EFFECT OF PLANE OF FEEDING DURING PRE-PARTUM AND LACTATING STAGES ON MOTHERING ABILITY AND SUBSEQUENT CONCEPTION IN SOWS

By

JOSEPH MATHEW

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

1992

DECLARATION

I hereby declare that this thesis entitled"EFFECT OF PLANE OF FEEDING DURING PRE-PARTUM AND LACTATING STAGES ON MOTHERING ABILITY AND SUBSEQUENT CONCEPTION IN SOWS"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.

Joseph Mathew

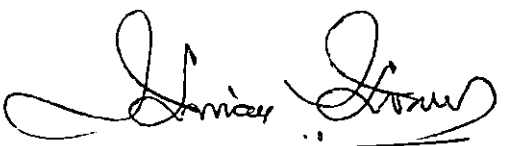
JOSEPH MATHEW

Mannuthy,

20-7-'92.

CERTIFICATE

Certified that this thesis entitled **"EFFECT OF PLANE OF FEEDING DURING PRE-PARTUM AND LACTATING STAGES ON MOTHERING ABILITY AND SUBSEQUENT CONCEPTION IN SOWS"** is a record of research work done independently by Dr. Joseph Mathew 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.



Dr. Kurien Thomas

(Chairman, Advisory Committee),
Professor,
University Pig Breeding Farm,
Mannuthy.

Mannuthy,

20-7-1992.

ACKNOWLEDGEMENTS

The author is indebted to:

Dr. Kurien Thomas, Professor, University Pig Breeding Farm, Mannuthy and Chairman of the Advisory Committee for his valuable and inspiring guidance and constant encouragement throughout the period of study and the preparation of the thesis.

Dr. T.G. Rajagopalan, Professor and Head, **Dr. C.K. Thomas**, Professor, Department of Livestock production Management, **Dr. E. Mathai**, Professor Animal Reproduction as members of the Advisory Committee for their valuable suggestions given from time to time.

Dr. G. Nirmalan, Dean i/c, College of Veterinary and Animal Sciences, Mannuthy for the facilities provided during the course of investigation.

Dr. K.C. George, Professor and Head and staff of the Depart. of Statistics for the statistical analysis of the data.

Dr. K.S. Sebastian, Associate Professor, University Pig Breeding Farm, Mannuthy for his valuable help and constant encouragement during the whole period of study.

Staff of the University Pig Breeding Farm, Mannuthy for the help and co-operation provided.

Beloved parents, sisters, wife and son for their constant inspiration, understanding and blessing for the successful completion of study.

Indian Council of Agricultural Research for the award of a Junior Fellowship.

Mannuthy
20-7-'92

JOSEPH MATHEW

CERTIFICATE

We, the undersigned members of the Advisory Committee of Dr. Joseph Mathew, a candidate for the degree of Master of Veterinary Science in Livestock Production Management, agree that the thesis entitled **"EFFECT OF PLANE OF FEEDING DURING PRE-PARTUM AND LACTATING STAGES ON MOTHERING ABILITY AND SUBSEQUENT CONCEPTION IN SOWS"** may be submitted by Dr. Joseph Mathew in partial fulfilment of the requirement for the degree.

Dr. Kurien Thomas,
Professor,
University Pig Breeding Farm Mannuthy.
(Chairman, Advisory Committee)

Dr. T.G.Rajagopalan,
Professor and Head,
Department of Livestock Production Management.

20/7/92

Dr. C.K. Thomas,
Professor,
Department of Livestock Production Management.

Dr. E. Mathai,
Professor,
Department of Animal Reproduction.

External Examiner.

23.10.92

ALL TO GOD AND THEN TO ASISH

CONTENTS

LIST OF TABLES

(Contd)

LIST OF FIGURES

Introduction

1 INTRODUCTION

Livestock Production is an important source of income of all developing nations. It meets one of the primary needs of human being-food- and provides input for various industries. Animal protein is a valuable nutrient in human food and because of its high biological value and compositional similarity with human body in regard to the profile and content of amino acids, meat industry has attained very great importance in the world.

Pigs are supreme amongst meat animals and are efficient converters of feed to valuable human food. According to one estimate, half of all the meat eaten in the world is from pigs. The rapid increase of human population, increased the demand of pork and farmers have intensified the pig production and suitable methods are being adopted to increase the net return from pig keeping. The breeders have succeeded greatly in bringing together the basic genetic elements and hereditary factors which determine the favourable production traits in pigs. Nutritionists have evolved various feeding levels for various physiological stages of growth and reproduction. Ethologists have identified various favourable behavioural patterns in animals which contribute to the expression of maximum production potential.

Producing pig is different from other forms of animal production. A failure to understand their peculiar demand at

different functional stages, is to fail at pig production (Colin, 1980). Feed commands a larger proportion of the total cost of running a pig unit and hence the diet and ration control, forms the crux of unit management. The cost of providing food and facilities to a breeding female is almost totally independent of her productivity. Financial success is therefore largely dependent upon the number of piglets produced annually from each female.

Time spent in the uterus is about half the total life of a growing pig destined for meat production and it is not without its hazards. There are two nutritionally critical periods during pregnancy, the early part of gestation and the later third of pregnancy. Most of the growth of the fetus is during the last 30 days of pregnancy. The vigour of the pigs and number produced in the litter at farrowing time are determined by the number of eggs fertilised by the boar at the time of breeding and by the methods used in feeding and managing the sows during pregnancy (Clarence et al, 1976).

Bred sows use feed to maintain their bodies and also to produce litters of pigs. Young gilt also need feed to grow and become mature sows. If the rations are inadequate, the sows will be incapable of maintaining themselves and in producing strong litters. Tests have shown that a 1.5kg pig at birth has a six times better chance to reach weaning than 0.75kg runt (Clarence et al., 1976). Hence the feeding of a balanced ration in adequate amounts during pregnancy and suckling periods is a must in

profitable pork production.

The ration given to the sow, the ration provided to the piglets and the management given to the sow and litter determine whether or not a high percentage of pigs in the litter will survive and attain heavy weight at weaning time. An average of seven or eight pigs marketed per sow is usually necessary to come out with economic efficiency. As the weaned litter size decreases the cost of production per weaned pig increases (Clarence et al.,1976).

A sow when fed a good ration may produce 3 to 4kg of milk per day which is sufficient for smaller litters while sows which are nursing 10 or more piglets must produce maximum of milk to satisfactorily meet the needs of the pig which demands, an increase in the ration fed to both the sow and its litter. The milk production of the sow declines after 3rd week and it is important that piglets may be fed a palatable ration in ample amounts when sows are in poor condition (Clarence et al., 1976).

Postnatal mortality may amount to 10 to 20 % of those born and often seems to be due to crushing under the mother (Colin, 1980). 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 whereas 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 litters during neonatal life are some of the striking ethological 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 a breeding sow demands a superior post-weaning performance and conception rate. The lactational stress on the animal is the real obstacle in the achievement of this aim. Hence vigilant feeding regime of the sow and the litter depending on the litter size is a critical milestone in obtaining optimum post-weaning performance.

Hence it has become necessary to have a better understanding of optimum feeding levels of breeding female swine during the critical periods of gestation and lactation in order to obtain superior litter efficiency and post-weaning performance. It would be advantages to the farmer if a method of quantifying the ability of a sow to give maximum litter output which is equated with the mothering ability of the sow is available with him, as a Composite index incorporating all the important influencing elements from genetic, reproductive, nutritional and behavioural aspects.

In the light of the forgoing resume the present study was undertaken with the following set objectives:

1. To assess the effect of plane of feeding during pre-partum and

lactating stages on mothering ability and subsequent conception in sow.

2. To find out the optimum plane of feeding of pigs during gestation and lactation and to recommend an optimum time for switch over of plane of nutrition during this period which is economical.

Review of Literature

2 REVIEW OF LITERATURE

Mothering ability in sows is a composite term used to denote the ability of a sow to give birth and rear piglets. It is influenced by various factors such as heredity, plane of feeding, management of reproduction, environment, health and behavioural aspects of sow and litter.

2.1. Plane Of Feeding And Mothering Ability.

The influence of plane of feeding on the sow to express its ability as a mother has been investigated extensively in order to recommend an economic and optimum plane of feeding during breeding, gestation and lactation.

2.1.1. Breeding Period.

The scientists have identified long back the carry-over effect of prebreeding feeding plane on the mothering ability. Cybuljko (1957) reported that when Berkshire sows were fed rations which represented 95, 75 and 55 percent respectively of concentrates, the number of mature follicles and viable embryos were poorest in sows that received 55 percent concentrate.

On keeping Duroc Jersey gilts on limited or full feeding, ovulation rates, embryo survival at 25 and 40 days of gestation, number of live piglets born or percentage survival were not affected by dietary treatments (Haines et al., 1958).

From the observations in three trials involving degree of full and limited feeding from 70 days of age till farrowing, Waldorf et al.(1958) came to the conclusion that a feeding regime

that altered the growth and fatness of the dam did not affect fetal growth.

The effect of restricting energy intake of Duroc-Jersey gilts by about 50 percent was investigated by Haines et al.,1959) and found that high ovulation rate resulted from full feeding, but a restricted ration was necessary for optimum embryonic survival.

Holness (1969) reported that when fed at levels equivalent to 100, 75 or 50 percent of the feed requirement to immature breeding gilts, the high level of nutrition resulted in a higher litter at birth, although age at sexual maturity was not affected.

Vinovrski (1969) and Arbabian (1970) did not observe any significant difference in the reproductive performance when gilts were fed ad- libitum, a complete food mixture varying in total digestible nutrients or energy content.

Production of sows reared under different nutritional and managemental condition was investigated by Borisenko (1974) and found that, at 100kg body weight, the highest number of ovarian follicles and live born piglets were in gilts fed a standard diet containing a full allowance of concentrate, combined with grazing.

In contrast Dyck (1974) could not derive any direct effect of level of feeding on fetal number, ovulation rate or fetal survival.

In restricting energy intake to 85 percent of free choice

intake from 45-50 kg body weight, Atherne et al. (1976), or in enriching the normal ration with additional supplement of protein Dammert and Giessler (1976) and Jones (1977) could not find any significant effect on the number of piglets born or weaned per litter.

On restricting the diet to nearly 50 % of the requirement, Papp et al (1979) and Wittman et al. (1978) found a significant reduction in litter size at birth, at 30 days, and number of live born piglets. This observation is at variance with reports of Ivanovski (1983) and Duee (1984). These workers did not observe any significant difference between groups of pigs maintained on varying plane of nutrition during premating, gestation and lactation periods, on pregnancy duration, service period, farrowing interval and litter size at birth and at weaning or for the number of liveborn piglets per litter, but there was significant difference for litter weight at weaning.

2.1.2. During Pregnancy.

According to O'Grady (1962), although feeding regime did not affect the number of piglets born or weaned per litter, it had a significant effect on litter weight at birth and at weaning.

The studies conducted by Ripple et al. (1965) on cross-bred gilts and sows indicated that neither the level nor the source of protein in feed during the later half of gestation influenced litter size, number of live piglets farrowed, birth weight or piglet viability. Similar observations were reported by Livingstone et al. (1966).

In contrast Frobish et al. (1966) reported that an increased protein level in feed during gestation in sows caused an increase in number of piglets farrowed and weaned. However, neither protein nor energy intake during gestation significantly affected average birth weight or gain from birth to weaning.

A significant difference in average piglet weight at birth was noticed by Elsley et al. (1969) in Landrace and Large White Yorkshire cross-bred gilts when given high, medium or low levels of feeding during their gestation.

When feeding regime of low and high energy intakes throughout gestation were followed, Frobish (1970), Elsley (1971) and Adam (1973) found that birth and weaning weights were not significantly affected by energy intake.

When pregnant sows were fed with a ration having nutrients at normal standards or an energy deficiency of 20% or an energy and protein deficiency of 20%, there was no significant differences between groups, in litter size, milk production and weaning weight (Lezhnina, 1971; Jasek, 1973 and Majerciak, 1973).

Frobish et al., 1973) investigated the minimum energy requirement for reproduction and the long term effect of energy intake on reproductive performance and found total piglets farrowed per litter decreased in a linear manner with increasing energy intake but number of live pigs farrowed per litter, number of piglets weaned and weaning weights were not affected.

Hammell (1974) studied the effect of protein restriction during gestation and found a significant reduction in piglet

birth weight and survival rate to 45 days in the low protein level, but litter size was not affected significantly.

A significant difference in both total number of fetuses produced and number of piglets born alive between high and low plane dietary treatments at all parities was noticed by Holness and Smith (1974). As plane of nutrition decreased mean percentage number of still born piglets per litter increased progressively. Still born piglets were lighter on average than their live contemporaries in the high and medium plane litters, but heavier in the low plane litters. Sows in lower plane weaned fewer piglets. Similar observations were reported by Libal (1974) in pigs provided with varying levels of metabolisable energy (ME) intake during gestation period.

Tagani et al. (1974) stated that sows maintained on high nutritional plane had poorer performance than sows on lower plane.

Young et al. (1976) found that protein supplementation of diets of gilts had increased litter weight, average piglet weight and survival rate of piglets with no effect on litter size at birth.

Hovell and Macpherson (1977) observed that protein and energy restricted animals gave birth to piglets with lower birth weight and became infertile after three reproductive cycles.

Kirchgessner and Roth (1977) did not find any significant difference in number of piglets born or reared between two groups of Landrace sows which received either a standard level or a

relatively poor level of nutrition during gestation.

On feeding isocaloric diets containing 10 or 14% protein supplemented with equal levels of minerals and vitamins at the level of 2kg/ head/ daily, Wahlstrom and Libal (1977) could find faster gains during gestation without any significant effect on number and weight of piglets at birth.

Restriction of pre-farrowing feed intake did not significantly affect litter size, birth weight or weaning weight of the piglets (Elliot and Lodge, 1978).

Sows fed gestation diets with 9 and 15% protein did not show any significant difference in total litter size at birth, number of live born piglets, piglet survival rate at 14 days and 14 day piglet weight (Anonymous, 1978).

Mahan (1979) reported that a low protein diet lowered the litter size and a 14% protein diet resulted in optimal reproductive performance.

Quantitative reduction in feed intake of 3kg, 2.4kg and 1.8kg was associated with a concurrent decrease in average litter size and number of live born piglets per litter. (Wittmann et al. 1978).

