CERTAIN SOCIAL ENVIRONMENTAL FACTORS ON THE REPRODUCTIVE PERFORMANCE OF PIGS

By

S. RAMAKRISHNAN

THESIS

Submitted in partial fulfilment of the
requirement for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Livestock Production Management
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
Mannuthy, Thrissur

1996

24/8/96

DECLARATION

I hereby declare that the thesis entitled **"CERTAIN SOCIAL ENVIRONMENTAL FACTORS ON THE REPRODUCTIVE PERFORMANCE OF PIGS"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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CERTIFICATE

Certified that this thesis, entitled **"CERTAIN SOCIAL ENVIRONMENTAL FACTORS ON THE REPRODUCTIVE PERFORMANCE OF PIGS"** is a record of research work done independently by **Sri. S. Ramakrishnan**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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We, the undersigned members of the Advisory Committee of **Sri. S. Ramakrishnan**, a candidate for the degree of Master of Veterinary Science in Livestock Production Management, agree that the thesis entitled **"CERTAIN SOCIAL ENVIRONMENTAL FACTORS ON THE REPRODUCTIVE PERFORMANCE OF PIGS"** may be submitted by Sri. S. Ramakrishnan, in partial fulfilment of the requirement for the degree.

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Mannuthy **S. RAMAKRISHNAN**

Dedicated to my
beloved parents and sister

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INTRODUCTION

Livestock in India accounts for one fourth of the total animal population of the world. The total population of pigs in India is 88.3 lakhs as per FAO Bulletin 39. Pigs are ideal suppliers of good quality meat. Pigs excel all other meat producing animals except well kept broiler. With today's increasing population and its ever increasing consumption of meat, swine production is gaining more importance in our economy and a leading role in agricultural income.

Pig rearing in India is still not in a satisfactory state and almost entirely in the hands of people with little resources who continue to follow the primitive method of rearing. The pig rearing community due to their low economic status and other reasons have not been able to provide necessary inputs like improved breeding, feeding, and management for making swine industry an economic enterprise. It has therefore, become imperative that due attention is given and all possible avenues explored to improve the productive capacity of pigs; while this could be achieved to a very great extent by proper genetic selection and scientific breeding, it is worthwhile to remember that improved managemental practices do play a vital role in accelerating the rate of production.

Pig is an extremely versatile animal, able to adapt to a wide variety of circumstances imposed by man (Hazel, 1963). They can thrive on highly concentrated or bulky feeds and produce high percentage of meat and fat.

From the point of efficient production of meat, pigs excel other livestock and play an important role in the economy of the country as they are good converters of feed into meat for human consumption. They are tolerant to wide variety of feed and can make full and efficient use of the farm and other products which would otherwise be wasted.

In tropical countries pig production has great potential, as it can be successfully and economically raised and requires only low cost building, labour requirements and other inputs are comparatively low.

The economy in swine production is influenced by such factors as (1) number of piglets farrowed per litter, (2) weight of the litter at weaning, (3) labour charges per 100 kg meat produced, (4) returns per amount of money spent and (5) cost per kg meat produced. Maynard (1969) has estimated the average percentage of the gross energy in the feed eaten by various kinds of animals converted into human food as follows pork 20 per cent, milk (dairy cows) 15 per cent, eggs 7 per cent, meat poultry 5 per cent, beef 4 per cent and lamb 4 per cent.

The success and efficiency of pig farming mainly depends on the reproductive performance of the pigs. The age at which gilt is first mated can have important implications on the efficiency of its lifetime production. Swine producers must exercise a continuous effort to regulate the swine breeding if financial profit is to be a reality. For the success of reproductive performance with optimum litter size, gilts should be first mated at the time of third oestrus (Bundy *et al.*, 1976). The farmers practised mating females at younger age or lighter weights in order to improve the total efficiency of breeding female. The success of such a move depends on the attainment of puberty at an early age together with satisfactory ovulation, conception and embryo survival (Hughes and Cole, 1975).

Puberty may be defined as that phase which links immaturity and maturity, recognised in the gilt by the occurrence of the first oestrus period (Hughes and Varley, 1980). It is the stage at which the gilt becomes capable of reproducing and normally occurs at about six to seven months of age (Hafez, 1987).

The introduction of a mature boar to immature gilts induces the precocious attainment of puberty (Brooks and Cole, 1970). Early puberty is considered necessary for the best economic management of female reproductive performance.

Financial success therefore largely depends on the onset of puberty, conception and litter performance. No significant difference could be observed in the performance of those animals having a floor space as per ISI specification and the one where the floor space reduced to the extend of 50 per cent (Leena, 1992).

Colin (1980) observed that the post-natal mortality may amount to 10 to 20 per cent of those born and often seems to be due to crushing under the mother. Close observation on the maternal behaviour reveals that there are some animals which have good maternal instinct and they respond rapidly to the alarming sounds of the piglets especially when being crushed and suddenly move away from that suckling position to save the crushed one where as some others are totally irresponsive to this and thus coming out with greater percentage of piglet mortality. The leading of newly born piglets wandering in search of teat and frequent suckling of the litter during neonatal life are some of striking etiological factors contributing much to the survivability of young piglets during the early critical life by making sure the optimum availability of colostrum to all piglets.

The maximum exploitation of the production potentiality of breeding gilt demands a superior postweaning performance.

The lactational stress on the animal is the real obstacle in the achievement of this aim.

The effect of social environment on the reproductive performance of pigs in tropics has not been fully assessed. So this is expected to throw light on these areas and thereby necessary management practices can be developed to improve reproductive potential and economics of rearing pigs. In traditional and organized farming systems, breeding males and females are housed separately. It leads to increased construction cost, managemental and labour expense and inturn resulting in reduction in profit.

In the light of the foregoing resume, the present study was undertaken with the following objectives.

1. To study the effect of social environment on the reproductive performance of pigs.

2. To study the feasibility and economics of rearing pigs of either sex together.

The present investigation is aimed to explore the possibility of reducing the cost of housing and labour to make suitable recommendation to farmers.

Review of Literature

REVIEW OF LITERATURE

The effect of social environment on production performance of pigs is well reviewed and reported by workers from Western countries. A review of the major factors influencing puberty attainment in gilts is of value in identifying those measures which may be taken to reduce pubertal age. But reports of such nature are scanty and scattered from tropical countries. The literature reviewed in this aspect is presented under the following heads.

2.1 Onset of oestrus in gilts

Puberty is an economically important criterion as it is related to the age at breeding and the consequent life time production. Puberty attainment represents the onset of reproductive capability, since the first behavioural oestrus normally coincides with the pubertal ovulation. Puberty is basically the result of a gradual adjustment between increasing gonadotrophic activity and the ability of the gonads to assume steroidogenesis and gametogenesis. Boar contact is the single most effective natural means of stimulating precocious puberty attainment in the gilt.

2.1.1 Age and body weight at first oestrus in gilts

The age at puberty (onset of first oestrus in gilts) is influenced by various factors such as breed and genotype of the gilt, nutritional, climatic and social environment.

Dyck (1971) stated an average age at puberty as 197.5 ± 1.8 days within a range of 141 to 254 days in 132 gilts. For local Chinese and Landrace gilts Mahendranathan and Mellish (1975) reported the first oestrus at 162.2 and 241.9 days respectively and body weight at first oestrus were 48.7 and 84.2 kg respectively. Reuther *et al.* (1976) observed the average age at puberty as 246 days in 1085 gilts which were examined daily for signs of oestrus from 100 days of age. Einarsson *et al.* (1978) suggested the onset of first oestrus from 5 months to 280 days of age and body weight of 104 kg in 44 Swedish crossbred gilts and found that 88.6 per cent of gilts exhibited oestrus and concluded that the time of first oestrus was correlated with age and body weight of gilts but could not ascertain which of these two factors was the most important.

Marayama *et al.* (1978) found that 90 per cent of crossbred gilts had reached puberty by 250 days of age and 130 kg body weight in which the first oestrus was observed in 170 days of age and body weight at 90 kg. Hutchens *et al.* (1979)

revealed a significant effect of breed of dam on the onset of puberty. He has further reported that in gilts from Spot,Duroc, Landrace and Yorkshire dams age at puberty averaged 188.8, 189.8, 191.9 and 197.6 days respectively and Landrace sired gilts were the lightest at puberty and Duroc sired gilts were heaviest (206.6 Vs 218.8 lb) and also found that crossbred gilts were 6.3 days younger at puberty than pure bred. Braune and Schlegel (1981) suggested significant difference between progeny groups of 173 gilts. The gilts were tested daily for oestrus from six months of age, age and weight at puberty averaged 235 days (218 to 251 days), 114 kg (105.3 to 120.6 kg) respectively with a daily gain of 485 gram (458 to 497 gram). Young and King (1981) studied that mean age and weight at puberty as 177.8 days and 91.7 kg in 112 Yorkshire gilts.

Mohanty and Nayak (1986) reported the reproductive performance in 60 Large White (LW) and 40 LW x Local. Age and body weight at puberty averaged 192.4, 237.8 days and 37.3, 42.7 kg respectively. Tzeng (1991) found that in 35 Taoyuan and 58 Landrace pigs age at puberty averaged at 189.3 and 257.6 days respectively. Eliasson and Rydhmer (1991) reported a mean age at first oestrus as 212 $\pm$ 20 days at mean body weight of 118 $\pm$ 14 kg in 414 Swedish Yorkshire fed on high or low protein diet. Mosch and Huhn (1992) suggested that reconstitution of 168 gilt groups had a stimulatory effect on

the onset of puberty and this procedures did not achieve synchronisation of oestrus within a 7 days period and some significant correlation between daily gain and age at puberty (-0.33 to -0.43). Nakamura *et al.* (1993) suggested that gilts in pens reached puberty at an average of 24.5 days earlier than gilts in individual stalls. Rozeboom *et al.* (1995) reported age at puberty averaged from 138 to 240 days in 93 Yorkshire x Landrace gilts. Tesic *et al.* (1995) suggested that the age of gilts at 1st, 2nd, 3rd oestrus were 178, 199 and 217 days respectively.

2.1.2 Nutritional status on puberty

Friend (1977) reported that a reduced feed intake and/or a suspected deterioration of a high fat diet delayed the onset of puberty by 21 days in pubertal gilts between 156 and 175 days of age. Friend *et al.* (1981) suggested that gilts fed *ad libitum* were younger and heavier at puberty (159 vs 170 days and 97 vs 92 kg) than those limit-fed-gilts. Gilts fed on diets containing 16, 16 or 12 per cent crude protein from 28 to 60 kg and thereafter reducing the protein content to 14, 14 or 10 per cent upto puberty did not significantly affect on the age at puberty (Duee *et al.*, 1981).

Crnojevic *et al.* (1984) studied that when Swedish Landrace gilts were fed at levels equivalent to 100, 90 or 80

per cent of the feed requirement from 60 kg body weight, age at puberty averaged 101, 98 and 94 days. Lo *et al.* (1985) found that age at puberty averaged 166.2, 167.3 and 174.3 days in Landrace litters fed at levels equivalent to 100, 90 or 75 per cent. The body weight at puberty averaged 88.8, 89.2 and 80.3 kg respectively.

On restricting the diet to 85 per cent of free choice, Lunen and Aherne (1987) reported that age at puberty was delayed but weight at puberty was unaffected by plane of feeding. Early maturity was observed by Shneider and Zelenin (1989) when gilts were fed at an increased level from four to nine months of age.

Hmar and Rajagopalan (1993) observed that the heavy weaners of HP, NRC and Low protein diet attained puberty at 180.50, 182.00 and 188.33 days respectively with average body weight of 42.13, 45.33 and 44.67 kg. The age at puberty in the light weaners were 233.33, 229.83 and 254.00 days with the average body weight of 51.00, 58.42 and 53.50 kg respectively. On feeding isonitrogenous diets at 80, 100 or 120 per cent of recommended energy level, Koczanowski *et al.* (1993) reported the first oestrus at 198, 190 and 183 days respectively.

