COMPARATIVE STUDIES ON THE REPRODUCTIVE CHARACTERISTICS IN LARGE WHITE YORKSHIRE AND INDIGENOUS PIGS (*Sus domesticus*) WITH REFERENCE TO GESTATION AND FARROWING

BY

P. RAM BABU

THESIS SUBMITTED TO THE
ANDHRA PRADESH AGRICULTURAL UNIVERSITY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF

MASTER OF VETERINARY SCIENCE

IN THE FACULTY OF VETERINARY SCIENCE

DEPARTMENT OF ANIMAL REPRODUCTION & GYNAECOLOGY
COLLEGE OF VETERINARY SCIENCE, TIRUPATI
ANDHRA PRADESH AGRICULTURAL UNIVERSITY
RAJENDRANAGAR, HYDERABAD - 500 030

AUGUST, *1992*

C E R T I F I C A T E

Mr. P. RAMBABU has satisfactorily prosecuted the course of research and that the thesis entitled "COMPARATIVE STUDIES ON THE REPRODUCTIVE CHARACTERISTICS IN LARGE WHITE YORKSHIRE AND INDIGENOUS PIGS (Sus-domesticus) WITH REFERENCE TO GESTATION AND FARROWING" submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination.

I also certify that the thesis or part thereof has not been previously submitted by him for a degree of any University.

Date: 26.8.92

(S.V. RAMACHANDRAIAH)
MAJOR ADVISOR
ASSOCIATE PROFESSOR
DEPARTMENT OF ANIMAL REPRODUCTION
AND GYNAECOLOGY
COLLEGE OF VETERINARY SCIENCE
TIRUPATI.

C E R T I F I C A T E

This is to certify that the thesis entitled "COMPARATIVE STUDIES ON THE REPRODUCTIVE CHARACTERISTICS IN LARGE WHITE YORKSHIRE AND INDIGENOUS PIGS (Sus-domesticus) WITH REFERENCE TO GESTATION AND FARROWING" submitted in partial fulfilment of the requirements for the degree of MASTER OF VETERINARY SCIENCE of the Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad is a record of the bonafide research work carried out by Mr. P. RAMBABU under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

No part of thesis has been submitted for any other degree or diploma. The published part has been fully acknowledged. All assistance and help received during the course of the investigation have been fully acknowledged by the author of the thesis.

CHAIRMAN OF THE ADVISORY COMMITTEE

Thesis approved by the Student Advisory Committee.

CHAIRMAN: (S.V. RAMACHANDRAIAH)
Associate Professor
Dept. of Animal Reproduction
& Gynaecology
College of Vety. Science, Tirupati

MEMBER: (A. VENKATAMUNI CHETTY)
Professor & University Head
Dept. of Animal Reproduction
& Gynaecology
College of Vety. Science, Tirupati

MEMBER: (N.R. GOPAL NAIDU)
Associate Professor
Department of Pathology
College of Vety. Science, Tirupati

MEMBER: (K. KRISHNA REDDY)
Scientist
A.I.C.R.P. on Pigs
College of Vety. Science, Tirupati

ASSOCIATE
DEPARTMENT
ANIMAL REPRODUCTION
COLLEGE OF VETY. SCIENCE
TIRUPATI

Professor and Head,
Dept. of Animal Reproduction & Gynaecology
COLLEGE OF VETERINARY SCIENCE,
TIRUPATI - 517 502
ANDHRA PRADESH

SCIENTIST
All India Co-ordinated
Research Project on
College of Vety. Science

C O N T E N T S

LIST OF ILLUSTRATIONS

LIST OF TABLES

ACKNOWLEDGEMENTS

I wish to express my heartiest gratitude to my major advisor Dr. S.V. Ramachandraiah, Ph.D., Associate Professor, Department of Animal Reproduction & Gynaecology, for suggesting the problem, inspiring and able guidance, keen and sustained interest evinced during every phase of the investigation and preparation of thesis. I owe to his valuable advice, benevolence and help rendered throughout the period of my study.

I wish to express my gratitude to Prof. A.Venkatamuni Chetty, University Head, Department of Animal Reproduction and Gynaecology for his suggestions and encouragement in carrying out this work.

I wish to express my gratitude to Dr. N.R.Gopal Naidu, Phl Associate Professor, Department of Pathology for his suggestions and encouragement.

I wish to express my deep sense of appreciation to Dr. P.K. Sreeraman, Ph.D., Assistant Professor, Department of Pathology for his valuable practical suggestions, continuous encouragement, without whose guidance, assistance and constructive criticism, this thesis would not have taken this shape and form.

With great pleasure, I place on record my indebtedne to Dr. K. Krishna Reddy, Scientist, A.I.C.R.P. on Pigs, College of Veterinary Science, Tirupati, who has readily accepted my request to provide necessary facilities in the project to carry out research work as well as his valuable suggestions and encouragement during my study.

I earnestly thank the Director, Directorate of Animal Husbandry, Hyderabad and Dr. P. Jagannadha Rao, Assistant Director (AH), Pig Breeding Station, Gopannapalem, Eluru who has readily accepted my request to provid necessary facilities in the station to carry out the resea work.

I feel great pleasure in expressing my thanks to Dr.K. Subramanyam Naidu, Assistant Professor, Dr. K. Venugopal Naidu, Assistant Professor, non-teaching staff of Animal Reproduction and Gynaecology, Pig Breeding Station, and AICRP on Pigs for their help rendered in completion of this work.

I am indebted to Dr. K.G. Solmon Raju, Veterinary Assistant Surgeon, Pedavegi (West Godavari), for his cordi co-operation and valuable suggestion in completion of this work.

My thanks are due to my colleagues and friends for their constant help and encouragement.

I avail this opportunity to express my thanks to my major guide's family for their encouragement during my study.

My appreciation is extended to Sri P. Gangaiah and Sri P. Venkatesu for their excellent typing of thesis.

The lack of vocabulary utterly fails me to express my heartfelt gratitude to my mother (late), father and brothers without whose encouragement and help I would not have taken up higher studies.

I wish to express my deep sense of appreciation to my wife, Neelima and sisters for their encouragements and affection showen during the study period.

Finally I am thankful to Government of Andhra Pradesh for providing financial assistance.

(P. RAMBABU)

Name of the author	:	P. RAMBABU
Title of the thesis	:	"COMPARATIVE STUDIES ON THE REPRODUCTIVE CHARACTERISTICS IN LARGE WHITE YORKSHIRE AND INDIGENOUS PIGS (*Sus-domesticus*) WITH REFERENCE TO GESTATION AND FARROWING"
Degree to which it is submitted	:	MASTER OF VETERINARY SCIENCE
Faculty	:	Faculty of Veterinary Science Department of Animal Reproduction and Gynaecology
Guide	:	Dr. S.V.RAMACHANDRAIAH Associate Professor Department of Animal Reproduction & Gynaecology College of Veterinary Science TIRUPATI-517 502.
University	:	Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad-500 030.
Year of submission	:	1992.

ABSTRACT

A comparative study was undertaken on certain reproductive characteristics in twelve each of indigenous and Large White Yorkshire pigs, stationed at A.I.C.R.P. on Pigs, College of Veterinary Science, Tirupati and Pig Breeding Station, Gopannapalem, Eluru, respectively.

The first visible sign of pregnancy i.e. abdominal distension was noticed by 1½ months. The change in mammary gland was conspicuous by 2½ months and in the external

genitalia by 2½ to 3 months. These changes were more conspicuous as the pregnancy advanced.

Before the impending act of farrowing, various symptoms like anorexia (except LWY) restlessness, nest building behaviour etc. were noticed. Farrowing occurred during the quiet period of the day i.e. 12.00 noon to 12.00 mid night.

The average gestation length in the indigenous pigs was 110.9 ± 0.94 days and 113.33 ± 0.41 days in the LWY.

The duration of 1st stage of farrowing was 434.5 ± 39.42 mts in the indigenous pigs and 498.5 ± 36.88 mts in the LWY. The second stage lasted for 80.8 ± 13.81 in the indigenous breed and 95.25 ± 2.68 mts in LWY.

The time taken for expulsion of placentae differed significantly between the breeds (169.3 ± 26.20 mts in the indigenous and 98.0 ± 9.06 mts in the LWY breed). The combined duration of 2nd and 3rd stage of farrowings between the breeds differed significantly. It was longer (250.1 ± 23.17 mts) in the indigenous pigs and shorter (193.25 ± 11.08 mts) in the LWY breed.

Most of the piglets were delivered in the anterior presentation and dorso-sacral position.

The time interval between the birth of successive liveborn piglets was shorter (10.13 ± 1.76 mts and 8.2 ±

0.25 mts in the indigenous and LWY breeds, respectively) when compared to the interval between the liveborn and stillborn piglets (15.8 ± 7.14 mts in the indigenous and 14.33 ± 4.48 mts in the LWY). Between the breeds, the time interval between birth of successive liveborn piglets was shorter in LWY.

A significant difference in the litter size and liveborn piglets/litter was noticed between the two breeds. The litter size and liveborn piglets/litter were 7.7 ± 0.90 and 7.2 ± 0.74, respectively in the indigenous and 10.17 ± 0.64 and 9.67 ± 0.59, respectively in the LWY breed.

The mean liveborn piglet weight was significantly lesser in the indigenous pigs(827.02 ± 51.13 g) than that in LWY (1075.65 ± 48.10 g).

The incidence of stillborn piglets was 6.49% in the indigenous breed and 4.92% in the LWY pigs.

The percentage of males born was less in both the breeds. Most of the indigenous and LWY sows expelled the placentae either in a single mass and or in batches, after the birth of the last piglet. A few LWY sows expelled it during the birth phase. The placentae of mummified fetuses were found wrapped around the fetus.

Most of the LWY piglets (62.93%) and few of the indigenous piglets(16.67%) had intact umbilical cords when born, which were broken within a few minutes.

None of the sows in both the breeds had any type of dystocia nor the piglets any teratological defects.

A significant difference in the gestation length of mixed group of dams was noticed between LWY breed and indigenous pigs. The duration of second stage of farrowing did not differ in the normal group of dams in these two breeds. In the indigenous breed the litter size of mixed group of dams (10.64 $\pm$ 0.54) differed significantly from that of normal group (6.42 $\pm$ 0.90).

A significant and positive correlation between the litter size and litter weight and between the number of placentae and their weight or between the number of live-born piglets/litter and their weight was observed in both the breeds.

In LWY, a significant and positive correlation between 2nd and 3rd stage of farrowing and litter size and between liveborn piglet weight/litter and gestation length was observed. A negative and significant correlation was seen between the mean liveborn piglet weight and number of stillborn piglets.

LIST OF ABBREVIATIONS

A.I.C.R.P.	:	All India Co-ordinated Research Project
A.P.	:	Andhra Pradesh
g	:	Grams
hrs	:	Hours
Kg	:	Kilograms
LWY	:	Large White Yorkshire
M.P.	:	Madhya Pradesh
mts	:	minutes
wt	:	Weight
U.P.	:	Uttar Pradesh

::::

to enable the farmer to maintain the pig herd in a more economic way and thus earn more profits by prompt culling of non-productive female pigs, reducing the piglet losses etc.

On perusal of the available literature, information on the reproductive characteristics of indigenous and Large White Yorkshire pigs under Indian conditions was found to be scanty and these can be hardly construed as authentic. Since the available information on the various aspects of normal gestation and farrowing appeared to vary between the Large White Yorkshire and indigenous pigs, a study was undertaken to investigate these on scientific lines and compare the data obtained from these two breeds, so that a better package of management practices can be thought off for a successful and profitable pig enterprises.

In this investigation, detailed studies on the gestation and farrowing, litter traits, placenta and umbilical cord, including the age at farrowing as well as age at conception were made both in the Large White Yorkshire (LWY) and indigenous (sus-domesticus) breeds of pigs. The incidence of dystocia and teratological defects, if any were also recorded and the results compared.

CHAPTER II

2. REVIEW OF LITERATURE

Information on the reproductive characteristics on the indigenous and Large White Yorkshire (LWY) breeds was found to be scanty. However, the information available on the indigenous and Large White Yorkshire pigs was reviewed in brief along with that of exotic breeds, giving only the salient and important observations of different workers to avoid cumbersomeness. The mean values of various characters reported by several authors are grouped in a particular range for each breed to avoid giving numbers repeatedly. The details of the observations by different workers are given in the Appendix.

2.1 GESTATION:

2.1.1 Signs of pregnancy:

Literature on the various signs of pregnancy viz., abdominal distension, mammary gland development, changes in the external genitalia and the behaviour of the pigs, prior to, during or after the farrowing are reviewed.

2.1.1.1 Abdominal distension:

The only report available was that of Solmon Raju (1991) of Andhra Pradesh (AP) on indigenous pigs, who

reported a visible abdominal distension at 1½ months of pregnancy and the abdominal distension was prominant as the pregnancy advanced.

2.1.1.2 Development of mammary gland:

The information on the visible changes in the mammary gland during the gestation period was also scanty. A few reports available are reviewed.

Jones (1966a), Hughes and Varley (1980), Arthur et al. (1982), Gordon (1983) and Hurnik (1985) reported in exotic breeds, a well developed, flacid mammary gland during advanced stages of gestation and enlarged, turgid individual cone shaped glands a few hours to a day prior to farrowing.

Hafez (1987) observed the tubulo-alveolar development of the mammary gland by Day 45 of pregnancy, which developed well by Day 60.

Solmon Raju (1991) observed a conspicuous change in the size of mammary gland by 2½ months of pregnancy in the indigenous gilts and the changes were prominent as pregnancy advanced.

2.1.1.3 Changes in external genitalia:

Jones (1966 a) noticed in LWY pigs a prominent and swollen vulval lips with eversion of vaginal mucous

membrane, about 4 days prior to farrowing, which subsided gradually by Day 4 post-partum.

In exotic breeds of pigs, Roberts (1971), Hughes and Varley (1980), Hurnik (1985) and Solmon Raju (1991) in indigenous pigs of A.P. observed a progressively swollen and edematous vulva as pregnancy advanced.

2.1.1.4 Behaviour of the pigs prior, during and after farrowing:

A few days prior to the onset of farrowing, the exotic pigs were found to be sleeping and feeding (Jones, 1966a and Fraser 1978) moving slowly (Sambraus, 1978) or tried to select a site for farrowing (Fraser, 1978). Hurnik (1985) reported the signs of anorexia.

Jones (1966a), Roberts (1971), Hughes and Varley (1980) and Graves (1984) reported a variation in the time of exhibition of nesting behaviour. While, Hurnik (1985) found it only a day prior to farrowing.

Fraser (1978), McDonald (1980), Gordon (1983), Reddy and Charyulu (1985) and Lammers and Lange (1986) reported that nesting behaviour occurred a few days prior to farrowing.

The nesting behaviour was manifested either by vigorous pawing movements of forelegs (Jones, 1966 b, Signoret et al., 1975, Fraser, 1978 and Lammers and Lange, 1986 in exotic breed and Solmon Raju, 1991 in indigenous pigs) or heaping up of the bedding with snout in one place; (Jones, 1966 b) or even carrying the straw with their mouths and moving around the pen (Hughes and Varley, 1980 and Solmon Raju, 1991) and plugging the holes and openings in the pen (Hurnick, 1985).

Lammers and Lange (1986) in Dutch Landrace breed and Solmon Raju (1991) in indigenous pigs of A.P., found a more efficient nest building behaviour.

As the hours of farrowing approached the various signs exhibited by the pigs were frequent standing, lying and restlessness (Roberts, 1971 , Randall, 1972a, Kelly and Curtis, 1978, Fraser, 1978, Hansen and Curtis, 1980, Hughes and Varley, 1980, Arthur et al., 1982, Jensen, 1986 and Edward and Furniss, 1988), chewing of jaws and grinding of the teeth (Jones, 1966 b, Hurnik, 1985; in LWY and Solmon Raju .1991; in indigenous pigs) and inappetance, distress, anxiety and withdrawal from usual environment (McDonald, 1980).

A few minutes prior to actual expulsion of the first piglet, pigs were found to be quieter and settled in

lateral recumbancy (15-60 mts - Jones, 1966 b, and 15 mts to 3 hours - Hurnik, 1985) and maintained a lying posture during the expulsion of subsequent piglets (Jones, 1966 b, Roberts, 1971, Fraser, 1978, McDonald, 1980 and Hurnik, 1985). Fraser (1978) reported ventral recumbancy during the initial stages of farrowing in his observation.

The recumbant sows when expelling the piglets, stretched out.or tried to kick with the upper hind leg, simultaneously exhibiting vigorous tail movements (Jones, 1966 b, Roberts, 1971 and Fraser, 1978). The expulsive efforts made by the animal was indicated by the visible intervals of abdominal straining (Jones (1966 b; and Roberts 1971; in.exotic pigs; and Solmon Raju (1991; in indigenous pigs), whichwere not noticed by Mathai et al. (1972) in LWY breed.

A few minutes (1-22 minutes) prior to the birth of the 1st piglet, Randall (1972 a) noticed blood strained allantoic fluid, whereas Hurnik (1985) found mucoid vulval discharges.

Postural differences were noticed between the birth of each piglet (Jones, 1966b and McDonald, 1980). Arthur et al. (1982) and Hurnik (1985) reported that the gilts got up or changed the sides or postures from lateral to

ventral recumbancy. During the birth phase intermittent blood tinged discharges from the external genitalia were found between the birth of each piglet (Jones, 1966 b, Randall, 1972a and Solmon Raju, 1991).

In the exotic breed, the birth of a single piglet or birth of two or three or even more piglets simultaneously, was reported by Jones (1966 b) and Randall (1972 a).

A variation in the maternal instinct among the pigs was observed, though McDonald (1980) reported that the pigs had strong protective reaction against other animals. Gordon (1980) found that the pigs could not provide much maternal help to the piglets at birth. Stigson (1980) reported that the Sweedish Landrace pigs had better mothering characters than Sweedish LWY. Solmon Raju(1991) observed a good maternal instinct in indigenous pigs.

One of the good signs of maternal instinct was reported to be loud barking, grunts in rapid succession towards their own nest when intruder disturbed the nest (Fraser, 1978 and Reddy and Charyulu, 1985, and Solmon Raju, 1991). Jensen (1986) noticed a close association of the mother to the nest for about 9 days.

2.1.1.5 Gestation length:

The length of gestation was influenced by factors like breed, strains of sow and boar, number of fetuses, hormones of pituitary etc. (Cole and Cupps, 1977).

In the indigenous breed of pigs in Africa, the gestation length was found to be between 113-128 days (Holness, 1970). In Nigerian indigenous breed, the average length was 113.6 days (Adebambo, 1986). In India, in indigenous pigs of Orissa, Mishra et al. (1985) recorded the gestation length to be 110.43 days and in wild variety of pigs, Tamuli et al. (1986) reported it to range between 106-120 days.

Among the indigenous pigs maintained by co-ordinated Projects at different centres in India, the average length of gestation was found to be 109.69 days (Summary reports, 1971-90, AICRP on Pigs). But Singh et al. (1990) reported the average length of gestation to be 113.6 days in Desi pigs. In the indigenous gilts, Solmon Raju (1991) found it to be 113.37 days.

The gestation length in LWY pigs was found to range from 112.8 to 115.6 days (Banov, 1971, Tan and Chan, 1983, Reyes, 1983, Adebambo, 1986, Tsitsyurskil, 1986, Kurcman and Wardowski, 1987, and Kim et al., 1988) but Singh et al. (1990) reported it to be 114.09 days in LWY.

In Landrace breed, Stankovic (1971), Stojanovic et al. (1973), Bonte et al. (1980), Reyes (1983) Tan and Chen (1983), Lee et al. (1984), Kim et al. (1988), Tsitsyurskil and Mikhno (1991) found the gestation length to range from 112.3 to 115.1 days, but Huhn (1989) reported it to be 114.9 days. In Duroc breed, Reyes (1983) and Tan and Chen (1983) recorded the same to be 115.1 and 115.24 days, respectively.

The Hampshire pigs had a gestation length of 111.42 - 115.7 days (Tan and Chen, 1983, Adebambo, 1986, Kim et al., 1988 and Rico, 1988). The Vietnamese breed had a highest range of gestation period ranging between 117-118 days (Hottmar, 1982) in Russian LWY sows, the gestation length averaged 114.74 days (Tsitsyurskil and Mikhno, 1991).

2.2 FARROWING:

2.2.1 Time (diurnal pattern) of farrowing:

The time of farrowing in a day differed among the pigs, while Roberts (1971) reported 73% of farrowings during the day time, Dinu et al. (1978) noticed 72.3% in the night. Similarly Highes and Varley (1980) and Arthur et al. (1982) observed 60-70% of farrowings in the night.

In the Indigenous pigs of Assam, Devi (1986) reported 62% of farrowings in the night. In the wild variety, Tamuli et al. (1986) found the farrowings either early at dawn or in the early morning. In the indigenous pigs of A.P., Solmon Raju (1991) recorded 66.67% of farrowings in the day time.

In LWY, Benkov (1981) and Reyes (1983) noticed 44.8% and 60% of farrowings to occur during the day time, respectively.

2.2.2 Stages of farrowing:

The act of farrowing was divided into three stages.

2.2.2.1 First stage:

The first stage of farrowing was found to be variable amongst individual pigs. It usually ranged from two to twelve hours (Salisbury and VanDemark, 1961; Roberts, 1971; Hughes and Varley, 1980, Bearden and Fuquay, 1980, and Hafez, 1987).

In the indigenous pigs of Assam, Devi (1986) recorded the duration of 1st stage to be from 317.33 to 448.68 mts, while in the wild variety it was to be the least i.e., 3-6 hours by Tamuli et al. (1986). In the Indigenous pigs Solmon Raju (1991) found the 1st stage to last for 431.33 minutes.

Singh and Singh (1989) reported that the duration of first stage was 1.59, 3.18 and 2.70 hours in LWY, Landrace and Hampshire breeds, respectively.

2.2.2.2 Second stage:

In the Indigenous pigs of Assam, Devi (1986) recorded the second stage to last for 67.85 to 247.64 mts. Tamuli et al. (1986) reported the same to last 75-190 mts in wild variety of pigs. In the Indigenous pigs of A.P., Solmon Raju (1991) observed the duration of second stage to be 90.73 mts.

In LWY, Mathai et al. (1972), Cavalcanti et al. (1979), Fahmy and Friend (1981) and Singh and Singh(1989) recorded the 2nd stage to last for 2.53; 4.30; 3.9 and 2.39 hours, respectively.

In Landrace, Cavalcanti et al. (1979), Fahmy and Friend (1981), Reyes (1983) and Singh and Singh (1989) observed the second stage of farrowing to last for 5.4 hour, 140.5 mts, 114.7 mts and 2.62 hours, respectively. Whereas in Duroc breed, it was found to be 5.55 hours (Cavalcanti et al., 1979) and 114.7 mts by Reyes (1983). In Hampshire, Cavalcanti (1979) and Singh and Singh (1989) reported the same to last for 5.33 hrs and 1.82 hrs, respectively.

2.2.2.3 Third stage:

Normally placentae were expelled in pigs within 4 hrs after the birth of the last piglet (Hughes and Varley, 1980, Bearden and Fuquay, 1980 and Hafez, 1987).

The third stage in the Indigenous pigs of Assam, lasted for 136.67 to 262.33 mts (Devi, 1986) and in the wild pigs 45-105 mts (Tamuli et al., 1986). In the indigenous pigs, the same was reported to last for 126.07 mts (Solmon Raju, 1991).

The third stage in LWY was found to last for 1.53 hr by Jones (1966 b), and 3.26 hr by Mathai et al. (1972). In Landrace, it was found to be 3.15 hrs and in Hampshire 2.28 hrs, by Singh and Singh (1989).

2.2.2.4 Time taken for second and third stages:

In the Indigenous pigs of Assam, Devi (1986) reported the time taken for second and third stages of farrowing to be 204.50 to 509.99 mts and in wild variety of pigs 120-295 mts by Tamuli et al. (1986). In indigenous pigs of A.P., the same was noticed to be 216.80 mts (Solmon Raju, 1991).

The time taken for the second and third stages of farrowing in LWY was reported to be 6.54 hr (Jones, 1966 b) and 6.31 hr (Mathai et al., 1972).

2.2.3 'Presentation' and 'position' of the fetus:

2.2.3.1 'Presentation' of the fetus:

Many workers reported that the anterior presentation was the most common presentation. In exotic breeds of pigs, 75.7% - Jones, 1966 b; 60-70% - Roberts, 1971; 71% - Mathai et al., 1972; 55.4% - Randall, 1972a; and 63.0% - Taura et al., 1986.

In the indigenous pigs, Solmon Raju (1991) noticed the anterior presentation in 57.02% of births.

2.2.3.2 'Position' of the fetus:

Most of the piglets were found to be delivered in dorso-sacral position (94.3%), though dorso-lateral (4.2%) and dorso-pubic(1.5%) position were not uncommon (Roberts, 1971).

In the indigenous pigs of A.P., the frequency of different positions found were 94.74% - dorso-sacral, 4.38% - dorso-lateral and 0.88% - dorso-pubic position (Solmon Raju, 1991).

2.2.4 Time interval between the expulsion of successive piglets:

A variation in the time interval amongst the piglets in the birth order was reported.

The time interval between the expulsion of two liveborn piglets was observed to be 5 to 20 mts. by Tamulu et al. (1986) in wild variety of Assam pigs. In the indigenous pigs, Solmon Raju (1991) noticed it to be 1-93 mts between two liveborn piglets and 4 to 183 mts between the live and stillborn piglets.

In the exotic breeds of pigs, the time interval between the expulsion of two liveborn piglets was found to be from 3 to 60 mts (Jones, 1966 b; Roberts, 1971; Mathai et al., 1972; Cole and Cupps, 1977; Fraser, 1978; McDonald, 1980; Arthur et al., 1982; Dumitrescu et al., 1982; Gordon, 1983; Singh and Singh, 1989 and Murayamma, 1990).

The time interval between the expulsion of liveborn to stillborn piglets was reported to be between 45-55 mts by Cole and Cupps (1977) and 20 mts by Gordon (1983).

2.3 LITTER TRAITS:

2.3.1 Litter size:

Various factors like age at first farrowing, parity, ovulation rate, season, fertilization rate and type of breed, the strains within the breed influence the litter size in pigs (Mathai and Ramachandran, 1972; Hughes and Varley, 1980; Mohanty and Nayak, 1986; Park et al., 1989 and Chhabra et al., 1990).

The litter size in the indigenous pigs of different countries and within country was found to vary. The litter size was 0.9 in Africa (Holness, 1970), 6-8 in India (Ghatnekar, 1981), 6.0 in Sri Lanka (Rajamahendran et al., 1985) and 6.9 in Nigeria (Adebambo, 1986).

The litter size in the indigenous pigs of India, as reported by several authors of their locality were; Sharda and Singh (1982)-Haryana, 8.0, Dhingra (1987)-Andhra Pradesh, 6.5, Assam 4.70 and Madhya Pradesh, 6.76, Mishra et al. (1989)-A.P. 6.62, U.P. 7.51, Assam 4.93 and M.P. 6.52; Mishra et al. (1989)-Orissa, 5.61., The coordinated projects located at different centres in India, 7.63 (Summary reports, 1971-90, AICRP on pigs). In the indigenous pigs, Solmon Raju (1991) recorded the litter size to be 8.40.

The litter size in LWY gilts varied from 7.09 to 10.10 (Elevage, 1974; Svinskotsel, 1984; Kurcman and Wardowski, 1987, Venev, 1988 and Singh et al., 1989) but in sows, the average size was found to be 10.1 by Silva and Dap (1990), which in dry season was recorded to be 9.18 and in wet season it was 11.06, by Omeke (1990).

The litter size in Landrace ranged from 6.55 to 11.14 (Stojanovic et al., 1973, Elevage, 1974, Kapko and Tokareva, 1974, Svinskotsel, 1984, Schoeps and Huhn, 1986,

Bogos and Cojocaru, 1987, Kayaba et al., 1989, Olsson and Svendsen, 1989 and Singh et al., 1989). The litter size in dry season was 8.17 and in the wet was 9.18 (Omeke, 1990).

The litter size in Duroc was 10.0 (Svinskotsel, 1984) and 9.2 (Sweden, 1988 and Nascimento, 1988).

In Hampshire breed of pigs, the litter size was 10.0 (Svinskotsel, 1984) and 8.9 (Sweden, 1988).

In Chinese breed of pigs, the litter size ranged from 11.9 to 15.9 (Cheng, 1985, Siler, 1985, Qi, 1985 and Molenat, 1987).

