GENETIC EVALUATION OF LITTER TRAITS AND VIABILITY OF DESI PIGS

KOWSIGARAJ. P.

Thesis submitted in partial fulfilment of the requirement for the degree of

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University, Thrissur

2003

Department of Animal Breeding and Genetics
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR - 680651
KERALA, INDIA

DECLARATION

I hereby declare that this thesis entitled **"GENETIC EVALUATION OF LITTER TRAITS AND VIABILITY OF DESI 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.

Mannuthy
23.09.03

KOWSIGARAJ, P.

CERTIFICATE

Certified that this thesis entitled **"GENETIC EVALUATION OF LITTER TRAITS AND VIABILITY OF DESI PIGS"** is a record of research work done independently by **Shri. Kowsigaraj, P.,** 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. M.R. Rajan
(Chairman, Advisory committee)
Associate Professor and Head
Centre for Pig Production and Research
College of Veterinary and Animal Sciences
Mannuthy

Mannuthy
23-9-03

CERTIFICATE

We, the undersigned members of the Advisory Committee of **Shri. Kowsigaraj, P.,** a candidate for the degree of Master of Veterinary Science in Animal Breeding and Genetics, agree that the thesis entitled **"GENETIC EVALUATION OF LITTER TRAITS AND VIABILITY OF DESI PIGS"** may be submitted by Shri. Kowsigaraj, P., in partial fulfilment of the requirement for the degree.

23/9/03

Dr. M. R. Rajan
(Chairman, Advisory Committee)
Associate Professor and Head
Centre for Pig Production and research
College of Veterinary and Animal Sciences
Mannuthy

23/9/03

Dr. K.V. Raghunandanan

Associate Professor and Head
Department of Animal Breeding and Genetics
College of Veterinary and
Animal Sciences, Mannuthy
(Member)

23/09/03

Dr. P. Nandakumar

Associate Professor and Head
University Goat and Sheep Farm
College of Veterinary and
Animal Sciences, Mannuthy
(Member)

23.9.03

Dr. Joseph Mathew

Assistant Professor
Department of Livestock Production
and Management
College of Veterinary and
Animal Sciences, Mannuthy
(Member)

26/11.03

External Examiner
Dr. P. KANAKARAJ.

Professor
Dept. of Animal Breeding and Genetics
Madras Veterinary College

ACKNOWLEDGEMENTS

It is a matter of great privilege and good fortune to get an opportunity to work under the potential guidance of an affectionate, dynamic and versatile academician ***Dr. Rajan, M.R.****, Associate Professor and Head, Centre for Pig Production and Research and Chairman, Advisory Committee. I express my deep sense of gratitude and indebtedness to him for meticulous guidance, never-ending enthusiasm, valuable suggestions, constructive criticism, parentness, long suffering in the pursuit of this work and whole-hearted co-operation throughout the study.*

I am cordially obliged to ***Dr. K.V. Raghunandanan****, Associate Professor and Head, Department of Animal Breeding and Genetics,* ***Dr.P. Nandakumar****, Associate Professor and Head, University Goat and Sheep farm and* ***Dr. Joseph Mathew****, Assistant Professor, Department of Livestock Production and Management, Members of the Advisory Committee for their invaluable help, critical supervision and guidance and moral support throughout the study.*

I am sincerely thankful to ***Dr.K.C.Raghavan, Dr.K.Anil kumar, Dr.T.V.Aravindhakshan, Dr.A.P.Usha, Dr.StephenMathew, Dr.T.V.Raja, Dr.Bindu*** *and all the staff members of Department of Animal Breeding and Genetics for their valuable guidance, timely help and moral support.*

I am grateful to my colleagues ***Dr. Sajeev, Dr. Suprabha and Dr. Jeeva*** *who always made me feel better. I greatly acknowledge the co-operation and help rendered by my junior colleagues* ***Drs. Ajo, Preethi and Bindu.*** *I am extremely thankful to my senior colleague* ***Dr. Chitra*** *for her moral support.*

I wish to express my sincere gratitude to ***Dr. K. Shyama****, Assistant Professor,* ***Dr. Kuriakosh Allosh Peter****, Teaching Assistant, staff and labours of University Pig* *breeding farm for their timely help, moral support and whole hearted co-operation throughout the research work.*

I am short of words to express my deep sense of gratitude to my respected as well-wishers and friends ***Israel Thomas, Drs Antony, Sagalai, Rasu, Oors, Potti Kanth, Prass, Bala, Maman, Eraja, Sekar, Suresh, Vivek, Sakthi, Madhan, Hari, Fakky, Siva, Sanjeetha, Sethu, Pradeep, Sujith, Renjith*** *and my juniors* ***Drs.Irwin, Satha, Giri, Kalai and Arun*** *for their encouragement, timely help and moral support throughout the course of study.*

I wish to place on record my sincere thanks to ***Dean,*** *College of Veterinary and Animal Sciences, Mannuthy for facilities provided and* ***Kerala Agricultural University*** *for granting Junior Research Fellowship for this study.*

I am thankful to my all time buddies ***Sams, Mama, Rajee, Pandy, Mnky, Kotti Saro and AKK***

I owe my sincere thanks to ***Mr. O.K. Ravindran,*** *M/s Peagles, Mannuthy for his great care and co-operation in the preparation of this thesis.*

I owe my special thanks to my ***parents and brothers*** *for their encouragement, help, prayer and moral support.*

Last but not least, I bow my head before ***The GOD*** *for the blessings showered on me.*

Kowsigaraj P.

CONTENTS

Chapter	Title	Page No.
1	INTRODUCTION	1
2	REVIEW OF LITERATURE	3
3	MATERIALS AND METHODS	21
4	RESULTS	32
5	DISCUSSION	46
6	SUMMARY	55
	REFERENCES	57
	ABSTRACT	

LIST OF TABLES

Table No.	Title	Page No.
1	Optical density values for standard gammaglobulin concentration	26
2	Mean, standard error and co-efficient of variation for litter traits	33
3	Least square analysis of variance for the effect of sex, sire and litter size at birth on birth weight.	33
4	Least squares means and standard error for the factors affecting average birth weight	34
5	Least square analysis of variance for the effect of sex, sire, birth weight and litter size at weaning on weaning weight	36
6	Least square means and standard error for the factors affecting average weaning weight	37
7	Mean, standard error and coefficient of variation for pre-weaning mortality	39
8	Mortality percentage with respect to birth weight (kg)	39
9	Causes for mortality based on post mortem findings	39
10	Mean and standard error for average monthly body weight (kg)	40
11	Mean and standard error for monthly average daily gain (g)	40
12	Mean and standard error for monthly body measurements (cm)	41
13	Body weight, total surface area and surface area/kg body weight in Desi and Large White Yorkshire pigs.	41
14	Least squares analysis of variance for the effect of sex, sire, birth weight, litter size at weaning, weaning weight and incidence of disease on serum gammaglobulin level.	44
15	Least square means and standard error for the factors affecting serum gammaglobulin level (mg/ml)	45

LIST OF PLATES

Plate No.	Title	Between pages.
1	Division of body of pig into different geometrical figures	23-24
2	Desi pigs	23-24

Introduction

1. INTRODUCTION

India has a vast potential in terms of genetic resources of domestic animals. Among domestic animals pigs are important and versatile animals with unique biological peculiarities. The biological advantages of pigs over other domestic animals are high prolificacy, short generation interval, high growth rate and its efficiency to convert feed and other waste products not useful to human consumption into meat.

Pigs belong to the Genus – *Sus Linn,* Order – *Artiodactyla,* Suborder – *Suiformis* and Family – *Suidae.*

The majority of pig population in India comprises of the indigenous pigs which are gradually domesticated wild pigs. The indigenous pigs belonging to different regions in India are morphologically different owing to the geographical and climatic conditions prevailing in their home tract.

The indigenous pigs of Kerala called as Desi or Angamally pigs are black in colour with a tapering face and heavily built head and shoulders. Their body is covered with thick hair and has a characteristic drooping abdomen which almost touches the floor in a pregnant sow. The tail of Desi pigs nearly reaches the hock with a tuft of hair.

The Desi pigs are rich in genetic variability and are endowed with many positive aspects like disease resistance, tolerance to high heat and humidity. These animals are evolved in and adapted to local climatic conditions and generally have good mothering ability which reflects on the litter traits. Moreover, Desi pigs are hardy, as they perform robustly in adverse climatic and managemental conditions.

Success of breeding depends on high survival rate and pre-weaning traits. Litter traits such as birth weight, litter size at birth and weaning and pre-weaning mortality influence the survivability and growth traits. Hence these traits are generally considered as fitness traits which contribute to the proliferation and procreation of its species. Apart from these, the body weight of an individual at various ages gives an indication of growth rate. The growth has definite economic importance as well as genetic significance, because it reflects the overall interaction of genotype with the environmental factors under which it is expressed.

Regarding the above said factors, the information on Desi pigs of Kerala is quite scanty. The present study was thus undertaken with the following objectives;

1. To evaluate the estimates of certain litter traits of Desi pigs.

2. To evaluate the association of the blood gammaglobulin contents at three months of age with the incidence of disease and

3. To evaluate the morphological differences of Desi pigs based on different body measurements.

Review of Literature

2. REVIEW OF LITERATURE

2.1 LITTER TRAITS

Gupta *et al.* (1983) reported that the average litter weights of male and female Large White Yorkshire piglets at birth was 5.84 ± 1.04 kg and 5.58 ± 1.05 kg and at weaning was 48.58 ± 2.84 kg and 46.29 ± 2.70 kg, respectively. The sire was found to be a significant source of variation affecting litter weight at weaning.

Nambudiri and Thomas (1984) stated that the mean litter size at birth, birth weight and pre-weaning weight gain during rainy season were 7.5 ± 0.16, 1.3 ± 0.01 kg and 7.75 ± 0.12 kg, respectively and during dry season were 7.65 ± 0.18, 1.32 ± 0.01 kg and 7.39 ± 0.14 kg, respectively for Large White Yorkshire piglets.

Rai and Desai (1985) observed that the mean birth weight of male and female Large White Yorkshire piglets were 1.232 ± 0.01 and 1.211 ± 0.01 kg and the mean weaning weight were 10.515 ± 0.17 and 10.074 ± 0.149 kg, respectively. The sex had significant effect on weaning weight, but not on birth weight. The average litter size at birth excluding still birth was 8.08 and at weaning was 5.32. The mean litter weight at birth was 9.896 ± 0.31 kg and at weaning was 54.79 ± 3.01 kg.

Singh *et al.* (1986) observed that in Large White Yorkshire breed the litter size at birth was 8.90 ± 0.09 and at weaning was 6.62 ± 0.11.

Dash and Mishra (1986) reported that the average birth weight of male and female crossbred piglets in Orissa were 1.03 ± 0.07 kg and 1.01 ± 0.06 kg, respectively. In Large White Yorkshire group the mean birth weight of male piglets was 1.085 ± 0.08 kg and the female piglets was 1.09 ± 0.07 kg and pooled mean birth weight was 1.09 ± 0.05 kg. The mean weaning weight of male piglets was 9.75 ± 1.06 kg and female piglets were 9.40 ± 0.79 kg.

According to Chatterjee *et al.* (1987), the litter size at birth and weaning, litter weight at birth and weaning and average birth weight and weaning weight for the Large White Yorkshire were, 9.55 ± 0.55 and 7.77 ± 0.46, 10.61 ± 0.46 and 58.03 ± 3.91 kg, 1.11 ± 0.01 and 7.46 ± 0.302 kg, respectively. He also observed that the litter size at birth and weaning, litter weight at birth and weaning, average birth and weaning weight were, 8.22 ± 0.52 and 5.88 ± 0.51, 8.88 ± 0.41 kg and 36.69 ± 3.88 kg, 1.05 ± 0.03 kg and 6.23 ± 0.33 kg, respectively in 75 per cent crossbred pigs.

Chatterjee *et al.* (1988) reported that the litter size and litter weight at weaning were 6.68 ± 1.14 and 43.29 ± 3.21 kg, respectively in Large White Yorkshire x Desi half bred pigs of West Bengal and in Large White Yorkshire group it was 6.89 ± 1.150, 45.19 ± 3.22 kg, respectively. The litter weight at weaning and daily weight gain was directly and positively influenced by the litter size at birth. Similarly, weaning weight and daily weight gain were influenced by the birth weight of the litter.

Lakhani (1988) observed that the average litter weight at birth of male and female indigenous pigs at Jabalpur were 2.23 ± 0.16 kg and 1.86 ± 0.16 kg and at weaning were 16.6 ± 1.08 kg and 15.73 ± 1.47 kg. The difference between sex was not significant and the sire was a significant source of variation affecting the litter weight at weaning.

According to Lakhani and Bhadoria (1988) the average weaning weight of male and female indigenous piglets were 6.323 ± 0.168 kg and 6.42 ± 0.201 kg, respectively in Jabalpur. The sex had no significant effect in weaning weight.

Chhabra *et al.* (1989) opined that the birth weight of male and female Large White Yorkshire piglets were 1.24 kg and 1.20 kg. Sex of the piglets had significant effect on birth and weaning weight. Litter size at birth had significant effect on all body weights.

Mishra *et al.* (1989a) reported that the litter size at birth was the highest for local pigs at Izatnagar 7.57 ± 0.27 followed by Jabalpur (6.52 ± 0.16), Tirupathi (6.22 ± 0.18) and Khanapara (4.93 ± 0.12) farms. The birth weight was observed to be 0.85 ± 0.007 kg 0.76 ± 0.008 kg, 0.73 ± 0.006 kg and 0.70 ± 0.006 kg at Khanapara, Izatnagar, Tirupathi and Jabalpur centers, respectively. The sex had no significant effect on birth weight at any center and the litter size had significant effect on birth weight at all centers (Mishra *et al.*, 1989b).

