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PERFORMANCE OF THREE INTRODUCED BREEDS OF PIGS IN KERALA

By

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THESIS

*Submitted in partial fulfilment of the
requirement for the degree*

Master of Veterinary Science

*Faculty of Veterinary and Animal Science
Kerala Agricultural University*

DEPARTMENT OF LIVESTOCK PRODUCTION MANAGEMENT
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
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2000

DECLARATION

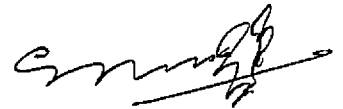
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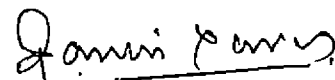
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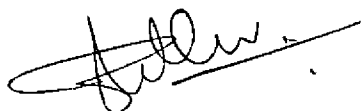
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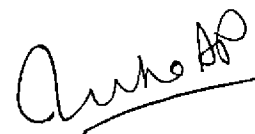
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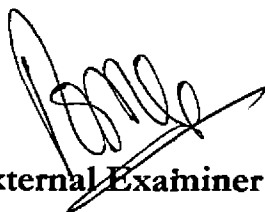
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INTRODUCTION

In India, dairy cattle production dominates the livestock economy. The other species, which also contribute substantially for the development of livestock sector, are neglected to a greater extent. Pig production is not at all an exception to this. In addition to the negligence on the part of authorities there are ever so many factors like social taboo and unhygienic farming systems causing backwardness in the pig production sector. Because of these, unlike in other countries, swine products fetch only very low price, which is not economical under most of the situations other than the one using garbage feeding or scavenging. Except in some isolated pockets in our country, no planned and systematic attempts were made for the improvement of this sector.

Since socially and economically backward communities practice swine husbandry, the information available about this sector in India is scanty. Even though pig production as an economic activity is popular among the North Eastern States, they are still maintained as scavenging animals in many other states. Any programme for the improvement of pig production, will not only improve the living condition of the weaker sections but also will help to utilize the unutilized or under utilized labour among the rural population, particularly the women. In order to increase swine production to meet the meat requirements of

twenty first century, we may have to break the vicious cycle of low price and the unhygienic system of pig rearing.

The pig production scenario existing in Kerala is not much better. Here this is traditionally practiced as a backyard operation involving two or three indigenous pigs. The livestock census 1996 reveals that the pig population in Kerala is mostly confined to districts of Kottayam, Idukki and Ernakulam. These three districts contribute about 67.8 per cent of the total 1.4 lakh pigs in the state. The pigs are either let loose or kept in pits / enclosures where their chief source of nourishment in many cases is human waste supplemented with available household and farm residues (SDC, 1998). Improvement of pig production industry requires induction of critical inputs like high quality pigs, feeds and management, a good marketing system and processing industry for producing value-added products.

Pigs can provide high returns with low investment and hence can help in improving the rural economy to a great extent. The census figures from 1982 to 1996 reveals that the percentage of indigenous pigs has decreased from 90.92 % in 1982 to 67.22 % in 1996, *i.e.* two thirds of the population are still indigenous (SDC, 1998). The main reason attributed for this high percentage of local blood is the shortage of good quality piglets. Presently the two major farms involved in

production and distribution of weaned piglets are those run by Kerala Agricultural University and Meat Products of India Ltd. There are also few pig farms under the State Animal Husbandry Department involved in piglet production. Even with all these facilities the State is running short of good quality piglets.

Due to the shortage of piglets the farmers in general are following a practice of breeding fattening pigs so as to get some piglets and then sell the farrowed sows for slaughter. In this process the female pigs are mated very early resulting in poor litter size and decreased dressing percentage at slaughter. This will also result in severe inbreeding and subsequent reduction in growth rate and dressing percentage. Due to the low dressing percentage, the purchase price offered by organized as well as unorganized abattoirs on live weight basis is quite low.

The Government of Kerala has identified the non-availability of superior germplasm sufficient quantities as one of the major lacunae for the development of this sector. So the Kerala Livestock Development Board (KLDB) has undertaken a major project to develop and supply highly productive and efficient pigs through cross breeding and line crossing of known highly productive exotic breeds of pigs. For this purpose they have imported 90 pigs belonging to Large White Yorkshire, Landrace and Duroc breeds.

In order to plan and execute such a project it is necessary to have the information on the productive performance of the pure breeds, which will go into the formation of the crossbreeds, under local conditions. The present study was undertaken to observe and record the production performance and adaptability of three pure bred exotic breeds of pigs namely Large White Yorkshire, Landrace and Duroc, imported from UK and compare them with the performance of contemporary Large White Yorkshire, ancestors of which were imported and maintained in the Centre for Pig Production and Research, Mannuthy for many generations.

REVIEW OF LITERATURE

Growth performance of exotic breeds of pigs maintained in India

Agarwala (1961) studied the growth rate of Yorkshire graded pigs from 3 to 6 months of age and reported that the body weight averaged 25.2 kg at 3 months of age and 102.6 kg at 6 months. The average daily gain was 0.42 kg, feed efficiency was 3.61 and daily feed intake averaged 1.51 kg.

Bhagavath *et al.* (1971) reported that the average feed conversion ratio of Yorkshire and Landrace pigs from 11 to 74 kg live weight was 4.2.

The average growth rate of the Large White Yorkshire pigs maintained at the pig farm attached to the college of Veterinary and Animal Sciences (Centre for Pig Production and Research), Mannuthy was 300 g per day (Sebastian, 1972).

Kumar *et al.* (1974) observed the growth rates of Large White Yorkshire pigs from 8 to 90 kg body weight. Daily growth rate during that period varied from 444 to 446 g/day. The feed efficiency from 8 to 50, 50 to 70 and from 70 to 90 kg body weight averaged 3.4, 4.0 and 4.5 respectively. They concluded that feed efficiency gradually decreased with increase in body weight and so the pigs must be slaughtered at 70 kg bodyweight instead of raising them to 90 kg with uneconomical returns.

In a comparative study between indigenous pigs and Large White Yorkshire, Saseendran (1977) reported that the growth rate of male and female

Large White Yorkshire pigs averaged 442 and 426 g/day respectively. The body weight of male and female pigs at 7½ months was 83.66 and 79.66 kg respectively. He has observed a feed conversion ratio of 3.94 and 3.83 from two to 7½ months.

Growth studies conducted by Jain *et al.* (1978) in two breeds of pigs from 20 to 60 kg body weight revealed that Large White Yorkshire had a better growth rate than Landrace pigs. The daily gain of Large White Yorkshire and Landrace pigs averaged 305.16 g and 298 g, the average feed intake per pig per day was 1.295 and 1.435, and feed conversion ratio averaged 4.25 and 4.82 respectively.

According to Rao *et al.* (1978) Large White Yorkshire pigs fed as per NRC recommendations, the weaning weight at 8 weeks averaged 9.1 kg and the final weight at 30 weeks 54.51 kg. Average daily gain from 56 days to 210 days averaged 294.9 g. The daily feed consumption and feed efficiency averaged 1.425 kg and 5.279.

Deo *et al.* (1981a) investigated the effect of genetic and non-genetic factors on body weight of Landrace, Large White and their half-breeds and found that the genetic make up of the body had a significant effect on the body weight. The average daily gain of the same stock during the same period was studied by Deo *et al.* (1981b). The results showed that Landrace and half breeds excelled the Large White during many periods of growth. Landrace recorded a maximum average daily gain during 32-34th week (0.417 ± 0.021 kg) and Large White pigs recorded a maximum of 0.335 ± 0.025 kg during 28-30 weeks of age.

The weight gain and feed conversion ratio for Large White Yorkshire pigs from 20 to 70 kg body weight averaged 431g/day and 4.43 (Pathak and Ranjhan, 1981).

The Large White Yorkshire fatteners at the pig farm attached to the College of Veterinary and Animal Sciences, Mannuthy when fed a ration containing 18% crude protein gained 385.9 g per day and feed efficiency was 3.59 (Sasikaladevi,1981).

Varadarajalu and Rao (1982) reported that the live weight of Large White and Landrace pigs averaged 39.56 and 45.23 kg at 24 weeks of age.

Goswami and Raina (1983) studied the body weight at various stages of age and daily weight gain during various periods of growth in Landrace pigs. The body weight at 2,3,4,5 and 6 months averaged 11.08 ± 0.14 , 18.15 ± 0.23 , 27.85 ± 0.36 , 40.46 ± 0.55 and 53.11 ± 0.72 kg respectively. The daily gain from 8-16, 16-20 and from 16-24 weeks averaged 365, 494 and 449 g. They concluded that the Landrace pigs grew faster from 10 to 24 weeks of age than in the earlier period and there was no difference between males and females.

Gupta *et al.* (1983) studied the growth curve of Large White Yorkshire pigs from two to eight months of age and found no difference due to sex.

Dash *et al.* (1986) studied growth and production performance of Large White Yorkshire pigs from 0 to 24 weeks of age. The study revealed no significant difference in live weight between males and females at 24 weeks of age

(29.42 ± 0.86 and 29.40 ± 0.82 kg). The average body length, height and heart girth at 24 weeks of age was 96.54 ± 2.08 , 54.27 ± 0.42 and 71.27 ± 1.17 cm respectively. Feed efficiency at 24 weeks of age averaged 5.39.

For Yorkshire boars, barrows and gilts, respectively daily gain averaged 360, 360 and 280 g, while feed consumption per day averaged 1.8, 2.66 and 2.07 kg and feed conversion ratio 5.0, 7.4 and 7.4 between 126 and 159 days of age. (Kumar and Barsaul, 1987)

Singh *et al.* (1990) reported that for Large White pigs weight at birth, 8 weeks and 16 weeks averaged 1.3, 7.77 and 12.07 kg respectively. Post weaning daily gain for Large White and Desi pigs averaged 65.6 and 28.8 g and feed conversion ratio averaged 4.45 and 4.95 respectively.

For Landrace, Large White and Desi pigs, body weight at six weeks averaged 9.63, 9.79 and 5.3 kg and at 30 weeks averaged 41.8 kg, 33.7 kg and 19.9 kg respectively. (Sharma *et al.*, 1990)

In a study conducted by Mohan (1991) at Centre for Pig Production and Research Mahanuthy, an average daily gain of 429 g and feed efficiency of 4.05 were obtained for Large White Yorkshire fatteners.

Investigations conducted by Dubey (1992) indicated that from 8 to 30 weeks of age Landrace pigs had higher growth rate and lower feed conversion efficiency than Large White pigs.

In a study at Centre for Pig Production and Research, Mannuthy Large White Yorkshire growers were fed standard farm ration containing 18% crude protein. The daily gain in weight increased from 131.62 ± 17.38 at 10th week to a peak of 392.28 ± 9.34 g at 32nd week and declined to 384.6 ± 6.98 at 40 weeks of age (Pradhan, 1993).

Growth performance of Large White pigs from birth to 16 weeks of age was studied by Singh and Associates (1997). Average body weight at the end of 16 weeks was 18.62 ± 0.11 kg and the cumulative feed conversion ratio was 3.38.

In a study conducted at Government Pig Breeding Farm, Ranchi, Sharma *et al.* (1998) observed that the post weaning daily gain was highest for Landrace followed by Large White and Large White crossbred. The winter born piglets had the highest daily weight gain and the piglets born in the rainy season had the lowest.

Large White Yorkshire pigs fed with a ration containing 18% crude protein during grower period and 14% crude protein during finisher period Sinthiya (1998) observed an average daily gain of 381 g and feed efficiency of 4.36.

From the analysis of the growth data recorded for 1228 Large White pigs maintained at Research Centres at Jabalpur and Tirupati Sing *et al.* (1999) reported that the post weaning (8-20 weeks) average daily gain was 283.96g and the average body weight at 8 and 20 weeks were 11.731 and 35.001 kg respectively. The 20-week weight and post weaning daily gain were higher in winter than in summer.

They concluded that at a given age the males were heavier than females but the differences were not significant.

Studies conducted by Ravi *et al.* (1999) revealed that the entire males had a better growth rate and feed conversion ratio than barrows and females.

Growth performance of purebred pigs outside India

Larambere (1980) observed that Large White pigs recorded the highest average daily gain (888 ± 0.010) and lowest feed conversion ratio (2.62 ± 0.02) from 30-100 kg body weight when compared to Landrace and Duroc (average daily gain 0.863 ± 0.018 , 0.862 ± 0.70 and feed conversion ratio 2.73 ± 0.02 , 2.70 ± 0.02). the difference between the breeds were insignificant.

Kaczmarczyk and Koczanocoski (1981) reported from Poland that the average daily gain for Landrace pigs housed at 12-15, 15-18 and 18-21°C during finishing averaged 516, 556 and 597 g respectively.

McPhee (1982) compared the performance of the progeny of 9 Landrace and 6 Large White boars imported to Australia from Newzealand with indigenous Landrace and Large White. The progeny of local and imported Landrace were compared with local and imported Large White. The daily gain from 50-90kg-body weight averaged 0.89 ± 0.06 , 0.89 ± 0.04 , 0.87 ± 0.06 and 0.90 ± 0.04 kg and feed

conversion ratio averaged 2.73 ± 0.13 , 2.75 ± 0.10 , 2.63 ± 0.14 and 2.58 ± 0.10 respectively.

Boulard *et al.* (1984) studied the performance of Large White, French Landrace and Belgian Landrace boars kept at a performance testing station in France. The daily gain from 35 to 90 kg averaged 929, 885 and 883 g/ day and the feed conversion ratio averaged 2.52, 2.63 and 2.66.

Studies carried out at a Performance Testing Station at Sweden, Ohrberg, (1986) indicated that the daily gain of Swedish Landrace, Swedish Large White and Duroc pigs from 30 to 102 kg averaged 914, 913 and 870 g. Feed consumption per kg gain during the period was 2.74, 2.71 and 2.86 kg. At the time of slaughter Durocs had the shortest body length (94.7cm) followed by Large White with 97.9 cm and Landrace recorded 100.3 cm.

Arganoza *et al.* (1986) reported from Philippines that the Yorkshire pigs had a better average daily gain and feed conversion efficiency than Landrace and Duroc.

The production performance of Swedish Landrace, Swedish Large White and Duroc pigs maintained at a Testing Station in Sweden during the period 1986-87 (Anon 1988). The daily weight gain from 30 to 104 kg live weight averaged 927, 935 and 896 g/day and feed consumption per kg gain averaged 2.7, 2.65 and 2.77 kg respectively. For the same stock during the period 1987-88 the daily gain averaged 919, 928 and 892 g/day and feed consumption per kg gain averaged

2.71, 2.66 and 2.75 kg. (Annon, 1989). In the same station, performance test during the year 1989-90 showed that the animals had an average gain of 929, 936 and 888 g/day and a feed conversion ratio of 2.69, 2.66 and 2.83 (Anon, 1991).

Large White females were heavier at sexual maturity, had a slightly greater gross feed efficiency, lower feed conversion ratio, a lower maximum fed intake and reached sexual maturity later than Pietrain females (Krieter and Kalm, 1989). They concluded that the animals, which grew rapidly during the early growth period, matured earlier and had a smaller mature size than slow growing pigs.

Adamezyk (1990) evaluated the finishing performance and carcass quality of Polish Large White, Polish Landrace and Duroc pigs maintained at a Testing station in Poland. The age at slaughter at 86 kg body weight averaged 185, 179 and 179 days respectively. The daily gain from 30 to 80 kg body weight averaged 737, 741 and 717 g. The consumption of feed per kg body weight gain was 3.5, 3.04 and 3.09 for Large White, landrace and Duroc pigs respectively.

A study conducted by Mironenko (1992) showed that growth rate of *ad libitum* fed Large White pigs from 35 to 120 kg body weight averaged 596 g/ day.

Dziaugys *et al.* (1992) reported from Lithuania the finishing and carcass traits of Swedish Large White, Swedish Landrace, German Landrace and Danish Landrace pigs. The highest average daily gain was for Swedish Large White (745 g), and German Landrace had the best feed conversion efficiency (3.7 kg feed/kg gain).

A study conducted by Iliescu *et al.* (1993) revealed that the Landrace pigs from 25 to 100 kg body weight had a daily gain of 690g. The average daily feed intake was 2.399 kg and the feed: gain ratio averaged 3.477.

Hammel *et al.* (1993) reported from Canada that commercial pigs sired by Duroc or Duroc X Hampshire boars had a growth performance superior to that of pigs sired by Landrace, Yorkshire or Hampshire boars. They also observed that the gilts had a better carcass yield and were leaner than castrated males.

Rico and Menchaca (1993) reported from Cuba a daily gain of 439.9 ± 0.6 g in Large White Yorkshire and 412.4 ± 1.2 g in Hampshire pigs.

Kawadia (1993) while studying the growth and meat quality of Landrace, Large White and Duroc pigs from 90 –110 kg body weight in Japan concluded that Landrace pigs had the highest daily gain and body length while Large White pigs had the best feed conversion ratio.

After analysing the data of 3145 purebred and crossbred Duroc, Landrace Yorkshire and Large White pigs Silva *et al.* (1994) concluded that Landrace purebred had a significantly higher birth weight and body weight at 21 days, a higher weaning weight than Duroc and Large White purebreds and a higher average daily gain at the end of growing period (77 days) than Large White pigs.

In a study conducted by Wu *et al.* (1994) in Taiwan the maximum daily gain (430 g) and feed: gain ratio (1.62) were recorded for Duroc pigs during the starting period (10-20 kg). During the growing period (25 –60 kg) the maximum

average daily gain and feed: gain ratio was 740 g and 2.36 respectively. During the finishing period the maximum average daily gain attained was 850 g/day.

Simms *et al.* (1994) reported that the average daily gain of Duroc, Large White and Landrace Averaged 1029, 1002 and 984 g respectively. The feed conversion efficiency averaged 2.43, 2.52 and 2.56 respectively.