In North Caucasus gilts, Kapko and Tokareva (1974) found the litter size to be from 8.72 to 9.4.

2.3.1.1 Litter weight:

Variation in the litter weight was found amongst different breeds.

In India, the litter weight in the indigenous pigs averaged 6.50 kg (Dhingra, 1987). In A.P., Solmon Raju (1991) recorded the litter weight in indigenous gilts as 6.31 Kg.

The litter weight in LWY breed was also found to vary, while Konyukhova (1974), Gal (1976), Gonzalez et al. (1987) recorded a litter weight of 12.98 to 13.60 Kg. Alves et al. (1987) noticed the litter weight to be 16.0 kg but Chhabra et al. (1990) observed the litter weight to be 14.90 kg.

In Landrace, Stojanovic et al. (1973), Alves et al. (1987), Gonzalez et al. (1987) and Mishra and Sharma (1990) recorded the litter weight in the range from 10.76 to 13.48 kg.

In Duroc breed, Alves et al. (1987) and Gonzalez et al. (1987) recorded the litter weight as 14.70 and 11.89 kg, respectively whereas in Hampshire, Gonzales et al. (1987) and Rico (1988) noticed it to be 14.45 and 12.35 kg, respectively.

2.3.2 Liveborn piglets per litter:

The number of liveborn piglets per litter was found to vary among the breeds. The number of liveborn piglets per litter in the indigenous pigs of Nigerian was found to be 6.9 by Adebambo (1986) and in the indigenous pigs of A.P., the same was 7.60 (Solmon Raju, 1991).

In LWY pigs, the number of liveborn piglets per litter ranged from 8.1 to 10.5. (Stankovic et al., 1973, Gal, 1976, Mani, 1985, Adebambo, 1986, Boulard et al., 1986 and Gonzalez et al., 1987). In Landrace pigs, the liveborn piglets per litter ranged from 9.2 to 10.4 (Gal, 1976, Moskal, 1980, Vidovic, 1984, Mani, 1985, Boulard et al., 1986 and Gonzalez et al., 1987).

In Duroc breed, Moskal (1980) and Gonzalez et al. (1987) recorded the liveborn piglets per litter to be 8.95 and 8.33, respectively. In Hampshire breed, it was reported as 7.3 by Adebambo (1986), 8.78 by Gonzalez et al. (1987) and 7.4 by Rico (1988).

In different Chinese breeds of pigs, the number of liveborn piglets per litter was found to vary from 11.3 to 14.5 (Molenat, 1987 and Cao et al., 1988).

2.3.2.1 Liveborn piglets weight per litter:

Various factors like season of birth, sex of the fetus, nutrition influenced the piglets weight at birth (Hughes and Varley, 1980 and Mishra et al., 1990). Variation was also noticed between the breeds and strains of the same breed (Appendix).

The mean piglet weight in the indigenous pigs located at different centres in India was found to be 0.74 kg

(Summary reports 1971-90, AICRP on pigs) but it was 0.69 and 1.02 kg in the pigs of Haryana (Sharda and Singh, 1982) and Orissa State (Mishra et al., 1985), respectively. Shylla et al. (1991) reported the average birth weight to be 0.92 kg in the indigenous pigs of Assam. In the indigenous pigs of A.P., it was found to be only 0.804 kg by Solmon Raju (1991).

The mean piglet weight in LWY breed was found to vary from 1.08 to 1.32 kg (Barnikhina, 1974; Jayarajan, 1976; Benkov and V'zharova, 1982; Tan and Chen, 1983; Siagian et al., 1986; Gonzalez et al., 1987; and Singh et al., 1989), whereas in Landrace it ranged from 1.22 to 1.52 kg (Barnikrina, 1974, Benkov and V'zharova, 1982; Tan and Chen, 1983, Schoeps and Huhn, 1986; Siagian et al. 1986; Gonzalez et al., 1987 and Singh et al., 1989).

In Duroc breed, Tan and Chen, (1983), Siagian et al. (1986) and Gonzalez et al. (1987) observed the mean piglet weight to be 1.14; 1.52 and 1.33 kg, respectively, and 1.21, 1.47 and 1.22 kg in Hampshire breed, respectively.

In Chinese breed, the mean piglet weight varied from 0.800 to 1.000 kg (Siler, 1985, Qi, 1985 and Cao et al., 1988).

The mean piglet weight was recorded to be 1.3, 0.45 and 1.29 kg in North Caucasus (Kapko and Tokareva, 1974). Vietnamese (Hottmar, 1982) and Pietrain (Tan and Chen, 1983). breeds, respectively.

2.3.3 Incidence of stillbirths:

Several factors cause stillbirths. A few among them are duration of farrowing, litter size, interval between the birth of piglets, position of the birth order, umbilical cord rupture, ambient temperature of 30° during 102-110 days of gestation, parity of the dam etc. (Randall, 1972 b, Sprecher et al., 1974 and Fonseca et al., 1988).

In the indigenous pigs of Nigeria, the percentage of stillbirths noticed by Osuagwuh and Akpokodje (1981) was 5.7 in 8 months aged dams and 9.0 in 11-12 months aged ones. In the indigenous pigs, the percentage of stillbirths noticed by Solmon Raju (1991) was 8.33.

In LWY pigs, the percentage of stillbirths varied from 3.0 to 8.80 (Mullerhaye and Vecchionacce, 1974, Nishida et al., 1976, Dagorn et al., 1980, Rai and Desai, 1985, Siagian et al., 1986, and Mishra et al., 1990).

In Landrace, the stillbirth percentage ranged from 3.3 - 10.71 (Mullerhaye and Vecchionacce, 1974, Nishida et al., 1976, Cavalcanti et al., 1979, Dagorn et al.,1980,

Petrovic, 1983, Reyes, 1983, Vidovic, 1984, Siagian et al., 1986, Schoeps and Huhn, 1986, Stolic, 1986, Bogos and Cojocaru, 1987, Park et al., 1988 and Singh, et al.,1989).

In Duroc, Cavalcanti et al. (1979) and Siagian et al. (1986) recorded the percentage of stillbirths to be 4.85 and 6.81, respectively, whereas in Hampshire breed, the same was found to be 1.5 by Mullerhaye and Vecchionacce (1974) 5.97 by Cavalcanti (1979), 5.66 by Park et al. (1988) and 10.30 by Singh et al. (1989).

Fetal mummification is also one of the important causes of pre-natal losses and usually mummies are expelled at parturition along with the normal fetuses (Roberts,1971).

The incidence of mummified fetuses as recorded by Roberts (1971) was 4.9% in Berkshire; 1.97% in Chesterwhite and 1.08% in Yorkshire breed of pigs. But Cavalcanti et al. (1979) found the same to be 1.97% in LWY, 1.69% in Landrace, 2.59% in Duroc and 2.82% in Hampshire breeds.

2.3.3.1. Weight of stillborn piglets:

The information in the weight of stillborn piglets was scanty.

In the indigenous pigs of A.P., stillborn piglet weight was found to be 491.67 g, by Solmon Raju (1991).

In exotic breeds of pigs, Timoshenko (1974) reported the weight of stillborn piglets to be 960.58 g and Meyer et al. (1976) recorded it to range from 700 to 800 g.

2.3.4 Sex ratio:

A variation in the sex ratio among the breeds and various strains within the same breed was reported (Appendix).

In India, in the indigenous pigs of Haryana (Sharda and Singh, 1982) and A.P.. (Solmon Raju, 1991), the sex ratio was noticed to be 47.5 and 56.35%, respectively.

In the indigenous pigs of Nigeria, the sex ratio was recorded to be 42.2% by Adebambo (1986).

The sex ratio in LWY was found to vary from 44.6 - 54.17% (Mathai and Ramachandran,1972, Kastyak and Miros, 1974, Nishida et al., 1981, Perez et al., 1984 and Adebambo, 1986).

In Landrace breed, while Lopezseco and Vieites (1971) reported the sex ratio to be 50.54% but Stojanovic et al. (1973) and Nishida et al. (1981) recorded it to be 50.0% and 50.9%, respectively.

The sex ratio in exotic breeds was found to be 51.77% by Kastyak and Miros (1974) and in Duroc breed it was noticed to be 50.29% (Perez et al., 1984).

In Berkshire breed, the sex ratio was found to be 49.8% by Gray and Katanbaf (1985), whereas in Hampshire breed, the same was reported it to be 52.4% by Adebambo (1986).

The sex ratio in liveborn was 52.5% and in stillborn it was 59.3% in Berkshire breeds (Nishida et al., 1976).

2.4 PLACENTA AND UMBILICAL CORD

2.4.1 Number of placentae:

The number of placentae was counted by the presence of number of umbilical stalks (Jones, 1966 b). Each piglet has an umbilical stalk, though the allantochorionic membranes of adjacent piglets were fused (Roberts, 1971).

In the indigenous pigs, Solmon Raju (1991) noticed that the number of placentae expelled tallied with the number of liveborn piglets as well as with the fully formed stillborn piglets.

2.4.2 Expulsion of placentae:

Observation on the expulsion of placentae, differed amongst different authors. While the expulsion of placentae

occurred during the birth phase either in masses of 2 or 3 or as a single mass (Jones, 1966 b, Roberts, 1971, Mathai et al., 1972, and Arthur et al., 1982) or even after birth of all the piglets (Fraser, 1978). Similarly, even in the indigenous pigs, the placentae were expelled after the birth of all the piglets in most of the dams as noticed by Solmon Raju (1991).

2.4.3 Weight of placentae:

The placental weight in the indigenous pigs of Assam ranged from 525 to 961.57 g (Devi, 1986) but in wild variety it was 0.4 to 1.2 kg (Tamuli et al., 1986). In the indigenous pigs, Solmon Raju (1991) found it to be in the range of 300 to 1800 g.

The placental weight in LWY was found to form 16% of total conception (Jones, 1966 b). Mathai et al. (1972) and Singh and Singh (1989) reported that the placenta weighed 1.27 and 1.42 kg, respectively in LWY.

The placental weight was found to be heavier in Duroc, but lighter in LWY and Berkshire breeds (Fahmy, 1971). In Landrace and Hampshire breeds, the placenta weighed 1.28 and 1.06 kg, respectively (Singh and Singh, 1989).

2.4.4 Retention of placenta:

The incidence of retention of placenta appeared to be less common in pigs (Jones, 1966 b and Roberts, 1971).

2.4.5 State of the umbilical cord:

At birth, the umbilical cord was found to remain intact in 75% of piglets (Roberts, 1971) or 60-70% piglets (Arthur et al., 1982).

In the indigenous pigs of A.P., 65% of piglets had intact umbilical cord (Solmon Raju, 1991).

2.4.6 Time taken for rupture of the umbilical cord:

The rupture of the umbilical cord was found to occur simultaneously and invariably by the birth of a piglet and it was noticed to take about 1-3 mts (Jones, 1966 b), 2-6 mts (Roberts, 1971) or even 2-12 mits (Randall, 1972 a).

In the indigenous pigs, it took a range of 0.50 - 14 mts (Solmon Raju, 1991).

2.5 DYSTOCIA:

Dystocia is rare in pigs. Jones (1966 b) recorded it in 2 pigs due to uterine inertia and over sized fetuses.

Roberts (1971) opined that dystocia was found to be rare in a litter of 6.12 piglets.

2.6 TERATOLOGICAL DEFECTS:

Congenital malformations are more frequently seen in pigs than in other domestic animals.

Anderson and Rydhmer (1991) and Falkanberg *et al.* (1991) reported some types of teratological defects in Sweedish Large White and Landrace breeds, respectively.

CHAPTER III

3. MATERIALS AND METHODS

The present investigation on certain reproductive characteristics of pigs was carried out on two breeds— Indigenous and Large White Yorkshire, at two places in Andhra Pradesh. The study on the indigenous pigs was carried out at the All India Co-ordinated Research Project on Pigs, College of Veterinary Science, Tirupati and that on Large White Yorkshire (LWY) at the pig breeding station, Gopannapalem, Eluru.

Experimental animals:

A total of 12 each of clinically healthy and sexually normal sows of Indigenous and Large White Yorkshire breeds, aged between 478 to 501 and 368 to 410 days, respectively were utilized for this study. All the animals farrowed their first litter already. The animals were maintained under similar conditions of housing and management.

When the animals exhibited heat symptoms, they were bred twice by a boar allotted to it in the breeding programme of the farm. Once the mating was over, these animals were observed daily. All the animals which did not evince symptoms of heat after a lapse of 30 days of mating,

were considered pregnant and the date of mating was taken as the day of conception and an approximate calculation was made for the expected day of farrowing. These animals were kept in the individual pens and observed closely and regularly.

Period of study:

The present investigation was conducted during the months of May to November, 1991 which is usually the late summer and the rainy season in these parts of Andhra Pradesh. The mean temperature during this period ranged between 25.5°C to 33.68°C at Tirupati and 22.57°C to 31.23°C at Gopannapalem. Likewise the humidity at Tirupati ranged from 48.4% to 71.2% and at Gopannapalem between 72.00% to 81.00% with an average rainfall of 142.86 mm at Tirupati and 196.7 mm at Gopannapalem.

3.1 GESTATION:

3.1.1 Signs of pregnancy:

3.1.1.1 Abdominal distension:

The degree of distension of the abdomen and its droopiness in relation to the age of pregnancy were observed.

3.1.1.2 Development of mammary gland:

Attention was paid to the changes in the development of mammary gland during the period of pregnancy to appreciate

the size of its development. All the observations were made from the back of the animal i.e., between the hind legs.

3.1.1.3 Changes in the external genitalia:

Observations on the changes in the size and appearance of the external genitalia were made during the course of gestation. The scoring pertaining to the degree of changes was done as slight, moderate and prominent.

3.1.1.4 Behaviour of the pigs: prior to, during and after farrowing:

Animals were keenly observed individually approximately five days prior to the expected day of farrowing for the physical and behavioural changes as well as for their maternal instinct.

3.1.1.5 Gestation length:

It was calculated as the period from the day of service to the day of farrowing.

3.2 FARROWING:

3.2.1 Time (Diurnal pattern) of farrowing:

The farrowing time, whether during the day or night was recorded.

3.2.2 Stages of farrowing:

The different stages of farrowing (as described below) and the time taken for each stage were recorded.

3.2.2.1 First stage:

The time interval from the onset of restlessness and abdominal straining to the time of appearance of sanguinous vulval discharges was considered as the first stage of farrowing.

3.2.2.2 Second stage:

The time that lapsed between the birth of the first and the last piglet was considered as the second stage.

3.2.2.3 Third stage:

The time taken between the expulsion of the last piglet and the complete shedding of the placenta was considered as the third stage.

3.2.2.4 Time taken for the second and the third stages of farrowing:

The duration of farrowing was calculated by adding the time taken for the second as well as for the third stage of farrowing (Jones, 1966 b and Mathai et al., 1972)

3.2.3 'Presentation' and 'position' of the fetuses:

3.2.3.1 'Presentation' of the fetus:

The relationship between the longitudinal axis of the fetus with that of the dam was defined as the presentation of the fetus. The type of presentation at the time of birth of each piglet was recorded.

3.2.3.2 'Position' of the fetus:

The relation of the dorsum of the fetus to the maternal pelvic quadrants was defined as the position of the fetus. The position of the piglets at birth was recorded.

3.2.4 Time interval between the expulsion of successive piglets:

The time taken to expel the successive fetuses from the first to the last piglet in the birth order was recorded.

3.3. LITTER TRAITS:

The birth order of the piglets born were assigned to 'early', 'middle' and 'late' stages of the farrowing according to their birth order by dividing the litter size by three (Randall, 1972a), where the litter size was six, it was divided as "early" and "middle" stages only. In a

litter size of thirteen, after division of three stages (3 piglets for each of the 3 stages) from the remaining four piglets, one each was added to each of the three stages, respectively and the last one remaining was added to the last stage.

3.3.1 Litter size:

The total number of piglets in a litter was designated as litter size. Stillbirths and the mummified fetuses were also included (Randall, 1972b).

3.3.1.1 Litter weight:

Soon after the birth of each piglet, whether alive or stillborn, the weight was recorded with a spring balance and the total litter weight was calculated.

3.3.2 Liveborn piglets per litter:

The number of liveborn piglets farrowed, out of total piglets born was counted and the percentage calculated.

3.3.2.1 Liveborn piglets weight per litter:

The weights of all the piglets born alive were recorded. The weights of the piglets born early and those born later were compared to know whether the heavier or the lighter piglets comes out first.

3.3.3 Incidence of stillbirths:

The piglets which were expelled dead at birth were designated as 'stillborn' piglets. These were subjected to post-mortem examination to determine whether death occurred prior to or during the farrowing, by collecting lung pieces and immersing it in water. All those piglets whose lung pieces floated were considered to be alive just prior to coming out of birth canal (intra-partum death) and those piglets whose lung pieces did not float were considered to have died while coming out of birth canal (pre-partum death). Mummified fetuses were also included under stillborn piglets (Randall, 1972 b).

The total number of stillborn piglets from all the sows farrowed was counted and the percentage calculated.

3.3.3.1 Weight of stillborn piglets:

The weight of all the stillborn piglets was recorded.

3.3.4 Sex ratio:

The sex ratio was expressed as the percentage of males born in a litter. This was calculated for the overall litter as well as for the liveborn and stillborn piglets (Mathai and Ramachandran, 1972 and Nishida et al., 1976).

3.4 PLACENTA AND UMBILICAL CORD:

3.4.1 Number of placentae:

The number of placentae expelled was counted based on the presence of umbilical stalks.

3.4.2 Expulsion of placentae:

The manner of expulsion of placentae whether in a mass or in batches or in between the birth of successive piglets was recorded.

3.4.3 Weight of placentae:

The placenta was collected immediately after the expulsion and the extraneous material, if any, was removed and weighed using a spring balance.

3.4.4 Retention of placenta:

Sows, whose placentae were not expelled even after 6 hrs following farrowing were considered to have retained the placenta. The number of such cases were recorded, if any.

3.4.5 State of the umbilical cord:

Soon after the expulsion of the fetus, the condition of the umbilical cord i.e., whether intact or ruptured was recorded for each of the piglet born.

3.4.6 Time taken for the rupture of the umbilical cord:

The time taken for severance of the umbilical cord of each of the piglet was recorded.

3.5 DYSTOCIA:

All those sows in which the first or the second stage of farrowing was prolonged for more than 6-12 hrs were considered to have dystocia. Such cases, if any were recorded.

3.6 TERATOLOGICAL DEFECTS:

The occurrence of teratological defects, if any was recorded.

3.7 CLASSIFICATION OF DAMS INTO 'NORMAL' AND 'MIXED' GROUP:

Those dams which gave birth to liveborn piglets were classified under 'normal' group and those gave birth to both liveborn and stillborn piglets were considered under 'mixed' group (Devi, 1986).

The data were subjected to standard statistical procedures as per Snedecor and Cochran (1967).

CHAPTER IV

4. RESULTS

The various reproductive characters of the indigenous as well as Large White Yorkshire sows viz., behaviour of the pigs during gestation, gestation length and farrowing were studied. The litter traits and placental characters were also investigated. The observations made in these two breeds were analysed and compared.

The details of reproductive characters of the indigenous and LWY sows are presented in the Table 1.

4.1 GESTATION:

4.1.1 Signs of pregnancy:

The visible changes during gestation viz., abdominal distension, mammary gland development, changes in the external genitalia and behaviour of the sows prior to, or during and after farrowing were recorded, and the observations are presented below.

4.1.1.1 Abdominal distension:

The size of abdomen increased as the pregnancy advanced. In both the breeds, the abdominal distension

Table 1. Reproductive characteristics (in days) of the individual Indigenous and Large White Yorkshire breeds

Indigenous						Large White Yorkshire					
S. No.	Dam No.	Age at service*	Age at conception*	Age at farrowing*	Gestation length	S. No.	Dam No.	Age at service*	Age at conception*	Age at farrowing*	Gestation length
1.	17	490	490	603	113	1.	120	384	404	515	111
2.	27	481	503	613	110	2.	125	382	382	494	112
3.	28	501	501	610	109	3.	141	402	402	514	112
4.	52	492	492	601	109	4.	142	390	390	505	115
5.	53	485	485	596	111	5.	144	402	402	516	114
6.	60	489	489	595	106	6.	145	382	382	496	114
7.	62	483	483	601	118	7.	148	395	395	508	113
8.	78	481	481	591	110	8.	149	388	388	501	113
9.	81	485	485	596	111	9.	154	368	368	480	112
10.	88	478	478	590	112	10.	156	410	410	525	115
11.	89	492	(aborted)	-	-	11.	158	388	406	522	116
12.	22	489	(not conceived)		-	12.	163	392	392	505	113
Mean		487.17	488.7	599.6	110.9	Mean		390.25	393.42	506.75	113.33
± SE		1.75	2.45	2.27	0.94	± SE		3.09	3.38	3.54	0.41
Range		478-492	478-503	590-613	106-118	Range		368-410	368-410	480-525	111-116

was negligible around one month of gestation. The distension was slight around 1½ month, moderate by 2 to 2½ months in both the breeds (Fig. 1 A & B).

In the indigenous sows, the abdominal distension was prominent by 3 and 3½ months (Fig 1 C). At this stage, the distension was well marked and greater in LWY (Fig. 1 D).

By 3 and 3½ months of pregnancy, demarcation between the abdominal wall and the mammary gland was more prominent in LWY. In the indigenous breed, the demarcation was less prominent. However, it disappeared a day before farrowing in both the breeds (Fig. 2).

4.1.1.2 Development of mammary gland:

Changes in the gland:

The development of mammary gland was progressive as the gestation advanced. In both the breeds, the changes in the mammary gland were slight to moderate at 2½ to 3 months of gestation and moderate around 3 months and prominent by 3½ months. In the LWY, the changes were much more appreciable and glaring than that in the indigenous breed. Marked changes were noticed in the mammary gland, a day prior to farrowing in the indigenous pigs (Fig. 3 A). But in the LWY pigs, the changes were appreciable even two

Fig. 1: ABDOMINAL DISTENSION DURING GESTATION

A :	Indigenous	- 2-2½ months	Moderate distension*
B :	LWY	- 2-2½ months	
C :	Indigenous	- 3-3½ months	Prominent distension and demarcation between the abdominal wall and mammary gland*
D :	LWY	- 3-3½ months	

* More appreciable in LWY

Fig 2: ABDOMINAL DISTENSION PRIOR TO FARROWING

A : Indigenous B : LWY	One day prior to farrowing	Absence of demarcation between the abdomen and udder*
C : Indigenous D : LWY	12 hours prior to farrowing -	Relaxed flank muscles with droopy and turgid udder*

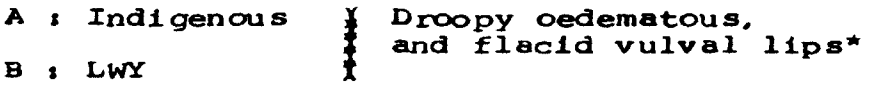
* More appreciable in LWY

Fig. 3: DEVELOPMENT OF MAMMARY GLAND PRIOR TO FARROWING

A :	Indigenous	1 day prior to farrowing	Enlargement of the individual glands with prominent base of the teat*
B :	LWY		
	Indigenous	12 hours prior to farrowing	Prominent enlargement of base of the teat with cone shaped distal extremity of the gland and turgidity of the udder appreciable*
D :	LWY		

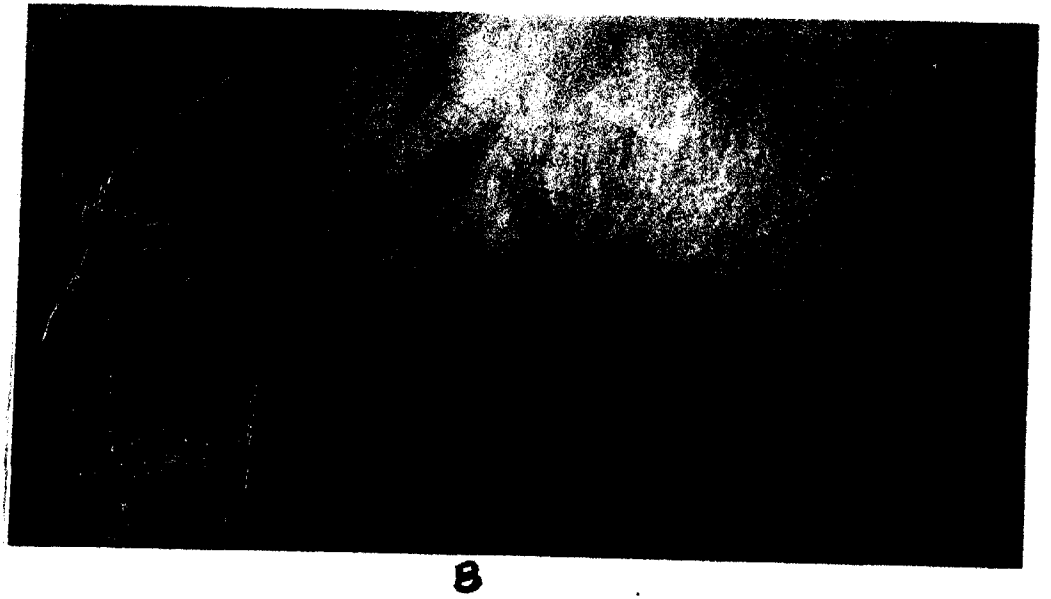
* More appreciable in LWY

Fig. 4: CHANGES IN THE EXTERNAL GENITALIA ON THE DAY OF FARROWING



*More appreciable in LWY

A



B

FIG. 4

restlessness and frequent changes in their resting postures i.e., from side to side or from recumbancy to standing or ventral postures.

As the farrowing time approached, the animals appeared distressed, showed frequent switching of the tail and changed the postures. At this stage, pigs shook their heads vigorously and exhibited pawing activity with the forelegs. Simultaneously making low intermittent grunts, grinding of teeth, clamping of jaws and disturbed the bedding material. Also the material was carried with mouth for site selection(Nesting behaviour) (Fig. 5 A & B). Prior to 30 mts (10-45 mts) of farrowing, the pigs became calm and rested in the lateral recumbency.

The LWY sows spent most of the time in sleeping, without showing any signs of anorexia from three to a day prior to farrowing was observed. But most of the dams were feeding even 3-4 hrs prior to farrowing, when they exhibited restlessness and frequently changing their resting postures.

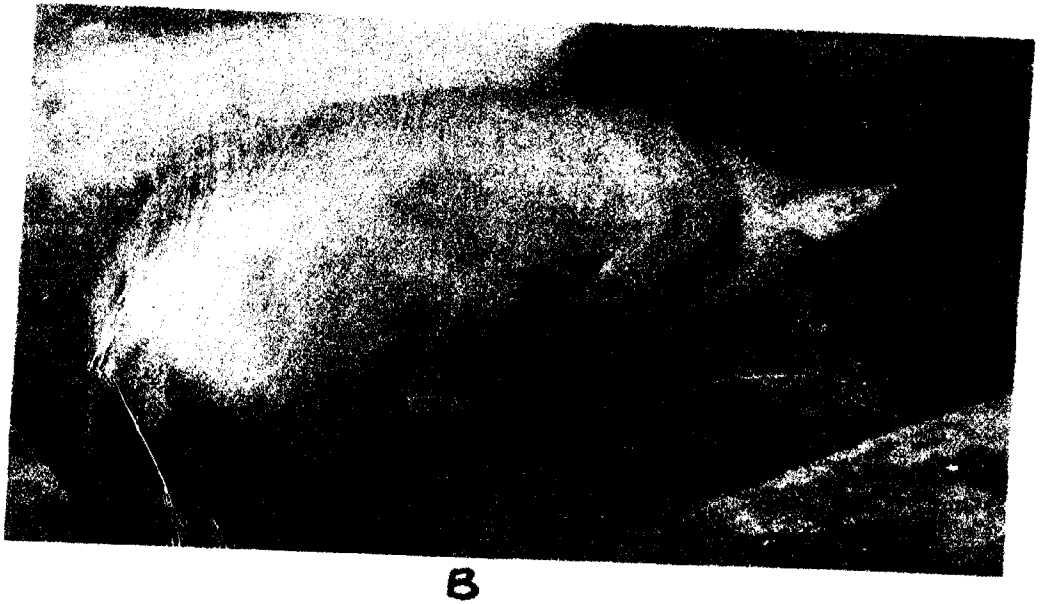
On the day of farrowing, sows were restless and exhibited grinding of teeth and also seen rubbing the walls with snout. They moved from one corner to the other in the pen and exhibited pawing activity and frequently disturbed the bed material with snout (nesting behaviour). Prior to ½ to 1 hr of farrowing, the sows were calm and rested in the lateral recumbency.