Mishra *et al.* (1990a) reported that the litter size at birth and weaning for Large White Yorkshire pigs were significantly higher at Jabalpur farm (9.8 ± 0.25 and 8.8 ± 0.22, respectively) as compared to Tirupathi farm (7.6 ± 0.32 and 7.2 ± 0.35, respectively). The litter weight at birth and weaning were also significantly higher at Jabalpur farm (12.1 ± 0.26 kg and 100.7 ± 2.71 kg, respectively) as compared to Tirupathi farm 10.2 ± 0.46 kg and 92.2 ± 4.50 kg, respectively).

Singh *et al.* (1990 a,b) observed that the litter size at birth and weaning for Large White Yorkshire pigs were reported to be 8.81 ± 0.39 and 6.78 ± 0.33 respectively and the birth weight and weaning weight were reported to be 1.3 ± 0.01 kg and 7.77 ± 0.17 kg, respectively.

Mishra *et al.* (1990b) observed that the litter weight at weaning for indigenous pigs was maximum at Izatnagar (43.21 ± 1.83 kg) followed by Tirupathi (42.57 ± 1.48 kg), Jabalpur (34.96 ± 1.24 kg) and Khanapara (28.49 ± 0.91 kg). Year and farm environment were found to have significant effect on litter weight at weaning.

Mishra *et al.* (1990c) reported that in Large White Yorkshire breed the male piglets had higher birth weight (1.29 ± 0.007 kg) than female piglets (1.25 ± 0.008 kg) and significant difference was observed between the sexes.

Chhabra *et al.* (1990) stated that the litter size at birth and weaning and litter weight at birth and weaning for Large White Yorkshire were, 12.0 and 10.0, 14.9 kg and 186.3 kg, respectively. The year or season of farrowing did not have significant effect on litter size at any of the stages.

According to Lakhani and Bhadoria (1990), for indigenous pigs the litter size at birth and weaning, litter weight at birth and weaning, average birth and weaning weight were 6.62 ± 0.155 and 4.99 ± 0.22, 4.55 ± 0.11 kg and 32.68 ± 1.45 kg, 0.7 ± 0.005 kg and 6.48 ± 0.072 kg, respectively at Jabalpur farm.

Sharma *et al.* (1990) reported that the mean birth weight of male piglets was 1.23 ± 0.02 kg and female piglets were 1.17 ± 0.03 kg for Large White Yorkshire breeds. The weaning weight of male piglets was 9.77 ± 0.18 kg and the female piglets were 9.81 ± 0.26 kg. For the Desi pigs the mean birth weight of male and female piglets was 0.63 ± 0.03 kg and 0.64 ± 0.03 kg, respectively. Similarly, the mean weaning weights of male and female piglets were 5.38 ± 0.32 kg and 5.23 ± 0.24 kg, respectively. They also observed that in crossbred pigs the birth weight of male and female piglets were 1.00 ± 0.04 kg and 1.06 ± 0.04 kg, respectively. The weaning weight of male and female piglets was 7.43 ± 0.12 kg and 7.81 ± 0.19 kg in Bihar. Sex of the piglet had no significant effect on birth weight and weaning weight in Large White Yorkshire, Desi and Crossbred pigs.

Singh *et al.* (1990 a,b) reported that the average litter weight at birth was 2.86 ± 0.27 kg and at weaning was 12.46 ± 1.52 kg and the litter size at birth and weaning was reported to be 6.02 ± 0.25 and 4.22 ± 0.25 respectively for indigenous pigs.

Mukhopadhyay *et al.* (1991) observed that the litter size at birth had significant effect on body weight during pre-weaning period and the sex had no significant effect on both birth and weaning weights in indigenous pigs.

According to Lakhani and Bhadoria (1991) the average litter size at birth of indigenous pigs in Jabalpur was 6.62 ± 0.15 and average birth weight was 0.7 ± 0.005 kg. But the litter size at weaning was 4.29 ± 0.221 with an average weaning weight of 6.48 ± 0.072 kg.

Shylla *et al.* (1991) observed that the birth weight and weaning weight of Doom pigs of Assam were 0.92 ± 0.01 kg and 7.44 ± 0.10 kg, respectively. The effect of sex was found to have no significant effect on above traits except at birth weight.

Deo *et al.* (1992) reported that the birth weight and weaning weight were 0.56 kg and 7.41 kg, respectively in local pigs of Izatnagar. The effect of sex on body weights at different stages was not found to be significant.

Lakhani (1992) reported that the average weaning weight of male and females were 11.93 ± 0.11 kg and 11.38 ± 0.12 kg, respectively. The overall weaning weight was 11.54 ± 0.08 kg. The litter size at birth was found to have significant effect on weaning weight in Large White Yorkshire.

Jayarajan and Ulaganathan (1992) reported that in Large White Yorkshire pigs the mean body weight was 1.26 ± 0.011 kg at birth and 10.79 ± 0.06 kg at weaning. Seasonal differences were found to have important role from birth to weaning.

Mathew (1992) noticed that the litter size at birth and weaning, litter weight at birth and weaning, average birth and weaning weight for Large White Yorkshire pigs were 6.25 ± 0.48 and 5.00 ± 0.56, 9.30 ± 0.66 kg and 51.53 ± 1.58 kg, 1.50 ± 0.09 kg and 10.64 ± 0.08 kg, respectively.

According to Sharma *et al.* (1992) the Large White Yorkshire pigs had a higher weaning weight of 9.91 ± 0.28 kg than the crossbreds with 8.05 ± 0.14 kg. Litter size at weaning had significant effect on weaning weight.

Jogi and Johar (1994) reported that in indigenous pigs the mean weaning weight of males was 7.68 ± 0.045 kg and females were 7.51 ± 0.047 kg. The sire had significant effect on weaning weight.

Kumari *et al.* (1994) reported that the litter size at birth and weaning, litter weight at birth and weaning were 6.67 ± 0.13 and 5.31 ± 0.12, 4.84 ± 0.10 kg and

43.92 ± 1.05 kg, respectively for indigenous pigs in Tirupathi. The season of birth had significant influence on litter weight at birth and weaning.

Chhabra et al (1996a) observed that the litter size at birth and weaning averaged 7.56 and 5.01 and the litter weight at birth and weaning averaged 4.57 kg and 33.57 kg in local pigs of Izatnagar.

Gaur *et al.* (1996) reported that the birth weight and weaning weight in indigenous pigs was 0.68 kg and 6.45 kg, respectively in Izatnagar. Litter size was found to have significant effect on body weight from birth to 20 weeks.

The litter size at birth and weaning, litter weight at birth and weaning for Desi pigs were 6.49 ± 0.71 and 6.017 ± 0.048, 5.02 ± 0.023 kg and 43.89 ± 0.456 kg, respectively at Jabalpur. The effect of sire was found to be significant for litter size at birth (Jogi and Johar, 1996).

Samanta *et al.* (1996) stated that the litter size and litter weight at birth and weaning were 8.67 ± 0.55, 12.53 241 0.65 kg and 7.33 ± 0.63, 58.80 ± 4.42 kg, respectively for Large White Yorkshire pigs, which did not vary significantly with season of farrowing.

Singh and Devi (1997) observed that the birth weight and weaning weight of Desi pigs at Bihar were 0.69 ± 0.02 kg and 6.10 ± 0.24 kg, respectively. The litter size at birth and weaning litter weight at birth and weaning were 6.32 ± 0.40 and 4.36 ± 0.43, 5.06 ± 0.56 kg and 25.5 ± 3.12 kg, respectively in Bihar. The sex of piglets had no significant effect on body weight at different age groups.

According to Mathew (1997) the litter size at birth and weaning, litter weight at birth and weaning, average birth and weaning weights were 5.81 ± 0.30 and 4.51 ± 0.52, 3.73 ± 0.10 kg and 32.12 ± 1.74 kg, 0.75 ± 0.02 kg and 7.21 ± 0.10 kg, respectively for Desi pigs and were 7.47 ± 0.22 and 5.88 ± 0.44, 8.65 ± 0.29 kg and 52.58 ± 4.39 kg, 1.26 ± 0.03 kg and 8.92 ± 0.06 kg, respectively for the Large White Yorkshire pigs reared at University Pig Breeding Farm, Mannuthy.

Lakhani and Jogi (1998) reported that the birth weight was 0.77 ± 0.058 kg in crossbred pigs of Jabalpur. Sire effect was highly significant for birth weight in Large White Yorkshire, Desi and their crossbred pigs.

Ramesh (1998) observed that the litter size at birth and weaning, litter weight at birth and weaning, average birth and weaning weights were 7.09 ± 0.18 and 4.63 ± 0.21, 10.73 ± 0.21 kg and 38.46 ± 3.12 kg, 1.47 ± 0.01 kg and 8.42 ± 0.09 kg, respectively for Large White Yorkshire pigs.

According to Singh *et al.* (1999) the weaning weight at Jabalpur and Tirupathi centers were 11.69 ± 0.30 kg and 11.78 ± 0.11 kg, respectively at eight weeks of age in Large White Yorkshire pigs.

Bhargava *et al.* (1999) observed that the mean litter size at birth and weaning, litter weight at birth and weaning were 4.88 ± 0.68 and 3.33 ± 0.70, 4.55 ± 0.71 kg and 42.66 ± 6.91 kg, respectively for local pigs and were 7.87 ± 0.77 and 6.12 ± 0.81, 8.73 ± 0.83 kg and 76.24 ± 8.23 kg, respectively for crossbreds pigs at Tirupathi.

Das and Gaur (1999) found that in crossbred pigs the litter size at birth and weaning, litter weight at birth and weaning were 5.60 ± 0.19 and 4.86 ± 0.19, 4.93 ± 0.18 kg and 49.05 ± 1.93 kg, respectively in Izatnagar.

Goswami *et al.* (1999) reported that in indigenous pigs the mean litter size at birth and weaning were 5.33 ± 0.24 and 5.00 ± 0.25 respectively in Khanapara and Guwahati farm.

Gopinath (2001) reported that the Desi pigs had higher litter size at birth compared to Large White Yorkshire and Crossbred pigs.

The average birth weight and weaning weight of indigenous pigs of Assam were 0.87 ± 0.01 kg and 8.22 ± 0.07 kg, respectively (Kalita et *al.*, 2001)

2.2 PRE-WEANING MORTALITY

One of the important litter traits is pre-weaning mortality as majority of mortality occurs during the pre-weaning period. The survivability of the piglets mainly depends upon several factors viz., management practices, parity of dam, litter size at birth, season of birth, age and weight of dam at farrowing and mothering ability of the sow.

Sadana and Singh (1972) opined that the incidence of pre-weaning mortality was closely related to the age of the piglet and is influenced by a number of factors as duration and season of farrowing, litter size, weight of the piglet at birth and weight loss of sow from parturition to weaning.

Yaguchi *et al.* (1980) observed that the average number of pigs that died per litter and the mortality rate increased with litter size, while the number of piglets per litter surviving up to two months of age was also higher in large litters.

Pillai and Thomas (1984) observed that the pre-weaning mortality was highest during first three weeks and progressively reduced at weaning in exotic pigs.

Singh *et al.* (1986) reported that the mortality percentage up to weaning was 25.71 ± 0.27 per cent in Large White Yorkshire pigs. The mortality was highest during winter.

Chakrabarti and Basak (1986) observed that in Large White Yorkshire breed the piglet mortality was 36.61 per cent up to weaning. Crushing was found to be responsible for high death rate amongst piglets during their first week of life.

Chatterjee *et al.* (1987) reported that the mortality percentage of sixth and eighth week weaning groups were 21.46 ± 3.26 per cent and 18.61 ± 2.06 per cent respectively in Large White Yorkshire pigs and for 75 per cent Crossbred pigs it was 23.49 ± 9.56 per cent and 27.41 ± 5.87 per cent respectively in West Bengal.

Prasad *et al.* (1987) reported that the pre-weaning mortality in indigenous pigs was 21.82 per cent in Izatnagar and no significant effect due to sex were observed on piglet mortality.

According to Chatterjee *et al.* (1988) the pre-weaning mortality was 22.19 ± 3.95 per cent in crossbred pigs and it was 21.02 ± 3.96 per cent in Large White Yorkshire pigs at West Bengal. The effect of sex was not significant but the age effect was significant on pre-weaning mortality.

Lal *et al.* (1988b) observed that the mortality in indigenous pigs was highest at Khanapara (27.19 per cent) followed by Jabalpur (21.62 per cent) and Tirupathi (20.02 per cent).

Kumar *et al.* (1990) reported a significantly higher mortality from birth to weaning in Desi pigs (35.71 per cent) at Bihar.

Singh *et al.* (1990b) reported that the pre-weaning mortality was 23.07 per cent and the effect of sex was not significant but the age had a significant effect on pre-weaning mortality in Large White Yorkshire pigs.

Chhabra *et al.* (1991) reported that in Large White Yorkshire pigs parity and litter size at birth affected survival percentage significantly and decrease in survivability was observed with advancing parity. The overall survival per cent was 83.27.

Sriraman and Krishnamacharyulu (1991) noted that the overall loss among the Large White Yorkshire piglets was 11.32 per cent from birth to weaning and in the indigenous pigs the pre-weaning losses in Tirupathi was 19.95

per cent and the losses were more in summer. Munyua *et al.* (1991) reported a pre-weaning mortality of 15.78 per cent in Central Kenya Desi pigs.

Jogi *et al.* (1993) stated that in Desi pigs the pre-weaning mortality was 38.05 per cent. The generation and sire differences were of no significance on pre-weaning mortality. The mortality was mostly of environmental effect rather than genetic effect at Jabalpur.

Pandey *et al.* (1995) concluded that the mortality of crossbred pigs was 3.47 ± 0.50 per cent. Litter size at birth and birth weight had significant effect on mortality rate at Bihar.

The pre-weaning mortality of Large White Yorkshire pigs and Desi pigs at University Pig Breeding Farm of Mannuthy was 24.52 ± 0.27 per cent and 24.05 ± 0.80 per cent respectively (Mathew, 1997).

Shobhamani and Krishna (1999) recorded high mortality rate due to gastroenteritis and pneumonia which was ascribed to lower intake of colostrum per piglet in large litters and the consequent increased susceptibility of piglets to diseases.