Luiting *et al.* (1995) while studying the body composition of Duroc and Norwegian Landrace pigs from 65 kg body weight for 8 weeks observed no significant difference in body weight between the two breeds.

In Croatia, Kralik *et al.* (1995) studied the effect of level of feeding on the production performance of 320 Large White boars from 30 to 100 kg live weight. The average age at the start and end of the study was 87.07 and 165.61 days. Average daily body weight gain was 904 g, feed: gain ratio 2.55 and average backfat thickness was 16.34 mm.

Studies carried out by Xue and Associates (1995) showed that daily gain, feed consumption, consumption of feed per kg gain and back fat thickness were significantly greater in barrows than in boars.

Venanzi *et al.* (1995) analysed the data of 3323 Large White, Duroc, Landrace and Hampshire X Duroc pigs in two herds in Venezuela. In herds A & B age at 90 kg body weight averaged 157.6 and 151.5 days and back fat thickness at 90 kg averaged 14.16 and 14.47 mm.

Apostolov (1996) reported from Bulgaria that during the finishing stages Duroc pigs showed a daily gain of 668 g. and a feed conversion ratio of 1 kg live weight gain for 3.069 kg feed intake.

Growth performance of Large White pigs of Ukraine was studied by Berezovskii (1996). The average daily weight gain recorded was 766 g with a feed conversion ratio of 3.54 and a back fat thickness of 28 mm.

Growth rate and carcass characteristics of Large White pigs of Ghana were studied by Rhule (1996). The average daily gain during the grower phase was 470 g / day and 450 g / day during the finisher periods. The feed conversion ratios were 3.84 and 6.71 respectively.

Gugelmann, (1996) conducted a study on the production performance of 20 litters sired by two Duroc boars imported to Switzerland from Denmark. The daily gain from birth to slaughter averaged 659 and 661 g. Daily gain on test averaged 908 and 916 g with a feed conversion ratio of 2.54 and 2.59.

Kralic *et al.* (1996) studied the level of feeding on the on the growth and reproductive performance of Large White boars of Croatia. The average weight of the boars at the beginning and at the end of the test was 87.07 and 65.61 kg. The average daily weight gain, daily feed intake, feed: gain ratio and average thickness of bacon were 904 g, 2.30 kg, 2.55 and 16.34 mm respectively.

Quiniou and Associates (1996) observed that the daily lean gain of castrated males of Large White pigs between 45 and 100 kg body weight increased

with metabolic energy intake according to a linear plateau relationship where as the daily fat gain increased linearly.

The body weight at 180 days of age was 121.0 and 117.0 kg for Polish Landrace and Polish Large White boars respectively. The average daily gain during that period was 621 and 602 g (Walkiewicz *et al.*, 1996).

The daily gains of male and female Russian Large White pigs was studied by Ukhterov and Ukhterov (1996). The daily gains of males and females averaged 711 and 686 g and consumption of feed per kg gain of body weight was 3.82 and 3.84 respectively during finishing stages.

Kao and Associates (1997) analysed the data on several hundred Landrace, Yorkshire and Duroc boars and gilts reared in Taiwan from 1994-96. For the three breeds daily gains from 30 to 110 kg body weight averaged 997, 952 and 921 g in boars. In females the daily gain was calculated up to 90 kg body weight. This averaged 768, 740 and 751 grams. For the average daily gain both breed and sex differences were significant. The feed conversion ratio up to 110 kg body weight was 2.42 for Landrace, 2.49 for Yorkshire and 2.55 for Duroc boars.

A study conducted in South Africa by Fisher and Mellet (1997) showed that pigs with a halothane genotype "nn" showed the highest average daily gain and fewer days to slaughter with a greater back fat thickness.

Kernerova *et al.* (1997) by analysing the data collected from a testing station in Czech Republic from 1993-96 involving Landrace, Piterains, Duroc and

Hampshire breeds reported that the highest daily gain (940 g) was recorded in Landrace.

Khun and Associates (1997) compared the growth rate of German Landrace and German Saddleback barrows. The age at slaughter weight (108 kg) averaged 187 and 238 days with a daily gain of 776 and 586 g respectively.

Chen *et al.* (1997) studied the performance of Duroc pigs in China. The growth rate in boars was 745.5 g / day and that of sows was 715.5 g /day. The feed conversion ratio was 2.8 and 2.89 for boars and sows respectively. The crossbreds produced by crossing Durocs with Large White X Landrace the daily gain averaged 906 g.

Growth rate studies were carried out in Polish Large White crossbred piglets from 23 to 100 kg live body weight by Jacyno and Pietruszka (1997). The average daily gain was 778 g with a dressing percentage of 76.9 %.

In an experiment conducted in Ukrain, at five months of age the body weight of Large White and Duroc boars averaged 67.6 and 71.5 kg. (Akimov and Oksinyuk, 1997).

Kosovac *et al.* (1997) reported that Swedish Landrace gilts reared in Yugoslavia had a body weight of 97.6 kg at the end of 198.1 days and the daily weight gain was 488 gram.

Sevon *et al.* (1997) analysed the growth and carcass traits of Dutch Yorkshire and Finnish Landrace pigs from the Finnish progeny testing station.

The average daily gain from 30 to 90 kg body weight was 957 g with a maximum daily gain of 1111 g/day at 72 kg body weight.

Studies conducted in two Russian breeding stations revealed that the daily gain of Large White pigs from 30 to 100 kg live weight averaged 568.9 g and the back fat thickness 37.4 mm. (Pavlova and Ryzhkov, 1997).

The growth performance of Large White pigs during the dry and cool seasons in France was studied by Lorvelec and Depres. (1997). Daily gain between body weights of 35 and 85 kg averaged 787 and 835 g in hot and cool seasons.

Baik *et al.* (1998) reported from Korea that compared to Large White and Landrace, Duroc showed the highest growth rate and reached 90 kg weight earliest. Yorkshire exhibited most efficient growth but had the lowest growth rate. They concluded that breed had a significant effect on Average daily gain, back fat thickness and feed efficiency.

Wang and Associates (1998) observed the growth rate of Duroc boars from 25 to 90 kg live weight. Mean and Phenotypic standard deviations were 18.64 ± 2.56 mm, 721.86 ± 80.68 g and 2.514 ± 0.24 for average back fat depth, average daily gain and for feed conversion ratio.

Chang *et al.* (1998) reported from Taiwan Livestock Research Institute that from 30-110 kg body weight Landrace pig had a better growth rate (916 g) than Yorkshire and Duroc boars (913 and 833 g). The feed conversion ratio was also lower for Landrace (2.34) than the other two breeds (3.39 and 2.46).

Buczynski *et al.* (1998) studied the growth rate of 540 daughters of 54 Polish Large White boars and 380 daughters of 38 Polish Landrace boars. For the two groups respectively the age at slaughter averaged 189 and 183 days, daily gain 685 and 713 g, the consumption of feed per kg gain 3.21 and 3.32 kg.

Eckret and Associates (1998) reported from Poland that the body weight of Polish Large White, Polish Landrace, Belgian Landrace and Duroc boars at 180 days of age averaged 113, 115, 103 and 112 kg respectively. The growth rate averaged 623, 625, 562 and 613 grams per day. From the same station Rozycky and Tyra (1998) reported that age at slaughter averaged 175, 171, 184 and 182 days respectively. The daily gain from 25 to 100 kg averaged 816, 816, 791 and 793 g/day and feed conversion ratio was 3.54, 3.58, 3.48 and 3.58.

Slancv *et al.* (1998) reported that daily gain from birth to 90 kg of Duroc pigs averaged 242 g / day.

Blanchard and Associates (1999) reported from United Kingdom that the Duroc boars had a faster growth rate and feed convention ratio (838 g / day and 2.39) from 30 to 90 kg body weight than gilts (799 g /day and 2.55) of same age.

Castro *et al.* (1999) while studying the growth of different breeds of pigs concluded that the intact males showed a better growth rate when compared to females and castrated males.

Czamecki *et al.* (1999) reported the growth and carcass characteristics of young Duroc X line 990 Boars maintained in Poland. The body weight at 70 and

180 days averaged 22.8 kg and 108.2 kg respectively. The daily gain and feed per kg gain during the same period averaged 786 g and 3.08.

Grikshas (1999) investigated the Average daily gain of Russian Large White pigs of five generations in a herd in which a selection intensity of 50 % was applied. In the five generations, daily gain during finishing averaged 492, 527, 541, 563 and 583 g, respectively. Selection pressure accounted for 44% of total variation in average daily gain.

Kim *et al.* (1999) investigated the effect of breed and sex on the growth and carcass traits of Duroc, Landrace and Large White pigs upto 90 kg body weight. Durocs had the highest daily gains, back fat thickness and body height (868 g, 1.66 cm and 62.9 cm) and were youngest at 90 kg body weight (152 days) and had the shortest body length (106 cm). Landrace pigs had the thinnest back fat (1.42 cm) and longest body length (112.3 cm). Large White pigs had the slowest growth rate (841 g/day) and were oldest at 90 kg (156 days). They concluded that in all the three breeds males had higher growth rates, younger at 90 kg and were longer and taller than female pigs.

Rico *et al.* (1999) reported that the slaughter weight for Duroc breeds maintained in a Breeding Centre in Cuba averaged 91.3 kg and daily gain averaged 464 g / day.

Sencic *et al.* (1999) measured the growth rate of Large White boars from 28 to 101 kg live weight. He concluded that at an average final age of 171.92 days the

young boars had an average daily weight gain of 0.90 kg, feed conversion efficiency of 2.50 and fat thickness of 13.99mm.

Song *et al.* (1999) reported from Korean Republic that the overall least square means for back fat thickness, average daily gain and age at 90 kg body weight of Duroc, Landrace and Large White pigs were 1.344 ± 0.007 cm, 0.862 ± 0.003 kg and 150.51 ± 0.356 days respectively.

Studies done by Na *et al.* (1999) at the Korean Second Swine Test Station from 1990-1997 showed that the average daily gain of Duroc pigs were superior to that of Landrace and Large White. The year of birth had a significant effect on back fat thickness, feed conversion efficiency and rate of growth up to 90 kg.

Feed consumption and utilisation studies were conducted by Jelen *et al.* (1999) in German Landrace and in Swedish Landrace pigs in Croatia. The results indicate that German Landrace pigs had a better growth rate and feed conversion ratio (775.75 and 2.475) than Swedish Landrace (738.99 and 2.59)

MATERIALS AND METHODS

Study area

Two farms, namely Centre for Pig Production and Research, Kerala Agricultural University, Mannuthy and Pig Breeding Centre, Kerala Livestock Development Board, Puthur were chosen for the experiment. The distance between these two farms is approximately 5km.

Experimental animals

Three breeds of pigs *viz.* Duroc, Large White Yorkshire and Landrace (Plates 1,2 & 3) imported from UK by Kerala Livestock Development Board and maintained at Pig Breeding Centre, Kainoor were used for the experiment. All the ninety animals imported (21 females and 9 males from the Landrace, 19 females and 9 males from Duroc and 23 females and 9 males from Large white) were selected for the experiment with an average age of 149.06 days for females and 165.74 for males. Simultaneously, 21 female and 9 male Large White Yorkshire pigs (Plate 4) with similar age was selected at random from the Centre for Pig Production and Research, Mannuthy. The Large White Yorkshire pigs maintained at Mannuthy was taken as the control group. The animals were maintained under the normal housing and managerial condition prevailing in the respective farms. All the females were maintained up to the age of breeding and males were maintained for a period of 6 months.



Plate - 1 Duroc



Plate - 2 Large White Yorkshire

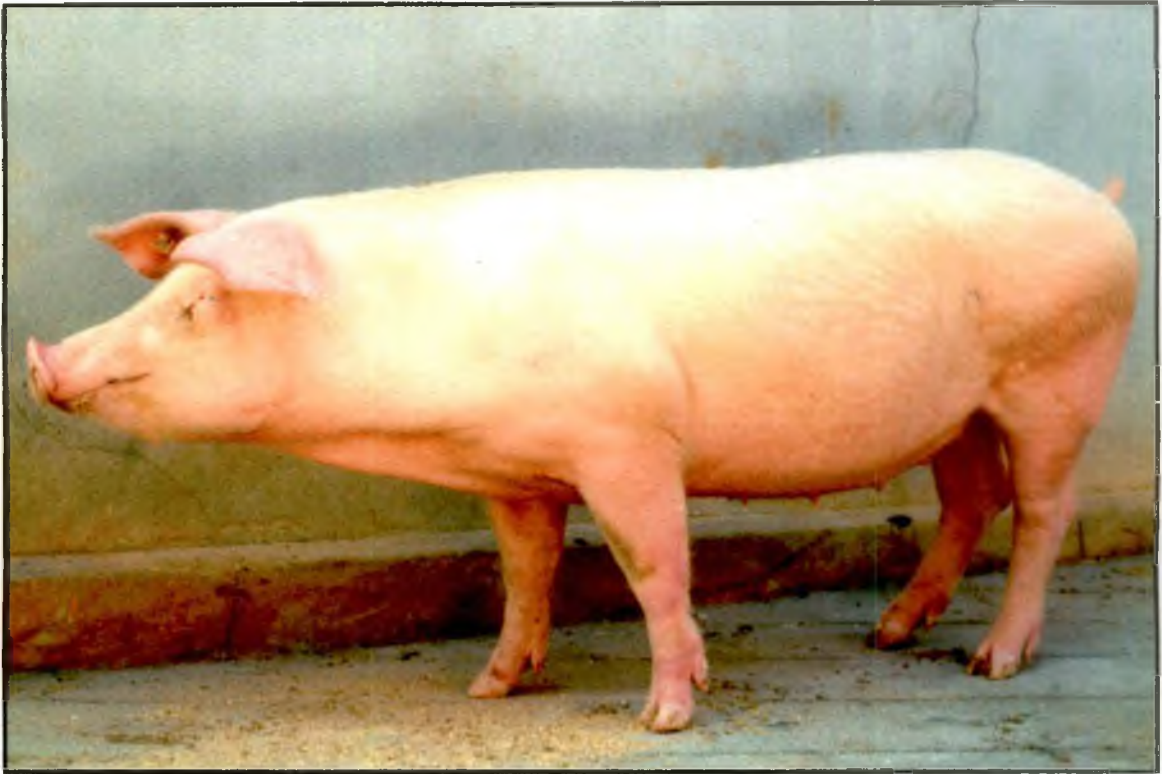


Plate - 3 Landrace

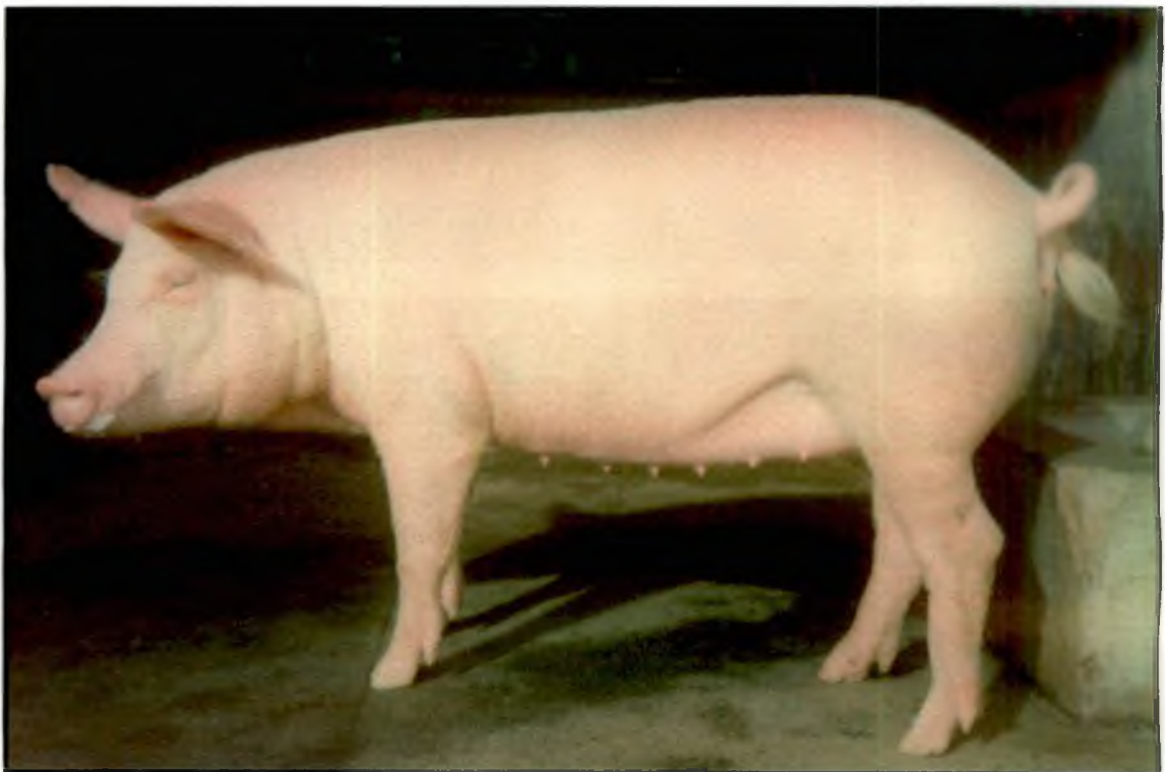


Plate - 4 Mannuthy Large White Yorkshire

Feeding

All the animals were fed with the same type of feed. Up to 8 months of age they were fed *ad libitum* after that the quantity of the feed was restricted to prevent over fattening of the breeding animals. They were fed twice daily through out the experimental period.

Observations

Climatic information

Data regarding the climatic variables was collected from Meteorological station at Vellanikkara (2 km from Centre for Pig Production and Research, Mannuthy). Fortnightly averages of maximum and minimum temperature, relative humidity, rainfall and hours of bright sunshine were obtained.