Fig. 5: BEHAVIOUR OF THE PIGS PRIOR TO FARROWING

A : Indigenous - Carrying the bedding material with mouth (nesting behaviour)

B : LWY - Distribution of the bedding material with snout (nest-behaviour) and note the pawing ativity with forelegs.

A



B

FIG. 5

Fig. 6: BEHAVIOUR OF THE PIGS DURING FARROWING

A : Indigenous	::	Sows exhibiting disregard towards the first born piglet by assuming standing position to avoid suckling (maternal instinct)
B : LWY	::	Sows allowing the first born piglet to suckle by assuming lateral recumbancy

A

B

FIG. 6

Table 2. Postures adopted by dams during the expulsion of the individual piglets in the indigenous and Large White Yorkshire breeds

Posture of the dams	Indigenous		Large White Yorkshire	
	No. of piglets observed	Percentage	No. of piglets observed	Percentage
1. Lateral recumbency	67	90.54	115	95.83
2. Standing position	3	4.05	3	2.50
3. Ventral recumbency	4	5.41	2	1.67
Total	74	100.00	120	100.00

The LWY dams delivered 95.83% of piglets in lateral recumbency, only 2.50% and 1.67% of piglets were delivered in standing position and ventral recumbency, respectively (Table 2).

Whenever an intruder disturbed the litter, the indigenous sows emitted loud barking grunts and became more aggressive. The dams of LWY were less aggressive though these pigs also emitted a low grunt.

4.1.1.5 Gestation length:

The duration of pregnancy varied from sow to sow within the breed and also differed between indigenous and LWY pigs (Fig. 7). The data is presented in the Table 1. The correlation between the gestation length and the litter traits within the breeds was presented in the Table 3.

The mean gestation length of the indigenous sows was 110.9 $\pm$ 0.94 days, with a range of 106 to 118 days. In the LWY sows the same was 113.33 $\pm$ 0.41 days with a range of 111 to 116 days. D2205

The gestation length differed significantly ($P<0.05$) amongst the indigenous and LWY breeds (Table 25).

The gestation length was significantly ($P<0.05$) and negetively correlated with the litter size as well as

Fig.7 : Gestation length (days n the individual sows indigenous and largew e Yorkshire breeds

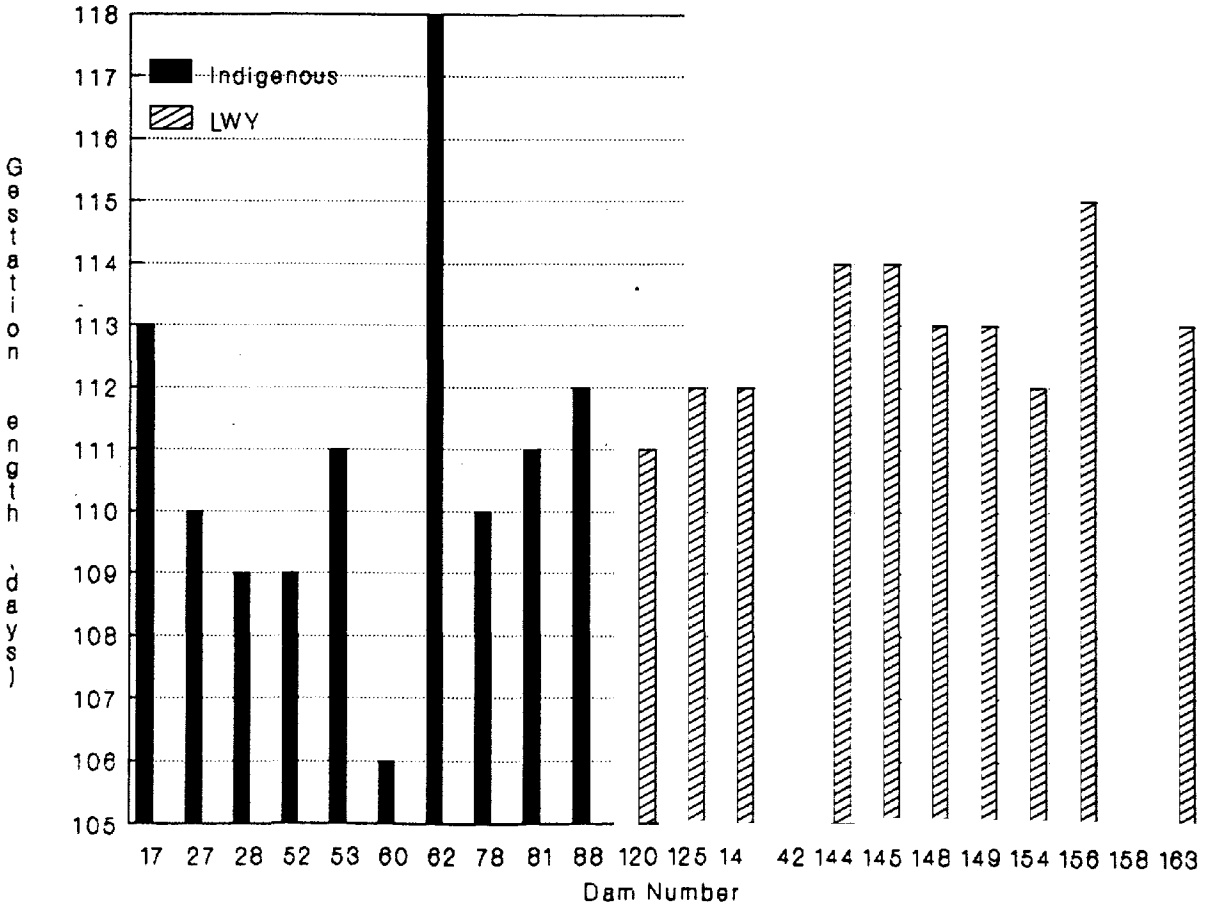


Table 3. Correlation between the duration of gestation and litter traits in the Indigenous and Large White Yorkshire breeds

S.No.	Character	'r' value	
		Indigenous	Large White Yorkshire
1.	Gestation length and litter size	0.08	-0.12
2.	Gestation length and liveborn piglets per litter	0.01	-0.19
3.	Gestation length and stillborn piglets	0.11^{NS}	0.19
4.	Gestation length and litter weight	0.37^{NS}	0.26^{NS}
5.	Gestation length and liveborn piglets weight per litter	0.45^{NS}	0.19^{NS}
6.	Gestation length and mean liveborn piglet weight	-0.60	0.63**

NS - Non significant

** ($P < 0.01$)

liveborn piglets per litter, in both the breeds (Table 3). But, it was significantly ($P<0.01$) and positively correlated with the liveborn piglet weight/litter in the LWY breed (Table 3).

4.2 FARROWING:

4.2.1 Time (Diurnal pattern) of farrowing:

The percentage of farrowings during the different times of the day in the indigenous and LWY breeds are given in the Table 4 and Fig. 8.

In the indigenous pigs, four (40.0%) farrowings occurred during the day time and six (60.0%) in the night time (Fig. 8).

In the LWY sows, farrowings occurred during the day and the night times, equally.

4.2.2 Stages of farrowing:

The details of duration of different stages of farrowing in the sows of indigenous and LWY breeds are presented in the Table 5.

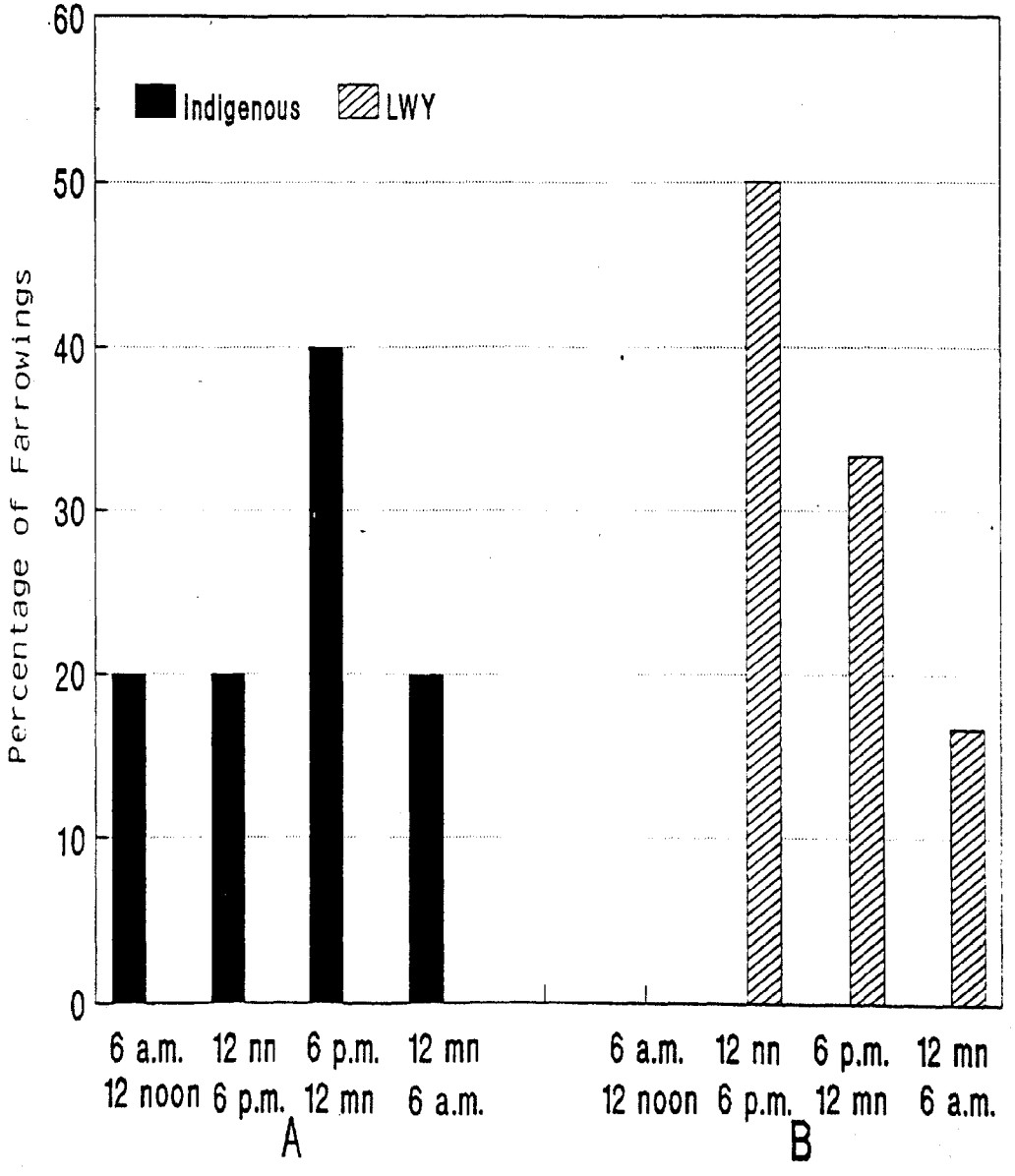
4.2.2.1 First stage:

In the indigenous sows, the first stage lasted for 239 to 695 mts with a mean duration of 434.5 $\pm$ 39.42 mts.

Table 4. Distribution of occurrence of farrowings during the different times of the day (diurnal pattern) in the sows of Indigenous and Large White Yorkshire breeds

Time of farrowing		Indigenous			Large White Yorkshire		
		No. of farrowings observed	Percentage		No. of farrowings observed	Percentage	
1. 6.00 AM – 12.00 Noon	DAY	2	20.00		0	0.00	
		4	40.00		6		50.00
2. 12.00 Noon – 6.00 PM		2	20.00		6	50.00	
3. 6.00 PM – 12.00 mid night	NIGHT	4	40.00		4	33.33	
		6	60.00		6		50.00
4. 12.00 mid night – 6.00 AM		2	20.00		2	16.67	
Total		10	100.00		12	100.00	

Fig. 8: Time (Diurnal pattern) of farrowing in the (A) indigenous and (B) large white Yorkshire breeds



In LWY sows, the first stage ranged from 286 to 695 mts. with a mean duration of 498.5 ± 36.88 mts.

The difference in the duration of first stage was not significant ($P > 0.05$) between the indigenous and LWY breeds (table 25).

4.2.2.2 Second stage:

The duration of second stage in the indigenous sows lasted on an average for 80.8 ± 13.81 mts with a range of 28 to 159 mts (Table 5).

In the LWY sows, this duration lasted on an average for 95.25 ±12.68 with a range of 27 to 180 mts. The difference in the duration of the second stage was not significant ($P > 0.05$) between the breeds (Table 25).

The duration of second stage had a significant ($P < 0.05$) negative correlation with the litter size and the number of stillborn piglets per litter in the indigenous sows (Table 6).

In LWY, duration of second stage was significantly ($P < 0.05$) positively correlated with the litter size but negatively correlated with the number of stillborn piglets (Table 6).

Table 5. Duration of stages of farrowing in the sows of Indigenous and Large White Yorkshire breeds (in minutes)

Indigenous						Large White Yorkshire					
S. No.	Dam No.	First stage	Second stage	Third stage	Second & third stage	S. No.	Dam No.	First stage	Second stage	Third stage	Second & third stage
1.	17	485	28	102	130	1.	120	286	116	87	203
2.	27	450	51	270	321	2.	125	395	48	102	150
3.	28	473	137	130	267	3.	141	497	100	98	198
4.	52	530	58	258	316	4.	142	475	69	99	168
5.	53	320	113	87	200	5.	144	573	82	128	210
6.	60	309	111	101	212	6.	145	334	75	149	224
7.	62	480	74	316	390	7.	148	470	76	94	170
8.	78	364	35	139	174	8.	149	395	180	48	228
9.	81	239	42	214	256	9.	154	628	124	146	270
10.	88	695	159	76	235	10.	156	694	171	41	212
*11.	89	(aborted)				11.	158	695	75	88	163
*12.	22	(Not conceived)				12.	163	540	27	96	123
Mean		434.5	80.8	169.3	250.1	Mean		498.5	95.25	98.0	193.25
± SE		39.42	13.81	26.20	23.17	± SE		36.88	12.68	9.06	11.08
Range		239-695	28-159	76-316	130-390	Range		286-695	27-180	41-149	123-270

*Not considered for statistical analysis.

4.2.2.3 Third stage:

In the indigenous sows, the mean time taken to expell the placentae (Table 5) was 169.3 ± 26.20 mts. with a variation from 76 to 316 mts.

In the LWY sows, the mean time was 98.0 ± 9.06 mts with a range of 41 to 149 mts. There was a significant ($P<0.05$) difference in the duration of third stage between the indigenous and LWY breeds (Table 25).

In both the breeds, a significant ($P<0.05$) negative correlation was noticed between the duration of third stage and number of placenta, weight of placenta and litter weight (Table 6).

4.2.2.4 Time taken for second and third stages:

In the sows of indigenous breed, the mean duration of second and third stages was 250.1 ± 23.17 mts with a range of 130 to 390 mts. In LWY sows, the same was 193.25 ± 11.08 mts with a range of 123 to 270 mts.

There was a significant ($P<0.05$) difference (Table 25) in the time taken for 2nd and 3rd stages of farrowing between the indigenous and LWY sows.

Table 6. Correlation between the duration of different stages of farrowing and litter traits and placental characters in the indigenous and Large White Yorkshire breeds

S. No.	Characters	'r' value	
		Indigenous	Large White Yorkshire
1.	Duration of second stage and litter size	0.20^{NS}	0.60*
2.	Duration of second stage and number of stillborn piglets	-0.99	-0.55
3.	Duration of second stage and litter weight	0.13^{NS}	0.51^{NS}
4.	Duration of second stage and stillborn piglets weight	0.55^{NS}	0.18^{NS}
5.	Duration of third stage and number of placentae	0.13^{NS}	0.04^{NS}
6.	Duration of third stage and weight of placenta	0.08^{NS}	0.36^{NS}
7.	Duration of third stage and litter weight	0.12^{NS}	0.22^{NS}
8.	Duration of second and third stages and litter size	0.25^{NS}	0.75**
9.	Duration of second and third stages and liveborn piglets litter	0.03^{NS}	0.69**
10.	Duration of second and third stages and number of stillborns	0.98^{NS}	0.90^{NS}
11.	Duration of second and third stages and litter weight	0.23^{NS}	0.49^{NS}

NS - Non significant * ($P < 0.05$) ** ($P < 0.01$)

In the indigenous sows a significant ($P < 0.05$) negative correlation was found between the duration of 2nd and 3rd stages of farrowing and the litter size (Table 6). But it is significantly ($P < 0.05$) positively correlated with the litter size in the LWY sows.

4.2.3 'Presentation' and 'Position' of the fetus:

The details of the presentation and position of the fetus at birth in both the breeds are given in the tables 7 and 8.

4.2.3.1 'Presentation' of the fetus:

In the indigenous sows, fifty four (72.97%) piglets were found in anterior presentation (Table 7 & Fig. 10 A) and twenty (27.03%) in posterior presentation at the time of birth (Fig.9).

In LWY sows, sixty seven (55.83%) piglets were found in anterior presentation and fifty three (44.17%) in posterior presentation (Fig. 10 B).

The interrelationship between the presentation of the fetus and the piglets birth order in both the breeds are given in the Table 7.

Table 7. Inter-relationship between the presentation of the fetus and the piglets birth order in the Indigenous and Large White Yorkshire breeds

Presentation of the fetus	Indigenous				Large White Yorkshire			
	Birth order				Birth order			
	First third	Middle third	Last third	Total	First third	Middle third	Last third	Total
Anterior	23 (71.88)	21 (80.77)	10 (62.50)	54 (72.97)	22 (51.16)	26 (61.90)	19 (54.28)	67 (55.83)
Posterior	9 (28.12)	5 (19.23)	6 (37.50)	20 (27.03)	21 (48.84)	16 (38.19)	16 (45.71)	53 (44.17)
Total	32 (100.00)	26 (100.00	16 (100.00)	74 (100.00)	43 (100.00)	42 (100.00)	35 (100.00)	120 (100.00)

Percentage in parentheses.

Fig.9. The relationship between anterio-posterior presentation of fetuses and their birth order in the Indigenous (A) and LWY (B) breeds

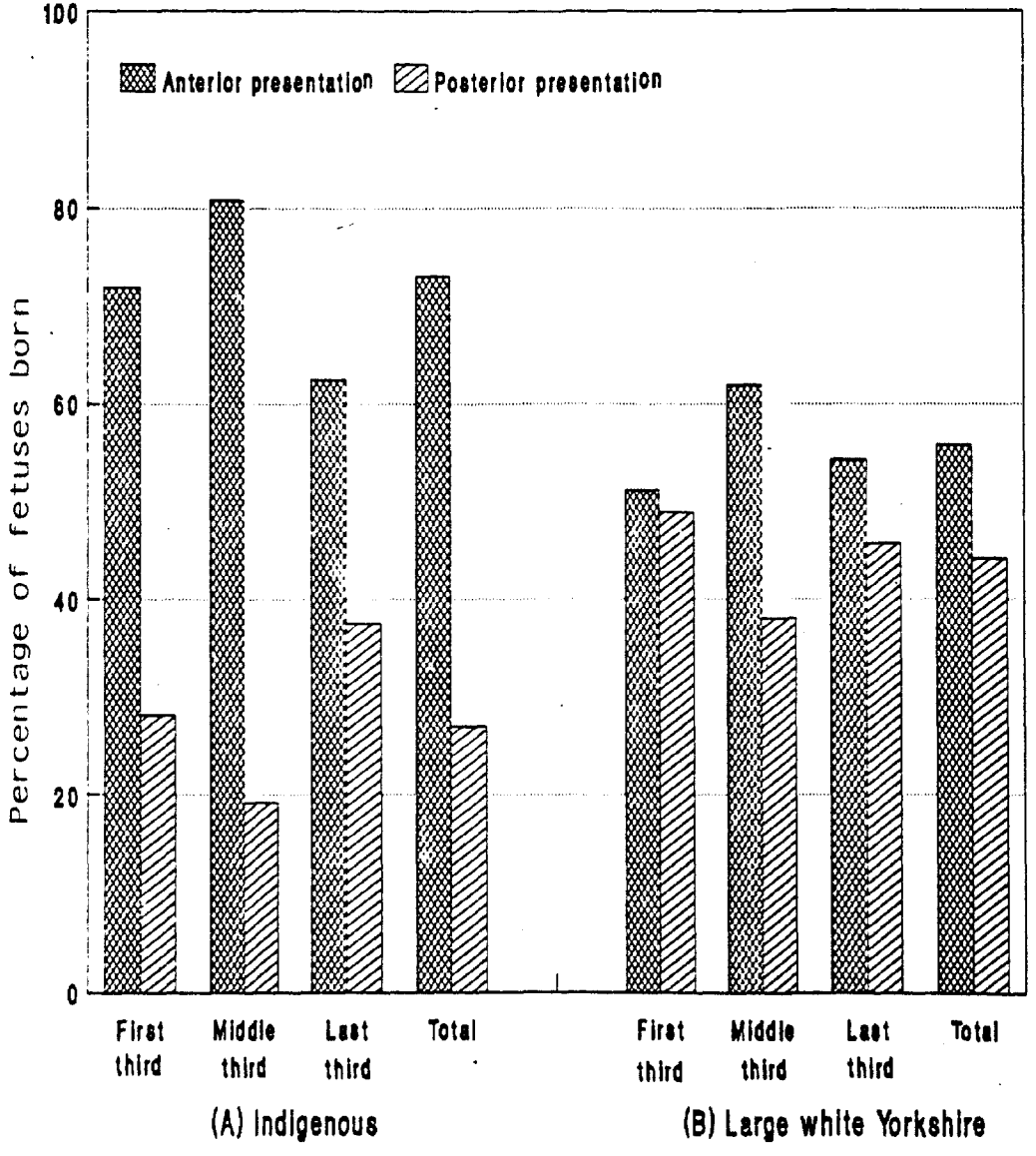


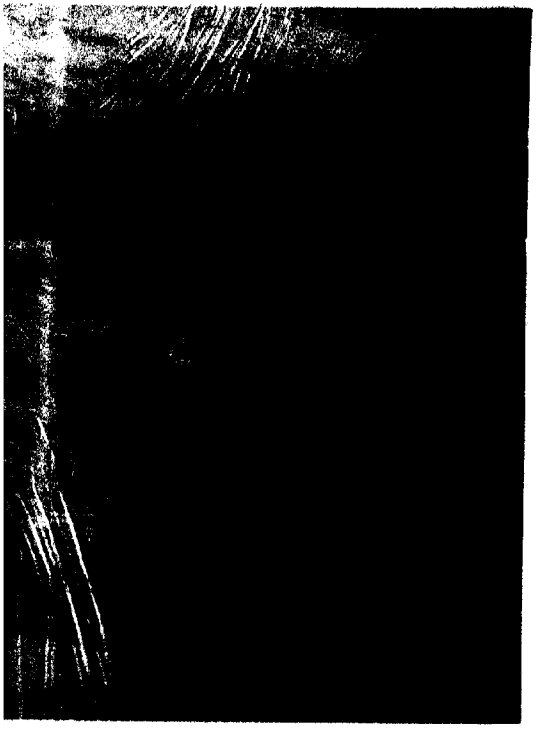
Fig. 10: PRESENTATIONAND EXPULSION OF PIGLETS DURING FARROWING

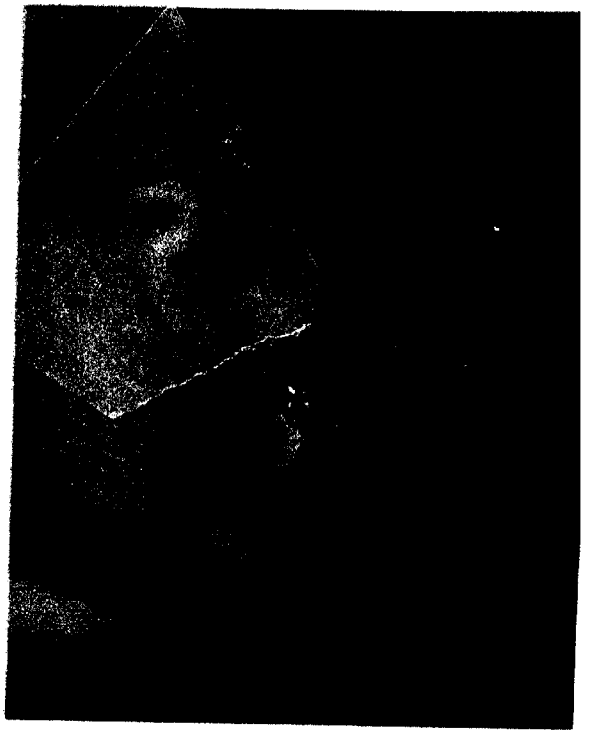
A : Indigenous - Expulsion of piglet in the anterior presentation.

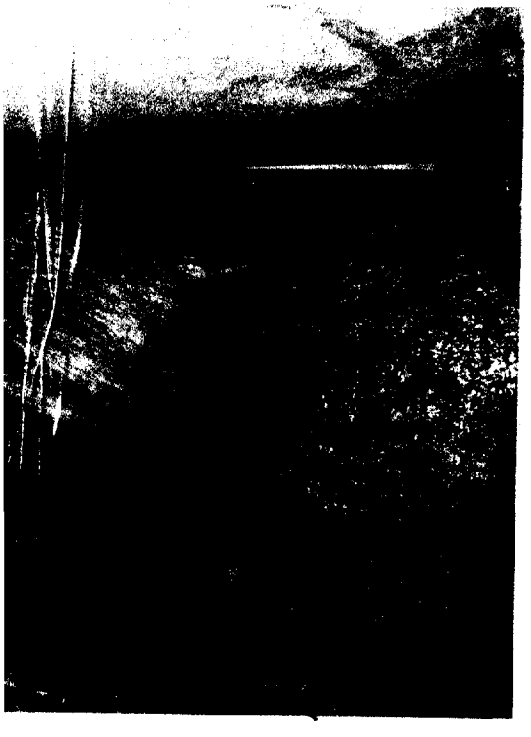
B : LWY - Expulsion of piglet in the posterior presentation.

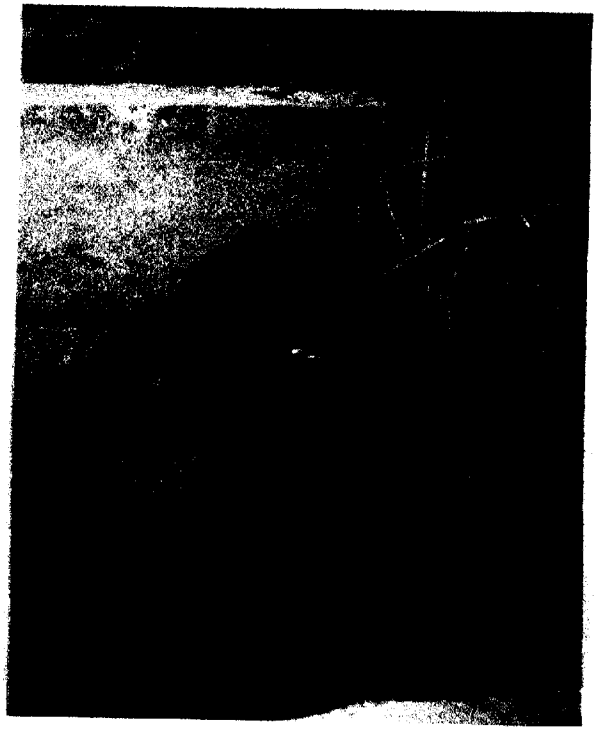
C : Indigenous - Expulsion of piglet during farrowing

D : LWY - Expulsion of two piglets in succession.









During the middle third of farrowing, larger proportion of piglets were found in anterior presentation in both the breeds. In the indigenous pigs, the anterior presentation was found to be highest during middle third (80.77%) and lowest in last third (62.50%) but in LWY, highest in middle third (61.90%) and lowest in first third (51.16%).

4.2.3.2 'Position' of the fetus:

The position of the fetuses at the time of farrowing in the sows of both breeds are given in the Table 8.

In the indigenous breed, seventy one (95.95%) piglets were delivered in dorso-sacral position (Fig. 10C) and three (4.05%) piglets in dorso-lateral. None were delivered in dorso-pubic.

