



Analysis of survey data of breeding herd for reproductive management practices in swine farms of Punjab

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ABSTRACT

The present survey was performed to analyze standard operating procedures for swine development and fertility based on prevailing reproductive management practices among different swine farms of Punjab. The average farrowing rate, farrowing interval, weaning to estrus interval, weaning to conception interval and age at first breeding were 71.5±11.4%, 165.4±13.8 days, 8.3±2.1 days, 42.7±11.0 days and 8.1±1.3 months, respectively. Mean live litter size at birth and weaning were 9.9±3.6 and 8.1±3.3 piglets per farrowing, respectively. Most farmers (94.1%) kept pigs in loose housing system with a mixture of both stalls and pens, and used cement and brick as construction material for sties. Majority of farms (84.3%) functioned as farrow to wean with intensive production systems (75.5%). The labor to animal ratio of 1:50 was most common. Accurate and well maintained records were noticed at 66.7% farms. Start of boar exposure after weaning began within 1 day, occurring most often in morning, with exposure times varying from < 2–5 min/sow in 87.3% farms. Natural mating was allowed within minutes to hours after detection of estrus on 100% of farms. At all farms (100%), sows were allowed ≥1 chance for breeding after conception failure before culling. Summer infertility was observed on 56.9% of farms. Feeding method for lactating sows was divided between *ad lib.* and gradual daily increase of concentrate feed and kitchen waste. None of the farmer practiced docking in newborn piglets. These results suggest that reproductive management of farms in key areas related to weaning, breeding, gestation, feeding and health care could be a source of varying reproductive performance among swine.

Key words: Breeding, Herd management, Punjab, Reproductive parameters, Swine

Variation in key reproductive traits is evident among swine breeding herds in North India (Pandey 2000) and elsewhere in the world (Vanderhaeghe *et al.* 2010). Analysis of data indicated large disparity in wean to estrus interval, duration of estrus, farrowing rate, born alive, and stillborn pigs within and among farms (Kraeling and Webel 2015). Various management practices like feeding, lactation, breeding, boar exposure, gestation, genotype, season (temperature, humidity), parity and body condition etc. have shown to affect reproduction in sow/gilt (Soede *et al.* 2009, Sharma *et al.* 2015). Nutritional deficit during lactation increased weaning to estrus interval in sow with lower conception rate and reduced litter size (Campos *et al.* 2012). However, proper management of gilts improved their

lifetime reproduction and production (Foxcroft *et al.* 2010). Further, Oliviero (2013) also showed that appropriate management of piglet before and after weaning affected its livability and future reproduction. Although, some causes of variation in reproductive measures can be attributed to single sources, most are complex and multi-factorial. The heritability of such reproductive traits is generally low. Therefore, much of the phenotypic variation of reproductive performance is due to environmental effects, of which a major portion would be considered management. Farm information about breeding herd management practices would help identify procedures as potential sources of reproductive performance in swine and may play a significant role in socio-economic and nutritional security of rural mass. Moreover, responses to reproductive management survey questions may help identify important successes and limitations to performance within swine breeding operations. Limited studies (Knox *et al.* 2013) have been attempted to identify and prioritize farm-level condition of swine based on their reproductive management practices. Keeping in view the above facts and also taken into assumption of observing commercial pig farming as an upcoming entrepreneurship in Punjab, the present survey

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was conducted to obtain information on existing pig management practices from breeding herds and to determine if reproductive performance could be related to variation in management decisions and practices during breeding and gestation.

MATERIALS AND METHODS

Survey, data collection and monitoring of reproductive performance: The survey was targeted at 102 private pig farm owners located in different areas of Punjab. No animals were directly used in this study. The information was based on breeding record registers, self-observation and personal interview of farm respondent. The survey was conducted from January to September, 2018. A common questionnaire of 78 questions, each with a series of responses to generate information regarding various fertility parameters such as farrowing rate (FR); farrowing interval (FI); weaning to estrus interval (WEI); weaning to conception interval (WCI); age at first breeding (AFB); weight at first breeding (WFB); gestation length; lactation length; average daily feed intake by sow (ADFIS); sow body weight at farrowing; sow body weight at weaning; live litter size at birth; live litter size at weaning; live litter weight at birth; live litter weight at weaning; live piglet weight at birth; live piglet weight at weaning; pre-wean mortality; live born per female per year and piglets weaned per female per year. Views of farmers regarding reasons for following certain breeding practices have also been gathered. The production and management practices were studied in respect of four aspects namely housing, breeding, feeding and health care. Most farms (74%) were located in the Ludhiana district while 26% farms were located in the districts of Sangrur, Patiala, Barnala and Fatehgarh Sahib. Total of 762 mating and 573 farrowing records (241 sows) were available.