Kalita *et al.* (2002) observed that out of the total pre-weaning deaths, highest mortality was recorded in the first (45.32 %) and second week (26.90 %) which gradually declined up to eighth week. Among the different causes of piglet mortality, gastroenteritis was found to be common (42.09 %) followed by pneumonia (15.82 %).

Lay *et al.* (2002) have categorized the major sources of pre-weaning mortality as overlying by the sow, insufficient energy intake and disease. They also suggested that high probabilities of neonatal losses are associated with low birth weight, thermal stress and scouring.

2.3 GROWTH

Growth an important economic trait is measured in terms of body weight. The growth rate is moderate to highly heritable trait than litter traits. Hence it is mostly influenced by the genetic factors than environmental, so it is more effective to select animals based on growth rate.

Somayazulu and Agarwal (1985) concluded that the weight of pigs at slaughter could be predicted in advance using body weight up to 20^{th} week of growth when a uniform system of management is practiced. Growth rate of pigs increased from four to sixth months of age and decreased thereafter.

Dash and Mishra (1986) reported that the body weight of male and female pigs at 24 weeks were 29.42 ± 0.86 kg and 29.40 ± 0.82 kg and 26.17 ± 1.73 kg and 27.21 ± 1.37 kg, respectively for Large White Yorkshire and Crossbred pigs. For weight gain at 24^{th} week, there was significant difference between Large White Yorkshire and Crossbred male piglets.

Chatterjee *et al.* (1987) observed that the average daily gain in weight from birth to 24^{th} week was 119.53 ± 3.17 gm and 115.24 ± 2.8 gm respectively in eighth week weaning groups of Large White Yorkshire and 75 per cent crossbred pigs at West Bengal.

According to Chatterjee *et al.* (1988) the weight gain during pre-weaning period and daily weight gain varied significantly from breed to breed. In purebreds the weight gains were always higher than in crossbred. The litter size at weaning, pre-weaning weight gain of the litter and daily weight gain up to weaning were directly and positively influenced by the litter size at birth.

Lal *et al.* (1988a) observed that in indigenous pigs the weights at 32 weeks of age were 48.28 kg, 32.32 kg and 28.43 kg at Tirupathi, Jabalpur and Khanapara centers respectively. It was observed that the body weight followed linear and quadratic trend for pre and post-weaning growth rates respectively.

Sharma *et al.* (1990) reported that the body weight at the end of 26th and 30th weeks were 25.55 ± 0.41 kg and 33.72 ± 0.43 kg, 15.26 ± 0.91 kg and 19.00 ± 1.20 kg and 24.08 ± 0.52 kg and 30.26 ± 0.49 kg, respectively for Large White Yorkshire, Desi and Crossbred pigs at Ranchi.

Lakhani and Bhadoria (1991) reported that the weight at 24th week and 32nd week were 20.14 ± 0.292 kg and 32.47 ± 0.339 kg, respectively for indigenous pigs at Jabalpur.

Shylla *et al.* (1991) observed that the average body weight of the Doom pigs of Assam were at 24th, 25th and 32nd week of age as 19.15 ± 0.35 kg 23.48 ± 0.44 kg and 28.70 ± 0.52 kg, respectively. The rate of growth was relatively faster from birth to weaning as well as from 20th to 32nd week. The sex of the animal did not affect the body weight.

Mukhopadhyay *et al.* (1991) reported that at 30th week the body weight of Desi pigs was 10.57 ± 2.92 at Ranchi. Season of birth had significant effect on body weight at all the ages except at 22nd week.

Deo *et al.* (1992) reported that in Desi pigs the weight at 32 weeks of age was 39.89 kg at Izatnagar. Piglets born in small litters weighed significantly heavier at all ages than those with larger litter. The effect of sex of animal on body weight at different ages was not significant.

Jayarajan and Ulaganathan (1992) observed that in Large White Yorkshire breed the fifth month body weight of male and female pigs was 61.60 ± 0.57 kg and 58.94 ± 0.42 kg, respectively. The year difference was significant for the body weight at all ages.

Studies conducted by Leena (1992) revealed that the body weight at weaning was 8.5 ± 0.669 kg and at eight months of age was 67.0 ± 4.902 kg in Large White Yorkshire pigs. The average rate of growth increased from the birth to the fourth month and thereafter showed a declining tendency. The absolute daily gain increased from 218 gm in the first month to a peak of 600 gm in the fourth month and then declined to 319 gm from fifth months.

Chauhan *et al.* (1993) observed that in indigenous pigs, the least squares means for daily gain in pre-weaning and post-weaning periods were estimated to be 107 gm and 184 gm respectively. The average daily gain from 24 to 28 weeks and 28 to 32 weeks were 265 ± 10 gm and 272 ± 8 gm respectively in Izatnagar. The effect of dam and sex was found to be significant for average daily gain.

Pradhan (1993) found that in Large White Yorkshire pigs, the average body weight increased from 9.00 ± 0.34 kg at weaning to 74.98 ± 1.34 kg at 32nd week of age. The daily gain in weight increased from 131.62 ± 1.738 gm at 10th week to a peak of 392.28 ± 9.34 gm at 32nd week, thereafter declined to 384.60 ± 6.98 gm at 40th week of age.

The body weight of Large White Yorkshire pigs had increased progressively from weaning (9.64 ± 0.82 kg) to eighth month of age (83.48 ± 2.70 kg). Pigs showed progressive increase in the average daily gain in weight from 137.84 ± 23.7 gm at weaning to 439.28 ± 10.05 gm at eighth months of age (Kannan, 1995).

Chhabra *et al.* (1996b) reported that in Desi pigs the body weights at 24th, 28th and 32nd weeks were 23.88 kg, 31.20 kg and 38.53 kg, respectively at Izatnagar. The effect of litter size was significant on body weight at all the ages. The sex had no significant effect on weight up to 16th week of age.

Pandey *et al.* (1996) reported that the genetic group difference in daily weight gain was significant from birth to 21st week of age. The interaction between genetic group and sex had no significant effect on post-weaning and the pre-weaning daily weight gain. Similarly, the post-weaning weight gain gradually increased with the increasing weaning weight. He also observed that the post-weaning daily gain was 138.06 ± 3.46 gm in crossbred pigs of Jabalpur.

The effect of birth weight on post-weaning daily weight gain was not significant while weaning weight had significant influence on post-weaning daily gain.

Jogi and Johar (1997) observed that in Desi pigs the body weights at three, six and eight months of age were 9.86 ± 0.16 kg, 22.00 ± 0.19 kg and 34.79 ± 1.02 kg, respectively at Jabalpur. The effect of sire was highly significant for all post-weaning body weights and sex had significant influence on growth.

Gaur *et al.* (1997) studied that in indigenous pigs the body weight at 32 weeks of age was 36.42 kg in Izatnagar. The effect of sire was significant for all stages of growth. The litter size and sex significantly affected the growth rate in most of the periods.

Mathew (1997) reported that the body weight of Large White Yorkshire pigs increased from weaning (12.6 ± 0.65 kg) to fifth months (42.813 ± 3.752 kg) of age, with the average daily gain of 237.70 ± 49.53 gm.

The body weights of indigenous pigs at the end of 32 weeks were 40.43 ± 2.70 kg (Izatnagar), 31.78 ± 1.39 kg (Jabalpur) and 42.91 ± 1.04 kg (Tirupathi), 38.05 ± 1.44 kg (Khanapara) and 31.32 ± 0.45 kg (Mannuthy), 33.01 ± 1.48 kg (Kattupakkam). The body weights of Large White Yorkshire half bred pigs at the end of eight months of age were 49.01 ± 1.99 kg and 57.74 ± 4.4 kg, 46.37 ± 0.93 kg at Jabalpur, Tirupati and Izatnagar centers respectively (Anon, 1997).

Suraj (2000) observed the mean average daily gain in weight of Large White Yorkshire, Crossbred and Desi pigs were 420 ± 0.63, 330 ± 0.46 and 234 ± 0.36 gm respectively and the body weight of Large White Yorkshire and Crossbred pigs were same from weaning to third month of age after that it will vary up to slaughter age. The maximum average daily gain was noticed during fifth month of age in all three genetic groups.

The body weights of indigenous pigs of Assam at 16^{th}, 24^{th} and 32^{nd} week were 14.99 ± 0.15 kg, 23.66 ± 0.23 kg and 33.35 ± 0.33 kg, respectively (Kalita *et al.,* 2001). They also observed that season of birth and parity exerted significant effect on body weight at all ages from birth to 32nd week of age, but sex had no significant effect on body weight.

2.4 BODY MEASUREMENTS AND BODY SURFACE AREA

Berge (1951) reported that live weight, body length, shoulder height, heart and abdominal girth were highly correlated and an increase in any of the trait was accompanied by a similar increase in others. But the body length was unreliable, while the chest measurement increased with increase in live weight.

The extent of heat exchange between animal and its surroundings depends partly on the body surface area. The lack of functional skin and hence the intrinsic mechanism of evaporative cooling in pigs is compensated by the wallowing behavior which helps in heat exchange through its effective surface area by radiation, conduction and convection (Hafez, 1968).

Studies by Gruev and Machev (1970) revealed that the sixth month body weight of both male and female pigs were correlated with body length, length at withers and heart girth.

According to Mickwitz and Bobeth (1972) the body measurement most highly correlated with live weight was chest circumference in pigs.

Deo and Raina (1983) stated that although the genetic correlation of body length with height at withers and barrel and chest girths were positive, it was non-significant at all ages. In Large White Yorkshire pigs, the contribution of length, height, heart and abdominal girths towards the live weight were 3.11, 27.02, 23.08 and 36.80 per cent respectively. The above values for crossbred piglets were 1.95, 25.76, 53.06 and 17.07 per cent respectively.

Sahaayaruban *et al.* (1984) also established the highly positive correlations between body weight, body length, chest girth, shoulder height and hip width.

Dash and Mishra (1986) reported that the body length, height, heart girth and abdominal girth of Large White Yorkshire and crossbreds at the slaughter age of 24 weeks were 96.54 and 94.23 cm, 54.27 and 52.61 cm, 71.27 and 68.23 cm, 66.18 and 63.23 cm respectively. They also concluded that the heart girth in crossbreds and abdominal girth in Large White Yorkshire were the important body measurements contributing towards increase in the body weight.

Ensminger *et al.* (1990) suggested the following relationship: heart girth x heart girth x length – 400 = weight in pounds. They also suggested that for hogs weighing less than 170 lb, 7 lb has to be added to the weight figure obtained from formula.

2.5 SERUM GAMMAGLOBULIN

A part of functional immune system comprising the cells of bone marrow origin or the B-lymphocytes on antigenic stimulation undergoes active division to produce plasma cells that are capable of antibody synthesis (humoral immune response). Antibodies belong to a group of related proteins called gamma globulin/Immunoglobulin which share common structures and other physico-chemical properties Antibodies are present in many tissues and fluids of the body. Gammaglobulin in blood serum is a well established indicator of health status of an individual.

Gay *et al.* (1965) reported a high mortality rate in calves with hypogamma globulinemia.

Ranatunga (1971) suspected that lack of passive transfer of immunity might contribute to heavy neonatal mortality in kids.

Fincher and Delafeunte (1971) reported a high incidence of deaths in neonatal calves with hypogammaglobulinaemia.

Roubik and Ray (1972) had found that the effect of sire was significant on serum Ig level in Hereford cattle.

Thomas and Swaan (1973) reported a higher incidence of pneumonia and subsequent deaths in calves with lower levels of gamma globulin in their serum.

Halliday (1976) reported that there was significant correlation between body weight gain and Ig level in sera of calves.

Mc Guire *et al.* (1976) reported that serum IgG concentration in calves below three weeks of age dying of infectious diseases were lower than that of clinically normal calves.

Ciupercescu (1977) found a significant negative correlation between body weight gain at 6-12 weeks and IgG_1 and IgG_2 concentration at 14 weeks ($r=0.63$ and 0.368 respectively).

Hendrix *et al.* (1978) found that the piglets that survived to 21 days of age had a higher ($P<0.001$) gammaglobulin concentration than those piglets that were born alive but died before 21 days.

It has been well established that sufficient levels of gammaglobulin is essential for health, better performance and survival of pigs, goats and sheep (Yaguchi, 1980, Nandakumar and Raja, 1983, Caldow *et al.*, 1988 and Ciupercesu, 1997).

Yaguchi *et al.* (1980) reported that the birth order, birth weight and litter size influence the serum gamma globulin levels of neonatal piglets and piglets that are hypogammaglobulinaemic at 12 to 18 hours of age have little chance of surviving more than a few days.

Halliday and Williams (1980) reported that cows with normally high levels of Ig generally produced more antibodies in response to antigenic challenge.

The absolute amounts of gammaglobulin absorbed by the various species are different: however one half of the gammaglobulin ingested during the first nursing period are found in the blood of the pig when peak levels are reached 6 to 12 hours later. At that time the gammaglobulin levels are 2 to 3 times higher than in adult hogs. After 24 to 48 hours, gammaglobulin levels fall rapidly for 7 to 10 days, decrease more slowly for an additional two weeks, stabilize for 3 to 4 weeks and then gradually rise (Winkler, 1982).

Nandakumar and Raja (1983) found that neonatal kid mortality was often associated with hypogammaglobulinemia. Mortality rate of goat kid with hypogammaglobulinaemia was found to be 44 per cent.

Raja and Balakrishnan (1985) observed that the younger animals often had a lower serum Ig level compared to older animals. In cattle below two years of age Ig level was 29.133 mg/ml while in cattle above two years of age it was 36.211 mg/ml. Nandakumar *et al.* (1991) could observe similar trend in goats.

Raja *et al.* (1986) reported that the effect of sire was not significant on *serum immunoglobulin* level in goats.

Caldow *et al.* (1988) reported that there was no statistically significant relationship between plasma IgG, concentration, initial live weight or overall live weight in goats.