In the LWY breed, one hundred and fifteen (95.33%) piglets in dorso-sacral position (Fig. 10B), four (3.33%) piglets in dorso-lateral and 1 (0.83%) in dorso-pubic positions were delivered

4.2.4 Time interval between the expulsion of successive piglets:

The mean time taken for the expulsion of successive liveborn as well as liveborn and stillborn piglets in both the breeds are presented in the Table 9. The mean

Table 8. Frequencies of different positions adopted by fetus at birth in the indigenous and Large White Yorkshire breeds

Position of the fetus	Indigenous		Large White Yorkshire	
	Number observed	Percentage	Number observed	Percentage
Dorso-sacral	71	95.95	115	95.83
Dorso-lateral	3	4.05	4	3.33
Dorso-pubic	0	0.00	1	0.83
Total	74	100.00	120	100.00

Table 9. Mean time interval between liveborn as well as stillborn piglets in the indigenous and Large White Yorkshire breeds

Piglets	Indigenous		Large White Yorkshire	
	Number recorded	Mean time interval proceeding delivery (minutes)	Number recorded	Mean time interval proceeding delivery (minutes)
Successive liveborn	72	10.13 ± 1.76 (1 - 97)	116	8.25 ± 0.85 (0 - 51)
Live to stillborn	5	15.8 ± 7.14 (10 - 39)	6	14.33 ± 4.48 (0 - 28)
Total	77		122	

expulsion time interval between the successive piglets in both the breeds are given in the Table 10.

In the indigenous pigs the mean time lapse between the two successive liveborn piglets was 10.13 ± 1.76 mts. (1-97 mts) (Fig. 10 C) but between the live and stillborn piglets, the same was 15.8 ± 7.14 mts (10-39 mts).

In LWY pigs, it has taken 8.25 ± 0.85 mts (0-15 mts) for the expulsion of two successive liveborn piglets (Fig.10 D). But between the live and stillborn the time lapse was 14.33 ± 4.48 mts (0-28 mts).

The mean time taken for the first and second piglet to expel was 19.9 ± 8.33 in indigenous and 15.75 ± 2.70 mts in LWY breed. Similarly, the average time taken for the last born piglets was 23.00 ± 11.31 mts and 19.0 ± 6.43 mts in the indigenous and LWY breeds, respectively.

4.3 LITTER TRAITS:

4.3.1 Litter size:

Details of litter size observed in both ehe breeds are given in the Table 11.

In the indigenous pigs, the mean litter size was observed to be 7.7 ± 0.90 with a range from 3 to 12 piglets (Fig. 11 A).

Table 10. Mean time interval between the expulsion of successive piglets in the Indigenous and Large White Yorkshire breeds

Successive piglets	Indigenous	Large White Yorkshire
	Time interval (minutes)	Time interval (minutes)
1st and second piglet	19.9 ± 8.33	15.75 ± 2.70
2nd and third piglet	15.9 ± 5.71	10.67 ± 1.26
3rd and fourth piglet	5.89 ± 1.42	12.08 ± 2.22
4th and fifth piglet	9.00 ± 2.72	8.08 ± 3.81
5th and sixth piglet	4.57 ± 0.85	8.67 ± 1.85
6th and seventh piglet	7.17 ± 1.92	7.42 ± 2.44
7th and eighth piglet	6.20 ± 2.22	5.55 ± 1.45
8th and nineth piglet	21.00 ± 4.62	2.56 ± 0.45
9th and tenth piglet	20.00 ± 9.14	10.29 ± 5.22
10th and eleventh piglet	23.00 ± 11.31	10.00 ± 2.84
11th and twelvth piglet	—	19.00 ± 6.43

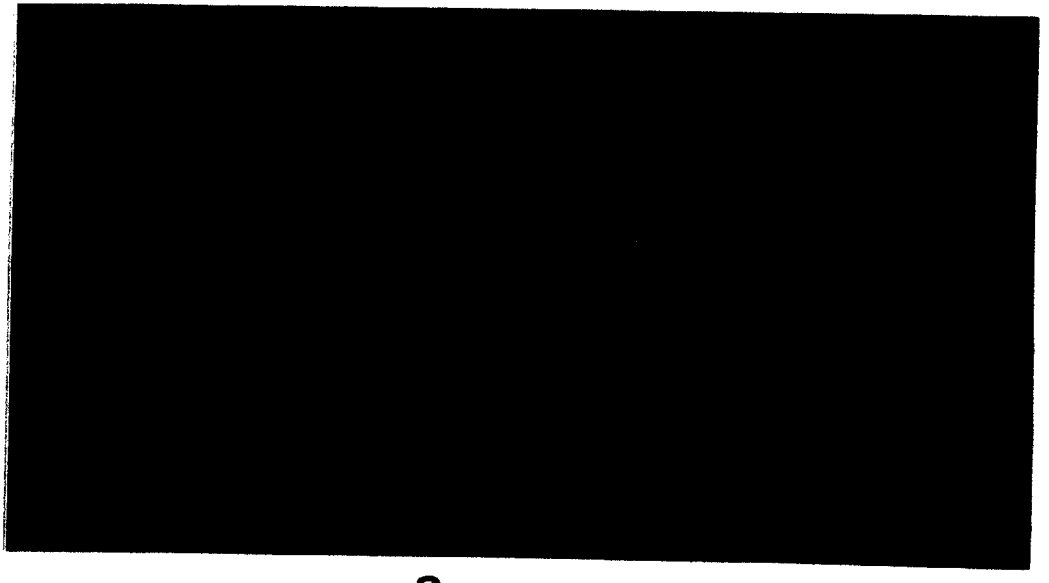
Table 11. Total litter size with number of live and stillborn piglets in the Indigenous and Large White Yorkshire breeds

Indigenous					Large White Yorkshire				
S. No.	Dam No.	Total litter size	Liveborn piglets	Stillborn piglets	S.No.	Dam No.	Total litter size	Liveborn piglets	Stillborn piglets
1.	17	6	6	0	1.	120	12	11	1
2.	27	8	8	0	2.	125	9	9	0
3.	28	10	9	1	3.	141	7	7	0
4.	52	5	5	0	4.	142	11	11	0
5.	53	12	10	2	5.	144	11	10	1
6.	60	10	8	2	6.	145	12	9	3
7.	62	11	11	0	7.	148	7	7	0
8.	78	5	5	0	8.	149	14	14	0
9.	81	7	7	0	9.	154	12	12	0
10.	88	3	3	0	10.	156	11	10	1
					11.	158	7	7	0
					12.	163	9	9	0
Mean		7.7	7.2	0.5	Mean		10.17	9.67	0.5
± SE		0.90	0.74	0.25	± SE		0.64	0.59	0.25
Range		3-12	3-11	0-2	Range		7-14	7-14	0-3

Fig. 11: BEHAVIOUR OF THE PIGS AFTER FARROWING WITH ITS LITTER

A : Indigenous - Sow with its litter suckling.

B : LWY - Sow with its litter suckling



B

FIG. 11

In LWY pigs, the litter size ranged from 7 to 14 with an average of 10.17 ± 0.64 piglets (Fig. 11 B). A significant (P 0.05) difference was noticed in the litter size between the two breeds (25).

The frequency distribution of litter size in both the breeds is presented in the Table 12.

In the indigenous breed, half (50.0%) the sows gave birth to 6-7 piglets while 2 sows (20.0%) gave birth to 8-9 piglets and 3 sows (30.0%) 10 and above.

In LWY breed, 7 (58.33%) sows gave birth to 10 and above piglets whereas in 3 (25.0%) sows, the litter size was 6-7 and two (16.67%) sows gave birth to 8-9 piglets.

A significantly ($P<0.01$) positive correlation between the litter size and litter weight was observed both in indigenous and LWY (Table13).

4.3.1.1 Litter weight:

The details of the litter weight in both the breeds are given individually in the Table 14. In the indigenous sows, the litter weight ranged from 1750 to 10,000 g, with a mean of 6148 ± 710.42 g.

In LWY breed of sows, the average of litter weight was 10676.25 ± 776.23 g with a range from 6350 to 14650 g.

Table 12. Frequency distribution of litter size in the Indigenous and Large White Yorkshire breeds

No. of piglets in a litter	Indigenous		Large White Yorkshire	
	No. of farrowings observed	Percentage	No. of farrowings observed	Percentage
6 - 7	5	50.00	3	25.00
8 - 9	2	20.00	2	16.67
10 and above	3	30.00	7	58.33
Total	10	100.00	12	100.00

Table 13. Correlation among litter traits in the Indigenous and Large White Yorkshire breeds

S. No.	Characters	'r' value	
		Indigenous	Large White Yorkshire
1.	Litter size and litter weight	0.88**	0.79**
2.	Litter weight and number of stillborn piglets	0.41	0.12
3.	Liveborn piglets per litter and liveborn piglets weight per litter	0.90**	0.82**
4.	Liveborn piglets per litter and number of stillborns	0.00^{NS}	-0.83^{NS}
5.	Number of stillborn piglets and gestation length	0.11^{NS}	0.19^{NS}
6.	Number of stillborn piglets and litter weight	0.41^{NS}	0.12^{NS}
7.	Number of stillborn piglets and liveborn piglets/litter	0.00^{NS}	-0.83^{NS}
8.	Number of stillborn piglets and mean piglet weight	-0.37^{NS}	-0.31^{NS}

NS : Non-significant

* : $P < 0.05$

** : $P < 0.01$

Table 14. Particulars of litter weight, liveborn, stillborn, liveborn male and female piglets weight per litter in the Indigenous and Large White Yorkshire breeds

Indigenous							Large White Yorkshire					
S. No.	Dam No.	Litter weight (g)	Liveborn piglets/ litter (g)	Stillborn piglets wt/litter (g)	Liveborn male piglets wt/ litter (g)	Liveborn female piglets wt/litter (g)	S. No.	Dam No.	Litter weight (g)	Liveborn piglets wt/litter (g)	Stillborn piglets wt/litter (g)	Liveborn male piglets wt/litter (g)	Liveborn female piglets wt/litter (g)
1.	17	7250	7250	-	4850	2400	1.	120	9660	9650	10	1700	7950
2.	27	5950	5950	-	2275	3675	2.	125	10300	10300	-	4900	5500
3.	28	6630	6130	500	1450	4680	3.	141	6350	6350	-	3600	2750
4.	52	4750	4750	-	3250	1500	4.	142	12100	12100	-	5700	6400
5.	53	8800	8450	350	5050	3400	5.	144	12855	12750	105	5500	7250
6.	60	6950	6225	725	2475	3750	6.	145	10000	7800	2200	3700	4100
7.	62	10000	10000	--	5550	4450	7.	148	6900	6800	-	5100	1800
8.	78	4000	4000	--	2325	1675	8.	149	14650	14650	-	8650	6000
9.	81	5400	5400	--	3950	1450	9.	154	13200	13200	-	5900	7300
10.	98	1750	1750	--	1150	600	10.	156	14600	13700	900	7050	6650
							11.	158	9200	9200	-	8100	1100
							12.	163	8300	8300	-	3600	4700
Mean		6148	5990.5	525	3232.5	2758	Mean		10676.25	10408.33	803.75	5283.33	5125
± SE		710.42	690.15	88.98	465.12	424.80	± SE		776.23	777.46	438.54	554.47	624.79
Range		1750-10000	1750-10000	350-725	1150-5550	600-4680	Range		6350-14650	6350-14650	10-2200	1700-8650	1100-7950

The litter weight was highly significant ($P < 0.01$) between the breeds (Table 25).

In both breeds, the litter weight was significantly negatively correlated with the number of stillborn piglets (Table 13).

4.3.2 Liveborn piglets per litter:

In the indigenous sows, liveborn piglets ranged from 3 to 11 with a mean number of 7.2 ± 0.74 (Table 11). The percentage of liveborn piglets were 93.51, in the birth order, the percentage of liveborn piglets were highest in the first third (96.97%) and lowest (82.35%) in the last third (Table 15).

In LWY sows, the mean number of liveborn piglets was 9.67 ± 0.59 with a range of 7 to 14 piglets, of these 95.08% of piglets were alive. In birth order, the percentage of liveborn piglets were highest in the last third (97.22%) and lowest (93.02%) in the middle third (Table 15)

There was a significant difference ($P < 0.05$) in the number of piglets born alive between the breeds (Table 25).

In both the breeds, the correlation between the liveborn piglets/litter and liveborn piglets weight per litter was found to be positively significant ($P < 0.01$) (Table 13).

Table 15. Particulars of distribution of live and stillborn piglets in the birth order in the Indigenous and Large White Yorkshire breeds

Piglets group	Indigenous				Large White Yorkshire			
	Birth order				Birth order			
	First third	Middle third	Last third	Total	First third	Middle third	Last third	Total
1. Liveborn	32 (96.97)	26 (96.30)	14 (82.35)	72 (93.51)	41 (95.35)	40 (93.02)	35 (96.22)	116 (95.08)
2. Stillborn	1 (3.03)	1 (3.70)	3 (17.65)	5 (6.49)	2 (4.65)	3 (6.98)	1 (2.78)	6 (4.92)
a) Fully formed fetuses	1 (3.03)	0 (0.00)	1 (5.88)	2 (2.60)	2 (4.65)	2 (4.65)	0 (0.00)	4 (3.28)
b) Mummified fetuses	0 (0.00)	1 (3.70)	2 (11.77)	3 (3.89)	0 (0.00)	1 (2.33)	1 (2.78)	2 (1.64)
Total	33 (100.00)	27 (100.00)	17 (100.00)	77 (100.00)	43 (100.00)	43 (100.00)	36 (100.00)	122 (100.00)

Percentage in parentheses

4.3.2.1 Liveborn piglets weight per litter:

In the indigenous sows, the total liveborn piglets weight per litter varied from 1750 to 10,000 g with an average of 5990.5 ± 690.15 g. The mean male and female piglets weights per litter was 3232.5 ± 465.12 g and 2758±424.80 g, respectively(Table 14).

The mean liveborn piglet weight in the indigenous breed was 827.02 ± 51.13 g with a range of 583.33 to 1208.33 g (Table 16).

In the LWY sows, the liveborn piglets weight per litter ranged from 6350 to 14650 g with a mean of 10408.33± 777.46 g. The mean liveborn piglets weight was found to be 1075.76 ± 48.10 g with a range of 866.67 to 1370 g (Table 16).

The mean male and female piglet weight per litter was 5283.33 ± 554.47 g and 5125 ± 624.79 g, respectively (Table 14).

A significant ($P < 0.05$) difference was found in the total liveborn piglets weight per litter, liveborn male and female piglets weights/litter and also in the mean liveborn piglet weight/litter, between the indigenous and LWY breeds (Table 25).

Table 16. Mean weight of live and stillborn piglets of the individual litter in the Indigenous and Large White Yorkshire breeds

Indigenous				Large White Yorkshire			
S. No.	Dam No.	Mean liveborn piglet weight (g)	Mean still-born piglet weight (g)	S. No.	Dam No.	Mean liveborn piglet weight (g)	Mean still-born piglet weight (g)
1.	17	1208.33	-	1.	120	877.27	10.00
2.	27	743.75	-	2.	125	1144.44	-
3.	28	681.11	500.00	3.	141	907.14	-
4.	52	950.00	-	4.	142	1100.00	-
5.	53	845.00	175.00	5.	144	1275.00	105.00
6.	60	778.13	362.50	6.	145	866.67	733.33
7.	62	909.09	-	7.	148	985.71	-
8.	78	800.00	-	8.	149	1046.43	-
9.	81	771.43	-	9.	154	1100.00	-
10.	88	583.33	-	10.	156	1370.00	900.00
				11.	158	1314.29	-
				12.	163	922.22	-
	Mean	827.02	345.83		Mean	1075.76	437.08
	± SE	51.13	76.90		± SE	48.10	192.80
	Range	583.33 to 1208.33	175-362.50		Range	866.67 to 1370.00	10-900

In both the breeds, the mean liveborn piglet weight was significantly ($P<0.05$) negatively correlated with the number of stillborn piglets (Table 13).

4.3.3 Incidence of stillbirths:

In the indigenous sows, there were only five still births (6.49% and 0.5 piglet/litter) of which three (3.89% and 0.3 piglet/litter) were mummified fetuses (Fig 13 A) and 2 (2.60% and 0.2 piglet/litter) were fully formed piglets (Table 15 & Fig. 12).

In LWY breeds, the number of stillborn piglets recorded were six (4.92% and 0.5 piglet/litter) only of which 2 (1.64% and 0.17 piglet/litter) were mummified fetuses and 4 (3.28% and 0.33% piglet/litter) were fully formed piglets (Table 15, Fig. 12 & 13 B).

There was nonsignificant difference in the incidence of stillbirths between the indigenous and LWY breeds.

In the indigenous sows, a gradual increase in percentage of stillbirths was noticed from the first (3.03%) to last third (17.65%) of the birth sequence. But in LWY, the incidence was higher in the middle third (6.98%) (Table 15).

Fig.12; Incidence of still births in the birth order in the Indigenous (A) and Largewhite Yorkshire (B) breeds

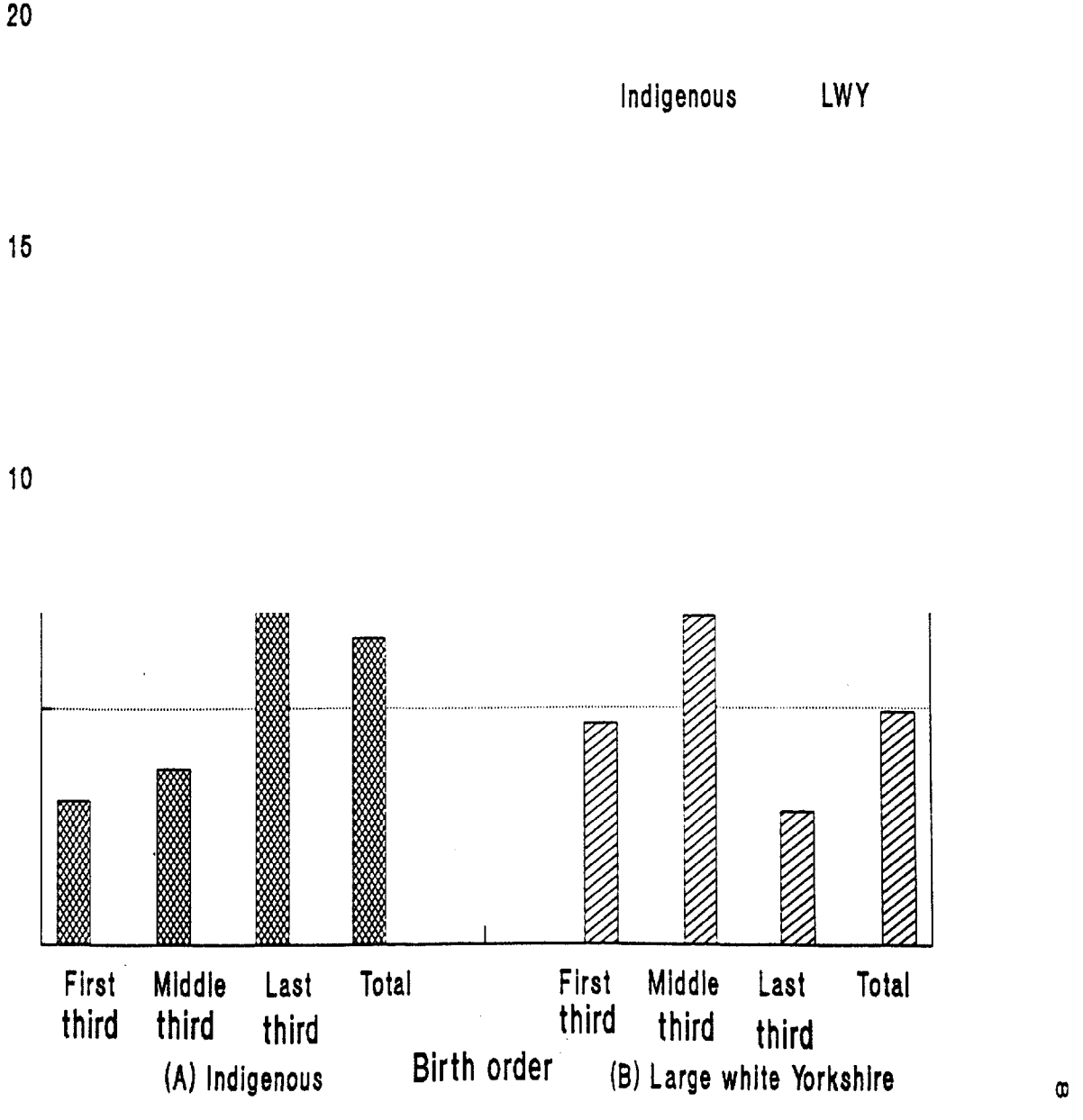
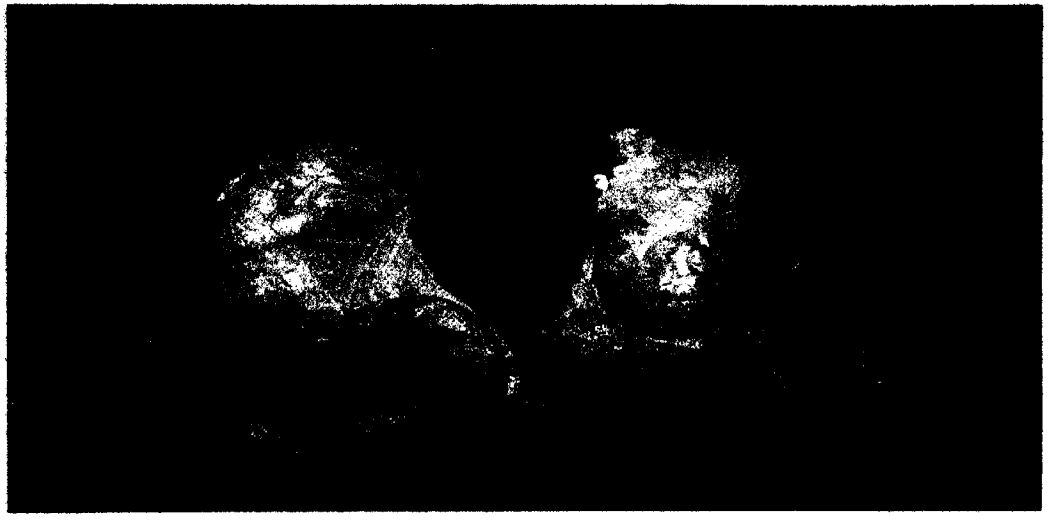


Fig. 13: MUMMIFIED FETUSES AND STILLBORN PIGLETS

A : Mummified fetus with fetal membranes wrapped around it.

B : Fully formed (pre-partum) dead piglets--Stillbirths.



B

FIG. 13

It is observed that the percentage of stillborn piglets appeared to increase as the litter size increased in the indigenous sows, but in LWY no such relation was found (Table 17).

The number of stillbirths was significantly ($P < 0.05$) negatively correlated with the litter weight, number of liveborn piglets/litter and the mean piglet weight in both the breeds (Table 13).

4.3.3.1 Weight of stillborn piglets:

In the indigenous pigs, the total stillborn piglet weight/litter (Table 14) recorded was525±88.98 g (350-725g) and the mean stillborn piglet weight was 345.83 ± 76.90 g (175 to 362.50 g) (Table 16).

In LWY breed, the total weight of stillborn piglets was 803.75 ± 438.54 g (10 to 2200 g) (Table 14) and that of mean stillborn piglet was 437.08 ± 192.80 g (10-900 g) (Table 16).

The difference in the stillborn piglets weight/litter between the two breeds was insignificant.

4.3.4 Sex ratio:

The details of sex ratio amongst the live and still born piglets in both the breeds are given in the table 18 and Fig. 14.

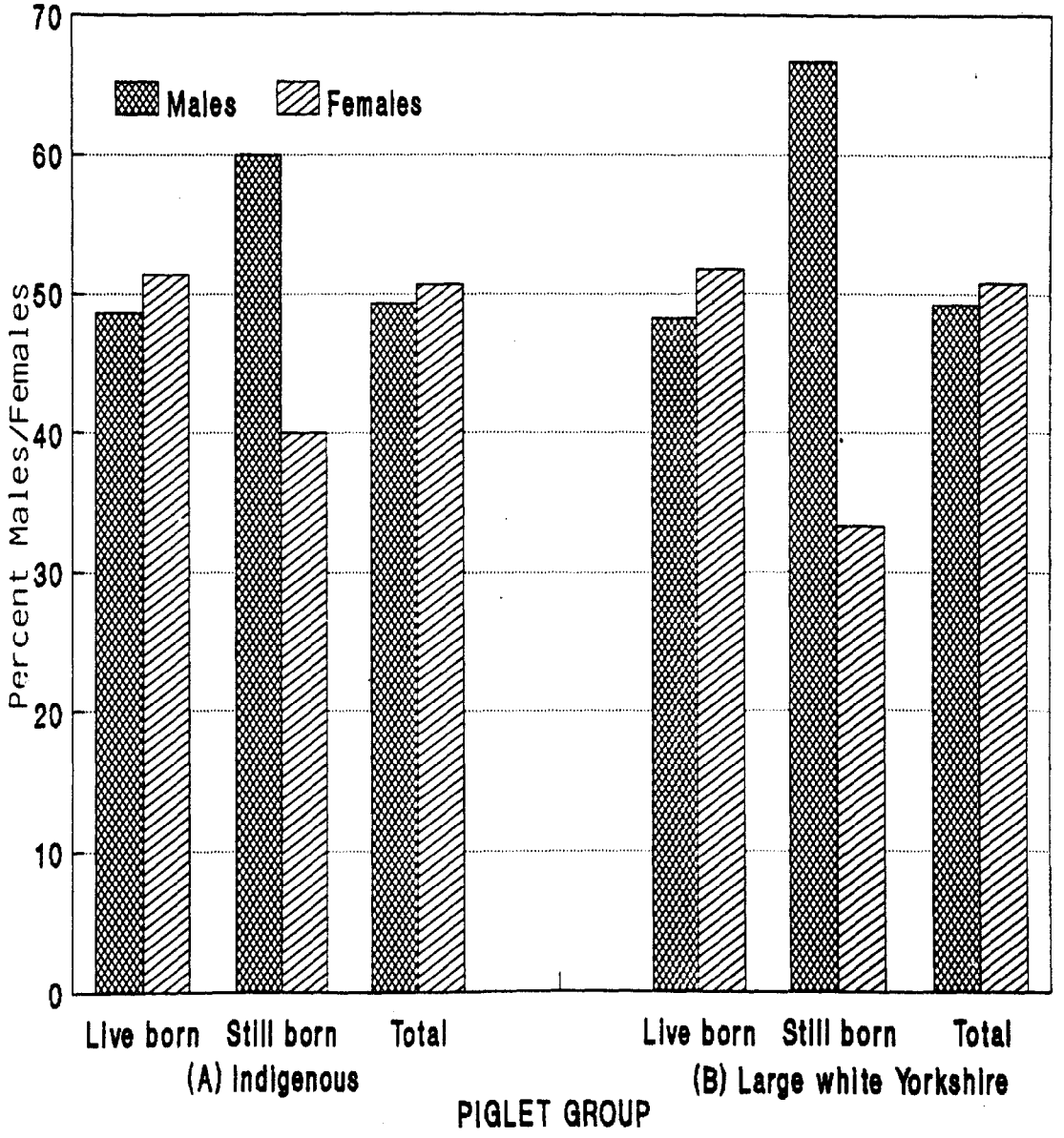
Table 17. Number of litters, average litter size and incidence of still birth at different durations of second stage of farrowing in the indigenous and Large White Yorkshire breeds

Duration of second stage of farrowing (minutes)	Indigenous					Large White Yorkshire				
	No. of litters	Average litter size	Still-born piglet	Percent still-born piglets	Percent litters with stillborn piglets	No. of litters	Average litter size	Still-born piglets	Percent still-born piglets	Percent litters with still-born piglets
< 60	5	6.20	0	0.00	0.00	2	9.00	0	0.00	00.00
60-120	3	11.00	4	12.12	66.67	7	9.57	5	7.46	42.86
120-180	2	6.50	1	7.69	50.00	2	11.50	1	4.35	50.00
180-240	0	0.00	0	0.00	-	1	14.00	0	0.00	-
> 240	0	0.00	0	0.00	-	0.	0.00	0	0.00	-

Table 18. Sex ratio amongst the live and stillborn piglets in the indigenous and Large White Yorkshire breeds

Indigenous						Large White Yorkshire					
No. of farrowings observed	Piglets group	Number	Males	Females	Percentage of males	No. of farrowings observed	Piglets group	Number	Males	Females	Percentage of males
10	Liveborn	72	35	37	48.61	12	Liveborn	116	56	60	48.27
	Stillborn	5	3	2	60.00		Stillborn	6	4	2	66.66
	Total	77	38	39	49.35			122	60	62	49.18

Fig.14. Sex ratio amongst the live and still born piglets in the Indigenous (A) and Largewhite Yorkshire (B) breeds



In the indigenous breed, the percentage of male piglets born was 48.61, 60.00 and 49.35 among the liveborn, stillborn and overall litter, respectively (Table 18).