General management of animals at farm: During gestation period, the sows were housed in groups of 3–4 and fed a conventional (gestation) diet (3.0–3.5 kg/day) and kitchen waste. About 7–10 days before farrowing, pregnant animals were moved to a semi-open farrowing unit. From the day of farrowing until day four post-partum, gestation diet was decreased regularly with an increase in lactation diet. Following day five post-farrowing, sows were offered *ad lib.* feed and had free access to water. Cross fostering was practiced within 48 h after birth in order to homogenize the litter size to 10–12 piglets. Creep feed to piglets was provided from 28 days of age. At weaning, sows were moved into individual stalls located in front of the boar pens. During the first 14 days after weaning, sows were observed twice daily in presence of a mature boar for onset of standing estrus. Other signs of estrus such as swelling and reddening of vulva, mounting, mucus discharge and reaction to back-pressure were also checked. Once sows stood to be mounted by a boar, they were mated naturally under supervision. At similar pattern, gilts were also checked each day for estrus and served accordingly.

Traits and statistical analysis: Statistical evaluations were carried out using the SAS (Statistical Analysis System,

version 9.3, USA) program. Responses to individual questions were analyzed by GENMOD procedure using multinomial distribution and cumulative logit link. Descriptive statistics were obtained using MEANS and FREQ procedures. The studied variables for reproductive performance were FR, FI, WEI, WCI, AFB and WFB. All studied and discrete variables were analysed using the mixed procedure. Values were expressed as mean±standard deviation. To ensure homogeneity, the collected data was logarithmically transformed, and then back-transformed by Kolmogorov-Smirnov (K-S) test using Lilliefors correction with 95% confidence intervals. Finally, Spearman correlation analysis was used to determine the relationships between residual values of performance in management and reproductive performance. Differences in farrowing interval and litter size according to parity were estimated by analysis of variance. The level of significance throughout the study was $P>0.05$.

RESULTS AND DISCUSSION

Farm productivity and fertility measures: Data on 762 mating revealed that mean FR and FI were $71.5\pm 11.4\%$ and $165.4\pm 13.8\%$, respectively. The FI did not show a significant decrease ($P = 0.637$) with increased parity (Fig. 1). WEI, WCI and AFB averaged 8.3 ± 2.1 days, 42.7 ± 11.0 days and 8.1 ± 1.3 months, respectively. Of the total farrowing, 326 (56.8%) conceptions took three weeks while remaining 248 (43.2%) conceptions took more than 3 weeks to consider a sow in pregnancy (Table 1). During lactation, average daily feed intake by sow was 3.8 ± 0.9 kg. At birth and weaning, average live litter size was 9.9 ± 3.6 and 8.1 ± 3.3 piglets per farrowing, respectively. Live litter size at birth showed no significant difference ($P=0.794$) with respect to parity (Fig. 2). Piglet weight at birth and weaning averaged 996.9 ± 150.8 g and 9.6 ± 1.7 kg, respectively. Pre-weaning mortality was $18.5\pm 12.6\%$ of the total newborn population and seemed to be quite high. A higher standard deviation indicated wider range of values (0–50). The observed pre-weaning mortality rate constitutes an important restrictive factor for reproductive efficiency of farm. This fact suggests that efforts focusing on giving maximum care and attention to growing piglets and identifying causes of pre-weaned mortality are needed. Newborn mortality generally occurred

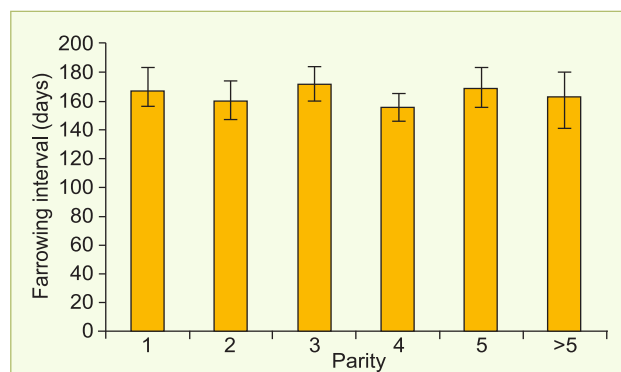


Fig. 1. Farrowing interval (Mean±SD) according to parity in sows.