The effect of increased feed intake during late gestation of sows and gilts were studied by Walker et al.. (1981) by providing a high level of feeding from day 90 to farrowing and this had no significant effect on litter size, survival rate or piglet weight at birth , 21 days and at 42 days .

The influence of quantitative variation in feed allowance on the reproduction of sows and gilts during gestation was studied by Walker et al. (1982) and found that progeny of females on the higher plane of nutrition showed higher rate of survival to 21 and 42 days of age.

Grudniewska et al. (1983) studied the effect of feeding sows as per Polish standards and requirement diets or restricted diets during pregnancy and ad lib diet during lactation or an ad lib diet throughout the experiment and did not find any significant difference between treatments for litter size, piglet body weight and weight gain.

Preliminary results of reducing amount of protein in the ration of pregnant sow in the trial conducted by Vass and Boldman (1990) suggested that the feed for pregnant sow should contain at least 10% crude protein.

2.1.3. Suckling Sows.

The stress due to lactation in sow is severe. Scientist have tried various methods to alleviate strain on the sow due to lactation.

HitchCock et al., (1971) reported that limiting feed intakes of the dam during a 49 day lactation to 0.45kg/ piglet suckled per day with those of ad lib feeding showed no difference in number or weight of piglets at 49 days, but resulted in significant difference in sow weight at weaning.

Reese et al. (1982) observed that sows fed a low level ration lost more weight and back fat and increased the number of

lighter weight piglets than those fed with high level ration.

When sows were arranged for ME intakes of 10, 12 or 14 Mcal/ day during lactation, weaning weight of litter increased linearly with increasing energy intake of the dam (Nelssen, 1984).

2.2. Post Weaning Oestrus And Conception.

According to O'Grady (1962) feeding regime did not significantly affect breeding regularity of sows.

A high level of feeding during lactation followed by a low level during pregnancy was reported to be a more efficient system of feeding and was found to reduce the time from weaning to effective mating (Bellis, 1968).

Svajur et al. (1972) indicated that severe protein restriction during gestation and lactation significantly impaired subsequent reproductive efficiency, especially in gilts.

Brooks and Cole (1975) reported that the high or low feed pattern during the last week of lactation and following weaning did not significantly affect period from weaning to mating and litter size at birth.

According to Nicolaiewsky et al. (1976) and Greenhalgh et al. (1977) oestrus interval was not affected by restricted lactation diets.

Sows which received diets containing 9 or 11% protein during pregnancy and 13, 15, 17 or 19% during lactation in a total of eight treatment combinations did not influence the post weaning interval to conception (Greenhalgh et al., 1980).

King and Willams (1981) observed that only 40% of the females fed 2kg feed daily during lactation ovulated within 5 days of weaning. Lactation feeding level had no significant effects on ovulation rate, embryo mortality or subsequent litter size.

Reese et al. (1982) observed that fewer sows fed low level ration during lactation exhibited oestrus by 7, 14, 21 and 70 days after weaning than those fed high level and further they found that the number of piglets born were not affected by energy intake during first lactation.

Reese (1983) investigated the effect of energy intake during lactation on the interval from weaning to first oestrus in sows by providing a low, medium or high levels of energy in 8, 12, or 16 Mcal ME respectively per day and they reported that the number of sows in oestrus 7 days after weaning were significantly lower for lower energy diet and body weight and back fat loss decreased linearly as energy intake increased. The observation was supported by the findings of Nelssen (1984).

Johnston et al., (1986) suggested that feeding level during lactation of 12.5Mcal ME daily or higher, supported adequate rebreeding performance but post-weaning feeding levels did not influence the interval to first postpartum oestrus, feeding a high energy diet continuously throughout lactation and rebreeding phase in primiparous sows might increase post-weaning oestrus interval.

Kirkwood et al.,(1986) reported that low level lactation

feed intake led to an extension in weaning to "oestrus interval", increased incidence of anoestrus and a reduction in pregnancy rates. In continuation to this they also reported that low level feeding in lactation resulted in greater body weight and back fat loss, the pregnancy rate and embryo survival was influenced by feed intake with ovulation rate being unaffected (Kirkwood et al., 1987).

2.3. Parturient And Maternal Behaviour.

Parturient and material behaviour occupy a central position in the survival of the offspring and in the social shaping of the individual animal. For the new born, the behaviour of the mother is critical not only immediately for life, but for ongoing adjustment to the finite environment into which it is born. Since the mother is the initial source of learning, her responses to the various activities of the young can shape the behavioural characteristic of the later (Rheingold, 1963).

2.3.1. Parturient Behaviour.

Fraser and Broom (1990) partitioned the principal events in parturient behaviour into pre-partum, parturient and post partum behavioural patterns.

Extensive nest building tendency with available material was reported in swine by Taylor et al. (1986).

A high incidence of birth at night have been reported in pigs by Deakin and Fraser (1935); Friend et al. (1962) which makes proper supervision, difficult.

Pigs are reported to be placentophagic if the placenta is not removed promptly from the pen and this may lead to digestive disturbances and reduce milk flow during early stages of lactation (Fraser and Broom, 1990).

Jones (1966) reported 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 cannibalism and crushing could frequently occur.

2.3.2. Nursing And Suckling Behaviour.

Experimental findings suggested cause and effect relationship between the different elements of sow and piglet behaviour and the relationship of the behaviour of milk ejection. Synchronous features of pig nursing and suckling behaviour promoted an even distribution of milk among all litter mates (McBride, 1963; Hemsworth et al., 1976) thereby providing equal chances of survivability to all piglings.

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 (Bourne, 1969; Hartsock and Graves,1976). Later born piglets were less likely to obtain sufficient colostrum for a variety of reasons (Broom, 1983).

About 10hrs. after farrowing milk let down became synchronised and periodic (Lewis and Hurnick, 1985). The sow gave a characteristic grunting call (McBride, 1963; Whittemore and Fraser, 1974) and milk was let down simultaneously from each

teat. The piglets learn the call and the periodicity. So they are ready on the teat. The milk let down lasts only 10-15 seconds and occur every 50-60 mt. and this system ensures that, provided there are not too many piglets for the teat, all can suckle satisfactorily.

The nursing position of the sow is 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) suggested udder massage for quantitative stimulation of milk flow.

Some sows are reported to try to position the piglet near her udder or draw them towards her teats using her forelegs in scooping action (Fraser and Broom 1990) which are critical behavioural patterns with regard to survivability of weak and wandering piglets.

Abnormal maternal behaviour leads to rejection of newborn animal and depriving the new born of intake of colostrum, while for passive immunity should be ingested promptly after, birth under calm conditions Broom (1983) which is very important in the survivability of piglets.

New born piglets, with their small body size, sparse pelage and skin wet with fluids are proven to chill in air temperature as high as 20 ^{o}C with a 5km per hr. wind speed despite of vigorous thermogenic responses (Mount, 1968).

and inactive metabolic pathway postnatally (Kasser et al., 1981).

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, grasped and suckled (Scheel et al., 1977). Piglets that do not find a functional teat soon after birth rapidly deplete their energy reserves in cold weather and die from hypothermia.

There is clear preference for the anterior teat and although their control is usually gained by the large dominant piglets, there appears to be no major advantages in suckling from this (Fraser and Jones, 1975).

Stimulation of anterior teat play a critical role in promoting normal suckling behaviour (Fraser, 1973).

The time for teat order to stabilise varies widely from a day or 2 to 1 to 2 weeks (Hemsworth et al..1976). It is shortest with sows that remain lying on one side for suckling during the first day or so. Changes in position unsettle the order and the fighting phase is prolonged.

Starvation accounts for nearly half of the mortality in live born domestic piglets (Hafez, 1987).

Materials and Methods

3 MATERIALS AND METHODS

3.1. MATERIALS.

Thirty six pregnant gilts belonging to the University Pig Breeding Farm, Kerala Agricultural University, Mannuthy, in their later half of gestation were utilised for the study. Three planes of feeding with respect to Crude Protein (CP) and Digestible Energy (DE) were tried viz.

i. NRC recommended level (NRC,1979) (NRC)

ii. A high plane (HP) of 10% increase of CP with reference to NRC level and

iii. A low plane (LP) of 10% decrease of CP and DE with reference to NRC (Table 3.1)

The rations to pigs contained varying proportions of the following feed ingredients:

Ingredients	Cost/100kg (Rs.)
1. Yellow maize	375.00
2. Groundnut cake (GNC)	450.00
3. Rice polish	315.00
4. Rice bran	270.00
5. Dried unsalted fish	670.00
6. Beef tallow	2000.00
7. Common salt	125.00
8. Mineral mixture	325.00
9. Vitamin AB D (Rovimix).	328.00 per kg.

Table 3.1. CP and DE content of the Experimental Diets

	Plane of Feeding	CP%	DEkcal/kg
NRC	Pre-partum	12.0	3300
	Post-partum	13.0	3300
High plane (HP)	Pre-partum	13.2	3300
	Post-partum	14.3	3300
Low Plane (LP)	Pre-partum	10.8	2970
	Post-partum	11.7	2970

DESIGN.

Presuming that farrowing generally occurs at 112 days of conception, the period from 56 days of gestation to 56 days after farrowing was divided into 4 stages viz. A, B, C, & D; each having a duration of four weeks (Table 3.2). Of the thirty six pigs, four were maintained on NRC recommended level of nutrients from 56 days of gestation to 56 days after farrowing when they were weaned as usual. Of the remaining 32 pigs 16 each were assigned at random either to high or low planes of feeding from 56 days of gestation. In either planes of feeding 4 pigs each were shifted to the other plane from 84 days of gestation, from the day of farrowing; and from 28 days of farrowing till weaning, respectively so that there were a total of 9 treatment groups each having 4 experimental units, as shown in Table 3.2.

Table 3.2 Design of the Experiment

Treatment Groups	Experimental Units	Plane of Feeding			
		Pre-partum (days)		Post-partum (days)	
		56-83	84-farrowing (112)	Farrowing (28)	29-56
		Stage A	Stage B	Stage C	Stage D
I	a1 a2 a3 a4	NRC	NRC	NRC	NRC
II	b1 b2 b3 b4	HP	HP	HP	HP
III	c1 c2 c3 c4	HP	HP	HP	LP
IV	d1 d2 d3 d4	HP	HP	LP	LP
V	e1 e2 e3 e4	HP	LP	LP	LP
VI	f1 f2 f3 f4	LP	LP	LP	LP
VII	g1 g2 g3 g4	LP	Lp	LP	HP
VIII	h1 h2 h3 h4	LP	LP	HP	HP
IX	i1 i2 i3 i4	LP	HP	HP	HP

MANAGEMENT.

All the pigs and their respective litters, were housed separately till weaning and were cared as per usual managemental practices prevailing in the farm. Prior to admittance (at 56 days of gestation) into the farrowing pens of identical size the pigs were dewormed with Helatac* and sprayed against ectoparasitic infestation using a solution of Malathion 0.5%. All the piglets were given Imferon** 1ml i/m on the 3rd day of farrowing. The

*Helatac- Parbendazole 4 percent, manufactured by Eskay Labs Ltd.

**Imferon- A product of Rallis India Ltd. Containing 50mg Iron/ml

sows were bred during the first post-weaning heat itself and observed for positive signs of conception, viz. non-return to heat and physical signs of pregnancy within a period of 8 weeks.

Feed was provided to the pigs both in the morning and evening and allowed to consume as much as they could in 1 hr. Drinking water was made available in the pen at all times.

The following observations were recorded:

1. Body weight of dam
   a) At 56 days of gestation
   b) At 84 days of gestation
   c) At 28 days of lactation
   d) At 56 days of lactation
2. Litter size
   a) At birth
   b) At weaning
3. Litter weight
   a) At birth
   b) At weaning
4. Daily feed consumption of sow and the litter within one hour both in the morning and evening.
5. Days required for onset of post-weaning heat
6. Pigs conceived within 56 days after weaning
7. Behaviour of sow and litter during feeding, suckling and oestrus.

The sows were scored for their behavioural patterns during feeding, parturition suckling and post-weaning oestrus as described below:

Sl.No.	Description	Score
1.	Excitement, restlessness, eagerness, grunting, gnawing, drooling of saliva, etc. at feeding.	3
2.	Moving around in the pen, grunting, drooling saliva etc.	2
3.	Quite with casual interest towards feed.	1

Table 3.4 Parturient And Suckling Behaviour.

Sl.No.	Description	Score	
		+ve	-ve
1.	Good temperament docile and confidence on attendant	1	0
2.	Teats and udder engorged with milk	1	0
3.	Early completion of parturition-[3hrs. or less]	1	0
4.	Early expulsion of placenta-[2.5hrs. or less]	1	0
5.	Alertness towards safety of pigling	1	0
6.	Fondling piglings before and after suckling	1	0
7.	An interval of 90 min or less between suckling during first 14 days	1	0
8.	Steady, progressive and uniform gain in weight of piglings	1	0
9.	Over lying. biting, injuring and killing the piglings and hostile to attendants	0	1
10.	Placentophagy	0	1

Table 3.5. Post-weaning Oestrus Behaviour Of Sow.

Sl. No.	Description	Score	
		+ve	-ve
1.	Restlessness, excitement, swollen and moist vulva	1	0
2.	Oestrus grunt and eagerly searching for boar	1	0
3.	Mounting on other pigs	1	0
4.	Sniffing and fondling of boar and genitalia	1	0
5.	Typical mating stance on the first sight of boar and allowing mating without any ill-will.	1	0

Based on the data and management conditions prevailing in the farm a "Composite Sow Index" was formulated as shown below:

Table 3.6 Composite Sow Index

Trait	Score
1. Age at first farrowing- 12 months Deduct 0.1 point for every additional month taken (Breedable age is taken as 8 months)	1
2. Live litter size at birth- 8 piglets Deduct /add 0.2 point for every piglet (Maximum suckling piglets limited to number of teats-7 pairs)	1
3. Litter size at weaning - 8 piglets Deduct /add 0.2 point for every piglet	1
4. Live litter weight at birth -10kg Deduct /add 0.2 points for every kg	1

5. Litter weight at weaning- 72kg Deduct /add 0.2 points for every 10kg	1
6. Post-weaning conception within one month of weaning Deduct 0.2 points for every additional month.	1

The cost of production of a weaned piglet and of per kg body weight were calculated in all the treatment groups with assumptions that feed represented 75% of the total cost of production and the cost of maintenance of boar was identical to all the piglets.