In LWY breed, the same was 48.27% in liveborn, 66.66% in stillborn and 49.18% in overall litter were recorded.

4.4. PLACENTA AND UMBILICAL CORD:

4.4.1 Number of placentae:

The details regarding the number of placentae noticed in both the breeds are presented in the Table 19 and Fig. 15.

In the indigenous pigs, seventy two placentae belonged to liveborn piglets and two stillborn piglets. The mean number of placentae was 7.4 $\pm$ 0.79 (3-11).

In LWY breed, one hundred and sixteen placentae belonged to liveborn and four to stillborn piglets. The mean number of placentae was 10.0 $\pm$ 0.62 (7 to 14) (Table 19).

In both the breeds, the mummified fetuses were found wrapped with membranes.

A significant ($P<0.05$) difference in the placentae number between the indigenous and LWY breeds was noticed (Table 25).

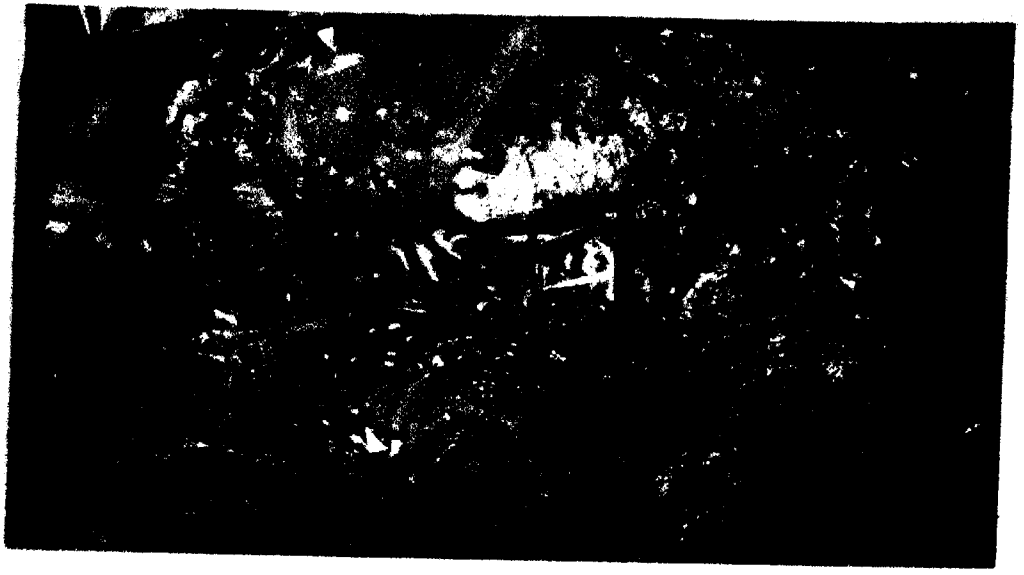
Table 19. Placental number, its weight and weight per piglet in the Indigenous and Large White Yorkshire breeds

Indigenous					Large White Yorkshire				
S. No.	Dam No.	Placenta			S. No.	Dam No.	Placenta		
		Number	Weight/ litter (g)	Weight/ piglet (g)			Number	Weight/ litter (g)	Weight/ piglet (g)
1.	17	6	800	133.33	1.	120	11	2150	195.45
2.	27	8	875	109.38	2.	125	9	2585	287.22
3.	28	10	2050	205.00	3.	141	7	1450	207.14
4.	52	5	925	185.00	4.	142	11	2350	213.64
5.	53	10	3150	315.00	5.	144	10	2700	270.00
6.	60	9	1600	177.78	6.	145	12	2450	204.17
7.	62	11	2800	254.55	7.	148	7	1360	194.29
8.	78	5	1050	210.00	8.	149	14	2800	200.00
9.	81	7	1125	160.71	9.	154	12	2800	233.33
10.	88	3	450	150.00	10.	156	11	1650	150.00
					11.	158	7	1600	228.57
					12.	163	9	1750	194.44
Mean		7.4	1482.5	190.08	Mean		10.0	2137.08	214.85
± SE		0.79	271.64	18.09	± SE		0.62	151.18	10.08
Range		3-11	450-3150	109.38-315	Range		7-14	1360-2800	150-287.22

Fig. 15: PLACENTAL CHARACTERS

A : Mass of placenta with number of placental bags.

B : Placentae with the umbilical stalks.



B

FIG. 15

A significant positive ($P<0.01$) correlation was noticed between the placental number and its weight in both the breeds (Table 20).

4.4.2 Expulsion of placentae:

In the indigenous breed, 7 dams (70%) expelled the membranes after the birth of the last piglet and 3 dams (30%) expelled during the birth phase.

In LWY, while 8 dams (66.67%) expelled the membranes after the birth of the last piglet and 4 dams (33.33%) expelled during the birth phase.

In the indigenous, 5 sows (50%) expelled the placentae in masses and 5 sows (50%) in batches. In LWY, 3 sows (25%) expelled the placentae in masses and 9 sows (75%) in batches.

4.4.3 Weight of placenta:

The mean placental weight per litter in the indigenous was 1482.5 ± 271.64 g with a range of 450 to 3150 g. The placental weight per piglet ranged from 109.38 to 315 g with a mean of 190.08 ± 18.09 g (Table 19).

In LWY sows, the placental weight per litter ranged from 1360 to 2800 g with a mean of 2137.08 ± 151.18 g and

Table 20. Correlation between the placental characters and litter traits in the indigenous and Large White Yorkshire breeds

S. No.	Characters	'r' value	
		Indigenous	Large White Yorkshire
1.	Placenta number and placenta weight	0.86**	0.76**
2.	Placenta weight and liveborn piglets per litter	0.79**	0.64**
3.	Placenta weight and liveborn piglets weight per litter	0.87**	0.76**

** $P < 0.01$

its weight per piglet ranged from 150 to 287.22 g with a mean of 214.85 ± 10.08 g (Table 19).

A significant difference in the placental weight per litter between the indigenous and LWY was recorded whereas a non-significant difference was found in placental weight per piglet between the breeds (Table 25).

In both the breeds, a positive and significant ($P<0.01$) correlation was found between the placental weight and placental number, liveborn piglets/litter as well as with their weights (Table 20).

The percentage of fetal membranes contributes 18.81 and 16.88 of the weight of the total products of conceptus (excepting fluid) in the indigenous and LWY breeds (Table 21), respectively.

4.4.4 Retention of placenta:

Not a single case of retention of placenta was found in this study.

4.4.5 State of the umbilical cord:

The state of the umbilical cord at birth in birth order was given in the Table 22.

Table 21. Litter size, litter weight, weight of placenta and weight of conceptus in the Indigenous and Large White Yorkshire breeds.

Indigenous							Large White Yorkshire						
S. No.	Dam No.	Litter size	Litter weight	Weight of placenta (g)	Total wt. of conceptus(g)	Percentage	S. No.	Dam No.	Litter size	Litter weight (g)	Weight of placenta (g)	Total wt. of conceptus(g)	Percentage
1.	17	6	7250	800	8050	9.94	1.	120	12	9660	2150	11810	18.20
2.	27	8	5950	875	6825	12.82	2.	125	9	10300	2585	12885	20.06
3.	28	10	6630	2050	8680	23.62	3.	141	7	6350	1450	7800	18.58
4.	52	5	4750	925	5675	16.30	4.	142	11	12100	2350	14450	16.25
5.	53	12	9800	3150	11950	26.36	5.	144	11	12855	2700	15555	17.36
6.	60	10	6950	1600	8550	18.71	6.	145	12	10000	2450	12450	19.68
7.	62	11	10000	2800	12800	21.88	7.	148	7	6900	1360	8260	16.46
8.	78	5	4000	1050	5050	20.79	8.	149	14	14650	2800	17450	16.05
9.	81	7	5400	1125	6525	17.24	9.	154	12	13200	2800	16000	17.50
10.	88	3	1750	450	2200	20.45	10.	156	11	14600	1650	16250	10.15
							11.	158	7	9200	1600	10800	14.81
							12.	163	9	8300	1750	10050	17.41
Mean		7.7	6148	1482.5	7630.5	18.811	Mean		10.17	10676.25	2137.08	12813.33	16.88
± SE		0.90	710.42	271.64	945.26	1.48	± SE		0.64	776.23	151.18	883.33	0.72
Range		3-12	1750-10,000	450-3150	2200-12800	9.94-26.36	Range		7-14	6350-14650	1360-2800	7800-17450	10.15-20.06

Table 22. Number of intact and ruptured umbilical cords of the liveborn piglets and their position in the birth order in the Indigenous and Large White Yorkshire breeds

State of umbilical cord	Indigenous				Large White Yorkshire			
	Birth order				Birth order			
	First third	Middle third	Last third	Total	First third	Middle third	Last third	Total
Intact	1	7	4	12	21	26	26	73
	(3.13)	(26.92)	(28.57)	(16.67)	(51.22)	(65.00)	(74.29)	(62.93)
Ruptured	31	19	10	60	20	14	9	43
	(96.88)	(73.08)	(71.43)	(83.33)	(48.78)	(35.00)	(25.71)	(37.07)
Total	32	26	14	72*	41	40	35	116*
	(100.00	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Percentage inparenthesis

* Observations pertains to 72 liveborn piglets

* Observations pertains to 116 liveborn piglets

In the indigenous pigs, twelve piglets (16.67%) had intact umbilical cord, only sixty (83.33%) had ruptured cords.

In LWY pigs, 73 (62.93%) piglets had intact (Fig. 10D) and 43 (37.07%) had ruptured umbilical cord (Table 22).

In both the breeds, there was a gradual increase in the piglets with intact cord from first, middle and last third of the birth order (Table 22).

4.4.6 Time taken for the rupture of the umbilical cord:

The mean time taken for the rupture of the umbilical cord in indigenous pigs was 3.08 $\pm$ 0.49 mts (1-7 mts) and the same in LWY was 4.75 $\pm$ 0.40 mts (1-14 mits) (Table 25).

A significant difference ($P < 0.05$) in the mean time taken for the rupture of umbilical cord between the breeds were recorded (Table 25).

4.5 DYSTOCIA:

There was no incidence of dystocia either in the indigenous or LWY breeds in the present investigation.

4.6 TERATOLOGICAL DEFECTS:

Recognisable teratological defects were not observed in this study.

4.7 DAMS CLASSIFIED AS 'NORMAL' AND 'MIXED' GROUPS:

The details of various reproductive characteristics of the 'normal' and 'mixed' groups of dams in both the breeds and the significance between the breeds as well as both the breeds are given in the Tables 23 and 24.

A significant difference was noticed in the litter size, litter weight; mean liveborn piglet weight, duration of third stage, second and third stage of farrowing and placental weight per piglet (g) between the normal groups of indigenous and LWY breed (Table 23).

In the mixed group of both the breeds, a significant difference was observed only in the duration of gestation and litter weight (Table 23).

In the indigenous pigs, a significant ($P < 0.05$) difference was noticed only in the litter size between the normal and mixed groups. The mean litter size in normal group was 6.42 ± 0.90 whereas in mixed group it was 10.67 ± 0.54 (Table 24).

In LWY pigs, non-significant difference was noticed in all the reproductive characters between the normal and mixed groups (Table 24).

Table 23. Various reproductive characteristics between the breeds of Indigenous and Large White Yorkshire normal and mixed groups ('t' test)

S.No.	Characters	Normal group ('t' value)	Mixed group ('t' value)
1.	Duration of gestation (days)	1.18^{NS}	3.06*
2.	Litter size (number)	2.28*	1.28^{NS}
3.	Litter weight (g)	3.10**	2.88*
4.	Liveborn piglets weight (g)	0.35^{NS}	1.47^{NS}
5.	Mean liveborn piglets weight (g)	2.47*	2.06^{NS}
6.	Duration of first stage of farrowing(minutes)	0.76^{NS}	0.85^{NS}
7.	Duration of second stage of farrowing (minutes)	0.98^{NS}	0.35^{NS}
8.	Duration third stage of farrowing(minutes)	2.95*	0.16^{NS}
9.	Duration of second and third stages of farrowing (minutes)	2.10*	0.79^{NS}
10.	Placental weight per piglet (g)	2.29*	0.60^{NS}

NS : Non significant

* : $P<0.05$

** : $P<0.01$

Table 24. Various reproductive characteristics of normal and mixed group of Indigenous and Large White Yorkshire breeds (t test)

S.No.	Characters	Indigenous			Large White Yorkshire		
		Normal	Mixed	Test of significance	Normal	Mixed	Test of significance
1.	Duration of gestation (days)	111.86±1.06	108.67±1.19	1.60	113.25±0.49	113.[illegible]±0.75	0.26^{NS}
2.	Litter size (number)	6.42±0.90	10.67±0.54	2.67*	9.50±0.87	11.5±0.25	1.48^{NS}
3.	Litter weight (g)	5585.71±907.44	7460 ±552.23	2.17^{NS}	10125±989.79	1177[illegible].75±1023	0.96^{NS}
4.	Liveborn piglets/litter (number)	6.42±0.90	9.0±0.47	1.44	9.5±0.87	10.0±0.35	0.38^{NS}
5.	Mean liveborn piglet weight (g)	852.28±68.95	768.08±38.85	0.70^{NS}	1065.03±43.81	1097.24±11389	0.29^{NS}
6.	Duration of first stage of farrowing (minutes)	663.29±49.33	367.33±43.22	1.07^{NS}	511.88±35.01	471.75±84.09	[illegible].48^{NS}
7.	Duration of second stage of farrowing	63.86±15.62	120.33±6.82	2.08^{NS}	87.38±15.76	111.0±18.[illegible]	0.83^{NS}
8.	Duration of third stage of farrowing (mts)	196.43±32.11	106.±10.34	1.63^{NS}	96.38±8.77	101.25±20.66	0.23^{NS}
9.	Duration of second and third stages of farrowing (minutes)	260.29±31.52	226.33±16.84	0.61^{NS}	183.75±14.46	212.25±3.78	1.19^{NS}
10.	Placental weight/piglet(g)	171.85±17.18	232.33±34.38	1.56^{NS}	219.83±10.22	204.91±21.42	0.65^{NS}
11.	Time taken for the expulsion of placenta	196.43±32.11	106±10.34	1.63^{NS}	96.38±8.77	101.25±20.66	0.23^{NS}

NS : Non significant

* P <0.05

Table 25. Various reproductive characteristics between the breeds of Indigenous and Large White Yorkshire

S.No.	Parameter	Indigenous		Large White Yorkshire		
		Mean	S.E.	Mean	S.E.	't' value
1.	Gestation length (days)	110.9	±0.94	113.33	±0.41	2.38*
2.	First stage (mts)	434.5	±39.42	498.5	±36.88	1.12^{NS}
3.	Second stage (mts)	80.18	±13.81	95.25	±12.68	0.74^{NS}
4.	Third stage (mts)	169.3	±26.20	98.00	±9.06	2.61*
5.	Second and third stage (mts)	250.1	±23.17	193.25	±11.08	1.60*
6.	Total litter size	7.7	±0.90	10.17	±0.64	2.17*
7.	Liveborn piglets/litter	7.2	±0.74	9.67	±0.59	2.49*
8.	Stillborn piglets/litter	0.5	±0.25	0.5	±0.25	0.00^{NS}
9.	Litter weight (g)	6148	±710.42	10676.25	±776.23	4.02**
10.	Mean liveborn piglet weight(g)	827.02	±51.13	1075.76	±48.10	3.36*
11.	Mean stillborn piglet weight(g)	345.83	±76.90	437.08	±192.80	0.33^{NS}
12.	Placental number	7.4	±0.79	10.0	±0.62	2.50*
13.	Weight of placenta (g)	1482.5	±271.64	2137.08	±151.18	2.08*
14.	Placenta weight per piglet(g)	190.08	±18.09	214.85	±10.08	1.18^{NS}
15.	Time taken for rupturing of the intact umbilical cord(mts)	3.08	±0.49	4.75	±0.40	1.67*

NS: Non significant * $P<0.05$ ** $P<0.01$

CHAPTER V

5. DISCUSSION

The various reproductive characteristics like gestation, farrowing pattern, litter traits, placental characters, umbilical cord etc. in the indigenous as well as in the Large White Yorkshire (LWY) breeds were studied and the results were compared and discussed.

In this study, the changes in the abdomen were progressive as the days of gestation advanced, with marked changes by 2 or 3 days to few hours prior to farrowing, in both the breeds (Fig. 2). Similar observations were also reported by Solmon Raju (1991) in the indigenous pigs.

A gradual abdominal distension with mammary gland demarcation was observed as an external sign of pregnancy in both the breeds (Fig. 1 C & D) in this study and this was attributed to the increase in the size of the fetuses as well as to the accumulation of voluminous uterine contents during the pregnancy after implantation of embryo by Day 24 (Hafez, 1987).

In this investigation the changes in the abdomen were more conspicuous in the LWY when compared to those

in the indigenous breed, which might be due to the breed variation, larger body size of the animal and more number of fetuses.

The initial development of the mammary gland by 2½ months of pregnancy in both the breeds, followed by prominent changes by 3½ months as seen in the present investigation were also reported by Gyer et al. (1986) by 4-6 weeks of prepartum. Solmon Raju (1991) reported the initial development of mammary gland as early as 2 months of gestation in the indigenous gilts.

The development of mammary gland was due to the combined action of hormones like oestrogens, progesterone, growth hormone and prolactin as opined by Catchpole(1969), Baldwin and Teresaplucinski (1975) and Hafez (1987).

The turgid mammary gland with distal extremity of each gland assuming cone shape on the day of farrowing and the increase in the turgidity as the hours of farrowing approached as noticed (Fig. 3) in both the breeds were also reported by Jones (1966 a), Arthur et al. (1982), Gordon (1983) and Hurnik (1985) in exotic breeds and Solmon Raju (1991) in the indigenous pigs.

The more conspicuous changes in the development of mammary gland and its turgidity two days prior to farrowing

in LWY, when compared to those in the indigenous breed as noticed might be dueto the difference in the breed of the sow or due to the elevated levels of hormones viz. oestrogen, oxytocin and relaxin as opined by Catchpole (1969), Ash and Heap (1975), Randall et al. (1986) who reported that the hormonal levels increased steadily during the last week of gestation.

The clear cut changes in the size and shape of the teats around 3 months of gestation with prominent and enlarged base around a day prior to farrowing as noticed in this investigation in both the breeds (Fig. 3 A & B) were also observed by Solmon Raju (1991) in the indigenous breed and these were consequent to the elevated levels of oxytocin 12 hours prepartum (Nara and First, 1981) as well as due to the accumulation of secreted milk or colostrum, a day prior to the farrowing (Hurnik, 1985).

The changes in the size and shape of teats were very much prominent in LWY when compared to those in indigenous breed and this might be due to the difference in the breed of the sow, body size, and higher hormonal levels (Jones, 1966 a).

In this investigation, while the changes in the external genitalia were appreciable from 3 months of gestation

in most of the indigenous sows, in a few, these changes were noticed (Fig. 4) a day or two prior to farrowing. Solmon Raju (1991) also made similar observation in the indigenous pigs. But in LWY sows, the changes were appreciable even from 2½ month of gestation which progressed as the pregnancy advanced in all the dams. This might be attributed to the action of oestrogens, whose levels start rising from Day 60 of pregnancy (Hafez, 1987). The excessive edema of vulval lips during the last week of pregnancy might be attributed to the action of oestrogens secreted in large quantities (Hughes and Varley, 1980) and that of relaxin hormone (Hafez, 1987).

The absence of clear cut changes in the external genitalia until a day or two prior to farrowing in a few of the indigenous pigs, might be due to the low levels of oestrogens (Catchpole, 1969).

The changes in the external genitalia were more conspicuous and appeared earlier in the LWY when compared to those in the indigenous breed. This difference might be attributed to the variation in the breed and the levels of hormones during the pregnancy (Catchpole, 1969; Cole and Cupps, 1977, and Hughes and Varley, 1980).

In this study, the gradual disappearance of the changes in the external genitalia after farrowing by Day 4-7 in the indigenous breed and by 7-10 days in the LWY breed. This variation might be due to the variation in the postpartum decline in the hormones levels (oestrogen and relaxin) in the two breeds. Solmon Raju (1991) also reported the disappearance of the changes in the external genitalia by Day 5 in the indigenous breed.

Most of the dams were seen lying frequently in the lateral recumbency and exhibited signs of anorexia prior to farrowing. These findings were in accordance with those of Jones (1966 a), Fraser (1978), Sambraus (1978), Hurnik (1985) in the exotic breeds and Solmon Raju (1991) in the indigenous breed.

The restlessness, marked anorexia, distress, frequent changes of resting postures, moving the bedding material with snout (nesting behaviour) (Fig. 5), scratching the ground with forelegs (pawing activity), frequent switching of the tail and the low barking grunts observed on the day of farrowing, were similar to the findings of Jones (1966 a), Signoret *et al.* (1975), Fraser (1978), Hurnik (1985), Lammers and Lange (1986) and Solmon Raju (1991). The exhibition of nesting behaviour might be due to the

strong genetic predisposition as well as the action of hormones viz., prolactin, oxytocin (Forsling et al., 1979) and oestrogens (Ash and Heap, 1975). Dusza and Krzymowskah (1981) opined that prolactin was responsible for the nesting behaviour and found an increased levels of prolactin a day prior to farrowing.

The assumption of lateral recumbency by the sows of both the breeds, calmness and evincing abdominal straining and vigorous tail switching with frequent flexing and stretching of hind legs as well as the expulsion of little quantity of mucoid or serous discharges, before birth of the first piglet as noticed, were akin to the observations of Jones (1966 b), Randall (1972 a), Kelly and Curtis (1978), Arthur et al. (1982), Jensen (1986) and Solmon Raju 1991).

The behavioural signs were attributed to the labor under the influence of increased levels of oxytocin, before 4 to 9 hours of the expulsion of the first piglet (Forsling et al., 1979). The mucoid discharges prior to parturition were due to the breaking down of mucus plug that was established during the pregnancy.

The small volumes of blood stained fluid noticed between the birth of the individual piglets was due to the rupture of foetal membranes.

The indigenous pigs delivered most of the piglets (90.54%) in lateral recumbency, with some in ventral recumbency (5.41%) and a few in the standing position (4.05%) (Table 2). But Solmon Raju (1991) reported that 75.83% of the piglets were delivered in lateral recumbency in the indigenous pigs. The LWY dams delivered 95.83% piglets in lateral recumbency, 2.50% in standing and 1.67% in ventral recumbency, in this study (Table 2).

The sows of both the breeds adopted mostly the lateral recumbency during farrowing. However, the changes in the postures during farrowing was often noticed frequently in the indigenous pigs than in the LWY pigs (Fig.6). This might be due to more alertness of the indigenous dams to surroundings, restlessness and or less domestication.

During farrowing the LWY sows were mostly docile and allowed the first born piglet to suckle, unlike the indigenous sows which were alert to noise, and assumed ventral or standing recombency and avoided the suckling by the first piglet (Fig. 6) until two or more piglets secured the teats. Similar observations were also reported by Solmon Raju (1991).

All the dams exhibited loud barking grunts and became aggressive, whenever an intruder disturbed the nest

indicating the maternal instinct. These observations were in concurrence with those of Fraser (1978) in exotic breeds, Reddy and Charyulu (1985) and Solmon Raju (1991) in indigenous pigs. This might be due to the development of mothering instinct to protect its piglets from the surrounding disturbances.

The less aggressiveness and exhibition of low barking grunts in the LWY breed might be attributed to high domestication and docile nature of the breed.

The average gestation length of indigenous breed was 110.9 ± 0.94 days with a range of 106 to 118 days (Table 1 and Fig. 7) and was akin to the observations of Mishra *et al.* (1985), who recorded a mean gestation length of 110.43 days, though Tamuli *et al.* (1986) reported it to range between 106-120 days. A lesser gestation length of 109.69 days was observed at different centres of AICRP on pigs (1971-90) in India. Unlike the present observation, a higher gestation length of 113.6 days was reported by Holness (1970), Adebambo (1986), Singh *et al.* (1990) and Solmon Raju (1991) in the indigenous pigs.

In this study, the average gestation length of LWY breed was 113.33 ± 0.41 days with a range of 111 to 116 days (Table 1 & Fig. 7) which was similar to the reports of Banov (1971), Reyes (1983), Tan and Chen (1983), Adebambo (1986), Tsitsyurskil (1986), Kurcman and Wardowski (1987), Kim *et al.* (1988) and Singh *et al.* (1990).

The variation in the length of gestation between the breeds could be attributed to the genetic make up of the breed of sow and boar, the levels of hormones of pituitary and fetus etc. (Lancho De Leon et al., 1975; Cole and Cupps, 1977 and Tan and Chen, 1983), parity (Adebambo, 1986 and Kim et al., 1988) and size of the litter and season (First et al., 1982). In this study in both the breeds, it was found that the litter size or the liveborn piglets per litter did not influence the gestation length, though the liveborn piglet weight per litter influenced in LWY (Table 3). Hafez (1987) and Solmon Raju (1991) found a positive correlation between the litter size and liveborn piglets per litter and gestation length, unlike the present observation.

A significant ($P < 0.05$) difference was noticed between the gestation length of two breeds (Table 25). It was more in the LWY breed (113.33 days) than the indigenous breed (110.9 days). This might be attributed to heavy mean liveborn piglet weight of the LWY breed, genetic make up of the sow or boar (Cole and Cupps, 1977).

Most of the dams in both the breeds (50% in the indigenous and 60% in LWY breed) farrowed during the night times (Table 4 & Fig. 8). Dinu et al. (1978), Hughes and Varley (1980), Benkov (1981), Arthur et al. (1982), and Devi (1986) also observed most of the farrowings

during night time. But Solmon Raju (1991) noticed 66.67% of the farrowing in the indigenous pigs during the day time.

The occurrence of farrowings between 12 noon and 6.00 AM coincided with the quiet period when the farm activities were minimum. Similar observations were made by Bughart (1959) and Solmon Raju (1991).

The farrowing in this study, was divided into three stages (Table 5).

In this investigation the mean duration of first stage of farrowing was 434.5 ± 39.42 mts (with a range of 239 to 695 mts) in the indigenous breed (Table 5). This observation was almost similar to the findings of Devi (1986) who recorded it to be 317.33 to 448.68 mts and Solmon Raju (1991) 431.33 mts in the indigenous pigs.

In LWY breed, the mean duration of 1st stage was 498.5 ± 36.88 mts (with a range of 286 to 695 mts) (Table 5). Salisbury and VanDemark (1961), Roberts(1971) Bearden and Fuquay (1980), Hughes and Varley (1980) and Hafez (1987) reported the duration of 1st stage to vary from 2 to 12 hours.

The variation in the duration of first stage between the sows of both the breeds might be due to the

variation in the quantum of release of oxytocin. However, there was no significant ($P > 0.05$) difference in the first stage between the breeds (Table 25).

The mean duration of second stage in the indigenous breed was 80.8 ± 13.81 mts with a range of 28 to 159 mts (Table 5). Devi (1986) and Tamuli et al. (1986) recorded the 2nd stage to last for 67.85 to 247.66 mts in the Assam pigs and 75-190 mts in the wild variety of Assam pigs, respectively. The mean duration of second stage in LWY breed was 95.25 ± 2.68 mts with a range of 27 to 180 mts (Table 5). Singh and Singh (1989) reported the average duration of 2nd stage to be 2.39 hours in LWY and 1.82 hours in Hampshire breed. But in exotic breeds of pigs, Mathai et al. (1972) recorded it to be 2.53 hr, Cavalcanti et al. (1979) 4.3 hr and Fahmy and Friend (1981) found it to be 3.9 hrs.

In this investigation, no difference in the duration of 2nd stage was noticed between the two breeds (Table 25). Though the second stage was significantly ($P < 0.05$) and positively correlated with the litter size in the LWY breed, the same was not in the indigenous breed (Table 6).