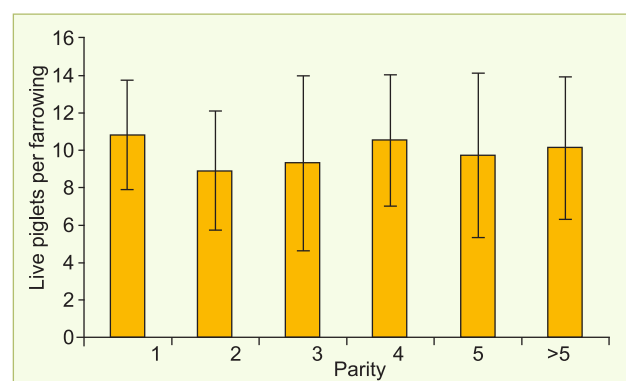


Fig. 2. Live litter size at birth (Mean±SD) according to parity in sows.

Table 1. Descriptive statistics of reproductive parameters in swine

Parameter	N	Mean±SD	Range
<i>Dependent variables</i>			
Farrowing rate (%)	762	71.5±11.4	52–87
Farrowing interval (Days)	762	165.4±13.8	145–185
Weaning to estrus interval (Days)	489	8.3±2.1	3–10
Duration of estrus (Days)	489	3.5±1.1	2–5
Weaning to conception interval (Days)	489	42.7±11.0	28–79
Age at first breeding (Months)	241	8.1±1.3	6–10
Weight at first breeding (kg)	241	97.8±16.9	75–125
<i>Independent variables</i>			
Parity	762	3.4±1.8	1–7
Gestation length (Days)	573	115.6±2.3	111–118
Lactation length (Days)	573	31.2±6.5	21–42
Average daily feed intake by sow (kg)	241	3.8±0.9	2.5–5
Sow bodyweight at farrowing (kg)	241	237.5±44.7	175–300
Sow bodyweight at weaning (kg)	241	200.7±33.7	150–250
Total litter size at birth	573	11.6±4.1	5–17
Live litter size at birth	573	9.9±3.6	4–16
Live litter size at weaning	573	8.1±3.3	3–13
Live litter weight at birth (kg)	573	12.2±2.9	8–16
Live litter weight at weaning (kg)	573	56.2±13.7	34–77
Live piglet weight at birth (g)	573	996.9±150.8	786–1293
Live piglet weight at weaning (kg)	573	9.6±1.7	7–12
Pre-wean mortality (%)	573	18.5±12.6	0–50
Live born/female/year	573	25.1±5.1	14–32
Piglets weaned/female/year	573	21.7±4.6	11–28

during the first two days of life. These observations are in agreement with the findings of previous field reports conducted in different parts of the world which revealed

minor variations among different reproductive traits owing to difference in environment, feeding and management practices. Accordingly, FI (156 days) and WCI (38 days) in sows of Brazil (Mayor *et al.* 2007), WEI (3–8 days) in Thailand (Tantasuparuk *et al.* 2000), gestation length (114.5±1.0 days) in Bangladesh (Motaleb *et al.* 2014), live litter size at birth (10.45) and weaning (9.44) in Czech Republic (Nevrkla *et al.* 2016) and pre-wean mortality (18.2%) in North America (Holtkamp *et al.* 2012) have been recorded previously. Nevertheless, most dependent variables in this study exhibited low values as compared to those revealed in an earlier report by Gouridine *et al.* (2006) who maintained pigs in closed confinement under constant observation. In the present study, non-adoption of scientific management, breeding and health care practices, lack of adequate information and thermal stress seemed to influence the fertility parameters of sows/gilts.

