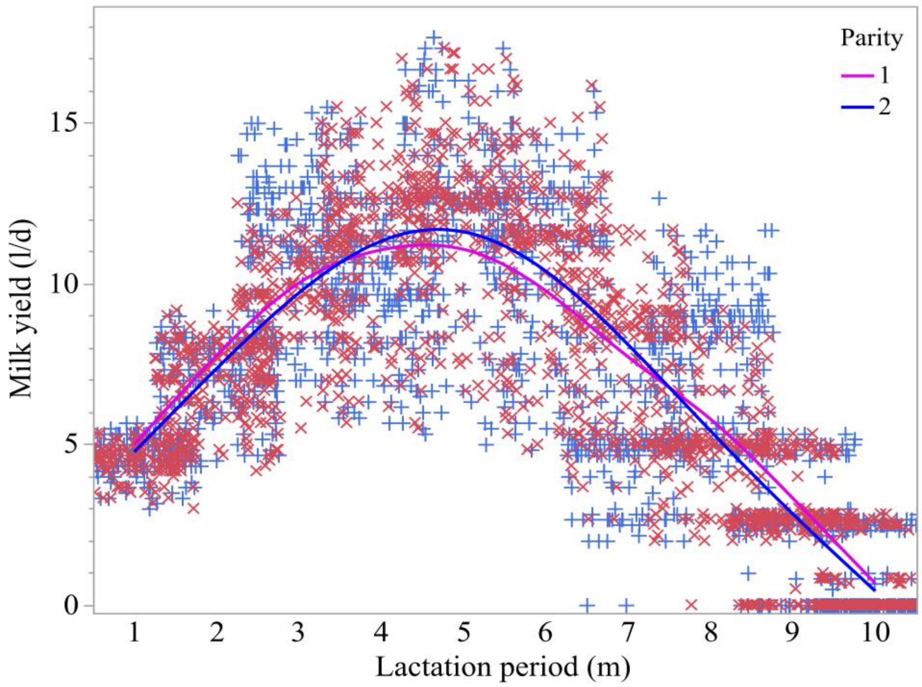

Figure 9. Effects of parity on milk yield over the entire lactation period of the different sub-types of Pabna cattle at Bhangura, Pabna, Bangladesh (N=170)

Herd health

Increased body weight of the sub-types of PC with increased milk yield had increased probability of lumpy skin disease (Figure 10). However, increased roughage and concentrate supply substantially reduced probability of foot and mouth disease.