The indigenous breed with smaller litter size took more time for completion of second stage, due to the longer

interval between the successive piglets (Table 9) as well as restlessness of the dam, during farrowing. In LWY pigs with larger litter size took comparatively lesser time for 2nd stage, since the interval was less between the successive piglets (Table 9) and this variation in this study might be attributed to the difference in the breed characters as stated by Devi (1986) and Tamuli et al. (1986).

The mean time for the third stage (Table 5) i.e., time taken to expel the placentae in the indigenous breed was 169.3 ± 26.20 mts (76 to 316 mts) and in the LWY breed, the same was 98.0 ± 9.06 mts (41 to 149 mts). The present findings fell well within the time limit for the 3rd stage of farrowing in the pigs. In the indigenous pigs, Devi (1986) recorded it to be 136.67 ± 262.33 mts. Tamuli et al. 45-105 mts in the wild variety of Assam pigs and Solmon Raju 1991), 126.07 mts in the indigenous pigs of A.P. In the LWY breed of this study, the duration of 3rd stage was lower than the observations of Jones (1966 b) and Singh and Singh (1989)

In both the breeds of this study, the 3rd stage was non-significantly correlated with the number and weight of the placenta and the litter weight (Table 6).

A significant ($P < 0.05$) difference in the 3rd stage between the LWY and indigenous breed was noticed in this

study (Table 25). The lesser duration of 3rd stage in LWY breed might be due to the higher levels of oxytocin in the circulation consequent to immediate suckling of piglets or due to the breed difference and also due to the expulsion of the placentae during the birth phase, as noticed in this study.

In the present investigation, the combined duration of 2nd and 3rd stages of farrowing in the indigenous sows from between 130 to 390 mts with an average time of 250.1 mts (Table 5). In the wild variety of Assam pigs, Tamuli et al. (1986) reported the same to range from 120 to 295 mts. In the indigenous pigs of Assam, Devi (1986) recorded a slightly higher time of 204.52 to 509.99 minutes. But Solmon Raju (1991) reported a lower time in indigenous pigs of A.P. ie., 216.80 mts than the present study.

In LWY, the combined duration of 2nd and 3rd stages of farrowing ranged from 123 to 270 mts with a mean duration of 193.25 mts. But Jones (1966 b) and Mathai et al. (1972) reported 6.54 hrs and 6.31 hrs, respectively. In this investigation, the LWY breed took lesser time when compared to indigenous breed.

A significant ($P < 0.05$) difference was noticed in the combined duration of 2nd and 3rd stage between the

two breeds (Table 25). This might be due to the difference in the litter size, which influences the duration of farrowing, and also breed, health status, physical exercise during pregnancy and hormonal levels of estrogens, oxytocin, $PGF_{2\alpha}$ and corticosteroids as opined by Peo (1960), Svendsen and Bengtsson (1982) and Houpt and Wolski (1982).

A significant ($P<0.01$) positive correlation was noticed in LWY breed between the duration of 2nd and 3rd stages with the litter size. But the same was observed to non-significant, in the indigenous breed, which indicated that the litter size, suckling habbit of the piglets and hormonal levels, influence the duration of 2nd and 3rd stages.

In this study, 72.97% of indigenous piglets were delivered in the anterior presentation, the rest (27.03%) were found in the posterior presentation (Table 7 and Fig. 9 & 10A). In the indigenous pigs, Solmon Raju (1991) reported anterior presentation in 57.02% of piglets born. Similarly in LWY pigs 55.83% of piglets were farrowed in anterior presentation (Table 7 & Fig. 9). This observation gains support from Randall (1972 a) who recorded anterior presentation in 55.4% of piglets. Many workers reported that the anterior presentation was most common presentation in exotic breeds of pigs (Jones (1966b) -75.7%, Roberts (1971) -60-70%, and Mathai et al. (1972) -71%).

The presentation of the fetus did not influence the course/duration of farrowing. The higher percentage of posterior presentation, noticed in the LWY pigs (Fig. 9 & 10B) is considered to be physiological in swine (Randall, 1972 a).

In this study there was a variation in the presentation of the piglets in the birth order (Table 7 & Fig.9). A higher percentage of piglets were delivered in the anterior presentation in the middle third of birth order (80.77%) in the indigenous and 61.90% in the LWY) in both the breeds, contrary to the findings of Randall (1972 a) Cole and Cupps (1977) and Solmon Raju (1991), who reported larger proportion of piglets in anterior presentation during the early stages of farrowing.

In the present study, most of the piglets (95.95% in the indigenous and 95.83% in LWY) were delivered in Dorso-sacral position. Similar observations were made by Roberts (1971) and Solmon Raju (1991) in pigs. The dorso-sacral position appeared to be the normal position of the piglet during birth (Table 8 and Fig. 10).

The mean time lapse between the two successive liveborn piglets was 10.13 $\pm$ 1.76 mts (1-97 mts) and between the live and stillborn piglets was 15.8 $\pm$ 7.14 mts (10-39 mts)

in the indigenous breed (Table 9). Tamuli et al. (1986) recorded it to be 5 to 20 mts in between the two successive piglets in the wild variety of indigenous pigs. Solmon Raju (1991) noticed 8.22 mts in between the two successive liveborn piglets and 45.58 mts in between the live and stillborn piglets in the indigenous breed.

In LWY, the mean time lapse between the two successive liveborn piglets was 8.25 ± 0.35 mts (0-51 mts) and between the live and stillborn piglet was 14.33 ± 4.48 mts (0-28 mts) in this study (Table 9). Jones (1966 b) recorded it to be 15.3 mts and Randall (1972) mts between the successive piglets.

The time between the birth of the live and stillborn piglet in this study was lesser than those noticed by Cole and Cupps (1977) (45.55 mts); and Solmon Raju (1991) (45.58 mts) in exotic and indigenous breeds, respectively.

In this study, the mean time interval between the two successive piglet was lesser in LWY breed than that in indigenous breed and this might be due to difference in the breed, behaviour of the dam during farrowing, hormonal levels and also due to quicker expulsion of piglets (Fig.10D) in the birth order. In both the breeds, live to stillborn

piglets took more time (Table 9) than that of two successive liveborn piglets, which might be attributed to the lack of fetal efforts and mechanical stimulation of birth canal by the stillborn ones during farrowing.

In both the breeds, the 1st and 2nd successive piglets as well as the last born piglets took longer time to come out, when compared to the piglets born in between, noticed in thisinvestigation(Table 10). Similarly Jones (1966 b), Roberts (1971), Edwards and Furniss (1988) and Solmon Raju (1991) reported longer interval in the first and 2nd piglet as well as in the last piglet.

In the pigs, the est rogens produced by the blastocyst initiate the events, that result in the maintenance of C.L. (Luteostatic) and the endometrial secretions, which contain luteolytic ($PGF_2\alpha$), and embryotropic factor, help in the maintenance of pregnancy. The free estrogens of blastocyst acting locally in the uterus increase the uterine blood flow, water and electrolytic movement, bring about "maternal recognition" of pregnancy phenomenon (from Day 11 pregnancy). Uterine secretory activity other events associated with placentation alter the direction of movement of $PGF_2\alpha$, so that its secretion do not enter the uterine blood and cause systemic effect i.e., luteolysis. An increase in the frequently

and amplitude of myometrial contractions and gradual appearance of straining efforts by the dam take place during the last few hours before the birth of 1st piglet.

The farrowing was proceeded by a multitude of hormonal changes in the blood of the dam (increased concentrations of estrone, estradiol, relaxin, corticosteroids, prolactin and oxytocin) and increased levels of cortisol (glucocorticoids by fetal adrenal) in the fetus. The maternal progesterone levels decrease within 1-2 days before parturition due to rapid increase in the synthesis of $PGF_{2\alpha}$ which causes the release of prolactin and stimulates. The release of concentration of oxytocin 9 to 4 hrs before the birth of the first piglet. At this time the plasma estrogen levels in the dam are at the peak. The elevated levels of oxytocin causes increased myometrial activity (contractions) and also stimulates the uterine production of $PGF_{2\alpha}$ both of which have a cascading effect of the development of uterine contractions. The relaxin softens or loosens the cervix and facilitates the delivery of fetus. The very high levels of oxytocin during expulsion of pig fetuses is due to the mechanical stimulation of the cervix (has large surface area) and or birth canal. The delivery of successive fetuses is achieved with high

concentration of oxytocin (Forsling et al. (1979, Bazer et al., 1982, First et al., 1982 and Sherwood, 1982).

The litter size at birth (Fig. 11) is a major trait for selection of sows to produce the next generation.

In this study, the mean litter size in the indigenous pigs was 7.7 ± 0.90 with a range from 3 to 12 piglets per litter (Table 11), which was akin to the reports of AICRP on Pigs (1981-91) (7.63 piglets/litter). But Solmon Raju (1991) reported slightly higher litter size (8.40 piglets/litter). A lower litter size was also reported by different authors in India in the indigenous pigs (Mishra et al., 1985) 5.6 in Orissa, Dhingra (1987) - 4.70 in Assam, and 6.5 in A.P. and Mishra et al. (1989 - 6.62 in A.P).

In LWY the mean litter size was 10.17 ± 0.64 piglets with a range of 7 to 14 piglets/litter (Table 11)., which was in agreement with the reports of Kurcmann and Wardowksi (1987) 10.10 in Polish LWY, Venev (1988) 10.15 in Bulgarian LWY and Silva and Dap (1990) 10.1 in LWY.

The litter size in 50% of indigenous and 25% of LWY sows was 6-7 and in 30% of indigenous pigs and in 58.38% of LWY pigs the same was above 10 (Table 12).

In this study in both the breeds the litter size was significant ($P<0.01$) and positively correlated (Table 13) with the litter weight and this was in agreement with the observations of Fahmy (1971), Milagres et al. (1981), Park and Kim (1986) and Solmon Raju (1991).

A significant ($P<0.05$) difference in the litter size was noticed between the two breeds (Table 25). The mean litter size was more in LWY when compared to that of indigenous breed, and this might be due to the variation in the breed, ovulation rate and the length of uterine horn (Hughes and Varley, 1980; Gonzalez et al., 1987, Wu et al., 1987, Franz et al., 1989 and Mishra et al., 1990).

The mean litter weight in the indigenous pigs was only 6148 ± 710.42 g (1750-10,000 g)(Table.14) which was slightly lower compared to the findings of Dhingra (1981-82) 6.50 kg and Solmon Raju (1991) 6.31 kg in the indigenous pigs.

In LWY breed, the mean litter weight was 10676.25 ± 776.23 g (6350 to 14650 g) (Table 14). Similarly Nambudri and Thomas (1984) reported it to be 10.8 kg and Mishra and Sharma (1990) found it to be 10.76 kg in Landrace breed. Konyukhova (1974), Gal, (1976), Alves

et al. (1987), Gonzalez et al. (1987) and Mishra and Sharma (1990) reported the litter weight to range from 12.98 to 16.00 kg in LWY. The mean litter weight in LWY was significantly ($P<0.01$) more when compared to that in indigenous breed (Table 25), which might be due to larger litter size or due to the difference in the breed of pigs (Mishra and Sharma, 1990).

A significant ($P<0.05$) negative correlation was observed between the litter weight and incidence of still-births in both the breeds (Table 13).

The various factors like difference in the breed, parity, level of nutrition, ovulation rate, season and management influence the litter size (Mathai and Ramachandran, 1972; Singh et al., 1977; Hughes and Varley, 1980, Mohanty and Nayak, 1986, Gonzalez et al., 1987, Franz et al., 1989, Omeke, 1990 and Mishra et al., 1990) and the litter weight (Holness, 1970, Dudzus and Vecker, 1977, Szoradi, 1979, Benevides et al., 1985, and Mishra and Sharma, 1990).

In this study, 93.51% of piglets were born alive (Table 15) and the mean number of liveborn piglets per litter was 7.2 $\pm$ 0.74 out of a total litter size of 7.7 $\pm$ 0.90 in the indigenous pigs (Table 11). These findings

were in accordance with those of Adebambo (1986) and Rico (1988) who reported the mean liveborn piglets to be 7.3 and 7.4, respectively, in Hampshire breed. A slightly higher number of liveborn piglets (7.6) was reported by Solmon Raju (1991) in the indigenous pigs.

Similarly in LWY breed, 95.08% of piglets were born alive (Table 15) and the mean liveborn piglets per litter was 9.67 $\pm$ 0.59 out of a total litter size of 10.17 $\pm$ 0.64 (Table 11) and fell well within the range of 8.1 to 10.5 piglets as reported by Stankovic et al. (1973), Gal (1976), Mani (1985), Adebambo (1986), Boulard et al. (1986) and Gonzalez et al. (1987).

In both the breeds, a significant ($P < 0.01$) positive correlation was found between the liveborn piglets/litter and their weight/litter (Table 13). Unlike a significant negative correlation that was noticed in liveborn piglets/litter with the number of stillborn piglets. These observations gained support from the observation of Solmon Raju (1991) in the indigenous pigs.

The variation in the number of liveborn piglets per litter between the breeds might be attributed to the variation in the breed, strain, parity, managemental factors, interval between the successive piglets, duration of farrowing and the state of umbilical cord.

A significant ($P < 0.05$) difference was noticed between the two breeds in the liveborn piglets/litter which was more in LWY than that in the indigenous breed and this might be due to the difference in the breed and larger litter size in this study.

The individual body weight of the piglet at birth is an important trait mainly concerned with the growth and survival rates.

In this study, the mean total liveborn piglets weight/litter in the indigenous pigs was 5990.5 ± 690.15 g (1750 to 10,000 g) (Table 14) with a mean liveborn piglet weight of 827.02 ± 51.13 g (583.33 to 1208.33 g) (Table 16). But Solmon Raju (1991) noticed a slightly higher mean total liveborn piglets weight/litter 6116.67 in the indigenous pigs with a mean liveborn piglet weight of 804.80 g which was slightly lower than the present findings. In the LWY breed the total liveborn piglets weight/litter was 10408.33 ± 7777 g (6350 to 14650 g) (Table 14) with mean live born piglet weight of 1075.76 ± 48.10 g (866.67 to 1370.00 g) (Table 16) which were similar to the reports of Barnikhina (1974), Jayarajan (1976), Benkov and Vzharova (1982), Tan and Chen (1983), Siagian *et al.* (1986), Gonzalez *et al.* (1987) and Singh *et al.* (1989) in LWY breed.

In both the breeds, the male liveborn piglet weight was more (Table 14) (3232.5 ± 465.12 g in the indigenous and 5283.33 ± 554.49 g in LWY breed, when compared to that of the female (2758 ± 424.8 g in the indigenous and 5125 ± 624.79 g in LWY((Table 14).

A significant ($P<0.05$) and negative correlation was noticed between the mean liveborn piglet weight and the number of stillborn piglets in both the breeds (Table 13) and this was similar to the observations of Solmon Raju (1991).

A significant ($P<0.05$) difference was observed between the two breeds in the mean liveborn piglet weight. A heavier weight in LWY might be due to the difference in the breed, larger size of the piglet, litter size and heritability of the traits (Schlindwein, 1975; Singh et al., 1977, Rai and Desai, 1985; Franz et al., 1989 and Mishra and Sharma, 1990).

In this study, the first born piglet was heavier when compared to the late born ones in both the breeds. Similar findings were also reported by Harstock (1975), Schoeps and Huhn (1985) and Solomn Raju (1991). The heavier weight of the 1st born piglet might be due to the better growth of the piglet in the uterus, near the cervical end where the uterine space is more.

The stillbirths in this study were classified as intrapartum and pre-partum deaths in which mummified fetuses were also included (Table 15 and Fig 12 & 13).

The percentage of stillbirths in the indigenous breed was 6.49 (0.5 piglet/litter) amongst which the mummified fetuses and fully formed piglets were 3.89 (0.3 piglet/litter) and 2.60 (0.2 pgilet/litter), respectively. In Nigeria pigs (Osuagwuh and Akpokodje, 1981) noticed the stillbirth to be 5.7%. A higher (8.33) percentage of still births was reported by Solmon Raju (1991) in the indigenous breed.

The percentage of stillborn piglets in this study, in LWY breed was 4.92 (0.5 piglet/litter) of which the mummified fetuses were 1.64 (0.17 piglet/litter) and fully formed fetuses were 3.28% (0.33 piglet/litter). Similarly, Cavalcanti et al. (1979) reported 4.85% of stillbirths in the Duroc breed, while Muller-Haye and Vecchionance (1974), Nishida et al. (1976), Dagorn et al. (1980), Rai and Desai (1985), Siagian et al. (1986) and Mishra et al. (1990) reported the lowest percentage of stillbirth (3.88) in LWY breed. Under Indian conditions, Singh and Singh (1989) reported it to be 8.80% in LWY.

A high percentage of mummified fetuses (3.89) was noticed in the indigenous breed. Solmon Raju (1991) also

reported a higher percentage of (6.35) mummified fetuses in the indigenous pigs. The percentage of mummified fetuses increased as the litter size increased in the indigenous breed. This might be due to the lack of sufficient uterine space for the growth, consequent to shorter uterine horne (Wu et al., 1987). Though the litter size in the LWY was higher, the percentage of mummified fetuses was less (1.67%) which may be attributed to the availability of uterine space.

The variation in the incidence of stillbirths was attributed to factors like larger litter size with shorter uterine horns of the dam, (Wu et al., 1987), lower birth weights of the piglets (Singh and Singh, 1989), the birth interval of the piglets, state of the umbilical cord, ambient temperature of 30°C during 102 to 110 days of gestation, parity etc. (Randall, 1972b; Sprecher et al., 1974 and Fonseca et al., 1988).

The death of a fully formed piglet (without mummification) might be due to the rupture of umbilical cord a few days prior to farrowing as opined by Randall (1972b).

The percentage of stillbirths was the highest (17.65%) in the last third in the birth order

in the indigenous breed and in the middle third (6.89%) in the birth order in LWY breed (Table 15, and Fig. 12). Though Randall (1972 b), Linneman et al. (1973), Sprechr et al. (1974) and Cole and Cupps (1977) reported a gradual increase in the percentage of stillbirths from first to the last third piglets in the birth order in the exotic breeds, similar observations could not be noticed in the present study inLWY, but were seen in the indigenous breed. Solmon Raju (1991) also noticed similar findings in the indigenous pigs. The variation in the incidence of stillbirths in the birth order in these two breeds might be attributed to the smaller size of the sample in this study.

A direct relationship between the incidence of stillbirths and the litter size was noticed in the indigenous breed. But in LWY an inverse relationship was observed (Table 17). This variation might be due to more number of mummified fetuses in the indigenous breed and also might be due to smaller size of the sample.

In the present investigation, the mean stillborn piglet weight was 345.83 ± 76.90 g in the indigenous breed. In LWY, the same was 437.08 ± 192.80 g. It was observed that the stillborn piglet weight was lesser than

that of liveborn piglet in both the breeds (Table 16). Similar observations were also noticed by Meyer et al. (1976) and Solmon Raju (1991).

The sex ratio among the liveborn, stillborn and the overall litter in this study (Table 18 & Fig. 14) was 48.61%, 60.00% and 49.35%, respectively in the indigenous breed. The same in the LWY breed was 48.27%, 66.66% and 49.18%, respectively. Nearly similar sex ratios were reported in the indigenous pigs of Haryana, 47.5% by Sharda and Singh (1982) and of Nigeria, 42.2% by Adebambo (1986). But Solmon Raju (1991) reported a higher sex ratio (56.35%) in the indigenous pigs of A.P. In LWY the sex ratio was 49.18% and this observation was nearly in agreement with the observations of Sharda and Singh (1982) - 50%, Perez et al. (1983 - 50.25% and Gray and Katanbaf (1985) --50.74% in LWY breed.

The lower percentage of males observed in this study in both the breeds (Table 18 & Fig. 14) might be due to study on the dams of 2nd parity. Mathai and Ramachandran (1972) reported decreased sex ratio as the parity of the pigs increased. Solmon Raju (1991) reported higher sex ratio in the 1st parity pigs, in his studies.

In this investigation, males accounted for 60% of stillborn piglets in the indigenous and 66.66% in the LWY breed. Nishida et al. (1976) in LWY breed and Solmon Raju (1991) in the indigenous breed also reported a higher percentage of stillborn males 59.33 and 58.33, respectively in their studies.

The number of placentae (Table 19 & Fig.15) expelled in both the breeds, tallied with the number of liveborn piglets as well as with the fully formed stillborn piglets except in case of mummified fetuses, where the placentae was found wrapped around the fetus (Fig. 13 A). These observations were similar to those of Solmon Raju (1991) in the indigenous pigs. A significant ($P < 0.01$) and positive correlation was observed in both the breeds between the placental number and the weight of placentae (Table 20). Similar observations were also made by Fahmy (1971) and Solmon Raju (1991).

There was a significant ($P < 0.05$) difference in the number of placentae in between the breeds in which it was more in LWY than in indigenous breed (Table 25). This might be due to larger litter size of the breed, as well as due to live and fully formed piglets.

In this investigation 70% of the indigenous dams and 66.67% of the LWY dams expelled the placentae after the birth of the last piglet. These observations gains support from those of Jones (1966 b), Roberts (1971), Mathai et al. (1972), Arthur et al. (1982) and Solmon Raju (1991).

The expulsion of placentae during the birth phase in some of the dams in this study might be due to either high levels of oxytocin (Florsling et al., 1979) or due to the early detachment of placentae from the uterine wall.

It was observed that the placentae were expelled either in single mass or in batches. Fifty per cent of the sows expelled placentae in single mass and rest in batches in the indigenous breed. Contrary to the observation of Solmon Raju (1991) who reported expulsion of placentae in single mass in 13.37% of cases only in the indigenous pigs. But in LWY breed in this study, majority of the sows (75%) expelled the placentae in batches. Jones (1966 b) also reported similar findings.

The mean placental weight/litter was 1482.5 $\pm$ 271.64 g (450 to 3150 g) and the placental weight per piglet was 190.08 $\pm$ 18.09 g (109.38 to 315 g) in the indigenous breed (Table 19).

The observations on the placental weight per litter varied amongst different workers. While Devi (1986) reported it to be 525 to 961.57 g, Tamuli et al. (1986) noticed it to be 0.4 to 1.2 kg while Solmon Raju (1991) observed it to be 1.2 kg in the indigenous pigs.

In the LWY breed, the mean placental weight per litter was 2137.08 ± 151.18 g (1360 to 2800 g) and its weight per piglet was 214.86 ± 0.08 g (150 to 287.22 g) (Table 19). The placental weight/litter in this study was higher unlike those of Mathai et al. (1972) who recorded it to be 1.27 kg and Singh and Singh (1989) 1.42kg, respectively in LWY.

The variation in the placental weight between the breeds might be due to litter size, parity, and breed of the sow. Fahmy (1971) reported heavier placental weight in Duroc but lighter in LWY and Berkshire breeds. In both breeds, in this study placental weight was positively, significantly ($P < 0.01$) correlated with the liveborn piglets per litter and its weight per litter (Table 20)

A heavier placental weight in the LWY breed as seen in this study might be due to the difference in the breed of the sow, and differencein the litter size as well as liveborn and its weights in this study.

The fetal membranes in this study contributed 18.81% and 16.88% of the weight of the total products of conceptus (excepting fluid) in the indigenous and LWY breeds, respectively (Table 21). Similar observations were also reported by Jones (1966 b) 16.20% in LWY and Solmon Raju (1991) who reported it to be 16.19% in the indigenous pigs.

In the present study, not a single case of retained placenta was observed. In pigs, retention of placenta is less common feature (Roberts, 1971).

In the present investigation, 16.67% of the piglets were born with intact umbilical cord and 83.33% had ruptured cords in the indigenous pigs (Table 22) contrary to the reports of Solmon Raju (1991) who reported the birth of 60.19% of piglets with intact cords in the indigenous breed.

In LWY breed 62.93% of piglets were born with intact umbilical cord and 37.07% with ruptured ones (Table 22). Similarly Randall (1972a) and Arthur et al. (1982) also noticed intact umbilical cords in 60-70% of piglets.

In this study, the birth of most of the piglets with intact umbilical cords (62.93%) in LWY when compared

to that (16.67%) of indigenous breed (Table 22). This might be due to the difference in the breed and length and thickness of the umbilical stalk in LWY. A higher percentage of piglets with ruptured umbilical cords in the indigenous breed might be due to the restlessness of the dam during farrowing as well as thinness of the cord.

The mean time taken for rupture of umbilical cord was 3.08 ± 0.49 mts (1-7 mts) in the indigenous breed and in LWY 4.75 ± 0.40 mts (1-14 mts). Randall (1972 a) reported it to be 2-12 mts in exotic breeds and Solomn Raju (1991) found it to be 1.91 mts in the indigenous breed. The variation in the time taken for the rupture of the umbilical cord might be due to considerable stretching of the cord before reaching the breaking point, which might be responsible for the lowering the blood pressure and collapse of chorionic villi which inturn facilitates the detachment and expulsion of fetal membranes during the birth phase (Randall, 1972 a; and Solmon Raju, 1991).

In this study, none of the breeds (either indigenous or LWY breed) had dystocia of any kind. Jones (1966b) and Roberts (1971) also stated that dystocia were rare in pigs. The pigs fetus with its short neck, small and short flexible

limbs and with little deviation of head and neck pose little problems during farrowing.

No teratological defects were observed in the piglets of both the breeds in this study.

Inthis study, the dams were classified as 'normal' and 'mixed' groups, basing on the liveborn and stillborn piglets in the litter.

The normal groups of LWY dams significantly differed from indigenous normal dams in the duration of third stage, 2nd and 3rd stage, litter size, litter weight mean liveborn piglet weight and placental weight per piglet. Similarly, the mixed group of LWY dams differed significantly ($P < 0.05$) from the mixed indigenous dams in the gestation length and litter weight (Table 23). The gestation length of LWY dams were longer (113.5 $\pm$ 0.75 days) than that of the indigenous dams (108.67 $\pm$ 1.19 day) (Table 24. The breed of the sow, the size of the litter and the number of stillborn piglets may influence the gestation length.

In the indigenous pigs, the mixed group of dams differed significantly ($P < 0.05$) from the normal group, in the litter size which was larger in the mixed group (10.67 $\pm$ 0.54 piglets/litter) than in the normal group

(6.42 ± 0.90 piglet/litter) (Table 24) indicating higher percentage of stillbirths with increasing litter size.

In the LWY breed, in all the reproductive characters, no difference (Table 24) was found between the normal and mixed group of dams.

CONCLUSIONS:

1. The physical signs of pregnancy include abdominal distension, development of the mammary glands and swelling of vulva. These changes are more appreciable in the LWY breed than in the indigenous breed.

2. During the day preceding parturition, pigs were restless, anorexic (not in LWY pigs), nest building as well as pawing activity and chewing. The indigenous dams are more aggressive and made loud barking sounds.

3. The signs of farrowing are enlargement of individual mammary glands with distended and turgid base 12-24 hours before actual time of farrowing and dribbling of a few drops of clear or straw coloured mammary secretion on expression.

4. The duration of pregnancy, litter size, liveborn piglets/litter, mean liveborn piglet weight/litter and placental weight are more in the LWY breed when compared to the indigenous breed.

5. The farrowing time was shorter in LWY unlike indigenous breed.

6. The presentation or position of the piglets will not affect the duration of farrowing.

7. In the indigenous pigs, the incidence of stillborn piglets/mummified fetuses may be more when the litter size increases.

8. The incidence of dystocia and retention of placenta are rare in the pigs.

9. Since the sows changes their positions frequently (left lateral to right lateral) while farrowing, attention during this time may avoid trampling, thereby preventing piglet losses.

CHAPTER VI

6. SUMMARY

A comparative study was undertaken with particular reference to gestation, farrowing pattern and litter traits between the indigenous and Large White Yorkshire breeds.

In both the breeds, the visible abdominal distension was noticed by 1½ month of gestation and enlargement of mammary gland by 2½-3 months. The changes that occurred in the external genitalia starting from 2 to 3 months of gestation disappeared one week post-partum. As the pregnancy advanced conspicuous changes were noticed both in the external genitalia and mammary gland, which was well developed with enlarged teats at the base. These changes noticed were marked in LWY, than those in the indigenous. During gestation the pigs were seen in lateral recumbency most of the times.

Before the impending act of farrowing, the common signs exhibited by the sows of both the breeds were anorexia (not noticed in LWY) and restlessness with frequent changes in resting positions, nest building behaviour, low barking grunts, tail switching and abdominal straining were conspicuous before the expulsion of mucoid

or serous discharges from the flacid external genitalia. The mammary glands were turgid, the animals calmed down and assumed lateral recumbency before farrowing. Many sows farrowed during the quiet period of the day, when the farm activities were minimum and exhibited good maternal instict. The sows of indigenous pigs were more alert to noise and restless than that of LWY sows.