The parameters like temperature, humidity and hours of bright sunshine were used to formulate the Temperature Humidity Sunshine Index (TH SI) using the equation.

$$\text{TH SI} = \{(0.75 \text{ BS}) \text{ THI}_e + (24 - 0.75 \cdot \text{BS}) \text{ THI}_m\} / 24 \text{ (Thomas and Acharya 1981)}$$

Fortnightly recording of body weight

The body weight of pigs was recorded at fortnightly intervals using a platform balance having a built in cage.

Fortnightly recording of body measurements

Body length

The distance from the point of shoulder to the pin bones; *i.e.* the body length of the was recorded in cm using a measuring tape. The measurements were recorded once in a fortnight for a period of six months.

Chest girth

The chest girth was measured in centimeters just behind the elbow using a standard measuring tape. Fortnightly recordings were taken for a period of six months.

Height

The height at withers was measured once in a fortnight using standard measuring tape and was recorded in centimeter.

Weekly recording of rectal temperature

The rectal temperature was measured using a clinical thermometer once in every week. The recording was done during the afternoon hours *i.e.* between 13.00 and 14.00 hours.

Feed intake

The animals in each group were fed *ad libitum* up to eight months of age. As they were used as breeding animals, to prevent over fattening the feed intake was restricted after eight months of age. The quantity of feed consumed daily by each

group was recorded. Statistical analysis of data employing standard methods (Snedecor and Cochran, 1967) was carried out.

Adaptive behaviour

Aggressive and adaptive behavioural patterns manifested by the pigs were observed. Behavioural patterns were studied during the noon hours of the day. The animals were observed just before, during and after feeding to find out any change in the patterns of behaviour. One group was observed on one day and other groups were observed on subsequent days.

Proximate analysis of the feed

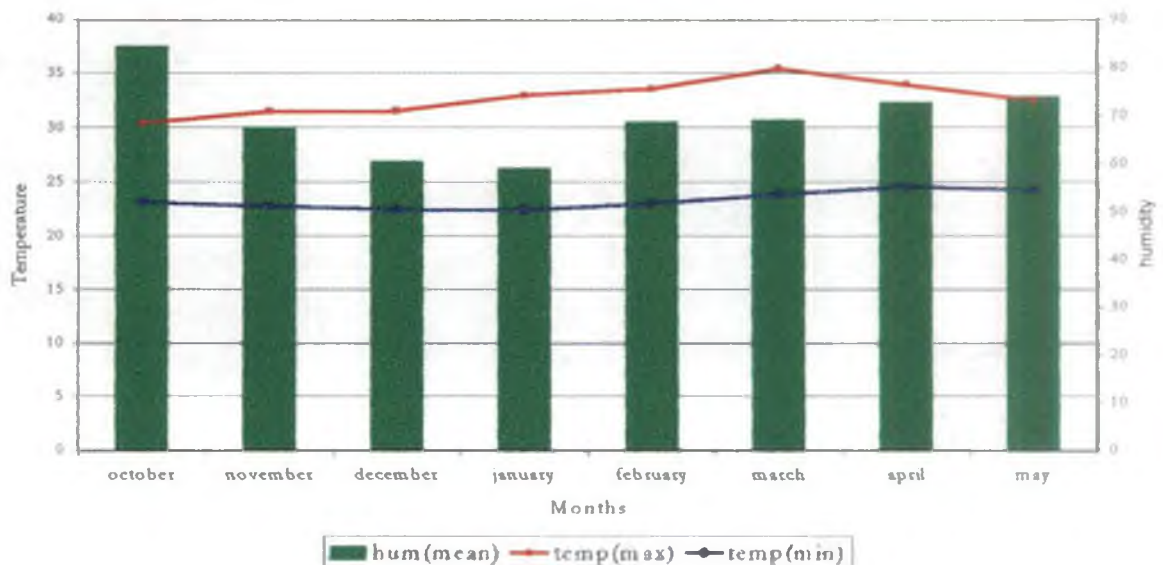
Analysis of the feed for proximate principles was done at the Department of Animal Nutrition, College of Veterinary and Animal Sciences, Mannuthy. According to the feed analysis report feed contained 12 % moisture, 19.4 % crude protein, 9.4 % crude fibre, 14.5 % total ash and 4.2 % acid insoluble ash.

RESULTS

1. Meteorological information

The meteorological data was collected from meteorological station at Vellanikkara (2 km from Centre for Pig Production and Research, Mannuthy). Monthly averages of maximum and minimum temperature, humidity, rainfall, sunshine and wind velocity for the entire study period were collected from the station. Temperature Humidity Index (THI) and Temperature Humidity Sunshine Index (TH SI) values (Thomas and Acharya 1981) were calculated from the collected data. Figure 1 gives the data pertaining to mean daily maximum and minimum temperature and mean humidity from October 1999 to May 2000. The

Fig 1 Monthly variation of maximum and minimum temperature and humidity



mean daily maximum temperature observed varied between 30.5 and 35.5 ° C and minimum temperature varied between 22.5 and 24.6 ° C. The mean values for humidity ranged from 59.1 in January to 84.5 in October.

Temperature Humidity Sunshine Index was calculated using the formula

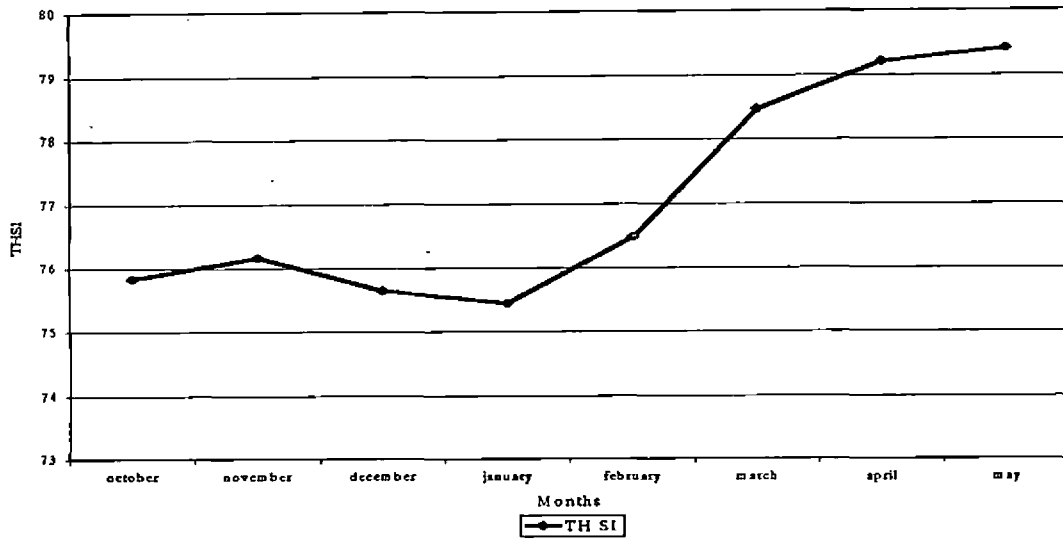
$$TH\ SI = \{(0.75\ BS)\ THI_e + (24 - 0.75\ BS)\ THI_m\} / 24 \text{ (Thomas and Acharya 1981)}$$

TH SI values observed for the entire study period is given in table 1 and represented in figure 2. The values reveal that the stress was maximum during the month of May (79.40) and minimum in January (75.44).

Table 1 Mean monthly values of TH SI

Months	TH SI
October	75.83
November	76.16
December	75.64
January	75.44
February	76.47
March	78.46
April	79.21
May	79.40

Fig 2 Monthly variation of TH SI



The rainfall recorded during the study period varied from 508.5 mm in October practically nil during the months of December, January and March (table 2)

Table 2 Total rainfall (mm)

Months	Rain (mm)
October	508.5
November	6.8
December	0
January	0
February	4.6
March	0
April	72.4
May	144.7

2. Body weight

All the 120 animals were weighed at fortnightly intervals. The age and body weight of different breeds of pigs is given in table 3. Table 4 and 5 represents the body weight of male and female pigs at different ages.

Table 3 Age (months) and body weight (kg) of four groups of pigs

Age	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
4.0-4.5	50.00 ±9.39		57.70 ±6.42	34.91 ±7.13
4.5-5.0	64.50 ±6.63 ^A	62.75 ±5.16 ^A	82.03 ±8.50 ^A	39.88 ±7.23 ^B
5.0-5.5	76.71 ±7.60 ^A	76.93 ±7.55 ^A	86.01 ±10.23 ^A	47.30 ±8.84 ^B
5.5-6.0	88.48 ±9.75 ^A	86.86 ±11.27 ^A	92.21 ±11.11 ^A	52.51 ±9.61 ^B
6.0-6.5	95.08 ±10.94 ^A	93.79 ±12.51 ^A	101.46 ±11.81 ^A	61.49 ±9.94 ^B
6.5-7.0	104.55 ±11.52 ^A	105.47 ±12.13 ^A	109.32 ±9.44 ^A	66.75 ±10.84 ^B
7.0-7.5	114.97 ±10.30 ^A	111.91 ±14.21 ^A	119.16 ±10.77 ^A	72.40 ±11.77 ^B
7.5-8.0	118.94 ±11.58 ^A	119.03 ±13.70 ^A	123.10 ±8.48 ^A	77.39 ±8.60 ^B
8.0-8.5	126.80 ±10.65 ^A	126.87 ±11.87 ^A	134.03 ±10.79 ^A	86.81 ±10.04 ^B
8.5-9.0	132.18 ±11.05 ^A	133.91 ±12.16 ^A	137.87 ±9.38 ^A	93.18 ±8.36 ^B
9.0-9.5	140.41 ±6.62 ^A	141.25 ±9.27 ^A	151.00 ±10.41 ^A	93.93 ±12.29 ^B
9.5-10.0	155.11 ±9.29 ^A	154.77 ±9.13 ^A	157.88 ±11.15 ^A	102.75 ±11.77 ^B
10.0-10.5	161.38 ±9.13 ^A	160.69 ±9.06 ^A	163.72 ±12.13 ^A	108.16 ±11.76 ^B
10.5-11.0	168.00 ±6.88 ^A	164.07 ±5.03 ^A	164.35 ±9.63 ^A	116.37 ±11.76 ^B
11.0-11.5	171.25 ±7.69 ^A	173.66 ±7.38 ^A	169.14 ±9.98 ^A	124.66 ±11.64 ^B

Figures having same super script in upper case in a row do not vary significantly (P<0.01)

The age at the beginning of the experiment averaged 151,159,151 and 138 days for Duroc, Large White Yorkshire, Landrace and Mannuthy Large White Yorkshire pigs respectively. The body weight averaged 64.50 ± 6.63 , 62.75 ± 5.16 , 82.031 ± 8.50 and 39.89 ± 7.23 between 4.5 to 5 months (135-150 days) of age. Throughout the study period the body weight of Mannuthy Large White Yorkshire pigs were lower than that of other groups.

Analysis of variance of body weight revealed that the Mannuthy Large White Yorkshire pigs differed significantly ($P < 0.01$) from other groups. Except during the time 4.5 to 5.0 months of age there was no significant difference between the newly imported breeds. During that period Landrace pigs differed significantly from that of Duroc and Large White Yorkshire pigs. During the study period (six months) Duroc, Large White Yorkshire and Landrace pigs gained an average of 65.57, 64.03 and 64.65 kg in their body weight. On the other hand the control group grew only 59 kg during the six-month period.

The Landrace pigs achieved a body weight of 100 kg between 6 and 6.5 months of age while Duroc and Large White Yorkshire achieved the 100 kg mark between 6.5 and 7.0 months of age. The treatment groups were ready for slaughter at 6.5 to 7.0 months of age while the Mannuthy Large White Yorkshire pigs crossed the 100-kg target during 9.5 to 10 months of age.

Table 4 Age (months) & body weight (kg) of female pigs

Age	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
4.0-4.5	50 ±9.39		57.70 ±6.41	32.42 ±4.42
4.5-5.0	59.50 ±8.26 ^A	55.00 ±5.16 ^A	69.56 ±8.50 ^A	36.78 ±5.39 ^B
5.0-5.5	71.14 ±9.57 ^A	74.20 ±8.32 ^A	77.27 ±10.20 ^A	44.12 ±8.31 ^B
5.5-6.0	82.03 ±10.45 ^A	80.39 ±12.50 ^A	87.78 ±9.99 ^A	51.08 ±9.21 ^B
6.0-6.5	90.33 ±10.38 ^A	85.64 ±12.59 ^A	96.20 ±10.41 ^A	57.57 ±10.08 ^B
6.5-7.0	96.67 ±11.14 ^A	99.89 ±10.91 ^A	102.71 ±7.41 ^A	64.58 ±10.20 ^B
7.0-7.5	106.21 ±9.45 ^A	104.20 ±13.49 ^A	112.63 ±8.83 ^A	69.63 ±9.98 ^B
7.5-8.0	111.43 ±10.14 ^A	112.56 ±13.56 ^A	117.20 ±5.33 ^A	76.61 ±10.68 ^B
8.0-8.5	119.75 ±7.46 ^A	121.52 ±12.78 ^A	127.42 ±8.25 ^A	83.81 ±10.61 ^B
8.5-9.0	123.93 ±10.38 ^A	126.58 ±12.52 ^A	130.80 ±7.46 ^A	85.75 ±7.34 ^B
9.0-9.5	135.00 ±3.00 ^A	135.50 ±8.50 ^A		89.75 ±14.25 ^B

Figures having same super script in upper case in a row do not vary significantly ($P < 0.01$)

Table 4 presents the age and body weight of female pigs during the study period. The body weight of Mannuthy Large White Yorkshire pigs was less than ($P < 0.01$) that of other three breeds. Increase in body weight averaged 59.31, 57.26 and 59.07 kg for the newly imported groups and 54 kg for Mannuthy Large White Yorkshire group. Between 4.5 and 5.0 months of age the body weight of the three treatment groups averaged 59.5 ± 8.26 , 55.00 ± 5.16 and 69.56 ± 8.50 kg. On the other hand the body weight of Mannuthy Large White Yorkshire pigs was only 36.78 ± 5.39 kg. The female Landrace pigs attained 100 kg live weight between 6.5 and 7.0 months of age while Duroc and Large White Yorkshire female pigs reached

that weight during 7.0 to 7.5 months of age. The female pigs belonging to the Mannuthy stock of Large White Yorkshire weighed only 89 kg during 9.0 to 9.5 months of age.

The body weights of male pigs during the study period are presented in table 5. The male pigs were maintained for a period of six months from the beginning of the experiment.

Table 5 Age (months) & body weight (kg) of male pigs

Age	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
4.0-4.5				37.40 ± 9.83
4.5-5.0	69.50 ± 5.00	70.50	94.50	43.00 ± 9.07
5.0-5.5	82.30 ± 5.62 ^A	79.66 ± 6.78 ^A	94.75 ± 10.25 ^A	50.50 ± 9.35 ^B
5.5-6.0	94.93 ± 9.04 ^A	93.33 ± 10.04 ^A	96.65 ± 12.23 ^A	53.95 ± 10.00 ^B
6.0-6.5	99.85 ± 11.50 ^A	101.95 ± 12.73 ^A	106.72 ± 13.20 ^A	65.42 ± 9.80 ^B
6.5-7.0	112.44 ± 11.89 ^A	111.06 ± 13.35 ^A	115.92 ± 11.46 ^A	68.93 ± 11.48 ^B
7.0-7.5	123.75 ± 11.14 ^A	119.62 ± 14.93 ^A	125.70 ± 12.69 ^A	75.16 ± 13.54 ^B
7.5-8.0	126.44 ± 13.00 ^A	125.50 ± 13.85 ^A	129.00 ± 11.61 ^A	78.18 ± 6.50 ^B
8.0-8.5	133.86 ± 13.83 ^A	132.22 ± 10.96 ^A	140.65 ± 13.31 ^A	89.83 ± 9.47 ^B
8.5-9.0	140.44 ± 11.72 ^A	141.25 ± 11.79 ^A	144.95 ± 11.30 ^A	96.61 ± 9.37 ^B
9.0-9.5	145.82 ± 10.24 ^A	147.00 ± 10.04 ^A	151.00 ± 10.40 ^A	102.12 ± 10.33 ^B
9.5-10.0	155.11 ± 9.28 ^A	154.77 ± 9.13 ^A	157.88 ± 11.15 ^A	102.75 ± 11.76 ^B
10.0-10.5	161.38 ± 9.12 ^A	160.69 ± 9.06 ^A	163.72 ± 12.13 ^A	108.16 ± 11.76 ^B
10.5-11.0	168.00 ± 6.88 ^A	164.07 ± 5.03 ^A	164.35 ± 9.62 ^A	116.37 ± 11.76 ^B
11.0-11.5	171.25 ± 7.69 ^A	173.66 ± 7.38 ^A	169.14 ± 9.97 ^A	124.66 ± 11.63 ^B

Figures having same super script in upper case in a row do not vary significantly ($P < 0.01$)

In male pigs also the body weight of Mannuthy Large White Yorkshire were lower than ($P < 0.01$) that of other three breeds. Body weight at the end of the experiment (11.0 to 11.5 months) averaged 171.25 ± 7.69 , 173.667 ± 7.38 and 169.143 ± 9.97 kg for Duroc, Large White Yorkshire and Landrace groups while that of control group was only 124.66 ± 11.63 .

3. Average daily gain (ADG)

Average daily gain of the four breeds of pigs was grouped based on their weight and age.

The body weights and average daily gain of all the four breeds of pigs are given in table 6. Since the average body weight attained by Mannuthy Large White Yorkshire at the end of the experiment (11 to 11.5 months) was only 124.66 kg average daily gain was not calculated beyond 130 kg body weight.