In pigs IgG is the predominant serum immunoglobulin, accounting for about 85 per cent of the total followed by IgM which accounts for about 12 per cent and IgA for about three per cent of serum immunoglobulins. The normal serum immunoglobulin levels in pigs ranges from 17-29 mg/ml, 1-5 mg/ml and 0.5-5 mg/ml for IgG, IgM and IgA respectively (Tizard, 2000).

Rooke *et al.* (2003) suggested that naturally suckling piglets begin synthesizing IgG from seven days of age and that the amounts of IgG synthesized are positively correlated with the amounts of IgG absorbed from colostrum.

Materials and Methods

3. MATERIALS AND METHODS

The work was carried out at the Centre for Pig Production and Research (CPPR), Kerala Agricultural University, Mannuthy. The experimental animals belonged to the Desi pigs.

3.1 LITTER TRAITS

Twelve female pigs belonging to Desi groups of pigs were bred with six boars of the same genetic group. The breeding was synchronized in such a way that all the sows farrowed in the same period of season in that year. Ninety six piglets obtained as progenies were studied for litter traits. All the progenies were maintained under uniform conditions of housing, feeding, health cover and managemental practices prevailing at Centre for Pig Production and Research, Mannuthy. Animals were allowed to remain with their dams up to weaning (56 days). Males and females were housed together for a month after weaning and thereafter were housed separately.

Observations

The following data were recorded on traits

Birth weight
Litter size at birth
Litter weight at birth
Weaning weight at eight weeks of age
Litter size at weaning
Litter weight at weaning
Pre-weaning mortality
Monthly body weight up to six months of age
Monthly body measurements like body length, height, chest and abdominal girths up to six months of age
Serum gammaglobulin level at three months of age

3.2 MONTHLY BODY WEIGHT

Body weight of each animal was recorded at monthly intervals. Weighing was done in the morning before feeding and watering. The average monthly body weight was estimated from birth to six months of age and monthly average daily gain in weight was also calculated.

3.3 MONTHLY BODY MEASUREMENTS

Body measurements of each animal such as length, height and chest and abdominal girth were measured and recorded monthly.

3.3.1 Body Length

The distance in centimeters between the point of shoulder and pin bone was taken as the body length.

3.3.2 Body Girth

The circumference of the body barrel just behind the forelimb was taken in centimeters as the chest girth.

The circumference of the body barrel at the mid point of the mid dorsal line was taken in centimeters as the abdominal girth.

3.3.3 Body Height

Height at withers was measured in centimeters as the body height of the animal.

3.3.4 Body Surface Area

The body of the pig was divided into different geometrical figures and the area in square centimeters was worked out individually. The summing up of these individual areas gave the total body surface area in square centimeters. The division of the body of the pigs into different geometrical figures is illustrated in Plate. 1.

The head (A) was considered as a cone and the circumference and length of the head was measured. Area of a cone excluding the area of the base was worked out.

The length of neck was measured from the base of the head to base of neck and it was taken as the breadth of a rectangle (B) and the circumference of the base of the head as taken as the length of the rectangle. The rest of the area of neck was taken as triangle (b) i.e., the difference in circumference between neck and head as the base of triangle and the length of neck was taken as the height of the triangle.

The measurement of body area in Desi and Large White Yorkshire pigs was done in different ways. In Desi pigs the body girth was measured at three different levels, i.e., anterior, middle and posterior regions. The length of the body was measured from the base of the neck to the pin bone. The mean of the anterior and posterior circumferences was taken as the length of a rectangle and the length of the body was taken as the breadth of rectangle and area was worked out (C). The drooping area was considered as four triangles (c). Half of the ventral body length was taken as the height of triangle and half the differences between the anterior and middle body girths as the base of the triangle. In Large White Yorkshire pigs the body girth was measured at two different levels ie., anterior and posterior. The average of body girths was taken as the length of the rectangle and body length as the breadth of rectangle and the area was worked out.

The area of the forelimb (D) was measured by considering it as a cylinder and circumference of the forelimb as the circumference of the cylinder and length of the leg as the height of cylinder.

The area of the hind limb was worked out by considering the upper region as triangle (E) (including both inner and outer area) and the rest as a cylinder (e).

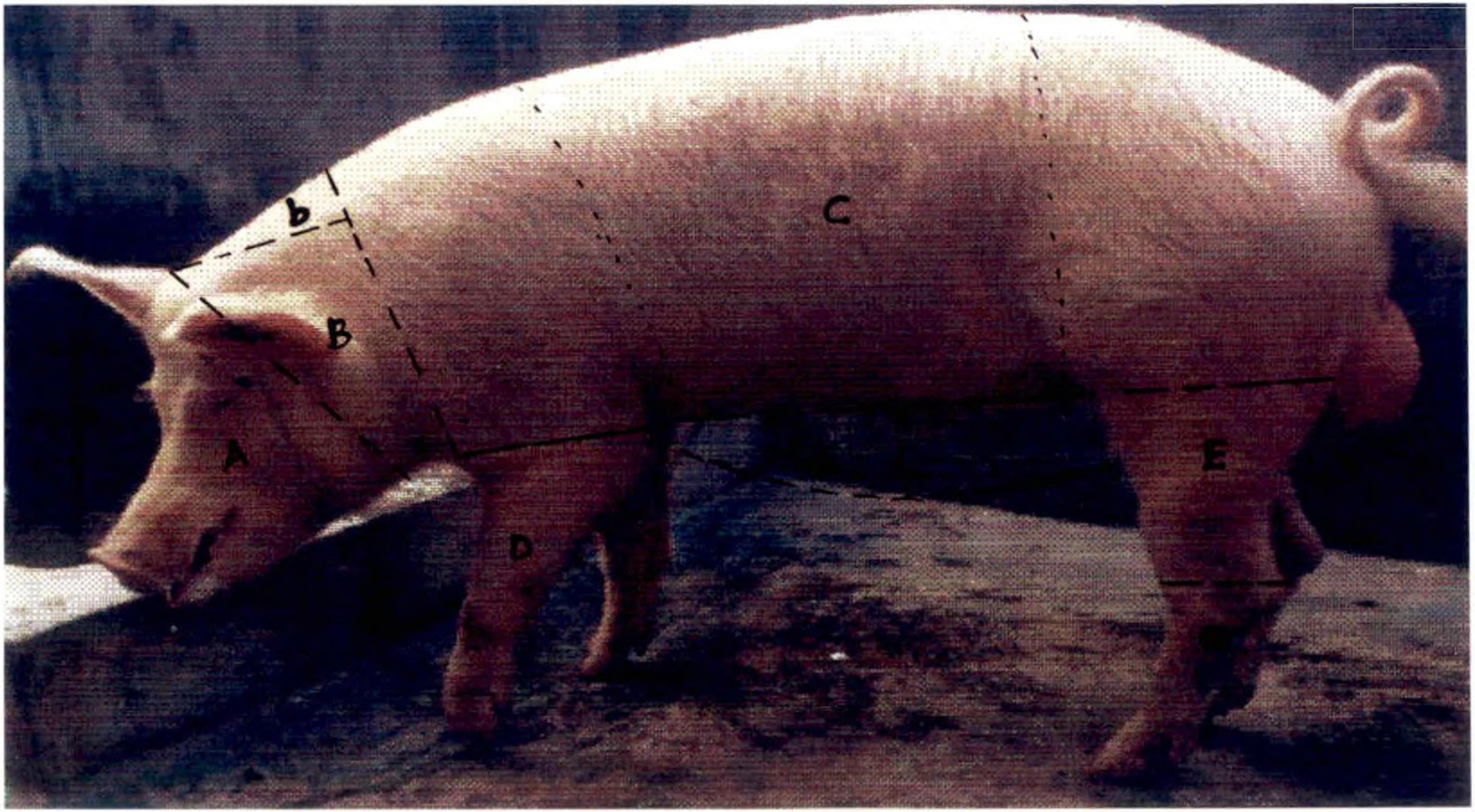

Plate 1. Division of body of pig into different geometrical figures

A

B

C

(A) Boar (B) Pregnant sow (C) Sow with litter

Plate 2. Desi pigs

Area of a cone (excluding the area of base) = π r l

Where 'r' is the radius and 'l' is the length of the cone.

Area of the rectangle = l x b

Where 'l' is the length and b' is the breadth of the rectangle.

Area of a triangle = ½ bh

Where 'b' is the base,'h' is the height of the triangle.

3.4 MEASUREMENT OF SERUM GAMMAGLOBULIN LEVEL

Ten ml of blood was collected from each animal and was allowed to clot and left standing upright at 4°C for 24 hours before being centrifuged at 1500 rpm for fifteen minutes. The serum samples were stored in tightly capped storage vials at –20°C for analysis of gammaglobulin level.

Zinc Sulphate Turbidity Test (ZSTT) developed by McEwan et al. (1970) and routinely used in immunoglobulin analysis of farm animals was chosen as the method of estimation of gammaglobulin level.

3.4.1 Zinc Sulphate Turbidity Test Procedure

Zinc sulphate turbidity test procedure described by McEwan et al. (1970) was followed with suitable modifications as suggested by Nandakumar (1995). A working solution of zinc sulphate was prepared by adding 205 mg of zinc sulphate to one liter of freshly boiled and cooled double distilled water.

Test tubes were arranged in three rows on the rack. The number of tubes in each row depended on the number of samples to be tested. For convenience of observation the first two rows of tubes were termed 'test tubes' and the third row of tubes were named 'control tubes'. Six ml of working solution of zinc sulphate was poured into each of the test tubes. A similar volume of distilled water was poured into the control tubes. Using a precision pipette 0.1 ml of the serum sample diluted to 1 in 2 with distilled water was pipetted into each of the tubes in a single column with a label corresponding to the serum samples. The tubes were shaken well and allowed to stand at room temperature for an hour. The turbidity developed in each tube was read in a spectrophotometer (Spectronic 1001_{plus}, Milton Roy Co., USA) at a wave length of 595 nm. The adjustment was made against zinc sulphate solution. The tubes were shaken for redistribution of precipitate. The reading of the control tube was subtracted from the average readings of the test solution to arrive at the optical density of each individual serum sample. The optical density values were converted into gammaglobulin concentration (mg/ml) of serum with the help of prediction equation developed from standard curve.

3.4.1.1 Preparation of standard curve

Porcine gammaglobulin (Jackson Immuno Research, Co. USA) was dissolved in normal saline solution to give a concentration ranging from 0 to 80 mg/ml. These solutions were diluted to 1 in 2 with distilled water. The standard solutions were subjected to zinc sulphate turbidity test. To arrive at the net OD values, the values obtained for the control was subtracted from the average of observed values of test solution. The net optical density values are presented in Table 1. From the table values a prediction equation was prepared using multiple regression analysis which could be used to predict any optical density value to gammaglobulin concentration (mg/ml).

Prediction equation:

$$Y = 9.30 + 235.14\,X$$

Where, Y = the predicted gammaglobulin level in unknown serum.

X = the optical density value of the serum.

The coefficient correlation between actual and predicted values was 0.981.

Table 1. The optical density values for known concentration of gammaglobulin (mg/ml)

Gammaglobulin concentration (mg/ml)	Optical Density Values
0	0
10	0.008
15	0.016
20	0.028
25	0.057
30	0.079
40	0.124
50	0.168
60	0.216
70	0.259
80	0.311

3.5 ASSESSMENT OF INCIDENCE OF DISEASES AND MORTALITY

All the experimental animals were observed from birth to six months of age for occurrence of disease symptoms. Symptoms such as diarrhea and signs of respiratory infections were noted for the whole experimental period. Mortality of the piglets if any were noted and the reasons for mortality were recorded from the postmortem reports.

3.6 STATISTICAL ANALYSIS

The mean, standard error and co-efficient of variation were estimated for all the traits studied in the genetic group and correlations between the traits were also computed (Snedecor and Cochran, 1985).

Least squares analysis of variance was performed to study effect of different factors on birth weight, weaning weight and serum gammaglobulin levels in the genetic group. The standard programme LSML (Harvey, 1986) was used for least squares analysis.

3.6.1 Birth Weight

Three different factors were considered for analyzing their effect on birth weight of piglets namely sex, sire and litter size at birth and the data were classified accordingly.

3.6.1.1 Sex

The sex of the piglets were classified as

Male – 1 Female – 2

3.6.1.2 Sire

The number of sires in the experiment was 1 to 6.

3.6.1.3 Litter size at birth

Litter size at birth were grouped as

Size 1	-	≤ 7
Size 2	-	8-9
Size 3	-	≥ 10

The statistical model used was

$$Y_{ijkl} = \mu + S_i + R_j + L_k + e_{ijkl}$$

Where

Y_{ijkl}	=	The birth weight of the l^{th} piglet born in i^{th} sex of j^{th} sire and k^{th} litter size at birth
μ	=	Population mean
S_i	=	Effect of i^{th} sex (I = 1-2)
R_j	=	Effect of j^{th} sire (j=1-6)
L_k	=	Effect of k^{th} litter size at birth (k = 1-3)
e_{ijkl}	=	Random error

3.6.2 Weaning Weight

The effect of sex, sire, birth weight and litter size at weaning of piglets on weaning weight was analyzed and data were classified accordingly.

3.6.2.1 *Sex and sire*

The data were classified as earlier for analyzing birth weight.

3.6.2.2 *Birth weight*

The birth weights of the piglets were classified as follows:

Group I	-	$\leq$0.05
Group II	-	0.51 – 0.70
Group III	-	0.71 – 1.0
Group IV	-	$\geq$1.1

3.6.2.3 *Litter size at weaning*

The litter size at weaning was classified as

Size I	-	$\leq$5
Size II	-	6-7
Size III	-	$\geq$8

The statistical model was used.

$$Y_{ijklm} = \mu + S_i + R_j + B_k + W_l + e_{ijkl\,m}$$

Where

$Y_{ijkl\,m}$	=	The weaning weight of the m^{th} piglet born in i^{th} sex of j^{th} sire, k^{th} birth weight and l^{th} litter size at weaning
μ	=	Population mean
S_i	=	Effect of i^{th} sex (i = 1-2)
R_j	=	Effect of j^{th} sire of genetic group (j = 1-6)
B_k	=	Effect of k^{th} birth weight (k = 1-4)
W_l	=	Effect of l^{th} litter size at weaning (l = 1-3)
e_{ijklm}	=	Random error

3.6.3 Serum Gammaglobulin Level

The effect of sex, birth weight, sire, litter size at weaning, weaning weight and incidence of disease symptoms on serum gammaglobulin level was analyzed and data were classified accordingly.