Farm system information: The survey of 102 farms provided new perspectives and insight into the causes of variation in general management practices at swine breeding farms in Punjab that could have dramatic effects on fertility

Table 2. Response frequency for breeding farms based on housing practices followed by pig farmers

Question addressing	N	Response class	Response frequency
Primary occupation	102	Agriculture	19 (18.6)
		Livestock	56 (54.9)
		Both	27 (26.5)
Land holding	102	Landless	11 (10.8)
		1–2 acre	48 (47.1)
		2–5 acres	26 (25.5)
Size of farm	102	> 5 acres	17 (16.7)
		< 25	30 (29.4)
		25–50	61 (59.8)
Type of farm	102	51–100	8 (7.8)
		> 100	3 (2.9)
		Farrow to wean	86 (84.3)
Production system	102	Farrow to finish	16 (15.7)
		Backyard	25 (24.5)
		Intensive	77 (75.5)
Type of housing	102	No houses	0 (0.0)
		Loose housing	96 (94.1)
		Indoor	6 (5.9)
Plans for future sow housing	102	Stall only	18 (17.6)
		Stall and pen	49 (48.0)
		Group	32 (31.4)
Type of construction	102	Other	12 (11.8)
		Cement and brick	102 (100.0)
		Wood	0 (0.0)
Personnel to animal ratio	102	1:10	15 (14.7)
		1:11–20	29 (28.4)
		1:21–50	56 (54.9)
Record keeping	102	1:51–100	2 (2.0)
		Well maintained	68 (66.7)
		Haphazard	31 (30.4)
		Not maintained	3 (2.9)

Figures in parenthesis indicate percentage.

Table 3. Response frequency for breeding farms based on breeding practices followed by pig farmers for reproductive management

Question addressing	N	Response class	Response frequency	Question addressing	N	Response class	Response frequency
Types of pig	102	Large White	87 (85.3)	Pre-farrowing complications	102	Abortion	4 (3.9)
		Yorkshire				None	96 (94.1)
		Landrace	0 (0.0)	Post-farrowing complications	102	Dystocia	35 (34.3)
		Duroc	0 (0.0)			Stillbirth	6 (5.9)
		All	15 (14.7)			Mummified	3 (2.9)
		Others	0 (0.0)			None	58 (56.9)
Rearing of breeding boar	102	Reared	93 (91.2)	Method for pregnancy diagnosis	102	Non-return to estrus	102 (100.0)
		Not reared	9 (8.8)			Ultrasound scanning	0 (0.0)
Method of breeding	102	Natural mating	102 (100.0)	Seasonal decline in fertility	102	Summer	58 (56.9)
		Artificial insemination	0 (0.0)			Rainy	28 (27.5)
						Winter	11 (10.8)
Method of estrus detection	102	Visual observation	45 (44.1)			None	5 (4.9)
		Swollen vulva	14 (13.7)	Time of mating by boar to sow	102	12 h after onset of estrus	22 (21.6)
		Mounting behavior	27 (26.5)			24 h after onset of estrus	67 (65.7)
		Back pressure test	16 (15.7)			48 h after onset of estrus	13 (12.7)
Frequency of daily estrus detection	102	None	4 (3.9)				
		Once	70 (68.6)	Duration of boar exposure for each sow	102	< 2 minutes	50 (49.0)
		Twice	28 (27.5)			2–5 minutes	39 (38.2)
Time spent on estrus detection daily	102	< 15 minutes	40 (39.2)			> 5 minutes	13 (12.7)
		15–30 minutes	52 (51.0)	Day of initiation of boar exposure after weaning	102	No exposure	2 (2.0)
		> 30 minutes	10 (9.8)			1	10 (9.8)
Time of day for estrus detection	102	Morning	74 (72.5)			2	13 (12.7)
		Evening	8 (7.8)			3	46 (45.1)
		Both	20 (19.6)			4	23 (22.5)
Number of chances for re-breeding females that fail to conceive before culling	102	0	0 (0.0)			5	8 (7.8)
		1	52 (51.0)				
		2	24 (23.5)				
		3	19 (18.6)				
		No limit	7 (6.9)				
Reason for culling	102	Conception failure after third mating	11 (10.8)				
		Health problems	84 (82.4)				
		Pregnancy failure	7 (6.9)				

Figures in parenthesis indicate percentage.