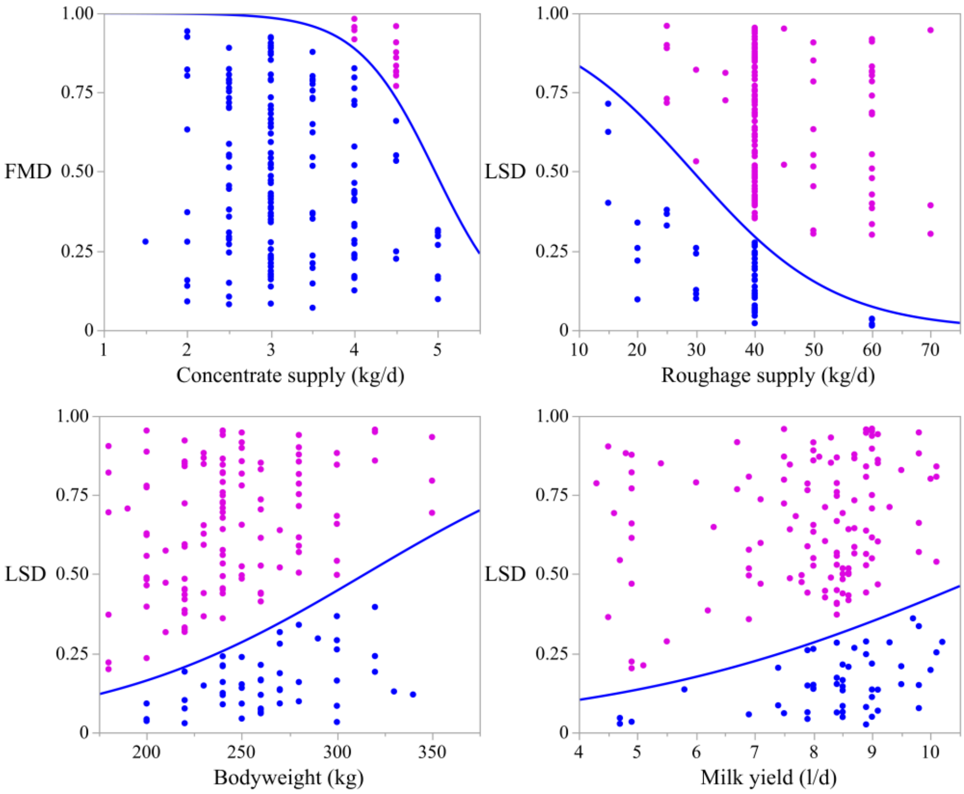

Figure 10. Bivariate logistic regression showing effects of live weight, milk yield, roughage and concentrate supply on herd health of the different sub-types of Pabna cattle at Bhangura, Pabna, Bangladesh (N=170)

Marketing of milk

Approximately 64.1% of total CDC milk was collected by various companies like Pran, Akij, Milk vita, BRAC etc. and the rest 35.9% was consumed, sold to market or sold to the sweet shops. Among the various companies, the Pran collected 45.9% of the milk where other companies like Akij, BRAC and Milk vita collected 12.8%, 40.4% and 0.92% of total milk respectively. Based on the data, milk vita stood at the last position and Pran, BRAC, Akij were at 1st, 2nd and 3rd positions, respectively on milk collection (Figure 11).

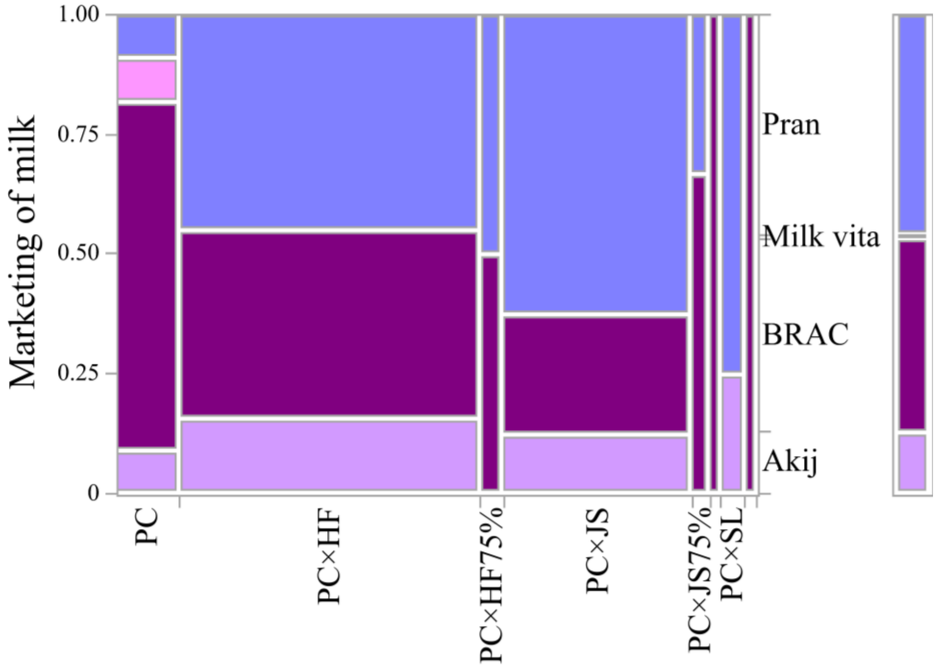

Figure 11. Marketing system of milk of the different sub-types of Pabna cattle at Bhangura, Pabna, Bangladesh (N=170)

Discussion

Herd management

The majority of the cows were reared in loose housing, although certain high-quality crossbreds, such as PC×SH, were in stanchion barns. Taking into consideration the aforementioned points, the essential components of ideal housing in a tropical climate also include adequate shelter, appropriate roof angle, roofing materials, bedding materials, ventilation, a structure for adequate watering facility and manger, temperature, microorganism load, and building materials. As was already established, animals living in tropical temperature benefit from a looser housing structure than those living in more typical environments. Animals in loose housing are kept free for the vast majority of the time and only restrained for milking and medication delivery (Singh et al., 2020) which support our findings.