2.1.3 Climatic environment on puberty

Mavrogenis and Robison (1976) observed that crossbred gilts born in the fall reached puberty at a younger age and a lower weight than those born in the spring. Day length is responsible for the delay in the onset of puberty during summer months (Paterson and Pearce, 1990). Lee *et al.* (1993) observed that there was a significant season x breed interaction for the percentage of gilts reaching puberty by 300 days. Faillace *et al.* (1994) suggested that gilts attained puberty earlier in the spring than in the autumn.

2.1.4 Social environment on puberty

Male effect

The introduction of a mature boar to immature gilts is known to induce the precocious attainment of puberty. When boar contact was initiated at very young gilt ages (3 to 4 months), pubertal response was minimal and sexual development was possibly be delayed (Zimmerman *et al.*, 1969; Hughes and Cole, 1976). Kirkwood and Hughes (1979) suggested that with boar contact at young gilt ages (4 to 5 months) pubertal response was minimal and sexual development was delayed.

Kirkwood and Hughes (1980) reported that the stimulus from the mature boar responsible for early attainment of

puberty in the gilt was olfactory in nature and that the production of this pheromone was age dependent. Clark *et al.* (1982) found that social stresses delayed the onset of puberty in gilts.

Cronin (1983) observed that exposure to mature boar at 23 rather than 28 weeks of age increased the reproductive efficiency of the gilts. Caton *et al.* (1983) suggested that by boar exposure to different time intervals age at puberty averaged 195.7 days in 100 cross bred gilts. Prunier *et al.* (1989) found that the boar exposure in tethered and group-penned gilts resulted puberty at 233 and 215 days of age and by non boar exposure the puberty averaged 260 and 264 days of age. Hughes and Pearce (1990) suggested that sufficient boar contact was achieved to stimulate puberty even in the large exposure pen with 8 gilts per group. Peacock *et al.* (1990) found that housing gilts with dry sows before entry into the boar shed was detrimental to attainment of puberty. Prunier and Mounier (1991) revealed that when boar contact was initiated before 225 days of gilt ages, pubertal response was maximum than later introduced the boar. Soede and Schouten (1991) observed that social conditions of gilts during rearing affected their initial sexual behaviour. Paterson *et al.* (1991) concluded that higher proportion of boar exposed than isolated gilts reached puberty by 225 days of age and the mean

interval from commencement of oestrus detection until puberty was shorter for the boar exposed groups.

Tilbrook and Hemsworth (1992) reported that exposure of gilts to boar stimuli did not influence their sexual behaviour. Hughes (1994a) studied that the actual frequency of daily boar contact required to maximise puberty stimulation in the gilt may be dependent on season. Hughes (1994b) concluded that exposure to a high libido boar stimulated puberty at an earlier age than exposure to a low libido boar (179.6 vs 194.1 days). Philip and Hughes (1995) concluded that pubertal response of the gilt to the boar effect was enhanced when boar contact occurred several times each day compared with a single boar contact period.

Siswadi and Hughes (1996) observed that daily exposure to a boar is a potent stimulus for early puberty in gilts. Germanova *et al.* (1996) reported that gilts attained puberty earlier in group penned females than in the individually penned groups.

2.2 Post weaning oestrus interval in sows

The interval from weaning to oestrus is influenced by a number of variable factors. Shimizu and Takeuchi (1969) found that mean interval from weaning to oestrus was delayed by

60 days due to early weaning. Weaning to conception interval being consistently longer for later mated gilts and had a slight increase in the farrowing interval as mating age increased (Legault and Dagorn, 1973). Hillyer (1976) reported that the weaning to conception interval was reduced from 27 to 9 days by spraying sows shortly after weaning with a synthetic boar odour containing the steroid 5 alpha-androst-16-en-3-one. Aumaitre *et al.* (1976) observed that the weaning to conception interval varied according to the season of farrowing, the average length was 15 to 20 days between October and June and 26 to 30 days for the summer months. Fahmy and Dufour (1976) found that there was no significant difference in this interval in sows housed either in groups or in individual pens. Rowlinson and Bryant (1976) revealed that *ad libitum* feeding, grouping and the continuous presence of a boar within the group after 20 or 21 days of lactation were associated with the successful induction of oestrus in lactating sows. Lengele *et al.* (1976) suggested that correlation between weight of sow at weaning and post-partum oestrus interval were -0.260 ($P<0.05$). In sows weighing 84-111, 112-125 and 120-148 kg at weaning, the interval between weaning and conception was 22.27, 18.88 and 7 days respectively. This variation in weaning weight of dam was accounted by litter size, and piglet weight during lactation. Madhavan and Raja (1978) found that the onset of post-weaning

oestrus in sows were not significantly altered by the age of weaning. Housing sows in groups with the majority adjacent to, rather than with a boar, from day 14 of lactation and feeding the sows 6.4 kg of feed per day during lactation resulted in 48 per cent of the lactating sows exhibiting oestrus (Petchey and Jolly, 1979). Karlberg (1980) studied that 75 Norwegian piggeries weaning to mating interval was not significantly affected by housing weaned sows in either the presence or absence of boars. Sommer (1980) reported a shorter weaning to mating interval for sows housed in groups rather than in individual pens (7.9 and 23.0 days respectively). Petchey and English (1980) suggested that post-weaning oestrus interval was 2.28 days for the sows exposed to a boar and 10.0 days for the control groups, the difference approaching significance ($0.05 < P < 0.10$), none of the sows in the boar treatment groups had a weaning to oestrus interval exceeding 9 days. Fahmy (1981) observed that the interval from weaning to oestrus could be reduced by improving the feeding and management of sows before weaning and few days after weaning. Young and King (1981) reported that weaning to oestrus interval was not influenced by initial breeding on first or third oestrous cycle of gilt. Hemsworth *et al.* (1982) found that the group housing and boar stimulation showed significant influence in reducing the interval. Heyde *et al.* (1982) observed a highly significant correlation (0.30)

between the interval from weaning to oestrus and weight of sow at end of first lactation. King *et al.* (1982) concluded that interval from weaning to mating was significantly correlated (0.23) with losses of weight and fat during lactation, but not related to age.

Paterson and Lindsay (1983) reported that weaning to oestrus interval declined by 5.8 days for each 10 day increases in initial age and by four day for each 10 kg increase in initial weight. Mathew (1992) observed that post-weaning oestrus did not give any projectable inference in connection with plane of feeding. Tarocco (1992) stated that 12 primiparous and 83 multiparous sows were exposed to a boar contact daily and 39 primiparous and 68 multiparous control sows were not exposed to a boar in the 4 groups respectively, the interval from weaning to oestrus averaged 5.58, 5.55, 9.33 and 9.26 days, the difference between exposed and control sows being significant only for the primiparous animals. Pearce and Pearce (1992) studied that housing sows next to either an oestrous sow or a mature boar and allowing them to have a short period of physical contact with these animals daily stimulated the early synchronised onset of oestrus after weaning in sows in summer and winter and to minimise the weaning to remating interval. Newton and Mahan (1993) studied 114 F_1 gilts (Landrance x Yorkshire) which showed post weaning breeding interval were not significantly affected by initial

breeding weight but a higher percentage of sows in the 120 kg group were anoestrus or failed to conceive compared with the heavier groups and suggested that an initial breeding weight of approximately 135 kg at 8 months of age might be optimal when sows farrow in crates, whereas a lower breeding weight might be more desirable for sows farrowing in pens. Gertken *et al.* (1993) found that when 53 sows and their litters were group housed and 39 sows and their litters were housed in farrowing pens with cubicles, the interval from weaning to oestrus was 8.18 ± 0.60 and 7.19 ± 0.28 days respectively. Lee and Yen (1994) stated that post-weaning interval to conception was significantly affected by parity in 2 of the herds (longest after 1st parities) and by season of weaning in one herd and found that interval was not significantly affected by breed of sow, lactation length or litter size. Dourmad *et al.* (1994) observed that energy deficit at weaning showed delay in weaning to oestrus interval. Weitze *et al.* (1994) found that 80 per cent of the sows came into heat within 3-5 days after weaning. Kannan (1995) observed that the onset of post-weaning oestrus did not vary significantly between groups in primiparous sows.

2.3 Fortnightly body weight

Agarwala (1961) found pigs attaining 90 kg (197 Lbs) in 6 month of post-weaning period. Mahadevan (1962) studied a

growth level of 68 kg body weight during 33 weeks (8 months) period. Saxena (1968) concluded that 62-82 kg weight level could be reached in 48 weeks (11 months). Berger *et al.* (1980) recorded that the extended photoperiod did not exert a beneficial effect on weight gain of boars, barrows or gilts. Gupta (1983) studied that for large white pigs at 18 weeks, the body weight averaged 26.0 and 26.5 kg for males and females respectively. Mishra *et al.* (1989) observed the highest average daily gain (ADG) during 20-24th week and sex of pig had significant effect on average daily gain during 12-16, 16-20, 20-24 and 28-32 weeks of age. Petherick *et al.* (1989) studied that group size had no effect on food intake, but the food conversion efficiency of the animals in groups of 36 was significantly poorer than in groups of 6 and 18. Leena (1992) studied that for large white Yorkshire pigs, total weight gain averaged 58.5, 56.2 and 55.5 kg and the differences among groups were not significant. Kannan (1995) reported that the fortnightly body weight was seen linearly increased as age advanced. The average gain in body weight for pigs in all groups increased progressively with age, from weaning and reached a peak at 12th fortnight and thereafter declined gradually in large white pigs.

Nowicki *et al.* (1963) suggested that the daily gain to respective live weights of 100, 115, 130 kg were for large whites 650, 678 and 641 gram and for Swedish Landrace 628, 625

and 690 gram. Intakes per kilogram gain in that order were 4.35, 4.52, 4.86, 4.50, 4.76 and 5.14 feed units. Brooks *et al.* (1964) concluded that in the successive periods from birth to 50, 50 to 100, 100 to 150 and 150 to 200 lb average daily weight gains were 0.70 and 1.52, 1.76 and 1.96 lb respectively. Thompson (1965) reported that daily weighing of spotted Belourssian pigs from birth to 10 months of age suggested that there was a rhythm of growth rate with peaks at intervals of 12 days not being significantly affected by sex or season of birth. Walstra (1980) concluded that animals grew well upto 36 weeks of age (125-165 kg) with maximum growth between 13 to 24 weeks of age for boars and gilts and between birth to 18 weeks for boars. Morrison (1984) suggested that growth rate in pigs increased gradually until the pig reached a weight of about 102 kg and then decreased slightly. When carried to higher weight gain 136 kg, the rate of gain was considerably less. Schmitten *et al.* (1986) concluded that average daily gains of 753, 758 and 712 g for Piettain x German Landrace pigs finished to 80, 100 and 120 kg respectively. Matousek *et al.* (1989) suggested that point of inflection of the growth curve occurred at 169.5 days of age and 90.7 kg body weight with the decrease in growth rate being highest at 215.9 days in commercial hybrid pigs born to Landrace x Czech improved white and sired by Duroc x Belgian Landrace boars.

Mugge (1963) compared the growth performance over periods from 20 to 90, 30 to 100 and 40 to 110 kg live weight and observed that the period 30 to 100 kg had several advantage including lower feed consumption for the same gain. Koinarski (1983) observed that for male and female Duroc pigs, daily gain averaged 246 and 246 g respectively, from birth to 20 kg body weight, 294 and 306 g from 60 to 80 kg, 420 and 406 g from 80 to 90 kg, 469, 446 g from 110 to 120 kg and 484 and 485 g from 120 to 130 kg and also found that the correlation of daily gain with body weight and age were highly significant. Albar *et al.* (1990) suggested that increase of slaughter weight by 10 kg from 105 to 125 kg resulted in increased food consumption by 0.10 to 0.15 kg feed per kilogram of gain. Pradhan (1993) found that the daily gain in weight increased from 131.62 ± 17.38 g at 10th week to a peak of 392.28 ± 9.34 g at 32nd week thereafter declining to 384.60 ± 6.98 g at 40th week of age. Kannan (1995) observed the average daily gain in weight from 137.84 ± 23.7 g at first fortnight to 461.7 g at 16th fortnight.