and production. Most farmers had marginal land holdings with diversified occupation as a source of income (Table 2). Farm size in this survey was low ranging from < 25–100. Only three farms had pigs more than 100. This is unlike to the average herd size reported in PigCHAMP survey data from North America where most producers manage large barns with more than 2000 sows/barn (PigCHAMP 2010). Majority of farms (84.3%) functioned as farrow to finish (all weaned pigs maintained on-site until market) whereas, merely 15.7% of farms were classified as farrow to wean (all weaned pigs moved off-site). These findings are in accordance with the observations of a previous survey report (USDA-APHIS 2006) of small swine farms (<100 pigs) that reported the use of farrow to finish production systems at most farms (91.2%). Further, parity segregation did not differ and was applied on seven percent of farms only with most farms (93%) co-managing gilts and sows in same barns. The high number of intensive production systems could be due to better availability of scavenging material

in Punjab. However, future housing plans were kept as alternative option depending upon the income of the owner. Previous studies (Harris 2000) have shown that use of intensive production systems was intended to improve the health and growth of weaned pigs to commercial grow-finish size units for better margin of profit. The climatic conditions in Punjab are extreme with minimum to maximum temperature range of 1.8–26.8°C in winter, 18.6–45.8°C in summer, mean relative humidity 63% and total rainfall of 565.9 mm (during the period of survey). As a result, most farmers (94.1%) kept pigs in loose housing system with a mixture of both stalls and pens and used cement and brick as construction material for sties. Previously, Karlen *et al.* (2007) have observed that use of stalls, concrete, keeping mixed parity animals and conventional housing systems as a viable and better option of housing swine in rural areas. Moreover, use of dynamic housing groups with electronic sow feeders, parity segregated animals and deep-bedded systems to evaluate

reproductive efficiency of sows were questionable (Jansen *et al.* 2007). At majority of farms, labor to animal ratio of 1:50 was most common which was in consonance with the outcomes of Knox *et al.* (2013) who reported a similar (1:50) ratio as most frequent in small to medium sized swine farms. They further established that time spent on record keeping should be about 10 h/week. In the current survey, 66.7% swine barns had accurate and well maintained records. Therefore, efforts should be made to give more considerations on precise record keeping as they provide valuable information about the performance of animal.

Breeding management: Not surprisingly, natural mating (100%) in animals was being followed by the people of rural areas, possibly due to non-availability of extended boar semen and lack of artificial insemination technology (Pandey 2000). Therefore, traditional practice of boar rearing was followed for natural mating. Most farms had single genotype (Large White Yorkshire) with only two percent having pure line while few farms (14.7%) had multiple genotypes (Table 3). These findings were in agreement with the observations of Knox *et al.* (2013) who

Table 4. Response frequency for breeding farms based on feeding practices followed by pig farmers

Question addressing	N	Response class	Response frequency
Roughage feeding	102	Yes	12 (11.8)
		No	90 (88.2)
Concentrate feeding	102	Yes	62 (60.8)
		No	40 (39.2)
Source of concentrate	62	Purchased	13 (21.0)
		Home made	49 (79.0)
Frequency of daily concentrate feeding	62	Once	3 (4.8)
		Twice	55 (88.7)
		Thrice	4 (6.5)
Method of feeding concentrate	62	<i>ad lib.</i>	30 (48.4)
		Daily increase	32 (51.6)
Type of concentrate	62	Boiled	15 (24.2)
		Raw	47 (75.8)
Kitchen waste	102	Yes	40 (39.2)
		No	62 (60.8)
Supplementation of mineral mixture	102	Yes	59 (57.8)
		No	43 (42.2)
Type of mineral mixture fed	59	Simple	75 (73.5)
		Chelated	27 (26.5)
Additional feeding of pregnant sow	102	Yes	67 (65.7)
		No	35 (34.3)
Additional feeding of lactating sow	102	Yes	64 (62.7)
		No	38 (37.3)
Colostrum feeding to newborn piglets	102	Yes	71 (69.6)
		No	31 (30.4)
Creep starter feeding	102	Yes	29 (28.4)
		No	73 (71.6)
Milk replacer feeding	102	Yes	25 (24.5)
		No	77 (75.5)
Daily provision of clean drinking water	102	Twice	7 (6.9)
		Thrice	13 (12.7)
		<i>ad lib.</i>	82 (80.4)

Figures in parenthesis indicate percentage.

described Large White Yorkshire as the most preferred swine breed for pork across the globe. In our survey, once daily estrus detection in morning was common and most practical. Twice daily estrus checks would exhibit only a 6 h interval between AM and PM and was questionable. This has been substantiated in an earlier report by Lamberson and Safranski (2000) where the frequency of estrus check and timing of mating had minimal impact on reproductive performance of sows. There was great variation in pregnancy diagnostic approach, since none of the farm used real-time ultrasound for diagnosis of pregnancy probably due to lack of a qualified veterinarian having precise knowledge of swine reproduction. Accordingly, non-return to estrus was the only mode to categorize an animal as pregnant. Furthermore, farm actions in response to a failed pregnancy test were also variable in the number of chances a sow was given to conceive and weeks that passed before culling. The farm responses also suggested that seasonal infertility was common and was a major concern for management alternatives. Irrespective