The data collected were statistically analysed as per methods described by Snedecor and Cochran (1967) and results interpreted.

Results

4 RESULTS

The results obtained during the course of the experiment, on body weight of dam, litter size and weight at birth, litter size and weight at weaning etc. are summarised in Tables 4.1 to 4.11 and graphically depicted in Fig. 4.1 to 4.6.

4.1. Body Weight Of Dam.

The pre-partum and post-partum body weight changes of the dam during stages A and D are presented in Table 4.1 & 4.4 and Fig 4.1 & 4.3.

4.2. Litter Size At Birth.

The total and live litter size at birth showed an increase in the order of treatments I, V, VI, VII, VIII, IX, II, III, IV and V, VI, VII, VIII, I, IX, II, III, IV respectively (Tables 4.2 and Fig 4.2). The highest percentage of still birth was noticed in group V and the least in group IX.

4.3. Litter Weight At Birth.

The total and live litter weight at birth revealed an increase in groups V, VI, VII, VIII, I, IX, II, III, IV,and V, VI, VII, VIII, I, IX, II, III, IV respectively (Table 4.3). The highest Average live birth weight was seen in group I.

4.4. Litter Size At Weaning.

The litter size at weaning increased in the order of treatments VI, V, IV, VII, VIII, III, I, II and IX respectively

(Table 4.5 & Fig. 4.4). There was no piglet for weaning in group VI due to death. The percentage mortality of pigling in various groups are presented in Table 4.6.

4.5. Litter Weight At Weaning.

The litter weight at weaning was in the decreasing order of IX, II, I, III, VIII. VII, IV, and V respectively, while in group VI,due to death, there was no piglet at weaning. The average piglet weight at weaning was highest in group I (Table 4.5 & Fig. 4.5).

4.6. Post-weaning Oestrus And Conception.

The number of days required for the onset of post-weaning heat and the subsequent conception within 56 days of weaning are presented in Table 4.7. All the pigs in group II suffered from paraplegia at about weaning.

4.7. Feed Consumption.

The total daily feed consumption was seen to be increasing in the order of treatment groups V, VI, III, IV, VII, II, IX, VIII and I respectively (Table 4.8).

4.8. Behaviour.

4.8.1. Feeding.

The behaviour of pigs at feed intake was scored and time taken thereof, in the various treatment groups are presented in Table 4.9 and 4.8 respectively. The highest score value was observed in group III and the least in group V.

4.8.2. Parturient And Suckling Behaviour.

The parturient and suckling behaviour score ranged from 2.75

to 9.5, the highest being in group IX and the lowest in group VI respectively(Table 4.9).

4.8.3. Post-weaning Oestrus.

The behavioural observations made during post-weaning oestrus and scores thereon are shown in Table 4.9.

4.9. Composite Sow Index.

The composite sow indices with respect to their efficiency and mothering ability in various groups are set out in Table 4.9..

4.10. Correlation Co-efficients.

Correlation co-efficients of certain traits studied are presented in Table 4.10.

4.11. Cost Of Production Of Weaned Piglets.

The cost of production of piglet at weaning and per kg body weight are presented in Table 4.11. The cost of piglet per kg body weight was least in group IX (Rs. 30.10) and highest in group V (Rs. 159.37).

Fig. 4.2

TOTAL AND LIVE LITTER SIZE AT BIRTH

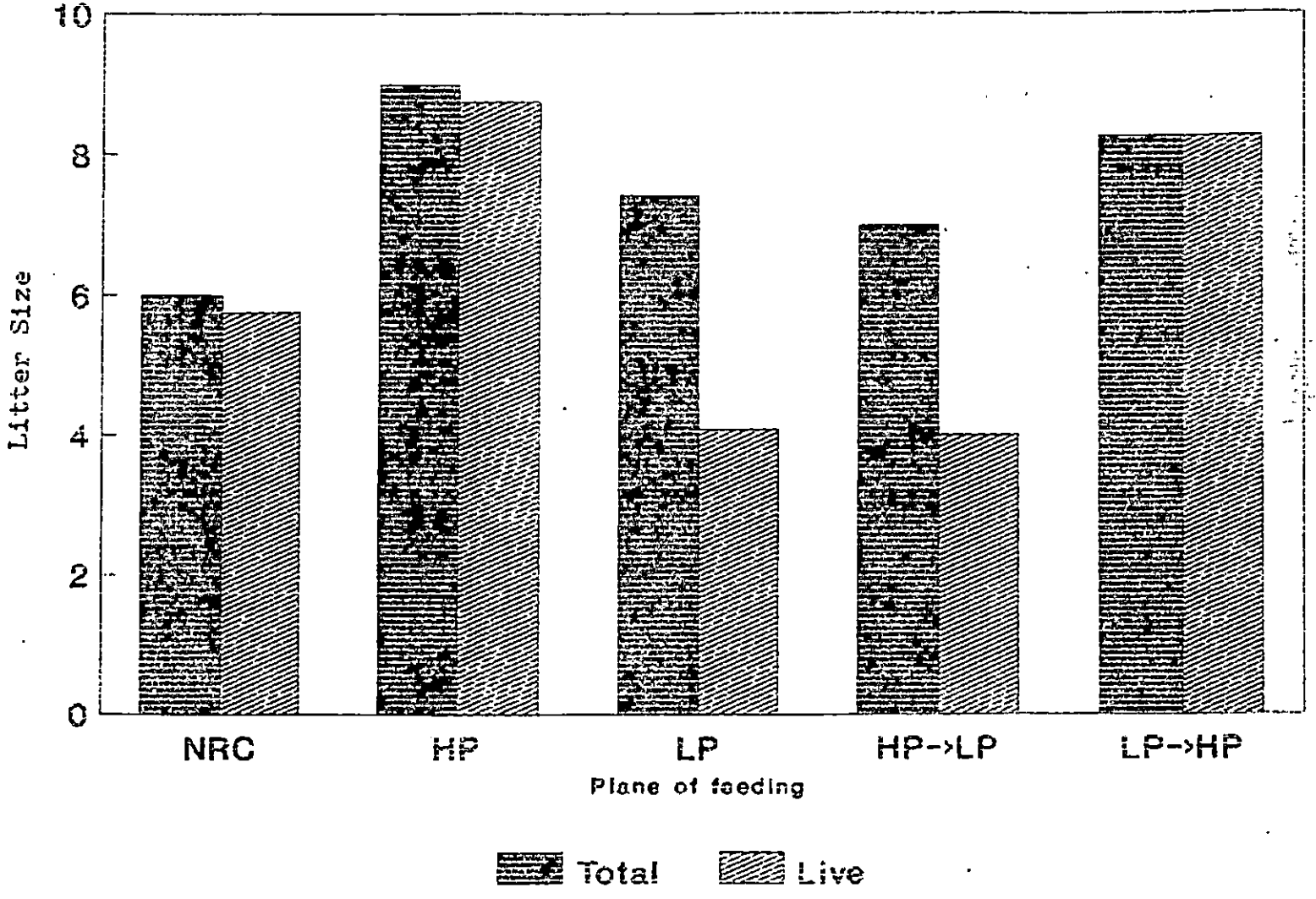


TABLE 4.1
MEAN & S.E OF PRE-PARTUM BODY WEIGHT GAIN IN STAGE A (56-84 DAYS)

TREATMENT GROUPS	I [NRC]	II,III IV,V [HP]	VI,VII VIII,XI [LP]
WEIGHT GAIN kg	15.65±1.57 [a]	17.19±0.75 [a]	9.06±0.78 [b]
AVERAGE DAILY WEIGHT GAIN (g)	559±60 [a]	615±40 [a]	324±30 [b]
WEIGHT GAIN [%] OVER INITIAL WEIGHT	12.36±2.34 [c]	15.82±0.65 [d]	8.15±0.74 [e]

FIGURES HAVING SAME SUPERSCRIPTS DO NOT VARY SIGNIFICANTLY

Fig. 4.2

TOTAL AND LIVE LITTER SIZE AT BIRTH

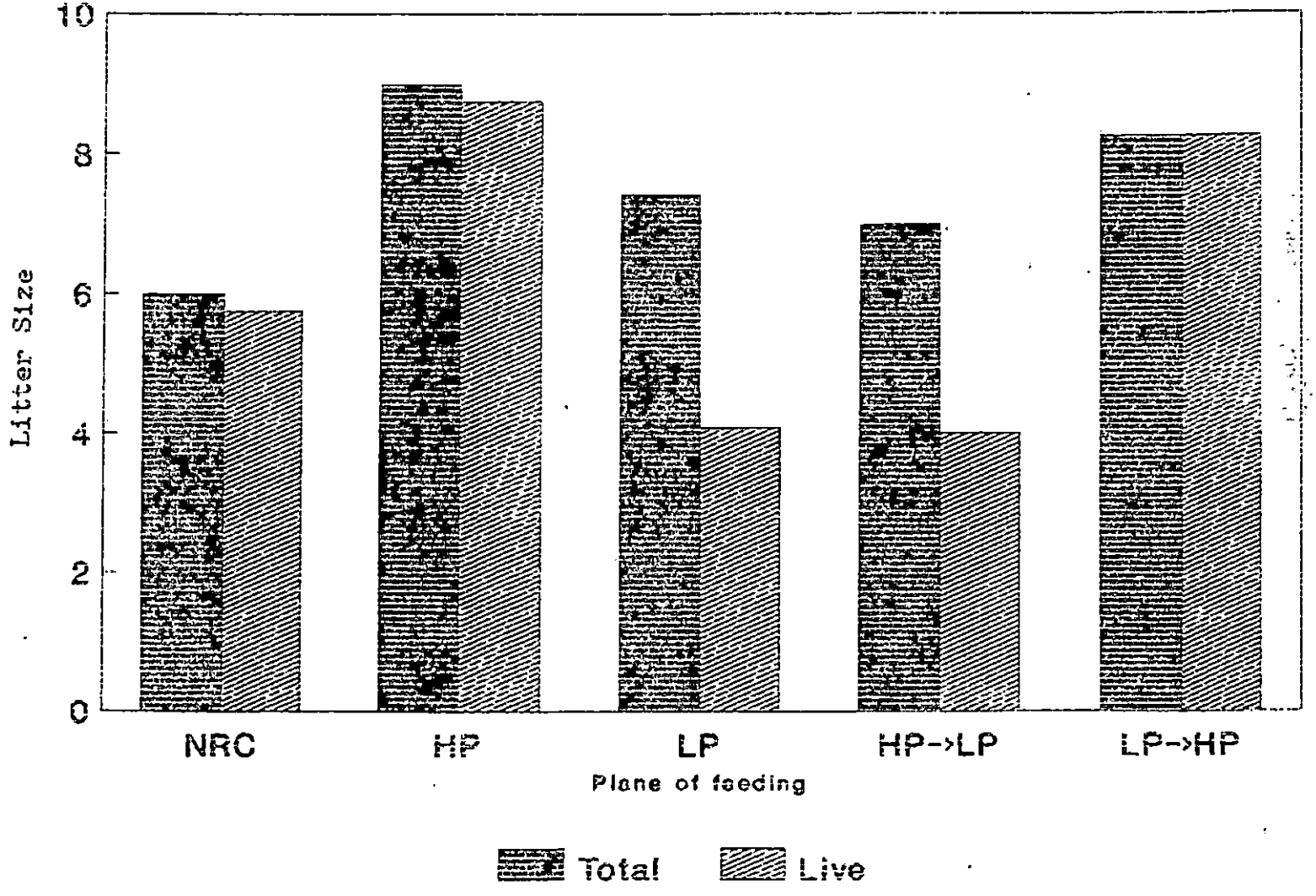


Fig. 4.1

THE PLANE OF FEEDING AND PRE-PARTUM BODY WEIGHT GAIN OF PREGNANT GILT

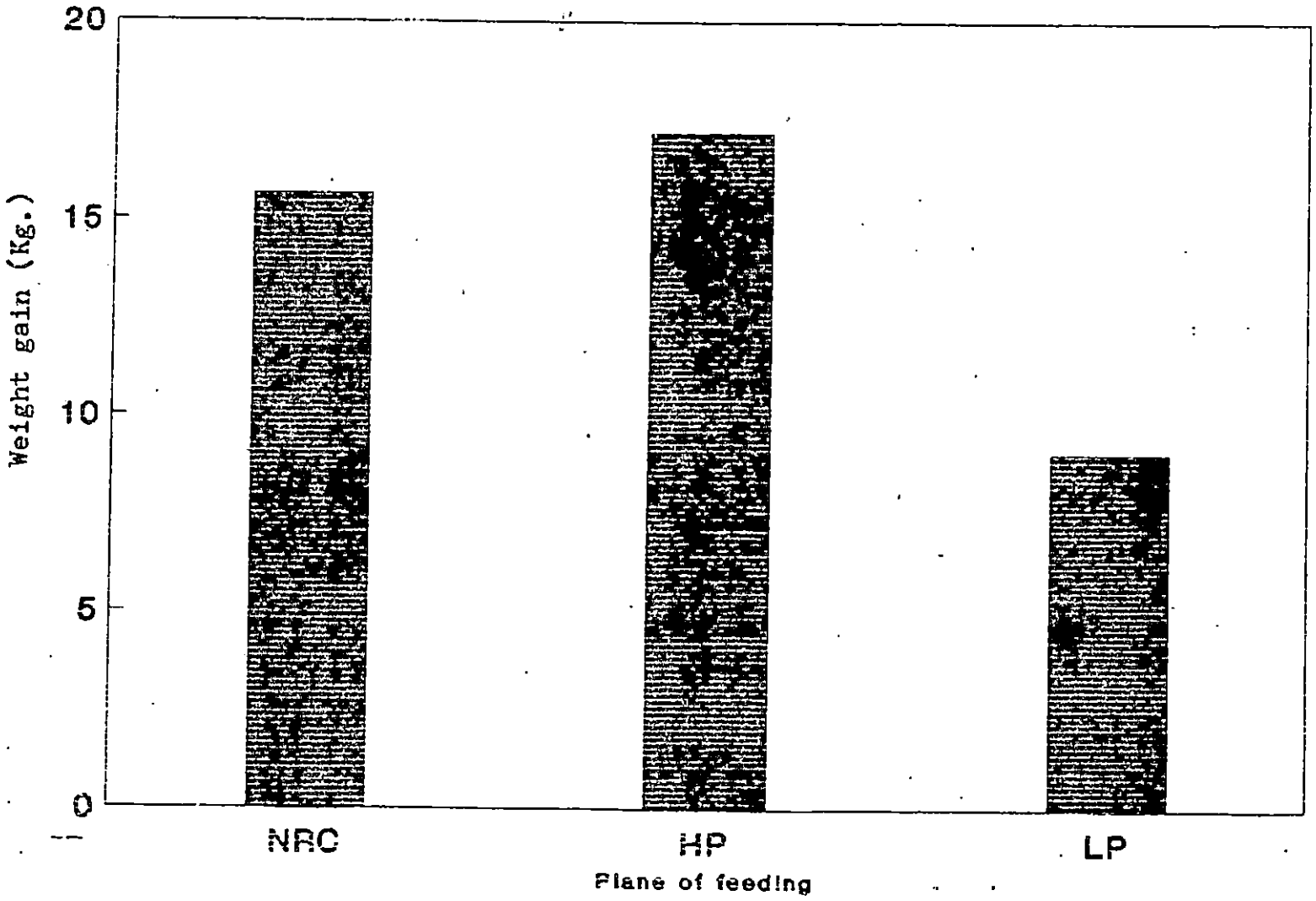


TABLE 4.2
MEAN & S.E OF LITTER SIZE AT BIRTH

STAGE-B

TREATMENT GROUPS	I [NRC]	II,III,IV [HP]	VI,VII,VIII [LP]	V HP->LP	IX LP->HP
TOTAL [Nos]	a 6.25± 0.48	a 9.00± 0.46	a 7.42± 0.69	a 7.00± 0.58	a 8.25± 0.63
LIVE	abc 5.75± 0.48	a 8.75± 0.48	bd 4.08± 0.73	cd 4.00± 0.71	a 8.25± 0.63
STILL BIRTH	0.50± 0.29	0.25± 0.13	3.33± 1.19	3.00± 1.73	0.00± 0.00
STILL BIRTH [%]	8.57	2.87	37.90	42.71	0.00