Body condition and weight change are often quoted as being important determinants of ability to hold the service. Greater weight gain during pregnancy resulted in greater number of piglets born per litter (Stewart, 1945; Robertson *et al.*, 1951; Haines *et al.*, 1959). There was a consistent increase in rate of gain during fourth week followed by marked

check in gain around sixth week of pregnancy. In general, the higher gain in weight was during earlier part of pregnancy as reported by Lodge *et al.* (1961). Omtvedt *et al.* (1965) suggested a correlation between breeding weight of dam and weight gain during gestation. It was negatively (-0.14) correlated with litter size and positively correlated (0.16) with average pig weight at birth. Total weight gain during gestation was 43.6 kg for gilt. Tomov and associates (1971) suggested that daily gain during pregnancy and weight loss during suckling period were correlated with breeding weight of dam. Majerciak (1972) observed in Czechoslovaiken improved white pigs, the body weight at mating was 132.8 kg for gilt and 177.7 kg for sow and during pregnancy, it was 172.44 and 224.8 kg. During lactation and there was a loss of body weight of 27 and 30.2 kg respectively. Brooks and Smith (1980) observed that early mated gilts caught up with initially heavier and by the middle of second pregnancy and had similar pattern of weight change thereafter. Heavier mated gilts lost more fat during first lactation. Babu and Deo (1992) recorded body weight of gilts at fortnightly interval during pregnancy for 35 desi pigs, 26 (desi x Landrace) x (desi x Landrace) and 27 (Landrace x desi) x (Landrace x desi pigs) body weight averaged 48.8 $\pm$ 1.41, 64.0 $\pm$ 2.19 and 56.07 $\pm$ 2.08 kg respectively at the start of pregnancy and 81.4 $\pm$ 1.80, 111.4 $\pm$ 2.13 and 98.7 $\pm$ 2.80 kg at the 14th week of pregnancy.

Kannan (1995) reported that the weight gain during gestation did not differ when pigs bred at varying ages and the weight gain during gestation ranged from 38.4 to 40.1 kg and the average daily gain during gestation period ranged from 352 to 365 gram.

2.4 Duration and intensity of oestrus

Signoret (1970) revealed that early deprivation of social contact had no effect on the two major components of female sexual behaviour such as attraction by the male and the immobility reaction. The result suggested that the female sexual behaviour of the pig was largely a genetic function. In vergin gilts duration of oestrus ranged from 18 to 48 hours (Danilov, 1972). Roshevskii (1974) analysed oestrus detection in gilts by different method and showed that 78.0 per cent, 76.1 per cent and 70.4 per cent were detected by teaser boar, visual assessment by attendants and standing reflex respectively. From the observation on the first oestrous cycle of 52 Dutch Landrace, Bednjfsontwikkeling (1977) found that duration of oestrus averaged 40 hour (15-75 hour). In 30 per cent of female, oestrus could not be detected visually, 30 per cent of females in oestrus did not show standing reflex, but one-third of these female responded to boar odour; 20 per cent of female responded only to the boar. Sommer (1980) reported that the female housed individually showed more contact

seeking activity and stronger reaction to the observer during oestrus than group housed females; although a typical oestrus behaviour such as mounting was possible only in group. Mohanty and Nayak (1986) observed that duration of oestrus in 60 Large White (LW) and 40 LW x Local averaged 72.4 and 82.3 hours respectively. Eliasson (1991) found that out of 547 Swedish Yorkshire gilts, 481 reached puberty during the experimental period from 160 to 260 days of age in the presence of boar. Of these 77 gilts did not show standing oestrus at first ovulation but showed red and swollen vulva. Gilts with low back fat thickness had less intense and a shorter period of reddening and swelling of vulva at puberty than gilts with high back fat thickness. Growth rate and back fat thickness did not influence oestrus symptoms at puberty. Gilts which attained puberty earlier showed more intense and longer duration of reddening and swelling of the vulva than those which attained puberty at later age. Tzeng (1991) reported that duration of oestrus in 35 Taoyuan and 58 Landrace pigs averaged 62.5 hour and 50.8 hour respectively.

Hmar (1993) observed the duration of oestrus, first oestrus and second oestrus in heavy and light weaners of Large White Yorkshire pigs averaged 42.75 $\pm$ 1.63, 40.91 $\pm$ 1.97, 58.88 $\pm$ 2.273 and 54.18 $\pm$ 2.807 hours respectively. Plane of feeding had no significant effect on duration of oestrus and

also found that in both the groups, pubertal oestrus was shorter than second oestrus period.

Weitze *et al.* (1994) found that the 481 of 483 weaner sows, the duration of oestrus was between 32 and 96 hour, while 2 sows showed oestrus for more than 4 days and also observed that sows coming into oestrus early after weaning had a significantly longer oestrus period than sows entering oestrus later. Sterning (1995) observed that the oestrus symptoms in 203 Swedish Yorkshire primiparous sows, at the first oestrus after weaning, the duration of pro-oestrus positively correlated with the interval from weaning to oestrus (IWO) the pro oestrus was shorter during seasons with long day length than in the season with short but increasing day length, duration of standing oestrus negatively correlated with the IWO, total duration of reddening and swelling of vulva negatively correlated with the litter size and intensity of reddening and swelling of vulva negatively correlated with the litter size at 3 and 6 weeks.

2.5 Conception rate

Moody *et al.* (1967) reported that when Yorkshire x Landrace sows were allotted to two groups and when sows in group I were exposed to a boar in a pen mating system immediately after weaning and sows in group II were withheld

for 15 days and then exposed to the boar, conception rates for group I and group II were 35.2 and 70 per cent respectively. Knap (1969) found a higher conception rate for sows housed in groups of 5-6 after weaning than for sows individually housed (87.2 and 82.4 per cent) respectively. Aumaitre (1972) stated that sows weaned after a 35 day lactation showed a conception rate of 97.6 per cent, whereas the figure for sows which were weaned at seven days was 86.0 per cent. Pay and Davies (1973) observed conception rate (72.5 per cent) among gilts bred at pubertal oestrus was significantly lower than those bred at following oestrus. On the contrary, Hughes and Cole (1975) reported the conception rate in pubertal gilts as 92.4 per cent.

Libal and Wahlstrom (1976); Macpherson *et al.* (1977) reported that the conception rate among gilts bred at first oestrus (64 per cent to 69.6 per cent) was lower than that of 86 per cent to 83 per cent) those mated on third oestrus.

Hughes and Varley (1980) stated age or weight change play a significant role in determination of conception rate. Young and King (1981) reported a higher conception rate among gilt bred at third oestrus. Knott *et al.* (1984) reported that there was significant difference among conception rate and in three weight groups of gilts from 70-80, 91-100, and 109-116 kg as 76, 79 and 79 per cent respectively. O'dehnal (1984)

concluded a higher conception rate of 91.6 vs 69.3 per cent with gilt mated at 300 and 190 days of age respectively. Glei and Schlegel (1990) observed that gilts had lower conception rate at first mating (74.0 per cent). Dourmad *et al.* (1994) observed that the energy deficit at weaning had lower conception rate in sows.

Spitschak and Rausch (1994) suggested that German Landrace gilts mated in their first, second, and third oestrus and at an average age of 248, 252 and 253 days at a body weight of 120-125 kg as 62.8, 71.4 and 72.2 per cent respectively. Kannan (1995) observed the conception rate did not vary significantly with the age and body weight of Large White Yorkshire gilts. Gilts mated at seven months of age had lowest percentage of conception when compared to other groups. Huang and Lee (1995) reported that conception rate did not vary significantly with the age of Landrace, Yorkshire and Duroc pigs.

2.6 Gestation length

Pregnancy or gestation begins at fertilization, generally the length of gestation period is non variable factor and is unaffected by any external stimulus or the size of the litter carried as it is in other species. It has a mean value for

the British White breeds of about 114 days (Braude *et al.*, 1954) although the range can be from 110 to 120 days. Vlcek (1942), Chiboka (1981) reported average gestation length in local pigs ranged between 114 and 116.3 days but there was little or no dependence of gestation length on age at first service. Omtvedt *et al.* (1965) found that age and weight of gilt at breeding did not influence the gestation length and average pig weight at birth increased as gestation length increased. Moody *et al.* (1967) observed in Yorkshire x Landrace sows the gestation period averaged 114 days. Vangelov *et al.* (1970) stated that the parity had no significant effect on gestation length.

Busko (1974) reported that earlier age of conception have shorter duration of gestation and small litter size and higher still births. Kennedy and Moxley (1978) found gestation length of Locombe sows was 1.34 days shorter than Large White Yorkshire pigs. Preinbergs *et al.* (1979) observed pregnancy duration averaged 115.8 $\pm$ 0.7 days and ranged between 100-129 days. This duration was significantly affected by age of dam and litter size.

Bonte *et al.* (1982) reported in Belgian Landrace gilts and sows the gestation period was same (115.0 $\pm$ 1.9 days). Sang *et al.* (1988) reported in Landrace, Yorkshire, Hampshire and Duroc pigs the gestation length averaged 115.28 $\pm$ 0.34

days. Huhn (1989) found in German Landrace gilts the gestation length averaged 114.9 days. The number of piglets born was highest (9.69-10.8) for gilts with gestation length 112-115 days and lowest (7.51) after a gestation of 119 days and litter weight was higher (13.25 kg) after gestation of 115 days and lower (11.68 kg) of the 112 days. Piglet birth weight was decreasing with increasing litter size. Kunavongkrit *et al.* (1989) reported that duration of pregnancy period averaged 113.6 ± 2.5 days in summer and 114.2 ± 2.0 days in other seasons. Kannan (1995) reported in Large White Yorkshire gilts the pregnancy period averaged 113.75 days.

2.7 Litter performance

Litter performance is the sum total of effects of both genetic and environmental factors associated with production and rearing of piglets. Out of which the social environment forms the crux of the situation.

Omtvedt *et al.* (1965) and Skiba (1969) stated an increase in weight at breeding resulted significant increase in litter size and litter weight. Ploek (1967) reported that age of gilt at mating had little or no effect on the number of litter born dead and pre weaning death. Bhasan (1969); Skiba (1969) observed that litter size and litter weight at birth and at two months of age positively correlated with age of dam.

Litter size at birth positively correlated with age at farrowing and had no effect on average number of still births and pre weaning mortality but it had significant effect on litter size at weaning (Arganosa and Radillo, 1972). Vangelov and Co-workers (1972) reported that the percentage of still born piglet per litter decreased as the age advances. Mating at lower body weight had lower conception, and smaller litter size, but average birth weight did not vary significantly (Pay and Davies, 1973).

Angelov (1973) and Kapko and Takareva (1974) suggested in Bulgarian fattened pigs, litter performances were positively correlated with age at first insemination. Gilts mated at earlier life had smaller litters and larger service period than older one (Antie and Trbojevic, 1975). Hughes and Cole (1976) suggested that mature boar contact during rearing does not appear significantly to influence conception rate, ovulation rate and litter size of the gilt.

Macpherson *et al.* (1977) studied that gilts mated at first, second and third oestrus produced 7.8, 9.8 and 10.2 piglets respectively, when they first farrowed. Gilts mated at an average age of 198 days produced smaller first litters than mated at 237 days but over five litters the number of piglets born differed by only 0.2 per cent (Brooks and Smith, 1977).

Hemsworth *et al.* (1978) observed that sows housed in pairs after weaning had a higher farrowing rate and litter size (born alive) than those housed in individual pens (farrowing rates were 86.7 percentage and 50.0 percentage respectively; litter sizes were 10.31 and 6.67, respectively). Petchey and Jolly (1979) suggested that sows mated early in lactation had piglets with lower weaning weights and sows mated in late lactation had greater weaning weights than piglets whose dams showed oestrus after weaning. Deo *et al.* (1979) found that average litter size of Landrace, Landrace White half bred and large white pigs at birth were 7.8 ± 0.26, 8.4 ± 0.27 and 8.5 ± 0.48 respectively and litter weight at birth was 13.6 ± 1.57, 10.5 ± 0.34 and 9.3 ± 0.58 kg respectively and average litter size at weaning was 5.4 ± 0.28, 6.1 ± 0.26 and 7.2 ± 0.56 respectively and adjusted litter weight at weaning was 59.5 ± 6.24, 55.4 ± 2.88 and 48.2 ± 4.87 kg respectively.