Table 5. Response frequency for breeding farms based on health care management followed by pig farmers

Question addressing	N	Response class	Response frequency
Biosecurity measures at farm	102	Disinfection	26 (25.5)
		Banned entry of trespassers	63 (61.8)
		None	13 (12.7)
Daily cleaning of sty	102	Once	64 (62.7)
		Twice	28 (27.5)
		None	10 (9.8)
Periodic disinfection	102	Once a week	29 (28.4)
		Once in 15 days	33 (32.4)
		Once a month	40 (39.2)
Vaccination	102	Yes	102 (100.0)
		No	0 (0.0)
Regularity in vaccination	102	Annually	89 (87.3)
		Biannually	13 (12.7)
Deworming	102	Yes	76 (74.5)
		No	26 (25.5)
Regularity in deworming	76	Quarterly	25 (32.9)
		Biannually	31 (40.8)
		Annually	20 (26.3)
Annual disease testing	102	Yes	21 (20.6)
		No	81 (79.4)
Segregation of sick pig	102	Yes	98 (96.1)
		No	4 (3.9)
Cutting wolf teeth	102	Yes	96 (94.1)
		No	6 (5.9)
Castration	102	Yes	37 (36.3)
		No	65 (63.7)
Ear notching	102	Yes	69 (67.6)
		No	33 (32.4)
Docking	102	Yes	0 (0.0)
		No	102 (100.0)
Iron injection to piglets	102	Yes	79 (77.5)
		No	23 (22.5)

Figures in parenthesis indicate percentage.

of parity, conception failure after third mating (10.8%), pregnancy failure (6.9%) and health problems (82.4%) were the main reasons for sow culling. Interestingly, history of abortion was noticed in a meagre proportion of farms (3.9%). Dystocia as a cause of post-farrowing complication was observed in 34.3% farms. Both duration of boar stimulation per sow and timing for initiation of boar exposure after weaning were variable. Filha *et al.* (2009) reported that boar exposure can affect ovarian follicle stimulation and wean to estrus interval. Any variation in boar stimulation procedures could result in discrepancy associated with conception failure (Knox *et al.* 2011). It has been well documented that presence of a mature boar at the time of estrus detection is essential for maximizing standing response of sow and gilt. In this survey, mating occurred within minutes to hours after first detection of heat and then 24 h later, whereas some provided a third service if the female was still standing the next day. However, some farms delayed by 24 h based on wean to estrus interval. This variation in timing was uncertain, and may have little impact on fertility due to relationship between WEI, duration of estrus and time of ovulation after onset of estrus (Belstra *et al.* 2004). These approaches could impact non-productive days and prove useful for troubleshooting incidences of reproductive failure at farms.

Feeding practices: An essential element for sustained herd fertility involves adequate and balanced feed intake (Ball *et al.* 2008). Feed consumption can be influenced by many factors including genetics, nevertheless, methods used to improve feed intake for lactating sows are not well defined. The survey indicated that feeding method for sows in lactation was divided between *ad lib.* and gradual daily increases of concentrate feed and kitchen waste with variation in frequency and method of feeding (Table 4). The concentrate in pig diet extensively comprised of maize,

wheat, bajra, soyabean meal, ground nut cake, deoiled rice bran and wheat bran whereas roughage mainly consisted of berseem. However, there was no information from survey about how each method was accomplished. Anyhow, the goal was to get animals to eat as much as they could (Renaudeau *et al.* 2001). Alternatively, kitchen waste was preferred in 39.2% farms. Differences in additional feeding practices like supplementary nutrition during pregnancy and lactation in sow, colostrum to newborn, creep starter and milk replacer in grower were observed in many farms. Nonetheless, discrepancy in feeding system in the current survey may also be associated with reproductive failure (Einarsson *et al.* 2008).