FIGURES HAVING THE SAME SUPER SCRIPTS
DO NOT DIFFER SIGNIFICANTLY

Fig. 4.2

TOTAL AND LIVE LITTER SIZE AT BIRTH

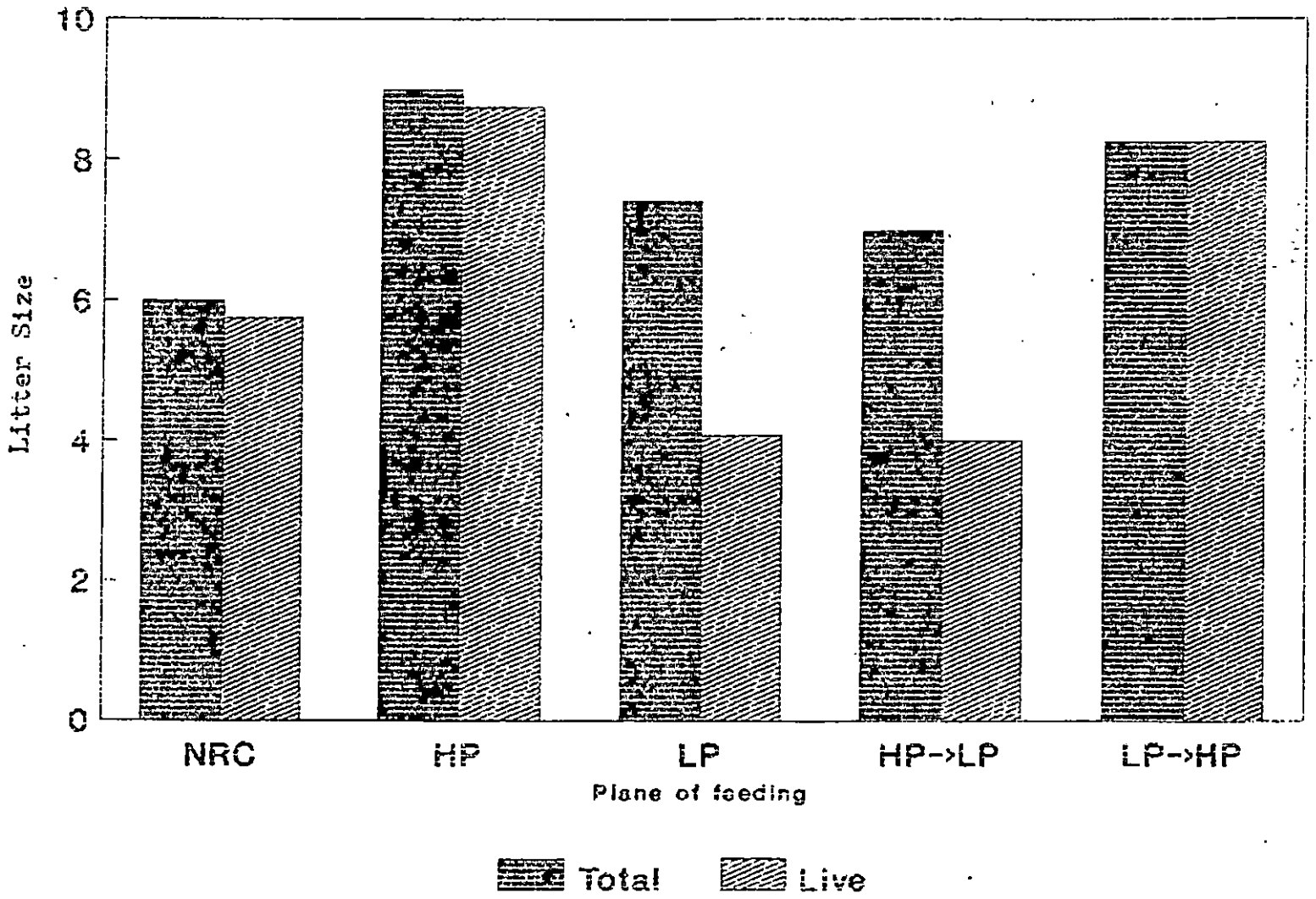


TABLE 4.3
MEAN & S.E OF LITTER WEIGHT AT BIRTH [kg]

TREATMENT GROUPS	I [NRC]	II,III,IV [HP]	VI,VII,VII [LP]	STAGE-B V HP->LP	IX LP->HP
TOTAL [kg]	a 9.30±0.66	b 12.95±0.44	a 8.83±0.51	a 8.58±1.01	a 11.93±0.24
LIVE	a 8.63±1.05	b 12.73±0.47	ad 6.49±0.79	d 4.98±1.02	b 11.93±0.24
AV. BIRTH WIGHT OF PIGS BORN ALIVE	a 1.50±0.09	a 1.48±0.05	a 1.34±0.07	a 1.25±0.11	a 1.47±0.10
AV. BIRTH WIGHT OF PIGS BORN DEAD	1.35±0.15	0.90±0.10	1.31±0.10	1.2±0.097	**

FIGURES HAVING THE SAME SUPERSCIPTRS IN THE SAME ROW DO NOT DIFFER SIGNIFICANTLY
** There was no still birth

TABLE 4.4
MEAN & S.E OF VARIATION IN BODY WEIGHT OF DAMS DURING STAGE D [kg]

TREATMENT GROUPS	I	II	III	IV	V	VI **	VII	VIII	IX
WEIGHT GAIN/ LOSS..[kg]	ac -10.00±1.84	a -17.25±5.81	ac -10.63±1.39	ad -10.00±1.10	cde -4.48±3.84	f 5.00±1.27	efg 2.00±6.18	cdg -6.00±1.43	a -16.63±3.08
DAILY GAIN/ LOSS [gms]	ac 357±70	a 616±210	ac 379.5±50	ac 357±40	cd 174±140	e 183±40	def 71.5±220	cf 214.25±50	a 594±110
PERCENTAGE GAIN/LOSS	7.63±1.24	15.35±4.99	10.88±2.36	6.86±3.4	7.67±0.97	5.07±1.0	3.19±4.10	5.38±1.18	10.62±4.59

FIGURES HAVING THE SAME SUPERSCRIPTS DO NOT VARY SIGNIFICANTLY
** THERE WERE NO SURVIVING PIGLETS WITH THE DAM

Fig. 4.3

POSTPARTUM WEIGHT CHANGE OF DAM -STAGE-D

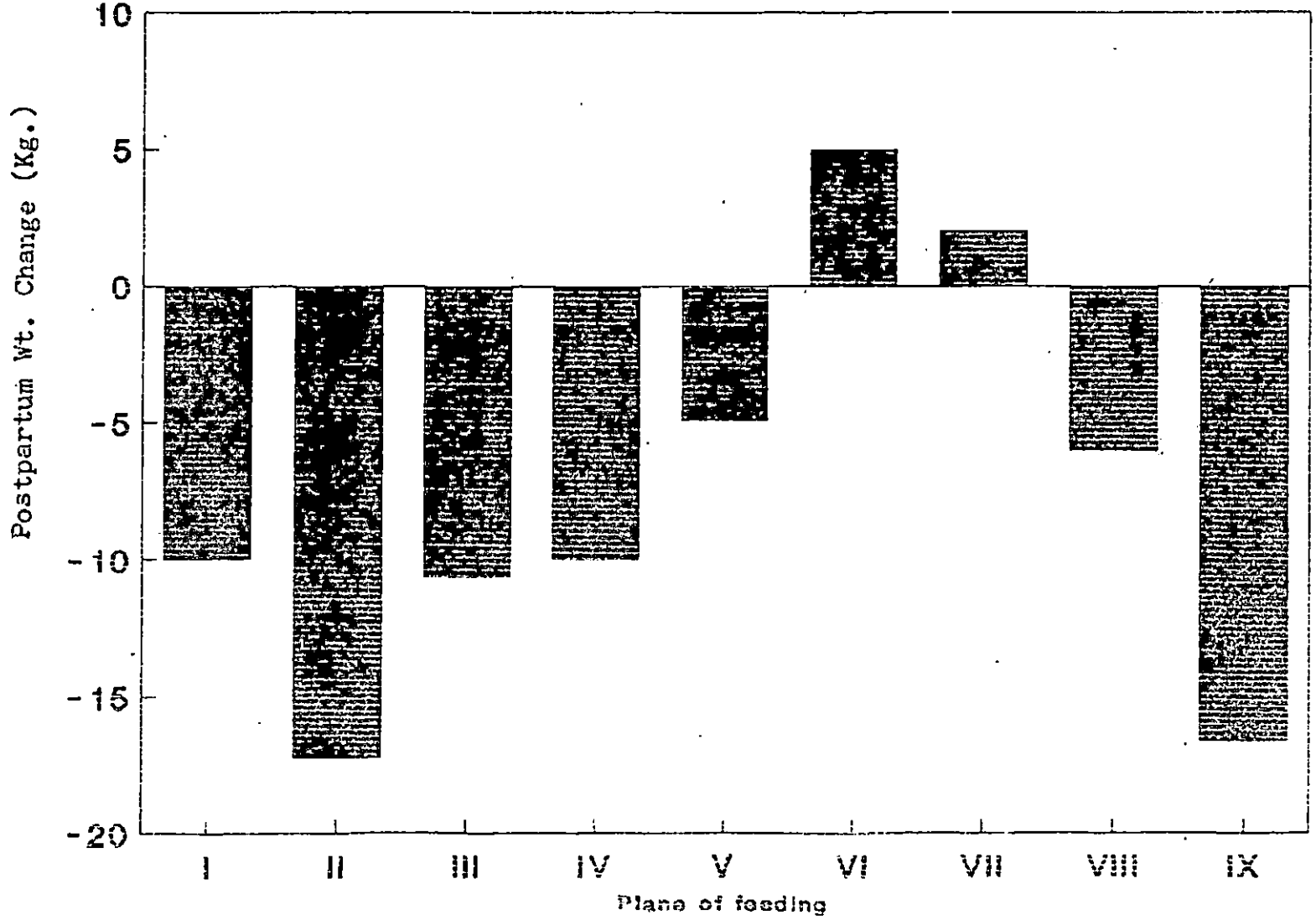


TABLE 4.5

MEAN AND SE OF LITTER SIZE AND LITTER WEIGHT [kg] OF PIGS AT WEANING

TREATMENT GROUPS	I NRC	II HP	III STAGE D->LP	IV STAGE C->LP	V STAGE B->LP	VI ** LP	VII STAGE D->HP	VIII STAGE C->HP	IX STAGE B->HP
LITTER SIZE * [NUMBERS]	ab 5.00± 0.58	a 7.00± 1.58	ac 4.75± 0.85	bcde 2.75± 1.38	df 1.00± 0.71	0	bcfg 2.75± 0.95	aeg 4.50± 0.50	a 7.50± 0.29
LITTER * WEIGHT [kg]	acbd 51.53± 1.58	ad 59.55± 10.60	c 41.30± 6.14	e 21.30± 9.01	e 16.85± 11.35	0	bce 34.33± 2.22	cb 40.28± 3.28	d 60.90± 2.86
Av.WEIGHT PER $ PIGLET [kg]	a 10.64± 0.98	ab 8.78± 0.54	ac 8.97± 1.08	d 5.79± 0.31	bcde 7.45± 1.95	0	aef 9.44± 0.28	af 9.21± 0.93	bcf 8.15± 0.47

FIGURES HAVING SAME SUPERSCRIPTION IN THE SAME ROW DO NOT DIFFER SIGNIFICANTLY.