Lopez *et al.* (1979) suggested that the weight at first mating had significant effect on litter performance and gilts mated at 80 to 90 kg body weight had poorer performance and concluded that gilts should not be mated at body weight of less than 90 kg. Bonte *et al.* (1982) suggested that litter size decreased with increasing gestation length beyond 112 days in gilts and 111 days in sows.

Young and King (1981) reported that there was tendency towards increased litter size at birth and weaning, when breeding was delayed to third oestrus. But the differences were not statistically significant, although delaying up to third oestrus required extra food and accommodation. Oswagwuh and Akpokodje (1981) reported that mating at eight months of age had smaller mean litter size than those which were delayed in age as 2.3 vs. 3.6. A higher litter size (total piglets born) was also found for sows housed in groups of four from weaning to mating than those individually housed during this period (10.91 and 10.69 respectively (Hemsworth *et al.*, 1982).

Lopez *et al.* (1982) reported gilts mated at body weight approximately 84.81, 96.4, 106.3, 116.4, 126.5, 135.2, 145.7 and 160.7 kg at ages of 210-480 days. Gilts mated at 84.8 kg had significantly smaller litters than other seven groups. Body weight at mating had no significant effect on piglet birth weight. Knott *et al.*, 1984; Zeman and associates (1984) reported none of reproductive traits were significantly associated with difference in mean age and body weight at mating and also observed that the optimum age at first mating was 220 to 240 days. Neither age nor weight were reliable indices of the reproductive development and a minimum adipose to lean tissue ratio also is a pre-requisite for superior measure (Kirkwood and Aherne, 1985).

Mandic *et al.* (1988) suggested mating at an average of 218 days age and body weight had no adverse effect on later reproductive performance. Whitemore *et al.* (1988); Mercer and Francis (1988) showed a significant relationship between age at first service and total number of born in the litter and suggested the minimum age for breeding as 240 days. Gregor and Staaks (1989) compared gilts mating from 215 days of age resulted in a decrease of 0.45 live born piglets in litter size and mating from 235 days age leads to decrease of 0.29 piglets respectively. It is reported that daily gain of 490 to 509 gram combined with body weight of 115 kg is necessary for the early mating gilt. Chhabra *et al.* (1989) suggested in Large White gilts, the age at first mating had significant effect on their litter performance and found that in Large White gilts first conceived at body weight average of 121.76, 128.7, 139.75, 160.17 and 186.6 kg had litter size as 9.48, 10.32, 10.94, 11.17 and 10.40 and litter weight as 11.48, 13.02, 13.30, 13.37, and 11.56 kg at birth respectively.

Paterson (1990) reviewed the body weight at first mating on reproductive performance of gilts and reported that little to be gained from delaying mating. As a management strategy mating of gilts at body weight of more than 100 kg was suggested.

Tesic and Stankov (1991) reported that 114 gilts aged 7.5 months were exposed or not exposed daily for 30 minutes to the recorded voice of a boar during a 30 days periods had farrowing rate 61.64 and 45.07 per cent and litter size at birth averaged 9.33 and 9.40 kg respectively. Tarocco (1992) suggested that farrowing rate and litter size in primiparous and multiparous sows were not significantly affected by exposure to a boar.

Soede (1993) suggested that social conditions of sows may alter the effects of boar stimulation on reproductive processes. Newton and Mahan (1993) suggested in gilts body weight at mating had no significant effect on litter performance and piglet mortality increased with initial breeding weight. Gertken *et al.* (1993) found that 53 sows and their litters were group housed and 39 sows and their litters were housed under the usual management system (farrowing pens with cubicles), the number of live born piglets averaged per litter 10.13 $\pm$ 0.29 and 9.93 $\pm$ 0.16 respectively, litter size at weaning 8.54 $\pm$ 0.22 and 8.91 $\pm$ 0.12 respectively. Nakamura *et al.* (1993) observed in 12 Landrace x Large White gilts, litter size at birth and at weaning averaged 9.6 and 8.7 respectively in pens and 11.0 and 9.4 in individual stalls and also average piglet weight at birth was significantly higher in pens than in stalls (1.55 vs 1.32 kg) and average weaning weight was significantly higher in pens than in individual

stalls (7.43 vs 6.37 kg) and weaning percentage has significantly higher in pens than in individual stalls (96 vs 86 per cent). Lember (1994) suggested that litter size and weight are not affected by protein intake and weight at weaning was not significant. Yakhnitskaya (1995) revealed that litter size was highest for mating in which boars and sows were both from high body weight groups. Goetz and Troxler (1996) observed that by group housing of sows during farrowing and lactation period, the number for alive averaged 11.5 ± 3.5 piglets per litter, litter size at weaning 9.0 ± 2.7 and piglet weight at weaning 6.79 ± 1.63 kg.

2.8 Behaviour of parents and other penmates towards the litter

A higher incidence of birth at night have been observed in pigs by Deakin and Fraser (1935), Friend *et al.* (1962) which makes proper supervision, difficult. The major causes of death of baby piglets in most studies have been starvation leading to hypoglycaemia and overlying by the sow. These two factors together accounted for 79.0 per cent of piglet mortality (Gracey, 1955).

McBride (1963) and Hemsworth *et al.* (1976) observed that cause and effect relationship between the different elements of sow and piglet behaviour and the relation of the behaviour of the milk ejection. Synchronous features of pig nursing and

suckling behaviour promoted an even distribution of milk among all litter-mates thereby providing equal chances of survivability to all piglings. Jones (1966) suggested that sows paid little attention to her young until the last one was born and so it was important to provide close observations over a particularly nervous sow for it was in such animal that cannibolism and crushing could frequently occur. Mount (1968) studied that newborn piglets, with their small body size, sparse pelage and skin wet with fluids are proven to chill in air temperature as high as 20°C with a 5 km per hour wind speed despite of vigorous thermogenic responses. Bourne (1969) and Hartsock and Graves (1976) revealed that the sow lied on her sides and in the first hours of life colostrum was available continuously. The first born piglets went from teat to teat taking colostrum. Later born piglets were less likely to obtain sufficient colostrum for a variety of reasons (Broom, 1983). Over 50 per cent of the losses of liveborn piglets occur within the first 2-3 days of life (Fahmy and Bernard, 1971). The poor insulation and inadequate temperature regulating mechanism of the newborn pig (Mount, 1972) rendered it very vulnerable to chilling unless an adequate thermal environment was provided for it. Stimulation of anterior teat played a critical role in promoting normal suckling behaviour (Fraser, 1973). Fraser and Jones (1975) suggested that there was clear preference for the anterior

teat and although their control was usually gained by the large dominant piglets.

The time for teat order to stabilise varies widely from a day or 2 to 1 to 2 weeks (Hemsworth *et al.*, 1976). It was shortest with sows that remained lying on one side for suckling during the first day or so. Changes in position unsettled the order and the fighting phase was prolonged. In the search for the teat, the piglets tend to concentrate on the pectoral regions of the udder and explore vertical surfaces with their noses until a teat is contacted, grouped and suckled (Scheel *et al.*, 1977). Piglets that did not find a functional teat soon after birth rapidly depleted their energy reserves in cold weather and died from hypothermia. The nursing position of the sow was full lateral recumbency. Abnormal postures like habitual lying on one side leading to a reduced milk supply as nursing while standing often resulting in lower milk yields due to lack of lactogenic udder massage by piglets and so Fraser (1980) and Algers (1989) observed udder massage for quantitative stimulation of milk flow. Kasser *et al.* (1981) reported that piglet mortality was attributed to infection, chilling, poor nutrition and crushing. These ultimate causes of death might be secondary to inadequate development of energy stores prenatally and inactive metabolic pathway postnatally.

Bryant *et al.* (1983) studied sows in group (G) with boar present showed oestrus during lactation on average 15 days after farrowing and there was no incidence of lactational oestrus in individual (S) sows without boar present which showed oestrus 5 days after weaning.

About 10 hours after farrowing milk let down became synchronised and periodic (Lewis and Hurnik, 1985). The sow gave a characteristic grunting call (Mc Bride, 1963; Whitemore and Fraser, 1974) and milk was let down simultaneously from each teat. The piglets learn the call and the periodicity. So they were ready on the teat, the milk let down lasted only 10-15 seconds and occurred every 50-60 minutes and this system ensured that, provided there were not too many piglets for the teat, all could suckle satisfactorily. Desai *et al.* (1986) suggested that the major causes of mortality due to pneumonia (26.18 per cent) trampling or overlying by dam (23.12 per cent) enteritis (22.29 per cent) and weakness (15.34 per cent). The incidence of still-births was to the extent of 1.17 piglet per farrowing and the correlation between litter size at birth and number of the pre-weaning deaths was positive and highly significant. Extensive nest building tendency with available material was reported in swine by Taylor *et al.* (1986).

Hafez (1987) studied starvation accounts for nearly half of the mortality in live born domestic piglets. Kerr *et al.* (1988) suggested that having animals along with their offsprings thereby enriching the production environment, enhanced the production performance and welfare of pigs. Hemsworth and Barnett (1989) found that social and physical factors influenced the behavioural responses in the female pig which had an impact on reproduction.

Olsson and Svendsen (1990) studied that sow and piglet behaviour was monitored from 24 hour prior to farrowing until 72 hour after farrowing and the main causes of mortality being trampling, starvation or low birth weight and also found that housing had a significant effect on piglet mortality due to trampling, which was higher for loose than tied sows and small piglets were more prone to being trampled than those with a high birth weight and the average number of tramplings per litter was 1.23 and 59 per cent of trampling were serious. Fraser and Broom (1990) observed that pigs are to be placentophagic if the placenta is not removed promptly from the pen and this might lead to digestive disturbances and reduced milk flow during early stages of lactation.

Stolba *et al.* (1990) suggested that increasing the complexity of a housing system for lactating sows reduces the contact between the sow and the piglets which may enhance the

incidence of lactational oestrus. Maier *et al.* (1992) suggested that a modified Stolba family pen as a housing design for 4 sows and their litters and each piglet was observed continuously for 50 minutes during weeks 2, 5, 8, 11, 14 and 19. From week 2 to week 8 locomotor rotational movements, play-running, play chasing and wrestling games were observed and from 11 to 19 mainly play with objects took place. During the first week of social interactions like nose to body, nose to nose, play fighting and agonistic interactions occurred mainly between littermates. From week 11, the piglets interest in non littermates increased, the sows tolerance towards their own and other piglets decreased and suckling become less important. Soede (1993) suggested that social conditions of sows might alter the effects of boar stimulation on reproductive processes. Houwers (1994) concluded that individually reared gilts were unsuitable for introduction into group sow housing, whilst animals exposed to a complex environment in early life were adaptable to a new environment.