According to Bhat et al., (2000) the differences between the high fed and control groups were statistically significant ($P<0.05$) and the high fed cows excreted more milk with a greater fat percentage than the control fed cows. Additionally, they discovered that there was a significant ($P<0.05$) difference in between high and low-fed groups in regard to the mean SNF and TS levels between cows fed in high nutritious groups and those fed in low nutritional groups. Peterson et al., (2003) discovered that high concentrate but low forage diets lowered milk fat levels by 25% and yield by 27% with no impact on food intake, milk production, protein, or lactose which support current findings. Cattle, particularly calves were especially susceptible to parasite infections.

Giasuddin et al., (2019) reported that the rates of illness and death were 55.4% and 5.2%, respectively in the CDC whereas in native cattle, the rates were 77.8% and 12.4%. Naher et al., (2020) reported that in all of 30.0% cows had sub-clinical hypocalcemia (SCHC) of which 32.1% was HF×L, 15.0% was SL×L and 20.0% was JS×L CDC. In Bangladesh, the sub-clinical hypocalcemia (SCHC) was found to be ten times higher than the milk fever (MF) and six times higher than the clinical ketosis (CK). Lactating cows with SCHC were reported to have hypocalcemia, hypophosphatemia and hypermagnesemia. The findings of this study are congruent with those reported by Baird et al., (2009), who found that genetic, viral, and environmental factors all play a part in dairy cow foot illnesses.

According to Saadullah, (2001), a number of diseases had a significant negative impact on the productivity of cattle in Bangladesh. These diseases had significant negative effects on society. Infections with parasites could be extremely dangerous for cattle, especially calves. The principal ailments including liver fluke, calf diarrhea, anthrax, HS, FMD, and BQ. Animals go through terrible suffering when they were parasite-infested. The FMD had caused substantial losses for farmers.

Productive performance

Birth weight

The average birth weight of the Pabna crossbred dairy cattle (CDC) varied from 19.2 to 33.3 kg in our study. According to Hoque et al. (1999), the birth weight of Friesian×Pabna cross-bred and Pabna cattle (PC) was 22.5±4.9 kg and 17.9±3.5 kg, respectively which is consistent with the findings of our study. In a previous study, Hasan et al. (2014) reported that the birth weight of Local×Friesian, Local×Sahiwal and Local×Sindhi varied from 22.3±2.0 to 24±1.0, 19.8±1.6 to 21.8±1.6 and 18.6±1.5 kg, respectively which is lower than our study. In another study, Mondal et al. (2005) reported that the birth weight of Local×Jersey, Sahiwal cross, Sindhi cross and Friesian cross was 14.2±1.7, 13.5±0.9, 13.6±1.0 and 15.2±0.9 kg which is also lower than the current study. These variations, however, could be due to differences in the genotype, nutrition, feeding, environment, semen quality, ovum condition, disease and other management factors.

Body weight

The average body weight of the CDC used in our study varied from 202.8 to 312.5 kg. According to Amin & Afroz (2021) and Hossain et al. (2016), the body weight of Pabna cattle was 224-280 kg and 252.5±1.2 kg, respectively which is consistent with the current study. Sarder et al. (1997) reported that the body weight of Holstein Friesian cross, Sahiwal cross, Sindhi cross and Jersey cross was 264±73, 242±64, 223±60 and 271±75 kg, respectively which is consistent with the current study. Hossain et al. (2016) further reported that the body weight of Holstein Friesian and Pabna crossbred was 324.0±0.7 kg which is higher than the present study. The body weight of different genotype may vary because of genetic variation, environment, management, feeding, nutrition and disease condition.

Lactation length

Vijayakumar et al. (2019) reported that the lactation length (LL) of Jersey crossbred was 364.2±9.5 day which is higher than the current study. Islam et al. (2017) reported that the LL for the Local, Local-Friesian, Local-Sahiwal and Local-Jersey was 274.0±3.8, 274.8±2.8, 279.6±3.4 and 292.1±7.9 day which supports the current study. Rahman et al. (2017) reported that the LL for the Local, Local×Friesian and Local×Friesian×Friesian was 198.46±2.36, 232.20±1.16 and 266.43±1.18 day, respectively which is much lower than the current study. Auldist et al. (2007) further reported that more than 16 months longer LL decreased the annual milk yield and 10 to 16 months LL was optimum.