* P<0.01,
$ P<0.05
** THERE WAS NO SURVIVING PIGLET AT WEANING

Fig. 4.4

THE PLANE OF FEEDING AND
LITTER SIZE AT WEANING

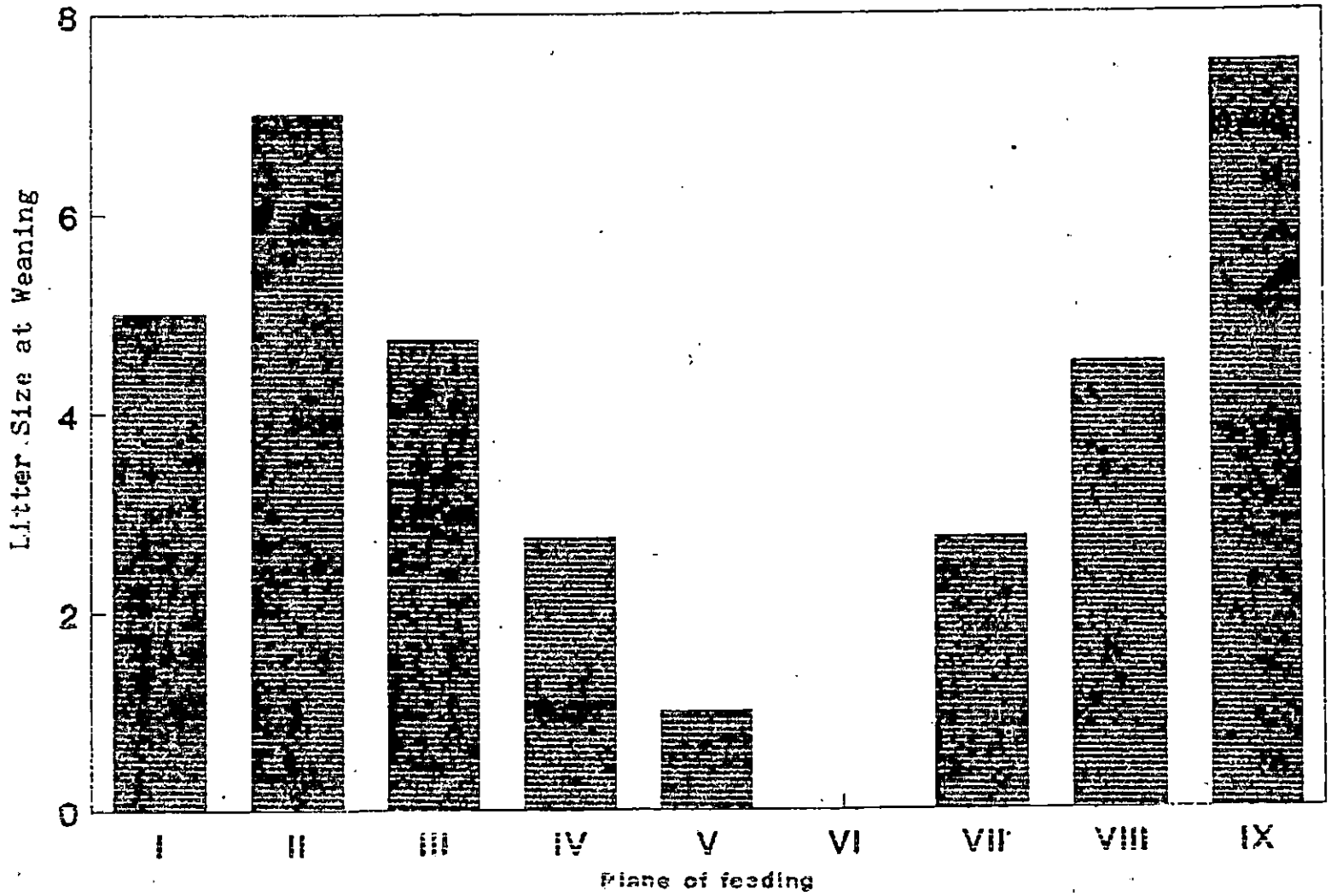


Fig. 4.5

THE PLANE OF FEEDING AND LITTER WEIGHT AT WEANING

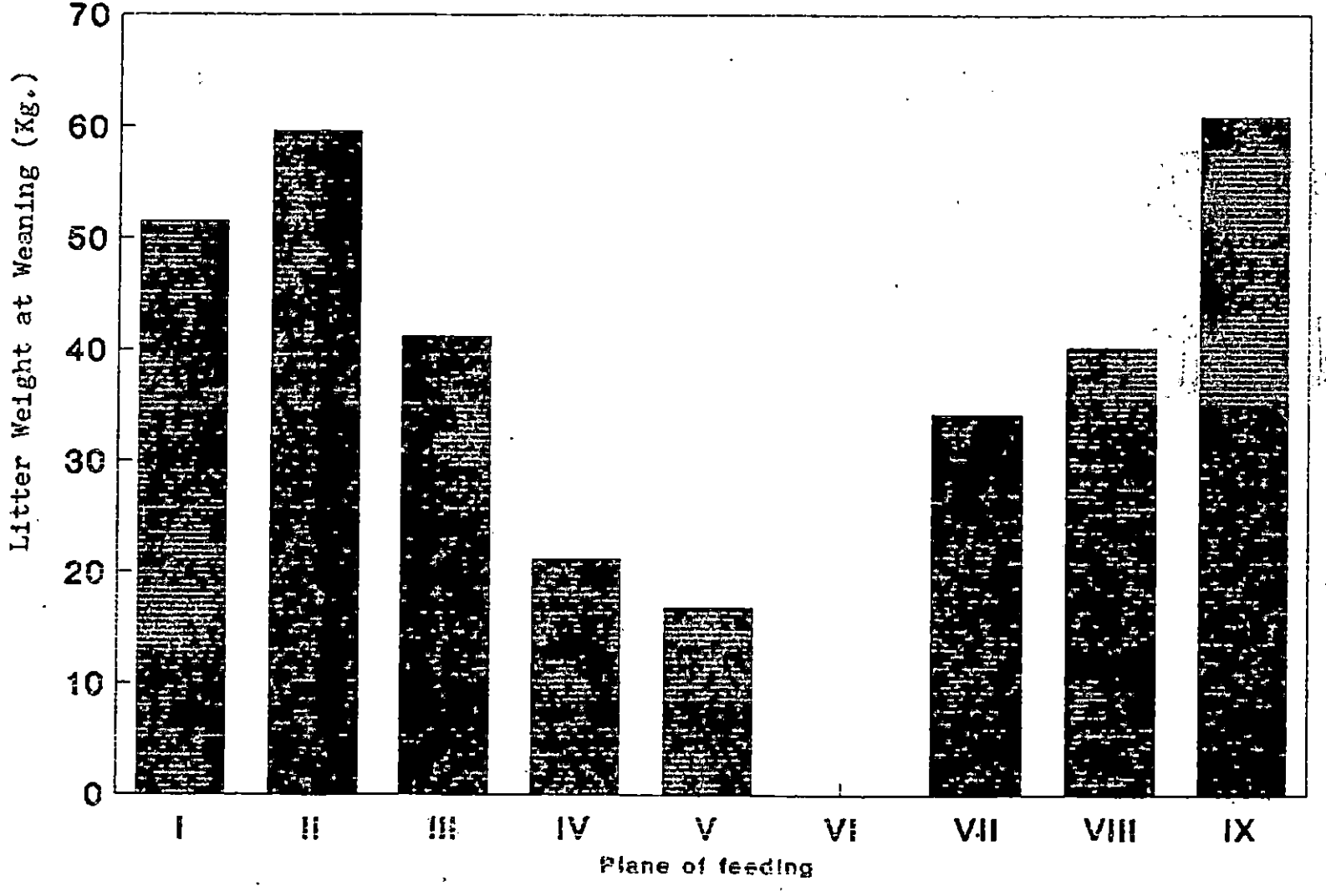


TABLE 4.6

MORTALITY OF PIGLINGS DURING POST-PARTUM STAGES [%]

TREATMENT GROUPS	I NRC	II HP	III STAGE D->LP	IV STAGE C->LP	V STAGE B->LP	VI LP	VII STAGE D->HP	VIII STAGE C->HP	IX STAGE B->HP
DURING FIRST HALF OF LACTATION [STAGE C]	13.04	27.90	10.34	45.45	68.75	33.33	33.33	4.55	6.06
	[5.75]	[8.75]	[8.75]	[8.75]	[4]	[4.08]	[4.08]	[4.08]	[8.25]
DURING SECOND HALF OF LACTATION [STAGE D]	0.00	6.98	24.14	21.22	6.25	66.67	14.29	13.63	3.03
TOTAL	13.04	34.88	34.48	66.67	75.00	100.00	47.62	18.18	9.09

FIGURES IN PARENTHESIS INDICATE LIVE LITTER SIZE AT BIRTH.

TABLE 4.7

MEAN AND SE OF NO. OF DAYS REQUIRED FOR POST-WEANING HEAT AND PERCENTAGE CONCEPTION WITHIN 56 DAYS AFTER WEANING.

TREATMENT GROUPS	I NRC	II HP	III STAGE D->LP	IV STAGE C->LP	V STAGE B->LP	VI LP	VII STAGE D->HP	VIII STAGE C->HP	IX STAGE B->HP
NO OF DAYS TAKEN FOR POST-WEANING HEAT	a 3.75± 0.48	a 3.00± 0.71	a 4.50± 0.65	a 5.00± 1.08	b 16.50± 8.11	b 18.00± 5.76	a 3.75± 0.48	a 4.25± 0.63	a 3.50± 0.65
PERCENTAGE CONCEPTION DURING THE POST-WEANI HEAT	75	0	75	75	50	75	50	25	100

* SIGNIFICANT AT 5% LEVEL;

FIGURES HAVING SAME SUPERSCRIPTION DO NOT DIFFER SIGNIFICANTLY.

TABLE 4.8

MEAN AND SE OF FEED INTAKE [kg] DURING PREPARTUM AND POST-PARTUM PERIOD AND FEED CONSUMPTION TIME [mts]

TREATMENT GROUPS	I NRC	II HP	III STAGE D->LP	IV STAGE C->LP	V STAGE B->LP	VI LP	VII STAGE D->HP	VIII STAGE C->HP	IX STAGE B->HP
FEED CONSUMED [kg]	a 396.33± 18.92	a 354.18± 38.55	a 343.35± 6.68	a 350.38± 25.06	b 250.25± 18.39	b 283.10± 25.52	a 350.53± 19.40	a 365.30± 24.16	a 358.83± 16.62
DAILY CONSUMPTION PER PIG	a 3.50±0.16	a 3.12±0.32	a 3.03±0.05	a 3.10±0.23	b 2.23±0.15	b 2.53±0.22	a 3.10±0.17	a 3.22±0.20	a 3.18±0.13
TIME TAKEN FOR CONSUMPTION PER SESSION [mts]	a 19.8±1.52	a 24.8±3.57	a 27.5±2.03	a 29.0±2.45	a 21.7±2.30	a 22.7±2.56	a 27.6±4.52	a 30.6±1.89	a 29.9±3.02

FIGURES HAVING SAME SUPERSCRIPTION DO NOT VARY SIGNIFICANTLY

TABLE 4.9

MEAN AND SE OF BEHAVIOURAL SCORES AND COMPOSITE INDICES OF THE SOWS DURING THE PRE-PARTUM AND POST-PARTUM PERIOD

BEHAVIOUR	MAXIMUM SCORE	I NRC	II HP	III STAGE D->LP	IV STAGE C->LP	V STAGE B->LP	VI LP	VII STAGE D->HP	VIII STAGE C->HP	IX STAGE B->H
FEEDING	3	a 1.96± 0.01	a 2.07± 0.11	a 2.1± 0.14	a 2.09± 0.12	a 1.72± 0.09	a 1.88± 0.06	a 1.99± 0.07	a 2.04± 0.09	a 1.90± 0.06
PARTURIENT & SUCKLING	10	a 8.25± 2.14	a 7.25± 1.60	ac 7.00± 1.47	bc 4.75± 0.48	bc 4.75± 0.48	b 2.75± 0.48	a 6.75± 0.95	a 6.75± 0.85	a 9.50± 0.29
POST-WEANING OESTRUS	5	a 1.75± 0.48	e 1.25± 0.25	bd 3.50± 0.29	cd 3.00± 0.41	ad 2.75± 0.63	bd 3.75± 0.75	b 3.50± 0.75	b 4.50± 0.50	b 4.00± 0.41
COMPOSITE SOW INDEX	11.4	3.4± 0.9	5.1± 1.2	4.1± 0.5	3.9± 0.7	1.5± 0.8	1.8± 0.7	1.9± 0.3	2.40± 1.3	5.5± 0.5

FIGURES HAVING SAME SUPERSCRIPTION DO NOT VARY SIGNIFICANTLY

TABLE 4.10
CORRELATION COEFFICIENTS

TRAITS	LITTER SIZE AT WEANING	LITTER WEIGHT AT WEANING	WEIGHT AT 56 DAYS OF GESTATION	LIVE LITTER SIZE AT BIRTH	LIVE LITTER WEIGHT AT BIRTH	WEIGHT LOSS DURING LACTATION	AGE AT FIRST FARROWING	DAYS FOR POST WEANING OESTRUS	PRE-PARTUM WEIGHT GAIN	PARTURIENT & SUCKLING BEHAVIOUR SCORE
		**		**	**	**				**
LITTER SIZE AT WEANING	1.0000	0.9008	0.2357	0.5372	0.4863	-0.6349	-0.1081	0.0027	0.1651	0.6718
				*		**				**
LITTER WT AT WEANING		1.0000	0.3152	0.3863	0.3519	-0.5354	0.0330	0.1227	0.0894	0.7023
						**				
WT AT 56 DAYS OF GESTATION			1.0000	0.2245	0.1382	-0.5084	0.1800	0.0752	-0.1464	0.1594
					**	**			**	
LIVE LITTER SIZE AT BIRTH				1.0000	0.9033	-0.5819	0.1247	0.0069	0.5990	0.0018
						**			**	
LIVE LITTER WT AT BIRTH					1.0000	-0.5243	0.0071	0.0168	0.6170	-0.0233
WT LOSS DURING LACTATION						1.0000	0.1065	0.0896	-0.2973	-0.3314
AGE AT FIRST FARROWING							1.0000	0.2802	-0.0113	-0.2115
DAYS FOR POST-WEANING OESTRUS								1.0000	-0.2123	-0.1133
PRE-PARTUM WT GAIN									1.0000	-0.2010
PARTURIENT & SUCKLING BEHAVIOUR SCORE										1.0000
		**								
FEED CONSUMPTION OF DAM		0.6720				-0.1259				