3.6.3.1 *Sex, sire ,birth weight and litter size at weaning*

The data were classified as earlier for analyzing weaning weight.

3.6.3.2 *Weaning weight*

The weaning weight was classified as

Group I	-	≤ 5
Group II	-	5.1 – 7.0
Group III	-	≥ 7.1

3.6.3.4 *Incidence of disease symptoms*

The data pertaining to incidence of disease symptoms were classified as

Incidence of diarrhea	Yes - 1
	No - 2
Incidence of respiratory infections	Yes - 1
	No – 2

The statistical model used was

$$Y_{ijklmnop} = \mu + S_i + R_j + B_k + W_l + G_m + D_n + R_o + e_{ijkl\,m\,nop}$$

Where

$Y_{ijklmnop}$	=	The serum gammaglobulin level of p^{th} piglet born in i^{th} sex of j^{th} sire, k^{th} birth weight, l^{th} litter size at weaning, m^{th} weaning weight, n^{th} group of incidence of diarrhea and o^{th} group of incidence of respiratory infections.
μ	=	Overall mean
S_i	=	Effect of i^{th} sex (i = 1-2)
R_j	=	Effect of j^{th} sire (j = 1-6)
B_k	=	Effect of k^{th} birth weight (k = 1-4)
W_l	=	Effect of l^{th} litter size at weaning (l = 1-3)
G_m	=	Effect of m^{th} weaning weight (m = 1-3)
D_n	=	Effect of n^{th} incidence of diarrhea group (n = 1-2)
R_o	=	Effect of o^{th} incidence of respiratory infections group (n = 1-2)
$e_{ijklm\,nop}$	=	Random error

Results

4. RESULTS

4.1. LITTER TRAITS

The average values for litter traits such as birth weight, litter size at birth and litter weight at birth, weaning weight, litter size at weaning and litter weight at weaning for the Desi pigs are shown in Table 2.

4.2 BIRTH WEIGHT

The least squares analysis of variance for birth weight for different factors such as sex, sire and litter size at birth are presented in Table 3. Least squares means and standard error for birth weight according to different factors are given in Table 4.

4.2.1 Effect of Sex

Sex had a significant ($P \leq 0.05$) effect on the birth weight with an average of 0.849 ± 0.037 kg and 0.763 ± 0.036 kg for male and female piglets respectively.

4.2.2 Effect of Sire

Sire had no significant effect on the birth weight. A numerical difference was found between sires, the sire number two had the offsprings with highest average birth weight of 0.908 ± 0.00562 kg and the offsprings of the sire number four had lowest average birth weight of 0.6531 ± 0.088 kg.

4.2.3 Effect of Litter Size at Birth

Litter size at birth had no significant effect on the birth weight. The least squares means observed in litter size groups one, two and three were 0.8715 ± 0.050 kg, 0.7919 ± 0.636 kg and 0.7557 ± 0.086 kg respectively.

Table 2. Mean, standard error and co-efficient of variation for litter traits

Litter Traits	Mean ± S.E.	CV (percentage)
Birth weight (kg)	0.827 ± 0.020	23.82
Litter size at birth	8.000 ± 0.520	22.62
Litter weight at birth (kg)	6.621 ± 0.477	24.99
Weaning weight (kg)	6.360 ± 0.156	20.75
Litter size at weaning	6.000 ± 0.325	18.80
Litter weight at weaning (kg)	38.160 ± 2.48	22.58

Table 3. Least square analysis of variance for the effect of sex, sire and litter size at birth on birth weight.

Source of variation	DF	Mean squares
Sex	1	0.1697*
Sire	5	0.0697
Litter size at birth	2	0.0149
Error	87	0.0354

* $P<0.05$

Table 4. Least squares means and standard error for the factors affecting average birth weight

Factors	Probability	Classes	n	Mean ± S.E.
Sex	0.0313	Male	48	0.8491 ± 0.037
		Female	48	0.7636 ± 0.036
Sire	0.0906	1	21	0.8110 ± 0.079
		2	20	0.9080 ± 0.056
		3	14	0.8200 ± 0.087
		4	13	0.6531 ± 0.088
		5	15	0.8501 ± 0.057
		6	13	0.7953 ± 0.088
Litter size at birth	0.6565	≤7	47	0.8715 ± 0.050
		8-9	17	0.7919 ± 0.636
		≥10	32	0.7557 ± 0.086
Overall Mean			96	0.8064 ± 0.032

Mean = 0.82771 Error standard Deviation = 0.1828

CV = 22.75 R = 0.407

4.3 WEANING WEIGHT

Least squares analysis of variance for weaning weight according to sex, sire, birth weight and litter size at weaning are presented in Table 5 and the least squares mean and standard error of weaning weight according to different factors are presented in Table 6.

4.3.1 Effect of Sex

Sex of the piglet had no significant effect on weaning weight. The average weaning weights for male and female piglets were 5.603 ± 0.243 kg and 5.496 ± 0.260 kg respectively.

4.3.2 Effect of Sire

Sire had a significant effect ($P \leq 0.01$) on the weaning weight. The least squares mean for weaning weight was highest in sire number two with an average of 6.808 ± 0.329 kg and sire number five had the lowest average weaning weight of 4.773 ± 0.383 kg.

4.3.3 Effect of Birth Weight

Effect of average birth weight was significant ($P \leq 0.01$) on the average weaning weight. The birth weight group four had the highest average weaning weight of 6.860 ± 0.369 kg and the birth weight group two had the lowest average weaning weight of 4.564 ± 0.326 kg.

4.3.4 Effect of Litter Size at Weaning

Significant effect of litter size at weaning ($P \leq 0.01$) was noticed on weaning weight. The litter size group one had the highest average of weaning weight and the litter size group three had the lowest average of weaning weight with 6.456 ± 0.274 kg and 3.815 ± 0.924 kg respectively.

Table 5. Least square analysis of variance for the effect of sex, sire, birth weight and litter size at weaning on weaning weight

Source of variation	DF	Mean squares
Sex	1	0.185
Sire	5	3.470**
Birth weight	3	9.203**
Litter size at weaning	2	12.137**
Error	60	1.013

** P<0.01

Table 6. Least square means and standard error for the factors affecting average weaning weight

Factors	Probability	Classes	n	Mean ± S.E.
Sex	0.6700	Male	40	5.603 ± 0.243
		Female	32	5.496 ± 0.260
Sire	0.0088	1	13	5.769 ± 0.365
		2	15	6.808 ± 0.329
		3	11	5.461 ± 0.381
		4	11	5.264 ± 0.367
		5	11	4.773 ± 0.383
		6	11	5.221 ± 0.388
Birth weight	0.0001	≤0.5	4	4.867 ± 0.541
		0.51-0.70	12	4.654 ± 0.326
		0.71-1.0	46	5.816 ± 0.193
		≥1.1	10	6.860 ± 0.369
Litter size at weaning	0.0000	≤5	19	6.456 ± 0.274
		6-7	45	6.378 ± 0.203
		≥8	8	3.815 ± 0.524
Overall Mean			72	5.549 ± 0.218

Mean = 6.361 Error standard Deviation = 1.00676

CV = 15.83 R = 0.715

4.4 PRE-WEANING MORTALITY

The mortality percentage in the first month, second month and the total pre-weaning mortality are given in the Table 7. The mortality percentages with respect to birth weight (kg) are given in Table 8. The causes for the pre-weaning mortality based on the postmortem findings are detailed in Table 9.

4.5 MONTHLY BODY WEIGHT

The mean and standard error for body weight of the experimental animals recorded at monthly intervals from one to six months of age are presented in Table 10.

The body weight of the animals increased along with increase in age. The average body weight at sixth month of age was 25.670 ± 0.205 kg. The fourth and sixth month had the highest numerical increase in body weight.

The average daily weight gain values are presented in Table 11. The highest average daily gain was noticed in the fourth month (190.046 ± 4.030 g). An increasing trend of average daily gain was found from second to fourth month of age and then a decreasing trend was observed up to six months of age.

4.6 MONTHLY BODY MEASUREMENTS

The mean and standard error for different body measurements such as length, chest girth, abdominal girth and height recorded on monthly intervals are presented in Table12.

4.6.1 Body Surface Area

The mean values of total surface area and the surface area per kg body weight for various classes of body weights in Desi and Large White Yorkshire pigs are indicated in Table 13.

Table 7. Mean, standard error and coefficient of variation for pre-weaning mortality

Pre-weaning mortality	Mean ± S.E.	CV (percentage)
Month I	22.185 ± 2.34	33.39
Month II	15.354 ± 1.951	28.41
Total pre-weaning mortality	25.865 ± 3.107	39.82

Table 8. Mortality percentage with respect to birth weight (kg)

Birth Weight Group	No of piglets died	% of piglets (out of 24)
≤ 0.5	11	45.8
0.51 – 0.70	6	25
0.71 – 1.0	3	12.5
≥ 1.0	4	16.6

Table 9. Causes for mortality based on post mortem findings

Causes	No. of piglets affected	% of piglets (out of 24)
Gastro enteritis	13	54.16
Pneumonia	5	20.83
Hemorrhagic enteritis	3	12.5
Catarrhal gastritis	2	8.33
Cardiac tamponade	1	4.16

Table 10. Mean and standard error for average monthly body weight (kg)

Age	Mean ± S.E.
Month I	4.144 ± 0.096
Month II	6.406 ± 0.154
Month III	8.916 ± 0.183
Month IV	14.618 ± 0.227
Month V	20.211 ± 0.223
Month VI	25.670 ± 0.205

Table 11. Mean and standard error for monthly average daily gain (g)

Age	Mean ± S.E.
Month I	109.767 ± 2.814
Month II	74.074 ± 2.865
Month III	83.657 ± 2.527
Month IV	190.046 ± 4.030
Month V	186.435 ± 3.527
Month VI	181.990 ± 3.193

Table 12. Mean and standard error for monthly body measurements (cm)

Month	Length	Chest girth	Abdominal Girth	Height
I	27.128 ± 0.157	33.384 ± 0.246	35.794 ± 0.251	25.673 ± 0.167
II	30.638 ± 0.240	36.548 ± 0.277	41.083 ± 0.306	29.465 ± 0.238
III	37.743 ± 0.259	41.402 ± 0.362	46.402 ± 0.280	33.868 ± 0.258
IV	43.152 ± 0.321	45.694 ± 0.343	51.930 ± 0.290	37.756 ± 0.266
V	48.701 ± 0.284	50.013 ± 0.379	57.916 ± 0.442	42.048 ± 0.284
VI	53.361 ± 0.305	54.798 ± 0.397	66.312 ± 0.502	47.222 ± 0.342

Table 13. Body weight, total surface area and surface area/kg body weight in Desi and Large White Yorkshire pigs.

Body weight(kg)	Desi		Large White Yorkshire	
	Surface Area (cm^2)	Surface Area/kg body weight	Surface Area (cm^2)	Surface Area/kg body weight
16	5109.250	319.30	5099.50	318.71
22	5750.900	261.40	5325.00	242.00
28	7114.375	254.00	6568.00	234.50**
38	9514.375	250.00	8509.50	223.90**
49	11579.562	236.00	10291.50	210.03**
55	12008.900	218.34	10997.58	199.95**
61	12849.400	210.60	11789.00	193.20**
78	15542.680	199.26	14586.75	187.00**
86	16439.000	191.15	15486.50	180.07**

** P<0.01

4.7 SERUM GAMMAGLOBULIN

The least squares analysis of variance for serum gammaglobulin level according to sex, sire, birth weight, litter size at weaning, weaning weight, incidence of diarrhea and incidence of respiratory infections are presented in Table 14. The least squares mean and standard error for average serum gammaglobulin level according to various factors are presented in Table 15.

4.7.1 Effect of Sex

Sex had no significant effect on the serum gammaglobulin level. The male and female pigs had an average serum gammaglobulin value of 17.002 ± 0.720 mg/ml and 16.760 ± 0.378 mg/ml respectively.

4.7.2 Effect of Sire

Effect of sire was significant ($P \leq 0.01$) on the serum gammaglobulin level. The piglets of sire number one had the highest value of serum gammaglobulin of 19.029 ± 0.934 mg/ml and the piglets of sire number three had the lowest value of serum gammaglobulin of 15.010 ± 1.02 mg/ml.

4.7.3 Effect of Birth Weight

No significant effect of birth weight was found on serum gammaglobulin values. The birth weight group three, four, one and two had the values of 17.305 ± 0.621 mg/ml, 17.279 ± 0.951 mg/ml, 17.244 ± 1.44 mg/ml and 15.698 ± 0.921 mg/ml respectively.

4.7.4 Effect of Litter Size at Weaning

Litter size at weaning had a significant ($P \leq 0.05$) effect on serum gammaglobulin level. The litter size at weaning group two had the highest value for serum gammaglobulin of 18.496 ± 0.609 mg/ml followed by group one with

17.846 ± 0.759 mg/ml. The litter size at weaning group three had the lowest level of serum gammaglobulin with 14.300 ± 1.44 mg/ml.

4.7.5 Effect of Weaning Weight

Weaning weight had no significant effect on the serum gammaglobulin level. The weaning weight group three, two and one had 17.342 ± 0.95 mg/ml, 16.700 ± 0.824 mg/ml and 16.600 ± 0.786 mg/ml of serum gammaglobulin values respectively.