The average daily gains recorded for Mannuthy Large White Yorkshire pigs were lower than that of other three breeds of pigs. The daily gain of the Duroc, Large White Yorkshire and Landrace pigs was above 650 g per day up to the age of slaughter. Landrace pigs recorded the highest average daily gain of 763 g between 60 to 70 kg body weight. Duroc and Large White Yorkshire pigs registered peak ADG of 704.25 and 719.85g between 70 and 80 kg body weight, where as the control group of pigs recorded a maximum daily gain of 551.13 g from 60 to 70 kg body weight.

Table 6 Body weight (kg) and average daily gain (g) of four groups of pigs

Body weight	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
30-40				428.18± 81.51
40-50	615.84± 31.24			489.50± 122.98
50-60	623.20± 30.78		724.13	516.56± 128.19
60-70	688.02± 184.11 ^A	540.23± 172.35 ^A	763.88± 205.39 ^A	551.13± 168.34 ^b
70-80	704.25± 220.14 ^A	719.85± 120.70 ^v	751.01± 138.77 ^A	501.43± 79.24 ^B
80-90	660.80± 137.85 ^A	672.41± 155.90 ^A	756.63± 231.46 ^A	488.96± 87.90 ^B
90-100	555.15± 128.86 ^c	696.46± 258.56 ^A	654.62± 183.92 ^A	437.47± 124.88 ^B
100-110	549.13± 257.64 ^A	646.18± 144.77 ^A	619.71± 162.17 ^A	404.43± 121.28 ^B
110-120	568.27± 136.15 ^A	608.47± 151.03 ^A	550.58± 129.75 ^A	369.46± 108.51 ^b
120-130	546.20± 138.39 ^A	581.00± 150.81 ^A	553.32± 122.20 ^A	397.03± 21.51 ^b
130-140	556.76± 176.41 ^A	521.95± 141.69 ^A	547.58± 127.93 ^A	
140-150	518.98± 118.20 ^A	490.75± 90.07 ^A	456.87± 143.22 ^A	
150-160	403.96± 70.94 ^A	429.18± 104.86 ^A	376.41± 128.67 ^A	
160-170	408.40± 152.56 ^A	406.94± 98.56 ^A	381.39± 106.04 ^A	
170-180	212.70	424.19± 102.58 ^A	380.43± 155.99 ^A	

Figures having same super script in upper case in a row do not vary significantly ($P < 0.01$)

Figures having same super script in lower case in a row do not vary significantly ($P < 0.05$)

From 90 to 100 kg body weight the daily gain recorded by Duroc pigs differed significantly from Large White Yorkshire and Landrace pigs. In all other age groups there was no significant difference between the newly imported breeds.

The average daily gains of female pigs were calculated and are presented in table 7. The daily gain of Duroc and Large White Yorkshire females increased steadily from 40 kg body weight to around 80 kg and then declined. The average

daily gain of Landrace females increased up to 90 kg body weight where as in the case of Mannuthy Large White Yorkshire female pigs the ADG showed declining trends from 70 kg. The imported stock maintained a higher growth rate for a longer period when compared with the performance of existing Large White Yorkshire pigs. Average daily gain of Duroc females differed significantly ($P<0.05$) from other two treatment groups between 100-110 kg body weight and Large White Yorkshire females differed significantly ($P<0.05$) between 110 to 120 kg body weight.

Table 7 Body weight (kg) and average daily gain (g) of female pigs

Body weight	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
30-40				414.36± 73.45
40-50	615.84± 31.24			499.79± 133.13
50-60	623.20± 30.78		724.13	517.87± 129.89
60-70	688.02± 184.11 ^A	540.23± 172.35 ^A	763.88± 205.39 ^A	540.46± 178.54 ^b
70-80	712.12± 225.52 ^A	719.85± 120.70 ^A	751.01± 138.77 ^A	512.65± 68.34 ^B
80-90	664.56± 123.65 ^A	686.47± 140.46 ^A	752.45± 237.88 ^A	508.79± 85.25 ^B
90-100	551.35± 136.27 ^A	655.51± 160.95 ^A	640.47± 194.62 ^A	405.24± 101.86 ^B
100-110	479.67± 92.04 ^b	645.86± 143.96 ^A	606.13± 164.35 ^A	355.26± 55.82
110-120	525.43± 108.76 ^A	622.00± 154.44 ^b	533.56± 104.12 ^A	
120-130	523.16± 133.46 ^A	568.34± 148.05 ^A	549.53± 134.76 ^A	
130-140	547.91± 100.21 ^A	478.39± 149.12 ^A	622.29± 181.06 ^A	

Figures having same super script in upper case in a row do not vary significantly ($P<0.01$)

Figures having same super script in lower case in a row do not vary significantly ($P<0.05$)

Table 8 Body weight (kg) and average daily gain (g) of male pigs

Body weight	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
30-40				476.56± 121.53
40-50				452.46± 75.33
50-60				513.14± 132.32
60-70				574.85± 150.21
70-80				491.06± 97.51
80-90	630.74± 302.75	573.95± 293.15	827.58	442.38± 81.58
90-100	565.91± 115.96 ^A	819.32± 437.04 ^A	744.25± 17.94 ^A	443.82± 155.28 ^b
100-110	745.93± 449.53 ^A	647.43± 165.24 ^A	656.55± 162.40 ^A	418.48± 134.37 ^A
110-120	666.18± 149.41 ^A	569.81± 144.74 ^A	594.34± 183.08 ^A	369.46± 108.51 ^A
120-130	572.11± 148.23 ^A	604.93± 162.01 ^A	561.38± 97.88 ^A	397.03± 21.51 ^A
130-140	563.39± 224.74 ^A	584.87± 108.68 ^A	506.07± 69.12 ^A	500.00
140-150	518.98± 118.20 ^A	487.67± 92.33 ^A	430.46± 88.74 ^A	
150-160	403.96± 70.94 ^A	429.18± 104.86 ^A	376.41± 128.67 ^A	
160-170	408.40± 152.56 ^A	406.94± 98.56 ^A	381.39± 106.04 ^A	
170-180	212.70± 0.00	424.19± 102.58 ^A	380.43± 155.99 ^A	

Figures having same super script in upper case in a row do not vary significantly ($P < 0.01$)

Figures having same super script in lower case in a row do not vary significantly ($P < 0.05$)

Average daily gain of male pigs during the experimental period was calculated separately. The findings are presented in table 8. The peak daily gain was noticed between 100 to 110 kg for Duroc pigs (745.93g/day), between 90 to 100 kg for Large White Yorkshire (819.32 g/ day) and between 80 to 90 kg for Landrace pigs (827.58 g/ day). On the other hand the pigs maintained in the Mannuthy farm recorded the highest daily gain (574.85g/day) between 60 and 70

kg body weight. A significant difference was noticed between the locally adapted Large White Yorkshire and newly imported breeds during 90 to 100 kg body weight. In all other age groups the difference between the treatment and control groups were not significant.

Average daily gain up to 100 kg body weight

Average daily gain up to 100 kg body weight was calculated for the four breeds and the findings are given in table 9. Daily gain of Mannuthy Large White Yorkshire was less ($P < 0.01$) than that of treatment groups.

Table 9 Average daily gain (g) up to 100 kg body weight

Breed	Average Daily Gain (g)
Duroc	630 ±134
Large White Yorkshire	673 ±236
Landrace	672 ±124
Mannuthy LWY	453 ±61

Average daily gain of male and female pigs up to 100 kg body weight is given in table 10. The maximum body weight attained by Mannuthy Large White Yorkshire females was only 89.75 kg. So the average daily gain of Mannuthy Large

White Yorkshire females was calculated up to 90 kg body weight in both males and females

Table 10 Average daily gain (g) of male and female pigs up to 100 kg body weight

Breed	Female	Male
Duroc	615 ±91 ^A	660 ±197 ^A
Large White Yorkshire	631 ±121 ^A	781 ±374 ^A
Landrace	655 ±123 ^A	714 ±123 ^A
Mannuthy LWY	463 ±53 ^A	429 ±72 ^b

Figures having same super script in upper case in a row do not vary significantly ($P < 0.01$)
 Figures having same super script in lower case in a row do not vary significantly ($P < 0.05$)

Average daily gain up to 100 kg body weight of Mannuthy Large White Yorkshire females were significantly lower ($P < 0.01$) than the other breeds.

Average daily gain of the four breeds of pig was calculated for different age groups and the values are presented in table 11. The average daily gain recorded by Mannuthy Large White Yorkshire pigs during the first four fortnights were less than ($P < 0.01$) that recorded by other three breeds. In the later age groups also they recorded a lower ADG than the treatment groups but the difference was not significant. From 8.5 to 9.5 months of age the average daily gain of Mannuthy Large White Yorkshire was significantly ($P < 0.01$) lower than other groups. From

10 to 11 months of age the daily gain recorded by Mannuthy pigs were greater than that recorded by two of the imported stock. But the difference was not significant.

Table 11 Age (months) and average daily gain (g) of four groups of pigs

Age(m)	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
4.0-4.5	709.36± 173.39 ^A	568.96	669.54± 198.81 ^A	483.55 ±117.32 ^B
4.5-5.0	696.65± 134.84 ^A	667.18± 165.93 ^A	735.13± 100.31 ^A	502.80 ±152.23 ^B
5.0-5.5	611.67± 140.39 ^A	667.61± 178.16 ^A	630.54± 170.55 ^A	446.76 ±136.15 ^B
5.5-6.0	531.90± 165.20 ^A	593.32± 165.46 ^A	575.52± 183.34 ^A	400.00 ±112.05 ^B
6.0-6.5	536.42± 155.47 ^A	485.80± 162.64 ^A	534.72± 133.93 ^A	448.74 ±104.15 ^A
6.5-7.0	517.32± 140.62 ^A	481.73± 152.02 ^A	465.61± 141.11 ^A	485.69 ±88.60 ^A
7.0-7.5	518.87± 125.61 ^A	530.58± 197.47 ^A	522.65± 107.27 ^A	489.39 ±83.03 ^A
7.5-8.0	489.85± 139.71 ^A	522.76± 184.32 ^A	510.06± 132.24 ^A	471.33 ±102.44 ^A
8.0-8.5	464.11± 169.68 ^A	537.65± 176.77 ^A	452.88± 159.11 ^A	395.11 ±156.23 ^A
8.5-9.0	490.13± 107.41 ^A	519.88± 154.95 ^A	449.85± 78.35 ^A	280.22 ±113.36 ^B
9.0-9.5	456.05± 100.47 ^A	419.77± 108.24 ^A	432.54± 86.61 ^A	256.11 ±82.81 ^B
9.5-10.0	334.55± 101.85 ^A	393.81± 83.19 ^A	334.22± 138.85 ^A	275.00 ±85.45 ^A
10.0-10.5	236.41± 136.93 ^A	382.76± 109.83 ^A	267.40± 135.08 ^A	378.57 ±91.33 ^A
10.5-11.0	164.06± 138.29 ^A	375.00± 134.41 ^A	234.37± 135.13 ^A	333.33 ±88.19 ^A

Figures having same super script in upper case in a row do not vary significantly (P<0.01)

Average daily gains of female and male pigs at different age groups were calculated and are presented in table 12 and 13. Maximum growth rate was noticed between 4.0 and 4.5 months for Duroc females (709.36g) and between 4.5 and 5.0 months for Large White Yorkshire (692.17g), Landrace (733.66g) and Mannuthy Large White Yorkshire (514.40g) females. Even though the average daily gain

recorded by Mannuthy Large White Yorkshire pigs was lower than that of the treatment groups at all ages, a significant difference ($P < 0.01$) was noticed only during the first four fortnights.

Table 12 Age (in months) and average daily gain (g) of female pigs

Age (m)	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
4.0-4.5	709.36 \pm 173.39 ^A	568.96	669.54 \pm 198.81 ^A	483.25 \pm 127.89 ^B
4.5-5.0	693.96 \pm 135.44 ^A	692.17 \pm 166.71 ^A	733.66 \pm 103.41 ^A	514.40 \pm 169.23 ^B
5.0-5.5	641.22 \pm 135.51 ^A	655.42 \pm 161.67 ^A	624.07 \pm 179.55 ^A	447.84 \pm 115.93 ^B
5.5-6.0	486.16 \pm 121.47 ^A	568.26 \pm 152.97 ^A	506.54 \pm 165.26 ^A	405.59 \pm 64.75 ^B
6.0-6.5	485.96 \pm 125.91 ^A	473.77 \pm 153.04 ^A	513.14 \pm 145.53 ^A	452.90 \pm 89.59 ^A
6.5-7.0	537.53 \pm 144.40 ^A	453.30 \pm 220.31 ^A	470.74 \pm 161.35 ^A	484.79 \pm 81.72 ^A
7.0-7.5	556.18 \pm 132.76 ^A	552.43 \pm 191.32 ^A	506.72 \pm 180.05 ^A	473.50 \pm 77.58 ^A
7.5-8.0	494.52 \pm 153.17 ^A	549.56 \pm 181.44 ^A	560.65 \pm 133.98 ^A	475.97 \pm 103.63 ^A
8.0-8.5	474.35 \pm 126.91 ^A	553.38 \pm 206.27 ^A	576.92 \pm 151.42 ^A	496.99 \pm 106.00 ^A
8.5-9.0	517.24	557.69 \pm 218.70 ^A		381.57 \pm 93.04 ^A

Figures having same super script in upper case in a row do not vary significantly ($P < 0.01$)

Table 13 shows the average daily growth rate of male pigs during different ages. The average daily gain of Mannuthy Large White Yorkshire Yorkshire pigs was less when compared to the newly imported stock. While the average daily gain of imported stock varied from 164.06 to 758.62 g per day, that of existing exotic pigs varied from 256.11g to 526.48 g per day. Among the newly imported stock the highest average daily gain was recorded for Duroc females between 4.0 and 4.5

months of age, but for the entire experimental period there was no significant difference between the breeds.

Table 13 Age (in months) and average daily gain (g) of male pigs

Age	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
4.0-4.5				484.37±93.75
4.5-5.0	715.51±182.87	517.24	758.62	466.08±77.50
5.0-5.5	505.28±110.80 ^A	725.48±265.60 ^A	675.82±92.68 ^A	444.32±183.18 ^A
5.5-6.0	623.38±207.91 ^A	657.38±187.92 ^A	736.47±109.3 ^A	386.95±186.44 ^B
6.0-6.5	642.94±164.62 ^A	516.55±191.34 ^A	585.06±89.45 ^A	439.03±138.23 ^b
6.5-7.0	474.65±129.62 ^A	454.16±154.76 ^A	453.65±82.84 ^A	487.78±108.43 ^A
7.0-7.5	440.10±57.53 ^A	474.75±213.46 ^A	490.27±79.93 ^A	526.48±87.92 ^A
7.5-8.0	483.61±128.30 ^A	460.21±185.94 ^A	425.73±77.91 ^A	460.51±104.91 ^A
8.0-8.5	458.42±196.54 ^A	509.69±112.22 ^A	383.96±121.31 ^A	315.87±145.58 ^b
8.5-9.0	487.12±113.47 ^A	503.08±130.56 ^A	449.85±78.35 ^A	257.70±108.83 ^B
9.0-9.5	456.05±100.47 ^A	419.77±108.24 ^A	432.54±86.61 ^A	256.11±82.81 ^B
9.5-10.0	334.55±101.85 ^A	393.81±83.19 ^A	334.22±138.85 ^A	275.00±85.45 ^A
10.0-10.5	236.41±136.93 ^A	382.76±109.83 ^A	267.40±135.08 ^A	378.57±91.33 ^A
10.5-11.0	164.06±138.29 ^A	375.00±134.41 ^A	234.37±135.13 ^A	333.33±88.19 ^A

Figures having same super script in upper case in a row do not vary significantly ($P < 0.01$)

Figures having same super script in lower case in a row do not vary significantly ($P < 0.05$)

In general the data revealed that the rate of growth of the newly imported breeds was significantly higher than the existing Large White Yorkshire pigs in Mannuthy.

4. Feed conversion ratio (FCR)

The amount of feed consumed by each pig was measured daily. From that data the amount of feed required to produce one kilo gram of live weight was calculated. The feed conversion ratio of the four breeds was calculated based on their body weight and age.

The body weight and average feed conversion ratio of all the four breeds are given in table 14.

Table 14 Body weight (kg) and feed conversion ratio of four groups of pigs

Body weight	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
30-40				4.76± 0.91
40-50	3.76			4.25± 0.94
50-60	3.85± 0.18 ^A	2.28	3.27	4.14± 0.98
60-70	3.71± 0.95 ^A	4.58± 1.39 ^A	3.37± 0.94 ^A	4.22± 0.98 ^A
70-80	3.69± 1.00 ^A	3.45± 0.55 ^A	3.29± 0.53 ^A	4.74± 0.72 ^B
80-90	3.86± 0.91 ^A	3.79± 1.00 ^A	3.42± 0.99 ^A	5.13± 0.96 ^B
90-100	4.61± 1.17 ^A	3.87± 1.45 ^A	3.99± 1.21 ^A	6.46± 2.50 ^B
100-110	4.81± 1.38 ^A	4.03± 1.13 ^A	4.15± 1.12 ^A	6.77± 2.56 ^B
110-120	4.60± 1.34 ^A	4.17± 1.10 ^A	4.74± 1.16 ^A	7.16± 2.04 ^B
120-130	4.75± 1.32 ^A	4.51± 1.34 ^A	4.89± 1.73 ^A	6.30± 0.33 ^A
130-140	4.74± 1.14 ^A	5.29± 2.29 ^A	4.54± 0.89 ^A	
140-150	4.59± 1.02 ^A	5.11± 1.04 ^A	5.46± 1.45 ^A	
150-160	5.75± 2.01 ^A	5.95± 1.78 ^A	7.24± 3.24 ^A	
160-170	7.09± 3.53 ^A	6.57± 1.93 ^A	7.53± 3.70 ^A	
170-180	10.00± 2.03	7.03± 2.47	6.40± 1.49	
180-190		6.34	6.55± 3.30	

Figures having same super script in upper case in a row do not vary significantly ($P < 0.01$)

Feed conversion ratio of Mannuthy Large White Yorkshire pigs were comparatively higher than that of newly imported breeds of pigs. Feed conversion ratio recorded by existing Large White Yorkshire from 60 to 120 kg body weight was significantly higher than that recorded by Duroc, Large White Yorkshire and Landrace pigs. The lowest feed conversion ratio recorded for Duroc, Large White Yorkshire, Landrace and Mannuthy Large White Yorkshire pigs were 3.69, 2.28, 3.27 and 4.22 respectively. The difference in feed efficiency noticed between the newly imported breeds were found to be non significant.