** - P<0.01

TABLE 4.11

COST OF WEANED PIGLETS AND PER kg BODY WEIGHT IN TREATMENTS I TO IX

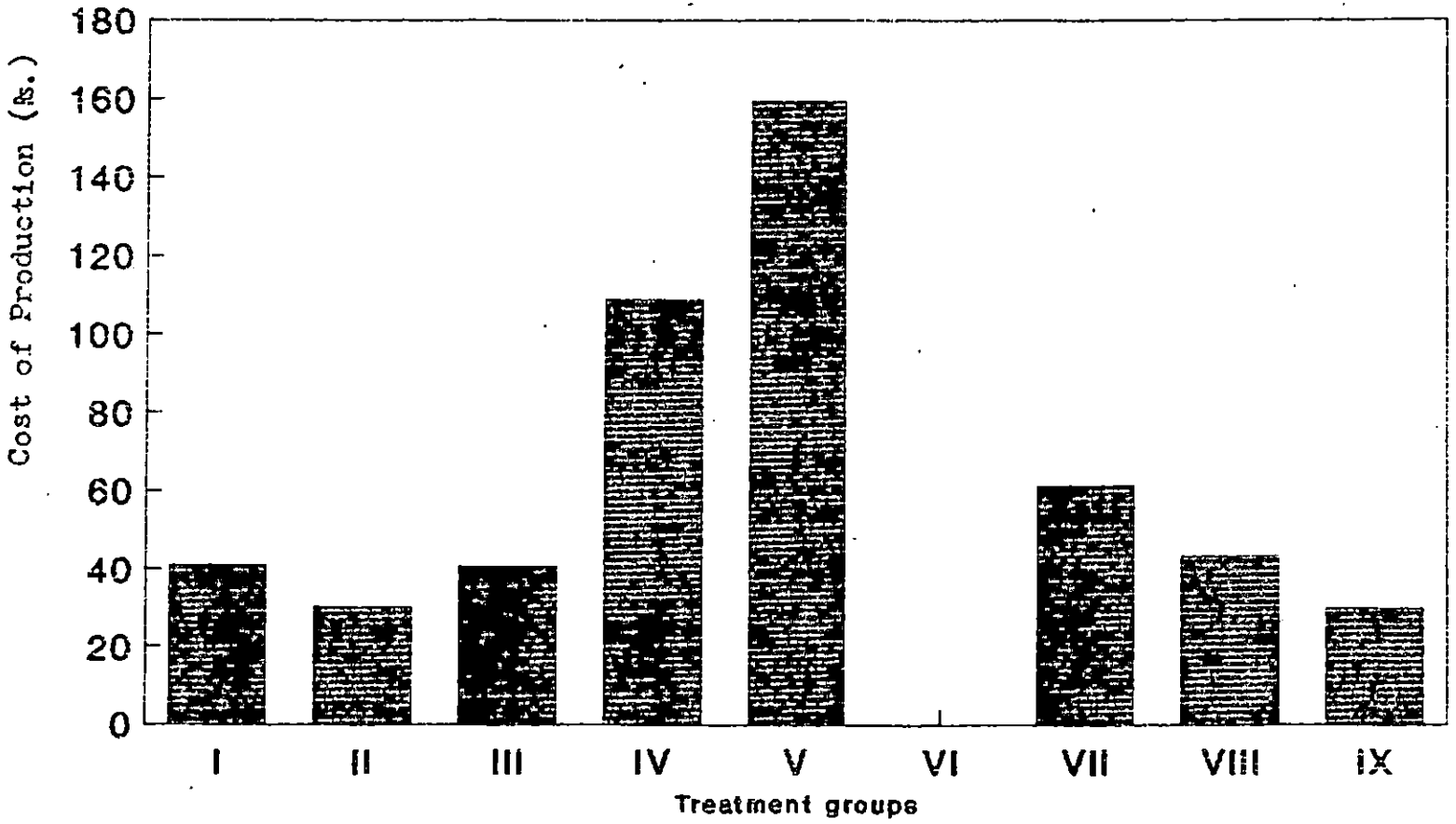
FEED CONSUMED PER SOW & LITTER	TREATMENTS I	II	III	IV	V	VI	VII	VIII	IX
STAGE A	90.75	77.38	65.63	74.15	59.00	63.83	77.10	74.85	66.80
STAGE B	100.90	82.13	73.18	92.33	68.23	73.30	75.85	87.43	86.55
STAGE C	96.60	89.03	89.60	79.45	57.70	78.93	86.75	83.95	90.63
STAGE D	108.08	105.65	114.45	104.45	65.33	67.05	110.83	119.08	114.85
TOTAL COST OF FEED [Rs.]	1632.75	1404.38	1303.53	1300.03	890.47	965.58	1196.20	1346.01	1379.86
COST OF PRODUCTION [Rs.]	2177.00	1872.51	1738.04	1733.37	1187.29	1287.44	1594.93	1794.68	1839.81
LITTER SIZE AT WEANING	5.00	7.00	4.75	2.75	1.00	0 *	2.75	4.50	7.50
COST PER PIGLET [Rs.]	435.40	267.50	365.90	630.32	1187.29		579.97	398.82	245.31
AV. WT. AT WEANING [kg]	10.64	8.78	8.97	5.79	7.45	0.00	9.44	9.21	8.15
COST/kg PIGLET [Rs.] $	40.92	30.47	40.79	108.86	159.37		61.43	43.30	30.10

* THERE WERE NO SURVIVING PIGLETS AT WEANING

$ EXCLUSIVE OF THE COST DUE TO MAINTENANCE OF BOAR

Fig. 4.6

COST OF PRODUCTION PER KG.BODY WEIGHT OF WEANED PIGLET



Discussion

5 DISCUSSION

The results of the experiment are discussed here under.

5.1. Body Weight Of Dam- Stage A.

It can be seen from Table 4.1 that there was a significantly higher ($P<0.01$) gain in body weight in pigs maintained on HP (17.19kg) and NRC recommended levels (15.65kg), respectively while the gain was only 9.06kg in pigs on low plane of nutrition. The average daily gains in the above treatments were 559 ± 60, 615 ± 40 and 324 ± 30g. respectively. The percentage increase in weight gain over the initial weight at 56 days of gestation, significantly differed in all the three groups. These observations are in accordance with that obtained by Wahlstrom & Libal (1977), Hartog and Den (1984), but are at variance with that of Michel and Easter (1985).

A positive correlation ($P<0.01$) is being observed (Table 4.10) in regard to the body weight gain and live litter size and litter weight which is suggestive of the ability to the dam to accommodate healthy fetuses in her uterus. It reveals the importance of plane of feeding during pre-partum period lending support to studies carried out by Hammel *et al.* (1976) in this regard.

5.2. Litter Size At Birth.

The total litter size at birth did not differ significantly between treatments(Table 4.2) as reported by Ripple *et al.*

(1965), Annoymous (1978) and Hammel (1974). It appears that total litter size is determined mostly by heredity and less influenced by environment and nutrition.

The significant difference ($P<0.01$) in live litter size between treatments II, III, IV (HP) and VI, VII, VIII (LP) and also I (NRC) and VI, VII, VIII (LP) reveals the critical nature of plane of feeding during last quarter of gestation, which is in line with findings of Holness (1969) and Mahan (1979).

Treatment IX (LP--->HP) was found more effective than treatment I, and treatment V (HP---->LP) being drastically deleterious.(Fig.4.2) disclosing the increased demand of nutrients during last 28 days of gestation (Mayrose et al. 1966) This is more clearly indicated by the highest percentage of still births in group V, where most of the fetal death occurred during later stages of gestation as denoted by its birth weight (Table 4.3).

The very high percentage of still birth noticed in treatments VI, TO VIII indicate the inadequacy of the low plane of feeding during stages A & B. This observation is in agreement with that of Holness & Smith (1974) and Kirchgessner and Muller (1987).

5.3. Litter Weight At Birth.

It can be seen from Table 4.3 that the apparent variation in total weight of litter was not significant when the plane of feeding was either as per NRC standard (Gr. I) or 10% lower than

that (Gr. VI, VII and VIII). A significantly higher ($P<0.01$) litter weight was noticed in pigs which were maintained (Gr. II, III, IV) or shifted to high plane of feeding prior to farrowing (Gr. IX), suggesting that the plane of feeding of gilts during gestation may have influence on the litter weight. This observation is in conformity with those reported by O'Grady (1962), Young et al. (1976), Clarence et al. (1976).

The live litter weight at birth seems to have a positive correlation with litter size ($P<0.01$) and weight ($P<0.05$) at weaning Table 4.10.

The average birth weight of live piglings did not differ significantly between treatments, an observation, which is in line with that of Ripple et al.(1965), Livingstone et al.(1966) and Forbish(1970) but disagreeing with that of Elsley et al. (1969) Hammell(1974), Young et al.(1976) and Hovell and Macpherson (1977). It was also noticed that the average birth weight of piglets born dead was lower when compared to their live contemporaries, especially in treatments I, II, III, and IV(NRC & HP), and this finding is in full accordance with that of Holness and Smith(1974). It indicates that the chances for becoming still birth is more for piglets with low birth weight and hence the dam should be on adequate plane of nutrition in order to give birth to piglings with optimum birth weight. It is also important with regard to the survivability of piglings, as the piglings with low birth weight have less survivability when compared with those having more birth weight(Clarence et al. 1976).

5.4. Post-partum Body Weight Of Dam- Stage D.

It can be seen from Table 4.4 that there was loss in body weight of dam in all the treatments irrespective of plane of feeding except in treatments VI having no surviving piglet and VII which had an extremely poor litter.

The average daily loss and total loss in body weight during stage D was significantly higher ($P<0.01$) in groups I, II, III, IV & IX and lesser in V & VIII, while the sows in groups VI & VII had gain in body weight obviously because there was no surviving piglets in group VI and extremely poor litter in group VII, to produce lactational strain. These observations are in accordance with the reports of Colin (1980), Armstrong et al. (1986). These findings indicate that the physiological function of the sow to produce milk to meet the demands of the piglets has been aggravated by the litter size and there is limitation of the gut in regard to feed intake. The highest negative weight change ($-15.35\pm4.99\%$) with respect to body weight at 28 days of post-partum in treatment group II indicates the insufficiency of high plane of feeding for sows with heavy litter size at birth. This observation is in agreement with that of Colin (1980).

5.5. Litter Size At Weaning.

It can be seen from Table 4.5 that the litter size at weaning of treatment groups I, II, III, & IX was significantly higher ($P<0.01$) than group V. The smaller litter size in

treatment groups IV, V, VI, VII & VIII reveals the inadequacy of low plane of feeding during gestation and lactation. These observations lend support to the findings of Frobish et al. (1966), Frobish (1970), Holness & Smith (1974) but are at variance with the findings of O'Grady (1962), Holden et al. (1968) and Frobish & Steele (1973).

The litter size at weaning may be considered as the product of interaction between the litter size at birth, survivability / mortality of piglings and milk production of the dam. Hence the plane of feeding of dam appear to have direct relation to litter size at weaning Fig. 4.4. Although, the highest litter size at birth was in treatment group II (Table 4.2), a non-significantly higher litter size at weaning was noticed in treatment group IX due to the increased survivability of piglings. This may be due to the fact that exposure of animals to low plane of feeding during stage A might have improved the feed consumption capacity which is evidenced by a high feed intake and there by compensating the lactational strain. This finding is in accordance with that of Mayrose et al. (1966).

The significant correlation ($P<0.01$) of litter size at weaning with live litter size at birth (0.54), weight loss during lactation (-0.63), and parturient and suckling behaviour score (0.67) Table 4.10 calls for an approach in the selection of animals based on criteria such as good litter size at birth, the presence of efficient compensatory mechanism to alleviate lactational stress by increasing the feed consumption and the

behaviour of the animal during the suckling period.

5.6. Litter Weight At Weaning.

The litter weights at weaning of treatment groups I, II, & IX were significantly higher ($P<0.01$) than that of IV, V, & VI, while the other groups III, VII, & VIII were in between (Table 4.5). The lesser litter weight in groups IV, V, & VI compared to I, II, & IX clearly indicate the adverse effect of low plane of feeding during pre-partum and post-partum stages of gilts supporting the findings of O'Grady (1962), Holness (1973), Mohan (1979), Ivanovski (1983), Reese et al. (1982) and Nelssen (1984), but at variance with that of Sljivovacki et al., (1969), Frobish (1970) and Lezhnina (1971).

Litter weight at weaning is a direct function of litter size and weight at birth contributed by the mothering ability and plane of feeding of the dam. Although the pigs on high plane of feeding (group II) had the highest litter size and weight at birth the group IX had a non-significantly higher litter weight at weaning, which according to Mayrose et al. (1966) might be due to the beneficial effect of interaction of plane of feeding and the relatively higher feed consumption of the animal to compensate inefficiency of the feed during the initial stages of gestation.

It may be noticed that the average weaning weight of piglets (Table 4.5) did not differ significantly between treatment groups I, II, III, VII, VIII, and IX inspite of the shift in the plane

of feeding at different stages. This observation is in conformity with the findings of Sljivovacki et al., (1969), Frobish (1970) and Lezhnina (1971). The poor weaning weight of piglings in treatment groups IV & V inspite of the smaller litter size is further indicative of the deleterious effect of continuous low plane feeding of gilts during stages B, C and D.

5.7. Mortality Of Piglings.

The percentage mortality of piglings in treatment IX was found to be least (9.09%) followed by I, VIII, III, II, VII, IV, V and the highest in group VI (100%) Table 4.6. Much of the piglets died during the neonatal or early post-natal stages. While there was no mortality of piglets during the later stages of lactation in group I, the maximum casualty was observed in group VI. These findings bring to light the relationship between plane of feeding of dam and survivability of piglings and also the total inadequacy of low plane feeding for pregnant and lactating animals with respect to survivability of piglings and it is in agreement with the observations made by Hammell et al., (1976), Young et al. (1976), and Walker et al. (1982) but in variance with that of Haines et al. (1958), Ripple et al. (1965), Heap et al. (1967), Annonymous (1978) and Wales-Worth et al., (1978).

Analysis of stage C and Stage D mortality of piglings reveals that the death of piglings occurs concurrent with the low plane of feeding during lactation and also as an immediate carry-over effect of pre-partum plane of feeding. It explains the view

that the pre-partum feeding plane not only affect the fetal life, but also influences the coming lactation and survivability of young ones during neonatal life. An animal deprived of nutrients during gestation might have utilised almost all of the body reserves for fetal development and little left for lactation there by causing severe reduction in milk secretion, leading to heavy mortality of young ones by starvation. These views are being supported by the reports of Young et al. (1976) and Walker et al. (1982).