4.7.6 Effect of Incidence of Diarrhea

Incidence of diarrhea had a significant ($P \leq 0.05$) effect on the serum gammaglobulin level. Serum gammaglobulin value was higher for the animals when there was incidence of diarrhea (17.998 ± 0.772 mg/ml) than the serum gammaglobulin level for the animals that had no incidence of diarrhea (15.809 ± 0.705 mg/ml)

4.7.7 Effect of Incidence of Respiratory Infections

The effect of incidence of respiratory infections was not significant on the serum gammaglobulin level.

Table 14. Least squares analysis of variance for the effect of sex, sire, birth weight, litter size at weaning, weaning weight and incidence of disease on serum gammaglobulin level.

Source of variation	DF	Mean squares
Sex	1	0.8122
Sire	5	20.5587**
Birth weight	3	6.7442
Litter size at weaning	2	25.1974*
Weaning weight	2	2.1673
Incidence of diarrhea	1	53.6963*
Incidence of respiratory infections	1	1.1491
Error	56	5.2014

** P<0.01
* P<0.05

Table 15. Least square means and standard error for the factors affecting serum gammaglobulin level (mg/ml)

Factors	Probability	Classes	n	Mean ± S.E.
Sex	0.6942	Male	40	17.019 ± 0.711
		Female	32	16.787 ± 0.725
Sire	0.0040	1	13	18.968 ± 0.897
		2	15	18.499 ± 0.848
		3	11	15.058 ± 1.000
		4	11	15.714 ± 0.963
		5	11	15.951 ± 1.072
		6	11	17.228 ± 1.073
Birth weight	0.2841	≤0.5	4	17.264 ± 1.431
		0.51-0.70	12	15.710 ± 0.912
		0.71-1.0	46	17.359 ± 0.581
		≥1.1	10	17.279 ± 0.943
Litter size at weaning	0.0115	≤5	19	17.856 ± 0.752
		6-7	45	18.522 ± 0.596
		≥8	8	14.332 ± 1.424
Weaning weight	0.6613	≥5	15	16.635 ± 0.769
		5.1-7	37	16.705 ± 0.817
		≥7.1	20	17.370 ± 0.941
Incidence of Diarrhea	0.022	No	50	15.809 ± 0.705
		Yes	22	17.998 ± 0.772
Incidence of Respiratory infections	0.6402	No	62	16.702 ± 0.538
		Yes	10	17.865 ± 0.723
Overall Mean			72	16.903 ± 0.656

Mean = 17.605   Error standard deviation = 2.299
CV = 13.06   R = 0.708

Discussion

5. DISCUSSION

5.1 LITTER TRAITS

The mean of litter traits such as birth weight, weaning weight, litter size at birth and weaning, litter weight at birth and weaning were 0.827 ± 0.02 kg, 6.36 ± 0.156 kg, 8 ± 0.520, 6 ± 0.325, 6.621 ± 0.477 kg and 38.16 ± 2.41 kg, respectively.

The value for birth weight is in agreement with the reports of Mishra *et al.* (1989b). However the value obtained is more than those reported by Lakhani and Bhadoria (1990), Sharma *et al.* (1990), Lakhani and Bhadoria (1991), Deo *et al.* (1992), Gaur *et al.* (1996), Singh and Devi (1997a, b) and Mathew (1997). Shylla *et al.* (1991) reported higher values.

For weaning weight values the present findings are comparable with the reports of Lakhani and Bhadoria (1988; 1990; 1991), Gaur (1996) and Singh and Devi (1997a, b). However, Shylla *et al.* (1991), Deo *et al.* (1992), Jogi and Johar (1994) and Mathew (1997) reported higher values. Sharma *et al.* (1990) reported a lesser value.

The present findings excelled the values reported by Lakhani and Badoria (1990), Sharma *et al.* (1990), Kumari *et al.* (1994), Chhabra *et al.* (1996a), Singh and Devi (1997a, b), Mathew (1997), Goswami *et al.* (1999) and Bhargava *et al.* (1999) for litter size at birth and litter size at weaning and litter weight at birth. However, Mishra *et al.* (1990b), Kumari *et al.* (1994), Jogi and Johar (1996) and Bhargava *et al.* (1999) reported higher values for litter weight at weaning.

The co-efficient of variation for all the litter traits were almost 20 per cent. The variation in observations from other reports might possibly be due to the difference in nutritional and managemental conditions as well as the varying geographical conditions and hence varied climatic conditions under which the pigs would have been reared.

5.1.1 Different Factors Affecting Birth Weight

The present study revealed that sex had a significant effect on birth weight as reported by Shylla *et al.* (1991). However, this is not agreement with the studies of Mishra *et al.* (1989b), Lakhani and Bhadoria (1988), Sharma *et al.* (1990), Mukhopadhyay *et al.* (1991) and Deo *et al.* (1992) who reported a non significant effect of sex on the birth weight.

In the present study, sire had no significant effect on the birth weight. The findings do not agree with Lakhani and Jogi (1998). The non significant effect of sire on the birth weight might be because the birth weight is dependant on the nutrient availability for the foetus in the intra uterine environment. This is indirectly but definitely dependent upon the nutrition and health status of the sow as well as number of foetuses that develop in the uterus.

The litter size at birth had no significant effect on the birth weight. But there was a numerical decrease in the least squares means of birth weight when there was an increasing trend in litter size at birth. Mishra *et al.* (1989b) and Gaur *et al.* (1996) reported a significant effect of litter size at birth on birth weight.

5.1.2 Different Factors Affecting Weaning Weight

There was no significant effect of sex on weaning weight. Sharma *et al.* (1990), Mukhopadhyay *et al.* (1991), Lakhani and Bhadoria (1988), Shylla *et al.* (1991), Deo *et al.* (1992), Jogi and Johar (1994), Singh and Devi (1997a, b) observed similar results.

Sire had a significant effect on weaning weight. Similar results were observed by Lakhani (1988) and Jogi and Johar (1996). Weaning weight being significantly influenced by sire and its positive correlation with the post-weaning body weights indicate that it could be used as one of the selection criterion for growth.

Least square analysis of variance revealed that there was a significant effect of average birth weight on the average weaning weight. It was also noticed that there was a positive correlation between birth weight and weaning weight. Similar result was reported by Chatterjee *et al.* (1988). Thus when selecting animals for growth traits, selection could be well made in an earlier stage, at birth by opting for piglets with high birth weight.

Significant effect of litter size at weaning was noticed on weaning weight. Sharma *et al.* (1992) attributed similar results. It was noticed that there was a decreasing trend in weaning weight as the litter size at weaning increased. However it is apparent that higher litter size at weaning is advantageous as it results in increased total litter weight at weaning.

From the present study it is evident that various litter traits could be used in selecting the animals for increased growth. As these traits have a low heritability, instead of considering them directly for selection, they could be given certain weightage in formulating indices in the selection of sow.

5.2 PRE-WEANING MORTALITY

The observations from the present study revealed that the pre-weaning mortality was 25.86 per cent. The findings are in close proximity with the reports of Prasad *et al.* (1987), Lal *et al.* (1988b) and Mathew (1997). However, Kumar *et al.* *(1990)* and Jogi *et al.* *(1993b) reported a higher values for pre-weaning* mortality. However the result obtained is higher than the observations made by Sriraman and Krishnamacharyulu (1991) and Munyua *et al.* (1991).

In the present study, out of the total pre-weaning mortality, the maximum mortality occurred during the first month (75%). Similar findings were reported by Sadana and Singh (1972), Pillai and Thomas (1984), Chatterjee *et al.* (1988), Singh *et al.* (1990b) Gupta *et al.* (2001) and Kalita *et al.* (2002).

Further, the present study indicated that the pre-weaning mortality was highest in those piglets whose birth weight were less than 0.5 kg. The rate of mortality decreased with increasing birth weight but slightly increased for piglets with birth weight greater than one kg. These findings agree with the reports of Sadana and Singh (1972), Prasad *et al.* (1987), Chhabra *et al.* (1991), Pandey *et al.* (1995) and Lay *et al.* (2002).

Among the different causes of pre-weaning piglet mortality, gastro enteritis was found to be common (54.16%) followed by pneumonia (20.83%), haemorrhagic enteritis (12.5%) and catarrhal gastritis (8.33%). The mortality if piglets weighing less than 0.5 kg could be ascribed to lower intake of colostrum by those weak piglets, and hence the consequent increased susceptibility of those piglets to diseases. High humidity and the practice of cleaning the pens with pressurized water may be attributed to mortality due to pneumonia. Strict hygienic measures, adequate colostrum and provision of proper heating devices would help in reducing the infection related diseases and hence the piglet mortality. The above observations are in concurrence with the findings of Sadana and Singh (1972), Yaguchi *et al.* (1980), Sriraman and Krishnamachanyulu (1991), Munyua *et al.* (1991), Shobhamani and Krishna (1999), Kalita *et al.* (2002) and Lay *et al.* (2002).

5.3 GROWTH

In the present study the monthly body weights were found to be 4.144 ± 0.096 kg, 6.406 ± 0.154 kg, 8.916 ± 0.183 kg, 14.618 ± 0.227 kg, 20.211 ± 0.223 kg and 25.670 ± 0.205 kg for first, second, third, fourth, fifth and sixth months, respectively. The body weights increased as the age increased. The higher growth rate was found from fourth to sixth months of age. Similar observations were made by Chhabra *et al.* (1996b) and Jogi and Johar (1997). However a lower values were reported by Sharma *et al.* (1990), Lakhani and Bhadoria (1991) and Shylla *et al.* (1991).

The average daily gain for first, second, third, fourth, fifth and sixth months were 109.76 ± 2.814 g, 74.074 ± 2.865 g, 83.657 ± 2.527 g, 190.046 ± 4.030 g, 186.435 ± 3.927 g and 181.990 ± 3.793 g, respectively. The average daily gain increased from second month to fourth month and slightly decreased thereafter up to six months of age. Highest average daily gain was found during the fourth month of age. The higher growth rate from third to sixth month might be due to the revival of the piglets from weaning stress as well as the adaptation of their digestive system towards conventional diet. Reports by Gaur *et al.* (1997) were similar to the present findings. Chauhan (1993) reported higher values.

Sex of the animal was not found to be important in affecting the body weight. Only the birth weight of the animals was affected by sex. All the rest of the body weights measured were free from the effect of sex. Shylla *et al.* (1991) also observed that body weights up to 32nd week of age were not affected by sex except at birth. Similar findings were reported by Deo *et al.* (1992), Chhabra *et al.* (1996b), Pandey *et al.* (1996) and Kalita *et al.* (2001). But the findings do not concur with those of Chauhan *et al.* (1993), Jogi and Johar (1997) and Gaur *et al.* (1997) who reported a significant influence of sex on the growth rate.

5.4 BODY MEASUREMENTS

In the present study different body measurements such as length, height, chest girth and abdominal girth were recorded on monthly intervals. There was a parallel increase in different body measurements as the body weight of the animals increased. The correlation coefficients between body measurements and the body weight at all ages observed, showed that the body weight, length, height, chest girth and abdominal girths were positively and highly correlated, suggesting that an increase in any of the traits was accompanied by a similar increase in others.

Similar results of linear relationship between body weight and body measurements were reported by Gruev and Machov (1970), Sahaayaruban *et al.*

(1984) and Dash and Mishra (1986). But according to Berge (1951) body length was unreliable, while the chest measurement increased with increase in live weight. However, according to Deo and Raina (1983), although the genetic correlation of body length with heights at withers and barrel and heart girths were positive, it was not significant at all ages.

The multiple regression analysis of body measurements on the body weights revealed that the chest girth was the most highly contributing body measurement towards body weight until three months of age. However at later ages from fourth month onwards body length contributed the most towards the body weight. These revelations are in accordance with the findings of Mickwitz and Bobeth (1972). When the data were pooled over all the ages the body measurements contributing towards the body weight were in the order of body length (40.50%) followed by abdominal girth (22.20%), height (14.24%) and chest girth (4.14%).

5.4.1 Body Surface Area

In the present study the total body surface area was computed by dividing the body of the pig into different geometrical figures and summing up of these individual areas in square centimeters for both the genetic group at different classes of body weights. The body surface area of the Desi pigs was compared with that of Large White Yorkshire pigs. The Desi pigs were morphologically unique and different from that of Large White Yorkshire pigs.

The surface area in square centimeters increased with increase in body weight in both the Desi and Large White Yorkshire pigs. In both groups there was a negative linear relationship between body weight and surface area per kg body weight. For the pigs within the range of body weight from 16-22 kg the difference in surface area per kg body weight was not significant between the genetic groups. But when the pigs with increased body weights from 28 to 86 kg of Desi and Large White Yorkshire were compared there was a significant ($P<0.01$) difference in surface area per kg body weight. The Desi pigs had higher values for the body surface area per kg body weight in all the body weight classes above 22 kg. Pigs with lack of functional skin dissipate heat by wallowing behaviour through its effective surface area by radiation, conduction and convection (Hafez, 1968). The revelations of the present study indicate that Desi pigs with more effective surface area are morphologically unique and specially adapted to the tropical climate in which they have evolved. In Large White Yorkshire the effective surface area is comparatively less than the Desi pigs for all the weight classes above 22 kg. Though the Large White Yorkshire pigs have higher growth rate these are not comparable with their counterparts in the temperate climate. This might be due to the fact that pig being a versatile animal able to adapt to variety of circumstances, the imported temperate Large White Yorkshire breed would have adapted itself by reducing its growth rate and hence body weight resulting in marginal increase in effective surface area. Thus, the study also reveals that adaptability to humid tropical climate is largely influenced by body surface area.

5.5 SERUM GAMMAGLOBULIN

Serum gammaglobulin as estimated by turbidimetic method indicated that the average level of serum gammaglobulin was 17.605 mg/ml which falls in the lower limits of the normal range of gammaglobulins for pigs (Tizard, 2000). The level of gammaglobulin at three months of age will increase up to five months and then plateaus after a slight decline (Hafez, 1968).

In the present study the serum gammaglobulin had a positive and medium correlation with the post weaning body weights up to six months of age. Similar significant correlation between body weight gain and Ig level in sera of calves was reported by Halliday (1976). However, Caldow *et al.* (1988) reported that there was no statistically significant relationship between plasma IgG and overall live weight. But Ciupercescu (1977) reported a significant but negative correlation between body weight gain and IgG concentrations in sheep.