Table 15 contains the body weight and feed conversion ratio of female pigs during different body weights.

Table 15 Body weight (kg) and feed conversion ratio of female pigs

Body weight	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
30-40				4.79± 0.93
40-50	3.76			4.14± 0.96
50-60	3.85± 0.18	2.28	3.27	4.12± 1.00
60-70	3.71± 0.95 ^A	4.58± 1.39 ^A	3.37± 0.94 ^A	4.35± 1.02 ^A
70-80	3.67± 1.03 ^A	3.45± 0.55 ^A	3.29± 0.53 ^A	4.73± 0.74 ^B
80-90	3.81± 0.79 ^A	3.65± 0.71 ^A	3.45± 1.01 ^A	5.01± 0.89 ^B
90-100	4.70± 1.26 ^A	3.88± 1.03 ^A	4.11± 1.26 ^A	6.52± 1.87 ^B
100-110	4.91± 1.12 ^A	4.10± 1.10 ^A	4.30± 1.18 ^A	7.12± 1.12 ^B
110-120	5.04± 1.32 ^A	4.16± 1.09 ^A	4.91± 1.08 ^A	
120-130	5.33± 1.39 ^A	4.80± 1.21 ^A	5.22± 2.00 ^A	
130-140	5.12± 1.19 ^A	6.24± 2.53 ^A	4.59± 1.39 ^A	
140-150	4.58± 1.02 ^A	5.60± 1.04 ^A	5.41± 2.88 ^A	

Figures having same super script in upper case in a row do not vary significantly ($P < 0.01$)

Feed conversion ratio for all the four breeds were calculated based on their age (table 19, 20 and 21). FCR was calculated for every fortnight starting from 4.5 months of age up to 11 months.

Table 19 gives the results of age wise classification of feed conversion ratio of all the four breeds. Even though the feed conversion ratio recorded by Mannuthy Large White Yorkshire pigs were higher than that of the three treatment groups a significant difference was seen only during three stages viz. 5 to 5.5, 9 to 9.5 and 9.5 to 10 months of age. During the whole study period there was no significant difference in feed conversion ratio between the three imported breeds.

Table 19 Age (months) and feed conversion ratio of four groups of pigs

Age	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
4.5-5.0	3.56± 0.84 ^A	4.23	3.98± 1.85 ^A	4.34± 0.91 ^A
5.0-5.5	3.53± 0.70 ^A	3.69± 0.94 ^A	3.29± 0.46 ^A	4.50± 1.46 ^B
5.5-6.0	4.16± 1.06 ^A	3.95± 1.73 ^A	4.11± 1.27 ^A	4.75± 1.57 ^A
6.0-6.5	5.02± 1.68 ^A	4.47± 1.71 ^A	4.80± 2.03 ^A	5.18± 2.82 ^A
6.5-7.0	4.91± 1.58 ^A	5.42± 2.03 ^A	5.03± 2.42 ^A	4.92± 1.02 ^A
7.0-7.5	5.28± 2.53 ^A	5.37± 2.29 ^A	5.99± 3.30 ^A	4.76± 0.94 ^A
7.5-8.0	4.92± 1.19 ^A	5.72± 5.04 ^A	4.90± 1.19 ^A	5.11± 0.89 ^A
8.0-8.5	5.33± 1.77 ^A	5.08± 2.37 ^A	5.08± 1.24 ^A	5.49± 1.42 ^A
8.5-9.0	6.95± 6.98 ^A	4.79± 1.39 ^A	5.92± 2.56 ^A	7.91± 4.97 ^A
9.0-9.5	5.09± 1.03 ^A	5.11± 1.49 ^A	5.39± 0.94 ^A	10.41± 4.34 ^B
9.5-10.0	5.76± 1.82 ^A	6.34± 2.15 ^A	5.87± 1.09 ^A	10.80± 3.88 ^B
10.0-10.5	8.19± 2.80 ^A	6.69± 1.87 ^A	8.67± 3.41 ^A	9.89± 3.01 ^A
10.5-11.0	16.45± 13.25 ^A	7.05± 2.12 ^A	9.61± 3.78 ^A	6.89± 1.62 ^A

Figures having same super script in upper case in a row do not vary significantly ($P < 0.01$)

Table 20 and 21 depicts the age wise feed conversion ratio of female and male pigs during the entire study period.

Table 20 Age(months) and feed conversion ratio of females

Age	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
4.5-5.0	3.56± 0.84 ^A	4.23	3.98± 1.85 ^A	4.28± 0.96 ^A
5.0-5.5	3.55± 0.71 ^A	3.55± 0.95 ^A	3.30± 0.48 ^A	4.44± 1.62 ^B
5.5-6.0	3.93± 0.82 ^A	3.99± 1.75 ^A	4.19± 1.33 ^A	4.55± 1.04 ^A
6.0-6.5	5.40± 1.65 ^A	4.65± 1.74 ^A	5.45± 2.10 ^A	4.58± 0.90 ^A
6.5-7.0	5.36± 1.61 ^A	5.43± 1.86 ^A	5.38± 2.82 ^A	4.91± 1.06 ^A
7.0-7.5	5.20± 2.77 ^A	5.06± 1.19 ^A	6.19± 3.83 ^A	4.87± 0.99 ^A
7.5-8.0	4.84± 1.34 ^A	5.02± 1.93 ^A	5.01± 1.31 ^A	5.28± 0.94 ^A
8.0-8.5	5.81± 2.07 ^A	4.82± 1.42 ^A	5.07± 1.40 ^A	5.45± 1.52 ^A
8.5-9.0	5.78± 1.30 ^A	4.93± 1.53 ^A	4.97± 1.13 ^A	5.23± 1.20 ^A
9.0-9.5	5.10	5.27± 1.65		6.75± 1.64

Figures having same super script in upper case in a row do not vary significantly ($P < 0.01$)

In females a significant difference ($P < 0.05$) between imported breeds and locally adapted Large White Yorkshire was noticed only from 5.0 and 5.5 months of age. During all other age groups the difference was not significant. Similarly in males a significant difference ($P < 0.01$) was observed between these during 9.0 and 9.5 and between 9.5 to 10 months of age. In both males and females Landrace pigs recorded the lowest feed conversion ratio.

Table 21 Age (months) and feed conversion ratio of males

Age	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
4.5-5.0				4.50± 0.82
5.0-5.5	3.37± 0.86	4.54	3.15	4.71± 0.82
5.5-6.0	4.96± 1.52 ^A	3.75± 1.86 ^A	3.56± 0.53 ^A	5.19± 2.41 ^A
6.0-6.5	4.26± 1.53 ^A	4.00± 1.64 ^A	3.30± 0.48 ^A	6.58± 4.88 ^A
6.5-7.0	3.96± 1.04 ^A	5.41± 2.52 ^A	4.22± 0.63 ^A	4.93± 1.00 ^A
7.0-7.5	5.44± 2.09 ^A	6.13± 3.88 ^A	5.51± 1.55 ^A	4.51± 0.80 ^A
7.5-8.0	5.09± 0.81 ^A	7.52± 9.11 ^A	4.65± 0.90 ^A	4.72± 0.67 ^A
8.0-8.5	4.69± 1.07 ^A	5.70± 3.69 ^A	5.10± 0.98 ^A	5.57± 1.23 ^A
8.5-9.0	7.60± 8.78 ^A	4.55± 1.15 ^A	6.46± 3.02 ^A	9.99± 5.84 ^A
9.0-9.5	5.09± 1.09 ^A	5.03± 1.51 ^A	5.39± 0.94 ^A	11.23± 4.37 ^B
9.5-10.0	5.76± 1.82 ^A	6.34± 2.15 ^A	5.87± 1.09 ^A	10.80± 3.88 ^B
10.0-10.5	8.19± 2.80 ^A	6.69± 1.87 ^A	8.67± 3.41 ^A	9.89± 3.01 ^A
10.5-11.0	16.45± 13.25 ^A	7.05± 2.12 ^A	9.61± 3.78 ^A	6.89± 1.62 ^A

Figures having same super script in upper case in a row do not vary significantly ($P<0.01$)

5. Body measurements

Length, height and girth were measured from the beginning of the experiment at fortnightly intervals. These parameters were later grouped based on body weight and age.

Table 22 depicts the average body length of the four breeds of pigs at different body weights. Among the four breeds the Mannuthy Large White Yorkshire pigs had lowest body length in all weight groups. Table 23 shows the body length of these four breeds during different age groups. Mannuthy Large

White Yorkshire pigs had the lowest body length among the four breeds between every age group. In both age wise and weight wise classification, body length of newly imported Landrace pigs was higher than that of other two imported breeds and from that of existing Mannuthy Large White Yorkshire breeds. From 4.5 to 11.5 months of age the increase in body length averaged 35.39 cm for Duroc, 31.75 cm for Large White Yorkshire, 38.81 cm for Landrace pigs. On the other hand during the same period increase in body length of Mannuthy Large White Yorkshire pigs averaged 23.4 cm only.

Table 22 Body Weight (kg) and body length (cm) of four groups of pigs

Body weight(kg)	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
20-30				59.87
30-40	68.58			66.33
40-50	74.51	81.28	76.20	74.23
50-60	80.93	83.66	85.09	79.07
60-70	83.75	87.90	87.31	83.11
70-80	88.96	90.03	91.50	85.45
80-90	92.57	93.79	95.76	88.90
90-100	95.25	98.09	99.84	91.52
100-110	97.49	101.16	104.22	96.06
110-120	100.41	104.41	108.02	101.60
120-130	103.42	107.75	111.18	105.05
130-140	106.28	109.78	112.36	107.95
140-150	109.22	110.01	115.63	
150-160	112.51	112.27	117.79	
160-170	113.98	116.42	121.11	
170-180	117.16	120.17	122.17	



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Table 23 Age (months) and body length(cm) of four groups of pigs

Age	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
4.0-4.5			81.28	64.21
4.5-5.0	81.45	84.55	90.62	69.95
5.0-5.5	87.23	89.13	94.46	73.76
5.5-6.0	92.39	93.00	97.16	78.27
6.0-6.5	94.49	96.48	101.47	80.53
6.5-7.0	96.33	99.57	104.38	82.83
7.0-7.5	98.60	101.90	107.91	84.85
7.5-8.0	101.16	104.85	110.49	87.19
8.0-8.5	103.87	107.67	112.62	90.36
8.5-9.0	105.81	109.13	115.91	90.93
9.0-9.5	108.53	110.49	117.83	93.35
9.5-10.0	111.25	113.74	118.96	94.46
10.0-10.5	114.30	114.16	120.09	97.08
10.5-11.0	115.03	116.30	120.11	101.92
11.0-11.5	116.84	118.96	120.47	105.41

The age wise and weight wise classification of front girth and body height are given in table 24 to 27.

Table 24 Body Weight (kg) and girth (cm) of four groups of pigs

Body weight(kg)	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
20-30				64.41
30-40	76.20			70.05
40-50	80.43	81.28	76.20	77.29
50-60	84.63	85.41	83.82	84.09
60-70	89.37	87.27	86.78	89.35
70-80	92.90	91.93	91.38	93.56
80-90	96.70	96.11	94.84	98.52
90-100	100.19	99.99	99.51	104.18
100-110	106.12	103.49	102.67	106.33
110-120	110.19	106.15	106.29	108.16
120-130	113.42	111.44	109.45	111.22
130-140	116.04	114.77	110.86	113.67
140-150	119.38	117.40	114.36	
150-160	123.56	118.96	118.51	
160-170	126.21	121.81	119.73	

Table 25 Age (months) and chest girth (cm) of four groups of pigs

Age (m)	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
4.0-4.5			83.57	69.36
4.5-5.0	86.64	84.36	89.35	72.49
5.0-5.5	92.04	91.44	92.71	77.32
5.5-6.0	96.52	96.19	97.32	82.22
6.0-6.5	99.27	98.32	100.72	85.49
6.5-7.0	102.63	100.54	102.82	89.42
7.0-7.5	107.65	103.93	106.14	92.59
7.5-8.0	110.29	107.24	108.85	95.98
8.0-8.5	114.50	110.97	111.35	99.58
8.5-9.0	116.44	113.91	113.62	103.12
9.0-9.5	119.26	117.20	115.85	105.54
9.5-10.0	121.92	119.38	118.53	106.20
10.0-10.5	125.45	121.07	120.79	108.80
10.5-11.0	128.63	121.38	121.56	110.17
11.0-11.5	131.13	124.04	123.37	111.76

Table 26 Body Weight (kg) and height(cm) of four groups of pigs

Body weight(kg)	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
20-30				44.27
30-40	52.07			47.52
40-50	56.73	55.88	52.07	51.47
50-60	57.96	57.47	56.30	53.44
60-70	60.36	60.33	56.41	56.44
70-80	63.31	61.38	60.23	58.65
80-90	66.49	63.16	63.86	60.76
90-100	67.76	66.19	65.33	63.00
100-110	70.00	67.46	66.52	66.04
110-120	71.92	68.71	69.00	67.95
120-130	74.60	70.88	71.16	70.03
130-140	77.60	72.20	71.79	71.76
140-150	79.89	75.25	73.53	
150-160	82.62	78.91	78.58	
160-170	84.61	81.28	79.66	

Table 27 Age (months) and height (cm) of four groups of pigs

Age (m)	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
4.0-4.5			53.09	46.14
4.5-5.0	58.86	57.88	59.24	49.29
5.0-5.5	63.57	60.21	61.86	50.19
5.5-6.0	65.41	63.01	64.35	54.25
6.0-6.5	67.44	65.22	66.17	55.59
6.5-7.0	69.38	66.84	67.16	56.49
7.0-7.5	70.82	67.78	68.85	57.45
7.5-8.0	72.15	69.25	70.42	59.15
8.0-8.5	75.26	70.80	71.42	60.96
8.5-9.0	76.68	72.35	73.49	63.08
9.0-9.5	80.24	75.02	75.35	65.02
9.5-10.0	81.53	78.18	78.18	65.25
10.0-10.5	83.54	80.29	80.57	66.89
10.5-11.0	85.63	81.82	82.19	68.58
11.0-11.5	87.63	83.40	85.09	69.85

It was observed that for the same body weight the front girth of Mannuthy Large White Yorkshire pigs was higher than that of the three breeds in the treatment groups (Table 24). On the other hand for the same body weight the

height of Mannuthy Large White Yorkshire pigs was less than other groups (Table 26). Since the maximum weight attained by Mannuthy pigs during the experimental period was less than 140 kg, data was not available for this group of pigs from 140kg body weight. In weight wise classification, the girth and height of the three newly imported breeds were higher than that of the control group (Table 25 and 27).

The average body height between 11 and 11.5 months of age for Duroc, Large White Yorkshire, Landrace and Mannuthy Large White Yorkshire pigs averaged 87.63, 83.40, 85.09 and 69.85 cm respectively. Among the three newly imported breeds Duroc pigs were the tallest at the end of the experimental period (Table 27). Duroc pigs were also the tallest when compared with the other three breeds of pigs with same body weight (Table 26). Similar results were obtained when body heights of Duroc pigs were compared with other four breeds of pigs with same age (Table 27).

6. Rectal temperature

The rectal temperature of the pigs were measured at weakly intervals and the average monthly values are given in table 28. The rectal temperature was recorded during the noon hours *ie* between 13:00 and 14:00 hours.

Table 28 Average monthly rectal temperature ($^{\circ}$ F)

Months	Duroc	Large White Yorkshire	Landrace	Mannuthy LWY
November	103.45	102.89	103.42	104.30
December	103.07	103.02	102.82	104.34
January	102.26	102.13	101.74	104.31
February	101.50	100.99	101.27	104.09
March	101.50	101.05	101.23	104.01
April	101.62	101.20	101.20	104.00

Among the four breeds the temperature recorded for the Mannuthy Large White Yorkshire pigs was slightly higher than the three treatment groups but the difference was not significant. Among the three imported groups Duroc pigs had the highest average monthly rectal temperature.

7. Behaviour

The behavioural patterns manifested by the pigs were observed during the noon hours of the day, before during and after feeding. Even though all the four breeds were exposed to human contact in very early stage of life itself the excitement during human contact varied between the breeds. Mannuthy Large White Yorkshire pigs were the most aggressive / excited class followed by Duroc, Large White Yorkshire and Landrace pigs. During feeding time the animals tried to displace the other animals from the manger. All the four breeds manifested this

behaviour. Among the four breeds newly imported Large White Yorkshire pigs were the most aggressive animals at the time of feeding while Duroc pigs were comparatively quiet at the time of feeding. All the pigs marked a definite area either near waterer or near the wallowing tank for defecation and urination. During the noon hours stress signs like panting, salivation etc were not noticed in the three newly imported breeds.