The gestation length differed significantly ($P < 0.05$) between the breeds i.e. 110.90 $\pm$ 0.94 days in the indigenous and 113.33 $\pm$ 0.41 days in the LWY breed. Gestation length was significantly ($P < 0.05$) and negatively correlated with the litter size as well as liveborn piglets/litter in both breeds, but it was significantly ($P < 0.01$) and positively correlated with mean liveborn piglet weight/litter in the LWY breed.

The duration of first and second stages of farrowing were observed to be non-significant between two breeds. The second stage was significantly ($P < 0.01$) and positively correlated with the litter size in the LWY, but it was negatively correlated in the indigenous breed. The time taken to expell the placenta differed significantly ($P < 0.05$) between the two breeds. It was more in the indigenous pigs (169.3 $\pm$ 26.30 mts) than in LWY pigs (98.0 $\pm$ 9.06 mts).

The time taken to expell the piglets as well as the placentae was more in the indigenous pigs (250.1 ± 23.17 mts) and less in the LWY pigs (184.92 ± 11.76 mts).

Most of the piglets were expelled in anterior presentation and dorso-sacral position in both the breeds.

The time interval between the birth of successive liveborn piglets was higher in the indigenous pigs (10.13 ± 1.76 mts) than that in LWY (8.25 ± 0.85 mts). But a larger interval was observed between the birth of a live born to stillborn piglet in both the breeds. The time interval was slightly longer between 1st and 2nd piglet and also between the last born piglets in both the breeds when compared to the birth of piglets in between.

The litter size was significantly ($P<0.05$) higher in the LWY (10.17 ± 0.64) when compared to indigenous pigs (7.7 ± 0.90). The average total litter weight in indigenous breed was low (6148 ± 710.42 g) when compared to that in LWY (10676.25 ± 776.23 g). In both the breeds the litter size was positively and significantly ($P<0.01$) correlated with the litter weight.

The liveborn piglets/litter differed significantly ($P<0.05$) between the indigenous (7.2 ± 0.74 piglets/litter) and LWY pigs (9.67 ± 0.59 piglets/litter) and it correlated positively and significantly ($P<0.01$) with the litter weight in both the breeds. The mean liveborn piglet weight was significantly heavier in LWY (1075.76 ± 48.10 g) than that in indigenous breed (827.02 ± 51.13 g).

The incidence of stillborn piglets was 6.49% in the indigenous and 4.92% in the LWY pigs and the difference in the incidence between breeds was non-significant ($P>0.05$). Mummified fetuses were more in the indigenous (3.89%) than that in the LWY pigs (1.64%).

The percentage of males born was less amongst the total as well as liveborn piglets in the 2nd parity of the dams in both the breeds.

Most of the placentae of the corresponding piglets, except those of mummified ones, which were wrapped around the fetuses were expelled after birth of the last piglet or occasionally during the birth phase as noticed in some LWY pigs. Placenta was mostly shed either in single mass or in batches.

The weight of placentae was significantly ($P<0.05$) heavier in LWY (2137.08 ± 151.18 g) than that in indigenous pigs (1482.5 ± 271.64 g). In both the breeds a

positive and significant ($P<0.01$) correlation was found between the placental weight and liveborn piglets/litter as well as their weights.

Most of the LWY piglets had umbilical cords intact. The intact umbilical cord was broken within 3.08 ± 0.49 mts in the indigenous and 4.75 ± 0.40 mts in the LWY after the birth of piglets, and the difference was significant between the breeds.

None of the pigs in both the breeds had any type of dystocia nor any teratological defects in the piglets.

The normal group of LWY dams differed significantly from that of indigenous dams with respect to the litter size, mean piglet weight/litter as well as with the time taken for the expulsion of placentae.

The mixed group of dams of LWY breed differed significantly ($P<0.05$) from that of indigenous ones with respect to the gestation length.

Though the litter size in the mixed group was significantly ($P<0.05$) larger (10.67 ± 0.54) than that in the normal group (6.42 ± 0.90), significant difference

was not noticed in the duration of 2nd stage of farrowing between them in the indigenous breed.

In the LWY pigs, no difference in all the reproductive characters was noticed between the normal and the mixed groups.

LITERATURE CITED

Adebambo O A 1986 Genetic and environmental effect on litter productivity of exotic and indigenous pure and crossbred pigs in Nigeria. Bulletin of Animal Health and Production in Africa 34:75-80.

A.I.C.R.P. on Pigs 1971-1990 Summary report pp 7-15.

Alves R G, Deo Silva M, De A E, Pereira J A A, Sancevero A B and Barbosa A S 1987 Effect of environment and genetic factors on pig litter size and weight at birth and at 21 days of age. Revista da sociedade Brasileira de zootechnia 16: 540-549. Cited Animal Breding Abstracts 57: Abstract No. 1004.

Andersson C and Rydhmer L 1991 How common are congenital defects of a new study carried out by the Sweedish agricultural University, Svinskotsel, 81: 14-15. Cited Animal Breeding Abstracts 59: Abstract No.4949.

Arthur G H, Noakes D and Pearson H 1982 Veterinary Reproduction and obstetrics ELBS 5th Edition, Bailliere Tindall, Grey Coat House 10, Grey Coat Place, London SWIPISB pp 109-132 & 145-152.

Ash R W and Heap R B 1975 Oestrogen, progesterone and corticosteroid concentrations in peripheral plasma of sows during pregnancy, parturition, lactation and after weaning. Journal of Endocrinology 64: 141-154.

Baldwin R L and Terasa plucinski 1975 Mammary gland development and lactation. Cited by Cole H H and Cupps P T (1977).

Banov T 1971 Study of length of gestation in pigs. Zhivot, Nauk 8: 61-66 Cited Animal Breeding Abstracts 40: Abstract No. 3448.

Baranikhina V V 1974 A comparison of economic traits of large White and Landrace pigs and their crossbreds. Nauchneje Trudy. Ukrainskaya Se Skokhozyai Stvennya akademiaya. 127: 110-112 (193-194). Cited Animal Breeding Abstracts 44: Abstract No. 3793.

Bazer F W, Geisert R D, Thatcher W W and Roberts R M 1982 In "The establishment and maintenance of pregnancy" Control of pig reproduction, Cole DJA and Foxcroft GR Butterworth Scientific, London, 1982 pp 227-252.

Bearden H J and Fuquay J 1980 Applied Animal Reproduction. Reston publishing company and A prentice-Hall Company Virginia. pp 99-109.

Benevides F I M, Schlindwein A P and Lobo R B 1985 Estimation of the effects of some non genetic factors on the performance of pian pigs. Arquiro Brasileinode Medicine Veterinariae Zootecnia. Cited Animal Breeding Abstracts 54: Abstract No. 387.

Benkov M and V'Zharova L 1982 The effect of birth weight of piglets on sucking order and growth birth to 21 days of age. Zhivotonov dni Nauki 19: 54-59. Cited Animal Breeding Abstract 51: Abstract No.6097.

Bogos V and Cojocaru F 1987 The effects of dynamics of body weight of Landrace sows during gestation on the performance of piglets. Production Animals 37: 8-12. Cited Animal Breeding Abstracts 56: Abstract No. 6941.

Bonte P, Moermans R, Brone E and Vandeplassche M 1980 Data on gestation length and parturition of 4148 litters. Vlaams Diergeneeskunding Tijdschrift 49: 431-441. Cited Animal Breeding Abstracts 50: Abstract No. 836.

Boulard J, Fleho J Y, Laloe D, Tiran M M L E and Runavot J P 1986 Performance in 1985. Techniporc 9:19-25. Cited Animal Breeding Abstracts 55: Abstract 3685.

Burghart M 1959 Beolachtungen uber die Geburtsvorgange beim schwein unter beson derer Beruchsichtigung der Geburtsdaver. Bay. Landw, Jb 36: 62. Cited by Hurnik 1985.

Cao H F, Han W H, Chen J F, Jin W M and Zheng Q W 1988 The Mi pig. Animal Husbandry and Veterinary Medicine 20: 63-65. Cited Animal Breeding Abstracts 56: Abstract No. 7624.

Catchpole H R 1969 Hormonal mechanisms in pregnancy and parturition. Cited by Cole HH and Cupps P T 1977.

Cavalcanti S DE S 1979 Occurrence of stillborn piglets and its relationship with some reproductive characters. Arquivos da Escola de Veterinaria da universidade Federal de Minas Gerais, 31: 501-502. Cited Animal Breeding Abstract 48: Abstract No.6113.

Cavalcanti S DE S, Barbosa A S and Sampaio I B M 1979 The effect of duration of farrowing on the incidence of stillborn piglets. Arquivos de Escola de veterinaria da universidade Federal de Minas Gerais 31: 43-49. Cited Animal Breeding Abstracts 47: Abstract No. 6666.

Cheng P L 1985 China-pig breeds. World Animal Review. 33-39. Cited Animal Breeding Abstracts 54:Abstract No.1717.

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 Veterinary Journal 67: 715-718.

Cole H H and Cupps P T 1977 Reproduction in domestic animals, 3rd edition. Academic Press, Inc. III. Fifth Avenue, New York 10003. pp 341-368, 456-474.

Dagorn J, Dervien A, Jubecort M DE Tiran M H L E, Meziere G and Owen J 1980 Performance 1979. Techniporc 3: 21. Cited Animal Breeding Abstracts 49:Abstract No. 3418.

Devi S 1986 M.V.Sc. Thesis, Assam Agricultural University Gauhati.

Dhingra M M 1987 Genetic improvement of indigenous pigs in India. Livestock Advisor 12: 13-16.

Dinu I, Alexander G and Ilioiu L 1978 Investigations into sow behaviour at farrowing Lucari stiintifice (Zootechnic 20/21: 39-47. Cited Animal Breeding Abstracts 48: Abstract No. 2007.

Dudzus M and Vecker E 1977 Investigation of piglet birth weight. Veterinarmedizin 32: 84-89. Cited Animal Breeding Abstracts 45: Abstract No. 6092.

Dumitrescu I. Stocia A, Culea C and Ristea P 1982 Parturition in pigs, Lucrari stiintifice (Zootechnic) 25: 7-11. Cited Animal Breeding Abstracts 53(12): Abstract No. 7710.

Dusza L Krzymowskah 1981 Plasma prolactin levels in sows during pregnancy, parturition and early lactation. Journal of Reproduction and Fertility 61: 131-134.

Edwards S A, and Furniss S J 1988 The effect of straw incrated farrowing systems on prepartal behaviour of sows and piglets. British Veterinary Journal 44: 139-146.

Elevage 1974 The crossbreeding programme of Rena pigs. Elevage 27: 101-108. Cited Animal Breeding Abstract 42: Abstract No. 2748.

Fahmy M H 1971 Weight of placental membranes in seven breeds of swine and its relationship with litter size and weight and at birth. Canadian Journal of Animal Science 51: 247-249.

Fahmy M H and Friend D M 1981 Factors and repeatability of the duration of farrowing in Yorkshire sows. Canadian Journal of Animal Science 61: 17-22.

Falkenberg H, Ritter E and Zschorlich H 1991 Studies on the occurrence of genetic defects on pig herds. Archivfur Tierzucht 34: 41-50. Cited Animal Breeding Abstracts 59: Abstract No. 4950.

FAO 1983 FAO Statistics on livestock population. In "Asian Livestock" IX (8) p. 87. Published from FAO Regional Office, Bangkok, Thailand 1984.

First N L and Bosc M H 1979 Proposed mechanisms controlling parturition and the induction of parturition in swine. Journal of Animal Science 48: 1407-1421.

First N L, Lohse J K and Nara B S 1982 In "The endocrine control of parturition" Control of Pig Production. Cole D J A and Foxcroft G R. Butterworth Scientific London. pp 311-342.

Gray E and Ktanbaf M N 1985 Sex ratio and distribution of sexes in swine. Journal of Heredity 76:36-38.

Hafez E S E 1987 Reproduction in farm animals, 5th edition. K M. Varghese Company P. Box 7119 Bombay-400 031. 229-259.

Hansen K E and Curtis S E 1980 Prepartial activity of sows in stall or pen. Journal of Animal Science 51: 456-460.

Herstock T G 1975 Behaviour and nutrition of newborn domestic swine (Sus-scrofa). Dissertation abstracts International 35: 5212-5213. Cited Animal Breeding Abstracts 44: Abstract No. 209.

Holness D H 1970 Factors affecting piglet birth weight in the indigenous gilt and sow. Proceedings of South African Society for Animal Production 9:169-171. Cited Animal Breeding Abstracts 39: Abstract No. 4951.

Hottmar V 1982 Breeding Vietnamese pigs. Choratal 21: 235-236. Cited Animal Breeding Abstracts 53:Abstract No. 720.

Houpt K A and Wolski T R 1982 Domestic animal behaviour for veterinarians and animal scientist. Cited by Hurnik 1985.

Hughes P and Varley M 1980 Reproduction in the pig. Butterworth and Co (Publishers) Ltd. pp 17-43, 93-123 & 124-135.

Huhn U 1989 Investigation on piglet birth weight in gilt litters and effects of gestation period and litter size. Archivfur Tierzucht. 32: 289-293. Cited Animal Breeding Abstracts 59: Abstract No.4207.

Hurnik J F1985 A review of peri-parturient behaviour in swine. Canadian Journal of Animal Science 65: 777-787.

Jayarajan S 1976 The performance of Large White Yorkshire pigs in Livestock Research Station, Kattupakkam, Cheiron 5: 51-55.

Jensen P 1986 Observations on the maternal behaviour of free ranging domestic pigs. Applied Animal Behaviour Science 16: 131-142.

Jones J E T 1966 a Observations on parturition in the sow part I: The prepartum phase. British Veterinary Journal 122: 420-426.

Jones J E T 1966 b Observations on parturition in the sow. Part II. The parturient and post-parturient phases. British Veterinary Journal 122: 471-478.

Kapko P S and Tokareva L N 1974 The effect of age at first mating on production of North Caucasus and Landrace sows. Nauchnye Trudy 1: 162-167. Cited Animal Breeding Abstracts 43: Abstract No. 4682.

Kastyak L and Miros J 1974 Observations on fertility, prolificacy, pregnancy duration and offspring sex ratio in sows from some farms in the Olsztyn district Zeszyty problemowe postepow Nauk Rolniczych 1953: 55-65. Cited Animal Breeding Abstracts 43:Abstract No. 457.

Kayaba T, Takahashi T and Konta T 1989 Studies on the genetic possibilities of improving sow fertility II. Heritability of litter size. Bulletin of the Yamagata University 1989. Cited Animal Breeding Abstracts 59: Abstract No. 8418.

Kelley K W and Curtis S E 1978 Effects of heat stress on the rectal temperature, respiratory rate and activity rates in peripartal sows and gilts. Journal of Animal Science 46: 356-361.

Kim Y H, Shin W J and Baik D H 1988 Effect of certain environmental factors on gestation length and sex ratio at birth in swine. Korean Journal of Animal Science 30: 406-410.

Konyukhova L 1974 Dynamics of body weight of sows during the reproductive cycle. Svinovodstvo 7:35-36. Cited Animal Breeding Abstracts 43: Abstract No.4646.

Kurcman B and Wardowski B 1987 The effect of pregnancy and parturition on some reproductive traits insows. Acta Academic Agriculture, Zootechnika 299: 163-172 Cited Animal Breeding Abstracts 56: Abstract No.306.

Lammers G J and Lange A DE 1986 Pre and post farrowing behaviour in primiparous domesticated pigs. Applied Animal Behaviour Science 15: 31-43.

Lancho DE Leon G, Tena Andrev S DE and Porras Castillo A 1975 Breed differences in gestation length. Zootecnia 24 (95-96), 245-250. Cited Animal Breeding Abstracts 44: Abstract No. 2244.

Lee J M, Park C S and Lee K S 1984 Studies on changes in sex hormone concentration throughout the oestrous cycle and pregnancy in gilts. Research reports of Agricultural Science and Technology 11: 233-243. Cited Animal Breeding Abstracts 55: Abstract No.352.

Linnemann F, Nielsen, H E, Lavren R 1973 The effect of order of birth on growth and viability in the pig and post-partum changes in haemoglobin content and erythrocyte volume in the blood. Frrederiksberg Bogtrykkery 26-30. Cited Animal Breeding Abstracts 44: Abstract No. 216.

Lopezseco J and Vieites C M 1971 Sex ratio in pigs Revista de la Facultad de agnonomia Y Veterinaria de Bvenos Aires 19: 9-13. Cited Animal Breeding Abstracts 42: Abstract No. 3276.

Mani R 1985 The reporting of inherited defects and malformations in A.I. boars. Milteilungen des schweizerischen verbandes fur kunstliche Besamung and der Interessenge me inchaft schweizerischer Be Samung. 23: 60-62. Cited Animal Breeding Abstracts 53: Abstract No. 7688.

Mathai E , Mahdevan E and Ramachandran P 1972 A study on parturition in Yorkshire pigs. Kerala Journal of Veterinary Science 3: 158-163.

Mathai E and Ramachandran P 1972 A study on litter size and sex ratio in pigs. Kerala Journal of Veterinary Science 3: 1-5.

McDonald L E 1980 Veterinary Endocrinology and Reproduction 3rd edition. Billiere Tindall, London. pp. 453-475.

Meyer H, Kroger H and Sagel B 1976 Investigations on the causes of variation in piglet birth weight and body and blood composition in under weight piglet. Deutsche Tieraztliche wochen schrift 83: 438-448. Cited Animal Breeding Abstracts 47: Abstract No.1872.

Milagres J C, Fedalto L M, Silva M De A E and Pereira J A 1981 Sources of variation in litter size and weight at birth and at 21 days of age in Duroc, Landrace and Large White pigs 1. Litter size. Zootecina 10: 653-671. Cited Animal Breeding Abstracts 51: Abstract No. 4452.

Mishra M, Dash P and Acharya S 1985 A study on economic traits and mortality in Large White Yorkshire, indigenous pigs and their crosses. A note : Indian Journal of Animal Production and Management 1: 41-44.

Mishra R R and Sharma G C 1990 Studies on reproductive traits in Landrace pigs in India. Indian Veterinary Journal 67: 425-429.

Mishra R R, Sharma G C, Prasad S and Krishnan L 1989 Litter size of indigenous pigs at birth. Indian Journal of Animal Science 59: 616-617.

Mishra R R and Shiv Prasad and Krishna Lal 1990 Factors affecting litter size in Large White Yorkshire pigs. Indian Veterinary Journal 67: 517-519.

Mohanty S and Nayak J B 1986 Reproductive performance of Large White Yorkshire pigs and their crosses with indigenous pigs in hot humid climate of Orissa. A note. Indian Journal of Animal Production and Management 2: 134-137.

Molenat M 1987 Breeding of chinese pigs in Europe 1. Chinese pig breeds, bred commercially in France. Tierzuchter 39: 331-334. Cited Animal Breeding Abstracts 56: Abstract No. 1549.

Moskal V 1980 A comparison of reproductive performance of dam and sire breeds of pigs. Zivocisna Vyroba 25: 903-910. Cited Animal Breeding Abstracts 49: Abstract No. 4045.

Muller-Haye B and Vacchionance H 1974 Age at first farrowing and its effect on productivity of sows. Memoria, Association tationaemericana de production Animal 9: 92-93. Cited Animal Breeding Abstracts 43: Abstract No. 3012.

Murayamma J 1990 Relationship between litter size and farrowing duration. Japanese Journal of Swine Science 27: 135-139. Cited Animal Breeding Abstracts 59: Abstract No. 1897.

Nambudiri Anandan and Kurien Thomas 1984 Effect of season of farrowing on litter size., birth weight gain and mortality in preweaned large White Yorksire pigs. Kerala Journal of Veterinary Science Vol.15: 9-14.

Nara B S and First N L 1981 Effect of Indomethacin and prostaglandin $F_2\alpha$ on parturition in swine. Journal of Animal Science 52: 1360-1370.

Nascimento J D DO 1988 Genetic and environmental factors affecting litter size in Duroc Pigs. Arquivo Bransileiro de medicine veterinaria e zootechia 40: 15-160. Cited Animal Breeding Abstracts 59: Abstract No. 799.

Nishida S, Otsuka J and Hayashi H 1976 Sex ratio of offspring in domestic animals, pigs. Japanese Journal of Animal Reproduction 22: 106-108.

Nishida S, Otsuka J and Sakai R 1981 Secondary sex ratio of pigs in six animals husbandry experiment stations Japanese Journal of Animal Reproduction 27:137-142.

Olsson A C and Svendsen J 1989 Course of farrowing and dam progeny interactions for sows in different types of housing. Rapport. Institutionen for lantbrukets Buggnadstekni 1989: 64. Cited Animal Breeding Abstracts 58: Abstract 5334.

Omeke B C 1990 Seasonal breeding performance in the field of Landrace and Large White pigs under humid environment. World Review of Animal Production 25: 33-36. Cited Animal Breeding Abstracts 59: Abstract No. 4987.

Osuagwuh A IA and Akpokodje J U 1981 Age of first breeding and incidence of dystokia and losses at parturition and post-partum in the indigenous Nigerian pig. Animal Reproduction Science 4:149-153.

Park Y I and Kim J B 1986 Heritabilities of litter size and litter weight at birth in swine. Breeding programmes for swine, poultry and fish pp. 59-62. Cited Animal Breeding Abstract 55: Abstract No. 332.

Park H C, Seo K S, and Park Y I 1989 Effect of the interaction between mating type and parity on litter size and litter weight in swine. Korean Journal of animal sciences 31: 572-577. Cited Animal Breeding Abstracts 58: Abstracts No. 255.

Peo E R 1960 Round stall for farrowing. Cited by Hurnik J F 1985.

Perez T, Sanchez C, Suarez M A and Dieguez F J 1984 Sex ratio in the progeny of Large White and Duroc pigs. Ciencia Y Technica en la agriculture, Ganado-porcino 7: 7-22. Cited Animal Breeding Abstracts 53: Abstract No. 7725.

Petrovic M 1983 The variability and inheritance of fertilit in Swedish Landrace pigs. Arhiv Za poljo provvede Nauke 44: 387-404. Cited Animal Breeding Abstracts 54: abstract No. 4577.

Qi G C 1985 The Wuai pig. Animal Husbandry and Veterinary Medicine 17: 16-18. Cited Animal Breeding Abstracts 54: Abstract No. 2255.

Rai A V and Desai M S 1985 Studies on the economic traits of Large White Yorkshire pigs. Kerala Journal of Veterinary Science 16: 11-18.

Rajamahendran R, Ravindran V, Goonewardene L A, Sahaayaruban P and Rajaguru A S B 1985 The native pig of Sri Lanka. Animal Genetic Resources Information 4: 9-12. Cited Animal Breeding Abstract 53: Abstract No. 7662.

Randall G C B 1972 a Observations on parturition in the sow 1. Factors associated with the delivery of the piglets and their subsequent behaviour. Veterinary Record 90: 178-182.

Randall G C B 1972 b Observations on parturition in the sow II. Factors influencing still birth and perinatal mortality. Veterinary Record 90: 183-186.

Randall G C B, Taverne M A M, Challis J R G, Kendall J Z and Tsang B K 1986 Interrelationships between endocrine changes in peripheral and uterine venous blood and uterine activity at parturition in the pig. Animal Reproduction Science 11: 283-294.

Reddy D V and Charyulu E K 1985 Behavioural patterns of swine. Livestock Advisor 10(2): 5-7.

Reyes F C 1983 Study of the correlation between some gilts and sow carrying characteristics and neonatal viability in a farm in stor-Maria, Bulacan. Philippine Journal of Animal Industry 38: 14-58. Cited Animal Breeding Abstracts 55: Abstract No. 360.

Rico C 1988 Reproductive performance of the Hampshire breed. Cuban Journal of Agricultural Science 22:17-24 Cited Animal Breeding Abstracts 56: Abstract No. 5086.

Roberts S J 1971 Veterinary Obstetrics and Genital diseases 2nd edition. CBS Publishers and Distributors 485: Bholnathnagar, Shahdra, Delhi-110 032.

Salisbury G W and VanDemark N L 1961 Physiology of Reproduction and A.I, of cattle. W H Freeman and Company, San Francisco and London pp 135-149.

Sambraus H H 1978 Nutztierethologie p Parey Verlag, Berli, Hamburg. Cited by Hurnik J F, 1985.

Schlindwein A P 1975 Sources of variation in litter size and piglet weight of Durocs at birth. Thesis. 721. Cited Animal Breeding Abstracts 46: Abstract No.874.

Schoeps P and Huhn U 1986 Relationship between body weight gain of sows in advanced pregnancy and litter size. Monatshafte Fur Veterinarmedizind 41: 767-769. Cited Animal Breeding Abstracts 55: Abstract No. 1598.

Sharda D P and Singh P 1982 Note on the size, sex ratio mortality and average daily gain of in White Yorkshire and iddigenous pigs and their crosses from birth to weaning at 8 weeks of age. Indian Journal of Animal Science 52: 1140-1141.

Sherwood O D 1982 Relaxin at parturition in the pig. In "controlof pig reproduction". Cole D JA and Foxcroft G R. Butterworth Scientific, London pp 343-375.

Shylla B, Bardoloi T, Das D and Goswamy R N 1991 Growth rate of indigenous pigs of Assam as affected by some non genetic factors. Indian Veterinary Journal 68: 232-234.

Siagian P H, Arganosa V G, Alcantara P F, Aquino A G and Millena R J 1986 The reproductive performance of Yorkshire, Landrace and Durec breeds of swine. Phillippine Agriculturist 69: 53-62. Cited Animal Breeding Abstract 56: Abstract No. 3814.

Signoret J P, Baldwin B A, Frazer D and Hafez E S E 1975 The behaviour of swine. In "The behaviour of domestic animals". Edt. by E.S.E.Hafez, Bailliere Tindall, London.

Siler R 1985 The renaissance of Chinese breeds of pigs. Narcov 45: 201-205. Cited Animal Breeding Abstracts 54: Abstratact No. 4592.

Silva L and Dap G D A 1989 Effect of mating management on farrowing rate and litter size at birth arquivo Brasileiro de medicina Veterinaria Zootechnia 41:83-85. Cited Animal Breeding Abstracts 58: Abstract No. 261.

Singh R N, Pandey R S and Biswas S C 1977 A study on some of the economic characters of Yorkshire pigs under farm conditions. Indian Veterinary Journal 54: 175-179.

Singh B K and Singh B K 1989 Studies on different stages of parturition in exotic pigs. Indian Veterinary Journal 66: 840-843.

Singh B K, Singh B K and Dubey C B 1989 Studies on certain economic traits of exotic breeds of pigs under tropical climate. Indian Vety. Journal 66: 322-328.

Singh K I, Singh R L, Sharma B D and Dubey C B 1990 Reproduction traits and mortality rate in pigs. Indian Journal of Animal Sciences 60: 886-887. Cited Animal Breeding Abstracts 69: Abstract No. 1230.

Snedecor G W and Cochran W G 1967 Statistical methods 6th edition. Oxford IBH publishing Co. 17, Park Street, Calcutta, 16.

Solmon Raju 1991 MVSc thesis Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad-30.

Sprecher D J, Leman A D, Dzink P D, Cropper M and De Decker M 1974 Causes and control of swine still births. Journal of American Veterinary Medical Association 165: 698-702.

Stankovic M 1971 Effect of mating method and length of gestation on reproductive performances in pigs. Stocarstvo 25: 25-30. Cited Animal Breeding Abstracts 39: Abstract No. 4965.

Stankovic M, Stankovic J, Zaletal I and Mickic M 1973 Effect of age of gilts at first mating on fertility and survival of piglet. Arhivza poljpriveedne Manke 26: 41-51. Cited Animal Breeding Abstracts 42: Abstract No. 2266.

Stigson M 1980 Studies on farrowings of sows in loose housing barns. Svinskotsel 70: 40-41. Cited Animal Breeding Abstract 50: Abstract No. 4580.

Stojanovic Z, Vapa M and Tarssenko B 1973 Effect of sex, litter size and litter weight on pregnancy duration in pigs. Veterinarski Glasnik 27: 617-621. Cited Animal Breeding Abstracts 42: Abstract No. 274.

Stolic N 1986 The effect of litter size on the incidence of still births in sweedish Landrace gilts. Stocarstvo 40: 42-44. Cited Animal Breeding Abstracts 55: Abstract No. 3771.