5.8. Post Weaning Oestrus And Conception

The number of days required for onset of post-weaning heat did not differ significantly between treatment groups I to IV and VII to IX (Table 4.7). A significantly higher ($P<0.05$) number of days required for post-weaning oestrus noticed in groups V and VI, might be due to the fact that most of the pigs in these groups (75% in group V and 100% in group VI) have lost their piglings in the early post-partum stage, which reduced lactational stress and provided adequate post-weaning interval. These observations with regard to the relatively low influence of plane of feeding on the oestrus interval during post-weaning stage, is in agreement with observations reported by O'Grady (1962), Brooks & Cole (1973), Nicolaiewsky et al. (1976), Varley and Cole (1976), Greenhalgh et al. (1977) and (1980) and disagree with the reports of Bellis (1968), King and Willams (1981), Reese (1983), and Willams and King (1983).

19.8 to 30,6 mts. which are not significant between treatments. However, the average quantity of feed consumed per day in treatments V & VI was significantly ($P<0.01$) poor which may be due to the higher volume of the feed per unit weight and limitation of the stomach of the animal to accommodate any further quantity of feed. This observation is in agreement with the reports of Colin (1980).

5.10. Behaviour

5.10.1. Feeding Behaviour

The feeding behaviour score of pigs (Table 4.9) which is a measure of manifestation of appetite in feeding, did not show any significant difference between treatment groups. But there is a tendency for the pigs in high plane fed groups to have higher score when compared to NRC (group I) and low plane fed groups (treatments V & VI).

5.10.2. Parturient And Suckling Behaviour.

The parturient and suckling behaviour score (Table 4.9) was significantly higher ($P<0.01$)in treatment groups I, II, VII. VIII and IX- the groups which had higher litter size and weight at weaning when compared to other groups- and it lends support to the reports of Rheingolds (1963) who has stressed the importance of maternal behaviour in the survivability of piglets. A positive correlation ($P<0.01$) was also noticed between parturient and suckling behaviour score and litter size and weight at weaning (Table 4.10). Pigs on low plane groups scored a significantly

The extreme variation in conception rate 0 to 100% in treatments II and IX respectively may be due to the result of varying degree of interaction between plane of feeding and its shifting at different stages, the litter size and weight and the feed consuming capacity /gut capacity of the animal. This finding with respect to post-weaning conception of sows is in line with that of Lodge (1969), Svajur et al. (1972), Hines et al. (1976), Huges et al. (1984), Kirkwood et al. (1986, 87, 90), but in variance with that of Reese et al. (1982), Rowlinson and Bryant (1982). Although the animals in treatment group II showed signs of heat within three days after weaning they could not be bred due to paralysis of hind quarters. Pigs in group IX which were exposed to a low plane of feeding during stage A, have conceived within 56 days of weaning. This may be due to the beneficial effects of shifting of plane of feeding from stage A to B, as reported by Bellis (1968) and Lodge (1969).

5.9. Feed Consumption Of Sow And Litter.

From table 4.8 it can be seen that the total and daily feed consumption did not vary significantly between groups I to IV and VII to IX while a highly significant ($P<0.01$) decreased consumption is noticed in treatments V & VI. It indicates that commensurate with the improvement in plane of feeding the feed consumption increases which lends support to the observation of Omtvedt (1966) and Young et al. (1990).

It may be noticed that the time taken to consume and voluntary fill of the stomach per session of feeding varied from

(P<0.01) poor rate, which suggest that the expression of behavioural patterns favourable for the better survivability of the young ones are , to a certain extent related to the nutritional status of the animal.

5.10.3. Post-weaning Oestrus Behaviour.

The oestrus behaviour scores of treatment groups VII, VIII & IX were significantly higher (P<0.01) than that of treatment groups I, II, IV & V (Table 4.9) which might be due to the beneficial effect of the forward condition of the animal with regard to the body weight Fig. 4.3. The score was significantly lower in group II than all other groups probably because all the pigs in that group suffered from paraplegia at about weaning.

5.11. Composite Sow Index.

It can be seen from Table 4.9 that the highest composite sow index was scored by treatment groups IX, closely followed by group Ii, and it was least in group V, while that of all other treatment groups was in between, indicating that the mothering ability of sow is beneficially influenced by a switch over to high plane of feeding from 84 days of gestation till weaning.

ECONOMICS OF PIGLET PRODUCTION

It can be seen from Table 4.11 that the cost of feed consumed per sow and litter in all the treatments was highest in group I (Rs. 1632.75) and least in group V (Rs. 890.47). Presuming that the cost of feed represents 75% of total cost of production (Krider and Carrol, 1971) the cost of maintenance of a sow with its litter, was highest in group I (Rs. 2177) and least

in group V (1187.29) and the cost per piglet weaned was highest in group V (Rs. 1187.29), least in group IX (Rs. 245.31); while the same for treatment groups II, III, VIII, VII and VI were in between. The least cost of production per kg body weight was noticed in group IX (Rs. 30.10) closely followed by group II (Rs. 30.47) and highest in group V (Rs. 159.37), Fig. 4.6 where the litter size and average weight at weaning were low when compared to other groups.

These observations indicate that a low plane of feeding during gestation and lactation was not conducive to the sow and litter and it reduces the economic efficiency with regard to litter out put. However, a switch over to high plane of feeding from 84 days of gestation till weaning seems to be most efficient with respect to litter out put and economy.

Summary

6 SUMMARY

An experiment was conducted to assess the effect of plane of feeding during pre-partum and lactating stages on mothering ability and subsequent conception in sows, and to recommend an optimum time for switch over of plane of feeding during this period so to increase the net return per litter produced.

Thirty six pregnant gilts were randomly assigned to nine treatment groups and maintained on NRC recommended levels, a higher and lower planes of feeding with respect to CP and DE, althrough four equally divided stages A, B, C &D from 56 days of gestation to 56 days of farrowing. The pigs in either planes of feeding were shifted sequentially to the other planes at the four stages constituting four treatment groups in high and low planes respectively, while pigs on NRC recommended levels of feeding were treated as control. At the end of stage "D" all the sows were weaned and observed for post-weaning conception within 56 days of weaning.

The body weight of dam at beginning and end of stage A and D, litter size and weight at birth and weaning, feed consumption of sow and litter, number of days required for onset of post-weaning oestrus, conception rate within 56 days post-weaning, were noted and the behaviour of the animal during feeding, suckling and oestrus were scored with reference to a ready-made scoring scale.

The statistical analysis of the above results gave the following inferences:

The body weight gain/loss in stages A & D were significantly different in different planes of feeding ie. more in HP and less in LP.

The total litter size at birth was independent of treatment effects, while live litter size was significantly higher in Hp and NRC when compared to Lp groups. The litter size and weight at weaning showed an almost clear and progressive beneficial effect of increasing the number of stages with HP feeding excepting in group IX where an exposure to Lp during stage A, have resulted in excellent litter out put. Post-weaning oestrus and conception did not give any projectable inference in connection with plane of feeding.

The behaviour of the animals during feeding and post-weaning oestrus did not reveal any significant difference with respect to plane of feeding. However, the parturient and suckling behaviour seem to be benefited by high plane of feeding as evidenced by high score values for the animals on HP of feeding.

The composite sow index which was designed as a tool to quantify the mothering ability of sows was found to be highly correlated with the litter out put of the animal.

From the above observations and inferences, it is concluded that pigs with larger litters require enhanced feeding regime with respect to plane of feeding, to reduce the extreme lactational stress and nutritional insufficiency. The provision

of a low plane of feeding during 56 to 84 days of gestation and then shifting to high plane of feeding seems to be economically beneficial, and efficient with respect to litter out put and post-weaning conception.

References

REFERENCES

Adam, J.L. (1973). Effect on sow and litter performance of pattern of feeding in gestation and of boar breed. Anim. Breed. Abstr. 42: 257

Algers, B. (1989). Vocal and tactile communication during suckling in pigs. Sveriges Lantbruksuniver-Sitet, Rapport, 25. Skara: S.L.V. (Cited by Fraser and Broom, 1990)

Anonymous. (1978). USA, NRC. 42 Committee on Swine Production. Effect of protein level during gestation and lactation on reproductive performance in Swine. J. Anim. Sci. 46(6): 1673-1684

Arbabian, M. (1970). Reproductive and digestibility Studies with gestating gilts and sows as affected by energy levels. Anim. Breed. Abstr. 40: 3425

Armstrong, J.D; Britt, J.H. and Kraeling, R.R. (1986). The effect of restriction of energy during lactation on body condition, energy metabolism, endocrine changes and reproductive performances in primiparous sows. J. Anim. Sci. 63(6): 1915-1925

Atherne, F.X; Christopherson, R.J; Thompson, J.R. and Hardin, R.T. (1976). Factors affecting the onset of puberty, post-weaning estrus and blood hormone levels of Lacombe gilts. J. Anim. Sci. 56(4): 681-692

Bellis, D.B. (1968). The influence of feeding level upon the reproduction performance of pregnant sows. Vet. Rec. 83: 600-601

Borisenko, A.E. (1974). Production of sows reared under

different nutritional and managemental conditions. Anim. Breed. Abstr. 43: 4675

Bourne, F.J. (1969). Studies on colostral and milk whey protein in the sow. 1. Transition of mammary secretion from colostrum to milk with natural suckling. Anim. Prod. 11: 337-343

Brooke, P.H. and Cole, D.J.A. (1975). The effect of feed pattern in lactation and fasting following weaning on reproductive phenomenon in the sow. Vet. Rec. 93(10): 276-280

Bromm, D.M. (1983). Cow-calf and sow-piglet behaviour in relation to colostrum ingestion. Ann. Rech. Vet. 14: 342-348. (Cited by Fraser and Broom, 1990)

Clarence. E.B; Ronald. V.D, and Virgil, W.C (1976). Swine Production, Prentice-Hall, INC; Englewood Cliffs, New Jersey. 4th ed. pp 102-176

Colin, T.W. (1980). Pig production The scientific and practical principles. Longman, London and New York. pp. 1-74

Cybuljko, V.D. (1957). The effect of level of nutrition on the generative function and fertility of Berkshire sows. Anim. Breed. Abstr. 57: 1984

Dammert. S. and Giessler. H. (1976). The effect of energy supply during pregnancy on the reproductive performance of sows fed a complete diet. Anim. Breed. Abstr. 45: 3348

Deakin, A. and Fraser, E.B. (1935). Fecundity and nursing capacity of large Yorkshire sows. Scientif. Agric. 15. 458-462. (Cited by Fraser and Bromm, 1990)

Duee, P.H. (1984). Influence of protein nutrition on

metabolism and reproduction in sows. Anim. Breed. Abstr. 53: 5117

Dyck, G.W. (1974). The effect of stage of pregnancy, mating at the first and second oestrus after weaning and level of feeding on fetal survival in sows. Can. J. Anim. Sci. 54(3): 277-285

Elliot, J.I. and Lodge, G.A. (1978). Severe feed restriction of the sow during pregnancy. Can. J. Anim. Sci. 58(1): 43-48

Elsley, F.W.H.; Mary Bannerman; Bathurst, E.V.J; Bracewell, A.G; Cunningham, J.M.M; Dodsworth, T.L; Dodds, P.A; Forbes, T.J and Laird, R. (1969). The effect of level of feed intake in pregnancy and in lactation upon the productivity of sows. Anim. Prod. 11: 225-34

Elsley, F.W.H. (1971). The effect of food intake in pregnancy upon sow productivity. Anim. Prod. 13: 257-270

Fraser, D. (1973). The nursing and suckling behaviour of pigs. 1. The importance of stimulation of the anterior teats. Br. Vet. J. 129, 324

Fraser, D. and Jones, R.M. (1975). The "teat order" of suckling pigs. 1. Relation to birth weight and subsequent growth. J. Agri. Sci. (Cambridge) 84, 387

Fraser, D. (1980). A review of the behavioural mechanism of milk ejection of the domestic pig. Appl. Anim. Ethol. 10, 301-317. (Cited by Fraser and Broom, 1990)

Fraser, A.F. and Broom, D.M. (1990). Farm Animal Behaviour and Welfare. English Language Book Society Bailliere Tindall. 3rd

ed pp. 208-235

Friend, D.W, Cunningham, H.m. and Nicholson, J.W.G (1962). The duration of farrowing in relation to reproductive performance of Yorkshire sows. Can. J. Comp. Med. Vet. Sci., 16: 127-130. (Cited by Fraser and Broom, 1990)

Frobish, L.T; Speer,V.C. and Hays, V.W.T. (1966). Effect of protein and energy intake on reproductive performance in swine. J. Anim. Sci. 25: 929-733

Frobish, L.T. (1970). Effect of energy intake on reproductive performance and estrous synchronisation of gilts. J. Anim. Sci. 31(3): 486-490

Frobish, L.T; Steele, N.C. and Davey, R.J. (1973). Long term effect of energy intake on reproductive performance of swine. J. Anim. Sci. 36(2): 293-297

Greenhalgh, J.F.D; Elsley, F.W.H; Grubb, D.A; Lightfoot, A.L; Saul, D.W; Smith, P; Walker, N; Williams, D. and Yeo, M.L. (1977). Co-ordinated trials on the protein requirement of sows 1. a comparison of four levels of diet protein in gestation and two in lactation. Anim. Prod. 24(3): 307-321

Greenhalgh, J.F.D; Baird, B; Grubb, D.A; Done, S; Lightfoot, A.L; Smith, P; Toplis, P; Walker, N; Williams, D. and Yeo, M.L. (1980). Co-ordinated trials on the protein requirements of sows. 2. A comparison of two levels of diet protein in gestation and four in lactation.Anim. Prod. 30(3): 395-406

Grudniewska, B; Kureman, B; Milewska, W. and Eljasiak,J. (1983). Different levels of sow feeding and the effects of their

reproductive utility in 1 and 2 subsequent reproductive cycles. Anim. Breed. Abstr. 52: 3455

Hafez, E.S.E. (1987). Reproduction in Farm Animals. Lea & Febiger, Pheladelphia, 5th ed. pp. 260 - 292

Haines, C.E; Warnick, A.C. and Wallace, H.D. (1958). The effect of exogenous progesterone and level of feeding on pre-natal survival in gilts. J. Anim. Sci. 17: 879-885

Haines, C.E; Warnick, A.C. and Wallace, H.D. (1959). The effect of two levels of energy intake on reproductive phenomenon in duroc Jersey gilts. J. Anim. Sci. 18: 347-354

Hammell, D .L. (1974). Effect of protein restriction on reproduction in gilts and performance and learning of their offspring. Anim. Breed. abstr. 42: 4953

Hammell, D.L; Kratzer, D.D; Cromwell, G.L. and Hays, V.W. (1976). Effect of protein malnutrition of the sow on reproductive performance and on postnatal learning and performance of the offspring. J. Anim. Sci. 43(3): 589-597

Hartog, L.A. and Den. (1984). The effect of energy intake during rearing on reproductive traits in gilts. Anim. Breed. Abstr. 53: 5899

Hartsock, T.G. and Graves, H.B. (1976). Neonatal behaviour and nutrition related mortality in domestic swine. J. Anim. Sci. 42: 235-241

Heap, F.C; Lodge, G.A. and Lanning, G.E. (1967). The influence of plane of nutrition in early pregnancy on the

survival and development of embryos in sows. J. Reprod. Fert. 13: 269-279

Hemsworth, P.H; Winfield, C.G. and Mullaney, P.G. (1976). A study of the development of the teat order in piglets. Appl. Anim. Ethol. 2, 225-233. (Cited by Fraser and Broom,1990).