DISCUSSION

1. Climatic profile

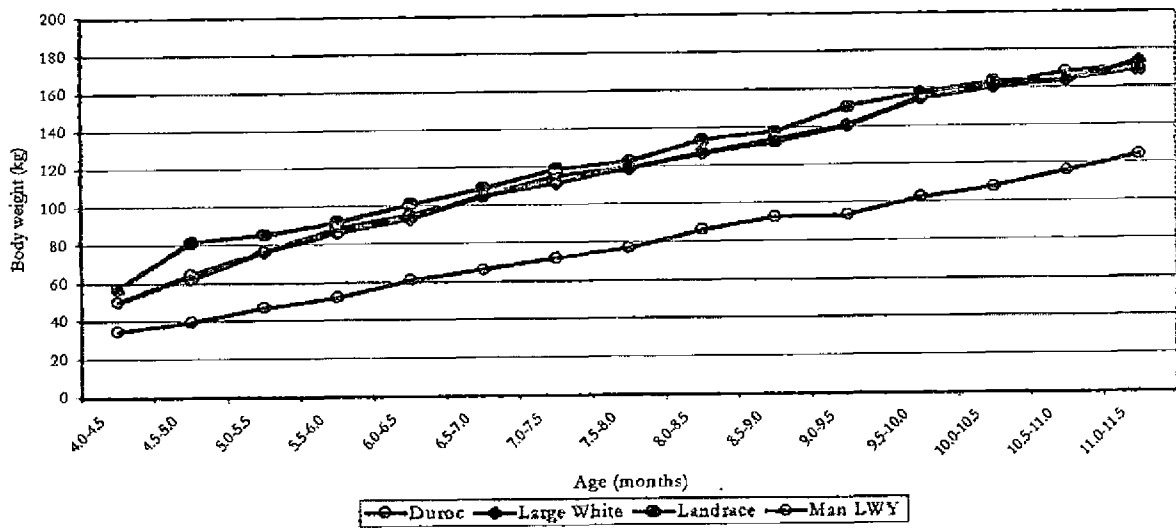
Various climatic parameters like air temperature, humidity, solar radiation, wind velocity and precipitation evoke a number of non specific regulatory mechanisms resulting in general adaptation syndrome in animals. Among these air temperature is the most important single climatic variable, which determines the thermal comfort of the animal. During the present study the mean maximum temperature varied from 30.48°C in October to 35.52 in March. The minimum temperature recorded varied from 22.5 to 24.6°C. The monthly mean relative humidity ranged between 59.13 in February to 84.5 in October. Along with high temperature, a high value of relative humidity increases the heat load of the animal. The condition is aggravated by prolonged hours of bright sunshine. High precipitation increases humidity. The combined effects of these environmental parameters are indicated by the THI SI values. The high values of THI SI indicate that the animals were under some degree of thermal stress during the entire study period.

2. Body weight

Increase in live weight is the most common measure of growth adopted in farm animals. This is the most widely used technique in experimental work to determine the growth rate of animals.

At the beginning of the experiment *ie* between 4.0 and 4.5 months of age the Landrace pigs were heaviest (57.70 ± 6.41 kg) when compared to other three breeds namely Duroc, Large White Yorkshire and Mannuthy Large White Yorkshire. On the other hand, the body weight of Mannuthy Large white Yorkshire pigs averaged only 34.91 ± 7.13 kg. This shows that there was a distinct difference between the body weights of existing and imported groups at the beginning of the experiment itself. This difference was maintained for the entire study period and at the end of eleven months the body weight averaged 171.25 ± 7.69 , 173.66 ± 7.38 and 169.14 ± 9.98 kg for the imported Duroc, Large White Yorkshire, and Landrace pigs and 124.66 ± 11.64 kg for the Mannuthy Large White Yorkshire pigs (figure 3). The figure shows that except during the last month, throughout the experimental period Landrace pigs had a higher body weight than Duroc and Large White Yorkshire pigs. The difference in body weight between the imported and existing groups averaged 15-17 kg at the beginning of the experiment and it increased to 45-48 kg by the end of the experiment.

Fig 3 Age and average body weight of four groups of pigs



The body weight of the three newly imported pigs viz. Duroc, Large White Yorkshire and Landrace pigs between 6.5 and seven months averaged 104.55 ± 11.52 , 105.47 ± 12.13 and 109.32 ± 9.44 kg. During the same period the body weight of the Mannuthy Large White Yorkshire pigs averaged only 66.75 ± 10.84 kg. The above values indicate that the three newly imported breeds were ready for slaughter at about six months of age while the already acclimatized stock attained the slaughter weight of 100 kg by about ten months of age.

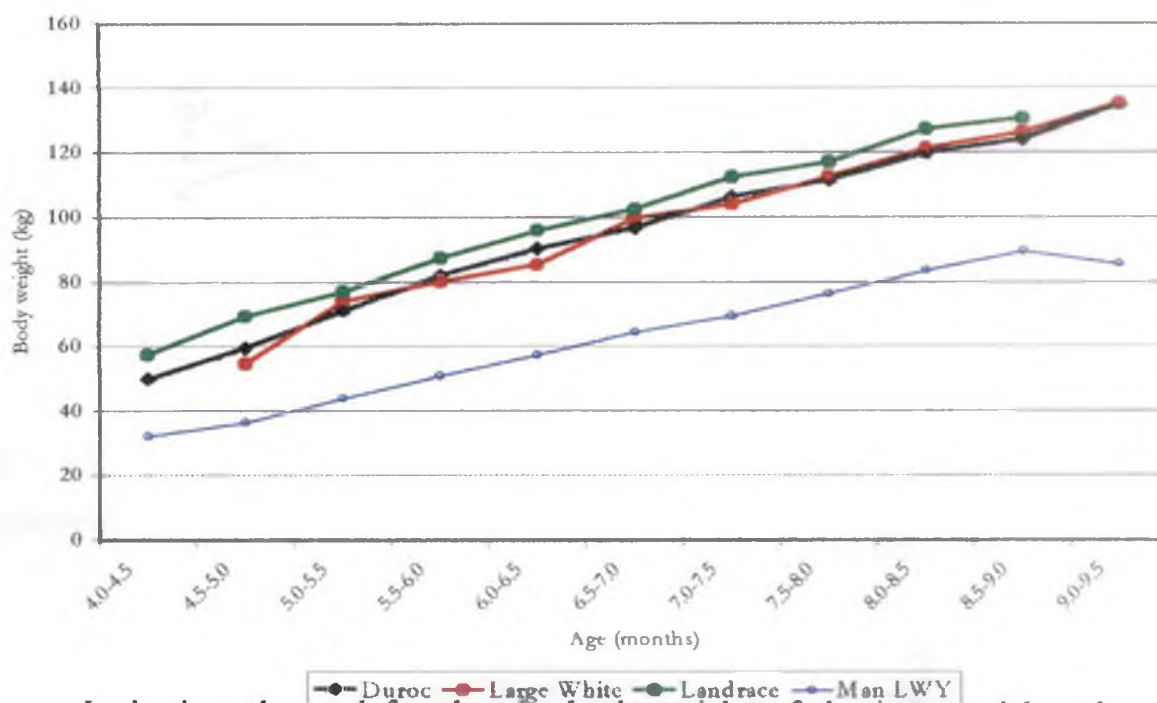
The body weight attained by the three newly imported breeds in the present study was found to be lower than that reported by Venanzi *et al* (1995), who found that the Large White Yorkshire, Landrace and Duroc pigs maintained in a farm in Venezuela attained a body weight of 90 kg in 157.6 days. In the present study Landrace pigs attained the slaughter weight earlier than other three breeds, whereas

in a study conducted by Baik *et al* in Korea, Duroc pigs attained an early slaughter weight when compared to Large White Yorkshire and Landrace pigs. Similar results were also reported by Kim *et al* (1999) from Korea.

Comparing the body weight of newly imported Large White Yorkshire and Landrace pigs with that of Large White Yorkshire and Landrace pigs maintained in India, reveals the same trend as that of present study. Rao *et al*(1978) reported that Large White Yorkshire pigs weighed 54 kg at 30 weeks of age. Varadarajalu and Rao (1982) reported that the live weight of Largewhite and Landrace pig averaged 39.56 and 45.23 kg at 24 weeks of age. Similarly in Landrace pigs Goswami and Raina (1983) reported that the body weight averaged 27.85 ± 0.36 , 40.46 ± 0.55 and 53.11 ± 0.72 kg at four, five and six months respectively. The above results shows that the body weight of the newly imported pigs were higher than that of Large White Yorkshire and Landrace pigs maintained in other station in India. But the body weight recorded for the Large White Yorkshire pigs maintained in Mannuthy were higher when compared with the above reports.

Body weights of male and female pigs are given separately in tables 4 and 5. The body weights of male and female pigs are illustrated in figure 4 and 5.

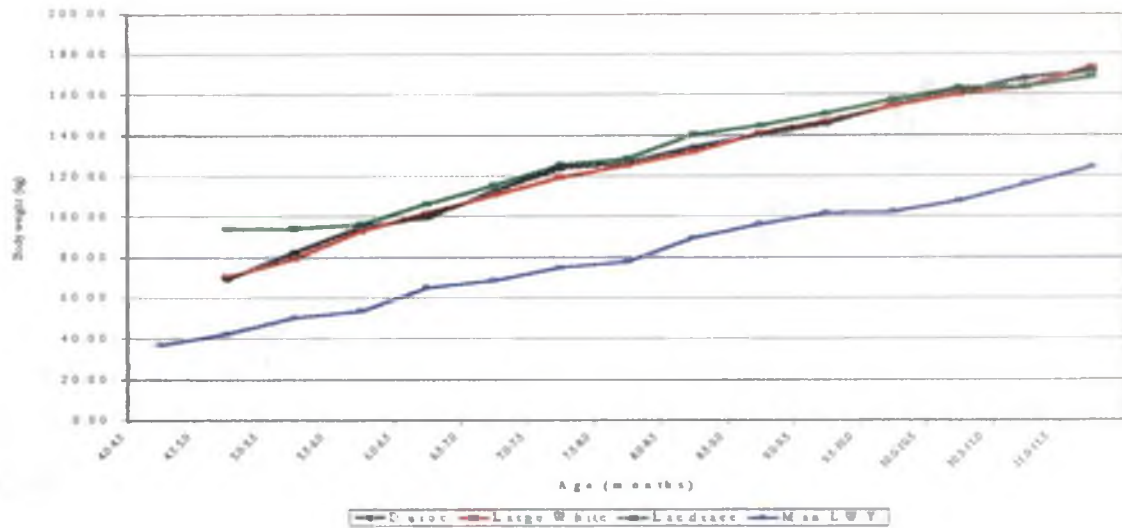
Fig 4 Body weight of female pigs at different ages



In both males and females the body weight of the imported breeds were higher than the locally existing strain of Large White Yorkshire and there was no significant difference between the three imported groups.

Figure 5 depicts the body weight of male pigs. The body weights recorded by Duroc, Large White Yorkshire and Landrace pigs were significantly higher than that of Mannuthy Large White Yorkshire males. The three newly imported males attained a body weight of 100 kg between six and 6.5 months of age. Walkiewicz *et al.* (1996) reported from Poland a much better growth rate. They reported that Polish Landrace and Polish Large White Yorkshire boars attained a body weight of 121 and 117 kg by six months of age. Similarly Kralik *et al.* (1995) also Reported better figures for Large White Yorkshire boars. The animals attained a body weight of 100 kg at 165 days of age.

Fig 5 Age and body weight of male pigs



But the results obtained for the newly imported Large White Yorkshire and Duroc pigs in the present study were much better than that reported by Akimov and Oksinyuk (1997) in Large White Yorkshire and Duroc boars (67.6 and 71.5 kg at five months).

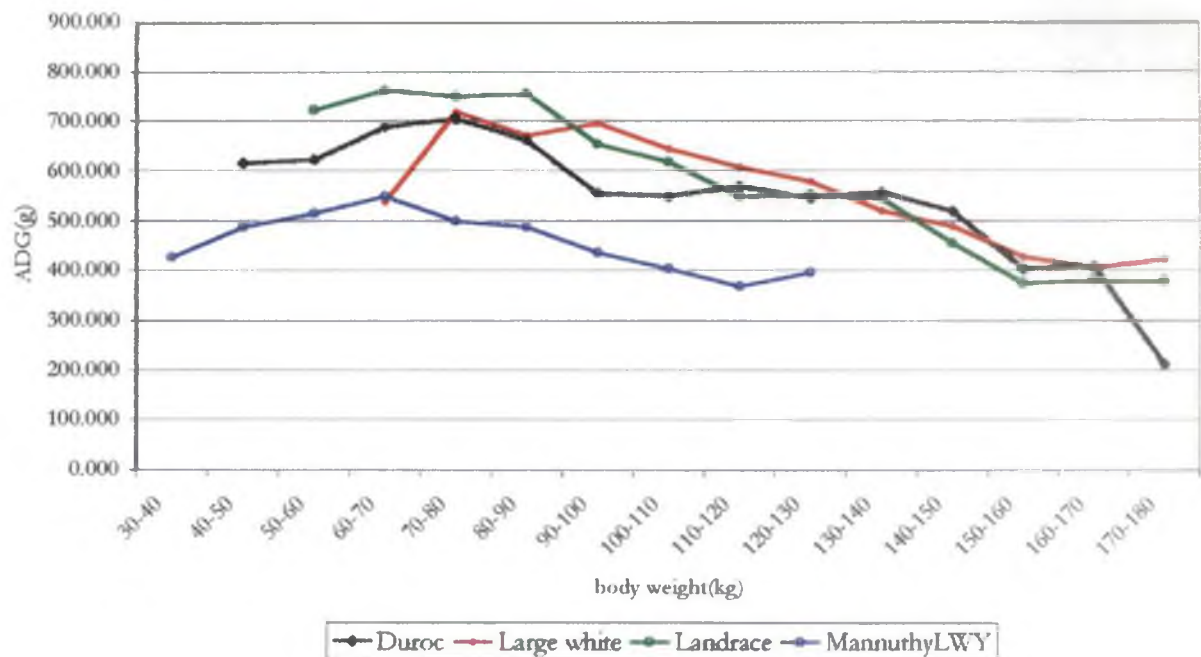
The Mannuthy Large White Yorkshire males weighed only 75 kg at 7.5 months of age and attained 100kg between nine and 9.5 months of age whereas the females weighed 69.63 kg at 7.5 months and they attained only 89 kg at the end of 9.5 months of age. This was less than that reported by Saseendran (1977) for the same breed from the same station. He observed a body weight of 83.66 kg for males and 79.66 kg for females at 7.5 months of age. But the body weight recorded by Mannuthy Large White Yorkshire pigs in the present study was much higher

than that reported by Gupta *et al* (1983). They reported a body weight of 68.18 and 68.76 kg for male and female Large White Yorkshire pigs at seven months of age.

1. Average Daily Gain (ADG)

Average daily gain was calculated for the four groups and was classified based on body weight, age and sex. Hamond (1955) explained that the rate at which an animal grows is of greater importance for the livestock owner than its mature weight as only a few animals live long enough to reach mature weight.

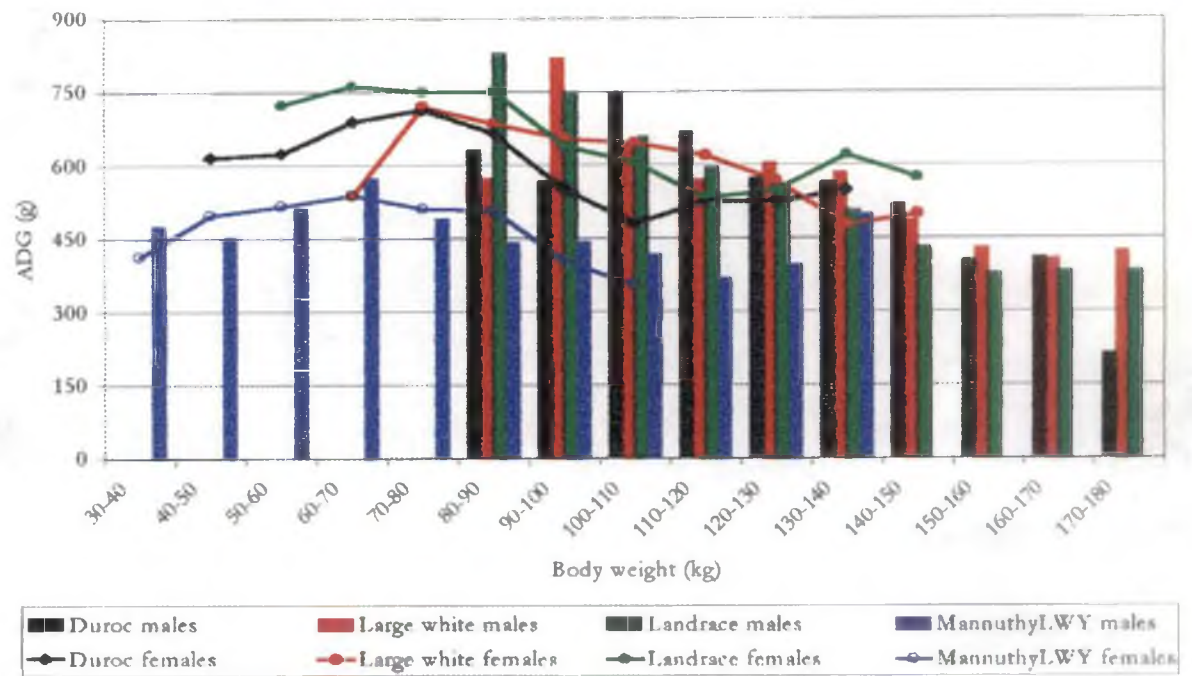
Fig 6 Body weight and average daily gain of four groups of pigs



The average daily gain for the three breeds increased from the beginning of the experiment attained a maximum between 70 and 80 kg for Duroc and Large White Yorkshire pigs and between 80 and 90 kg for Landrace pigs, while the Mannuthy Large White Yorkshire pigs attained a maximum average daily gain of 551.13 g between 60 and 70 kg body weight (table 6 and figure 6)

In the present study upto 90 kg body weight, the daily growth rate of Landrace pigs was higher than that of other three breeds (fig 6). Even though the Mannuthy Large White Yorkshire pigs showed the same growth pattern as that of other three breeds, the growth rate was much lower. The growth rate of the newly imported Duroc breed in the present study was in agreement with the findings of Apostolov (1996) who reported from Bulgaria a growth rate of 668 g per day during the finishing stages. The average daily gain obtained for Large White Yorkshire pigs was higher than that reported by Grikshas (1998) from Russia. He obtained a growth rate of 583 g per day during finishing periods. The average daily gain calculated for Landrace pigs was also higher than that reported by Kaczmarczyk and Koczanocoski (1981). They reported an average daily gain of 597 g during finishing periods.