Lactation yield

In a previous study, lactation yield for Local-Friesian, Local-Sahiwal and Local cows was 1715±659, 1149±409, and 1274±354 liter, respectively (Sarder et al., 2007) which is lower than the current study. For Jersey, Vijayakumar et al. (2019) reported 2459.27±68.98 liter milk yield per lactation which supports our study. Islam et al. (2017) reported that lactation yield of Local, Local-Friesian cross, Local-Sahiwal cross and Local-Jersey cross was 499.1±20.5, 1636.8±47.3, 1538.5±63.1 and 1595.7±114.2 liter which is lower than the current study. Hasan et al. (2014) reported that the lactation yield of L×F, L×F×F, L×SL and L×S CDC was 1710±6, 2565±6, 1129.5±6 and 992±7 liter. The variation in lactation yield depends on heritability, performance, BCS and other management factors.

Milk yield

Amin and Afroz (2021) reported that the average daily milk yield (ADMY) of the PC was 5.3 liter. Ahmed et al. (2007) observed that the ADMY of $HF_{50\%}$ crossbred was 9.8±0.3 liter, while the ADMY of $HF_{75\%}$ was 10.2±0.5 liter. Rahman *et al.* (2017) further reported that the ADMY of Local×Friesian was 5.6±0.1 liter and 7.5±0.1 liter for Local×Friesian×Friesian. Garai et al. (2017) reported that the Jersey crossbred produced 9.6 kg of milk per day which supports our findings. Singh et al. (2020) further reported that the Jersey CDC in the tropical region may yield up to 12.7 liter/day. Miazi et al. (2007) reported that the local and Jersey cross produced 5.7±0.9 liter/day which is lower than our findings. Sarder et al. (1997) reported that Sahiwal and Sindhi cross-bred produced 5.8±2.2 and 6.4±2.76 liter/day. In contrast, Mondal et al. (2005) found that Sahiwal and Sindhi cross produced only 2.8±0.6 and 3.0±0.5 liter milk per day. In our study, ADMY was 8.0±0.1 liter/day which was lower than that in Chad (9.4±2.5 liter; Tellah et al., 2019), Ethiopia (11.6±3.1 liter; Genzebu et al., 2016) and Senegal (9.9±9.6 liter; Habimana, 2013) although it was higher in Côte d'Ivoire (4.3±1.1 liter; Sokouri et al., 2014), Congo (5.2±0.2 liter; Kibwana et al., 2012) and India (6.28±2.29; Singh, 2016). Rios-Utrera et al. (2013) reported that the ADMY increased with body weight which support our findings. Deresz et al. (1987) and Řehák et al., (2012) found that milk production increased when body weight and lactation length increased. Salgado et al. (2012) reported that the inclusion of increased fodder in diets eventually increased the ADMY in the CDC.

Reproductive performance

Age at puberty

Paul et al. (2013) reported that the age at puberty (AP) of Deshi, Sahiwal×Deshi and Holstein×Deshi and Jersey×Deshi was 25.9±1.1, 18.0±0.0, 21.6±2.4 and 20.4±1.6 months, respectively which is consistent with our study. Islam et al. (2017) reported that the average AP of the Local and Friesian cross was 1125.8±6.8 and 1055.97±11.5 day, respectively which is not supported by our study. Sultana et al. (2001) reported that the AP of Deshi, Friesian×Deshi and Sahiwal×Deshi CDC was 25.2, 21.4 and 24.4 months, respectively which is closely aligned with the current study. The difference of AP among different genotype could be due to genetic variation, management, feeding, disease condition, hormonal activity, stress factor and body condition score.

Age at first service

Hasan et al. (2014) reported that the age at first service for the Local-Friesian was 28.1±2.0 to 28.4±2.0, for Local-Sahiwal 30.1±2 to 30.2±2 and for Local-Sindhi 30.1±2 month, respectively which is slightly higher than the current study. The variation could be due to age at puberty, hormonal balance, nutrition and management.

Age at first conception

The average age at first conception (AFC) varied from 22.0 to 27.3 month in our study. Islam et al., (2021) reported that the AFC for the Local-Friesian cross, Local, Local-Jersey cross, Local-Sahiwal cross and Local-Sindhi cross was 22.5±0.4, 32.7±0.8, 27.7±0.8, 28.0±0.5 and 29.5±0.6 month which is slightly higher than the current study. The AFC may vary due to genetic variation, climate, age at puberty, hormonal factor and estrous synchronization.