Biswas and Pan (1994) found that there was enough scope to control agonistic behaviour among piglets through different managemental techniques. Dourmad *et al.* (1994) reported that it was necessary to apply a feeding strategy adapted to each sow in relation to its own level of production, its behaviour and the housing condition in order to maintain body reserves

within an optimal zone throughout reproductive life and so maximise longevity. Hessing *et al.* (1994) suggested that a better and more profitable group composition of pigs in intensive husbandry could be realized when based on the behavioural characteristics of a pig. Simonsen (1995) observed that docking did not significantly affect the frequency of nibbling or of biting of tail or tail stump. Relative growth rate was not significantly affected by rearing environment or docking. Bunger and Schlichting (1995) found that the housing system gave better results in relation to neonatal behaviour, health, body weight gain and survival of piglets in the suckling period compared with two types of farrowing crates and the change of housing 10 days after farrowing from farrowing crates to a group housing system resulted in growth retardation of piglets. Roy-Choudhury *et al.* (1995) suggested that the farrowing of 9 sows took place mostly between 10.00 and 15.25 hr and the position adopted by the sows during farrowing was mostly lateral recumbency, although, some sows changed their position to standing before returning to lateral recumbency and also found that teat orders of the piglets was established within 48-72 hour of farrowing, the stronger or earlier born piglets tended to occupy the most anterior teats and piglets suckled every 40-60 minutes, the interval being longer at night than during the day and increasing as lactation progressed. Braun (1996)

observed that the incidence of cross sucking ranged from 25 to 71.4 per cent and also found that individual piglets differed in their ability to adapt to a move to group housing. Wechsler (1996) suggested that there were no significant differences between stolba and conventional pens in economic returns or labour requirements. Hoy and Lutter (1996) reported that group housing had no effect on piglet vitality which was enhanced by high birth weight and environmental temperature greater than 20°C.

Material and Methods

MATERIAL AND METHODS

Sixteen weaned large white Yorkshire gilts, twelve weaned sows and two boars belonging to University pig breeding farm, Kerala Agricultural University, Mannuthy were utilised for the study. The pigs were maintained on rations which contained the following ingredients.

Ingredients (Parts/1000	Grade of ration	
	CP 18%	CP 14%
Yellow maize	400	300
Groundnut cake	150	80
Rice polish	170	280
Wheat bran	170	280
Dried unsalted fish	100	50
Common salts	5	5
Mineral mixture	5	5
Vitamin A B_2 D_3 (Rovimix)	100	100

Design

The pigs were randomly assigned to five experimental groups T_1, T_2, T_3, T_4 and T_5 each consisting of six pigs as given below.

T_1 - 6 gilts alone (4 months of age)

T_2 - 5 gilts + 1 boar

T_3 - 5 gilts + 1 weaned sow

T_4 - 5 weaned sows + 1 boar

T_5 - 6 weaned sows alone

They were housed in identical styes with concrete flooring and each having a covered area of 6.1 m^2. All of the styes had access to concrete floor pen exercise yards with wallowing tanks.

Pigs were fed with standard concentrate rations having 18 and 14 per cent crude protein throughout the study.

During the experimental period feed was provided to pigs twice daily at 09.00 hour and 14.30 hour, and allowed to consume as much as they could in an hour. Clean drinking water was made available to the animals at all times. All groups of pigs were reared under the managemental conditions prevailed at the University pig breeding farm.

Pigs in T_1 and T_3 groups were bred at the body weight of 70-80 kg with designated boars at the time of breeding. The pigs in T_5 group were bred in the first oestrus after weaning. In T_2 and T_4 group female pigs were reared with boar.

The onset of oestrus in the pigs were recorded based on the behavioural manifestation and the nature of external symptoms of heat and further confirmed with the use of a boar. The oestrus period was recorded based on the duration of sexual receptivity to the boar.

The intensity of oestrus symptom were scored as given below.

Intensity of oestrus

Sl.No.	Description	Score
1.	Grunting, off feed, keeping away from other animals, restlessness, swollen vulva	1
2.	Discharge from vagina, swollen vulva, slight discharge, immobility response	2
3.	Mounting on other animals, restlessness, profused discharge, swollen vulva	3

The sows were bred during the first post weaning oestrus itself and observed for positive signs of conception, viz. non-return to oestrus and physical signs of pregnancy within a period of 8 weeks. All gilts and sows in each group were allowed to farrow in the same pen in which they were housed and litters were weaned at 56 days after farrowing. Body weights were recorded wherever required during morning before feeding using a platform balance with built in cage.

The pigs were scored for their behaviour of parents and other penmates towards the litter as described below.

Sl.No.	Description	Score	
		+ve	-ve
1.	Perfect identification of its own litter	1	0
2.	Good temperament, docile and confidence on attendant	1	0
3.	Alertness towards the safety of piglings	1	0
4.	Fondling piglings before and after suckling	1	0
5.	Overlying (trampling) biting, injuring, killing the piglings and hostility to piglings	0	1
6.	Presence of cross sucklings	0	1
7.	Presence of lactational estrus	0	1
8.	Presence of cannibalism	-1	1
9.	Aggressive behaviour towards the piglets at the time of feeding	0	1
10.	Presence of aggressive behaviour between the piglets belonging to different litters	0	1

Management

All pregnant gilts and sows were allowed to farrow in the open styes. The pen and pigs were cleaned and washed in the morning and evening before feeding. Malathion (0.5% solution) was sprayed once in a month on pigs and premises to prevent ectoparasitic infection. The pigs were dewormed at the commencement of the experiment using Panfugal. All the pigs and their respective litters were housed together till weaning and were cared as per usual managemental practices prevailing in the farm. Immediately after farrowing, all piglets were identified by contrast color markings and ear notching was done on second day. The piglets were administered Imferon intramuscularly at rate of 1 ml per piglet on the second day.

The following parameters were recorded.

1. Onset of oestrus in case of gilts
2. Post weaning oestrus in case of sows
3. Duration of oestrus
4. Fortnightly body weight in gilts
5. Intensity of oestrus
6. Conception rate
7. Gestation length

8. Litter performance

a. At birth

(i) Litter size

(ii) Litter weight

b. At weaning

(i) Litter size

(ii) Litter weight

9. Behaviour of parents and other penmates towards the litter

The data collected during the course of the study were statistically analysed as per the method described by Snedecor and Cochran (1967).

Results

RESULTS

The results obtained during the course of the experiment on; onset of oestrus in gilts, post weaning oestrus in sows, fortnightly body weight in gilts, duration of oestrus, intensity of oestrus, conception rate, gestation length, litter size and litter weight at birth and weaning and behaviour of parents and other penmates towards the litter are summarised in Table 4.1 to 4.9 and graphically depicted in Fig.4.1 to 4.6.

4.1 Onset of oestrus in gilts

The onset of oestrus (days) in gilts in treatment groups I, II and III are shown in Table 4.1 and Fig.4.1. Treatment group II has attained puberty earlier than other groups.

4.2 Post weaning oestrus in sows

The number of days required for the onset of post weaning oestrus are presented in Table 4.2.

4.3 Fortnightly body weight of gilts

The fortnightly body weight of gilts from four months of age to farrowing are presented in Table 4.3 and depicted in Fig.4.2.

4.4 Duration of oestrus

The average duration of oestrus are recorded in Table 4.4.

4.5 Intensity of oestrus

The intensity of oestrus behaviour are scored in the various treatment groups and are shown in Table 4.5. The highest score was observed in Groups II and IV and the lowest in Group III.

4.6 Conception rate

The conception rate at first mating and overall conception rate among different groups are given in Table 4.6. Treatment group IV had lowest conception rate at first mating (60%) compared to other groups.

4.7 Gestation length

The gestation length of animals in different treatment groups are furnished in Table 4.7.

4.8 Litter performance

The litter performance at birth and weaning such as litter size, litter weight, number of still born and pre weaning mortality are presented in Table 4.8.

4.9 Behaviour of parents and other penmates towards the litter

Behaviour of parents and other penmates towards the litter are scored in the various treatment groups and are presented in Table 4.9. The highest score was observed in group V and the least in group I.

Table 4.1 Mean and SE of onset of oestrus in gilts

Treatment groups	I	II	III
Onset of oestrus (days)	a 168±5.84	b 149.8±4.488	a 173.2±3.105

Figures having different superscription in a row differ significantly ($P<0.05$)

Table 4.2 Mean and SE of no of days required for post weaning oestrus of sows

Treatment groups	I	II	III	IV	V
Onset of post weaning oestrus (days)	a 5.4± 0.02	a 7.6± 1.691	a 7.4± 2.014	a 5.0± 0.316	a 4.6± 0.2449

Figures having the same superscripts do not vary significantly

Fig.4.1 ONSET OF OESTRUS IN GILTS

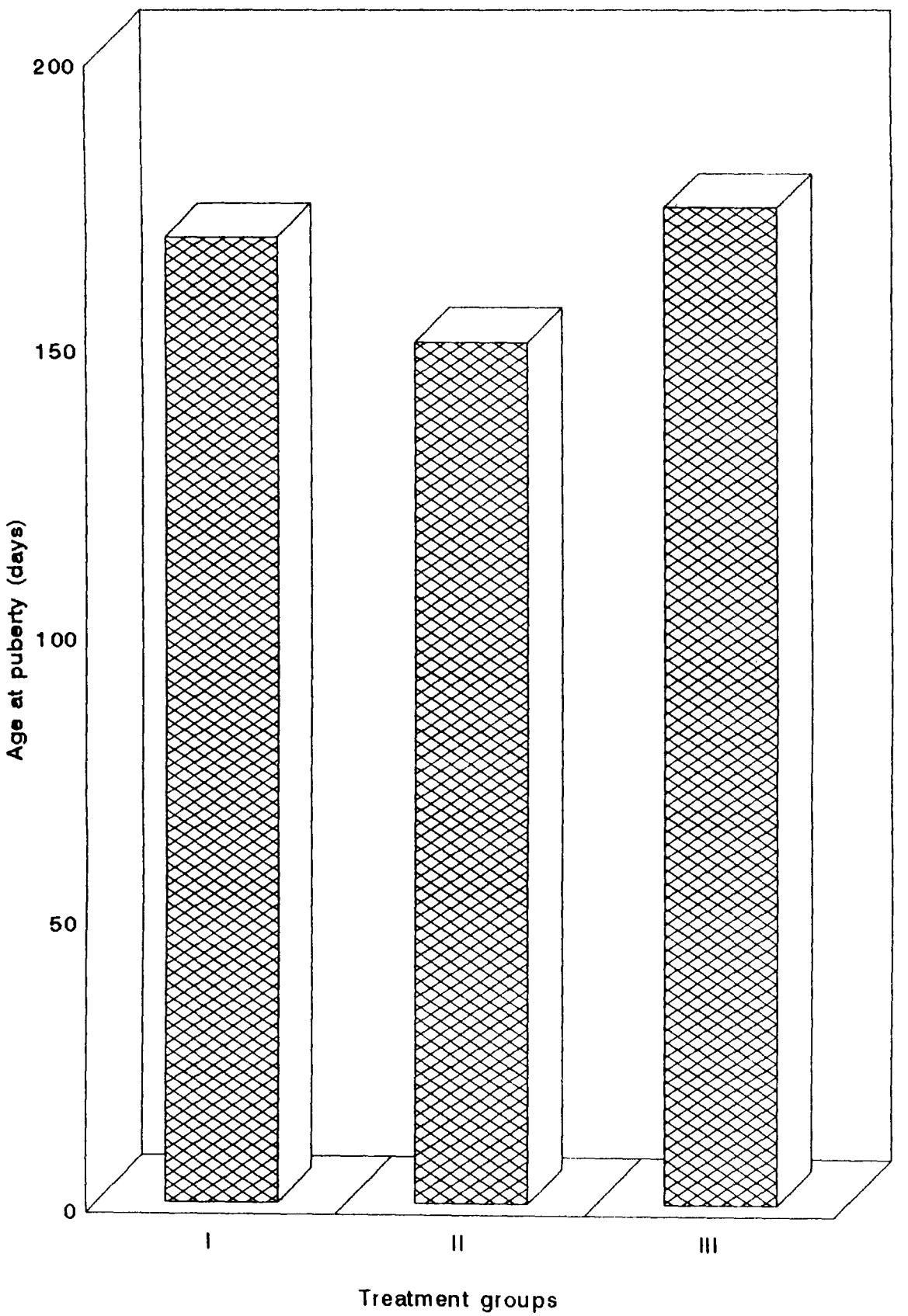

Table 4.3 Mean and SE of fortnightly body weight of pigs from four months of age to ten and half months