Fig 7 Average daily gain of male and female pigs

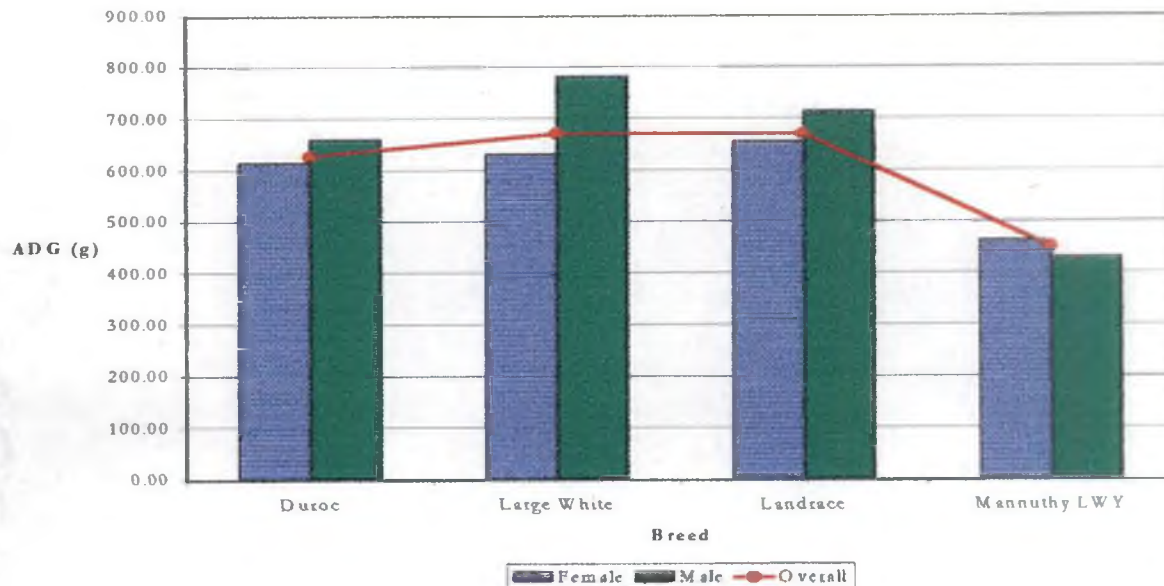


The weight wise average daily gain of male and female pigs (table 7 and 8 and figure 7) shows the same trend. In the case of females growth rate increases attains a maximum at 70 –80 kg body weight and then decreases. In the case of males the peak value is attained at about 90-100 kg body weight.

Average daily gain upto 100 kg body weight

The average daily gain of the four breeds upto 100 kg body weight is given in table 9 and figure 8.

Fig 8 Average daily gain up to 100 kg body weight



The results show that among the treatment groups Large White Yorkshire pigs had a better growth rate than Landrace and Duroc pigs (673.37, 672.50 and 629.90 g per day). But Kawadia (1993) while studying the growth and meat quality of Landrace, Largewhite and Duroc pigs from 90 to 110 kg body weight in Japan concluded that Landrace pigs had the highest daily gain. Na *et al* (1999) reported from Korea that the average daily gain of Duroc pigs was superior to that of Landrace and Large White Yorkshire pigs.

The average daily gain observed in the present study was higher than that reported by Mironenko *et al.* (1992), in *ad libitum* fed Largewhite pigs from 35 to 120 kg body weight (596 g). Similarly in studies conducted in two Russian breeding stations revealed that the daily gain of Large White Yorkshire pigs from 30 to 100 kg live weight averaged 568.9 g (Pavlova and Ryzhkov, 1997). However it was

found to be lower than that reported by Iliescu *et al.* (1993) for Landrace pigs from 25 to 100 kg body weight (690 g). Larambebere (1980) observed that Largewhite pigs recorded the highest average daily gain (888 ± 0.010 g) from 30-100 kg body weight compared to Landrace (0.863 ± 0.018 g) and Duroc (0.862 ± 0.70 g) pigs.

The Mannuthy Large White Yorkshire pigs had a much lower growth rate (452.67g per day) than the imported groups. But this value was found to be higher than the growth performance of Large White Yorkshire pigs maintained in different stations in India. Kumar *et al.* (1974) reported that the growth rates varied between 444 and 446 g per day for Largewhite Yorkshire pigs from 8 to 90 kg body weight. Similarly Pathak and Ranjhan, (1981) observe the weight gain of 431 g / day. From the same station and with the same breed of pigs Mohan (1991) reported an average daily gain of 429 g.

Average daily gain of male and female pigs is given in table 10 (figure 8). Even though for the imported groups the average daily gain of the male pigs showed higher values than the females, there was no significant difference ($P < 0.01$) between them. Since the average final weight of the female Mannuthy Large White Yorkshire pigs was only 87 kg the daily gain was calculated only up to 87 kg for females. For male pigs the average daily gain was calculated up to 100 kg. So the average daily gain calculated for Mannuthy Large White Yorkshire females was higher than that of males.

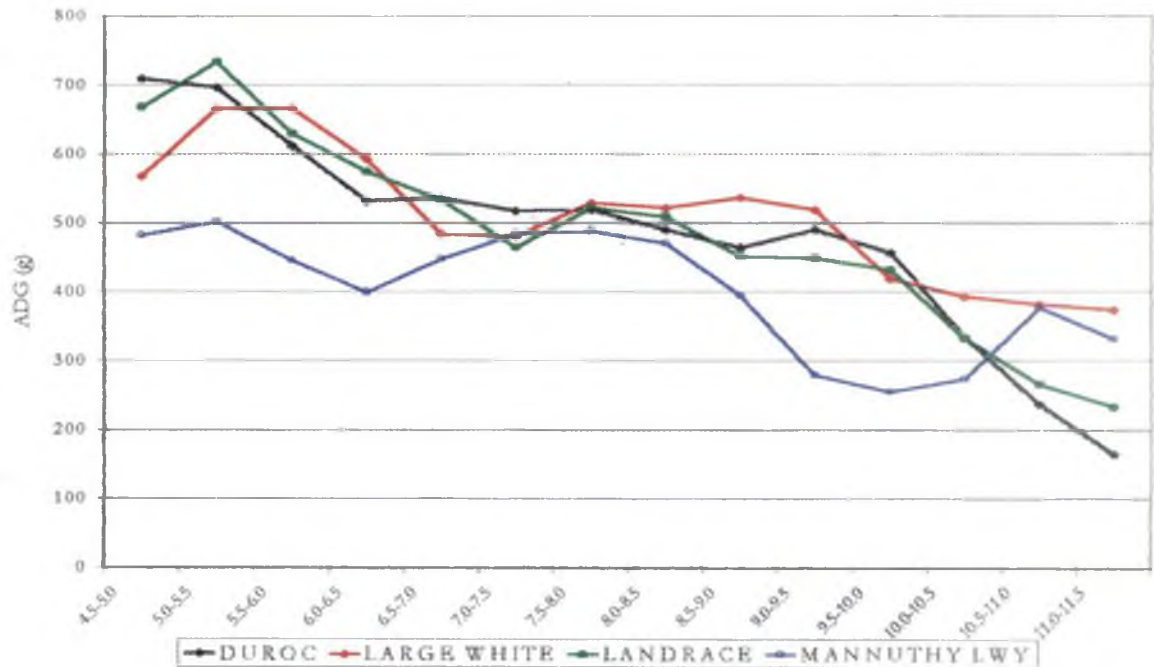
The average daily gain calculated for the imported breeds were found to be lower than that reported by McPhee (1982) for Landrace and Large White Yorkshire boars from 50 to 90 kg body weight (0.89 ± 0.06 , 0.89 ± 0.04 kg), Boulard *et al.* (1984) for Large White Yorkshire and Landrace boars from 35 to 90 kg body weight (929, 885 g), Ohrberg (1986) for Landrace, Large White Yorkshire and Duroc boars from 30 to 102 kg (914, 913 and 870 g), Kao *et al.* (1997) for Landrace, Large White Yorkshire and Duroc boars from 30 to 110 kg body weight (997, 952 and 921g) and Chen *et al.* (1997) for male and female Duroc pigs (745.5 and 715.5 g)

However the average daily gain recorded by the Large White Yorkshire boars in the present study was found to be superior to that observed by Ukhterov and Ukhterov (1996) for Russian Largewhite boars (711 g).

Age wise average daily gain

The average daily gain recorded by the four groups at different age intervals is given in table 11 and figure 9. Throughout the experimental period there was no significant difference between the three newly imported groups. In age wise classification the difference between the newly imported breeds and the existing Large White Yorkshire pigs was not as wide as that in weight wise grouping. This was because at a given age the difference in weight between the control and

Fig 9 Age wise average daily gain of four groups of pigs



treatment groups was very wide. This shows that in fast growing species like pig weight wise grouping is more reliable than age wise classification.

Table 12 and 13 shows the average daily gain of male and female pigs during different ages. Both males and females showed the same trend as above *ie.*, a significant difference was present between the newly imported and existing pigs only up to six months of age.

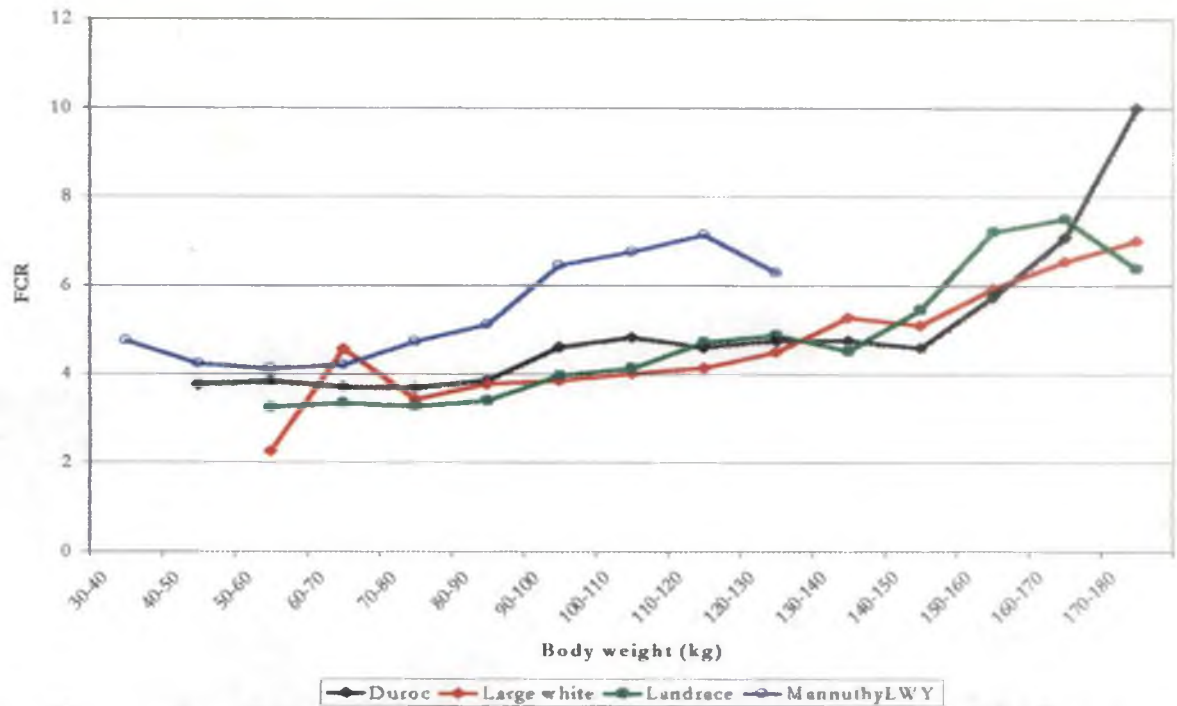
The average daily gain obtained for Large White Yorkshire and Landrace boars in the present experiment was higher than that reported by Walkiewicz *et al.*, (1996). They recorded a daily gain of 621 and 602 g for Polish Landrace and Polish Large White Yorkshire boars at six months of age. Eckrek and associates (1998) reported from Poland that growth rate of Polish Large White Yorkshire, Polish

Landrace, Belgian Landrace and Duroc boars at six months averaged 623,625,562 and 613 grams per day. But Buczynski *et al.* (1998) reported a higher daily gain for Polish Large White Yorkshire boars(685 g) at six months of age.

4. Feed conversion ratio

As in the case of average daily gain, feed conversion ratio was calculated and grouped based on body weight, age and sex. Table 14 and figure 10 show the feed conversion ratio for all the four breeds at different body weights. The difference between the imported and existing groups was significant ($P < 0.01$) from 70 to 120 kg body weight. Feed conversion ratio is the most important trait, which controls the profitability of pig farming. In the current study feed conversion ratio for all the three imported groups was below four up to the age of slaughter *ie* to about 90 kg body weight. Since the animals were imported as breeding stock, after 90 kg the feed was restricted. So the feed conversion ratio values obtained for animals above 90 kg body weight appears to be uneconomical. However the ratio might have been influenced by the feed restriction. In the case of Mannuthy Large White Yorkshire pigs for any body weight the feed conversion ratio was above four.

Fig 10 Body weight and feed conversion ratio of four groups of pigs



The results obtained for Duroc pigs in the present study was higher than that reported by Apostolov (1996) who reported a feed conversion ratio of 3.069 during finishing. Table 15 and 16 depicts the feed conversion ratio of male and female pigs during different stages. The feed conversion ratio for Large White Yorkshire females was better than that reported by Ukhterov and Ukhterov (1996) who reported a feed conversion ratio of 3.84, but in the case of male pigs they reported a better result than the present study (3.82).

Feed conversion ratio up to 100kg body weight

Feed conversion ratio from the beginning to 100 kg body weight was calculated for all the four groups and the results are given in table 17 and 18. Figure 11 gives the graphical representation of the same. The results indicate that

Landrace pigs are more economical than other three breeds. Up to 100 kg body weight Landrace and Large White Yorkshire pigs had a feed conversion ratio below four (3.72 and 3.96) , while that of Duroc was just above four (4.03). On the contrary the Mannuthy pigs had a feed conversion ratio of 4.63. The values indicate that cost of production for Mannuthy Large White Yorkshire pigs was higher than that required for other three breeds.

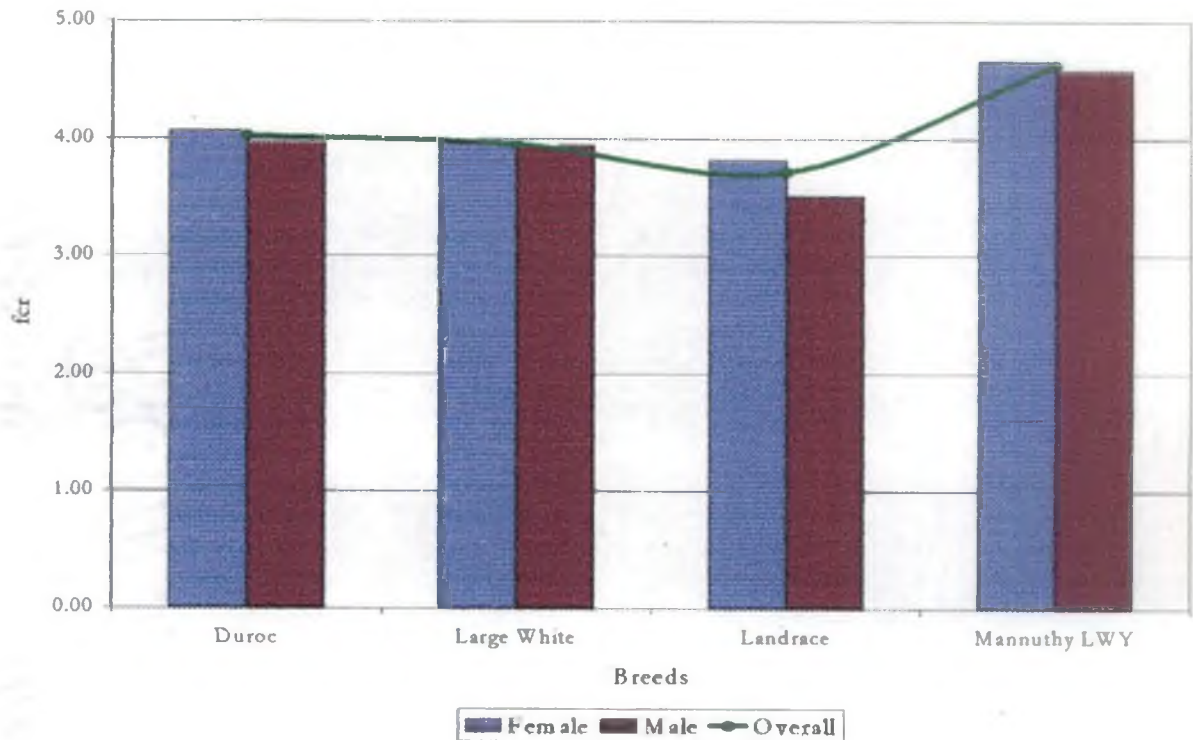
But the results obtained for the newly imported stock was higher than that reported by Larambebere (1980) for Duroc(2.70), Large White Yorkshire (2.62) and Landrace (2.73) pigs from 30-100 kg body weight. Similarly Iliescu *et al.* (1993) reported a lower feed conversion ratio of 3.74 for Landrace pigs from 25 to 100 kg body weight. Similarly the feed conversion ratio calculated for Mannuthy Large White Yorkshire pigs was higher than that reported by Pathak and Ranjhan (1981). They reported a feed conversion ratio of 4.43 for Large White Yorkshire pigs from 20 to 70 kg body weight.