Service per conception

The average service per conception (SPC) varied from 1.0 to 2.0 in our study. Islam et al. (2021) reported that the SPC in the Local-Friesian cross, Local-Sindhi cross, Local-Sahiwal cross, Local and Local-Jersey cross was 1.3±0.04, 1.7±0.08, 1.3±0.05, 1.4±0.07 and 1.6±0.10, respectively which is close to our findings. The average SPC of Pabna cattle and Friesian cross was between 1.6±0.0 to 1.0±0.0 which is supported by Moges (2012) and Mengistu et al. (2016). Mondal et al. (2005) found that the SPC in Jersey cross, Sahiwal cross, Sindhi cross, and Holstein cross was 1.6±0.6, 1.6±0.6, 1.6±0.7 and 1.6±0.6, respectively which is consistent with the current study.

Gestation period

Amin & Afroz (2021) reported that the gestation length (GL) of PC was 283.1 day which supports our result. Hasan et al. (2014) reported that the GL of Local×Friesian, Local×Friesian×Friesian, Local×Sahiwal and Local×Sindhi was 278.2±5, 278.2±5, 279.5±3.8 and 278.8±4.2 day, respectively which is consistent with the current study. Accordingly, Paul et al. (2013) reported that the GL of Deshi, Sahiwal×Deshi, Friesian×Deshi and Jersey×Deshi was 289.9±1.4, 285.0± 0.0, 285.0±4.2 and 282.1±2.4 day, respectively which is higher than the current study. Sultana et al. (2001) reported that the GL for the indigenous, Friesian cross, Jersey cross, Sahiwal cross and Sindhi cross was 279.7±2.7, 278.5±3.3, 277.0±2.9, 278.1±3.3 and 278.2±2.3 day, respectively.

Dry period

Islam et al. (2017) reported that the dry period (DP) of the local, Local-Friesian, Local-Sahiwal and Local-Jersey was 102.5±3.3, 87.4±2.5, 88.3±2.6 and 89.9±4.4 day, respectively which partially supports the current study. Famous et al. (2021) further reported that the DP of Local-Friesian, Local-Sahiwal and Local-Sindhi was 87±9, 96±13, and 116 ±14 day, respectively which is consistent with the current study. Several previous studious are also in accord (Kok et al., 2017; Řehák et al., 2012; Singh et al., 2020a).

Post-partum period

According to Islam et al. (2017), the post-partum period (PPP) of the Local, Local-Friesian, Local-Sahiwal and Local-Jersey was 98.6±4.4, 84.1±2.5, 80.7±1.8 and 73.3±3.8 day, respectively which is higher than the current study. Hasan et al. (2014) reported that the PPP for the Local-Friesian, Local-Friesian-Friesian, Local-Sahiwal, and Local-Sindhi was 133±4, 136±5, 142±10, and 144±10 day, respectively which is nearly double than the present study. Hossain et al. (2016) reported that the PPP of Pabna and Pabna-Friesian was 66.3±1.2 and 58.4±0.7 day, respectively. Post-partum anestrus period of Deshi, Sahiwal×Deshi, Friesian×Deshi, and Jersey×Deshi were 102.0±8.8, 95.0±25.0, 90.0±13.4, and 92.9±7.2 day, respectively most probably because of hormonal factor, stress, disease condition and estrous synchronization.

Days open

Islam et al., (2017) reported that the days open (DO) for the Local, Local-Friesian, Local-Sahiwal and Local-Jersey was 120.5±5.8, 121.3±3.9, 115.9±4.2 and 105.4±5 day, respectively which is higher than our study. Hasan et al. (2014) found that the DO for the Local-Friesian, Local-Friesian-Friesian, Local-Sahiwal and Local-Sindhi was 153±8, 155±10, 167±15 and 169±15 day which was higher than the current study.

Calving interval

In a previous study, Islam et al. (2017) reported that the calving interval (CI) was 404.5±5.6, 395.8±3.1, 398.9±5.9 and 399.7±7 d for the Local, Local-Friesian, Local-Sahiwal, and Local-Jersey which partially supports the current study. The average CI was 437.8±1.2, 437.2±1.1

and 481.9±0.3 d for the Local × Friesian × Friesian, Local × Friesian and Local cows, respectively (Rahman et al., 2017) which is much higher than the current study. Hossain et al. (2016) further reported that the CI of Local-Friesian and Pabna cattle was 12.4±0.7 and 12.2±1.2 months, respectively which supports the current study. The CI in the grassland-based productivity in New Zealand was 368 day (LIC and DairyNz. 2013). The higher CI is the result of more days open, which might be attributed to poor breeding management, low nutritional status and absence of suitable artificial insemination service (Belay et al., 2012).