5.5.1 Different Factors Affecting Serum Gammaglobulin Level

Effect of sex was not significant on the serum gammaglobulin level. This is in concordance with Ciupercescu (1977) who reported a non significant difference between sexes in total serum immunoglobulin concentrations.

Sire had a significant effect on the serum gammaglobulin level. Similar findings were reported by Roubik and Ray (1972). But Raja *et al.* (1986) reported a non significant effect of sire on serum gammaglobulin levels in goats.

In the present study there was no significant effect of both birth and weaning weight on serum gammaglobulin level. However a numerical increase in serum gammaglobulin was noticed in piglets which had higher birth weight. This could be attributed to the low but significant correlation between birth weight and serum gammaglobulin as reported by Hendrix *et al.* (1978). Similar observation was reported by Yaguchi *et al.* (1980). There was a trend of increase in serum gammaglobulin level with increase in weaning weight.

The effect of litter size at weaning was significant on serum gammaglobulin level. The serum gammaglobulin was found to be lowest when the litter size was highest. Yaguchi *et al.* (1980) reported similar observation. It has been well established that there is a positive and significant correlation between litter size at birth and litter size at weaning (Lakhani and Bhadoria, 1990). The quantum of colostrum consumed by the piglets born in larger litters might be comparatively lower than those born in smaller litters. Moreover, the amounts of gammaglobulin synthesised are positively correlated with the amounts of gammaglobulin absorbed from colostrum (Rooke *et al.*, 2003). Thus may be the reason for lower levels of serum gammaglobulin in the piglets belonging to larger litter size group.

In the present study it was noted that the incidence of diarrhoea had a significant effect on the serum gammaglobulin level. The pigs which had diarrhoea had higher levels of serum gammaglobulin. Increased levels of gammaglobulin might be due to the transient increase in the autogenous production of antibodies against the environmental antigenic challenge. Results of incidence of death and infectious diseases and death in animals with lower levels of serum gammaglobulin were reported by Fincher and Delafeunte (1971), Thomas and Swaan (1973) and McCuire *et al.* (1976). The non significant effect of incidence of respiratory symptoms on serum gammaglobulin level might be due to occurrence of non systemic inflammation of the upper respiratory tract.

From the present study it was observed that viable piglets were larger at birth and the majority of the piglets died during the pre-waning period had a lower weight at birth. The primary reason for the piglets that died during first month might be because they are weak at birth and hence could not compete effectively during agonistic encounters with their litter mates. This would have led to a lowered consumption of colostrum and milk which eventually causes starvation, increased susceptibility to infections and death of piglets. The inherent morphological distinction of Desi pigs from Large White Yorkshire pigs based on different body measurements is established by their augmented effective surface area to evade thermal stress.

The first attempt at selection of animal during its life time could be made on the basis of weight at birth, since it is the first observable metric character and can be measured with accuracy. Moreover, birth weight is also an early expression of growth in later life and indicates future survival, physiological and functional development and is associated with a number of economic characters.

The screening of the animals for the serum gammaglobulin levels at the earlier age could be done to assess their competence against the environmental antigenic challenge in the later life. Although serum gammaglobulin level ostensibly determines the health status and viability, molecular level investigation of the Major Histocompatibility Complex gene locus would help in exploring the cryptic genetic potential of the Desi pigs with regard to disease resistance.

Summary

6. SUMMARY

A study was carried out to evaluate the estimates of certain litter traits of Desi pigs, the association of the blood globulin contents at three months of age with the incidence of disease and the morphological differences of Desi pigs based on different body measurements. Twelve female Desi pigs were bred with six Desi boars. Ninety six piglets obtained as progenies were studied for litter traits. All the progenies were maintained under uniform conditions of housing, feeding, health cover and managemental practices prevailing at Centre for Pig Production and Research, Mannuthy, Kerala Agricultural University.

Average values for litter traits were 0.827 ± 0.020 kg, 6.360 ± 0.156 kg, 8.0 ± 0.520, 6.0 ± 0.325, 6.621 ± 0.477 kg and 38.160 ± 2.48 kg for birth weight, weaning weight, litter size at birth, litter size at weaning, litter weight at birth and litter weight at weaning. Least squares analyses of variance for birth weight indicates that sex had significant influence on birth weight. The sire and litter size at birth had no significant influence on birth weight. Least squares analysis of variance for weaning weight indicates that sex had no significant influence on the weaning weight, however the sire, birth weight and litter size at weaning had a significant association with the weaning weight. The total pre-weaning mortality was 25.865 ± 3.107 per cent. Seventy five per cent of mortality occurred in the first month. Highest mortality percentage was found in piglets weighing less than 0.5 kg at birth. The major cause for pre-weaning mortality was gastro-enteritis followed by pneumonia.

The monthly body weight recordings indicated that the average body weight at sixth month of age was 25.670 ± 0.250 kg. The growth rate was faster from third to sixth month of age owing to the acquittal of piglets from weaning stress and the acquaintance of piglets to the conventional diet. The highest

average daily gain in weight (190.046 ± 4.030 g) was observed in the fourth month of age.

The monthly recordings of body measurements such as the body length, chest girth, abdominal girth and body height increased correspondingly as the body weight of the animals increased. The body measurements and body weights had a positive correlation at all ages observed. Chest girth was the most contributing body measurement towards the pre-weaning body weight, while body length contributed the towards the post-weaning body weight.

The body surface area for pigs at different classes of body weight was calculated by dividing the body of the pig into different geometrical figures and summing up of the individual areas in square centimeters. The results revealed that the Desi pigs had a larger body surface area/kg when compared to the Large White Yorkshire and the difference was significant for the weights from 28-86 kg.

The average serum gammaglobulin level among the piglets was 17.605 mg/ml. The Least squares analysis of variance for serum gammaglobulin indicated that sex had no significant influence on the serum gammaglobulin level. Birth and weaning weight had no significant influence on the serum gammaglobulin level. Sire and litter size at weaning had a significant association with the serum gammaglobulin level. Serum gammaglobulin modulated the incidence of diarrhoea in piglets to a highly significant level while it had no influence on respiratory infections. Serum gammaglobulin levels had a significant positive correlation with the post weaning body weights.

Desi pigs form a unique genetic group with distinctive morphological features. The birth weight being an early indicator of viability and growth in later life, it could be used in early selection of pigs for enhancement in growth. The serum gammaglobulin levels could be used as the indicator for health status of the pigs.

References

REFERENCES

Anon. 1997. *All India Co-ordinated Research Project (AICRP) on pigs*, Annual Report, Kerala Agricultural University, Thrissur, p. 20

Berge, S. 1951. Live weight and slaughter weight in relation to chest circumference in pigs. *Anim. Breed. Abstr.* 20(2): 750

Bhargava, M.V., Reddy, V.R.C., Rao, S.T.V., Venkataramaiah, A. and Reddy, K.K. 1999. Effect of non-genetic factors and inbreeding on litter traits in Desi pigs and its crosses. *Indian J. Anim. Sci.* 69(10): 845-847

Caldow, G.L., White, D.G., Kelsex, M., Petern, A.R. and Solly, K.J. 1988. Relationship of calf antibody status to disease and performance. *Vet. Rec.* 122(3): 63-65

Chakrabarti, S. and Basak, D.K. 1986. Piglet mortality in an organized farm in West Bengal. *Indian J. Anim. Hlth.* 25(2): 161-164

Chatterjee, J.K., Majumder, S.C. and Duttagupta, K. 1988. Studies on some pre-weaning traits in Large White Yorkshire and crossbred piglets under intensive management. *Indian Vet. J.* 65(8): 683-686

Chatterjee, J.K., Majumder, S.C., Roy, S.K. and Maitra, D.N. 1987. Effect of early weaning on the performance of purebred and crossbred piglets. *Indian J. Anim. Sci.* 57(7): 770-772

Chauhan, V.P.S., Arora, R.L., Chhabra, A.K. and Bhat, P.N. 1993. Preweaning and post weaning growth rates in indigenous pigs. *Indian Vet. J.* 70(1): 32-34

Chhabra, A.K., Bhatia, S.S. and Sharma, N.K. 1989. Effect of non-genetic factors on individual traits in Large White Yorkshire pigs. I. Pre-weaning body weights. *Indian J. Anim. Sci.* 59(2): 300-302

Chhabra, A.K., Bhatia, S.S., Sharma, N.K. and Dutta, O.P. 1990. Genetic study of litter traits in Large White Yorkshire pigs. *Indian Vet. J.* 67(8): 715-718

Chhabra, A.K., Gaur, G.K., Bhatia, S.S., Rahaja, K.L. and Paul, S. 1996a. Studies on litter traits in Desi and crossbred pigs. *Indian J. Anim. Res.* 30(2): 134-136

Chhabra, A.K., Gaur, G.K., Bhatia, S.S., Deo, S. and Arora, A.L. 1996b. Influence of non-genetic factors on growth performance in Desi pigs. *Indian Vet. Med. J.* 20(3): 38-40

Chhabra, A.K., Sharma, G.C. and Bisht, G.S. 1991. Factors influencing preweaning survival in pigs. *Indian Vet. J.* 68(7): 652-655

Ciupercescu, D.D. 1977. Dyanamics of serum immunoglobulin concentration in sheep during pregnancy and lactation. *Res. Vet. Sci.* 22: 23-27

Das, A.K. and Gaur, G.K. 1999. A note on factors affecting litter traits in crossbred pigs. *Indian J. Anim. Res.* 33(1): 67-69

Dash, P. and Mishra, M. 1986. Performance of Large White Yorkshire and its crossbreds with indigenous pigs in Orissa. *Indian J. Anim. Sci.* 56(1): 144-146

Deo, S. and Raina, B.L. 1983. Genetic and phenotypic correlations among body weights and body measurements in Landrace and Landrace x Large White Yorkshire pigs. *Indian J. Anim. Sci.* 53(4): 451-454

Deo, S., Chhabra, A.K., Arora, R.L., Paul, S. and Bisht, G.S. 1992. Genetic and non-genetic factors affecting growth performance in desi pig and its crosses. *Indian J. Anim. Sci.* 62(11): 1107-1108

Ensminger, M.E., Oldfield, J.E. and Heinemann, W.W. 1990. *Feeds and Nutrition.* Second edition. The Ensminger Publishing Co., USA, p. 1544

Fincher, E.W. and Delafeunte, G.H. 1971. Antibiotics and calf diarrhoea the effect of serum immunoglobulin concentration. *Vet. Rec.* 89(2): 645-649

Gaur, G.K., Chhabra, A.K., Bhatia, S.S. and Paul, S. 1996. Variation in growth performance between Desi and its crosses with Landrace pigs. *Indian Vet. Med. J.* 20 (6): 124-127

Gaur, G.K., Chhabra, A.K. and Paul, S. 1997. Growth intensity of indigenous pigs from birth to slaughter age. *Indian J. Anim. Sci.* 67(4): 344-346

Gay, C.C., Fincher, E.W. and Mc Ewan, A.D. 1965. Gamma globulin levels and neonatal mortality in market calves. *Vet. Rec.* 77: 148-149

Gopinath, P. 2001. Comparative evaluation of litter traits in desi, Large White Yorkshire and their crossbred pigs. M.V.Sc. thesis, Kerala Agricultural University, Thrissur, p. 122

Goswami, B.K., V-Miachie, O., Bavgohain, B.N. and Barua, P.M. 1999. Gestation length, duration of farrowing, litter size at birth and weaning in Hampshire, indigenous pigs and their crosses. *Indian Vet. J.* 76(1): 65-66

Gruev, V. and Machev, M. 1970. Relationship between body weight and body measurements in Bulgarian White pigs. *Anim. Breed. Abstr.* 40: 2089

Gupta, R.N., Dhingra, M.M. and Parmar, S.N.S. 1983. A study on litter weight at birth and weaning in Large White Yorkshire pigs. *Indian Vet. J.* 60(5): 381-383

Hafez, E.S.E. 1968. *Adaptation of domestic animals*. Lea and Febiger. Philadelphia, p. 415

Halliday, R. 1976. Variations in immunoglobulin concentrations in Finnish x Dornet horn lambs. *Res. Vet. Sci.* 21(3): 331-334

Halliday, R. and Williams, M.R. 1980. The relationship between serum immunoglobulin level and specific antibody production in calves. *Res. Vet. Sci.* 28(1): 76-81

Harvey, W.R. 1986. Mixed model Least-Squares and Maximum Likelihood Computer Programme, PC Version (PC-1) LSMLMW with Parmcard.