Age in fortnights	Body weight (Kg) Treatment groups		
	I	II	III
1	a 21.0±1.225	a 15.2±0.860	a 17.4±0.812
2	b 28.0±1.327	b 19.2±1.068	b 23.6±1.122
3	c 37.8±1.594	c 26.5±1.628	c 32.0±1.549
4	d 45.3±2.053	d 32.7±1.868	d 38.6±2.141
5	e 51.3±2.234	e 37.6±2.477	e 41.5±2.110
6	f 56.2±3.007	f 44.8±2.453	f 47.1±1.907
7	g 64.3±2.998	g 51.4±3.043	g 55.8±2.493
8	h 69.1±2.921	h 59.0±2.954	h 60.9±1.971
9	i 71.5±2.665	i 62.6±3.411	i 64.9±2.839
10	j 74.8±2.442	j 66.3±3.777	j 68.6±2.861
11	k 77.5±2.302	k 70.5±4.062	k 71.4±2.799
12	l 83.2±2.251	l 78.8±4.045	l 77.2±2.273
13	m 90.3±2.463	m 87.4±4.383	m 82.5±1.949

Figures having the same superscripts in a row do not vary significantly

Fig.4.2 FORTNIGHTLY BODY WEIGHT OF PIGS FROM FOUR MONTHS OF AGE TO TEN AND HALF MONTHS

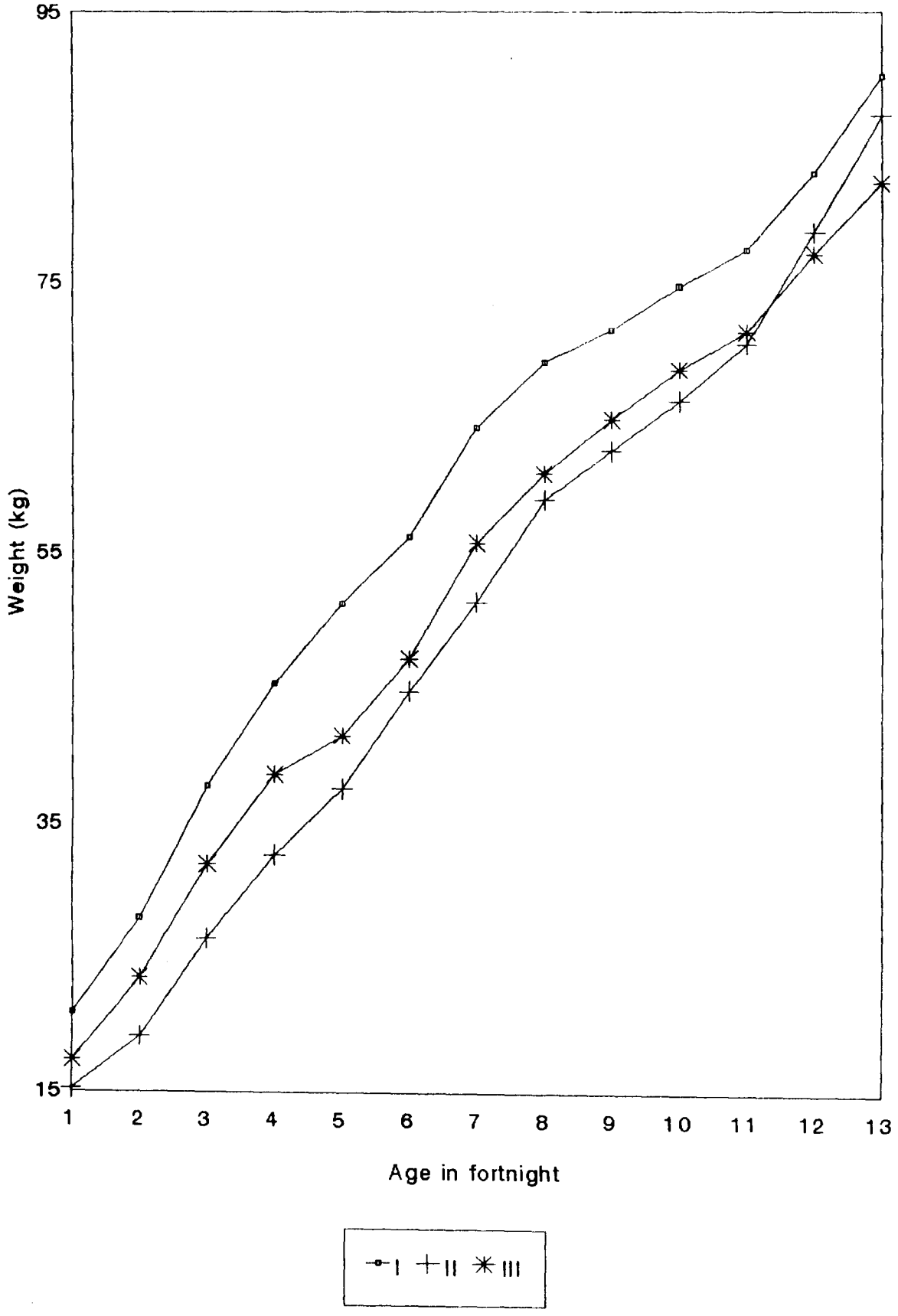

Table 4.4 Mean and SE of duration of oestrus of pigs

Treatment groups	I	II	III	IV	V
Duration of oestrus (Hours)	a 58.8± 2.273	a 54.4± 4.490	a 57.6± 4.490	a 50.4± 4.490	a 52.8± 2.939

Figures having the same superscripts do not vary significantly

Table 4.5 Mean and SE of intensity score of oestrus of pigs

Treatment groups	Maximum score	I	II	III	IV	V
Intensity of oestrus (Score)	3	a 2.6± 0.2449	b 2.8± 0.2	c 1.8± 0.2	d 2.8± 0.2	e 2.4± 0.2449

Figures having different superscription in a row differ significantly ($P<0.05$)

Fig.4.3 INTENSITY OF OESTRUS IN PIGS

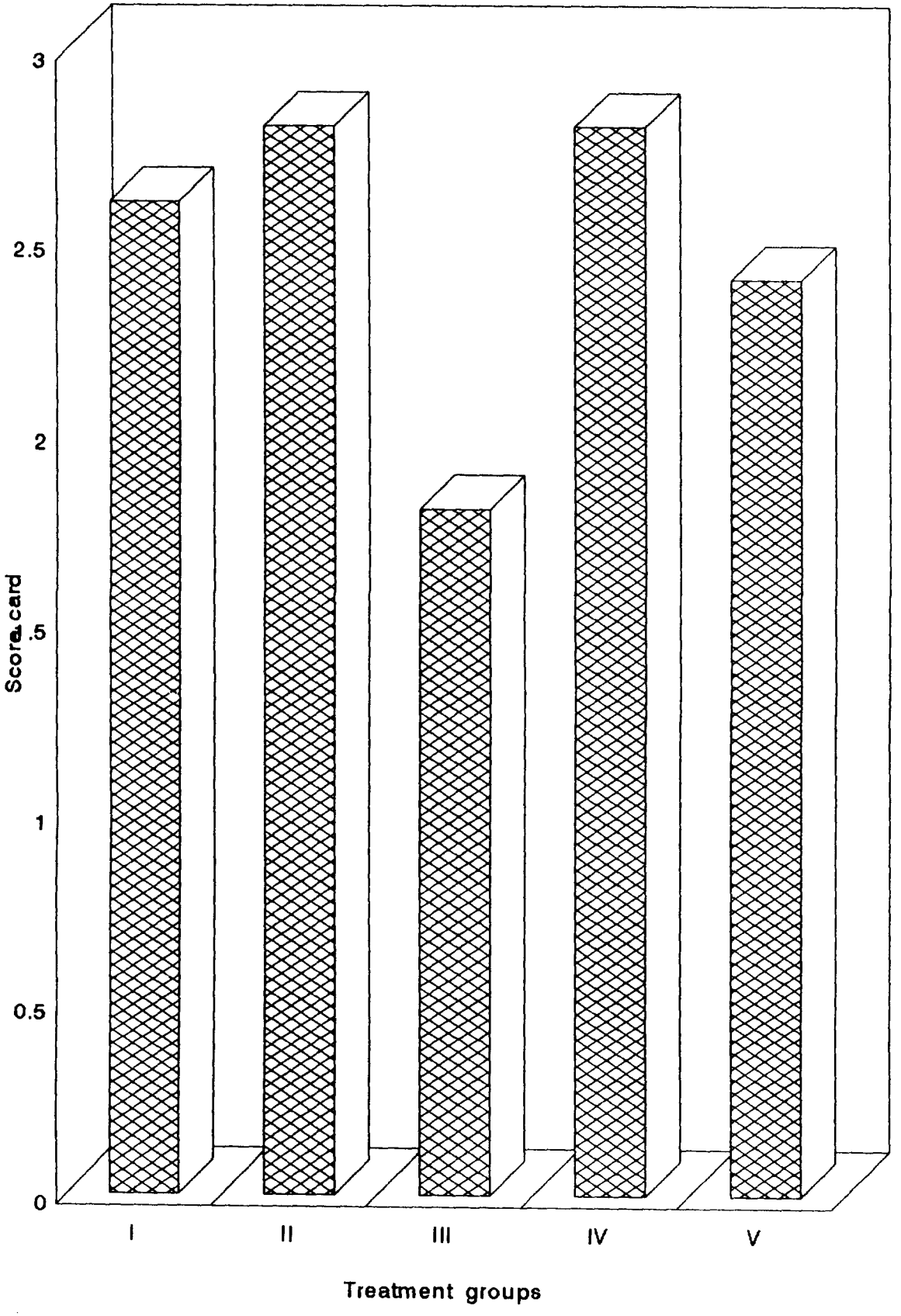

Table 4.6 Conception rate (%) at first mating and over all conception rate of pigs

Treatment groups	I	II	III	IV	V
Conception rate at first mating (%)	a 80.00	a 80.00	a 80.00	a 60.00	a 80.00
Over all conception rate (%)	b 100.00	b 100.00	b 100.00	b 100.00	b 100.00

Figures having the same superscripts in a row do not vary significantly

Table 4.7 Mean and SE of gestation length of pigs

Treatment groups	I	II	III	IV	V
Gestation length (Days)	a 113.2± 0.374	a 108.6± 4.66	a 113.4± 0.2449	a 113.8± 0.583	a 113.8± 0.489

Figures having the same superscripts in a row do not vary significantly

Table 4.8 Mean and SE of litter performance of pigs

Treatment groups	I	II	III	IV	V
Litter size at birth (Live) (Nos.)	a 7.20± 0.734	a 6.00± 1.581	a 7.00± 0.547	a 8.60± 1.435	a 9.40± 1.320
Litter weight at birth (Live) (kg)	b 8.16± 0.79	b 5.90± 1.794	b 8.36± 0.604	b 6.96± 1.150	b 11.68± 2.062
Average piglet weight (kg)	c 1.13	c 0.98	c 1.19	c 0.809	c 1.24
Still birth (%)	5.5	14.70	8.57	13.95	0.00
Litter size at weaning (Nos.)	d 2.60± 1.07	d 2.00± 1.063	d 2.80± 0.86	d 1.80± 1.113	d 2.40± 1.029
Litter weight at weaning (kg)	e 26.30± 10.387	e 18.76± 5.964	e 28.60± 9.321	e 18.20± 11.280	e 26.16± 10.237
Average piglet weight (kg)	f 10.11	f 9.38	f 10.21	f 10.11	f 10.9
Pre-weaning mortality (%)	58.33	55.88	51.42	65.11	74.46