Effect of genotype

Compared with 50% crossbred cows, milk yields from 62.5 and >75% crossbred cows were considerably higher. The highest milk was produced by the high merit cows, whereas the lowest milk by the low merit counterpart (Shibru et al., 2019). Because each cow has a distinct age, body condition score, individual physiology, and health status, the actual milk yield determined may vary from cow to cow (Windig et al., 2006). In a previous study, $PC{\times}JS_{75\%}$ had the highest milk yield than other Jersey crossbreds and local cattle which is supported by other studies (Hasan et al., 2014; Hossain et al., 2016; Shibru et al., 2019). In another study, 75% *Bos taurus* exotic inheritance had an ADMY that was 2.7 times higher than the native cattle in the tropical climate zone. Similarly, the milk yield 50% *Bos taurus* genes was also 2.6 times higher than that of indigenous cattle (Galukande et al., 2013).

Effects of parity

In a previous study, Ihsanullah *et al.* (2020) reported that milk production increased as lactation progressed up to the 4^{th} parity due to steadily growing secretary cells of the mammary gland. Compared to their 2^{nd} and 3^{rd} counterparts, cows after their 1^{st} lactation produced more milk. Additionally, it was reported that there was a declining trend after the 5^{th} parity even up to the 12^{th} with increased milk yield towards the 5^{th} parity (Bajwa et al., 2004). The early lactation phase of high-efficiency dairy cattle generally has a negative energy balance as the energy needed for body tissue reservation and milk yield exceeds the quantity used by the 1^{st} parity heifer. For this reason, the latter parities may become energy deficient which are met up following subsequent dry-off restore (Souissi & Bouraoui, 2020).

Herd health

Increased body weight of the subtypes of Pabna cattle with increased milk yield had a probability of lumpy skin disease. However, increased roughage and concentrate supply substantially reduced the probability of foot and mouth disease. El shoukary et al., 2019 in their study found that appetite score in Control, FMD, and LSD cattle was 3.3±0.02, 1.6±0.22, and 1.9±0.30. And there were slight changes in behavioural patterns (%) in FMD and LSD diseased cattle. Ayelet et al., 2013 found in their study in lumpy skin diseased cattle crossbred cattle had a higher morbidity rate, mortality rate, and fatality rate (%). Female cattle had high morbidity rate than male cattle. So, increased body weight has increased milk production and it may cause lumpy skin disease due to genotypes of cows and increasing supply of roughage and concentrate may reduce the probability of foot and mouth disease due to high nutrition in feed.

Marketing of milk

According to Ghosh and Maharjan (2002) and Halder and Barua (2003), there were three types of milk marketing channels present in Bangladesh such as, traditional milk marketing channel, pala milk marketing channel and cooperative milk marketing channel. Most of the dairy farms in Bangladesh were tiny in size, produced little milk, and sold the extra milk after consumption. On the other hand, compared to non-cooperative farmers, the cooperative farmers had a greater number of cows and were milking each cow more frequently. The milk quality of traditional and pala milk marketing channel was not good as cooperative milk marketing channel as those milk was contaminated by different adulterants. Also, farmers did not get a good price in those marketing system as they were depending on gowalas and middleman. The cooperative price, on the other hand, was set and changed depending on the milk fat percentage which indicated that the cooperative marketing channels were more effective than the alternatives. A better dairy farm plan would be possible by the reasonable set of milk price.

Conclusion

The $PC\times JS_{75\%}$ produces more milk than any other sub-types of Pabna cattle which is comparatively higher in parity 2 compared with parity 1. Overall, increased body weight of the sub-types of PC are associated with increased probability of health hazard which could be partially ameliorated by supplying optimum roughage and concentrate supply.

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Biography

I am Subrata Kumer Paul, son of Mr. Satyendra Nath Paul and Mrs. Basona Rani Paul. I passed my Secondary School Certificate (SSC) examination from Bera B.B. Pilot High School, Bera, Pabna in 2014 and Higher Secondary Certificate (HSC) examination from Alhera Academy (School & College), Bera, Pabna in 2016. I enrolled for Doctor of Veterinary Medicine (DVM) degree in Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram, Bangladesh in 2016-17 session. At present, I am doing my internship program which is compulsory for awarding my degree of Doctor of Veterinary Medicine (DVM) from CVASU. In the near future, I would like to work and have massive interest in epidemiology, production improvement and molecular biology.