Health care management: A prerequisite of effective breeding in a farm is ensuring good health care of animals (Horky *et al.* 2013). In the present survey, major percentage of farms exhibited greater variation in relation to health care services of animals during lactation, weaning, breeding and gestation (Table 5). Administration of vaccination was observed in all farms. Optimum biosecurity measures, segregation of sick pig and cutting wolf teeth were additional key notable features practiced by most farmers. However, none of the farmer practiced docking in newborn piglets. As the data was collected from the rural pig farms, the analysis of results was representative and suggested adoption of scientific health care services to reduce treatment costs and subsequently improve the productive performance of farm. Moreover, due to inadequate marketing and processing facilities in Punjab, most grow-finish pigs (81%) are transported to North Eastern states. Poor health management could be one of the most promising factors associated with reduced piglets/sow/year reflecting inefficiency in production (Martel *et al.* 2008).

Relationship between female fertility and production traits: Correlations between lactation and post-weaning

Table 6. Residual correlation coefficients between performance during lactation and post-weaning reproductive performance (n=209)

Parameters	FI	LL	ADFIS	WEI	WCI	SBWF	SBWW	LLSW	LLWW	LPWB	LPWW	AFB	WFB	GL
FR	0.396	-0.139	0.080	0.275	0.264*	-0.006*	0.027	0.155	-0.226	0.014	-0.047	0.128*	0.421	0.627
FI		0.481*	0.365	0.307*	0.456**	0.050	-0.131*	-0.010	-0.315	-0.053	-0.261	0.112	0.097	-0.020*
LL			0.614*	0.516**	0.438**	0.617	0.382	0.118	0.169*	0.249	0.369	-0.141	0.283*	0.017
ADFIS				-0.022*	-0.101	0.083	0.217*	-0.207	0.469**	0.109	0.721**	0.816	0.747**	-0.025*
WEI					0.412**	-0.061	-0.053	0.046	-0.081*	-0.532	0.003	0.612	-0.077	0.123
WCI						-0.108	-0.112	0.078	0.036	-0.073*	-0.015	0.460	0.520	0.208
SBWF							0.796**	-0.069	0.117	-0.203	-0.193*	0.257*	0.159*	-0.090
SBWW								0.103	-0.317*	0.138*	-0.411	0.357	0.268*	-0.214
LLSW									0.518**	0.291*	0.592*	-0.30	-0.117	0.010
LLWW										0.689	0.647**	0.481*	0.292*	-0.211
LPWB											0.385*	0.167	0.349	-0.248
LPWW												0.569	0.162*	-0.360
AFB													0.235*	0.059
WFB														-0.027

FR, Farrowing rate; FI, farrowing interval; LL, lactation length; ADFIS, average daily feed intake by sow; WEI, weaning to estrus interval; WCI, weaning to conception interval; SBWF, sow body weight at farrowing; SBWW, sow body weight at weaning; LLSW, live litter size at weaning; LLWW, live litter weight at weaning; LPWB, live piglet weight at birth; LPWW, live piglet weight at weaning; AB, age at first breeding; WB, weight at first breeding; GL, gestation length. *P<0.05; **P<0.01.

reproductive parameters were variable and have been presented in Table 6. These correlations varied from being poorly associated (negatively correlated; $P < 0.05$), low to moderate ($P > 0.05$), significant ($P < 0.05$) and highly significant ($P < 0.01$) indicating equivocal effects of variables on the reproductive parameters occur regardless of management level in a herd (Auvigne *et al.* 2010). Similar observations were noted by Gourdine *et al.* (2016) who demonstrated inconsistent relationships between lactation and post-weaning reproductive performance in swine farms of Thailand. Further, determination of residual correlations directly with reproductive parameters recorded at rural farms gives a more legitimate picture, owing to ground reality of management practices followed in rural areas (Hoving *et al.* 2011). However, a far greater impact ($P < 0.01$) was established by WEI, WCI, LL, ADFIS, live litter size and weight at weaning and live piglet weight at weaning which was in consonance with the findings of Weber *et al.* (2009) who explained significant positive relationships between similar variables, viz. WEI, WCI, litter size and weight at weaning and piglet weight at weaning during lactation. Clearly, lactation and post-weaning reproductive parameters involved a complex interplay of various related, unrelated variables and other physical cues.

The improvement of reproductive performance and establishment of suitable management practices could enhance viability of swine breeding systems. This study suggested that efforts focusing on reproductive management are needed. The FR, WEI, WCI, AFB and live litter size at weaning are important factors in order to improve the reproductive efficiency of sows. It is hoped that a process of reproductive selection could homogenize and improve the reproductive performance of swine herds since piggery has good potential for commercial production in Punjab.

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