Svendsen J and Bengtsson A C 1982 1. Perinatal mortality in pigs. 2. Sow behaviour studies at farrowing to study the incidence of intrapartum piglet mortality 14 Noradix Veterinary Congress, 415. Cited Animal Breeding Abstracts 52: Abstract No. 6738.

Svendsen J and Bengtsson A 1983 Housing of sows in gestation. Cited by Hurnik J F 1985.

Svinskotsel 1984 Fewer herds but more sows in the 1983-84 recording, Svinskotsel 74: 42-43. Cited Animal Breeding Abstracts 53: Abstract No. 2996.

Szoradi Z 1979 Examination of some reproductive parameters in pigs. Magyar Allatovosok Lipja 34:422-425. Cited Animal Breeding Abstracts 48: Abstract No. 709.

Tamuli M K, Rajkomar C K, Goswami B K and Mahanta S 1986 Parturition on behaviour in pigs. The Indian Journal of Animal Reproduction 7: 73-74.

Tan C N and Chen T W 1983 Reproductive performance of pigs in Singapore 2. Comparison of gestation and lactation periods, birth weight and body weight 56 days in five breeds of pigs. Singapore Journal of Primary Industries 11: 7:-13.

Taura Y, Hamana K and Matsuura E 1986 Fetal presentation at birth in pigs. Bulletin of the faculty of agricultural Kagoshima University 36: 131-134.

Timoshenko N N 1974 A study of the causes of still births in the pigs. Zhirotonovo dstvo 3: 75-76. Cited Animal Breeding Abstracts 42: Abstract No. 3285.

Tsitsyurskil L N 1986 Pregnancy duration of large White sows. From Referativonyl Zhyrnal 8.58, 554.92-95. Cited Animal Breeding Abstract 56: Abstract No. 320.

Tsitsyurskil L N and Mikhno V V 1991 Gestation period and productivity of Landrace and Large White sows. From Referativonyl Zhyrnal. Cited by Animal Breeding Abstracts 59: Abstract No. 1238.

Venev I 1988 Results of using imported Sweedish Large White sows 1. Litter size and fertility of sows. Genetika i selektsilja 21: 65-71. Cited Animal Breeding Abstracts 56: Abstract No. 6965.

Vidovic V 1984 Variability of reproductive traits of Dutch Landrace under commercial conditions. Stocarstov 38: 315-322. Cited Animal Breeding Abstracts 53: Abstract No. 4414.

Wu M C, Hentzel M D and Dziuk P J 1987 Relationship between uterine length and number of fetuses and prenatal mortality in pigs. Journal of Animal Science 65: 762-769.

APPENDIX: Certain reproductive characters of different breeds of pigs

S.No. Authors	Year	Breed**	Strain	Litter size	Litter wt(kg)	Live born/ litter	Piglet wt(kg)	Puberty (days)	First service (days)	First farrowing(days)	Gestation length (days	Sex ratio (%)	Anterior presentation(%)	Still-births (%)
(1) (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1. Jones	1966a,b	LWY	-	-	-	-	-	-	-	-	-	-	75.7	-
2. Holness	1970	Ind.	African	0.9	-	-	-	-	-	-	113.128	-	-	-
3. Angelov	1971	LWY	Bulgarian	-	-	-	-	7½-9½(M)	-	-	-	-	-	-
4. Benkov	1971	LWY	-do-	-	-	-	-	-	-	-	115	-	-	-
5. Lopezseco and Vietes	1971	LR	-	-	-	-	-	-	-	-	-	50.54	-	-
6. Roberts	1971	-	-	-	-	-	-	-	-	-	-	-	60.70	-
7. Stankovic	1971	LR	Sweedish	-	-	-	-	-	-	-	114.2	-	-	-
8. AICRP on pigs	1971-90	Ind.	Indian	7.63	-	-	0.74	-	263.65	373.33	109.69	-	-	-
9. Mathai and Ramachandran	1972	LWY	Indian	7.39	-	-	-	-	-	-	-	51.52	-	-
10. Mathai et al.	1972	LWY	-	8.07	-	-	-	-	-	-	-	-	71	-
11. Randall	1972a,b	-	-	-	-	-	-	-	-	-	-	-	55.4	-
12. Mahendranathan and Mellish	1973	LR CB	- -	- -	- -	- -	- -	241.9 162.2	- -	- -	-	-	-	-
13. Stankovic et al.	1973	LWY	Sweedish	-	-	9.95	-	7.11	-	-	-	-	-	-
14. Stojanovic	1973	LR	Dutch	9.43*	13.10*	-	-	-	-	-	-	50.80	-	-
15. Baranikhina	1974	LWY LR	Russian —	9.6 7.8	- -	- -	1.19 1.42	- -	- -	- -	- -	- -	- -	- -
16. Elevage	1974	LWY LR	- British	8.3* 8.0*	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
17. Kapko & Tokareva	1974	NC	-	8.72*	-	-	1.13	-	-	-	-	-	-	-
18. Kastyak & Miros	1974	LWY, D&HS	Polish	9.40	-	-	-	-	-	-	-	51.77	-	-
19. Konyukhova	1974	LWY	Russian	-	13.70*	-	-	-	-	-	-	-	-	-
20. Mullerhaye and Vecchionacce	1974	LWY&LR HS	-	-	-	-	-	-	-	-	-	-	-	3.3 1.5
21. Schlindwein	1975	D	-	6.86	-	-	-	-	-	-	-	-	-	-
22. Frolich	1976	LR	Sweedish	-	-	-	-	-	245	-	-	-	-	-

APPENDIX (CONTINUED)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
23.	Gal	1976	LWY	Hungarian	-	13.6	9.9	-	-	-	-	-	-	-	-
			LR	Dutch		12.1	9.2	-	-	-	-	-	-	-	-
24.	Jayarajan	1976	LWY	-	-	8.67	1.26	-	-	-	-	-	-	-	-
25.	Nishida et al.	1976	LWY	Japanese	-	-	-	-	-	-	-	-	-	-	3
26.	Poltarsky and Majerciak	1976	LR	German	-	-	-	-	-	-	389	-	-	-	-
				Bulgarian	-	-	-	-	-	-	409	-	-	-	-
				British	-	-	-	-	-	-	342	-	-	-	-
				Sweedish	-	-	-	-	-	-	389	-	-	-	-
				Belgian	-	-	-	-	-	-	371	-	-	-	-
27.	Fraser	1978	-	-	9.6	-	-	-	-	-	-	-	-	-	-
28.	Kihlberg	1978	LWY	-	-	-	-	-	-	-	370	-	-	-	-
			LR	Sweedish	-	-	-	-	-	-	441	-	-	-	-
			D	-	-	-	-	-	-	-	376	-	-	-	-
			HS	-	-	-	-	-	-	-	376	-	-	-	-
29.	Techni-porc	1978	LR	Belgian	-	-	-	-	-	-	375.6	-	-	-	-
			P	-	-	-	-	-	-	-	355.9	-	-	-	-
30.	Cavalcanti	1979	LWY	-	-	-	-	-	-	-	-	-	-	-	3.87
			LR	-	10.12	-	9.43	-	-	-	-	-	-	-	4.66
			D	-	-	-	-	-	-	-	-	-	-	-	4.83
			HS	-	-	-	-	-	-	-	-	-	-	-	5.97
31.	Techni-porc	1979	LWY	-	-	-	-	-	-	-	371.3	-	-	-	—
			LR	Belgian	-	-	-	-	-	-	369.3	-	-	-	—
				Sweedish	-	-	-	-	-	-	362.6	-	-	-	—
32.	Bonte et al.	1980	LR	Belgian	-	-	-	-	-	-	-	115	-	-	-
33.	Dagorn et al.	1980	LWY	French	-	-	10.6	-	-	-	375.5	-	-	-	0.5 P/L
			LR	-do-	-	-	9.9	-	-	-	360.6	-	-	-	0.3 ,,
			LR	Belgian	-	-	9.4	-	-	-	368.7	-	-	-	0.5 ,,
			P	-	-	-	10.3	-	-	-	365.1	-	-	-	0.4 ,,
34.	Hughes and Varley	1980	-	-	-	-	-	-	-	-	-	-	-	-	60.70
35.	Karlberg and Benjamenson	1980	LR	Norweign	-	-	-	-	-	221.3	-	-	-	-	-
36.	McDonald	1980	-	-	-	-	-	-	-	-	-	-	-	-	60
37.	Moskal	1980	LR	-	11.09	-	10.33	-	-	-	-	-	-	-	-
			D		9.71	-	8.95	-	-	-	-	-	-	-	-
			HS		8.57	-	8.09	-	-	-	-	-	-	-	-
			P		9.15	-	9.88	-	-	-	-	-	-	-	-
			LR		8.80	-	8.60	-	-	-	-	-	-	-	-
38.	Ghatnekar	1981	Ind.	India	6.8	-	-	-	18M	-	-	-	-	-	-

APPENDIX (Continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
39.	Nishida	1981	LWY, LR	Japanese	-	-	-	-	-	-	-	-	50.0	-	5.7 at 8M 9.0 at 10/12M
40.	Osuagwuh and Akpokodje	1981	Ind.	Nigerian	2-3 at 8AM 3-6 at 11/12M		-	-	-	-	6-8	-	-	-	-
41.	Arthur et al.	1982	-	-	-	-	-	-	-	-	-	-	5.4	-	-
42.	Benkov and V'zharova	1982	LWY	-	-	-	-	1.19	-	-	-	-	-	-	-
			LR	-	-	-	-	1.52	-	-	-	-	-	-	-
43.	Hottmar	1982	V	-	-	-	-	0.45	-	-	-	117-118	-	-	0.40 p/l
44.	Sharda and Singh	1982	LWY	Indian	8.80	-	-	-	-	-	-	-	50.00	-	-
			Ind.	-do-	8.00	-	-	-	-	-	-	-	-	-	-
45.	Petrovic	1983	LR	Swedish	9.54	-	-	-	-	-	374	-	-	-	-
46.	Reyes	1983	LWY	-	-	-	-	-	-	-	-	115.1	-	-	-
			LR	-	10.9	-	-	-	-	-	-	115.1	-	-	-
			D	-	-	-	-	-	-	-	-	115.1	-	-	-
47.	Tand and Chen	1983	LWY	-	-	-	-	1.08	-	-	-	112.80	-	-	-
			LR	-	-	-	-	1.25	-	-	-	113.40	-	-	-
			D	-	-	-	-	1.14	-	-	-	115.24	-	-	-
			HS	-	-	-	-	1.21	-	-	-	111.42	-	-	-
			PC	-	-	-	-	1.29	-	-	-	—	-	-	-
48.	Xushing	1983	CB(JB)						120.57	-	-	-	-	-	-
49.	Lee et al.	1984	LR	-	9.5	-	-	[illegible]	179.5	-	-	114	-	-	-
			-	-											
50.	Perez et al.	1984	LWY	-	-	-	-	-	-	-	-	-	50.25	-	-
			D	-	-	-	-	-	-	-	-	-	50.29	-	-
51.	Serdyuk and Tkachuk	1984	LWY	Russian	-	-	-	-	167	268	-	-	-	-	-
			LR	,,	-	-	-	-	163	256	-	-	-	-	-
52.	Siler	1984	CB						-	-	-	-	-	-	-
			MS						81	-	-	-	-	-	-
			JX						91	-	-	-	-	-	-
			Jh						109	-	-	-	-	-	-
53.	Svinskorsel	1984	LWY	-	-	-	-	-	-	-	375	-	-	-	0.42p/L
			LR	Sweedish	10.0	-	-	-	-	-	375	-	-	-	-
			HS&D	-	-	-	-	-	-	-	375	-	-	-	-
54.	Vidovic	1984	LR	Dutch	-	-	10.54	-	-	-	-	-	-	-	-
55.	Cheng	1985	CB(TH)	-	12.9	-	-	-	-	-	-	-	-	-	-
56.	Gray & Katamaf	1985	LWY	-	-	-	-	-	-	-	-	-	50.74	-	-
			BS	-	-	-	-	-	-	-	-	-	49.84	-	-
57.	Hurnik	1985	-	-	-	-	-	-	-	-	-	-	70	-	-
58.	Mani	1985	LWY	Swish	-	-	10.5	-	-	-	-	-	-	-	-
			LR	,,	-	-	10.2	-	-	-	-	-	-	-	-

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
59.	Mishra et al.	1985	LWY	Indian	6.84	-	-	0.80	338.46	-	493.17	114.16	-	-	-
			Ind.	,,	6.70	-	-	0.77	337.16	-	450.66	110.00	-	-	-
60.	Rajamahendran et al.	1985	Ind.	Srilanka	6.00	-	-	-	-	-	-	-	-	-	-
61.	Rai & Desai	1985	LWY	-	8.05	-	-	-	-	-	368.00	-	-	-	1.6 P/L
62.	Seino	1985	LWY	Russian	-	-	-	-	188.00	-	-	-	-	-	-
63.	Siler	1985	CB	-	-	-	-	-	-	-	-	-	-	-	-
			(DM)	-	13.9	-	-	1.00	-	-	-	-	-	-	-
			(Eh)	-	12.6	-	-	0.80	-	-	-	-	-	-	-
			(PJ)	-	13.9	-	-	0.80	-	-	-	-	-	-	-
			(JX)	-	13.0	-	-	0.80	-	-	-	-	-	-	-
			(MS)	-	14.0	-	-	0.90	-	-	-	-	-	-	-
			(MZ)	-	13.8	-	-	1.00	-	-	-	-	-	-	-
64.	Qi	1985	CB(WU)	-	12.9	-	-	0.89	-	8M	-	-	-	-	-
65.	Zhao et al.	1985	CB(FJ)	-	-	-	-	-	135.30	-	-	-	-	-	-
66.	Adebambo	1986	LWY	Nigerian	-	-	8.10	-	-	-	-	114.6	44.6	-	-
			HS	,,	-	-	7.30	-	-	-	-	114.6	52.4	-	-
			Ind.	,,	-	-	6.90	-	-	-	-	113.6	42.2	-	-
67.	Boulard et al.	1986	LWY	-	-	-	10.20	-	-	-	-	-	-	-	-
			LR	French	-	-	9.90	-	-	-	-	-	-	-	-
68.	Khomyak and Shmigel'skii	1986	LWY	Russian	-	-	-	-	-	8-14M	-	-	-	-	-
69.	Mohanty & Nayak	1986	LWY	Indian	6.4	-	-	-	192.40	-	-	-	-	-	-
70.	Schoeps & Huhn	1986	LR	German	10.16*	-	-	1.34	-	-	-	-	-	-	4.04
71.	Siagian et al.	1986	LWY	-	9.25	-	-	1.34	-	275.30	407.10	-	-	-	6.67
			LR	-	9.22	-	-	1.49	-	273.40	410.40	-	-	-	5.30
			D	-	7.78	-	-	1.52	-	269.80	401.70	-	-	-	6.81
72.	Stolic	1986	LR	German	8.85	-	-	-	-	-	-	-	-	-	0.3P/L
73.	Tamuli et al.	1986	SS	Indian	-	-	-	-	-	-	-	106-120	-	-	-
74.	Taura	1986	-	-	-	-	-	-	-	-	-	-	-	62	-
75.	Tsitsyurskii	1986	LWY	-	-	-	-	-	-	-	-	114.5	-	-	-
76.	Alves et al.	1987	LWY	-	-	16.0	-	-	-	-	-	-	-	-	-
77.	Bogos and Cojocaru	1987	LR	-	9.16*	-	-	-	-	-	-	-	-	-	-
78.	Dhingra	1987	Ind.	Indian	6.50	-	-	-	-	-	-	-	-	-	-
79.	Florea et al.	1987	LWY	-	-	-	-	-	-	246.8-268.6	-	-	-	-	-
80.	Gonzalez et al.	1987	LWY	-	-	12.98	9.22	1.32	-	-	-	-	-	-	-
			LR	-	-	13.48	8.33	1.33	-	-	-	-	-	-	-
			D	-	-	11.89	9.34	1.42	-	-	-	-	-	-	-
			HS	-	-	14.15	7.79	1.17	-	-	-	-	-	-	-

Appendix (continued)

(1) (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
81. Kurcman and Wardowski	1987	LWY	Polish	10.10*	-	-	-	-	-	-	113,8	-	-	-
82. Molenat	1987	CB	-	-	-	-	-	-	-	-	-	-	-	-
		(JK)	11,90	11,90	-	11.3	-	-	-	-	-	-	-	-
		(JH)	12,10	12,10	-	11.6	-	-	-	-	-	-	-	-
		(MS)	15,60	15,60	-	14.5	-	-	-	-	-	-	-	-
83. Cao et al.	1988	CB(M)	-	-	-	13.2	0.89	10	60-70	-	-	-	-	-
84. Kim et al.	1988	LWY	-	-	-	-	-	-	-	-	115.6	-	-	-
		LR	-	-	-	-	-	-	-	-	114.5	-	-	-
		HS	-	-	-	-	-	-	-	-	113.8	-	-	-
85. Meregalli et al.	1988	LWY	-	-	-	-	-	-	-	379	-	-	-	-
86. Na et al.	1988	LWY	-	8.06	-	-	-	-	-	-	-	-	-	-
		LR	-	9.35	-	-	-	-	-	-	-	-	-	-
87. Nascimento JD DO	1988	D	-	9.01	-	8.74	-	-	-	-	-	-	-	-
88. Park et al.	1988	LR	-	-	-	-	-	-	-	-	-	-	-	3.82
		D	-	-	-	-	-	-	-	-	-	-	-	5.66
89. Rico	1988	HS	-	7.80	12.30	7.40	-	-	-	-	115.7	-	-	-
90. Shipilov & Voronyanskaya	1988	NC	-	-	-	-	-	273.5	-	-	-	-	-	-
91. Sweden	1988	HS	-	8.90*	-	-	-	-	-	-	-	-	-	-
		D	-	9.20*	-	-	-	-	-	-	-	-	-	-
92. Venev	1988	LWY	Sweedish	6.29*	-	-	-	-	-	-	-	-	-	-
		LWY	Bulgarian	10.15*	-	-	-	-	-	-	-	-	-	-
93. Huhn U	1989	LR	German	10.19	-	9.63	-	-	-	-	114.9	-	-	-
94. Kayaba et al.	1989	LR	-	9.92	-	-	-	-	-	-	-	-	-	-
95. Mishra et al.	1989	Ind.	Indian											
			U.P.	7.57	-	-	-	-	-	-	-	-	-	-
			Assam	4.93	-	-	-	-	-	-	-	-	-	-
			M.P.	6.52	-	-	-	-	-	-	-	-	-	-
			A.P.	6.22	-	-	-	-	-	-	-	-	-	-

Appendix (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
96.	Olsson A C & Sevendsen	1989	LR	Sweedish	11.4	-	10.3	-	-	-	-	-	-	-	-
97.	Singh et al.	1989	LWY	Indian	7.09	-	-	1.26	-	-	-	-	-	-	9.80
			LR	,,	6.65	-	-	1.22	-	-	-	-	-	-	10.71
			HS	,	5.46	-	-	1.22	-	-	-	-	-	-	10.30
98.	Chhabra et al.	1990	LWY	Indian	12.00	14.90	-	-	-	-	-	-	-	-	-
99.	Mishra & Sharma	1990	LR	-	8.28	10.16	-	-	-	-	-	-	-	-	-
100.	Mishra et al.	1990	LWY	-	8.79	-	-	-	-	-	-	-	-	-	-
101.	Narayamma J	1990	Crossbred		11.13	-	-	-	-	-	-	-	-	-	-
102.	Omeke	1990	LWY	DS	9.18	-	-	-	-	-	-	-	-	-	-
			LR	DS	8.17	-	-	-	-	-	-	-	-	-	-
			LWY	WS	11.06	-	-	-	-	-	-	-	-	-	-
			LR	WS	9.18	-	-	-	-	-	-	-	-	-	-
103.	Silva, L, Dep, G. DA	1990	LWY	-	10.1	-	-	-	-	-	-	-	-	-	-
			LR	-	9.6	-	-	-	-	-	-	-	-	-	-
104.	Singh et al.	1990	LWY	-	8.31	-	-	-	-	-	-	-	-	-	-
			Ind.	-	6.02	-	-	-	-	-	-	-	-	-	-
105.	Solmon Raju	1991	Ind*	A.P.	8.40	6.31	7.60	0.80	235	258	374	111.27	56.35	57.02	9.52

CB - Chinese breeds
JM - Damin
Eh - Erhualiam
FJ - Fenjing
Jh - Jinva
JX - Jiaxing
MP - Mi pig
ML - Meisnan
MZ - Minznu

D - Duroc
Ind - Indigenous
HS - Hampshire
LR - Landrace
LWY - Large White Yorkshire
NC - North Caucecus
P - Pietrain
Pc - Poland China
SS - Sus scrofa
V - Vietnamese

A.P - Andhra Pradesh
M.P. - Madhya Pradesh
U.P - Uttar Pradesh
M - Months
P/L - Piglets/litter

DS - Dry season
WS - Wet season

*Observations confined to gilts only

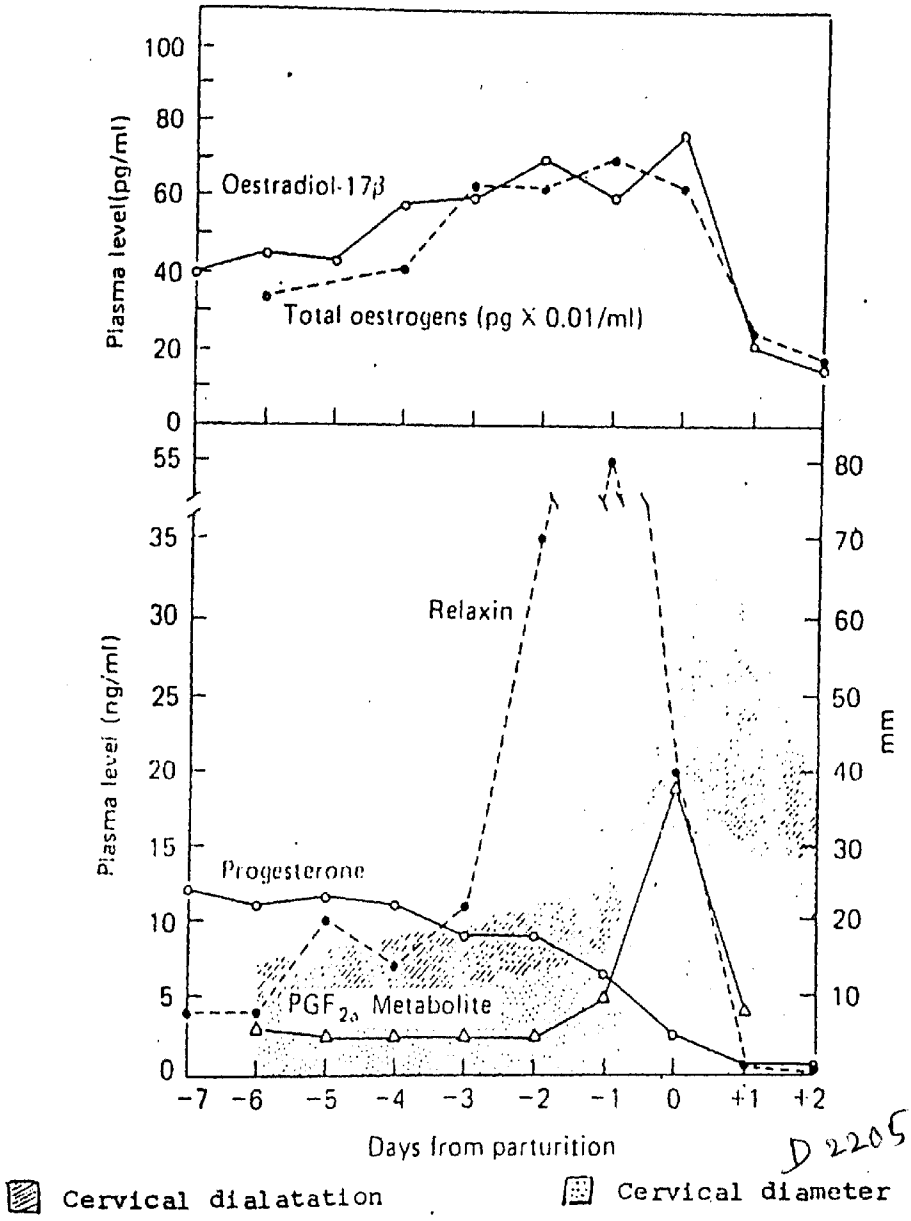
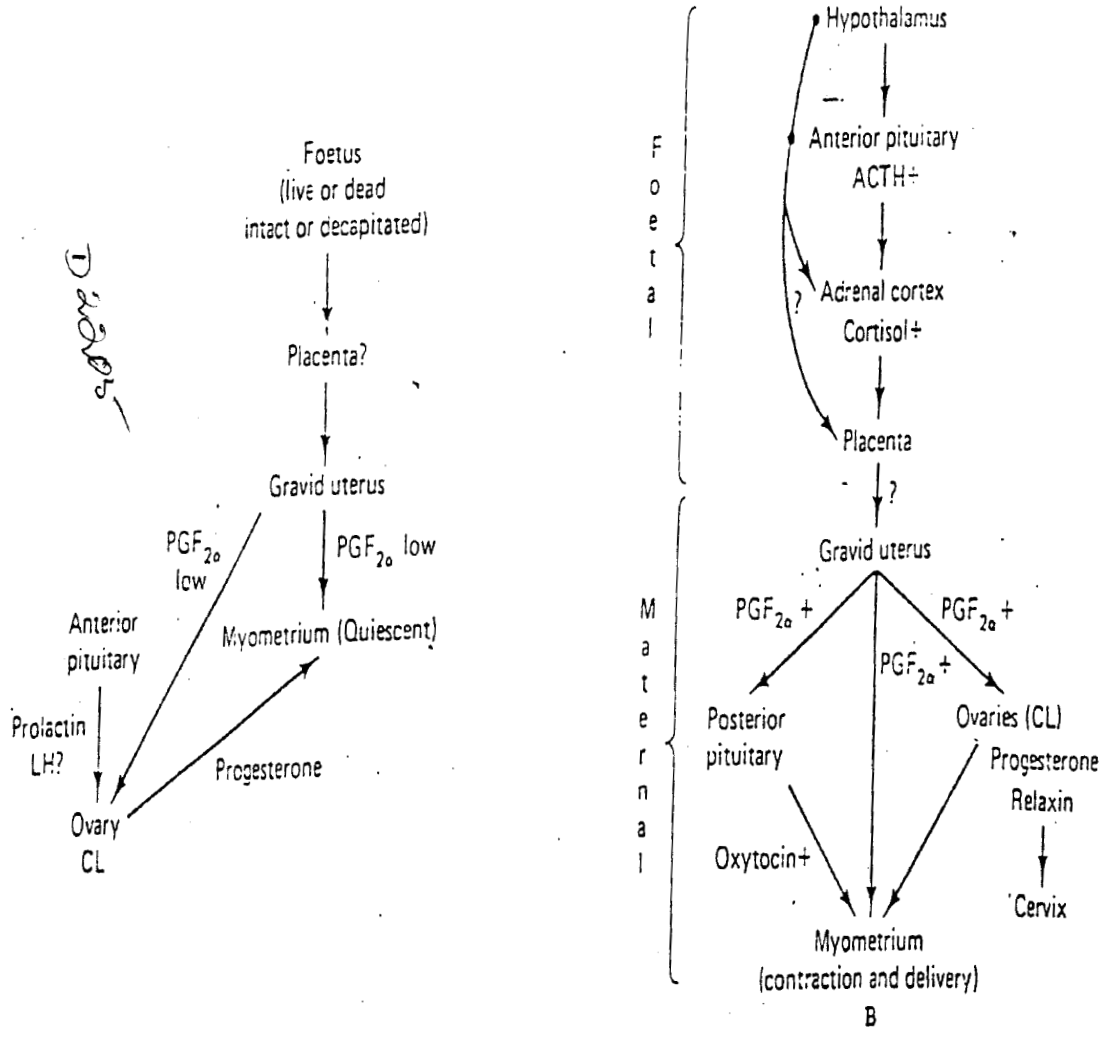


Fig.1: (Appendix). Peripheral plasma levels of relaxin, progesterone, $PGF_{2\alpha}$ metabolite and total oestrogens, a few days prior to, during and after 2 days of farrowing.



+ : Hormones having stimulatory effect on a target.

? : Unknown steps or compounds.

Fig. 2(Appendix): Sequence of events in the maintenance of late pregnancy (A) - First et al.(1982) and events leading to and associated with farrowing (B) - First and Boscu (1979).