Hendrix, W.F., Kelly, K.W., Gaskins, C.T. and Hinrichs, D.J. 1978. Porcine neonatal survival and serum gamma globulins. *J.Anim.Sci.* 47(6): 1281-1286

Jayarajan, S. and Ulaganathan, V. 1992. Non-genetic factor affecting performance of pigs. *Indian J. Anim. Sci.* 62(9): 899-903

Jogi, S. and Johar, K.S. 1994. Factors affecting weaning weight in Desi pigs. *Indian J. Anim. Res.* 25(1): 35-39

Jogi, S. and Johar, K.S. 1996. Genetic analysis of sow productivity traits of Desi pigs. *Indian Vet. Med. J.* 20(6): 85-88

Jogi, S. and Johar, K.S. 1997. Factors affecting post weaning weights in Desi pigs. *Indian J. Anim. Res.* 31(1): 44-46

Jogi, S., Joshi, S.K., Mathur, M.M. and Dwivedi, C.K. 1993. Mortality pattern in Desi pigs. *Indian Vet. Med. J.* 17(3): 8-13

Kalita, D., Das, D. and Goswami, R.N. 2001. Body weight of indigenous pigs of Assam and their crosses with Hampshire as affected by various factors. *Indian Vet. J.* 78(11): 1024-1027

Kalita, G., Roychoudhury, R. and Goswami, R.N. 2002. Causes of pre-weaning mortality in pigslets. *Indian Vet. J.* 79(1): 72-73

Kannan, A. 1995. Influence of age and weight of gilt on breeding performance and feed intake during gestation and suckling period. M.V.Sc. thesis, Kerala Agricultural University, Thrissur, p. 100

Kumar, S., Singh, S.K., Singh, R.L., Sharma, B.D., Dubey, C.B. and Verma, S.S. 1990. Effect of genetic and non-genetic factors on body weight, efficiency of feed utilization, reproductive performance and survivability in Landrace, Desi and their half breds. *Indian J. Anim. Sci.* 60(10): 1219-1223

Kumari, B.P., Roddy, V.R.C., Reddy, K.K., Rao, C.H. and Rao, S.T.V. 1994. Effect of certain non-genetic factors on reproductive performance of Indian pigs. *Indian J. Anim. Sci.* 64(12): 1376-1378

Lakhani, G.P. 1992. Heritability and variability of weaning weight of Large White Yorkshire pigs. *Indian J. Anim. Res.* 26(1): 6-8

Lakhani, G.P. and Bhadoria, S.S. 1990. Studies on some pre-weaned economic traits in indigenous pigs. *Indian J. Anim. Res.* 24(1): 25-28

Lakhani, G.P. and Bhadoria, S.S. 1991. Studies on performance of indigenous pigs at livestock farm, Jabalpur. *Indian J. Anim. Res.* 25(1): 56-58

Lakhani, G.P. and Bhadoria, S.S. 1988. Heritability and variability of weaning weight of indigenous pigs. *Indian Vet. J.* 65(12): 1134-1136

Lakhani, G.P. and Jogi, S. 1998. Genetic study of birth weight in Desi pigs and their Large White Yorkshire grades. *Indian J. Anim. Res.* 31(1): 47-50

Lakhani, G.P. 1988. Litter weight at birth and weaning in indigenous pigs. *Indian Vet. J.* 65(10): 888-890

Lal, K., Mishra, R.R., Sharma, G.C. and Prasad, S. 1988b. Litter size and pre-weaning mortality in indigenous piglets. *Indian Vet. J.* 65(4): 325-327

Lal, K., Sharma, G.C., Mishra, R.R. and Prasad, S. 1988a. Growth rate of indigenous pigs. *Indian J. Anim. Sci.* 58(9): 1116-1120

Lay, D.C.Jr., Matteri, R.L., Carroll, J.A., Fangman, T.J. and Safranski, T.J. 2002. Pre-weaning survival in swine. *J. Anim. Sci.* 80 (E.Suppl. 1): E74-E86.

Leena, K. 1992. Effect of stocking density on the performance of growing pigs. M.V.Sc. thesis, Kerala Agricultural University, Thrissur, p. 132

Mathew, J. 1992. Effect of plane of feeding during prepartum and lactating stages on mothering ability and subsequent conception in sows. M.V.Sc. thesis, Kerala Agricultural University, Thrissur, p. 67

Mathew, J. 1997. Effect of enrichment of environment of Halothane sensitivity on performance of Large White Yorkshire and Desi pigs. Ph.D. thesis, Kerala Agricultural University, Thrissur, p. 139

*Mc Guire, T.C., Pfeifer, N.E., Kleikal, J.M. and Bartnch, R.C. 1976. Failure of colostral immunoglobulin transfer in calves dying of infectious diseases. *J. Am. Vet. Med. Ass.* 169(7): 713-718

Mickwitz, G. and Bobeth, K. 1972. Estimation of body weight from body measurements in pigs. *Anim. Breed. Abstr.* 42: 232

Mishra, R.R., Sharma, G.C., Prasad, S. and Lal, K. 1989a. Litter size of Indian pigs at birth. *Indian J. Anim. Sci.* 59(5): 616-617

Mishra, R.R., Sharma, G.C., Prasad, S. and Lal, K. 1989b. Studies on birth weight of local pigs in India. *Indian Vet. J.* 68(11): 1027-1030

Mishra, R.R., Lal, K. and Prasad, S.1990a. A study on reproductive parameters of Large White Yorkshire pigs. *Indian J. Anim. Res.* 24(1): 34-38

Mishra, R.R., Lal, K., Sharma, G.C. and Prasad, S. 1990b. Studies on litter weight at weaning of local pigs maintained in India. *Indian Vet. J.* 67(7): 552-553

Mishra, R.R., Prasad, S. and Lal, K. 1990c. A study on variation in birth weight of Large White Yorkshire piglets under farm conditions. *Indian Vet. J.* 67(7): 619-622

Mukhopadhyay, A., Singh, R.L., Singh, S.K. and Sharma, B.D. 1991. Factors affecting performance of pigs. *Indian J. Anim. Sci.* 61(4): 438-442

Munyua, S.J.M., Agumbah,G.J.O., Nienga, M.J., Kuria, K.G.N. and Kaman, J.A. 1991. Causes of pre-weaning mortality in small scale and medium-scale intensive piggeries in Central Kenya. *Indian J. Anim. Sci.* 61(2): 126-128

Nambudiri, A. and Thomas, T. 1984. Effect of season of farrowing on litter size, birth weight, weight gain and mortality in preweaned Large White Yorkshire pigs. *Kerala J. Vet. Sci.* 15(2): 9-14

Nandakumar, P. 1995. Genetic studies on the immune response of broiler rabbits. Ph.D. thesis, Kerala Agricultural University, Thrissur, p. 148

Nandakumar, P. and Rajagopalaraja, C.A. 1983. Growth and mortality in relation to serum immunoglobulin level in neonatal kids. Kerala J. Vet. Sci. 14(1): 49-52

Nandakumar, P., Anilkumar, K., Muraleedharan, P. and Mukundan, G. 1991. Effect of genetic group and age in serum immunoglobulin level in goats. *J. Vet. Anim. Sci.* 22(1): 165-167

Pandey, R.N., Singh, S.K., Singh, R.L., Dubey, C.B. and Jha, D.D. 1995. Mortality in exotic, Desi and their half bred pigs under farm conditions of rearing. *Indian J. Anim. Sci.* 65(9): 1049-1053

Pandey, R.N., Singh, S.K., Singh, R.L., Dubey, C.B. and Sinha, N.R.P. 1996. Genetic studies on daily weight gain in exotic, Desi and their halfbred pigs. *Indian J. Anim. Sci.* 66(8): 797-805

Pillai, C.N. and Thomas, K. 1984. Study on pre-weaning and post-weaning mortality in exotic pigs. *Kerala J. Vet. Sci.* 15(2): 45-52

Pradhan, C.R. 1993. Influence of chitin on growth and fatty acid composition in growing pigs. Ph.D. thesis, Kerala Agricultural University, Thrissur, p. 136

Prasad, S., Lal, K., Mishra, R.R. and Sharma, G.C. 1987. Factors affecting mortality in indigenous piglets. *Indian Vet. J.* 64(12): 1035-1038

Rai, A.V. and Desai, M.S. 1985. Studies on the economic traits of Large White Yorkshire pigs. *Kerala J. Vet. Sci.* 16(2): 11-18

Raja, C.A.R. and Balakrishnan, C.R. 1985. Influence of breed, age, parity status and stage of lactation of serum immunoglobulin level in cattle. *Kerala J. Vet. Sci.* 16(1): 6-10

Raja, C.A.R, Reghunandanan, K.V., Nandakumar, P. and Nandakumaran, B. 1986. In heritance of immunoglobulin level in Saanen x Malabari goats. *Kerala J. Vet. Sci.* 17(2): 111-112

Ramesh, V. 1998. Effect of housing systems on the reproductive performance of sows and gilts. M.V.Sc. thesis, Kerala Agricultural University, Thrissur, p. 90

*Ranatunga, P. 1971. Kid mortality in two major Government farms in Ceylon. *Trop. Anim. Hlth. Prod.* 3: 52-61

Rooke, J.A., Carranca, C., Bland, I.M., Sinclair, A.G., Ewen, M., Bland, V.C. and Edwards, S.A. 2003. Relationships between passive absorption of immunoglobulin G by the piglet and plasma concentrations of immunoglobulin G at weaning. *Livest. Prod. Sci.* 81 : 223-234

*Roubick, C.B. and Ray, D.E. 1972. Serum protein and protein fractions in unsupplemented range cattle. *J. Anim. Sci.* 34(6): 931-934

Sadana, J.R. and Singh, C.M. 1972. A statistical analysis of mortality in body pigs in Punjab and Haryana States. *Indian J. Anim. Sci.* 42(7): 529-533

*Sahaayaruban, P., Goonewardane, L.A. and Ravindran, V. 1984. Growth and prediction of body weight of pigs. *World Rev. Anim. Prod.* 20(1): 73-78

Samanta, S.K., Samanta, A.K. and Gupta, R.D. and Koley, N. 1996. Litter size and litter weight of Large White Yorkshire pigs in hot humid climatic condition of West Bengal. *Indian J. Anim. Hlth.* 35(4): 189-191

Sharma, B.D., Dubey, C.B. and Singh, S.K. 1990. A comparison study of growth in purebred and crossbred pigs. *Indian J. Anim. Sci.* 60(4): 492-495

Sharma, B.D., Singh, S.K., Dubey, C.D. and Mishra, H.R. 1992. A comparative study on growth pattern of exotic and Desi pigs and their half bred under farm and village conditions of rearing. *Indian J. Anim. Sci.* 62(4): 378-380

Shylla, B., Bordoloi, T., Das, D. and Goswami, R.N. 1991. Growth rate of indigenous pigs of Assam as affected by some non-genetic factors. Indian Vet. J. 68(3): 232-234

Singh, K.I., Singh, R.L., Singh, S.K., Sharma, B.D. and Dubey, C.B. 1990a. Body weight and efficiency of feed utilization in pigs. *Indian J. Anim. Sci.* 60(5): 605-608

Singh, K.I., Singh, R.L., Singh, S.K., Sharma, B.D. and Dubey, C.B. 1990b. Reproductive traits and mortality in pigs. *Indian J. Anim. Sci.* 60(7): 886-887

Singh, K.P., Ahlawat, S.P.S. and Malik, S. 1999. Factors affecting pre-weaning and post weaning average daily gain in Large White Yorkshire pigs. *Indian Vet. J.* 76(4): 326-329

Singh, S.K. and Devi, A.A. 1997. Factors affecting pre and post weaning body weights in pigs. *Indian Vet. Med. J.* 21(6): 150-153

Singh, S.K., Sharma, B.D., Dubey, C.B. and Singh, R.L. 1986. Litter traits and preweaning mortality of Large White Yorkshire pigs. *Indian J. Anim. Sci.* 56(4): 459-460

172183

Snedecor, G.W. and Cochran, W.G. 1985. *Statistical Methods*. Seventh edition. The Iowa State University Press, USA, p. 313

Somayazulu, L.B.S. and Agarwal, S.C. 1985. Prediction of slaughter weight of pigs on the basis of early body weights. *Indian J. Anim. Sci.* 55(3): 198-200

Sriraman, P.K. and Krishnamacharyulu, E. 1991. Pre-weaning losses in pigs. A comparative study between the Large White Yorkshire and indigenous breeds. *Indian J. Anim. Sci.* 61(7): 705-707

Suraj, P.T. 2000. Development of an integrated farming system on pigs. M.V.Sc. thesis submitted to Kerala Agricultural University, Thrissur, p. 72

*Thomas, L.H. and Swaan, R.G. 1973. Influence of colostrum on the incidence of calf pneumonia. *Vet. Rec.* 92(17): 454-455

Tizard, I.R. 2000. *Veterinary immunology an introduction*. Sixth edition. W. B. Saunders Company, Philadelphia, p. 482

Winkler, J.K. 1982. *Farm animal health and disease control*. Second edition. Lea and Febiger. Philadelphia, p. 280

Yaguchi, H., Murata, H., Kagota, K. and Namioka, S. 1980. Studies on the relationship between the serum gamma globulin levels of neonatal piglets and their mortality during the first two months of life: An evaluation for the ammonium sulphate reaction. *Br. Vet. J.* 136: 63-70

* Originals not consulted

GENETIC EVALUATION OF LITTER TRAITS AND VIABILITY OF DESI PIGS

KOWSIGARAJ. P.

Abstract of a thesis submitted in partial fulfilment of the requirement for the degree of

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University, Thrissur

2003

Department of Animal Breeding and Genetics
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR - 680651
KERALA, INDIA

ABSTRACT

In a six month study ninety six Desi piglets born in the same period and year were observed for evaluation of certain litter traits, association of gammaglobulin with incidence of disease symptoms and morphological differences based on body measurements. The average birth weight, weaning weight, litter size at birth and weaning, litter weight at birth and weaning were 0.827 ± 0.020 kg, 6.36 ± 0.156 kg, 8 ± 0.520, 6 ± 0.325, 6.621 ± 0.477 kg and 38.160 ± 2.48 kg, respectively. Influence of different factors on birth and weaning weight were worked out by Least squares analysis of variance. The pre-weaning mortality was 25.865 ± 3.107 per cent. The mortality percentage was worked out with respect to birth weight and the causes for the mortality were recorded based on post mortem findings. Maximum mortality occurred in piglets with 0.5 kg weight and below at birth. Gastro-enteritis and pneumonia were found to be the common causes of pre-weaning mortality.

The body weights and body measurements up to 180 days were recorded at monthly intervals. The average body weight at sixth month of age was 25.670 ± 0.250 kg. Maximum growth rate was found from the fourth to sixth month. Body weights and body measurements were positively correlated at all ages. The post-weaning body weight was most influenced by body length. The total body surface area of Desi and Large White Yorkshire pigs were computed by dividing the body into different geometrical figures. Desi pigs excelled the Large White Yorkshire in surface area per kg body weight and the difference was significant ($P<0.01$). Serum gammaglobulin was estimated by Zinc Sulphate Turbidity Test and the factors influencing its level were determined by Least squares analysis of variance. Sire, litter size and incidence of diarrhoea had significant ($P<0.05$) association with serum gammaglobulin level. Serum gammaglobulin level was positively correlated with post-weaning body weights.