Figures having the same superscripts in the same row do not vary significantly

Fig.4.4 LITTER SIZE AND LITTER WEIGHT AT BIRTH OF PIGS IN DIFFERENT GROUPS

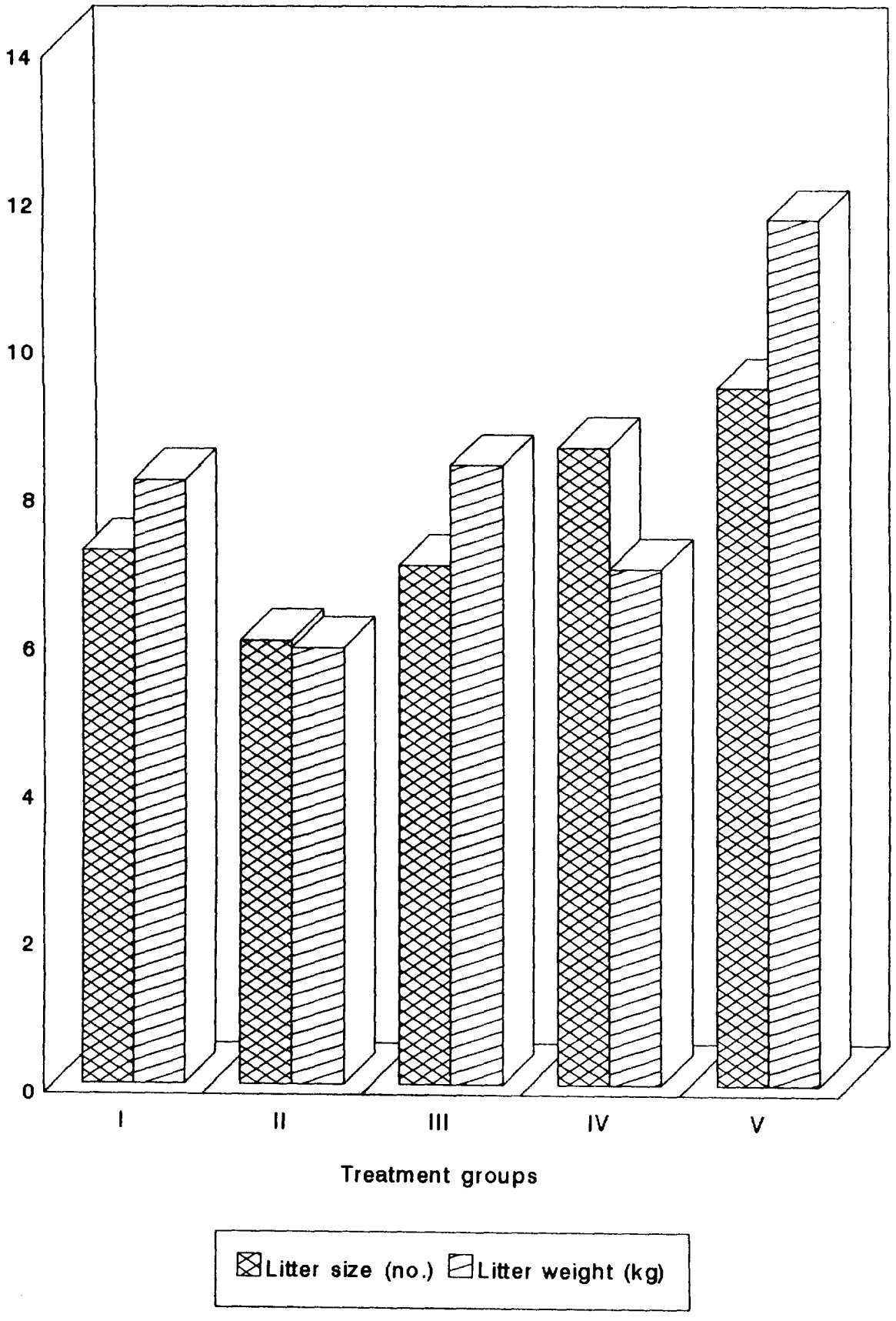

Fig. 4.5 LITTER SIZE AT WEANING OF PIGS IN DIFFERENT GROUPS

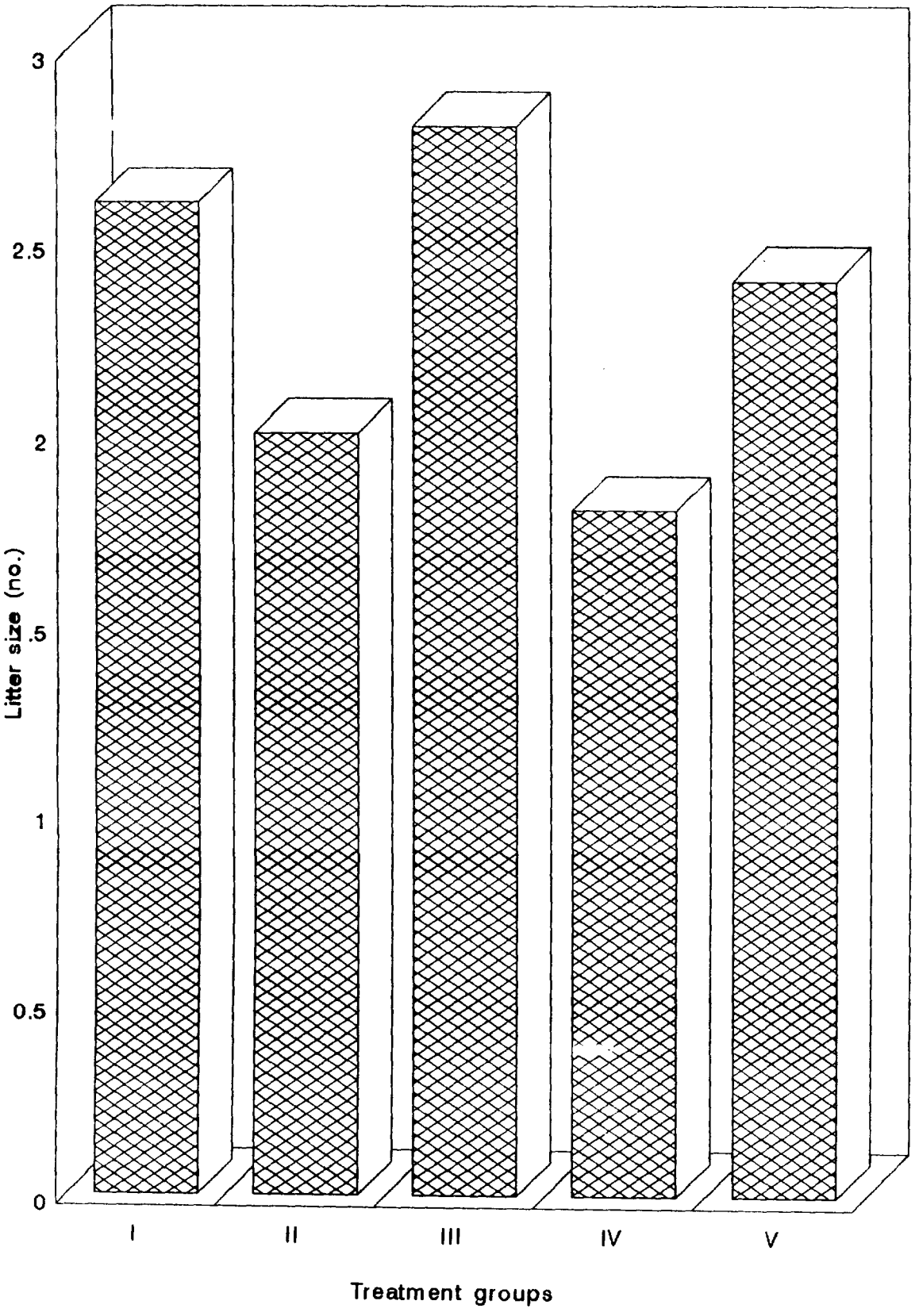

Fig.4.6 LITTER WEIGHT AT WEANING OF PIGS IN DIFFERENT GROUPS

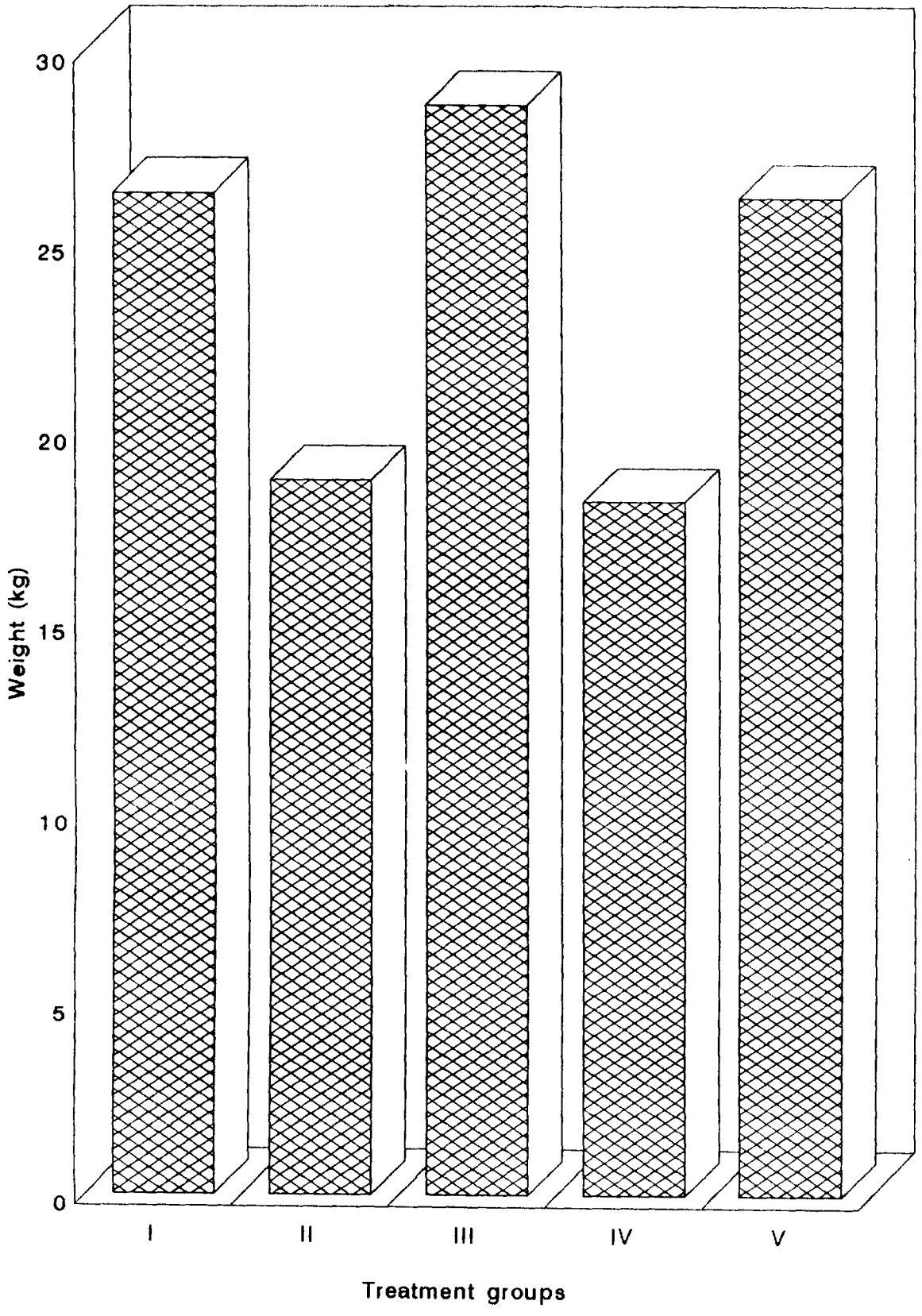

Table 4.9 Mean and SE of behavioural scores of pigs

Treatment groups	Maximum score	I	II	III	IV	V
Behaviour of parents and other penmates towards the litter (score)	10	$4.6^{a} \pm 0.812$	$5.6^{a} \pm 0.927$	$5.6^{a} \pm 0.509$	$5.2^{a} \pm 0.663$	$6.8^{a} \pm 0.489$

Figures having the same superscripts do not vary significantly

Discussion

DISCUSSION

The results of the experiment are discussed hereunder.