For the Mannuthy Large White Yorkshire pigs Sasikaladevi (1981) reported a feed conversion ratio of 3.59 upto 70 kg body weight. later Pradhan (1993) reported that feed conversion ratio varied between 4.21 and 5.19 at 40 weeks of age. Later Sbramanian (1998) reported a feed conversion ratio of 4.15 from 10 to 70 kg body weight.. Along with these reports, results from the present study reveals that the feed conversion ratio for the existing Large White Yorkshire pigs has increased slightly from generation to generation.

For the three newly imported groups the feed conversion ratio of males was higher than that of females, but the difference was not significant. But in the case of Mannuthy Large White Yorkshire pigs the feed conversion ratio of females was higher than that of males. This is because of the fact that the final body weight of Mannuthy Large White Yorkshire females averaged only 87 kg and so the feed conversion ratio was calculated only up to 87 kg and for males it was calculated for up to 100 kg body weight.

Comparing the feed efficiency values obtained for the three newly imported breeds with that of reports from outside India we can see that majority of the workers reported a lower feed conversion ratio values for these three breeds. McPhee (1982) reported that feed conversion ratio from 50-90kg body weight for Landrace and Large White Yorkshire boars averaged 2.63 and 2.58. Similar results were reported by Boulard *et al.* (1984) for Largewhite, French Landrace and Belgian Landrace boars from 35 to 90 kg body weight (2.52, 2.63 and 2.66), Kralik *et al.* (1995) for Large White Yorkshire boars from 30 to 100 kg live weight (2.55), Gugelmann, (1996) for Duroc boars from birth to slaughter (2.54), Kao and associates (1997) for Yorkshire, Landrace and Duroc boars up to 110 kg live wt (2.55, 2.42 and 2.55), Chen *et al.* (1997) in Duroc boars and gilts(2.8 and 2.89) and Blanchard and associates (1999) from UK in Duroc boars and gilts(2.39 and 2.55).

Fig 11 Feed conversion ratio Up to 100 kg body weight



The higher feed conversion ratio observed in the present study may be associated with the climatic stress and relatively low quality of feed. Throughout the experimental period the TH SI values were above 75 indicating the incidence of thermal stress.

Age and feed conversion ratio

Feed conversion ratio was calculated for different age groups and is given in table 19 and figure 12. From 4.5 to 10.5 months of age the feed conversion ratio

recorded for Mannuthy Large White Yorkshire pigs was higher than the treatment groups, but a significant difference was present between five and 5.5 months and between nine and ten months. During all other age groups there was no significant difference in feed conversion ratio between the four breeds. But this does not indicate the superiority of the Mannuthy Large White Yorkshire pigs because the difference in body weight between imported and Mannuthy Large White Yorkshire pigs was very high during the different age groups. In this classification also the feed conversion values obtained for the newly imported stock in the current study was higher than that reported by Buczynski *et al.* (1998) for Large White Yorkshire and Landrace boars at six months of age (3.31 and 3.32) and by Eckrek and Szyndler (1998). The later reported a feed conversion ratio of 3.54, 3.58, 3.48 and 3.58 for Polish Largewhite, Polish Landrace, Belgian Landrace and Duroc boars at 180 days of age.

The feed conversion ratio calculated for Mannuthy Large White Yorkshire pigs in the present study was higher than that reported by Saseendran (1977). In his study with the same stock at the same station he got a feed conversion ratio of 3.94 and 3.83 for male and female pigs between two and 7.5 months of age. On the other hand the feed conversion ratio of Mannuthy Large White Yorkshire pigs in the present study was better than that reported by Rao *et al.* (1978) for Largewhite Yorkshire pigs at six months of age (5.28).

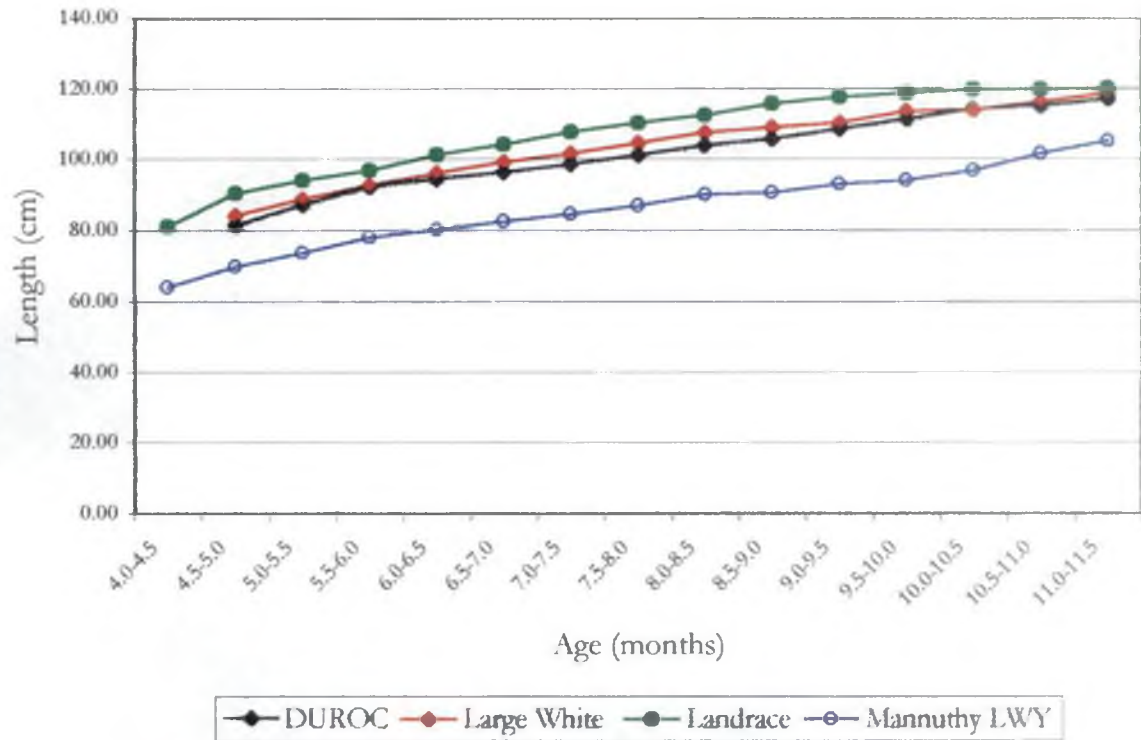
Fig 12 Age and feed conversion ratio of four groups of pigs



1. Body measurements

The body measurements viz. body length, front girth and height were measured at fortnightly intervals and are given in tables 22 to 27. The body length at any age was higher in Landrace pigs than that of other three breeds. This is in agreement with the reports of Kawadia (1993). The body length is more important for pigs which are used as the female line in the breeding system. In the present study higher body length assures more number of evenly placed teats for Landrace pigs.

Fig 13 Body length at different ages



The body length obtained for Duroc and Large White Yorkshire pigs in the present study are greater than that reported by Ohrberg (1986) at 102 kg body weight (94.7 and 97.9 cm). On the contrary Kim *et al.* (1999) reported higher values for length. He reported that at 152 days of age Duroc and Large White Yorkshire pigs had a body length of 106 and 112 cm, but the body height recorded for Duroc pigs (62.9 cm) was lower than that of the present study. The body measurements recorded for Mannuthy Large White Yorkshire pigs were compared with the report of Dash and Wishra (1986). The body length and girth recorded for Mannuthy Large White Yorkshire pigs at six months of age was lower than that reported by

Dash and Wishra (1986), but when the body height was compared Mannuthy Large White Yorkshire pigs were taller.

6. Rectal temperature

Rectal temperature was measured using a thermometer and the results are given in Table 28. Among the four breeds no regular pattern was noticed in the temperature variation. When the four breeds were compared the temperature recorded for the Mannuthy Large White Yorkshire pigs was higher than the newly imported breeds. The newly imported Large White Yorkshire and Landrace pigs were comparatively calm when compared with Duroc pigs at the time of measurement. Majority of the Large White Yorkshire and Landrace pigs were measured when they were lying in their cage itself but this was not possible in the Duroc pigs. In the case of Mannuthy Large White Yorkshire pigs even though they were adapted to this hot humid atmospheric condition the rectal temperature measured was higher than the three newly imported breeds. This was partly because they were highly restless at the time of measurement. It was not possible to record the temperature by keeping them in their shed itself. So they were taken to the weighing cage for measuring the rectal temperature. For the three newly imported breeds the rectal temperature decreased in the first three to four months and then either slightly increased or remained static. But for the Mannuthy Large White

Yorkshire pigs the temperature decreased steadily. This may be because the pigs might have got accustomed to the process of measuring temperature.

The results obtained for the Mannuthy Large White Yorkshire pigs in the present study is at variance from that reported by Leena (1992) for the same stock from the same station. In that report the maximum rectal temperature recorded was only 102.6 °F.

Another possibility is that the Mannuthy Large White Yorkshire pigs in the process of adaptation established a higher plane of rectal temperature which might help them for easier thermolysis.

7. Behaviour

In the present study the behavioural patterns manifested by the pigs during the noon hours of the day, before during and after feeding were observed. There was no evidence to show that the newly imported pigs suffered from heat stress. Symptoms of heat stress like panting, salivation, anorexia etc was not noticed among the three newly imported breeds.

Yorkshire and Landrace pigs. Inbreeding, improper selection methods and breeding policies adapted might be some of the reasons for the deterioration in the production performance of Large White Yorkshire pigs. The natural selection that have occurred for the last twenty years might have rendered the Large White Yorkshire pigs more fit to survive in a hot humid atmospheric condition but not necessarily more capable for better production. The present study indicates that the Large White Yorkshire pigs imported 20 years ago remained where it was at the time of importation or even deteriorated, while breeds in Europe were making steady progress. This is inspite of the fact that the Mannuthy stock's performance is much better than many other stocks in other parts of India. The results of the present study cautions that when we are introducing new germplasm we must be wary of possible deterioration in productivity over the generations. All possible measures like maintaining selection pressure, periodic introduction of imported males and provision of better environment, feeding and management may be given.

SUMMARY

To improve the production performance of the available exotic breeds of pigs in Kerala the Kerala Livestock Development Board (KLDB) imported three breeds namely Duroc, Large White Yorkshire and Landrace. In order to plan and execute the breeding policy it is necessary to have the information on the production performance of these exotic breeds. So a study was conducted to observe and record the production performance of three newly imported breeds along with that of Large White Yorkshire pigs, ancestors of which were imported and maintained in the Centre for Pig Production and Research, Mannuthy.

Three breeds of pigs (Duroc, Large White Yorkshire and Landrace) imported from UK by Kerala Livestock Development Board and maintained at Pig Breeding Centre, Kainoor were used for the experiment. All the 90 animals imported were used for the experiment. At the same time 30 animals belonging to Large White Yorkshire of the same age was maintained at the Centre for Pig Production and Research, Mannuthy as the control group.

All the animals were fed with the same type of feed. Since the animals were maintained as breeding stock they were fed *ad libitum* up to eight months of age after

that the feed intake was restricted. The quantity of feed consumed daily by each group was recorded. The fortnightly body weight and body measurements (length, chest girth and height) were recorded. The rectal temperature of the experimental animals was recorded once in every week *ie* between 13:00 and 14:00 hours. The behavioral patterns manifested by the pigs were also observed.

Meteorological information collected from the meteorological station Vellanikkara revealed that the animals were exposed to thermal stress throughout the experimental period. The body weight was measured at fortnightly intervals. The body weight averaged 64.50 ± 6.63 , 62.75 ± 5.16 , 82.031 ± 8.50 and 39.89 ± 7.23 between 4.5 to 5 months (135-150 days) of age. Throughout the study period, the body weights of Mannuthy Large White Yorkshire pigs were significantly lower ($P < 0.01$) than that of the newly imported groups. But a significant difference between the treatment groups was noticed only between 4.5 and 5.0 months of age. The Landrace pigs achieved a body weight of 100 kg between 6 and 6.5 months of age while Duroc and Large White Yorkshire achieved the 100 kg mark between 6.5 and 7.0 months of age. The treatment groups were ready for slaughter at 6.5 to 7.0 months of age while the Mannuthy Large White Yorkshire pigs crossed the 100-kg target during 9.5 to 10 months of age.

The average daily gain recorded for Mannuthy Large White Yorkshire pigs were lower than that of other three breeds of pigs. The daily gain of the Duroc, Large White Yorkshire and Landrace pigs was above 650 g per day up to the age of slaughter. Up to 100 kg body weight Large White Yorkshire pigs had the highest average daily gain, when compared with other four breeds. In age wise classification, up to six months of age the average daily gain recorded for Mannuthy Large White Yorkshire pigs was significantly ($P < 0.01$) lower than the treatment groups.

Feed conversion ratio was calculated from the daily feed intake values. Feed conversion ratio of Mannuthy Large White Yorkshire pigs was comparatively higher than that of newly imported breeds of pigs. Up to 100 kg body weight Landrace pigs recorded the lowest feed conversion ratio of 3.72 ± 0.69 . Among the three imported breeds, only Duroc pigs had a feed conversion ratio of above four. In age wise classification of even though the feed conversion ratio recorded by Mannuthy large White Yorkshire pigs were higher than that of the three imported groups a significant difference was seen only during three stages viz. 5 to 5.5, 9 to 9.5 and 9.5 to 10 months of age.

Length, height and girth were measured from the beginning of the experiment at fortnightly intervals and these parameters were later grouped based

on body weight and age. Among the four breeds the Mannuthy Large White Yorkshire pigs had the lowest body length in all weight groups. In both age wise and weight wise classification, body length of newly imported Landrace pigs was higher than that of other two imported breeds and from that of existing Mannuthy Large White Yorkshire breeds. Among the four breeds, the Duroc pigs were the tallest at the end of the experimental period.

The mean monthly rectal temperature observed for the Mannuthy Large White Yorkshire pigs was slightly higher than the three treatment groups. Among the three imported breeds Duroc pigs had the highest average monthly rectal temperature. The behaviour pattern manifested by the pigs was observed during the noon hours of the day and before, during and after feeding. Mannuthy Large White Yorkshire pigs were the most aggressive / excited class followed by Duroc, Large White Yorkshire and Landrace pigs. During feeding time the animals tried to displace the other animals from the manger. All the four breeds manifested this behaviour. During the noon hours stress signs like panting, salivation etc were not noticed in the three newly imported breeds or in the existing Large White Yorkshire pigs.

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PERFORMANCE OF THREE INTRODUCED BREEDS OF PIGS IN KERALA

By

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ABSTRACT OF THE THESIS

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ABSTRACT

A study was conducted to find out the production performance and adaptability of three newly imported breeds of pigs viz. Duroc, Large White Yorkshire and Landrace and to compare it with that of existing Large White Yorkshire pigs of Kerala. Thirty animals from each group were selected for the study. All the animals were fed with same type of feed through out the experimental period. Body weight and body measurements were recorded at fortnightly intervals. The quantity of feed consumed by each group was also recorded. Rectal temperature was measured at weekly intervals during the noon hours. Animals were also observed during noon and feeding hours to study the adaptive behavioral manifestations.

The results revealed that the body weight of the newly imported pigs were superior to that of Mannuthy Large White Yorkshire pigs. The body weight averaged 64.50 ± 6.63 , 62.75 ± 5.16 , 82.031 ± 8.50 and 39.89 ± 7.23 between 4.5 to 5 months of age and 171.25 ± 7.69 , 173.66 ± 7.38 , 169.14 ± 9.98 and 124.66 ± 11.64 between 11 and 11.5 months of age. The newly imported pigs were ready for slaughter at 6.5 to 7.0 months of age while the Mannuthy Large White Yorkshire pigs attained the 100-kg target during 9.5 to 10 months of age. The average daily

gain calculated for the Mannuthy Large White Yorkshire pigs was also lower than the three newly imported groups. Average daily gain up to 100 kg body weight averaged 630, 673, 672 and 453 g for Duroc, Large White Yorkshire Landrace and Mannuthy Large White Yorkshire pigs. Feed conversion ratio up to 100 kg body weight averaged 4.03, 3.95, 3.72 and 4.63 for the above four breeds. Results of body measurements show that the Large White Yorkshire pigs maintained at Mannuthy farm was the smallest animal in all weight groups. Landrace pigs were the longest (120.47 cm) and duroc pigs were the tallest (87.63) at the end of the experimental period. Data regarding the rectal temperature revealed that the temperature recorded for the Mannuthy pigs was slightly higher than the three newly imported groups. Among the four breeds the newly imported Large White Yorkshire pigs were the most aggressive animal at the time of feeding while Duroc pigs were comparatively quiet at the time of feeding.

The present study revealed that the overall production performance of Large White Yorkshire pigs, ancestors of which were imported to kerala about 20 years ago, is inferior to that of newly imported Duroc, Large White Yorkshire and Landrace pigs. But the production performance of Mannuthy, Large White Yorkshire pigs was found to superior to that of many other exotic pigs maintained in other parts of India.