Hines, R.H; Allee, G.L. and Koch, B.A. (1976). Restricting energy intake of gestating sows with 50% alfalfa meal ration. Anim. Breed. Abstr. 45: 3948

Hitchcock, J.P; Sherritt, G.W; Gobble, J.L. and Hazlett, V.E. (1971). Effect of lactation feeding level of the sow on performance and subsequent production. J. Anim. Sci. 33: 30-34

Holden, P.J; Lucas, E.W; Speer, V.C. and Hays, V.W. (1968). Effect of protein level during pregnancy and lactation on reproductive performance in swine. Anim. Breed. Abstr. 69; 2753

Holness, D.H. (1969). The effect of nutritional status on aspects of reproductive performance in the indigenous gilts. Anim. Breed. Abstr. 38: 2780

Holness, D.H. (1973). The effect of plane of nutrition on reproductive efficiency of the indigenous gilts. Anim. Breed. Abstr. 42: 1854

Holness, D.H. and Smith, A.J. (1974). Reproductive performance of the indigenous Rhodesian pig. 3. The influence of plane of nutrition of the sow on litter size, piglet birth mass and growth and survival of the piglet. Anim. Breed. Abstr. 42: 3834

Hovell, F.D; D[illegible] and Macpherson, R.M. (1977). Thin sows I.

Observations on the fecundity of sows when underfed for several parities. J. Agri. Sci. 89 (3): 513-522

Hughes, P.E; Henry, R.W. and Pickard, D.W. (1984). The effects of lactation feed level on subsequent ovulation rate and early embryonic survival in the sow. Anim. Breed. Abstr. 52: 3464

Ivanovski, R. (1983). The effect of nutritional level, breed and parity on reproduction of sows. Anim. Breed. Abstr. 52: 3467

Jasek, S. (1973). The effect of different levels of feeding on the productivity of sows and the results of rearing piglets weaned at different times. Anim. Breed. Abstr. 43: 4643.

Johnston, L.J. Orr, D.E. Jr; Tribble, L.F. and Clark. J.R. (1986). Effect of lactation and rebreeding phase energy intake on primiparous and multiparous sow performance. J. Anim. Sci. 63(3): 804-814

Jones, J.E.T. (1966a). Observations in parturition in the sow. The pre-partum phase. Br.Vet. J. 122, 420-426

Jones, J.E.T. (1966b). Observations on parturition in the sow. II The parturient and post parturient phases. Br. Vet. J. 122, 471-478

Jones, R.D. (1977). Influence of protein intake and stage of gestation on growth, reproductive performance, N_2 balance and tissue levels of proteins, DNA, RNA in gilts. Diss. Abstr. B 37(9): 4235

Kasser, T.R; Martin, R.J; Gahagan, J.H. and Wangsness, P.J. (1981). Fasting plasma hormones and metabolites in fetal and

newborn pigs. J. Anim. Sci. 53: 420-426

King, R.H. and Williams, I.H. (1981). Nutrition and reproductive performance of sows. Anim. Breed. Abstr. 50: 3927

Krichgessner, M. and Roth, F.X. (1977). Influence of nutritional level during pregnancy on live weight changes and reproductive performance of sows. Anim. Breed. Abstr. 45: 6129

Krichgessner, M. and Muller, R. (1987). Long term studies on the effect of level of energy supply during gestation on changes of body weight and reproductive performance in the sow. J. Vet. Med. 34(4): 289-295

Kirkwood, R.N; Lythgoe, E.S. and Atherne, F.X. (1986). The influence of lactation feed intake and GnRH therapy on the reproductive performance of sows. Anim. Breed. Abstr. 55: 3003

Kirkwood, R.N; Baidoo, S.K; Atherne, F.X. and Satherap. (1987). The influence of feeding level during lactation on the occurence and endocrinology of the post-weaning estrus in sows. Can. J. Anim. Sci. 67(2): 405-415

Kirkwood, R.N; Baidoo, S.K. and Atherne, F.X. (1990). The influence of feeding level during lactation and gestation on the endocrine status and reproductive performance of second parity sows. Can. J. Anim. Sci. 70(4): 1119-1126

Krider, J.L. and Carroll, W.E. (1971). Swine Production. McGraw-Hill Book Company. New York. 4th ed. pp. 251

Lewis, N.J. and Hurnik, J.F. (1985). The development of nursing behaviour in swine. Appl. Anim. Behav. Sci. 14: 225-232. (Cited by Fraser and Broom, 1990)

Lezhnina, L.I. (1971). The effect of energy and protein feeding on reproductive ability of pregnant sows. Anim. Breed. Abstr. 41: 3557

Libal, G.W. (1974). The effect of gestation ME on sow productivity and haematology. Anim. Breed. Abstr. 43: 3546

Livingstone, R.M; Macpherson, R.M; Elsley, F.W.H; Lucas, I.A.M. and Lodge, G.A. (1966). A note on the effect of protein concentration in the diet of pregnant sows on the performance and carcass quality of their progeny. Anim. Breed. Abstr. 66: 3149

Lodge, G.A. (1969). The effect of pattern of feed distribution during the reproductive cycle on the performance of sows. Anim. Prod. 11: 133-143

Mahan, D.C. (1979). Optimum sow protein needs for reproduction. Anim. Breed. Abstr. 48: 6234

McBride, G. (1963). The "teat order" and communication in young pigs. Anim. Behav. 11: 53-56. (Cited by Fraser and Broom, 1990)

Majerciak, P. (1973). Effect of restricted feeding of pregnant sows and of ad lib feeding of suckling sows compared with the effect of standard feeding on general performance. Anim. Breed. Abstr. 42: 1162

Mayrose, V.B; Speer, V.C. and Hays, V.W. (1966). Effect of feeding levels on the reproductive performance of swine. J. Anim. Sci. 25: 701-705

Michel, E.J. and Easter, R.A. (1985). Reproductive

performance of first and second parity sows fed daily or every third day. Livest. Prod. Sci. 13(2): 179-189

Mount, L.E. (1968). The climatic physiology of the pig. London, Arnold (Cited by Hafes, 1987)

Nelssen, J.L. (1984). Effects of source of energy and energy intake during lactation on reproductive performance and serum hormone concentration of sows following weaning. Anim. Breed. Abstr. 53: 4437

Nicolaiewsky, S; Leboute, E.M. and Umann, V. (1976). Effect of level of nutrition during the last 3rd of gestation and of suckling on reproductive performance of gilts. Anim. Breed. Abstr. 46: 3431

NRC. (1979). Cited by Maynard, L.A; Loosli, J.K; Hintz, H.F. and Warner, R.G. (1979).Animal Nutrition. Tata McGraw-Hill Publishing Company Ltd; New Delhi 7th ed. pp. 575

O'Grady, J.F.(1962). Effect of level and pattern of feeding on weight change and reproductive performance of sows. Anim. Breed. Abstr. 35:3868

Omtvedt, I.T. (1966). Reproductive performance of sows fed at two levels during gestation. Anim. Breed. Abstr. 35: 587

Papp, J; Wittmann, M. and Gundel, J. (1979). Effect of management and level of nutrition on reproductive performance and nursing ability of sows. Anim. Breed. Abstr. 48: 2026

Reese, D.E. (1983). Influence of energy intake during lactation on the interval from weaning to first estrus in sows. Anim. Breed. Abstr. 53: 1534

Reese, D.E; Moser, B.D; Peo, E.R. Jr; Lewis, A.J; Zimmerman, D.R; Kinder, J.E. and Stroup, W.W. (1982). Influence of energy intake during lactation on the interval from weaning to first

estrus in sows. J.Anim. Sci. 55(3): 590-598

Rheingold, H.L. (1963). Maternal Behaviour in Mammals. New York. Wiley*. (Cited by Fraser and Broom, 1990)

Ripple, R.H; Rasmussen, G.G; Jensen, A.H; Nortan, H.W. and Becker, D.E. (1965). Effect of level and source of protein on reproductive performance of swine. J.Anim. Sci. 24: 203-208

Rowlinson, P. and Bryant, M.J. (1982). Lactational oestrus in the sow. 2. The influence of group housing, boar presence and feeding level upon the occurence of oestrus in lactating sows. Anim. Prod. 34(3): 283-290

Scheel, D.E; Graver, H.B. and Sherritt, G.W. (1977). Nursing order, social dominance and growth in swine. J. Anim. Sci. 45: 219

Sljivovacki, K; Milic, N; Simovic, B. and Crnojacki, V. (1969). Effect of protein level in the ration on some performance characters and digestibility of food in sows. Anim. Breed. Abstr. 2230: 4009

Snedecor, G.W. and Cochran, W.G. (1967). Statistical Methods. The Iowa State University Press, Amer,USA. 6th ed.

Svajur, A.J; Hammel, D.L; Degecter, M.J; Hays, V.W; Cronwell, G.L. and Datt, R.H. (1972). Reproductive performance of sows on a protein restricted diet. J. Reprod. Fert. 30(3): 455-458

Tagani, S; Okano, W; Murakani, A. and Tonasaki, K. (1974). A survey of the relationship between reproductive performance and

nutrition in sows. Anim. Breed. Abstr. 45: 2425

Taylor, I.A; Widowski, T.M. and Cortis, S.E. (1986). Sows use toys with increasing intensity as farrowing approaches. J. Anim. Sci. 61, Suppl, 83-84

Varley, M.A. and Cole, D.J.A. (1976). Studies in sow reproduction. The effect of level of feeding in lactation and during the interval from weaning to remating on the subsequent reproductive performance of the early weaned sows. Anim. Prod. 22(1): 71-77

Vass, S. and Boldman, G. (1990). Preliminary results of reducing amount of protein in the ration of pregnant sows. Anim. Breed. Abstr. 59: 3482

Vinovrski, Z. (1969). Influence of different nutritional level on development and reproductive phenomenon in gilts. Anim. Breed. Abstr. 38: 2798

Wahlstrom, R.C. and Libal, G.W. (1977). Effect of dietary protein during growth and gestation on development and reproductive performance of gilts. J. Anim. Sci. 45(1): 94-99

Waldorf, D.P; Spig, H.G; Zimmerman, D.R; Self, H.L; Chapman, A.B. and Casida, L.E. (1958). The relationship of dam's feeding regime, breed and individuality to fetal development in swine. J.Anim. Sci. 17: 622-634

Walesworth, D.G; Cross, M.E. and Smith, K.L. (1978). The effect of protein on the reproductive performance of pigs for six parities. Anim. Breed. Abstr. 46: 5358

Walker, W.R; Maxwell, C; Hintz, R.L.and Brock. K. (1981). A

preliminary report on the effect of increased feed intake during late gestation. Anim. Breed. Abstr. 50: 3791

Walker, W.R; Maxwell, C.V; Hintz, R.L. and Brock, K. (1982). The effect of increased feed intake during late gestation on the reproductive performance of sows.Anim. Breed. Abstr. 51: 5075

Whittemore, C.T. and Fraser, D. (1974). The nursing and suckling behaviour of pigs. II Vocalisation of the sow in relation to suckling behaviour and milk ejection. Br.Vet.J. 130; 346-356

Williams, S.I and King, R. (1983). Nutritional manipulation of the post-partum interval in sows. Anim. Breed. Abstr. 52: 2694

Wittmann, M; Papp, J. and Gundel, J. (1978). Effect of accomodation and feeding level on the fertility and rearing performance in sows. Anim. Breed. Abstr. 48: 4111

Wittman, M; Gundel, J; Papp, J. and dregns,J. (1979). The effect of management and plane of nutrition on the performance of sows in large scale pig units. Anim. Breed. Abstr. 48: 2038

Young, L.G; Forshaw, R.D. and Smith, G.C. (1976). Protein supplementation of barley diets for two breeds of gestating swine over two parities. J. Anim. Sci. 42(5): 1182-1186

Young, L.G; King, G.J; Walton, J.S; MacMillan, I; Klevprick, M. and Shaw, J. (1990). Gestation energy and reproduction in sows over four parities. Can. J. Anim. Sci. 70(2): 493-506

EFFECT OF PLANE OF FEEDING DURING PRE-PARTUM AND LACTATING STAGES ON MOTHERING ABILITY AND SUBSEQUENT CONCEPTION IN SOWS

By

JOSEPH MATHEW

ABSTRACT OF A 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

1992

ABSTRACT

Thirty six pregnant gilts were randomly maintained on three different planes of feeding with respect to crude protein (CP) and digestible energy (DE) viz. (i) NRC recommended levels as control (ii) a high plane of 10% increase of CP with respect to NRC level and (iii) a low plane of 10% decrease of CP and DE with respect to NRC- at four stages A, B, C, and D which represented the periods 56- 83 days of gestation, 84 days to farrowing, farrowing to 28 days and 29 to 56 days post-partum respectively. Shifting of plane of feeding from low to high plane and vice versa while NRC level treated as control, resulted in nine treatment groups each having four experimental units. The body weight gain/ loss of the dam in stages A and D , live litter size and weight at birth, litter size and weight at weaning, parturient and suckling behaviour - expressed as a score- feed consumption of sow and the litter and the over all mothering ability of the sow expressed as composite sow index were beneficially influenced by a high plane of feeding when compared to NRC, while the low plane of feeding was significantly ($P<0.01$) poor with respect to almost all the above traits. However, the total litter size at birth, average birth weight of live piglets, feeding and post-weaning oestrus behaviour- expressed as scores- and conception rate were not significantly affected by plane of

feeding. Overall results suggested that a switch-over to high plane of feeding at 84 days of gestation till weaning is most efficient with respect to litter output, economy and post-weaning conception.