5.1 Onset of oestrus in gilts

It can be seen from Table 4.1 that the onset of oestrus (days) in gilts in treatment groups I, II and III was 168 ± 5.84, 149.8 ± 4.488 and 173.2 ± 3.105 respectively. A significantly lower ($P<0.05$) age at first oestrus in treatment group II, when compared to treatment groups I and III is indicative of the fact that a social environment enriched with the presence of a boar helps in early onset of oestrus which is advantagious to the farmer with respect to economic piglet production. This finding is in agreement with that of Kirkwood and Hughes (1980), Hughes and Pearce (1990), Philip and Hughes (1995) and Siswadi and Hughes (1996) who reported that the introduction of a mature boar to immature gilts is known to induce the precocious attainment of puberty.

5.2 Post weaning oestrus in sows

The number of days required for onset of post-weaning oestrus did not differ significantly ($P>0.05$) between treatment groups (Table 4.2). The pigs in all treatment

groups showed the signs of post weaning oestrus within a week. This observation is in accordance with that of Young and King (1981) who reported that weaning to oestrus interval was not influenced by initial breeding on first or third oestrous cycle of gilt. The onset of post weaning oestrus did not vary significantly between groups in primiparous sows as reported by Kannan (1995), but in contrast with reports of Hemsworth *et al.* (1982) who reported that the group housing and boar stimulation showed significant influence in reducing the interval.

5.3 Fortnightly body weight of pigs

The fortnightly body weight of animals in treatment groups I, II and III (Table 4.3) did not vary significantly ($P>0.05$). The average daily bodyweight gain in groups I, II and III were 381, 297 and 358 g respectively, a trend for higher growth rate in group II (gilts with boar) and least in group III (gilts with sow) is indicative of certain social environmental effect on growth rate and attainment of mature body weight. This observation is in accordance with that of Kerr *et al.* (1988) who reported that enrichment of environment has enhanced the production performance and welfare of pigs and is in contrast to that of Simonsen (1995) who reported that rearing environment had no significant effect on production performance of pigs.

5.4 Duration of oestrus in pigs

The duration of oestrus in animals in treatment groups I, II, III, IV and V group were 58.8 ± 2.273, 54.4 ± 4.490, 57.6 ± 4.490, 50.4 ± 4.490 and 52.8 ± 2.939 hours respectively. The variation of duration of oestrus was found to be non significant between treatments. This observation is in agreement with that of Signoret (1970) who reported that female sexual behaviour of the pig was largely a genetic one and is least affected by social contacts. The duration of oestrus observed here is in accordance with that of Tsig-anchuk (1976), Bednjfsontwikkeling (1977) and Hmar (1993) who reported that the duration of oestrus varied from 15-75 hours.

5.5 Intensity of oestrus in pigs

The intensity score of oestrus in pigs in treatment groups I, II, III, IV and V were 2.6 ± 0.2449, 2.8 ± 0.2, 1.8 ± 0.2, 2.8 ± 0.2 and 2.4 ± 0.2448 respectively. A significantly high score in groups II and IV clearly indicate that the presence of boar in the pen enhance the intensity of oestrus and probably the reproductive performance due to the fact that high intensity of oestrus helps in easy detection of heat and timely mating and hence may be advantagious to the farmer. The least response seen in group III is a clear

indication of effect of social environment on the oestrus intensity in pigs thereby bringing to light the disadvantage of housing sow and gilts together in commercial swine farming. The above observation is supporting the previous reports of Eliasson (1991) who reported that gilts attained puberty earlier showed more intense signs of heat when compared to that which attained puberty at a later age.

5.6 Conception rate

It can be seen from Table 4.6 that the conception rate at first mating and overall conception rate did not vary significantly between treatment groups supporting the similar findings of Hughes and Cole (1976) and Kannan (1995) who have found that age, body weight or boar contact have no influence on conception rate in pigs. A lower conception rate in group IV may be due to early post weaning exposure of sows to boar supporting the findings of Moody *et al.* (1967) who reported a lower conception rate in sows exposed to boar immediately after weaning.

5.7 Gestation length

The gestation length of animals in all the treatment groups (Table 4.7) did not vary significantly supporting the similar findings of Omtvedt *et al.* (1965) and Kannan (1995)

indicating that length of gestation is a property of the species and remain almost unchanged. But a trend for lower gestation length in group II is an indication for early termination of pregnancy in gilts due to boar contact and is also in support to the findings of Busko (1974) who reported that earlier age at conception led to shorter duration of gestation in pigs.

5.8 Litter performance

5.8.1 Litter size at birth

The live litter size at birth in treatment groups I, II, III, IV and V were 7.2 ± 0.734, 6.0 ± 1.581, 7 ± 0.547, 8.6 ± 1.435 and 9.4 ± 1.32 respectively (Table 4.8) indicating no significant difference ($P>0.05$) between groups. This observation is in agreement with that of Hughes and Cole (1975) and Tarocco (1992) who reported that mature boar contact during rearing did not appear to influence significantly the litter size of the pigs. A trend for relatively smaller litter size at birth noticed in group II is in support to that of Pay and Davies (1973) and Antie and Trbojevic (1975) indicating that the social environment may have certain effect on the litter size at birth in pigs. An apparently higher percentage of still birth noticed in treatment groups II and IV (14.70% and 13.95%) when compared

to that of groups I, III and V (5.5, 8.57 and 0) brings to light, the effect of intervention of social environment in the pre-partum survivability of piglets, supporting the finding of Sukhdeo *et al.* (1979) and Oswagwuh and Akpokodje (1981).

5.8.2 Litter weight at birth

The litter weight at birth varied from 5.9 kg in group II to 11.680 kg in group V with other groups in between (Table 4.8) projecting no significant difference between treatment groups. But a relatively higher litter weight in group V and least in group II may be indicative of the beneficiary effect of group housing of sows in litter performance as reported by Soede (1993) and Gertken *et al.* (1993). The average piglet weight at birth in treatment groups I, II, III, IV and V were 1.13, 0.98, 1.19, 0.809 and 1.24 kg respectively showing no significant difference between groups indicating the fact that birth weight has a relatively high genetic pre-disposition and it is less influenced by environmental factors as reported by Ripple *et al.* (1965).

5.8.3 Litter size and litter weight at weaning

It can be seen from Table 4.8 that the litter size at weaning did not differ significantly ($P>0.05$) between treatment groups I, II, III, IV and V and same trend was observed in litter weight at weaning. The average litter size

at weaning in treatment groups I, II, III, IV and V were 2.6 ± 1.07, 2 ± 0.63, 2.8 ± 0.86, 1.8 ± 1.113 and 2.4 ± 1.029 respectively. The litter weight at weaning in treatment groups I, II, III, IV and V were 26.3 ± 10.387, 18.76 ± 5.964, 28.6 ± 9.321, 18.2 ± 11.280 and 26.16 ± 10.237 respectively. This observation is in support to that of Hoy and Lutter (1996) who reported that group housing had no effect on piglet vitality. The average piglet weight at weaning in treatment groups I, II, III, IV and V were 10.11, 9.38, 10.21, 10.11 and 10.9 kg respectively projecting no significant difference between treatment groups indicating that social environment has little effect on the weaning weight of piglets. A very high percentage of pre weaning mortality of piglets noticed in treatment groups IV and V (65.11% and 74.46%) is indicative of certain effect of social environment on this trait as reported by Bunger and Schlichting (1995) who reported that group housing had an effect on piglet vitality but this observation is at variance with that of Hoy and Lutter (1996) who reported that group housing had no effect on piglet vitality.

5.9 Behaviour of parents and other penmates towards the litter

The behaviour of parents and other penmates towards the litter was scored in all the treatment groups. The observed scores in treatment groups I, II, III, IV and V were 4.6 ±

0.812, 5.6 ± 0.927, 5.6 ± 0.509, 5.2 ± 0.663 and 6.8 ± 0.789 respectively. The variation was found to be non-significant ($P>0.05$) between treatment groups. In the present study, group housing of nursing sows along with their penmates had resulted in higher mortality due to trampling and biting. This may suggest that provision of guard rails will provide maximum protection for the piglets. This present observation is also in agreement with the reports of Gracey (1955), Hafez (1987) and Olsson and Svendsen (1990) who reported the main causes of mortality are trampling, starvation, lower birth weight and housing system. Cannibalism was observed in all groups except in group V which is in support of the observation of Jones (1966). Cross suckling and sucking were observed in all treatment groups which may be due to the housing of nursing sows along with their penmates as reported by Braun (1996). Sows in treatment groups with boar (group IV) showed oestrus during lactation period and there was no incidence of lactational oestrus in other treatment groups which showed oestrus only after weaning. This observation is in support with the reports of Bryant *et al.* (1983). However, this finding is at variance with the reports of Kerr *et al.* (1988).

Overall results suggest that group housing system can be practiced in farming conditions provided that animals in advanced stage of pregnancy are shifted to farrowing pens till weaning of piglings.

Summary

SUMMARY

An experiment was conducted to study the effect of social environment on the reproductive performance of pigs and the feasibility and economics of rearing pigs of either sex together.

Sixteen weaned large white Yorkshire gilts, twelve weaned sows and two boars were randomly assigned to five groups as T_1, T_2, T_3, T_4 and T_5 each consisting of six pigs. All the groups were maintained under prevailing condition at University Pig Breeding Farm, Kerala Agricultural University, Mannuthy. Pigs in T_1 and T_3 groups were bred at the body weight of 70-80 kg with designated boars at the time of breeding. The pigs in T_5 group were bred in the first oestrus after weaning. In T_2 and T_4 group female pigs were reared with the boar.

Onset of oestrus, post weaning oestrus in sows were recorded. Fortnightly body weight was recorded in gilts. Duration of oestrus and intensity of oestrus were observed. Conception rate and gestation length were recorded.

All gilts and sows in each group were allowed to farrow in the same pen to study the performance of litter. The

behaviour of parents and other penmates towards the litter was also studied. The data were statistically analysed.

The onset of oestrus showed significant difference ($P<0.05$) between treatment groups I & II and II & III. The treatment group II (gilts with boar) attained puberty earlier than other groups.

The onset of post weaning oestrus did not vary significantly between groups.

The average fortnightly body weight for pigs in all groups increased progressively with age from four months of age to farrowing.

The duration of oestrus in all groups did not vary significantly between groups. The intensity of oestrus behaviour was found to be significant ($P>0.05$) between treatment groups.

The conception rate at first mating and overall conception rate did not vary significantly ($P<0.05$) between groups.

The length of gestation did not vary significantly between groups.

The litter size and weight at birth did not vary significantly ($P>0.05$) between groups. Similarly the litter size and weight at weaning also did not vary significantly.

The behaviour of parents and other penmates towards the litter did not vary significantly ($P>0.05$) in all groups.

Overall results suggest that in farming conditions group housing system can be practiced. It is advisable to keep animals in advanced stage of pregnancy in farrowing pens till weaning of piglings.

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CERTAIN SOCIAL ENVIRONMENTAL FACTORS ON THE REPRODUCTIVE PERFORMANCE OF PIGS

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ABSTRACT OF A THESIS

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ABSTRACT

An experiment was conducted to study the effect of social environment on the reproductive performance of pigs and the feasibility and economics of rearing pigs of either sex together.

Sixteen weaned large white Yorkshire gilts, twelve weaned sows and two boars were randomly assigned to five groups as T_1, T_2, T_3, T_4 and T_5 each consisting of six. Pigs in T_1 and T_3 groups were bred at the body weight of 70-80 kg with designated boars at the time of breeding. The pigs in T_5 group were bred in the first oestrus after weaning. In T_2 and T_4 group female pigs were reared with boar.

Post weaning oestrus, duration of oestrus, conception rate and gestation length did not vary significantly between groups. Onset and intensity of oestrus were significantly different ($P<0.05$) between groups. All gilts and sows in each group were allowed to farrow in the same pen and their litter performance was studied. The litter size and weight at birth did not vary significantly ($P>0.05$) between the groups. Litter size and weight at weaning did not vary significantly ($P>0.05$) between groups. The behaviour of parents and other penmates towards the litter did not vary significantly between groups. The behaviour of penmates to the litter was cordial.

Overall results suggest that in farming conditions group housing system can be practiced. It is advisable to keep animals in advanced stage of pregnancy in farrowing pens till weaning of piglings.